WSRC-STI-2006-00204
Revision 0

HIGH LEVEL WASTE (HLW) SLUDGE BATCH 4 (SB4) VARIABILITY STUDY

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October 2006

Process Science and Engineering Section
Savannah River National Laboratory
Aiken, SC 29808

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

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Keywords: *high level waste, glass, SB4, variability, durability*

Retention: *permanent*

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EXECUTIVE SUMMARY

The Defense Waste Processing Facility (DWPF) is preparing for vitrification of High Level Waste (HLW) Sludge Batch 4 (SB4) in early FY2007. To support this process, the Savannah River National Laboratory (SRNL) has provided a recommendation to utilize Frit 503 for vitrifying this sludge batch, based on the composition projection provided by the Liquid Waste Organization on June 22, 2006. Frit 418 was also recommended for possible use during the transition from SB3 to SB4. A critical step in the SB4 qualification process is to demonstrate the applicability of the durability models, which are used as part of the DWPF's process control strategy, to the glass system of interest via a variability study. A variability study is an experimentally-driven assessment of the predictability and acceptability of the quality of the vitrified waste product that is anticipated from the processing of a sludge batch. At the DWPF, the durability of the vitrified waste product is not directly measured. Instead, the durability is predicted using a set of models that relate the Product Consistency Test (PCT) response of a glass to the chemical composition of that glass. In addition, a glass sample is taken during the processing of that sludge batch, the sample is transmitted to SRNL, and the durability is measured to confirm acceptance. The objective of a variability study is to demonstrate that these models are applicable to the glass composition region anticipated during the processing of the sludge batch – in this case the Frit 503 – SB4 compositional region. The success of this demonstration allows the DWPF to confidently rely on the predictions of the durability/composition models as they are used in the control of the DWPF process.

The glass region for the SB4 variability study was determined using the June 22, 2006 projections of the SB4 composition that led to SRNL's frit recommendation memorandum. Variation was introduced into the composition of the sludge to account for the uncertainty present in these projections as well as for process variation that may be experienced at the DWPF during its normal operations (e.g., a range of waste loadings were covered). The glasses chosen for the variability study were fabricated by SRNL. Both quenched and centerline canister-cooled (ccc) heat treatments were performed, and chemical compositions were verified. The PCT was used to gauge the durability of each glass based on both quenched and ccc heat treatments. X-ray diffraction (XRD) was used to assess the possible formation of crystalline phases in the ccc-based glasses.

The results of the variability study show that vitrifying SB4 with Frit 503 will produce glasses with durabilities that are both predictable by the DWPF Product Composition Control System (PCCS) models and acceptable as compared to the Environmental Assessment (EA) glass, within the range of sludge compositions and waste loadings included in the study. All 35 of the glasses fabricated had durabilities that were very acceptable as compared to the EA glass for both quenched and ccc heat treatments. Two of the variability study glasses fell outside of the 95% confidence interval for the free energy of hydration durability model. One of these glasses had a high (more positive) ΔG_P value and an acceptable durability (more than an order of magnitude below that of the EA benchmark glass). This type of response has been seen in past studies and is not a cause for concern. The second of the glasses that fell outside of the 95% confidence interval was found to be prone to nepheline crystallization based on the measured composition, and therefore would not have passed the DWPF PCCS Measurement Acceptability Region (MAR). This glass showed a statistically significant decrease in durability after the ccc heat treatment due to nepheline crystallization. However, both the quenched and ccc versions of this glass were very acceptable when compared to the durability of the EA glass.

The glasses formulated with SB4 and Frit 418 were both predictable and acceptable. This frit is considered an option for DWPF processing during the transition from SB3 to SB4.

Chemical composition measurements of the variability study glasses indicate that the sulfate limit of 0.60 wt% in glass is viable for the Frit 503 / SB4 system, based on the nominal SB4 composition projections used as the technical basis for this study.

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LIST OF ACRONYMS

AD	Analytical Development
ANOVA	ANalysis Of VAriance
ARM	Approved Reference Material
ASTM	American Society for Testing and Materials
bc	bias-corrected
ccc	centerline canister-cooled
DWPF	Defense Waste Processing Facility
EA	Environmental Assessment glass
HLW	High Level Waste
ICP-AES	Inductively Coupled Plasma – Atomic Emission Spectroscopy
LM	Lithium Metaborate
MAR	Measurement Acceptability Region
NL	Normalized Leachate
PAR	Property Acceptability Region
PCCS	Product Composition Control System
PCT	Product Consistency Test
PF	Peroxide Fusion
ppm	parts per million
PSAL	Process Science Analytical Laboratory
SB3	Sludge Batch 3
SB4	Sludge Batch 4
SME	Slurry Mix Evaporator
SRNL	Savannah River National Laboratory
WL	Waste Loading (weight percent)
XRD	X-Ray Diffraction

1.0 Introduction

The Defense Waste Processing Facility (DWPF) is preparing for vitrification of High Level Waste (HLW) Sludge Batch 4 (SB4) in early FY2007. To support this process, the Savannah River National Laboratory (SRNL) has provided a recommendation to utilize Frit 503 for vitrifying this sludge batch.[1] This recommendation was based on the composition projections for SB4 available at that time,[a] assessments of operating windows in waste loading (WL) space,[2] melt rate data,[3] and the potential for nepheline formation (which reduces durability).[4-11]

A critical step in the SB4 qualification process is to demonstrate the applicability of the durability models,[12] which are used as part of the DWPF's process control strategy, to the glass system of interest via a variability study. A variability study is an experimentally-driven assessment of the predictability and acceptability of the quality of the vitrified waste product that is anticipated from the processing of a sludge batch. The quality of the waste form is a measure of its durability as determined by the Product Consistency Test (PCT).[13] At the DWPF, the durability of the vitrified waste product is not directly measured by this test during normal operation. Instead, the durability is predicted using a set of models that relate the PCT response of a glass to the chemical composition of that glass. In addition, a glass sample is taken during the processing of that sludge batch, the sample is transmitted to SRNL, and the durability is measured to confirm acceptance. The objective of a variability study is to demonstrate that these models are applicable to the glass composition region anticipated during the processing of the sludge batch – in this case the Frit 503 – SB4 compositional region. The success of this demonstration allows the DWPF to confidently rely on the predictions of the durability/composition models as they are used in the control of the DWPF process.

The glass region for the SB4 variability study was determined using the latest projections of the SB4 composition that led to SRNL's frit recommendation memorandum.[1] Variation was introduced into the composition of the sludge to account for the uncertainty present in these projections as well as for process variation that may be experienced at the DWPF during its normal operations (e.g., a range of waste loadings were covered). The primary focus of the variability study will be on the use of Frit 503, as this frit was recommended for SB4 processing.[1] However, the recommendation memorandum also stated that Frit 418 is a viable option for DWPF processing, especially during the transition from Sludge Batch 3 (SB3) to SB4 (i.e., an acceptable product can be produced with both SB3 and SB4 when Frit 418 is used).[b] As a result, additional glasses representing the SB4 / Frit 418 system were also chosen for the variability study.

The glasses chosen for the variability study were fabricated by SRNL. Both quenched and centerline canister-cooled (ccc) heat treatments were performed, and chemical compositions were verified. The PCT was used to gauge the durability of each glass based on both quenched and ccc heat treatments. X-ray diffraction (XRD) was used to assess the possible formation of crystalline phases in the ccc-based glasses.

The results of this variability study will provide guidance to DWPF on the applicability of the durability models to the frit / SB4 systems of interest. This work was initiated by a DWPF Technical Task Request[14] and is performed under a SRNL Task Technical and Quality Assurance Plan.[15]

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[a] Personal communication with H. B. Shah, via email, on June 22, 2006 (see WSRC-NB-2006-00017 for details).

[b] Frit 503 was recommended for the majority of SB4 processing since this higher B_2O_3-containing frit has advantages over Frit 418 in melt rate and is less prone to nepheline crystallization.[1]

2.0 Experimental Procedure

2.1 Glass Selection Strategy

The strategy used in selecting glasses for the SB4 variability study was described in a previous report,[16] however, a brief overview of the process will be provided here. The two frits described in SRNL's frit recommendation for SB4 processing,[1] Frits 418 and 503, were utilized in this variability study. The frit selection memorandum stated that Frit 418 is viable for use during the transition from SB3 to SB4, should DWPF choose to exhaust its remaining stock of this frit during the changeover period. Frit 503 was recommended for SB4 processing due to advantages over Frit 418 in melt rate, suppression of nepheline crystallization to higher WLs, and projected operating windows in terms of WL.[1, 3, 8] The nominal compositions of these frits are listed in Table 2-1.

Table 2-1. Compositions (in wt%) of the Frits Recommended for SB4 Processing.

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

Two nominal composition projections for SB4, Blend 1 (i.e., SB4 after transferring to a ~113" heel of SB3)[a] were used as the technical basis for defining the sludge compositional region of interest. The first nominal composition was referred to as the 0.92 M Na^+ with 12.2 wt% solids option. The second nominal composition was referred to as the 0.912 M Na^+ with 12.6 wt% solids option.

Table 2-2 provides the nominal compositions for these two projections. The minor oxide components in the sludge (those oxides present in the sludge that will result in concentrations less than 0.5 wt% in the glass) were grouped into an "Others" category. The relative contribution of the minor oxide components to the "Others" grouping is the same for the two composition projections, as indicated in Table 2-3.

[a] Personal communication with H. B. Shah, via email, on June 22, 2006 (see WSRC-NB-2006-00017 for details).

Table 2-2. Nominal SB4 Composition Projections and Sludge Composition Space with Traditional EVs Applied.

Oxide Component	SB4 Blend-1 12.2 wt% solids 0.92 M Na^+ nominal composition	SB4 Blend-1 12.6 wt% solids 0.912 M Na^+ nominal composition
	(wt%)	(wt%)
Al_2O_3	23.617	23.831
CaO	2.350	2.371
Fe_2O_3	26.017	26.253
MgO	2.480	2.502
MnO	5.394	5.442
Na_2O	23.753	23.131
NiO	1.545	1.559
SO_4^{2-}	1.417	1.368
SiO_2	3.963	3.998
U_3O_8	7.563	7.632
Others	1.486	1.500

Table 2-3. Minor Oxides Included in the Composition of "Others" (in wt%).

Oxide Component in "Others"	SB4 Blend-1 12.2 wt% solids 0.92 M Na^+	SB4 Blend-1 12.6 wt% solids 0.912 M Na^+
BaO	8.335	8.335
Ce_2O_3	10.088	10.088
Cr_2O_3	13.975	13.975
CuO	4.028	4.028
K_2O	22.153	22.153
La_2O_3	7.123	7.123
PbO	6.099	6.099
ThO_2	4.22	4.22
TiO_2	1.757	1.757
ZnO	6.576	6.576
ZrO_2	15.645	15.645
Others	100	100

As seen in Tables 2-2 and 2-3, the two nominal SB4 composition projections are very similar and have relatively high concentrations of Al_2O_3, Na_2O, and SO_4^{2-}, and relatively low concentrations of Fe_2O_3 (as compared to previous sludge batches processed in DWPF). Based on the minimal differences in composition, the two projections were combined into a single SB4 composition region for the variability study.

A statistical analysis approach was used to optimally select Frit 503-based glasses that cover this SB4 composition region at a series of WLs likely to be processed at DWPF.[16] The goal was to

maximize the compositional range studied to adequately address the effect of the potential variation on the applicability of the durability models while limiting the number of glasses to be fabricated in the laboratory. The glass selection process led to the identification of 35 glasses to support the study objectives. Thirty-one glasses were selected from the Frit 503 / SB4 glass compositional region (identified as SB4VS-05 through SB4VS-35 in Table 2-4). In addition, four Frit 418 / SB4 glasses (identified as SB4VS-01 through SB4VS-04 in Table 2-4) were selected using the SB4 centroid composition. The glass compositions selected met all of the DWPF Product Composition Control System (PCCS) Measurement Acceptability Region (MAR) criteria based on their targeted compositions.[16]

2.2 Target Compositions of Selected Glasses

The target compositions of the SB4 variability study glasses are presented in Table 2-4. Note that some of the selected glass compositions have SO_4^{2-} concentrations in excess of the 0.60 wt% limit established previously for SB3 / Frit 418 processing.[17] This is not seen as a threat to the success of the variability study, but could provide valuable feedback into the SO_4^{2-} retention issue given that uncertainty exists in the projected SO_4^{2-} concentration in SB4.

Table 2-4. Target Compositions (in wt%) of the SB4 Variability Study Glasses.

Glass ID	SB4VS-01	SB4VS-02	SB4VS-03	SB4VS-04	SB4VS-05	SB4VS-06	SB4VS-07	SB4VS-08	SB4VS-09	SB4VS-10	SB4VS-11	SB4VS-12	SB4VS-13	SB4VS-14
Frit	**418**	**418**	**418**	**418**	**503**	**503**	**503**	**503**	**503**	**503**	**503**	**503**	**503**	**503**
WL	**32**	**36**	**40**	**44**	**30**	**34**	**38**	**42**	**46**	**42**	**42**	**40**	**40**	**38**
Al_2O_3	7.631	8.585	9.539	10.493	7.154	8.108	9.062	10.016	10.970	10.047	10.422	9.926	9.926	8.709
B_2O_3	5.440	5.120	4.800	4.480	9.800	9.240	8.680	8.120	7.560	8.120	8.120	8.400	8.400	8.680
BaO	0.040	0.045	0.050	0.055	0.037	0.042	0.047	0.052	0.057	0.057	0.048	0.054	0.046	0.043
CaO	0.756	0.850	0.944	1.039	0.708	0.803	0.897	0.992	1.086	1.046	0.937	0.892	0.996	0.947
Ce_2O_3	0.048	0.054	0.060	0.066	0.045	0.051	0.057	0.063	0.069	0.069	0.058	0.066	0.055	0.052
Cr_2O_3	0.067	0.075	0.084	0.092	0.063	0.071	0.079	0.088	0.096	0.095	0.080	0.091	0.076	0.073
CuO	0.019	0.022	0.024	0.026	0.018	0.021	0.023	0.025	0.028	0.027	0.023	0.026	0.022	0.021
Fe_2O_3	8.407	9.458	10.509	11.560	7.882	8.933	9.984	11.035	12.086	10.604	10.604	10.408	10.611	10.013
K_2O	0.106	0.119	0.132	0.146	0.099	0.113	0.126	0.139	0.152	0.151	0.127	0.144	0.121	0.115
La_2O_3	0.034	0.038	0.043	0.047	0.032	0.036	0.040	0.045	0.049	0.049	0.041	0.046	0.039	0.037
Li_2O	5.440	5.120	4.800	4.480	5.600	5.280	4.960	4.640	4.320	4.640	4.640	4.800	4.800	4.960
MgO	0.797	0.897	0.997	1.096	0.748	0.847	0.947	1.047	1.146	0.992	0.992	1.049	1.049	0.897
MnO	1.734	1.951	2.167	2.384	1.626	1.842	2.059	2.276	2.493	2.218	2.333	2.222	2.112	2.111
Na_2O	12.989	13.612	14.236	14.859	9.877	10.660	11.444	12.228	13.011	12.668	12.329	11.423	11.423	11.843
NiO	0.497	0.559	0.621	0.683	0.466	0.528	0.590	0.652	0.714	0.706	0.706	0.672	0.570	0.541
PbO	0.029	0.033	0.036	0.040	0.027	0.031	0.035	0.038	0.042	0.042	0.035	0.040	0.033	0.032
SO_4^{2-}	0.446	0.501	0.557	0.613	0.418	0.474	0.529	0.585	0.641	0.611	0.559	0.532	0.532	0.505
SiO_2	52.954	50.073	47.192	44.312	52.994	50.194	47.393	44.592	41.791	44.536	44.536	46.046	45.939	47.443
ThO_2	0.020	0.023	0.025	0.028	0.019	0.021	0.024	0.027	0.029	0.029	0.024	0.027	0.023	0.022
TiO_2	0.008	0.009	0.011	0.012	0.008	0.009	0.010	0.011	0.012	0.012	0.010	0.011	0.010	0.009
U_3O_8	2.431	2.735	3.039	3.343	2.279	2.583	2.887	3.191	3.495	3.131	3.251	2.982	3.096	2.833
ZnO	0.031	0.035	0.039	0.043	0.030	0.033	0.037	0.041	0.045	0.045	0.038	0.043	0.036	0.034
ZrO_2	0.075	0.084	0.094	0.103	0.070	0.080	0.089	0.098	0.108	0.107	0.090	0.102	0.085	0.081

Table 2-4. Target Compositions (in wt%) of the SB4 Variability Study Glasses. (continued)

Glass ID	SB4VS-15	SB4VS-16	SB4VS-17	SB4VS-18	SB4VS-19	SB4VS-20	SB4VS-21	SB4VS-22	SB4VS-23	SB4VS-24	SB4VS-25	SB4VS-26	SB4VS-27	SB4VS-28
Frit	**503**	**503**	**503**	**503**	**503**	**503**	**503**	**503**	**503**	**503**	**503**	**503**	**503**	**503**
WL	**38**	**36**	**36**	**34**	**34**	**32**	**32**	**42**	**40**	**40**	**38**	**38**	**36**	**36**
Al_2O_3	8.709	8.250	8.933	8.036	7.792	7.516	7.941	10.820	9.286	8.788	8.696	8.348	8.821	7.909
B_2O_3	8.680	8.960	8.960	9.240	9.240	9.520	9.520	8.120	8.400	8.400	8.680	8.680	8.960	8.960
BaO	0.051	0.049	0.041	0.039	0.039	0.043	0.043	0.061	0.058	0.041	0.039	0.055	0.037	0.053
CaO	0.847	0.803	0.803	0.847	0.758	0.797	0.797	0.882	1.048	1.048	0.798	0.996	0.944	0.756
Ce_2O_3	0.062	0.059	0.050	0.047	0.047	0.052	0.052	0.074	0.071	0.050	0.047	0.067	0.045	0.064
Cr_2O_3	0.086	0.082	0.069	0.065	0.065	0.073	0.073	0.103	0.098	0.069	0.066	0.093	0.062	0.088
CuO	0.025	0.024	0.020	0.019	0.019	0.021	0.021	0.030	0.028	0.020	0.019	0.027	0.018	0.025
Fe_2O_3	10.388	9.588	9.700	9.294	8.825	8.748	8.079	10.165	9.681	10.571	9.197	9.644	8.713	10.217
K_2O	0.137	0.129	0.109	0.103	0.103	0.115	0.115	0.163	0.155	0.110	0.104	0.147	0.099	0.140
La_2O_3	0.044	0.042	0.035	0.033	0.033	0.037	0.037	0.052	0.050	0.035	0.034	0.047	0.032	0.045
Li_2O	4.960	5.120	5.120	5.280	5.280	5.440	5.440	4.640	4.800	4.800	4.960	4.960	5.120	5.120
MgO	0.897	0.944	0.850	0.892	0.892	0.756	0.839	0.937	1.101	0.892	1.046	1.046	0.803	0.991
MnO	2.111	1.901	1.901	1.889	1.796	1.690	1.778	2.391	2.058	2.058	2.163	2.163	2.049	1.852
Na_2O	11.415	11.430	10.681	10.310	11.017	9.939	10.053	12.459	12.672	12.672	12.238	12.238	11.804	11.031
NiO	0.541	0.513	0.513	0.572	0.572	0.538	0.456	0.544	0.724	0.518	0.687	0.492	0.466	0.466
PbO	0.038	0.036	0.030	0.028	0.028	0.032	0.032	0.045	0.043	0.030	0.029	0.041	0.027	0.038
SO_4^{2-}	0.553	0.479	0.524	0.495	0.495	0.426	0.466	0.533	0.507	0.507	0.577	0.482	0.546	0.546
SiO_2	47.342	48.745	48.841	50.148	50.239	51.637	51.637	44.704	46.099	46.099	47.494	47.291	48.697	48.889
ThO_2	0.026	0.025	0.021	0.020	0.020	0.022	0.022	0.031	0.030	0.021	0.020	0.028	0.019	0.027
TiO_2	0.011	0.010	0.009	0.008	0.008	0.009	0.009	0.013	0.012	0.009	0.008	0.012	0.008	0.011
U_3O_8	2.941	2.684	2.684	2.535	2.632	2.477	2.477	3.072	2.925	3.153	2.995	2.995	2.633	2.633
ZnO	0.041	0.038	0.032	0.031	0.031	0.034	0.034	0.048	0.046	0.033	0.031	0.044	0.029	0.041
ZrO_2	0.096	0.091	0.077	0.073	0.073	0.081	0.081	0.115	0.110	0.077	0.074	0.104	0.070	0.099

Table 2-4. Target Compositions (in wt%) of the SB4 Variability Study Glasses. (continued)

Glass ID	SB4VS-29	SB4VS-30	SB4VS-31	SB4VS-32	SB4VS-33	SB4VS-34	SB4VS-35
Frit	**503**	**503**	**503**	**503**	**503**	**503**	**503**
WL	**34**	**34**	**32**	**40**	**38**	**36**	**34**
Al_2O_3	8.151	7.470	7.030	8.400	9.880	9.360	7.140
B_2O_3	9.240	9.240	9.520	8.400	8.680	8.960	9.240
BaO	0.050	0.035	0.047	0.067	0.032	0.030	0.057
CaO	0.714	0.714	0.839	1.200	1.140	0.720	0.680
Ce_2O_3	0.060	0.042	0.057	0.081	0.038	0.036	0.069
Cr_2O_3	0.083	0.059	0.078	0.112	0.053	0.050	0.095
CuO	0.024	0.017	0.023	0.032	0.015	0.015	0.027
Fe_2O_3	8.229	9.650	9.082	10.800	9.120	10.080	8.500
K_2O	0.132	0.093	0.124	0.177	0.084	0.080	0.151
La_2O_3	0.042	0.030	0.040	0.057	0.027	0.026	0.048
Li_2O	5.280	5.280	5.440	4.800	4.960	5.120	5.280
MgO	0.758	0.758	0.714	0.800	1.140	1.080	0.680
MnO	1.749	1.935	1.821	2.000	2.280	1.800	2.040
Na_2O	11.371	10.898	9.728	12.800	10.460	10.120	11.480
NiO	0.615	0.615	0.579	0.800	0.760	0.360	0.340
PbO	0.036	0.026	0.034	0.049	0.023	0.022	0.042
SO_4^{2-}	0.516	0.431	0.485	0.800	0.760	0.720	0.680
SiO_2	50.102	50.102	51.679	45.600	47.780	48.440	50.540
ThO_2	0.025	0.018	0.024	0.034	0.016	0.015	0.029
TiO_2	0.011	0.007	0.010	0.014	0.007	0.006	0.012
U_3O_8	2.680	2.486	2.522	2.800	2.660	2.880	2.720
ZnO	0.039	0.028	0.037	0.053	0.025	0.024	0.045
ZrO_2	0.093	0.066	0.088	0.125	0.060	0.056	0.106

2.3 Glass Fabrication

Each variability study glass was prepared from the proper proportions of reagent-grade metal oxides, carbonates, H_3BO_3, and salts in 150 g batches.[18] The raw materials were thoroughly mixed and placed into a 95% platinum / 5% gold, 250 ml crucible. The batch was placed into a high-temperature furnace at the target melt temperature of 1150°C.[19] The crucible was removed from the furnace after an isothermal hold at 1150°C 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 (i.e., 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[20] to gauge the effects of thermal history on the product performance. This cooling schedule is referred to as the ccc curve. Visual observations on both quenched and ccc glasses were documented.[a]

2.4 Property Measurements

This section provides a general discussion of the chemical composition analyses, the PCTs, and the XRD analyses of the SB4 VS glasses.

2.4.1 *Compositional Analysis*

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

2.4.2 *Sulfate Solubility*

Sulfate retention is a secondary interest in this study. The applicability of the current 0.6 wt% SO_4^{2-} limit (established for the Frit 418 – SB3 system[17]) to SB4 was investigated. From Table 2-4, the targeted SO_4^{2-} concentrations in the variability study glasses range from 0.42 to 0.80 wt%. Since the variability study glasses cover a range of SO_4^{2-} concentrations (some exceeding the current PCCS limit), the ability of the glasses to retain the targeted SO_4^{2-} concentrations will provide valuable insight into the applicability of the SO_4^{2-} limit to SB4. Both visual observations (i.e., formation of a salt layer on the surface of the glass indicating that the SO_4^{2-} limit has been

[a] WSRC-NB-2004-00135 contains the visual observations of the quenched and ccc glasses.

exceeded) and a comparison of measured versus targeted SO_4^{2-} concentrations were used to support this assessment.

2.4.3 *Product Consistency Test (PCT)*

The PCT[13] 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) glass,[21] the Approved Reference Material (ARM) glass, and blanks from the sample cleaning batch. Samples were ground, washed, and prepared according to the standard procedure.[13] Fifteen milliliters of Type I American Society for Testing and Materials (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 three analytical plans (see Appendices B, C and D).[a] The aim of the plans 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 logs of the leachate concentrations.

2.4.4 *X-Ray Diffraction Analysis*

Although visual observations for crystallization were performed and documented, representative samples for all ccc glasses were submitted to SRNL Analytical Development (AD) for X-ray diffraction (XRD) analysis. Based on both visual observations and PCT responses (as will be discussed), there was no technical driver to submit the quenched samples for XRD analysis. Samples were run under conditions providing a detection limit of approximately 0.5 vol%. That is, if crystals (or undissolved solids) 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 devoid of crystalline spectral peaks indicates that the glass product is amorphous, suggesting either a completely amorphous product or that the degree of crystallization is below the detection limit.

[a] Analyses of the PCT solutions were divided into three sets due to the large number of glasses studied and limitations in the amount of laboratory equipment available.

3.0 Results and Discussion

3.1 A Statistical Review of the Chemical Composition Measurements of the SB4 Variability Study Glasses

In this section, the targeted and measured compositions of the 35 SB4 variability study glasses are presented and compared. The targeted compositions for these glasses are provided in Table E1 of Appendix E. A sum of oxides column is provided in this table as well. Chemical composition measurements for these glasses were conducted by the PSAL following the analytical plan provided in Appendix A. For each study glass, measurements were obtained from samples prepared in duplicate by both the LM and PF dissolution methods. All of the prepared samples were analyzed (twice for each element of interest) by ICP-AES.

Table E2 in Appendix E provides the elemental concentration measurements derived from the samples prepared using LM, and Table E3 in Appendix E provides the measurements derived from the samples prepared using PF. Measurements for standards (Batch 1 and a uranium standard, U_{std}) that were included in the PSAL analytical plan along with the study glasses are also provided in these two tables.

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

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

3.1.1 *Measurements in Analytical Sequence*

Exhibit E1 in Appendix E 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 E2 in Appendix E. These plots include all of the measurement data from Tables E2 and E3. A review of these plots indicates no significant patterns or trends in the analytical process over the course of these measurements. No obvious outliers are apparent in the 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 and uranium standard (U_{std}) glasses are reviewed. These measurements are investigated across the ICP-AES analytical blocks, and the results are used to bias correct the measurements for the study glasses.

Exhibit E3 in Appendix E provides statistical analyses of the Batch 1 and U_{std} results generated by the LM prep method by block/sub-block for each oxide of interest. The results include analysis of variance (ANOVA) investigations looking for statistically significant differences

between the means of these groups for each of the oxides for each of the standards. The results from the statistical tests for the Batch 1 standard may be summarized as follows: BaO, CaO, Cr_2O_3, CuO, MgO, TiO_2, and ZrO_2 have measurements that indicate a significant ICP-AES calibration effect on the block averages at the 5% significance level. For the U_{std}, CaO, Cr_2O_3, CuO, MgO, and TiO_2 have measurements that indicate a significant ICP-AES calibration effect on the block averages at the 5% significance level. The reference values for the oxide concentrations of the standard are given in the header for each set of measurements in the exhibit.

Exhibit E4 in Appendix E provides a similar set of analyses for the measurements derived from samples prepared via the PF method. The results from the statistical tests for the Batch 1 standard may be summarized as follows: Li_2O, NiO and SiO_2 have measurements that indicate significant ICP-AES calibration effects on the block averages at the 5% significance level. For the U_{std}, none of the oxides have measurements that indicate a significant ICP-AES calibration effect on the block averages at the 5% significance level. The reference values for the oxide concentrations of the standard are given in the headers for each set of measurements in the exhibit.

Thus, some of these results provide incentive for adjusting the measurements by the effects of the ICP-AES calibration. Therefore, the oxide measurements of the study glasses are to be bias corrected for the effect of the ICP-AES calibration on each of the analytical blocks and sub-blocks. The basis for this bias correction is presented as part of Exhibits E3 and E4: the average measurement for Batch 1 for each ICP-AES block/sub-block for the 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 concentrations and the average measurement for U_{std} for each ICP-AES set/block for the U_3O_8 concentration. The Batch 1 results served as the basis for bias correcting all of the oxides (that were bias corrected) except uranium. The U_{std} results were used to bias correct for uranium. For the other oxides, the Batch 1 results were used to conduct the bias correction as long as the reference value for the oxide concentration in the Batch 1 glass was greater than or equal to 0.1 wt%. Thus, applying this approach and based upon the information in the exhibits, the Batch 1 results were used to bias correct the Al_2O_3, B_2O_3, BaO, CaO, Cr_2O_3, CuO, Fe_2O_3, K_2O, Li_2O, MgO, MnO, Na_2O, NiO, SiO_2, and TiO_2 measurements. No bias correction was conducted for the Ce_2O_3, La_2O_3, PbO, SO_4^{2-}, ThO_2, ZnO, or ZrO_2 measurements.

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 (or U_{std} for uranium), and let t_i be the reference value for the i^{th} oxide for Batch 1 (or for U_{std} if uranium). The averages and reference values are provided in Exhibits E3 and E4. 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 as follows:

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

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

3.1.3 *Composition Measurements by Glass Number*

Exhibits E5 and E6 in Appendix E provide plots of the oxide concentration measurements by Glass ID (including Batch 1, labeled as glass number 100, U_{std}, labeled as glass number 200, and LRM, labeled as glass number 300) 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 good repeatability of the four individual, oxide values for each glass. There appears to be a good bit of scatter in the SiO_2 value, and some of the replicate ThO_2 measurements for some of the study glasses are significantly lower than the other measurements. There is some scatter in the ZnO_2 values for glass SB4VS-09. These issues will not have a significant effect on the outcome of the variability study (i.e., the applicability of the durability models to the frit – SB4 compositional region of interest will be addressed via all three compositional views – target, measured, and measured-biased corrected).

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 E7 in Appendix E provides plots showing results for each glass for each oxide to help highlight the comparisons among the measured, bias-corrected, and targeted values.

Some observations from the plots of Exhibit E7 are offered: For nearly every SB4 variability study glass except SB4VS-02, the average measured and measured-bc Al_2O_3 values are above the targeted values. Several of the glasses have measured and measured-bc CaO values that are above the targeted values. The average measured Fe_2O_3 and NiO values are less than their respective targeted concentrations for nearly every glass. Concentrations of ThO_2 for each glass are slightly higher than the targeted values. The SO_4^{2-} concentrations will be discussed in further detail below. These variations from the target compositions are relatively minor and should not have a significant effect on the outcome of the variability study.

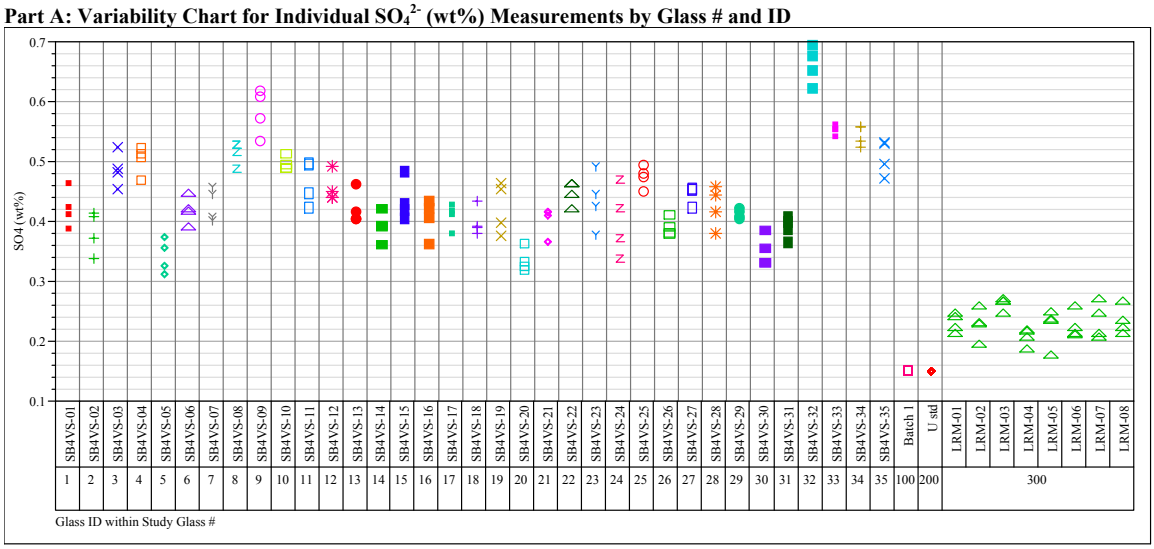
Table E4 in Appendix E provides a summary of the average compositions as well as the targeted compositions and some associated differences and relative differences. Notice that the targeted sums of oxides for the standard glasses do not sum to 100% due to an incomplete coverage of the oxides in the Batch 1 (glass # 100) and U_{std} (glass # 200) glasses. All of the sums of oxides (both measured and bias-corrected) for the study glasses fall within the interval of 95 to 105 wt%. Entries in Table E4 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 attaining the targeted compositions for some of the oxides for some of the glasses, none of which should have a significant effect on the results of the variability study.

3.1.5 *Assessment of Sulfate Values*

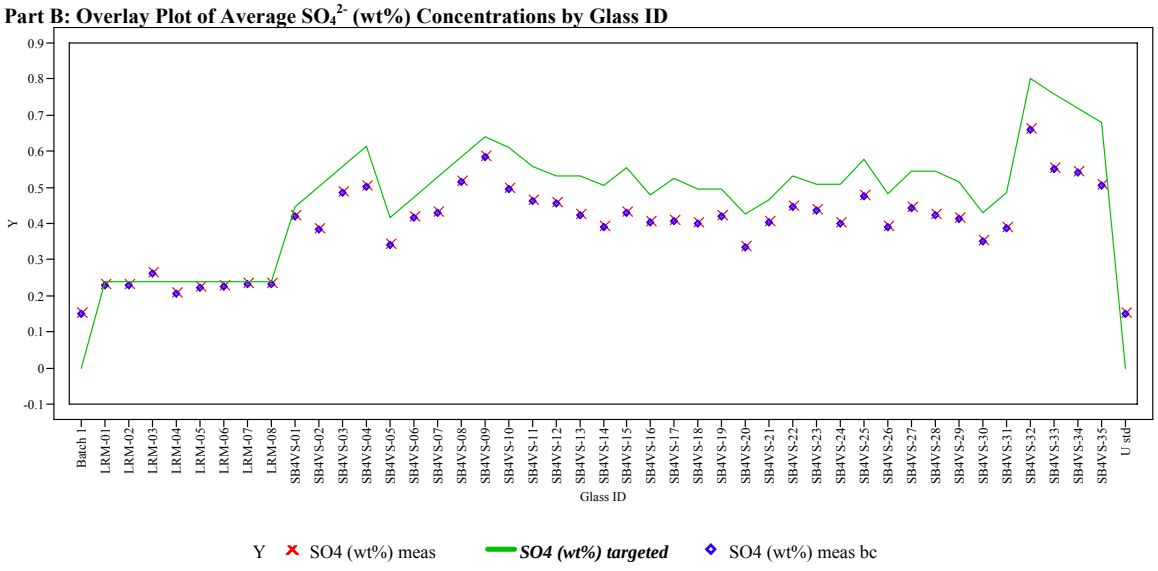
Figure 3-1 provides a pair of plots of the SO_4^{2-} values evaluated in this study. Part A shows the individual measurements by Glass ID (including the multiple measurements of the LRM glass labeled as 300). Part B shows the average measured value versus the targeted SO_4^{2-} concentration for each of the variability study glasses as well as samples of the LRM glass (LRM-01 through LRM-08). From Table E4, the average SO_4^{2-} value for the LRM glass samples is 0.23 wt%, which is only 0.01 wt% (or 4.2%) below the reference value for SO_4^{2-} of 0.24 wt% for this

glass.[22] This suggests that the preparation method and analytical data should provide a relatively accurate measurement of the SO_4^{2-} retention for the variability study glasses.

Part A: Variability Chart for Individual SO_4^{2-} (wt%) Measurements by Glass # and ID



Part B: Overlay Plot of Average SO_4^{2-} (wt%) Concentrations by Glass ID



(100 – Batch 1; 200 – Ustd; and 300 – LRM)

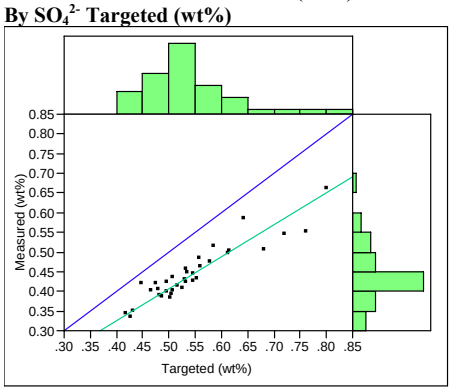
Figure 3-1. Measured Sulfate Values for the Variability Study Glasses by Glass Number

For all of the study glasses (SB4VS-01 through SB4VS-35), the average measured SO_4^{2-} values fall below the targeted concentrations. From Table E4, the percent differences range from a low of 5.8% for SB4VS-01 to a high of 27.6% for SB4VS-33. Given the results of the LRM analyses, the probability of the measured SO_4^{2-} values for the study glasses being biased low is remote. Therefore, the difference between target and measured SO_4^{2-} concentrations is most likely due to volatilization during melting. This difference has been observed in past experiments with open-crucible melts in the laboratory in the SB4 system.[8, 9, 11] Note that sulfate volatility from a slurry-fed melter has been estimated to be 40-70%.[23] Previous work has also indicated that as melting

conditions become more reducing (as is found in the melter at DWPF), sulfur volatility is expected to increase, with sulfur volatilizing primarily as SO_2 rather than Na_2SO_4 vapor.[23] Therefore, the oxidizing fabrication conditions used in this study should help to reduce volatility (i.e., the percent differences in sulfate concentration due to volatility are lower than those expected during actual DWPF melter operation) and be conservative with regard to the amount of sulfate volatility expected at DWPF.

Figure 3-2 provides a closer look at the measured versus targeted SO_4^{2-} values for the 35 study glasses. If the measured values showed a full recovery of the targeted SO_4^{2-} values, the plotted points would fall along the diagonal line of the plot. However, as seen Figure 3-1 Part B above, the measured values consistently fall below the diagonal line. The results of Figure 3-2 indicate that, on average, the measured values are equal to ~81% of their targets.

Bivariate Fit of SO_4^{2-} Measured (wt%) By SO_4^{2-} Targeted (wt%)



Summary of Fit

RSquare	.
RSquare Adj	.
Root Mean Square Error	0.026773
Mean of Response	0.443372
Observations (or Sum Wgts)	35

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	7.0174357	7.01744	9789.726
Error	34	0.0243718	0.00072	Prob > F
C. Total	35	7.0418074		<.0001

Tested against reduced model: Y=0

Linear Fit

Measured (wt%) = 0 + 0.8129201 Targeted (wt%)

Parameter Estimates

Term		Estimate	Std Error	t Ratio	Prob>|t|	Lower 95%	Upper 95%
Intercept	Zeroed	0	0	.	.	0	0
Targeted (wt%)		0.8129201	0.008216	98.94	<.0001	0.7962231	0.8296171

Figure 3-2. Measured versus Targeted Sulfate Concentration for Study Glasses

Note that some of the variability study glasses targeted SO_4^{2-} concentrations above the limit of 0.60 wt% set for SB3 / Frit 418 processing.[17] The SO_4^{2-} limit was intentionally relaxed in selecting the variability study glasses to further evaluate SO_4^{2-} retention for SB4.[16] For example, SB4VS-32 had the highest targeted SO_4^{2-} concentration at 0.80 wt% and returned a measured value of 0.659 wt% SO_4^{2-} (well above the 0.6 wt% PCCS limit). As will be discussed in Section 3.4, there was no sign of a salt layer on the surface of this glass. In fact, none of the study glasses had a visible salt layer on the surface. Five other SB4VS glasses (-04, -09, -33, -34, and -35) had targeted SO_4^{2-} concentrations above the 0.6 wt% limit (0.61, 0.64, 0.76, 0.72, and 0.68 wt%, respectively). Based on the measured values, SO_4^{2-} retention in these glasses ranged from 0.50 – 0.58 wt%. It should be noted that SO_4^{2-} solubility or retention is a function of overall glass composition, so the variation in the percentage retained is not surprising.

Based on the nominal compositions of the two projected sludges that formed the basis of this study, WLs of approximately 42% to 44% would be required to exceed the 0.6 wt% SO_4^{2-} limit currently defined in PCCS. This being the case, the likelihood of DWPF challenging the current 0.6 wt% limit is remote as other factors such as melt rate or waste throughput will be more restrictive in targeting higher WLs. If WLs of 42% or higher are desired, then the 0.6 wt% limit would become a limiting constraint. The 42% WL limit does not account for the volatilization that has been observed in the crucible scale studies supporting this task as well as (and perhaps more importantly) in actual melter tests.[23]

3.2 MAR Assessment of SB4 Variability Study Glasses

Another assessment that can be made for these SB4 variability study glasses is how well they satisfy the MAR criteria of DWPF's PCCS. All of the glasses that were selected for this study satisfied these criteria. That is, the targeted composition for each of these glasses fell within the MAR of PCCS.[16] In this section, the results of the MAR assessment of the measured and measured bias-corrected compositions for these glasses are presented along with the results for the targeted compositions. Table 3-1 provides this information. The columns in the table give the WL (in wt%), the frit identifier, the glass identifier with compositional view, the ΔG_P value for boron (B ΔG_P Value), the normalized leachate for boron (NL[B (g/L)]), the liquidus temperature prediction (T_L Pred (ºC)), the viscosity prediction (Visc Pred (P)), the sum of oxides (in wt%), the Al_2O_3 concentration (in wt%), the Na_2SO_4 concentration (in wt%), the total alkali concentration (R_2O, in wt%), the nepheline discriminator value, and the overall MAR assessment excluding any limitation on Na_2SO_4. A blank entry in this last column indicates that the glass satisfies all of the MAR criteria. The only glass that does not satisfy all of the MAR criteria is SB4VS-09, based on the measured composition view. The measured composition of this glass fails the MAR criterion for the nepheline discriminator and therefore would be classified as an unacceptable glass during DWPF PCCS Slurry Mix Evaporator (SME) acceptability decisions. The nepheline discriminator value for SB4VS-09 is 0.619, which also does not satisfy the nepheline discriminator Property Acceptability Region (PAR) of 0.620. All of the other results for these glasses indicate that they would pass the PCCS MAR and be deemed processable by and acceptable for the DWPF.

Table 3-1. Results of MAR Assessment of SB4 Variability Study Glasses for Measured, Bias-Corrected, and Targeted Compositional Views.

% WL	Frit	Glass ID/ Compositional View	B ΔG_P Value	NL[B (g/L)]	T_L Pred (°C)	Visc Pred (P)	Sum of Oxides	Al_2O_3 wt%	Na_2SO_4 wt%	R_2O wt%	Nepheline Discriminator	MAR Status w/o Na_2SO_4
32	418	SB4VS-01/measured	-10.395	0.96	821.7	63.78	98.94	8.871	0.621	19.065	0.697	
36	418	SB4VS-02/measured	-10.681	1.08	849.2	46.75	97.68	8.092	0.566	18.950	0.694	
40	418	SB4VS-03/measured	-10.980	1.23	890.2	44.18	100.14	9.995	0.717	19.966	0.655	
44	418	SB4VS-04/measured	-10.869	1.17	926.5	38.36	100.32	10.898	0.742	20.022	0.632	
30	503	SB4VS-05/measured	-8.638	0.46	838.7	69.92	99.26	7.586	0.506	15.888	0.747	
34	503	SB4VS-06/measured	-8.962	0.53	886.5	60.44	100.57	8.555	0.618	16.511	0.720	
38	503	SB4VS-07/measured	-8.707	0.47	921.0	59.54	101.56	9.920	0.634	16.789	0.695	
42	503	SB4VS-08/measured	-9.364	0.62	953.7	43.91	100.36	10.501	0.761	17.505	0.661	
46	503	SB4VS-09/measured	-9.992	0.81	967.0	29.42	97.76	11.294	0.862	18.203	0.619	Nepheline
42	503	SB4VS-10/measured	-10.037	0.83	940.6	37.18	99.95	10.638	0.733	18.309	0.649	
42	503	SB4VS-11/measured	-9.560	0.68	933.4	44.83	99.69	10.765	0.683	17.727	0.655	
40	503	SB4VS-12/measured	-9.033	0.54	937.1	46.91	97.47	10.142	0.674	16.835	0.671	
40	503	SB4VS-13/measured	-8.653	0.46	936.3	57.07	99.53	10.411	0.624	16.685	0.674	
38	503	SB4VS-14/measured	-9.869	0.77	893.1	40.30	98.23	8.933	0.577	17.403	0.685	
38	503	SB4VS-15/measured	-9.395	0.63	900.2	47.46	98.42	9.046	0.637	17.050	0.691	
36	503	SB4VS-16/measured	-9.981	0.81	876.4	42.31	98.24	8.555	0.597	17.466	0.696	
36	503	SB4VS-17/measured	-8.697	0.47	894.3	60.79	99.45	9.282	0.603	16.473	0.706	
34	503	SB4VS-18/measured	-8.771	0.49	892.3	57.50	97.70	8.233	0.590	16.081	0.721	
34	503	SB4VS-19/measured	-9.623	0.70	857.5	54.32	99.58	8.224	0.623	17.124	0.716	
32	503	SB4VS-20/measured	-8.620	0.46	864.1	67.11	99.41	7.851	0.494	15.953	0.740	
32	503	SB4VS-21/measured	-8.907	0.52	850.3	67.63	98.64	8.276	0.595	16.327	0.729	
42	503	SB4VS-22/measured	-9.109	0.56	939.3	49.76	99.76	11.351	0.660	17.499	0.652	
40	503	SB4VS-23/measured	-10.383	0.95	916.5	40.16	99.94	9.655	0.644	18.330	0.668	
40	503	SB4VS-24/measured	-10.190	0.88	897.2	37.03	99.28	9.126	0.593	17.977	0.674	
38	503	SB4VS-25/measured	-9.951	0.80	893.5	47.62	99.97	9.107	0.701	17.658	0.689	
38	503	SB4VS-26/measured	-9.392	0.63	903.8	51.26	99.71	8.753	0.576	16.901	0.702	
36	503	SB4VS-27/measured	-9.483	0.66	864.1	53.93	98.73	9.178	0.655	17.181	0.696	
36	503	SB4VS-28/measured	-9.215	0.59	893.4	51.85	99.35	8.285	0.628	16.693	0.715	
34	503	SB4VS-29/measured	-9.502	0.66	860.5	54.17	98.13	8.399	0.610	17.049	0.710	
34	503	SB4VS-30/measured	-9.343	0.62	876.4	45.81	95.96	7.601	0.516	16.347	0.718	
32	503	SB4VS-31/measured	-8.754	0.48	881.6	58.85	99.48	7.407	0.572	15.857	0.743	
40	503	SB4VS-32/measured	-10.423	0.97	913.2	35.05	97.97	8.890	0.975	18.106	0.673	
38	503	SB4VS-33/measured	-8.120	0.37	940.8	72.33	101.13	10.378	0.814	15.990	0.697	
36	503	SB4VS-34/measured	-7.433	0.28	924.3	76.06	100.34	10.066	0.803	15.456	0.710	
34	503	SB4VS-35/measured	-9.998	0.81	833.0	52.26	100.01	7.780	0.748	17.335	0.721	
32	418	SB4VS-01/targeted	-10.224	0.89	835.1	60.53	99.55	7.631	0.660	18.535	0.720	
36	418	SB4VS-02/targeted	-10.331	0.93	879.6	51.79	99.50	8.585	0.741	18.851	0.693	

Table 3-1. Results of MAR Assessment of SB4 Variability Study Glasses for Measured, Bias-Corrected, and Targeted Compositional Views. (continued)

% WL	Frit	Glass ID/ Compositional View	B Del Gp Value	NL[B (g/L)]	T_L Pred (°C)	Visc Pred (P)	Sum of Oxides	Al2O3 wt%	Na2SO4 wt%	R2O wt%	Nepheline Discriminator	MAR Status w/o Na2SO4
40	418	SB4VS-03/targeted	-10.438	0.98	920.2	43.47	99.44	9.539	0.824	19.168	0.665	
44	418	SB4VS-04/targeted	-10.546	1.02	956.7	35.67	99.39	10.493	0.907	19.485	0.636	
30	503	SB4VS-05/targeted	-8.495	0.43	864.1	67.62	99.58	7.154	0.618	15.576	0.757	
34	503	SB4VS-06/targeted	-8.698	0.47	908.4	58.10	99.52	8.108	0.701	16.053	0.728	
38	503	SB4VS-07/targeted	-8.901	0.51	947.7	49.04	99.47	9.062	0.782	16.530	0.698	
42	503	SB4VS-08/targeted	-9.105	0.56	983.2	40.51	99.41	10.016	0.865	17.007	0.667	
46	503	SB4VS-09/targeted	-9.307	0.61	1014.7	32.63	99.36	10.970	0.948	17.483	0.635	
42	503	SB4VS-10/targeted	-9.505	0.66	972.3	38.56	99.39	10.047	0.904	17.459	0.662	
42	503	SB4VS-11/targeted	-9.074	0.55	977.5	42.56	99.44	10.422	0.827	17.096	0.662	
40	503	SB4VS-12/targeted	-8.534	0.44	983.9	50.20	99.47	9.926	0.787	16.367	0.683	
40	503	SB4VS-13/targeted	-8.496	0.43	974.6	49.24	99.47	9.926	0.787	16.344	0.683	
38	503	SB4VS-14/targeted	-9.380	0.63	928.9	44.63	99.49	8.709	0.747	16.918	0.698	
38	503	SB4VS-15/targeted	-8.982	0.53	949.1	46.19	99.45	8.709	0.818	16.512	0.702	
36	503	SB4VS-16/targeted	-9.224	0.59	919.9	48.29	99.52	8.250	0.708	16.679	0.712	
36	503	SB4VS-17/targeted	-8.283	0.40	937.4	57.98	99.48	8.933	0.775	15.910	0.713	
34	503	SB4VS-18/targeted	-8.420	0.42	924.9	59.43	99.51	8.036	0.732	15.693	0.732	
34	503	SB4VS-19/targeted	-9.102	0.56	897.6	54.07	99.51	7.792	0.732	16.400	0.728	
32	503	SB4VS-20/targeted	-8.320	0.40	903.7	64.13	99.58	7.516	0.630	15.494	0.747	
32	503	SB4VS-21/targeted	-8.365	0.41	888.2	68.02	99.53	7.941	0.689	15.608	0.742	
42	503	SB4VS-22/targeted	-9.088	0.56	964.5	45.13	99.47	10.820	0.788	17.262	0.658	
40	503	SB4VS-23/targeted	-9.900	0.78	947.5	40.33	99.49	9.286	0.750	17.627	0.677	
40	503	SB4VS-24/targeted	-9.941	0.79	926.7	36.45	99.49	8.788	0.750	17.582	0.682	
38	503	SB4VS-25/targeted	-9.795	0.75	918.5	44.26	99.42	8.696	0.853	17.302	0.694	
38	503	SB4VS-26/targeted	-9.979	0.81	917.1	40.74	99.52	8.348	0.713	17.345	0.697	
36	503	SB4VS-27/targeted	-9.455	0.65	887.3	50.65	99.46	8.821	0.808	17.023	0.702	
36	503	SB4VS-28/targeted	-8.928	0.52	935.5	48.40	99.45	7.909	0.808	16.291	0.721	
34	503	SB4VS-29/targeted	-9.311	0.61	889.2	54.14	99.48	8.151	0.763	16.783	0.720	
34	503	SB4VS-30/targeted	-9.056	0.55	909.9	50.47	99.57	7.470	0.637	16.271	0.732	
32	503	SB4VS-31/targeted	-8.342	0.41	912.0	62.28	99.51	7.030	0.717	15.292	0.755	
40	503	SB4VS-32/targeted	-10.250	0.90	958.0	32.09	99.20	8.400	1.183	17.777	0.683	
38	503	SB4VS-33/targeted	-7.936	0.34	968.9	67.68	99.24	9.880	1.124	15.504	0.701	
36	503	SB4VS-34/targeted	-7.603	0.30	948.8	62.65	99.28	9.360	1.065	15.320	0.713	
34	503	SB4VS-35/targeted	-9.820	0.76	855.2	49.32	99.32	7.140	1.006	16.911	0.731	
32	418	SB4VS-01/measured bc	-9.802	0.75	844.5	69.29	98.55	8.933	0.621	18.399	0.703	
36	418	SB4VS-02/measured bc	-9.951	0.80	871.2	57.45	98.41	8.069	0.566	18.233	0.707	
40	418	SB4VS-03/measured bc	-10.082	0.84	918.6	50.94	99.47	10.065	0.717	18.970	0.663	
44	418	SB4VS-04/measured bc	-10.255	0.91	953.6	41.68	99.68	10.952	0.742	19.275	0.636	
30	503	SB4VS-05/measured bc	-8.097	0.37	862.9	75.70	99.02	7.649	0.506	15.292	0.753	

Table 3-1. Results of MAR Assessment of SB4 Variability Study Glasses for Measured, Bias-Corrected, and Targeted Compositional Views. (continued)

% WL	Frit	Glass ID/ Compositional View	B Del Gp Value	NL[B (g/L)]	T_L Pred (°C)	Visc Pred (P)	Sum of Oxides	Al2O3 wt%	Na2SO4 wt%	R2O wt%	Nepheline Discriminator	MAR Status w/o Na2SO4
34	503	SB4VS-06/measured bc	-8.301	0.40	912.0	66.50	100.03	8.614	0.618	15.796	0.727	
38	503	SB4VS-07/measured bc	-8.058	0.36	948.6	64.90	100.64	9.969	0.634	16.031	0.700	
42	503	SB4VS-08/measured bc	-8.798	0.49	978.9	48.37	100.28	10.588	0.761	16.890	0.667	
46	503	SB4VS-09/measured bc	-9.046	0.55	992.8	39.22	97.98	11.263	0.862	17.253	0.634	
42	503	SB4VS-10/measured bc	-9.224	0.59	968.6	42.89	99.52	10.726	0.733	17.432	0.656	
42	503	SB4VS-11/measured bc	-8.766	0.49	961.4	50.38	98.63	10.819	0.683	16.836	0.661	
40	503	SB4VS-12/measured bc	-8.249	0.39	964.0	59.40	97.97	10.114	0.674	16.055	0.685	
40	503	SB4VS-13/measured bc	-8.182	0.38	959.4	61.90	99.56	10.497	0.624	16.160	0.678	
38	503	SB4VS-14/measured bc	-9.245	0.59	914.2	49.64	98.92	8.908	0.577	16.809	0.697	
38	503	SB4VS-15/measured bc	-8.668	0.47	926.4	52.39	97.32	9.091	0.637	16.231	0.697	
36	503	SB4VS-16/measured bc	-9.109	0.56	899.4	53.97	98.55	8.531	0.597	16.626	0.710	
36	503	SB4VS-17/measured bc	-8.193	0.38	916.6	65.40	99.16	9.346	0.603	15.925	0.711	
34	503	SB4VS-18/measured bc	-8.188	0.38	920.5	62.85	97.34	8.291	0.590	15.428	0.727	
34	503	SB4VS-19/measured bc	-8.940	0.52	882.3	60.30	99.17	8.292	0.623	16.388	0.724	
32	503	SB4VS-20/measured bc	-8.069	0.36	889.6	72.85	99.19	7.916	0.494	15.345	0.746	
32	503	SB4VS-21/measured bc	-8.277	0.40	873.4	74.26	98.25	8.344	0.595	15.653	0.736	
42	503	SB4VS-22/measured bc	-8.538	0.44	962.1	54.92	99.63	11.445	0.660	16.882	0.658	
40	503	SB4VS-23/measured bc	-9.577	0.68	946.7	45.82	99.34	9.723	0.644	17.447	0.675	
40	503	SB4VS-24/measured bc	-9.659	0.71	921.1	39.63	98.56	9.172	0.593	17.345	0.678	
38	503	SB4VS-25/measured bc	-9.382	0.63	919.6	51.16	99.14	9.153	0.701	17.000	0.693	
38	503	SB4VS-26/measured bc	-8.751	0.48	933.3	56.69	99.35	8.814	0.576	16.177	0.709	
36	503	SB4VS-27/measured bc	-8.817	0.50	890.8	59.05	97.72	9.224	0.655	16.405	0.701	
36	503	SB4VS-28/measured bc	-8.759	0.49	917.6	54.59	98.61	8.327	0.628	16.145	0.718	
34	503	SB4VS-29/measured bc	-8.981	0.53	884.5	58.47	97.81	8.458	0.610	16.477	0.715	
34	503	SB4VS-30/measured bc	-8.766	0.49	897.4	55.62	96.69	7.579	0.516	15.817	0.729	
32	503	SB4VS-31/measured bc	-8.181	0.38	909.9	63.01	98.53	7.444	0.572	15.189	0.748	
40	503	SB4VS-32/measured bc	-9.813	0.75	940.8	37.96	97.11	8.934	0.975	17.405	0.678	
38	503	SB4VS-33/measured bc	-7.640	0.30	964.5	77.95	101.09	10.464	0.814	15.478	0.702	
36	503	SB4VS-34/measured bc	-7.036	0.24	944.8	80.57	100.25	10.136	0.803	15.011	0.713	
34	503	SB4VS-35/measured bc	-9.521	0.67	855.7	55.12	99.18	7.819	0.748	16.763	0.725	

3.3 A Statistical Review of the SB4 Variability Study PCT Results

The variability study glasses, after being batched and fabricated, were subjected to the 7-day PCT Method A[13] to assess their durability. Durability is the critical product quality metric for DWPF glass studies. Both heat treatments for each study glass (quenched and ccc) were subjected to the PCT in triplicate. In addition, PCTs were conducted in triplicate for samples of the EA and ARM glasses. Blanks (samples consisting only of ASTM Type I water) were also submitted for the PCT.

Three analytical plans, presented in Appendices B, C and D, were provided to the PSAL to support the measurement of the compositions of the solutions resulting from the PCTs. Samples of a multi-element, standard solution were also 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 F1 in Appendix F provides the elemental leachate concentration measurements determined by the PSAL for the solution samples generated by the PCTs. One of the quality control checkpoints for the PCT procedure is solution-weight loss over the course of the 7-day test. None of these PCT results indicated a solution-weight loss problem. Any measurement in Table F1 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 values for the study glasses, the blanks, and the ARM glass in Table F1 were multiplied by 1.6667 to determine the values in parts per million (ppm) and the values for EA were multiplied by 16.6667. Table F2 in Appendix F provides the resulting measurements. All of the measurements for the ARM specimens fall within the control limits (in ppm) for this glass,[12] indicating reliable measurements.

In the sections that follow, the analytical sequence of the measurements is explored, the measurements of the multi-element 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, the PCTs are normalized using the compositions (targeted, measured, and bias-corrected) presented in Table E4, and the normalized PCTs are compared to durability predictions for these compositions generated from the current DWPF models.[12]

3.3.1 *Measurements in Analytical Sequence*

Exhibits F1 and F2 in Appendix F provide plots of the leachate (ppm) concentrations 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 problems are seen in these plots.

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

Exhibit F3 in Appendix F provides analyses of the PSAL measurements of the samples of the multi-element solution standard by ICP-AES analytical (or calibration) block by analytical set. An ANOVA investigating for statistically significant differences among the set/block averages for these samples for each element of interest is included in this exhibit. These results indicate a statistically significant (at approximately a 5% level) difference among the average measurements of Al, B, Fe, Li, Na and Si over these sets/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 ppm values for each set of triplicates helps to minimize the impact of the ICP-AES bias 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 Part/Block	Avg B (ppm)	Avg Li (ppm)	Avg Na (ppm)	Avg Si (ppm)
1/1	21.4	9.9	83.0	49.9
1/2	21.2	9.9	80.7	49.8
1/3	21.4	9.9	82.5	50.3
2/1	20.5	9.8	81.0	47.4
2/2	20.4	10.0	85.8	49.2
2/3	21.4	10.0	84.3	49.5
2/4	21.2	9.8	81.9	48.7
2/5	20.7	9.7	81.3	47.9
2/6	20.7	10.0	80.8	46.1
3/1	20.8	9.7	81.9	49.9
3/2	20.8	9.7	81.4	49.6
3/3	20.5	9.6	83.1	48.8
3/4	20.1	9.8	82.8	49.1
3/5	20.8	9.9	82.7	51.3
3/6	20.7	9.7	83.0	50.9
Grand Average	**20.8**	**9.8**	**82.4**	**49.2**
Reference Value	**20**	**10**	**81**	**50**
% difference	**4.2%**	**-1.7%**	**1.7%**	**-1.5%**

3.3.3 *Measurements by Glass Number*

Exhibit F4 in Appendix F provide plots of the leachate concentrations for each type of submitted sample: the study glasses and the standards (EA (101), ARM (102), the multi-element solution standard (100), and blanks (103)). Exhibit F5 in Appendix F provide plots of the leachate concentrations for the PCT results of the study glasses by heat treatment. 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. Specifically, SB4VS-02 and SB4VS-09 show the most scatter in their values over their ccc triplicates for B, Li, and Na, and these glasses also show the biggest differences between their quenched and ccc counterparts for these elements. As a result of these differences, the PCTs for the ccc versions of three glasses, SB4VS-02, SB4VS-05, and SB4VS-09, were rerun with outcomes as given in Table 3-3.

Table 3-3. Results from PCT Reruns for the ccc Versions of SB4VS-02, SB4VS-05, and SB4VS-09.

Sample ID	Lab ID	B	Li	Na	Si
cust std 10x		20.9	9.7	79.3	48.3
VS-2CCC-1	2202-06	8.15	11.7	46.1	73.5
VS-2CCC-2	2203-06	7.79	11.7	46.2	73.0
VS-2CCC-3	2204-06	7.51	11.6	45.7	72.2
VS-5-CCC-1	2205-06	11.5	11.4	22.3	64.8
VS-5-CCC-2	2206-06	11.3	11.3	22.4	64.2
VS-5-CCC-3	2207-06	11.5	11.5	22.6	65.1
VS-9-CCC-1	2208-06	23.0	18.0	63.6	65.8
VS-9-CCC-2	2209-06	24.3	18.5	65.9	68.9
VS-9-CCC-3	2210-06	23.8	18.2	64.7	68.2

As demonstrated by the values in Table 3-3, the PCT results for each of these ccc glasses are more consistent than the initial set of results, which are given in Table F1 in Appendix F. In the discussion that follows, the values of Table 3-3 will be used to represent the PCT response for these three glasses.

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. 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 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 ppm leachate concentration for each of the triplicates and each of the elements of interest (these values are provided in Table F2 of Appendix F),

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 F6 in Appendix F 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 that for Na and Li, with a value of ~94%, indicating good consistency.

Table 3-4 summarizes the normalized PCTs for the glasses of this study. The glasses are listed by glass identifier, heat treatment and compositional view. A high level review of the PCT data shows that all glasses (regardless of heat treatment) are very acceptable as compared to the benchmark NL [B] of 16.695 g/L for the EA glass.[21] All of the quenched variability study glasses have NL [B] values of less than 0.9 g/L, regardless of compositional view. All of the ccc variability study glasses have NL [B] values of less than 1.8 g/L, regardless of compositional view. Note that the sample of EA glass measured with set 1 has a low NL [B] value of 13.89 g/L. This is likely due to an issue with this particular sample of the EA glass rather than an error in measurement, since the values for the ARM glass for set 1 are within the control limits.[12] Therefore, this discrepancy will not have an effect on the results of the variability study.

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

Glass ID	Heat Treatment	Composition	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)
ARM	Set 1	reference	-0.260	-0.215	-0.262	-0.533	0.55	0.61	0.55	0.29
EA	Set 1	reference	1.143	0.894	1.020	0.526	13.89	7.84	10.48	3.35
ARM	Set 2	reference	-0.312	-0.245	-0.307	-0.579	0.49	0.57	0.49	0.26
EA	Set 2	reference	1.245	0.966	1.126	0.573	17.58	9.24	13.37	3.74
ARM	Set 3	reference	-0.281	-0.232	-0.288	-0.549	0.52	0.59	0.51	0.28
EA	Set 3	reference	1.239	0.955	1.110	0.578	17.35	9.01	12.89	3.79
SB4VS-01	ccc	measured	-0.154	-0.101	-0.120	-0.292	0.70	0.79	0.76	0.51
SB4VS-02	ccc	measured	-0.127	-0.094	-0.122	-0.280	0.75	0.81	0.75	0.52
SB4VS-03	ccc	measured	-0.082	-0.060	-0.057	-0.260	0.83	0.87	0.88	0.55
SB4VS-04	ccc	measured	-0.026	-0.038	-0.011	-0.244	0.94	0.92	0.98	0.57
SB4VS-05	ccc	measured	-0.198	-0.129	-0.311	-0.360	0.63	0.74	0.49	0.44
SB4VS-06	ccc	measured	-0.200	-0.169	-0.275	-0.371	0.63	0.68	0.53	0.43
SB4VS-07	ccc	measured	-0.185	-0.169	-0.224	-0.378	0.65	0.68	0.60	0.42
SB4VS-08	ccc	measured	-0.175	-0.159	-0.206	-0.376	0.67	0.69	0.62	0.42
SB4VS-09	ccc	measured	0.224	0.182	0.024	-0.228	1.68	1.52	1.06	0.59
SB4VS-10	ccc	measured	-0.145	-0.146	-0.196	-0.372	0.72	0.71	0.64	0.42
SB4VS-11	ccc	measured	-0.145	-0.133	-0.195	-0.366	0.72	0.74	0.64	0.43
SB4VS-12	ccc	measured	-0.166	-0.140	-0.227	-0.359	0.68	0.72	0.59	0.44
SB4VS-13	ccc	measured	-0.178	-0.152	-0.258	-0.384	0.66	0.71	0.55	0.41
SB4VS-14	ccc	measured	-0.172	-0.142	-0.218	-0.348	0.67	0.72	0.60	0.45
SB4VS-15	ccc	measured	-0.140	-0.129	-0.230	-0.350	0.72	0.74	0.59	0.45
SB4VS-16	ccc	measured	-0.189	-0.169	-0.261	-0.362	0.65	0.68	0.55	0.43
SB4VS-17	ccc	measured	-0.215	-0.182	-0.307	-0.398	0.61	0.66	0.49	0.40
SB4VS-18	ccc	measured	-0.193	-0.164	-0.298	-0.376	0.64	0.69	0.50	0.42
SB4VS-19	ccc	measured	-0.193	-0.168	-0.275	-0.372	0.64	0.68	0.53	0.42
SB4VS-20	ccc	measured	-0.209	-0.168	-0.319	-0.384	0.62	0.68	0.48	0.41
SB4VS-21	ccc	measured	-0.215	-0.182	-0.343	-0.393	0.61	0.66	0.45	0.40
SB4VS-22	ccc	measured	-0.177	-0.164	-0.207	-0.376	0.67	0.69	0.62	0.42
SB4VS-23	ccc	measured	-0.146	-0.144	-0.175	-0.359	0.72	0.72	0.67	0.44
SB4VS-24	ccc	measured	-0.147	-0.147	-0.187	-0.344	0.71	0.71	0.65	0.45
SB4VS-25	ccc	measured	-0.140	-0.150	-0.200	-0.358	0.72	0.71	0.63	0.44
SB4VS-26	ccc	measured	-0.173	-0.158	-0.196	-0.366	0.67	0.69	0.64	0.43
SB4VS-27	ccc	measured	-0.196	-0.176	-0.243	-0.374	0.64	0.67	0.57	0.42
SB4VS-28	ccc	measured	-0.187	-0.176	-0.266	-0.376	0.65	0.67	0.54	0.42
SB4VS-29	ccc	measured	-0.183	-0.155	-0.250	-0.357	0.66	0.70	0.56	0.44
SB4VS-30	ccc	measured	-0.165	-0.136	-0.239	-0.321	0.68	0.73	0.58	0.48
SB4VS-31	ccc	measured	-0.206	-0.155	-0.312	-0.361	0.62	0.70	0.49	0.44
SB4VS-32	ccc	measured	-0.095	-0.119	-0.135	-0.334	0.80	0.76	0.73	0.46
SB4VS-33	ccc	measured	-0.219	-0.181	-0.301	-0.413	0.60	0.66	0.50	0.39
SB4VS-34	ccc	measured	-0.179	-0.142	-0.288	-0.367	0.66	0.72	0.51	0.43
SB4VS-35	ccc	measured	-0.166	-0.145	-0.219	-0.350	0.68	0.72	0.60	0.45
SB4VS-01	quenched	measured	-0.156	-0.101	-0.087	-0.289	0.70	0.79	0.82	0.51
SB4VS-02	quenched	measured	-0.148	-0.095	-0.082	-0.263	0.71	0.80	0.83	0.55
SB4VS-03	quenched	measured	-0.070	-0.064	-0.066	-0.253	0.85	0.86	0.86	0.56
SB4VS-04	quenched	measured	-0.071	-0.080	-0.004	-0.266	0.85	0.83	0.99	0.54
SB4VS-05	quenched	measured	-0.197	-0.143	-0.291	-0.351	0.64	0.72	0.51	0.45
SB4VS-06	quenched	measured	-0.182	-0.151	-0.281	-0.366	0.66	0.71	0.52	0.43
SB4VS-07	quenched	measured	-0.167	-0.153	-0.220	-0.374	0.68	0.70	0.60	0.42
SB4VS-08	quenched	measured	-0.174	-0.155	-0.203	-0.376	0.67	0.70	0.63	0.42
SB4VS-09	quenched	measured	-0.108	-0.123	-0.135	-0.327	0.78	0.75	0.73	0.47
SB4VS-10	quenched	measured	-0.127	-0.127	-0.167	-0.365	0.75	0.75	0.68	0.43
SB4VS-11	quenched	measured	-0.136	-0.129	-0.182	-0.362	0.73	0.74	0.66	0.43
SB4VS-12	quenched	measured	-0.160	-0.125	-0.208	-0.354	0.69	0.75	0.62	0.44
SB4VS-13	quenched	measured	-0.162	-0.127	-0.242	-0.381	0.69	0.75	0.57	0.42
SB4VS-14	quenched	measured	-0.148	-0.115	-0.195	-0.338	0.71	0.77	0.64	0.46
SB4VS-15	quenched	measured	-0.145	-0.116	-0.218	-0.353	0.72	0.77	0.61	0.44
SB4VS-16	quenched	measured	-0.159	-0.124	-0.223	-0.346	0.69	0.75	0.60	0.45
SB4VS-17	quenched	measured	-0.224	-0.168	-0.307	-0.403	0.60	0.68	0.49	0.40
SB4VS-18	quenched	measured	-0.186	-0.144	-0.305	-0.376	0.65	0.72	0.50	0.42
SB4VS-19	quenched	measured	-0.174	-0.150	-0.269	-0.372	0.67	0.71	0.54	0.42

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

Glass ID	Heat Treatment	Composition	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)
SB4VS-20	quenched	measured	-0.209	-0.156	-0.325	-0.388	0.62	0.70	0.47	0.41
SB4VS-21	quenched	measured	-0.200	-0.157	-0.345	-0.388	0.63	0.70	0.45	0.41
SB4VS-22	quenched	measured	-0.187	-0.183	-0.214	-0.390	0.65	0.66	0.61	0.41
SB4VS-23	quenched	measured	-0.154	-0.160	-0.181	-0.368	0.70	0.69	0.66	0.43
SB4VS-24	quenched	measured	-0.139	-0.145	-0.140	-0.350	0.73	0.72	0.72	0.45
SB4VS-25	quenched	measured	-0.164	-0.164	-0.203	-0.371	0.69	0.69	0.63	0.43
SB4VS-26	quenched	measured	-0.162	-0.152	-0.186	-0.370	0.69	0.70	0.65	0.43
SB4VS-27	quenched	measured	-0.176	-0.151	-0.229	-0.363	0.67	0.71	0.59	0.43
SB4VS-28	quenched	measured	-0.177	-0.158	-0.259	-0.370	0.66	0.70	0.55	0.43
SB4VS-29	quenched	measured	-0.179	-0.142	-0.251	-0.357	0.66	0.72	0.56	0.44
SB4VS-30	quenched	measured	-0.158	-0.129	-0.246	-0.328	0.69	0.74	0.57	0.47
SB4VS-31	quenched	measured	-0.212	-0.150	-0.335	-0.363	0.61	0.71	0.46	0.43
SB4VS-32	quenched	measured	-0.113	-0.133	-0.136	-0.343	0.77	0.74	0.73	0.45
SB4VS-33	quenched	measured	-0.205	-0.149	-0.304	-0.403	0.62	0.71	0.50	0.40
SB4VS-34	quenched	measured	-0.161	-0.115	-0.300	-0.353	0.69	0.77	0.50	0.44
SB4VS-35	quenched	measured	-0.144	-0.129	-0.214	-0.344	0.72	0.74	0.61	0.45
SB4VS-01	ccc	targeted	-0.192	-0.110	-0.098	-0.301	0.64	0.78	0.80	0.50
SB4VS-02	ccc	targeted	-0.087	-0.087	-0.120	-0.285	0.82	0.82	0.76	0.52
SB4VS-03	ccc	targeted	-0.087	-0.066	-0.031	-0.255	0.82	0.86	0.93	0.56
SB4VS-04	ccc	targeted	-0.017	-0.040	0.005	-0.236	0.96	0.91	1.01	0.58
SB4VS-05	ccc	targeted	-0.203	-0.136	-0.292	-0.361	0.63	0.73	0.51	0.44
SB4VS-06	ccc	targeted	-0.195	-0.171	-0.254	-0.366	0.64	0.67	0.56	0.43
SB4VS-07	ccc	targeted	-0.179	-0.167	-0.216	-0.362	0.66	0.68	0.61	0.43
SB4VS-08	ccc	targeted	-0.173	-0.160	-0.188	-0.369	0.67	0.69	0.65	0.43
SB4VS-09	ccc	targeted	0.226	0.180	0.048	-0.239	1.68	1.51	1.12	0.58
SB4VS-10	ccc	targeted	-0.151	-0.147	-0.168	-0.372	0.71	0.71	0.68	0.43
SB4VS-11	ccc	targeted	-0.143	-0.136	-0.172	-0.361	0.72	0.73	0.67	0.44
SB4VS-12	ccc	targeted	-0.160	-0.140	-0.210	-0.370	0.69	0.72	0.62	0.43
SB4VS-13	ccc	targeted	-0.180	-0.179	-0.232	-0.379	0.66	0.66	0.59	0.42
SB4VS-14	ccc	targeted	-0.162	-0.143	-0.199	-0.357	0.69	0.72	0.63	0.44
SB4VS-15	ccc	targeted	-0.150	-0.132	-0.206	-0.351	0.71	0.74	0.62	0.45
SB4VS-16	ccc	targeted	-0.184	-0.169	-0.233	-0.373	0.65	0.68	0.58	0.42
SB4VS-17	ccc	targeted	-0.217	-0.184	-0.284	-0.394	0.61	0.65	0.52	0.40
SB4VS-18	ccc	targeted	-0.207	-0.172	-0.276	-0.385	0.62	0.67	0.53	0.41
SB4VS-19	ccc	targeted	-0.199	-0.166	-0.247	-0.371	0.63	0.68	0.57	0.43
SB4VS-20	ccc	targeted	-0.213	-0.169	-0.298	-0.381	0.61	0.68	0.50	0.42
SB4VS-21	ccc	targeted	-0.233	-0.186	-0.310	-0.396	0.58	0.65	0.49	0.40
SB4VS-22	ccc	targeted	-0.178	-0.165	-0.198	-0.372	0.66	0.68	0.63	0.43
SB4VS-23	ccc	targeted	-0.148	-0.149	-0.150	-0.356	0.71	0.71	0.71	0.44
SB4VS-24	ccc	targeted	-0.146	-0.151	-0.171	-0.344	0.72	0.71	0.67	0.45
SB4VS-25	ccc	targeted	-0.138	-0.150	-0.186	-0.352	0.73	0.71	0.65	0.44
SB4VS-26	ccc	targeted	-0.169	-0.157	-0.212	-0.356	0.68	0.70	0.61	0.44
SB4VS-27	ccc	targeted	-0.200	-0.184	-0.232	-0.374	0.63	0.65	0.59	0.42
SB4VS-28	ccc	targeted	-0.187	-0.175	-0.251	-0.372	0.65	0.67	0.56	0.42
SB4VS-29	ccc	targeted	-0.193	-0.167	-0.235	-0.363	0.64	0.68	0.58	0.43
SB4VS-30	ccc	targeted	-0.170	-0.147	-0.229	-0.342	0.68	0.71	0.59	0.46
SB4VS-31	ccc	targeted	-0.198	-0.158	-0.286	-0.364	0.63	0.69	0.52	0.43
SB4VS-32	ccc	targeted	-0.108	-0.124	-0.123	-0.335	0.78	0.75	0.75	0.46
SB4VS-33	ccc	targeted	-0.208	-0.182	-0.280	-0.401	0.62	0.66	0.52	0.40
SB4VS-34	ccc	targeted	-0.183	-0.144	-0.281	-0.355	0.66	0.72	0.52	0.44
SB4VS-35	ccc	targeted	-0.165	-0.145	-0.203	-0.347	0.68	0.72	0.63	0.45
SB4VS-01	quenched	targeted	-0.194	-0.110	-0.065	-0.298	0.64	0.78	0.86	0.50
SB4VS-02	quenched	targeted	-0.108	-0.089	-0.079	-0.268	0.78	0.82	0.83	0.54
SB4VS-03	quenched	targeted	-0.074	-0.070	-0.040	-0.249	0.84	0.85	0.91	0.56
SB4VS-04	quenched	targeted	-0.062	-0.082	0.012	-0.258	0.87	0.83	1.03	0.55
SB4VS-05	quenched	targeted	-0.202	-0.151	-0.272	-0.352	0.63	0.71	0.53	0.44
SB4VS-06	quenched	targeted	-0.177	-0.154	-0.260	-0.361	0.67	0.70	0.55	0.44
SB4VS-07	quenched	targeted	-0.162	-0.151	-0.212	-0.358	0.69	0.71	0.61	0.44
SB4VS-08	quenched	targeted	-0.173	-0.156	-0.186	-0.369	0.67	0.70	0.65	0.43
SB4VS-09	quenched	targeted	-0.106	-0.124	-0.111	-0.338	0.78	0.75	0.77	0.46

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

Glass ID	Heat Treatment	Composition	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)
SB4VS-10	quenched	targeted	-0.132	-0.128	-0.139	-0.365	0.74	0.74	0.73	0.43
SB4VS-11	quenched	targeted	-0.133	-0.132	-0.160	-0.356	0.74	0.74	0.69	0.44
SB4VS-12	quenched	targeted	-0.155	-0.125	-0.191	-0.364	0.70	0.75	0.64	0.43
SB4VS-13	quenched	targeted	-0.164	-0.154	-0.216	-0.376	0.69	0.70	0.61	0.42
SB4VS-14	quenched	targeted	-0.138	-0.115	-0.175	-0.347	0.73	0.77	0.67	0.45
SB4VS-15	quenched	targeted	-0.155	-0.119	-0.194	-0.354	0.70	0.76	0.64	0.44
SB4VS-16	quenched	targeted	-0.154	-0.124	-0.195	-0.357	0.70	0.75	0.64	0.44
SB4VS-17	quenched	targeted	-0.226	-0.170	-0.284	-0.400	0.59	0.68	0.52	0.40
SB4VS-18	quenched	targeted	-0.200	-0.152	-0.284	-0.384	0.63	0.70	0.52	0.41
SB4VS-19	quenched	targeted	-0.181	-0.148	-0.241	-0.370	0.66	0.71	0.57	0.43
SB4VS-20	quenched	targeted	-0.213	-0.157	-0.304	-0.385	0.61	0.70	0.50	0.41
SB4VS-21	quenched	targeted	-0.219	-0.161	-0.311	-0.391	0.60	0.69	0.49	0.41
SB4VS-22	quenched	targeted	-0.187	-0.184	-0.206	-0.386	0.65	0.65	0.62	0.41
SB4VS-23	quenched	targeted	-0.156	-0.165	-0.156	-0.366	0.70	0.68	0.70	0.43
SB4VS-24	quenched	targeted	-0.138	-0.150	-0.125	-0.350	0.73	0.71	0.75	0.45
SB4VS-25	quenched	targeted	-0.162	-0.164	-0.189	-0.365	0.69	0.69	0.65	0.43
SB4VS-26	quenched	targeted	-0.158	-0.151	-0.202	-0.360	0.69	0.71	0.63	0.44
SB4VS-27	quenched	targeted	-0.180	-0.160	-0.219	-0.364	0.66	0.69	0.60	0.43
SB4VS-28	quenched	targeted	-0.177	-0.156	-0.245	-0.366	0.66	0.70	0.57	0.43
SB4VS-29	quenched	targeted	-0.189	-0.154	-0.236	-0.364	0.65	0.70	0.58	0.43
SB4VS-30	quenched	targeted	-0.163	-0.140	-0.237	-0.349	0.69	0.72	0.58	0.45
SB4VS-31	quenched	targeted	-0.204	-0.153	-0.309	-0.366	0.63	0.70	0.49	0.43
SB4VS-32	quenched	targeted	-0.126	-0.137	-0.124	-0.345	0.75	0.73	0.75	0.45
SB4VS-33	quenched	targeted	-0.193	-0.149	-0.284	-0.391	0.64	0.71	0.52	0.41
SB4VS-34	quenched	targeted	-0.165	-0.117	-0.292	-0.342	0.68	0.76	0.51	0.46
SB4VS-35	quenched	targeted	-0.144	-0.129	-0.198	-0.341	0.72	0.74	0.63	0.46
SB4VS-01	ccc	measured bc	-0.147	-0.106	-0.097	-0.291	0.71	0.78	0.80	0.51
SB4VS-02	ccc	measured bc	-0.106	-0.095	-0.099	-0.291	0.78	0.80	0.80	0.51
SB4VS-03	ccc	measured bc	-0.076	-0.065	-0.026	-0.259	0.84	0.86	0.94	0.55
SB4VS-04	ccc	measured bc	-0.015	-0.039	0.011	-0.239	0.97	0.91	1.03	0.58
SB4VS-05	ccc	measured bc	-0.193	-0.136	-0.282	-0.360	0.64	0.73	0.52	0.44
SB4VS-06	ccc	measured bc	-0.194	-0.174	-0.244	-0.370	0.64	0.67	0.57	0.43
SB4VS-07	ccc	measured bc	-0.174	-0.171	-0.195	-0.373	0.67	0.68	0.64	0.42
SB4VS-08	ccc	measured bc	-0.170	-0.166	-0.182	-0.376	0.68	0.68	0.66	0.42
SB4VS-09	ccc	measured bc	0.246	0.181	0.055	-0.239	1.76	1.52	1.14	0.58
SB4VS-10	ccc	measured bc	-0.140	-0.153	-0.165	-0.372	0.72	0.70	0.68	0.43
SB4VS-11	ccc	measured bc	-0.135	-0.135	-0.164	-0.361	0.73	0.73	0.69	0.44
SB4VS-12	ccc	measured bc	-0.144	-0.141	-0.198	-0.370	0.72	0.72	0.63	0.43
SB4VS-13	ccc	measured bc	-0.173	-0.158	-0.236	-0.384	0.67	0.69	0.58	0.41
SB4VS-14	ccc	measured bc	-0.150	-0.143	-0.197	-0.359	0.71	0.72	0.64	0.44
SB4VS-15	ccc	measured bc	-0.130	-0.130	-0.199	-0.345	0.74	0.74	0.63	0.45
SB4VS-16	ccc	measured bc	-0.167	-0.170	-0.230	-0.373	0.68	0.68	0.59	0.42
SB4VS-17	ccc	measured bc	-0.209	-0.187	-0.284	-0.397	0.62	0.65	0.52	0.40
SB4VS-18	ccc	measured bc	-0.186	-0.169	-0.268	-0.375	0.65	0.68	0.54	0.42
SB4VS-19	ccc	measured bc	-0.187	-0.174	-0.244	-0.372	0.65	0.67	0.57	0.42
SB4VS-20	ccc	measured bc	-0.203	-0.175	-0.290	-0.383	0.63	0.67	0.51	0.41
SB4VS-21	ccc	measured bc	-0.209	-0.189	-0.312	-0.393	0.62	0.65	0.49	0.40
SB4VS-22	ccc	measured bc	-0.171	-0.171	-0.183	-0.376	0.67	0.68	0.66	0.42
SB4VS-23	ccc	measured bc	-0.139	-0.149	-0.144	-0.358	0.73	0.71	0.72	0.44
SB4VS-24	ccc	measured bc	-0.137	-0.148	-0.165	-0.339	0.73	0.71	0.68	0.46
SB4VS-25	ccc	measured bc	-0.129	-0.151	-0.176	-0.353	0.74	0.71	0.67	0.44
SB4VS-26	ccc	measured bc	-0.166	-0.163	-0.167	-0.365	0.68	0.69	0.68	0.43
SB4VS-27	ccc	measured bc	-0.186	-0.177	-0.214	-0.369	0.65	0.67	0.61	0.43
SB4VS-28	ccc	measured bc	-0.176	-0.178	-0.245	-0.371	0.67	0.66	0.57	0.43
SB4VS-29	ccc	measured bc	-0.177	-0.160	-0.227	-0.356	0.67	0.69	0.59	0.44
SB4VS-30	ccc	measured bc	-0.144	-0.137	-0.217	-0.331	0.72	0.73	0.61	0.47
SB4VS-31	ccc	measured bc	-0.196	-0.156	-0.282	-0.356	0.64	0.70	0.52	0.44
SB4VS-32	ccc	measured bc	-0.084	-0.121	-0.111	-0.329	0.82	0.76	0.77	0.47
SB4VS-33	ccc	measured bc	-0.214	-0.188	-0.277	-0.413	0.61	0.65	0.53	0.39
SB4VS-34	ccc	measured bc	-0.173	-0.148	-0.267	-0.366	0.67	0.71	0.54	0.43

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

Glass ID	Heat Treatment	Composition	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)
SB4VS-35	ccc	measured bc	-0.155	-0.147	-0.197	-0.345	0.70	0.71	0.64	0.45
SB4VS-01	quenched	measured bc	-0.150	-0.106	-0.064	-0.288	0.71	0.78	0.86	0.52
SB4VS-02	quenched	measured bc	-0.127	-0.096	-0.058	-0.274	0.75	0.80	0.87	0.53
SB4VS-03	quenched	measured bc	-0.063	-0.069	-0.035	-0.252	0.86	0.85	0.92	0.56
SB4VS-04	quenched	measured bc	-0.060	-0.082	0.018	-0.261	0.87	0.83	1.04	0.55
SB4VS-05	quenched	measured bc	-0.192	-0.150	-0.262	-0.351	0.64	0.71	0.55	0.45
SB4VS-06	quenched	measured bc	-0.176	-0.156	-0.250	-0.365	0.67	0.70	0.56	0.43
SB4VS-07	quenched	measured bc	-0.157	-0.155	-0.191	-0.369	0.70	0.70	0.64	0.43
SB4VS-08	quenched	measured bc	-0.169	-0.161	-0.180	-0.376	0.68	0.69	0.66	0.42
SB4VS-09	quenched	measured bc	-0.086	-0.124	-0.104	-0.338	0.82	0.75	0.79	0.46
SB4VS-10	quenched	measured bc	-0.122	-0.134	-0.136	-0.365	0.76	0.73	0.73	0.43
SB4VS-11	quenched	measured bc	-0.125	-0.130	-0.151	-0.357	0.75	0.74	0.71	0.44
SB4VS-12	quenched	measured bc	-0.139	-0.126	-0.179	-0.365	0.73	0.75	0.66	0.43
SB4VS-13	quenched	measured bc	-0.156	-0.133	-0.220	-0.381	0.70	0.74	0.60	0.42
SB4VS-14	quenched	measured bc	-0.126	-0.116	-0.173	-0.348	0.75	0.77	0.67	0.45
SB4VS-15	quenched	measured bc	-0.134	-0.118	-0.187	-0.348	0.73	0.76	0.65	0.45
SB4VS-16	quenched	measured bc	-0.137	-0.126	-0.192	-0.357	0.73	0.75	0.64	0.44
SB4VS-17	quenched	measured bc	-0.217	-0.173	-0.284	-0.402	0.61	0.67	0.52	0.40
SB4VS-18	quenched	measured bc	-0.179	-0.149	-0.276	-0.375	0.66	0.71	0.53	0.42
SB4VS-19	quenched	measured bc	-0.169	-0.156	-0.238	-0.372	0.68	0.70	0.58	0.42
SB4VS-20	quenched	measured bc	-0.203	-0.162	-0.296	-0.388	0.63	0.69	0.51	0.41
SB4VS-21	quenched	measured bc	-0.195	-0.163	-0.314	-0.388	0.64	0.69	0.49	0.41
SB4VS-22	quenched	measured bc	-0.181	-0.189	-0.191	-0.390	0.66	0.65	0.64	0.41
SB4VS-23	quenched	measured bc	-0.147	-0.165	-0.150	-0.367	0.71	0.68	0.71	0.43
SB4VS-24	quenched	measured bc	-0.129	-0.147	-0.119	-0.345	0.74	0.71	0.76	0.45
SB4VS-25	quenched	measured bc	-0.153	-0.166	-0.179	-0.366	0.70	0.68	0.66	0.43
SB4VS-26	quenched	measured bc	-0.156	-0.157	-0.157	-0.369	0.70	0.70	0.70	0.43
SB4VS-27	quenched	measured bc	-0.165	-0.153	-0.200	-0.358	0.68	0.70	0.63	0.44
SB4VS-28	quenched	measured bc	-0.167	-0.159	-0.238	-0.365	0.68	0.69	0.58	0.43
SB4VS-29	quenched	measured bc	-0.173	-0.147	-0.228	-0.356	0.67	0.71	0.59	0.44
SB4VS-30	quenched	measured bc	-0.136	-0.131	-0.224	-0.338	0.73	0.74	0.60	0.46
SB4VS-31	quenched	measured bc	-0.201	-0.151	-0.306	-0.358	0.63	0.71	0.49	0.44
SB4VS-32	quenched	measured bc	-0.102	-0.134	-0.112	-0.339	0.79	0.73	0.77	0.46
SB4VS-33	quenched	measured bc	-0.200	-0.155	-0.281	-0.402	0.63	0.70	0.52	0.40
SB4VS-34	quenched	measured bc	-0.155	-0.120	-0.278	-0.352	0.70	0.76	0.53	0.44
SB4VS-35	quenched	measured bc	-0.134	-0.131	-0.192	-0.340	0.74	0.74	0.64	0.46

3.3.5 *Effects of Heat Treatment on PCTs*

Exhibit F7 in Appendix F provides a series of plots and statistical comparisons that show the effects of heat treatment on the common logarithm ppm responses over the triplicate PCTs for each element for each study glass. The ccc version of a given glass yielded measurements indicating a significantly (at the 5% significance level) larger mean log(ppm) response than the quenched version of the glass for a given element if the **Prob<t** value in the exhibit is 0.05 or smaller. This is true for SB4VS-09, which shows a statistically significant decrease in durability between the ccc and quenched versions for all four elements of interest.

Exhibit F8 in Appendix F provides a series of plots that show the effects of heat treatment on the PCT response based on the three different compositional views: measured, measured bias-corrected, and targeted. These plots allow for an assessment of the differences in PCT responses from a practical perspective. Again, the ccc version of SB4VS-09 stands out as having a reduced durability compared to the quenched version of this glass.

The slow cooling associated with the ccc heat treatment can provide the opportunity for thermodynamically favorable crystallization to occur. Historically, the ccc heat treatment has fostered the formation of spinels and/or nepheline in SB4 based glasses.[8, 9, 11] The highest NL [B] value, 1.42 g/L (based on the measured-bc compositional view), was measured for SB4VS-09ccc. This glass consists of Frit 503 coupled with the centroid SB4 sludge composition at 46% WL. As noted in the selection report, the Frit 503 centroid system becomes T_L and nepheline limited at 47% WL.[16] This glass is PCCS MAR acceptable based on the target composition but fails the nepheline discriminator when the measured composition is used in the MAR assessments (see Table 3-1). Although this glass would not be deemed processable based on the measured composition, its normalized release is still very acceptable relative to the EA benchmark of 16.695 g/L.[21] In addition, other factors (e.g., melt rate and/or waste throughput issues) will likely limit DWPF from targeting WLs greater than 40% for the SB4 system. SB4VS-02ccc is the only other ccc based glass with a NL [B] value greater than 1.0 g/L (e.g., 1.08 g/L based on the measured-bc compositional view). All other ccc glasses have NL [B] values of less than 1.0 g/L, which is very acceptable compared to the EA benchmark.

Based solely on the PCT responses (in terms of the NL [B] as compared to the EA benchmark), both Frit 418 and Frit 503 will produce very acceptable glasses within the SB4 compositional region bounded by this variability study.

3.3.6 *Predicted versus Measured PCTs*

As shown earlier in Table 3-4, the durabilities for the SB4 variability study glasses are all very acceptable when compared to the durability of the EA glass. Exhibit F9 in Appendix F provides plots of the DWPF models that relate the logarithm of the normalized PCT results (for each element of interest) to a linear function of a free energy of hydration term (ΔG_p, kcal/100g glass) derived from all of the glass compositional views and heat treatments.[12] Prediction limits (at a 95% confidence) for an individual PCT result are also plotted along with the linear fit. The EA and ARM results are indicated on these plots. Exhibit F10 in Appendix F provides a version of these plots for the quenched glasses only, while Exhibit F11 in Appendix F provides a version for the ccc glasses only.

Figure 3-3 is the plot associated with the NL [B] versus ΔG_p for the study glasses, both quenched (open circles) and ccc (closed circles) for all of the compositional views.[a] The quenched glasses all have acceptable PCT responses and with the exception of SB4VS-34, all are predictable (i.e., within the 95% prediction intervals). Glass SB4VS-34 is a Frit 503 composition at 36% WL. The quenched and ccc versions of SB4VS-34 (based on the measured-bc compositional view) lie outside the upper 95% prediction interval indicating that these glasses are not predictable, although they are very acceptable. From Table 3-1, the ΔG_p value for the quenched version of SB4VS-34 (based on the measured-bc view) is -7.036 kcal/mol and from Table 3-3, its NL [B] is 0.7 g/L. The ccc version of SB4VS-34 (based on the measured-bc view) lies at the same ΔG_p value but has a NL [B] of 0.67 g/L, which also pushes it slightly above the upper 95% confidence band. Historically, glasses with more positive ΔG_p values have demonstrated this same response.[7, 24]

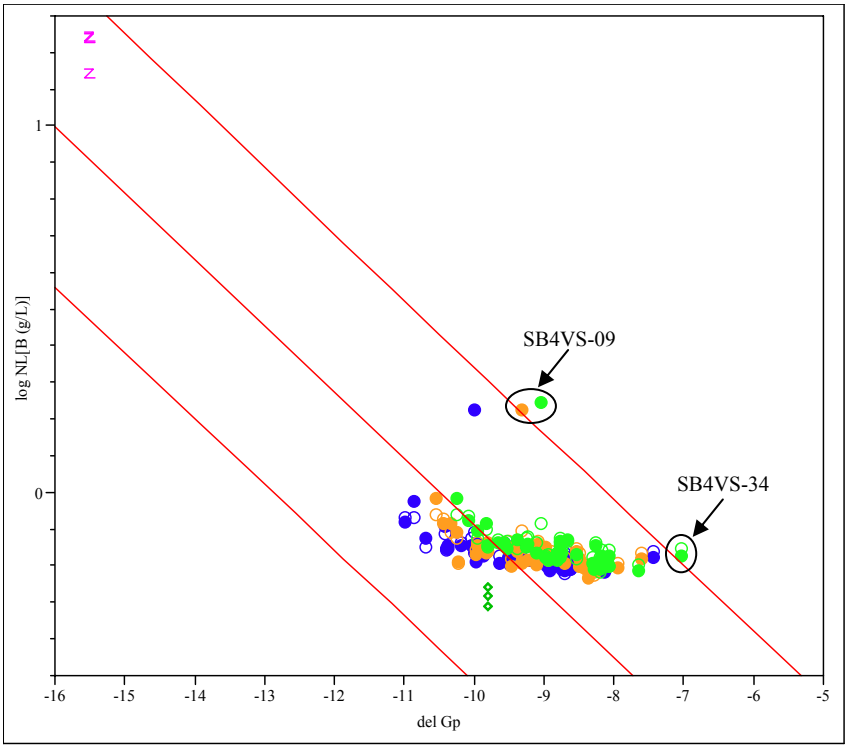


Figure 3-3. NL [B] versus ΔG_p for the SB4 Variability Study Glasses.

The glass of most interest is SB4VS-09ccc (a Frit 503 / SB4 centroid composition targeting 46% WL) represented by the three points which are well above all the other study glasses in Figure 3-3. Specifically, those three points having a log [NL [B]] of approximately 0.13 to 0.15 g/L with corresponding ΔG_p values of -10 to -9 kcal/mol. Two of the three compositional views (target and measured-bias corrected) are above the 95% confidence band indicating that their PCT responses are unpredictable by the current models. The PCT response based on the measured composition is predictable. In comparison to the EA benchmark, SB4VS-09ccc is very acceptable with a NL [B] of 1.35 to 1.42 g/L (based on the compositional view used to normalize

[a] Orange indicates the target compositional view; blue indicates the measured compositional view; and green represents the measured bias corrected compositional view.

the response), which again is the highest release or least durable glass from the SB4 variability study.

As shown in Table 3-1, SB4VS-09 would not be classified as a MAR acceptable glass based on the measured composition. More specifically, predictions of nepheline formation would restrict this glass from being processed in DWPF as the 0.62 discriminator value was not met. That being said, if SB4VS-09 represented a Frit 503 / SB4 melter feed (or SME batch), based on the compositional analysis this feed would not be classified as processable, even though the PCT response is very acceptable. Although not intentionally planned as part of the variability study, this glass shows the effectiveness of the nepheline discriminator in identifying potentially non-durable glasses based on the possibility of nepheline formation. In fact, in Section 3.4.2, XRD results will indicate that the ccc version of SB4VS-09 did contain nepheline (as expected based on the measured composition) which is responsible for the statistically significant difference in PCT response between the quenched and ccc version of this glass (i.e., NL [B] value of approximately 0.7 g/L for the quenched version compared to 1.4 g/L for its ccc counterpart). It should be noted that based on the MAR assessments, the Frit 503 / SB4 centroid composition was nepheline limited at 47% WL. With SB4VS-09 targeting 46% WL, it is not surprising that the measured composition suggested that nepheline formation was an issue.

3.4 Homogeneity

Table 3-5 lists the visual and XRD results for the quenched and ccc versions of the variability study glasses. These results will be summarized below. For a more detailed description of the visual observations and XRD results, see WSRC-NB-2004-00135.

Table 3-5. Visual Observations and XRD Results for the Variability Study Glasses.

Glass	Frit ID	Target WL	Heat Treatment	Visual Observations	XRD
SB4VS-01	418	32	quenched	Surface: Clean, homogeneous	
			ccc	Surface: Hazy with metallic swirls; Bulk: Black and shiny, clean	amorphous
SB4VS-02	418	36	quenched	Surface: Clean, homogeneous	
			ccc	Surface: Hazy with metallic swirls; Bulk: Black and shiny, clean	amorphous
SB4VS-03	418	40	quenched	Surface: Clean, homogeneous	
			ccc	Surface: Dull haze with metallic swirls; Bulk: Black and shiny, clean	amorphous
SB4VS-04	418	44	quenched	Surface: Light metallic swirls on surface, otherwise clean	
			ccc	Surface: Dull, devitrified; Bulk: Black, shiny and clean	amorphous
SB4VS-05	503	30	quenched	Surface: Clean, homogeneous	
			ccc	Surface: Black, shiny and clean; Bulk: Black, shiny and clean	amorphous
SB4VS-06	503	34	quenched	Surface: Clean, homogeneous	
			ccc	Surface: Black, shiny and clean; Bulk: Black, shiny and clean	amorphous
SB4VS-07	503	38	quenched	Surface: Clean, homogeneous	
			ccc	Surface: Shiny haze with brown swirls; Bulk: Black, shiny and clean	amorphous
SB4VS-08	503	42	quenched	Surface: Clean, homogeneous	
			ccc	Surface: Haze with crystal clusters; Bulk: Black, shiny and clean	amorphous
SB4VS-09	503	46	quenched	Surface: Clean, homogeneous	
			ccc	Surface: Dull with large clusters of crystals; Bulk: Black, shiny and clean	$NaAlSiO_4$
SB4VS-10	503	42	quenched	Surface: Clean, homogeneous	
			ccc	Surface: Milky, metallic haze; Bulk: Clean	amorphous
SB4VS-11	503	42	quenched	Surface: Black and shiny with some shiny metallic spots	
			ccc	Surface: Milky, metallic haze; Bulk: Clean	amorphous
SB4VS-12	503	40	quenched	Surface: Clean, homogeneous	
			ccc	Surface: Shiny, metallic with small amount of crystal swirls; Bulk: Clean	amorphous
SB4VS-13	503	40	quenched	Surface: Black and shiny with approx. five metallic spots	
			ccc	Surface: Shiny, metallic with small amount of crystal swirls; Bulk: Clean	amorphous
SB4VS-14	503	38	quenched	Surface: Clean, homogeneous	
			ccc	Surface: Shiny, metallic with small amount of crystal swirls; Bulk: Clean	amorphous
SB4VS-15	503	38	quenched	Surface: Clean, homogeneous	
			ccc	Surface: Shiny, metallic with small amount of crystal swirls; Bulk: Clean	amorphous

Table 3-5. Visual Observations and XRD Results for the Variability Study Glasses. (continued)

Glass	Frit ID	Target WL	Heat Treatment	Visual Observations	XRD
SB4VS-16	503	36	quenched	Surface: Clean, homogeneous	
			ccc	Surface: Shiny, metallic with small amount of crystal swirls; Bulk: Clean	amorphous
SB4VS-17	503	36	quenched	Surface: Clean, homogeneous	
			ccc	Surface: Black and shiny with a very small amount of crystals; Bulk: Clean	amorphous
SB4VS-18	503	34	quenched	Surface: Clean, homogeneous	
			ccc	Surface: Black and shiny with a very small amount of crystals; Bulk: Clean	amorphous
SB4VS-19	503	34	quenched	Surface: Clean, homogeneous	
			ccc	Surface: Clean, black and shiny; Bulk: Clean	amorphous
SB4VS-20	503	32	quenched	Surface: Clean, homogeneous	
			ccc	Surface: Clean, black and shiny; Bulk: Clean	amorphous
SB4VS-21	503	32	quenched	Surface: Clean, homogeneous	
			ccc	Surface: Clean, black and shiny; Bulk: Clean	amorphous
SB4VS-22	503	42	quenched	Surface: Clean and shiny	
			ccc	Surface: Hazy with small clusters of silver crystals; Bulk: Clean	amorphous
SB4VS-23	503	40	quenched	Surface: Clean and shiny	
			ccc	Surface: Shiny film with one spot of silver crystals; Bulk: Clean	amorphous
SB4VS-24	503	40	quenched	Surface: Clean, black and shiny	
			ccc	Surface: Shiny, milky haze; Bulk: Clean	amorphous
SB4VS-25	503	38	quenched	Surface: Clean, black and shiny	
			ccc	Surface: Shiny, milky haze; Bulk: Clean	amorphous
SB4VS-26	503	38	quenched	Surface: Clean, black and shiny	
			ccc	Surface: Shiny film with crystals; Bulk: Clean	amorphous
SB4VS-27	503	36	quenched	Surface: Clean, black and shiny	
			ccc	Surface: Haze with crystals; Bulk: Clean	amorphous
SB4VS-28	503	36	quenched	Surface: Clean, black and shiny	
			ccc	Surface: Shiny, hazy; Bulk: Clean	amorphous

Table 3-5. Visual Observations and XRD Results for the Variability Study Glasses. (continued)

Glass	Frit ID	Target WL	Heat Treatment	Visual Observations	XRD
SB4VS-29	503	34	quenched	Surface: Clean, black and shiny	
			ccc	Surface: Clean, black and shiny; Bulk: Clean	amorphous
SB4VS-30	503	34	quenched	Surface: Clean, black and shiny	
			ccc	Surface: Shiny, hazy; Bulk: Clean	amorphous
SB4VS-31	503	32	quenched	Surface: Clean, black and shiny	
			ccc	Surface: Clean; Bulk: Clean	amorphous
SB4VS-32	503	40	quenched	Surface: Clean, black and shiny	
			ccc	Surface: Shiny, hazy; Bulk: Clean	amorphous
SB4VS-33	503	38	quenched	Surface: Clean, black and shiny	
			ccc	Surface: Shiny, hazy; Bulk: Clean	amorphous
SB4VS-34	503	36	quenched	Surface: Clean, black and shiny	
			ccc	Surface: Shiny, hazy with spots of silver crystals; Bulk: Clean	amorphous
SB4VS-35	503	34	quenched	Surface: Clean, black and shiny	
			ccc	Surface: Black, shiny; Bulk: Clean	amorphous

3.4.1 *Visual Observations*

Prior to discussing the visual observations, a few words regarding the terminology used are warranted. The term "surface" refers to the surface of the quenched pour patty or glass sample after the ccc heat treatment. The term "bulk" refers to the cross-section of the quenched pour patty or glass sample after the ccc heat treatment. The use of "homogeneous" indicates that the sample was classified as a single-phase system (i.e., no evidence of crystallization). Other terms such as "swirls", "haze", "clusters", "milky", and/or "metallic spots" imply that the surface or bulk of the glass was characterized by the presence of crystallization or some other characteristic feature.

Visual observations of the quenched variability study glasses indicate that 32 of the glasses were homogeneous, while the remaining three glasses were characterized by metallic spots or swirls on the surface, with the bulk (cross-section) being homogeneous (Table 3-5). The three quenched glasses (SB4-VS-04, -11, and -13) with surface crystallization had generally higher WLs (i.e., ≥ 40% WL). Use of descriptions such as a metallic-like surface or spots is common for DWPF-type glasses targeting higher WLs. Previous XRD analyses have indicated that the metallic-like surface features are typically a result of spinels that precipitate during the cooling process. This follows glass theory which suggests that as WL increases, the concentrations of Fe_2O_3, NiO, Cr_2O_3, and/or MnO also increase, enhancing the likelihood of spinel devitrification. Based on the PCT responses for the quenched glasses, spinel formation on the surface resulting in metallic spots and swirls is reasonable as spinels have been shown to have minimal impact on the durability response.[25] In addition, the XRD results discussed in Section 3.4.2 will show that no spinels were present in the quenched glasses at levels greater than the detection limit of 0.5 vol%.

A metallic haze, either somewhat shiny or dull, characterized the surface of all but eight of the ccc glasses (Table 3-5). This behavior again is indicative of the formation of spinels, though the XRD results will show that no spinels were present in the ccc glasses at levels greater than the detection limit of 0.5 vol%. Devitrification at the surface was more prevalent in the ccc glasses than in the quenched glasses. This crystallization is expected, given kinetics are more favorable for devitrification during the slower cooling cycle. However, the bulk (cross-section) of each of the ccc glasses was free of any visible crystallization. Note though that nepheline crystallization, if present, is typically not visible. Based on these observations, XRD analysis of the ccc glasses was warranted.

3.4.2 *XRD Results*

The XRD results are included in Table 3-5, and provide qualitative results regarding crystallization in the variability study glasses. Only the ccc versions of the glasses were submitted for XRD analysis given that the visual observations and durability responses suggested no significant crystallization in the quenched glasses. That is, with normalized boron releases ranging from ~0.6 to 0.9 g/L, there is no evidence of nepheline formation in the quenched glasses.

All but one of the ccc glasses was found to be amorphous by XRD. Though visual observations indicated crystallization on the surface of several of the ccc glasses, they also indicated that the bulk, or cross-section of each glass was free of visible crystallization. The XRD results indicate that the amount of crystallization seen on the surface of some of the ccc glasses made up less than 0.5 vol% of the specimen. XRD results for glass SB4VS-01 ccc are shown in Figure 3-4. The characteristically high background devoid of crystalline spectral lines indicates that this glass is either amorphous, or has a crystalline content below the detection limit of 0.5 vol%. This pattern is representative of all of the ccc glasses in the variability study except for SB4VS-09.

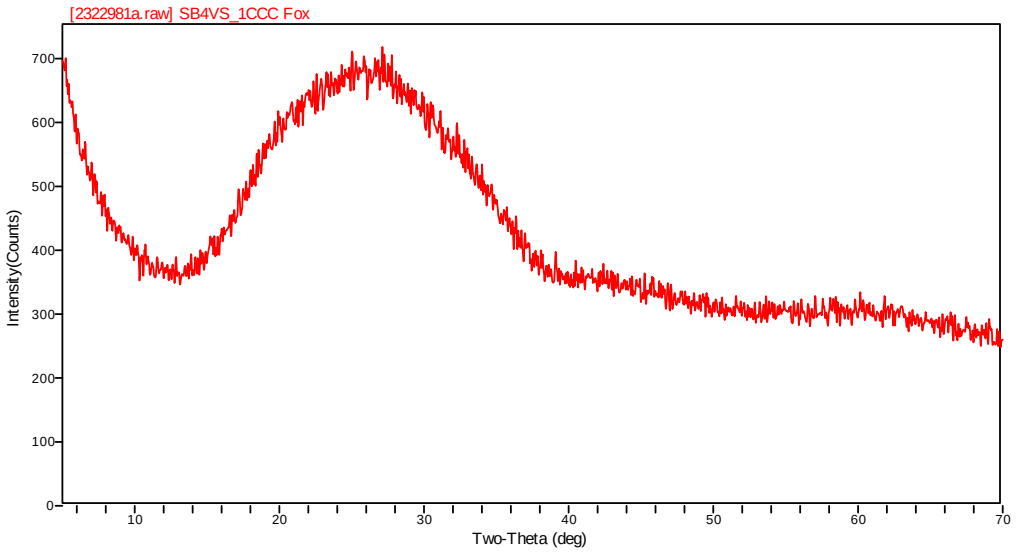


Figure 3-4. XRD Pattern for the ccc Version of Glass SB4VS-01.

Nepheline ($NaAlSiO_4$) was identified by XRD in the ccc version of glass SB4VS-09. The XRD pattern for this glass is shown in Figure 3-5. The target composition of this glass results in a nepheline discriminator value of 0.635, which is the lowest value for all of the variability study glasses. Recent work has shown that glass compositions with a nepheline discriminator value of 0.62 or less are prone to nepheline crystallization upon the ccc heat treatment.[4-11] When the nepheline discriminator for SB4VS-09 is calculated using the measured composition, the result is 0.619. Therefore, based on the critical value for the nepheline discriminator of 0.62, it is not surprising that some nepheline was detected in this glass via XRD. This serves as the technical basis for the statistically significant difference in PCT response between the quenched and ccc version of this glass. As discussed in Sections 3.2 and 3.3.6, SB4VS-09 would not be classified as a MAR acceptable glass based on the measured composition. More specifically, predictions of nepheline formation would restrict this glass from being processed in DWPF as the 0.62 discriminator value was not met. Although SB4VS-09 was not intentionally selected to challenge the ability of the nepheline discriminator, the results do demonstrate its effectiveness.

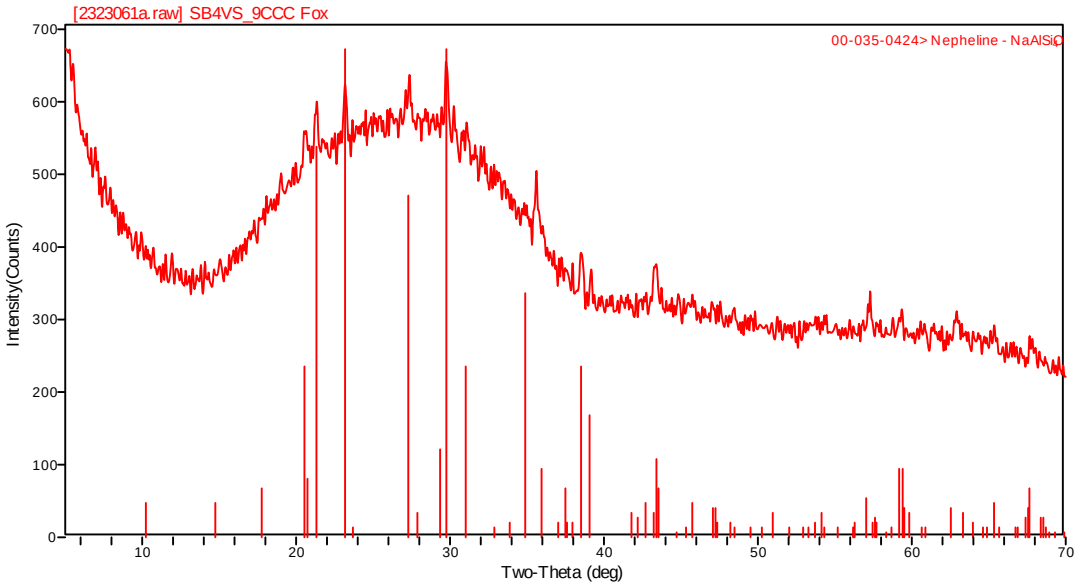


Figure 3-5. XRD Pattern for the ccc Version of Glass SB4VS-09.

4.0 Conclusions

The results of the variability study show that vitrifying SB4 with Frit 503 will produce glasses with durabilities that are both predictable by the DWPF PCCS models and acceptable as compared to the EA glass, within the range of sludge compositions and waste loadings included in the study. All 35 of the glasses fabricated had durabilities that were very acceptable as compared to the EA glass for both quenched and ccc heat treatments. Two of the variability study glasses (SB4VS-09 and SB4VS-34) fell outside of the 95% confidence interval for the free energy of hydration durability model. One of these glasses had a high (more positive) ΔG_P value and an acceptable durability (more than an order of magnitude below that of the EA benchmark glass). This type of response has been seen in past studies and is not a cause for concern. The second of the glasses that fell outside of the 95% confidence interval was found to be prone to nepheline crystallization based on the measured composition, and therefore would not have passed the DWPF PCCS MAR. This glass showed a statistically significant decrease in durability after the ccc heat treatment due to nepheline crystallization. However, both the quenched and ccc versions of this glass were very acceptable when compared to the durability of the EA glass.

The glasses formulated with SB4 and Frit 418 were both predictable and acceptable. This frit is considered an option for DWPF processing during the transition from SB3 to SB4.

Chemical composition measurements of the variability study glasses indicate that the sulfate limit of 0.60 wt% in glass is viable for the Frit 503 / SB4 system, based on the nominal SB4 composition projections used as the technical basis for this study.

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5.0 Recommendations

Based on the results and observations of this study, the following recommendations are made:

- Utilize Frit 503 to process SB4 in DWPF given the projected sludge compositions.
- Utilize Frit 418 during the transition from SB3 to SB4, if warranted.
- Maintain the PCCS SO_4^{2-} limit for the Frit 503 / SB4 system at 0.60 wt%.

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6.0 References

1. Peeler, D. K., T. B. Edwards and K. M. Fox, "Frit Recommendation for SB4," *U.S. Department of Energy Report SRNL-PSE-2006-00128,* Washington Savannah River Company, Aiken, South Carolina (2006).

2. Peeler, D. K. and T. B. Edwards, "Model Based Assessments of the Final SB4 Projections Compositions Leading to the Frit Recommendation," *U.S. Department of Energy Report WSRC-TR-2006-00269, Revision 0,* Washington Savannah River Company, Aiken, South Carolina (2006).

3. Smith, M. E., M. E. Stone, T. M. Jones, D. H. Miller and P. R. Burket, "SB4 MRF and SMRF Tests with Frits 418, 425, and 503 (U)," *U.S. Department of Energy Report WSRC-STI-2006-00015, Revision 0,* Washington Savannah River Company, Aiken, South Carolina (2006).

4. Edwards, T. B. and D. K. Peeler, "Nepheline Formation Potential in Sludge Batch 4 (SB4) and Its Impact on Durability: Selecting Glasses for a Phase 2 Study," *U.S. Department of Energy Report WSRC-TR-2005-00370, Revision 0,* Westinghouse Savannah River Company, Aiken, South Carolina (2005).

5. Edwards, T. B., D. K. Peeler and K. M. Fox, "The Nepheline Discriminator: Justification and DWPF PCCS Implementation Details," *U.S. Department of Energy Report WSRC-STI-2006-00014, Revision 0,* Washington Savannah River Company, Aiken, South Carolina (2006).

6. Fox, K. M., T. B. Edwards and D. K. Peeler, "Nepheline Formation Potential in Sludge Batch 4 (SB4) and Its Impact on Durability: Selecting Glasses for a Phase 3 Study," *U.S. Department of Energy Report WSRC-TR-2006-00053, Revision 0,* Washington Savannah River Company, Aiken, South Carolina (2006).

7. Fox, K. M., T. B. Edwards, D. K. Peeler, D. R. Best, I. A. Reamer and R. J. Workman, "Durability and Nepheline Crystallization Study for High Level Waste (HLW) Sludge Batch 4 (SB4) Glasses Formulated with Frit 503," *U.S. Department of Energy Report WSRC-STI-2006-00009, Revision 0,* Washington Savannah River Company, Aiken, South Carolina (2006).

8. Fox, K. M., D. K. Peeler, T. B. Edwards, D. R. Best, I. A. Reamer and R. J. Workman, "Nepheline Formation Study for Sludge Batch 4 (SB4): Phase 3 Experimental Results," *U.S. Department of Energy Report WSRC-TR-2006-00093, Revision 0,* Washington Savannah River Company, Aiken, South Carolina (2006).

9. Peeler, D. K., T. B. Edwards, D. R. Best, I. A. Reamer and R. J. Workman, "Nepheline Formation Study for Sludge Batch 4 (SB4): Phase 2 Experimental Results," *U.S. Department of Energy Report WSRC-TR-2006-00006, Revision 0,* Washington Savannah River Company, Aiken, South Carolina (2006).

10. Peeler, D. K., T. B. Edwards and T. H. Lorier, "Nepheline Formation Potential in Sludge Batch (SB4) Glasses," *U.S. Department of Energy Report WSRC-TR-2005-00153, Revision 0,* Westinghouse Savannah River Company, Aiken, South Carolina (2005).

11. Peeler, D. K., T. B. Edwards, I. A. Reamer and R. J. Workman, "Nepheline Formation Study for Sludge Batch 4 (SB4): Phase 1 Experimental Results," *U.S. Department of Energy Report WSRC-TR-2005-00371, Revision 0,* Westinghouse Savannah River Company, Aiken, South Carolina (2005).

12. Jantzen, C. M., J. B. Picket, K. G. Brown, T. B. Edwards and D. C. Beam, "Process/Product Models for the Defense Waste Processing Facility (DWPF): Part I. Predicting Glass Durability from Composition Using a Thermodynamic Hydration Energy Reaction Model (THERMO)," *U.S. Department of Energy Report WSRC-TR-93-672, Revision 1,* Westinghouse Savannah River Company, Aiken, South Carolina (1995).

13. ASTM, "Standard Test Methods for Determining Chemical Durability of Nuclear Waste Glasses: The Product Consistency Test (PCT)," *U.S. Department of Energy Report ASTM C-1285-2002,* (2002).

14. Washburn, F. A., "Technical Task Request: Sludge Batch 4 and MCU Frit Optimization," *U.S. Department of Energy Report HLW/DWPF/TTR-2004-0026, Revision 0,* Westinghouse Savannah River Company, Aiken, South Carolina (2004).

15. Peeler, D. K., "Task Technical & QA Plan: Sludge Batch and MCU Frit Optimization," *U.S. Department of Energy Report WSRC-RP-2004-00746, Revision 0,* Westinghouse Savannah River Company, Aiken, South Carolina (2004).

16. Fox, K. M., T. B. Edwards and D. K. Peeler, "High Level Waste (HLW) Sludge Batch 4 (SB4): Selecting Glasses for a Variability Study," *U.S. Department of Energy Report WSRC-STI-2006-00039, Revision 0,* Washington Savannah River Company, Aiken, South Carolina (2006).

17. Peeler, D. K., C. C. Herman, M. E. Smith, T. H. Lorier, D. R. Best, T. B. Edwards and M. A. Baich, "An Assessment of the Sulfate Solubility Limit for the Frit 418 – Sludge Batch 2/3 System," *U.S. Department of Energy Report WSRC-TR-2004-00081, Revision 0,* Westinghouse Savannah River Company, Aiken, South Carolina (2004).

18. SRNL, "Glass Batching," *U.S. Department of Energy Report SRTC Procedure Manual, L29, ITS-0001,* Westinghouse Savannah River Company, Aiken, South Carolina (2002).

19. SRNL, "Glass Melting," *U.S. Department of Energy Report SRTC Procedure Manual, L29, ITS-0003,* Westinghouse Savannah River Company, Aiken, South Carolina (2002).

20. Marra, S. L. and C. M. Jantzen, "Characterization of Projected DWPF Glass Heat Treated to Simulate Canister Centerline Cooling," *U.S. Department of Energy Report WSRC-TR-92-142, Revision 1,* Westinghouse Savannah River Company, Aiken, South Carolina (1993).

21. Jantzen, C. M., N. E. Bibler, D. C. Beam, C. L. Crawford and M. A. Pickett, "Characterization of the Defense Waste Processing Facility (DWPF) Environmental Assessment (EA) Glass Standard Reference Material," *U.S. Department of Energy Report WSRC-TR-92-346, Revision 1,* Westinghouse Savannah River Company, Aiken, South Carolina (1993).

22. Ebert, W. L. and S. F. Wolfe, "Round-robin Testing of a Reference Glass for Low-Activity Waste Forms," *U.S. Department of Energy Report ANL-99/22,* Argonne National Laboratory, Argonne, Illinois (1999).

23. Jantzen, C. M. and M. E. Smith, "Revision of the Defense Waste Processing Facility (DWPF) Sulfate Solubility Limit," *U.S. Department of Energy Report WSRC-TR-2003-00518, Revision 0,* Westinghouse Savannah River Company, Aiken, South Carolina (2003).

24. Harbour, J. R., T. B. Edwards and R. J. Workman, "Summary of Results for Macrobatch 3 Variability Study," *U.S. Department of Energy Report WSRC-TR-2000-00351, Revision 0,* Westinghouse Savannah River Company, Aiken, South Carolina (2000).

25. Bickford, D. F. and C. M. Jantzen, "Devitrification of SRL Defense Waste Glass," *Sci. Basis for Nuclear Waste Management VII, edited by G. L. McVay.* Elsevier, New York, pp. 557-565 (1984).

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Appendix A

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

(SRNL-SCS-2006-00030)

SRNL-SCS-2006-00030

August 14, 2006

To: K. M. Fox, SRNL

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wo – without glass identifiers

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

1.0 EXECUTIVE SUMMARY

A glass variability study is underway at the Savannah River National Laboratory (SRNL) to support the processing of Sludge Batch 4 (SB4) at the Defense Waste Processing Facility (DWPF). Thirty-five (35) glasses have been selected to be batched and fabricated as part of this study. The chemical composition of these glasses is to be analyzed by SRNL's Process Science Analytical Laboratory (PSAL). This memorandum provides an analytical plan for the measurements by PSAL.

2.0 INTRODUCTION

A glass variability study is underway at the Savannah River National Laboratory (SRNL) to support the processing of Sludge Batch 4 (SB4) at the Defense Waste Processing Facility (DWPF) [1]. Thirty-five (35) glasses have been selected to be batched and fabricated as part of this study. The chemical composition of these glasses is to be analyzed by SRNL's Process Science Analytical Laboratory (PSAL). This memorandum provides an analytical plan for the measurements by PSAL.

3.0 ANALYTICAL PLAN

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

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

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

Samples of glass standards will be included in the analytical plan to provide an opportunity for checking the performance of the instrumentation over the course of the analyses and for potential bias correction. Specifically, several samples of Waste Compliance Plan (WCP) Batch 1 (BCH) [2] and a uranium standard glass (Ustd) are included in this analytical plan. The reference compositions of these glasses are provided in Table 1.

In addition, samples of the Low-Activity Reference Material (LRM) standard glass (which contains sulfur – see [3] for details on the chemical composition of this glass) are to be included in the set of samples submitted to PSAL. The measurements of this glass will be used to provide insight into the uncertainty of PSAL's sulfur measurements. The LRM samples are to be labeled in the same manner as the study glasses, but with their labels known. The labels are being provided to assist in the interpretation of the sums of oxides for the glasses. Since some of the elements present in LRM will not be measured by PSAL, the measured sum of oxides for LRM may fall below 95% (i.e., the target sum of oxides for LRM for the elements listed above is only around 97.7%).

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

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

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

Table 2 presents identifying codes, U01 through U43, for the 35 glasses fabricated for this study and the 8 samples of the LRM standard that have been included. The table provides a naming convention that is to be used in analyzing the glasses and reporting the measurements of their compositions.[a]

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

Table 2: Glass Identifiers to Establish Blind Samples for PSAL

Glass ID	Sample ID	Glass ID	Sample ID	Glass ID	Sample ID
SB4VS-01	U07	SB4VS-16	U11	SB4VS-31	U17
SB4VS-02	U15	SB4VS-17	U38	SB4VS-32	U10
SB4VS-03	U22	SB4VS-18	U02	SB4VS-33	U30
SB4VS-04	U21	SB4VS-19	U18	SB4VS-34	U04
SB4VS-05	U13	SB4VS-20	U42	SB4VS-35	U41
SB4VS-06	U24	SB4VS-21	U01	LRM-01	U26
SB4VS-07	U27	SB4VS-22	U23	LRM-02	U33
SB4VS-08	U37	SB4VS-23	U19	LRM-03	U34
SB4VS-09	U06	SB4VS-24	U12	LRM-04	U08
SB4VS-10	U39	SB4VS-25	U16	LRM-05	U03
SB4VS-11	U28	SB4VS-26	U29	LRM-06	U36
SB4VS-12	U14	SB4VS-27	U05	LRM-07	U40
SB4VS-13	U32	SB4VS-28	U35	LRM-08	U31
SB4VS-14	U09	SB4VS-29	U43		
SB4VS-15	U25	SB4VS-30	U20		

3.1 PREPARATION OF THE SAMPLES

Each of the 43 glasses included in this analytical plan is to be prepared in duplicate by the LM and PF dissolution methods. Thus, the total number of prepared glass samples is determined by $43 \cdot 2 \cdot 2 = 172$, not including the samples of the BCH and Ustd glass standards.

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

Table 3: Preparation Blocks by Dissolution Method

LM (Lithium Metaborate) Blocks				PF (Peroxide Fusion) Blocks			
1	2	3	4	1	2	3	4
U26LM1	U04LM1	U34LM1	U38LM1	U14PF1	U31PF1	U33PF1	U08PF1
U32LM1	U05LM1	U21LM1	U20LM1	U11PF1	U27PF1	U39PF1	U08PF2
U30LM1	U16LM1	U15LM1	U12LM1	U11PF2	U31PF2	U39PF2	U34PF1
U27LM1	U19LM1	U21LM2	U38LM2	U12PF1	U27PF2	U18PF1	U15PF1
U31LM1	U16LM2	U34LM2	U20LM2	U14PF2	U21PF1	U18PF2	U34PF2
U02LM1	U07LM1	U15LM2	U12LM2	U17PF1	U41PF1	U23PF1	U03PF1
U30LM2	U19LM2	U36LM1	U28LM1	U05PF1	U26PF1	U24PF1	U09PF1
U26LM2	U07LM2	U25LM1	U10LM1	U37PF1	U42PF1	U33PF2	U03PF2
U02LM2	U04LM2	U06LM1	U11LM1	U36PF1	U21PF2	U23PF2	U43PF1
U35LM1	U22LM1	U13LM1	U33LM1	U12PF2	U35PF1	U20PF1	U15PF2
U27LM2	U05LM2	U09LM1	U03LM1	U30PF1	U19PF1	U13PF1	U04PF1
U31LM2	U42LM1	U40LM1	U10LM2	U17PF2	U38PF1	U02PF1	U43PF2
U35LM2	U22LM2	U40LM2	U33LM2	U22PF1	U29PF1	U13PF2	U09PF2
U32LM2	U29LM1	U36LM2	U39LM1	U22PF2	U35PF2	U24PF2	U28PF1
U17LM1	U23LM1	U25LM2	U28LM2	U05PF2	U19PF2	U07PF1	U10PF1
U08LM1	U23LM2	U18LM1	U11LM2	U32PF1	U42PF2	U07PF2	U06PF1
U24LM1	U37LM1	U14LM1	U39LM2	U40PF1	U41PF2	U20PF2	U06PF2
U01LM1	U42LM2	U09LM2	U43LM1	U32PF2	U16PF1	U25PF1	U04PF2
U24LM2	U41LM1	U14LM2	U03LM2	U37PF2	U26PF2	U01PF1	U10PF2
U17LM2	U41LM2	U06LM2	U43LM2	U36PF2	U16PF2	U25PF2	U28PF2
U01LM2	U37LM2	U13LM2		U40PF2	U38PF2	U02PF2	
U08LM2	U29LM2	U18LM2		U30PF2	U29PF2	U01PF2	

3.2 ICP-AES CALIBRATION BLOCKS

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

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

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

LM Glass Samples							
Used to Measure Elemental Ba, Ca, Ce, Cr, Cu, K, La, Mg, Mn, Na, Pb, S, Th, Ti, Zn, & Zr							
Block 1-1	**Block 1-2**	**Block 2-1**	**Block 2-2**	**Block 3-1**	**Block 3-2**	**Block 4-1**	**Block 4-2**
BCHLM111	BCHLM121	BCHLM211	BCHLM221	BCHLM311	BCHLM321	BCHLM411	BCHLM421
UstdLM111	UstdLM121	UstdLM211	UstdLM221	UstdLM311	UstdLM321	UstdLM411	UstdLM421
U02LM11	U33LM12	U32LM11	U03LM22	U22LM21	U24LM12	U37LM11	U34LM12
U14LM11	U27LM12	U03LM21	U35LM12	U28LM21	U28LM12	U23LM21	U10LM12
U33LM11	U31LM22	U32LM21	U35LM22	U19LM11	U24LM22	U43LM21	U30LM22
U14LM21	U14LM22	U12LM11	U32LM12	U24LM11	U39LM12	U38LM11	U34LM22
U31LM11	U36LM22	U04LM21	U20LM22	U01LM11	U18LM12	U34LM11	U38LM22
U36LM21	U42LM12	U40LM11	U20LM12	U39LM11	U11LM12	U23LM11	U15LM22
U29LM21	U02LM22	U21LM21	U41LM12	U39LM21	U06LM22	U15LM11	U15LM12
U42LM11	U31LM12	U20LM21	U41LM22	U25LM11	U28LM22	U07LM21	U07LM22
U31LM21	U05LM22	U09LM11	U04LM22	U11LM21	U25LM12	U34LM21	U23LM12
U36LM11	U14LM12	U04LM11	U21LM22	U06LM11	U01LM22	U43LM11	U07LM12
U13LM21	U17LM12	U08LM21	U04LM12	U18LM11	U25LM22	U16LM11	U16LM22
BCHLM112	BCHLM122	BCHLM212	BCHLM222	BCHLM312	BCHLM322	BCHLM412	BCHLM422
UstdLM112	UstdLM122	UstdLM212	UstdLM222	UstdLM312	UstdLM322	UstdLM412	UstdLM422
U27LM11	U29LM22	U09LM21	U09LM22	U11LM11	U11LM22	U30LM21	U37LM12
U02LM21	U17LM22	U40LM21	U12LM12	U18LM21	U22LM22	U10LM21	U16LM12
U42LM21	U27LM22	U35LM21	U03LM12	U25LM21	U26LM22	U10LM11	U10LM22
U05LM11	U02LM12	U20LM11	U40LM22	U01LM21	U22LM12	U15LM21	U37LM22
U33LM21	U29LM12	U21LM11	U08LM22	U26LM21	U06LM12	U30LM11	U43LM22
U17LM21	U13LM12	U03LM11	U08LM12	U19LM21	U26LM12	U16LM21	U23LM22
U29LM11	U33LM22	U12LM21	U09LM12	U24LM21	U39LM22	U37LM21	U38LM12
U17LM11	U36LM12	U41LM11	U21LM12	U28LM11	U19LM22	U38LM21	U30LM12
U13LM11	U05LM12	U35LM11	U12LM22	U22LM11	U18LM22	U07LM11	U43LM12
U27LM21	U42LM22	U08LM11	U40LM12	U26LM11	U01LM12	BCHLM413	BCHLM423
U05LM21	U13LM22	U41LM21	U32LM22	U06LM21	U19LM12	UstdLM413	UstdLM423
BCHLM113	BCHLM123	BCHLM213	BCHLM223	BCHLM313	BCHLM323		
UstdLM113	UstdLM123	UstdLM213	UstdLM223	UstdLM313	UstdLM323		

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

PF Glass Samples							
Used to Measure Elemental Al, B, Fe, Li, Ni, Si, & U							
Block 1-1	**Block 1-2**	**Block 2-1**	**Block 2-2**	**Block 3-1**	**Block 3-2**	**Block 4-1**	**Block 4-2**
BCHPF111	BCHPF121	BCHPF211	BCHPF221	BCHPF311	BCHPF321	BCHPF411	BCHPF421
UstdPF111	UstdPF121	UstdPF211	UstdPF221	UstdPF311	UstdPF321	UstdPF411	UstdPF421
U36PF21	U40PF22	U28PF11	U05PF12	U23PF11	U30PF22	U24PF21	U24PF12
U15PF21	U08PF12	U16PF21	U17PF22	U37PF11	U39PF22	U38PF11	U07PF12
U06PF11	U09PF22	U21PF21	U27PF22	U18PF21	U23PF12	U29PF11	U07PF22
U33PF11	U33PF22	U41PF11	U27PF12	U39PF11	U30PF12	U07PF11	U02PF12
U09PF21	U11PF12	U16PF11	U12PF12	U13PF11	U39PF12	U24PF11	U43PF12
U36PF11	U11PF22	U12PF21	U41PF22	U13PF21	U37PF22	U29PF21	U22PF22
U14PF21	U15PF12	U10PF21	U05PF22	U01PF21	U01PF22	U31PF21	U24PF22
U11PF11	U15PF22	U35PF21	U35PF12	U32PF21	U18PF22	U02PF11	U38PF22
U20PF11	U08PF22	U25PF21	U25PF12	U26PF21	U37PF12	U04PF11	U04PF12
U06PF21	U20PF22	U27PF11	U21PF22	U37PF21	U01PF12	U07PF21	U43PF22
U09PF11	U14PF12	U21PF11	U12PF22	U42PF21	U03PF12	U19PF11	U38PF12
BCHPF112	BCHPF122	BCHPF212	BCHPF222	BCHPF312	BCHPF322	BCHPF412	BCHPF422
UstdPF112	UstdPF122	UstdPF212	UstdPF222	UstdPF312	UstdPF322	UstdPF412	UstdPF422
U08PF11	U34PF22	U17PF11	U16PF22	U18PF11	U26PF12	U38PF21	U19PF12
U08PF21	U40PF12	U27PF21	U25PF22	U23PF21	U03PF22	U19PF21	U31PF12
U20PF21	U06PF12	U05PF21	U17PF12	U30PF21	U32PF22	U43PF21	U29PF12
U34PF21	U20PF12	U25PF11	U10PF22	U42PF11	U26PF22	U43PF11	U19PF22
U15PF11	U33PF12	U10PF11	U21PF12	U32PF11	U13PF22	U04PF21	U31PF22
U40PF11	U36PF22	U35PF11	U28PF12	U39PF21	U42PF12	U31PF11	U22PF12
U33PF21	U06PF22	U41PF21	U28PF22	U03PF11	U42PF22	U22PF21	U02PF22
U34PF11	U09PF12	U05PF11	U41PF12	U30PF11	U13PF12	U22PF11	U04PF22
U40PF21	U14PF22	U12PF11	U10PF12	U26PF11	U18PF12	U02PF21	U29PF22
U14PF11	U36PF12	U28PF21	U35PF22	U01PF11	U32PF12	BCHPF413	BCHPF423
U11PF21	U34PF12	U17PF21	U16PF12	U03PF21	U23PF22	UstdPF413	UstdPF423
BCHPF113	BCHPF123	BCHPF213	BCHPF223	BCHPF313	BCHPF323		
UstdPF113	UstdPF123	UstdPF213	UstdPF223	UstdPF313	UstdPF323		

4.0 CONCLUDING COMMENTS

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

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

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

5.0 REFERENCES

[1] Fox, K.M., T.B. Edwards, D.K. Peeler, "High Level Waste (HLW) Sludge Batch 4 (SB4): Selecting Glasses for a Variability Study," WSRC-STI-2006-00039, July 2006.

[2] Jantzen, C.M., J.B. Pickett, K.G. Brown, T.B. Edwards, and D.C. Beam, "Process/ Product Models for the Defense Waste Processing Facility (DWPF): Part I. Predicting Glass Durability from Composition Using a Thermodynamic Hydration Energy Reaction Model (THERMO^{TM}) (U)," WSRC-TR-93-673, Revision 1, Volume 2, Table B.1,
pp. B.9, 1995.

[3] Ebert, W.L. and S.F. Wolf, "Round-Robin Testing of a Reference Glass for Low-Activity Waste Forms," ANL-99/22, Argonne National Laboratory, Argonne, IL, October 1999.

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Appendix B

An Analytical Plan for Measuring the First Set of PCT Solutions for SB4 Variability Study (U)

(SRNL-SCS-2006-00026)

SRNL-SCS-2006-00026

July 31, 2006

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

wo – without glass identifiers

R. A. Baker, Technical Reviewer — Date: 8/3/2006

R. C. Tuckfield, Manager
Statistical Consulting Section — Date: 8/3/06

An Analytical Plan for Measuring the First Set of PCT Solutions for SB4 Variability Study (U)

1.0 EXECUTIVE SUMMARY

A glass variability study is underway at the Savannah River National Laboratory (SRNL) to support the processing of Sludge Batch 4 (SB4) at the Defense Waste Processing Facility (DWPF). Thirty-five (35) glasses have been selected to be batched and fabricated as part of this study. The durabilities of the glasses are to be measured using the Product Consistency Test (PCT) as defined in ASTM C-1285-2002. Two heat treatments are to be utilized during the fabrication of each of these glasses. Specifically, each of the glasses is to be quenched (i.e., rapidly cooled) and cooled in accordance with the centerline-canister-cooling (ccc) regime. Both heat treatments of each glass are to be subjected to the PCT. The PCT solutions are to be analyzed by SRNL's Process Science Analytical Laboratory (PSAL).

Due to the large number of glasses in this study, the PCTs for the variability study are to be grouped into three sets. This memorandum provides an analytical plan for the measurement of the PCTs by PSAL for the first set of glasses, which are labeled as SB4VS-01 through SB4VS-09.

2.0 INTRODUCTION

A glass variability study is underway at the Savannah River National Laboratory (SRNL) to support the processing of Sludge Batch 4 (SB4) at the Defense Waste Processing Facility (DWPF) [1]. Thirty-five (35) glasses have been selected to be batched and fabricated as part of this study. The durabilities of the glasses are to be measured using the Product Consistency Test (PCT) as defined in ASTM C-1285-2002 [2]. Two heat treatments are to be utilized during the fabrication of each of these glasses. Specifically, each of the glasses is to be quenched (i.e., rapidly cooled) and cooled in accordance with the centerline-canister-cooling (ccc) regime. Both heat treatments of each glass are to be subjected to the PCT. The PCT solutions are to be analyzed by SRNL's Process Science Analytical Laboratory (PSAL).

Due to the large number of glasses in this study, the PCTs are to be grouped into three sets. This memorandum provides an analytical plan for the measurement of the PCTs by PSAL for the first set of glasses. Table 1 presents a listing of the glasses covered by this memorandum.

Table 1: Identifiers for Glasses Covered by this Plan

SB4VS-01	SB4VS-06
SB4VS-01ccc	SB4VS-06ccc
SB4VS-02	SB4VS-07
SB4VS-02ccc	SB4VS-07ccc
SB4VS-03	SB4VS-08
SB4VS-03ccc	SB4VS-08ccc
SB4VS-04	SB4VS-09
SB4VS-04ccc	SB4VS-09ccc
SB4VS-05	
SB4VS-05ccc	

3.0 DISCUSSION

Each of the 18 study glasses of Table 1 is to be subjected to the PCT in triplicate. In addition to PCTs for the study glasses, triplicate PCTs are to be conducted on a sample of the Approved Reference Material – One (ARM-1) glass and a sample of the Environmental Assessment (EA) glass. Two reagent blank samples are also to be included in these tests. This results in 62 sample solutions being required to complete these PCTs.

The leachates from these tests will be diluted by adding 4 mL of 0.4 M HNO_3 to 6 mL of the leachate (a 6:10 volume to volume, v:v, dilution) before being submitted to PSAL. The leachates of EA will be further diluted (1:10 v:v) with deionized water prior to submission to PSAL in order to prevent problems with the nebulizer. Note that additional dilutions for the ccc versions of one or more of the study glasses may be needed due to a possible low durability of some of the glasses. Upon termination of the PCT, a decision is to be made (by the technicians and a PSAL representative, if called by the technician) as to whether any other dilutions are needed for these solutions to mitigate any potential gelling issues. Any extra dilutions are to be reported, and guidance is to be given as to how the dilutions are to be handled in the statistical assessment of the measurement data. More specifically, PSAL will be responsible for indicating if any additional dilutions were made and how they were, or how they should be, accounted for in the reported measurements.

Table 2 presents identifying codes, R01 through R62, for the individual solutions required for the PCTs of the select study glasses and of the standards (EA, ARM-1, and blanks). This provides a naming convention that is to be used by PSAL in analyzing the solutions and reporting the relevant concentration measurements.[a]

Table 2: Identifiers for the PCT Solutions Covered by this Plan

Original Sample	Solution Identifier	Original Sample	Solution Identifier	Original Sample	Solution Identifier
SB4VS-01	R29	SB4VS-04ccc	R52	SB4VS-08	R51
SB4VS-01	R45	SB4VS-04ccc	R36	SB4VS-08	R16
SB4VS-01	R35	SB4VS-04ccc	R02	SB4VS-08	R34
SB4VS-01ccc	R08	SB4VS-05	R42	SB4VS-08ccc	R23
SB4VS-01ccc	R21	SB4VS-05	R12	SB4VS-08ccc	R10
SB4VS-01ccc	R57	SB4VS-05	R44	SB4VS-08ccc	R31
SB4VS-02	R46	SB4VS-05ccc	R19	SB4VS-09	R22
SB4VS-02	R37	SB4VS-05ccc	R58	SB4VS-09	R11
SB4VS-02	R18	SB4VS-05ccc	R53	SB4VS-09	R07
SB4VS-02ccc	R54	SB4VS-06	R38	SB4VS-09ccc	R60
SB4VS-02ccc	R56	SB4VS-06	R39	SB4VS-09ccc	R27
SB4VS-02ccc	R14	SB4VS-06	R24	SB4VS-09ccc	R59
SB4VS-03	R32	SB4VS-06ccc	R40	EA	R30
SB4VS-03	R50	SB4VS-06ccc	R04	EA	R20
SB4VS-03	R55	SB4VS-06ccc	R33	EA	R25
SB4VS-03ccc	R06	SB4VS-07	R17	ARM-1	R05
SB4VS-03ccc	R01	SB4VS-07	R62	ARM-1	R61
SB4VS-03ccc	R28	SB4VS-07	R26	ARM-1	R09
SB4VS-04	R13	SB4VS-07ccc	R43	blank	R49
SB4VS-04	R48	SB4VS-07ccc	R47	blank	R03
SB4VS-04	R15	SB4VS-07ccc	R41		

4.0 ANALYTICAL PLAN

The analytical plan for PSAL is provided in this section. Each of the solution samples submitted to PSAL is to be analyzed only once for each of the following: boron (B), barium (Ba), cadmium (Cd), chromium (Cr), iron (Fe), lithium (Li), sodium (Na), lead (Pb), silicon (Si), thorium (Th), and uranium (U) concentrations. B, Li, Na, and Si are the elements that are to be used in the assessment of glass durability; the other elements are being monitored to address solution disposal issues in SRNL upon termination of the PCTs. The measurements are to be made in parts per million (ppm). The analytical procedure used by PSAL to determine the concentrations utilizes an Inductively Coupled Plasma – Atomic Emission Spectrometer (ICP-AES). The PCT solutions (as identified in Table 2) are grouped in three ICP-AES blocks for processing by PSAL in Table 3. Each block requires a different calibration of the ICP-AES.

[a] Renaming these samples ensures that they will be processed as blind samples by PSAL. This table does not contain the solution identifiers for those on the distribution list with a "wo" following their names.

Table 3: ICP-AES Calibration Blocks for Leachate Measurements

Block 1	Block 2	Block 3
std-b1-1	std-b2-1	std-b3-1
R38	R39	R24
R40	R04	R33
R29	R45	R03
R08	R21	R35
R49	R16	R57
R51	R10	R34
R23	R37	R31
R46	R56	R18
R54	R48	R14
R13	R36	R15
std-b1-2	std-b2-2	std-b3-2
R52	R62	R02
R17	R47	R26
R43	R12	R41
R42	R58	R44
R19	R20	R53
R30	R61	R25
R05	R11	R09
R22	R27	R07
R60	R50	R59
R32	R01	R55
R06	std-b2-3	R28
std-b1-3		std-b3-3

A multi-element solution standard (denoted by "std-bi-j" where i=1 to 3 represents the block number and j=1, 2, and 3 represents the position in the block) was added at the beginning, middle, and end of each of the three blocks. This standard may be useful in checking and correcting for bias in the concentration measurements arising from the ICP calibrations.

5.0 SUMMARY

In summary, this analytical plan provides identifiers for the PCT solutions in Table 2 and three ICP-AES calibration blocks in Table 3 for PSAL to use in conducting the boron (B), barium (Ba), cadmium (Cd), chromium (Cr), iron (Fe), lithium (Li), sodium (Na), lead (Pb), silicon (Si), thorium (Th), and uranium (U) concentration measurements for this PCT study. The sequencing of the activities associated with each of the steps in the analytical procedure has been randomized. The size of the blocks was selected so that each block could be completed in a single work shift. If for some reason the measurements are not conducted in the sequence presented in this memorandum, the actual order should be recorded along with any explanative comments.

The analytical plan indicated in the preceding tables should be modified by the personnel of PSAL to include any calibration check standards and/or other standards that are part of their standard operating procedures.

6.0 REFERENCES

[1] Fox, K.M., T.B. Edwards, D.K. Peeler, "High Level Waste (HLW) Sludge Batch 4 (SB4): Selecting Glasses for a Variability Study," WSRC-STI-2006-00039, July 2006.

[2] ASTM C-1285-2002, "Standard Test Methods for Determining Chemical Durability of Nuclear Waste Glasses: The Product Consistency Test (PCT)," ASTM, 2002.

Appendix C

An Analytical Plan for Measuring the Second Set of PCT Solutions for the SB4 Variability Study (U)

(SRNL-SCS-2006-00028)

SRNL-SCS-2006-00028

August 9, 2006

To: K. M. Fox, SRNL

cc: R. A. Baker, 773-42A
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D. K. Peeler, 999-W
I. A. Reamer, 999-1W
P. A. Toole, 786-1A (wo)
R. C. Tuckfield, 773-42A
R. J. Workman, 999-1W

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

wo – without glass identifiers

R. A. Baker, Technical Reviewer — 8/14/2006 Date

R. C. Tuckfield, Manager
Statistical Consulting Section — 8/14/06 Date

An Analytical Plan for Measuring the Second Set of PCT Solutions for the SB4 Variability Study (U)

1.0 EXECUTIVE SUMMARY

A glass variability study is underway at the Savannah River National Laboratory (SRNL) to support the processing of Sludge Batch 4 (SB4) at the Defense Waste Processing Facility (DWPF). Thirty-five (35) glasses have been selected to be batched and fabricated as part of this study. The durabilities of the glasses are to be measured using the Product Consistency Test (PCT) as defined in ASTM C-1285-2002. Two heat treatments are to be utilized during the fabrication of each of these glasses. Specifically, each of the glasses is to be quenched (i.e., rapidly cooled) and cooled in accordance with the centerline-canister-cooling (ccc) regime. Both heat treatments of each glass are to be subjected to the PCT. The PCT solutions are to be analyzed by SRNL's Process Science Analytical Laboratory (PSAL).

Due to the large number of glasses in this study, the PCTs for the variability study are to be grouped into three sets. This memorandum provides an analytical plan for the measurement of the PCTs by PSAL for the second set of glasses, which are labeled as SB4VS-10 through SB4VS-21.

2.0 INTRODUCTION

A glass variability study is underway at the Savannah River National Laboratory (SRNL) to support the processing of Sludge Batch 4 (SB4) at the Defense Waste Processing Facility (DWPF) [1]. Thirty-five (35) glasses have been selected to be batched and fabricated as part of this study. The durabilities of the glasses are to be measured using the Product Consistency Test (PCT) as defined in ASTM C-1285-2002 [2]. Two heat treatments are to be utilized during the fabrication of each of these glasses. Specifically, each of the glasses is to be quenched (i.e., rapidly cooled) and cooled in accordance with the centerline-canister-cooling (ccc) regime. Both heat treatments of each glass are to be subjected to the PCT. The PCT solutions are to be analyzed by SRNL's Process Science Analytical Laboratory (PSAL).

Due to the large number of glasses in this study, the PCTs are to be grouped into three sets. This memorandum provides an analytical plan for the measurement of the PCTs by PSAL for the second set of glasses. Table 1 presents a listing of the glasses covered by this memorandum.

Table 1: Identifiers for Glasses Covered by this Plan

SB4VS-10	SB4VS-16
SB4VS-10ccc	SB4VS-16ccc
SB4VS-11	SB4VS-17
SB4VS-11ccc	SB4VS-17ccc
SB4VS-12	SB4VS-18
SB4VS-12ccc	SB4VS-18ccc
SB4VS-13	SB4VS-19
SB4VS-13ccc	SB4VS-19ccc
SB4VS-14	SB4VS-20
SB4VS-14ccc	SB4VS-20ccc
SB4VS-15	SB4VS-21
SB4VS-15ccc	SB4VS-21ccc

3.0 DISCUSSION

Each of the 24 study glasses of Table 1 is to be subjected to the PCT in triplicate. In addition to PCTs for the study glasses, triplicate PCTs are to be conducted on a sample of the Approved Reference Material – One (ARM-1) glass and a sample of the Environmental Assessment (EA) glass. Two reagent blank samples are also to be included in these tests. This results in 80 sample solutions being required to complete these PCTs.

The leachates from these tests will be diluted by adding 4 mL of 0.4 M HNO_3 to 6 mL of the leachate (a 6:10 volume to volume, v:v, dilution) before being submitted to PSAL. The leachates of EA will be further diluted (1:10 v:v) with deionized water prior to submission to PSAL in order to prevent problems with the nebulizer. Note that additional dilutions for the ccc versions of one or more of the study glasses may be needed due to a possible low durability of some of the glasses. Upon termination of the PCT, a decision is to be made (by the technicians and a PSAL representative, if called by the technician) as to whether any other dilutions are needed for these solutions to mitigate any potential gelling issues. Any extra dilutions are to be reported, and guidance is to be given as to how the dilutions are to be handled in the statistical assessment of the measurement data. More specifically, PSAL will be responsible for indicating if any

additional dilutions were made and how they were, or how they should be, accounted for in the reported measurements.

Table 2 presents identifying codes, S01 through S80, for the individual solutions required for the PCTs of the select study glasses and of the standards (EA, ARM-1, and blanks). This provides a naming convention that is to be used by PSAL in analyzing the solutions and reporting the relevant concentration measurements.[a]

Table 2: Identifiers for the PCT Solutions Covered by this Plan

Original Sample	Solution Identifier	Original Sample	Solution Identifier	Original Sample	Solution Identifier
SB4VS-10	S52	SB4VS-14ccc	S05	SB4VS-19	S51
SB4VS-10	S24	SB4VS-14ccc	S64	SB4VS-19	S15
SB4VS-10	S47	SB4VS-14ccc	S17	SB4VS-19	S72
SB4VS-10ccc	S10	SB4VS-15	S74	SB4VS-19ccc	S65
SB4VS-10ccc	S03	SB4VS-15	S27	SB4VS-19ccc	S50
SB4VS-10ccc	S08	SB4VS-15	S49	SB4VS-19ccc	S73
SB4VS-11	S20	SB4VS-15ccc	S40	SB4VS-20	S33
SB4VS-11	S13	SB4VS-15ccc	S36	SB4VS-20	S42
SB4VS-11	S31	SB4VS-15ccc	S46	SB4VS-20	S71
SB4VS-11ccc	S48	SB4VS-16	S12	SB4VS-20ccc	S78
SB4VS-11ccc	S34	SB4VS-16	S75	SB4VS-20ccc	S06
SB4VS-11ccc	S77	SB4VS-16	S18	SB4VS-20ccc	S32
SB4VS-12	S25	SB4VS-16ccc	S61	SB4VS-21	S29
SB4VS-12	S54	SB4VS-16ccc	S14	SB4VS-21	S16
SB4VS-12	S59	SB4VS-16ccc	S35	SB4VS-21	S63
SB4VS-12ccc	S80	SB4VS-17	S28	SB4VS-21ccc	S01
SB4VS-12ccc	S57	SB4VS-17	S58	SB4VS-21ccc	S45
SB4VS-12ccc	S70	SB4VS-17	S43	SB4VS-21ccc	S09
SB4VS-13	S04	SB4VS-17ccc	S44	EA	S07
SB4VS-13	S69	SB4VS-17ccc	S38	EA	S30
SB4VS-13	S55	SB4VS-17ccc	S11	EA	S68
SB4VS-13ccc	S66	SB4VS-18	S56	ARM-1	S37
SB4VS-13ccc	S02	SB4VS-18	S53	ARM-1	S67
SB4VS-13ccc	S23	SB4VS-18	S22	ARM-1	S76
SB4VS-14	S41	SB4VS-18ccc	S79	blank	S26
SB4VS-14	S60	SB4VS-18ccc	S19	blank	S21
SB4VS-14	S62	SB4VS-18ccc	S39		

[a] Renaming these samples ensures that they will be processed as blind samples by PSAL. This table does not contain the solution identifiers for those on the distribution list with a "wo" following their names.

4.0 ANALYTICAL PLAN

The analytical plan for PSAL is provided in this section. Each of the solution samples submitted to PSAL is to be analyzed only once for each of the following: aluminum (Al), boron (B), barium (Ba), cadmium (Cd), chromium (Cr), iron (Fe), lithium (Li), sodium (Na), lead (Pb), silicon (Si), thorium (Th), and uranium (U) concentrations. B, Li, Na, and Si are the elements that are to be used in the assessment of glass durability; the other elements are being monitored to address solution disposal issues in SRNL upon termination of the PCTs. The measurements are to be made in parts per million (ppm). The analytical procedure used by PSAL to determine the concentrations utilizes an Inductively Coupled Plasma – Atomic Emission Spectrometer (ICP-AES). The PCT solutions (as identified in Table 2) are grouped in six ICP-AES blocks for processing by PSAL in Table 3. Each block requires a different calibration of the ICP-AES.

Table 3: ICP-AES Calibration Blocks for Leachate Measurements

Block 1	Block 2	Block 3	Block 4	Block 5	Block 6
std-b1-1	std-b2-1	std-b3-1	std-b4-1	std-b5-1	std-b6-1
S79	S13	S31	S61	S03	S11
S26	S34	S70	S05	S06	S46
S51	S57	S73	S78	S38	S32
S29	S45	S55	S44	S24	S62
S80	S53	S63	S52	S64	S08
S07	S54	S23	S10	S60	S47
S04	S16	S59	S41	S42	S17
std-b1-2	std-b2-2	std-b3-2	std-b4-2	std-b5-2	std-b6-2
S20	S50	S72	S33	S36	S35
S01	S69	S09	S12	S58	S18
S56	S30	S39	S40	S27	S71
S48	S02	S68	S74	S14	S21
S66	S19	S77	S28	S75	S49
S25	S15	S22	S37	S67	S43
S65	std-b2-3	std-b3-3	std-b4-3	std-b5-3	S76
std-b1-3					std-b6-3

A multi-element solution standard (denoted by "std-bi-j" where i=1 to 6 represents the block number and j=1, 2, and 3 represents the position in the block) was added at the beginning, middle, and end of each of the three blocks. This standard may be useful in checking and correcting for bias in the concentration measurements arising from the ICP calibrations.

5.0 SUMMARY

In summary, this analytical plan provides identifiers for the PCT solutions in Table 2 and six ICP-AES calibration blocks in Table 3 for PSAL to use in conducting the aluminum (Al), boron (B), barium (Ba), cadmium (Cd), chromium (Cr), iron (Fe), lithium (Li), sodium (Na), lead (Pb), silicon (Si), thorium (Th), and uranium (U) concentration measurements for this PCT study. The sequencing of the activities associated with each of the steps in the analytical procedure has been randomized. The size of the blocks was selected so that each block could be completed in a

single work shift. If for some reason the measurements are not conducted in the sequence presented in this memorandum, the actual order should be recorded along with any explanative comments.

The analytical plan indicated in the preceding tables should be modified by the personnel of PSAL to include any calibration check standards and/or other standards that are part of their standard operating procedures.

6.0 REFERENCES

[1] Fox, K.M., T.B. Edwards, D.K. Peeler, "High Level Waste (HLW) Sludge Batch 4 (SB4): Selecting Glasses for a Variability Study," WSRC-STI-2006-00039, July 2006.

[2] ASTM C-1285-2002, "Standard Test Methods for Determining Chemical Durability of Nuclear Waste Glasses: The Product Consistency Test (PCT)," ASTM, 2002.

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Appendix D

An Analytical Plan for Measuring the Third Set of PCT Solutions for the SB4 Variability Study (U)

(SRNL-SCS-2006-00031)

SRNL-SCS-2006-00031

August 18, 2006

To: K. M. Fox, SRNL

cc: R. A. Baker, 773-42A
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P. A. Toole, 786-1A (wo)
R. C. Tuckfield, 773-42A
R. J. Workman, 999-1W

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

wo – without glass identifiers

R. A. Baker, Technical Reviewer — 8/22/2006 Date

R. C. Tuckfield, Manager
Statistical Consulting Section — 8/23/2006 Date

An Analytical Plan for Measuring the Third Set of PCT Solutions for the SB4 Variability Study (U)

1.0 EXECUTIVE SUMMARY

A glass variability study is underway at the Savannah River National Laboratory (SRNL) to support the processing of Sludge Batch 4 (SB4) at the Defense Waste Processing Facility (DWPF). Thirty-five (35) glasses have been selected to be batched and fabricated as part of this study. The durabilities of the glasses are to be measured using the Product Consistency Test (PCT) as defined in ASTM C-1285-2002. Two heat treatments are to be utilized during the fabrication of each of these glasses. Specifically, each of the glasses is to be quenched (i.e., rapidly cooled) and cooled in accordance with the centerline-canister-cooling (ccc) regime. Both heat treatments of each glass are to be subjected to the PCT. The PCT solutions are to be analyzed by SRNL's Process Science Analytical Laboratory (PSAL).

Due to the large number of glasses in this study, the PCTs for the variability study are to be grouped into three sets. This memorandum provides an analytical plan for the measurement of the PCTs by PSAL for the third (and last) set of glasses, which are labeled as SB4VS-22 through SB4VS-35.

2.0 INTRODUCTION

A glass variability study is underway at the Savannah River National Laboratory (SRNL) to support the processing of Sludge Batch 4 (SB4) at the Defense Waste Processing Facility (DWPF) [1]. Thirty-five (35) glasses have been selected to be batched and fabricated as part of this study. The durabilities of the glasses are to be measured using the Product Consistency Test (PCT) as defined in ASTM C-1285-2002 [2]. Two heat treatments are to be utilized during the fabrication of each of these glasses. Specifically, each of the glasses is to be quenched (i.e., rapidly cooled) and cooled in accordance with the centerline-canister-cooling (ccc) regime. Both heat treatments of each glass are to be subjected to the PCT. The PCT solutions are to be analyzed by SRNL's Process Science Analytical Laboratory (PSAL).

Due to the large number of glasses in this study, the PCTs are to be grouped into three sets. This memorandum provides an analytical plan for the measurement of the PCTs by PSAL for the third (and last) set of glasses. Table 1 presents a listing of the glasses covered by this memorandum.

Table 1: Identifiers for Glasses Covered by this Plan

SB4VS-22	SB4VS-29
SB4VS-22ccc	SB4VS-29ccc
SB4VS-23	SB4VS-30
SB4VS-23ccc	SB4VS-30ccc
SB4VS-24	SB4VS-31
SB4VS-24ccc	SB4VS-31ccc
SB4VS-25	SB4VS-32
SB4VS-25ccc	SB4VS-32ccc
SB4VS-26	SB4VS-33
SB4VS-26ccc	SB4VS-33ccc
SB4VS-27	SB4VS-34
SB4VS-27ccc	SB4VS-34ccc
SB4VS-28	SB4VS-35
SB4VS-28ccc	SB4VS-35ccc

3.0 DISCUSSION

Each of the 28 study glasses of Table 1 is to be subjected to the PCT in triplicate. In addition to PCTs for the study glasses, triplicate PCTs are to be conducted on a sample of the Approved Reference Material – One (ARM-1) glass and a sample of the Environmental Assessment (EA) glass. Two reagent blank samples are also to be included in these tests. This results in 92 sample solutions being required to complete these PCTs.

The leachates from these tests will be diluted by adding 4 mL of 0.4 M HNO_3 to 6 mL of the leachate (a 6:10 volume to volume, v:v, dilution) before being submitted to PSAL. The leachates of EA will be further diluted (1:10 v:v) with deionized water prior to submission to PSAL in order to prevent problems with the nebulizer. Note that additional dilutions for the ccc versions of one or more of the study glasses may be needed due to a possible low durability of some of the glasses. Upon termination of the PCT, a decision is to be made (by the technicians and a PSAL

representative, if called by the technician) as to whether any other dilutions are needed for these solutions to mitigate any potential gelling issues. Any extra dilutions are to be reported, and guidance is to be given as to how the dilutions are to be handled in the statistical assessment of the measurement data. More specifically, PSAL will be responsible for indicating if any additional dilutions were made and how they were, or how they should be, accounted for in the reported measurements.

Table 2 presents identifying codes, T01 through T92, for the individual solutions required for the PCTs of the select study glasses and of the standards (EA, ARM-1, and blanks). This provides a naming convention that is to be used by PSAL in analyzing the solutions and reporting the relevant concentration measurements.[a]

Table 2: Identifiers for the PCT Solutions Covered by this Plan

Original Sample	Solution Identifier	Original Sample	Solution Identifier	Original Sample	Solution Identifier
SB4VS-22	T15	SB4VS-27ccc	T76	SB4VS-33	T31
SB4VS-22	T69	SB4VS-27ccc	T02	SB4VS-33	T38
SB4VS-22	T50	SB4VS-27ccc	T42	SB4VS-33	T40
SB4VS-22ccc	T35	SB4VS-28	T88	SB4VS-33ccc	T37
SB4VS-22ccc	T36	SB4VS-28	T03	SB4VS-33ccc	T92
SB4VS-22ccc	T44	SB4VS-28	T20	SB4VS-33ccc	T53
SB4VS-23	T47	SB4VS-28ccc	T82	SB4VS-34	T61
SB4VS-23	T08	SB4VS-28ccc	T41	SB4VS-34	T25
SB4VS-23	T54	SB4VS-28ccc	T46	SB4VS-34	T80
SB4VS-23ccc	T05	SB4VS-29	T18	SB4VS-34ccc	T21
SB4VS-23ccc	T75	SB4VS-29	T63	SB4VS-34ccc	T06
SB4VS-23ccc	T10	SB4VS-29	T58	SB4VS-34ccc	T33
SB4VS-24	T48	SB4VS-29ccc	T13	SB4VS-35	T11
SB4VS-24	T72	SB4VS-29ccc	T79	SB4VS-35	T27
SB4VS-24	T39	SB4VS-29ccc	T73	SB4VS-35	T51
SB4VS-24ccc	T16	SB4VS-30	T01	SB4VS-35ccc	T70
SB4VS-24ccc	T57	SB4VS-30	T84	SB4VS-35ccc	T43
SB4VS-24ccc	T64	SB4VS-30	T62	SB4VS-35ccc	T68
SB4VS-25	T52	SB4VS-30ccc	T81	EA	T77
SB4VS-25	T87	SB4VS-30ccc	T24	EA	T66
SB4VS-25	T59	SB4VS-30ccc	T32	EA	T12
SB4VS-25ccc	T71	SB4VS-31	T65	ARM-1	T91
SB4VS-25ccc	T30	SB4VS-31	T67	ARM-1	T83
SB4VS-25ccc	T34	SB4VS-31	T56	ARM-1	T74
SB4VS-26	T85	SB4VS-31ccc	T55	blank	T14
SB4VS-26	T19	SB4VS-31ccc	T60	blank	T90
SB4VS-26	T86	SB4VS-31ccc	T78		
SB4VS-26ccc	T29	SB4VS-32	T09		
SB4VS-26ccc	T07	SB4VS-32	T04		
SB4VS-26ccc	T45	SB4VS-32	T22		
SB4VS-27	T26	SB4VS-32ccc	T89		
SB4VS-27	T49	SB4VS-32ccc	T17		
SB4VS-27	T28	SB4VS-32ccc	T23		

[a] Renaming these samples ensures that they will be processed as blind samples by PSAL. This table does not contain the solution identifiers for those on the distribution list with a "wo" following their names.

4.0 ANALYTICAL PLAN

The analytical plan for PSAL is provided in this section. Each of the solution samples submitted to PSAL is to be analyzed only once for each of the following: aluminum (Al), boron (B), iron (Fe), lithium (Li), sodium (Na), silicon (Si), thorium (Th), and uranium (U) concentrations. B, Li, Na, and Si are the elements that are to be used in the assessment of glass durability. The measurements are to be made in parts per million (ppm). The analytical procedure used by PSAL to determine the concentrations utilizes an Inductively Coupled Plasma – Atomic Emission Spectrometer (ICP-AES). The PCT solutions (as identified in Table 2) are grouped in six ICP-AES blocks for processing by PSAL in Table 3. Each block requires a different calibration of the ICP-AES.

Table 3: ICP-AES Calibration Blocks for Leachate Measurements

Block 1	Block 2	Block 3	Block 4	Block 5	Block 6
std-b1-1	std-b2-1	std-b3-1	std-b4-1	std-b5-1	std-b6-1
T48	T87	T34	T05	T67	T50
T01	T66	T64	T21	T79	T56
T77	T84	T32	T11	T36	T44
T37	T03	T62	T61	T07	T74
T26	T30	T20	T55	T60	T51
T81	T24	T40	T18	T69	T58
T89	T57	T28	T29	T63	T33
T88	T92	T12	T35	T43	T90
std-b1-2	std-b2-2	std-b3-2	std-b4-2	std-b5-2	std-b6-2
T71	T17	T46	T85	T27	T80
T16	T72	T39	T47	T08	T10
T82	T04	T23	T15	T83	T73
T76	T41	T42	T65	T06	T54
T09	T02	T22	T13	T19	T45
T31	T49	T53	T70	T75	T78
T52	T38	T59	T91	T25	T86
T14	std-b2-3	std-b3-3	std-b4-3	std-b5-3	T68
std-b1-3					std-b6-3

A multi-element solution standard (denoted by "std-bi-j" where i=1 to 6 represents the block number and j=1, 2, and 3 represents the position in the block) was added at the beginning, middle, and end of each of the three blocks. This standard may be useful in checking and correcting for bias in the concentration measurements arising from the ICP calibrations.

5.0 SUMMARY

In summary, this analytical plan provides identifiers for the PCT solutions in Table 2 and six ICP-AES calibration blocks in Table 3 for PSAL to use in conducting the aluminum (Al), boron (B), iron (Fe), lithium (Li), sodium (Na), silicon (Si), thorium (Th), and uranium (U) concentration measurements for this PCT study. The sequencing of the activities associated with each of the steps in the analytical procedure has been randomized. The size of the blocks was selected so that each block could be completed in a single work shift. If for some reason the measurements are

not conducted in the sequence presented in this memorandum, the actual order should be recorded along with any explanative comments.

The analytical plan indicated in the preceding tables should be modified by the personnel of PSAL to include any calibration check standards and/or other standards that are part of their standard operating procedures.

6.0 REFERENCES

[1] Fox, K.M., T.B. Edwards, D.K. Peeler, "High Level Waste (HLW) Sludge Batch 4 (SB4): Selecting Glasses for a Variability Study," WSRC-STI-2006-00039, July 2006.

[2] ASTM C-1285-2002, "Standard Test Methods for Determining Chemical Durability of Nuclear Waste Glasses: The Product Consistency Test (PCT)," ASTM, 2002.

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Appendix E

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

Table E1. Targeted Oxide Concentrations (in wt%) for the SB4 Variability Study Glasses

Glass #	Al_2O_3	B_2O_3	BaO	CaO	Ce_2O_3	Cr_2O_3	CuO	Fe_2O_3	K_2O	La_2O_3	Li_2O	MgO	MnO	Na_2O	NiO	PbO	SO_4^{2-}	SiO_2	ThO_2	TiO_2	U_3O_8	ZnO	ZrO_2	Sum
SB4VS-01	7.631	5.440	0.040	0.756	0.048	0.067	0.019	8.407	0.106	0.034	5.440	0.797	1.734	12.989	0.497	0.029	0.446	52.954	0.020	0.008	2.431	0.031	0.075	100.00
SB4VS-02	8.585	5.120	0.045	0.850	0.054	0.075	0.022	9.458	0.119	0.038	5.120	0.897	1.951	13.612	0.559	0.033	0.501	50.073	0.023	0.009	2.735	0.035	0.084	100.00
SB4VS-03	9.539	4.800	0.050	0.944	0.060	0.084	0.024	10.509	0.132	0.043	4.800	0.997	2.167	14.236	0.621	0.036	0.557	47.192	0.025	0.011	3.039	0.039	0.094	100.00
SB4VS-04	10.493	4.480	0.055	1.039	0.066	0.092	0.026	11.560	0.146	0.047	4.480	1.096	2.384	14.859	0.683	0.040	0.613	44.312	0.028	0.012	3.343	0.043	0.103	100.00
SB4VS-05	7.154	9.800	0.037	0.708	0.045	0.063	0.018	7.882	0.099	0.032	5.600	0.748	1.626	9.877	0.466	0.027	0.418	52.994	0.019	0.008	2.279	0.030	0.070	100.00
SB4VS-06	8.108	9.240	0.042	0.803	0.051	0.071	0.021	8.933	0.113	0.036	5.280	0.847	1.842	10.660	0.528	0.031	0.474	50.194	0.021	0.009	2.583	0.033	0.080	100.00
SB4VS-07	9.062	8.680	0.047	0.897	0.057	0.079	0.023	9.984	0.126	0.040	4.960	0.947	2.059	11.444	0.590	0.035	0.529	47.393	0.024	0.010	2.887	0.037	0.089	100.00
SB4VS-08	10.016	8.120	0.052	0.992	0.063	0.088	0.025	11.035	0.139	0.045	4.640	1.047	2.276	12.228	0.652	0.038	0.585	44.592	0.027	0.011	3.191	0.041	0.098	100.00
SB4VS-09	10.970	7.560	0.057	1.086	0.069	0.096	0.028	12.086	0.152	0.049	4.320	1.146	2.493	13.011	0.714	0.042	0.641	41.791	0.029	0.012	3.495	0.045	0.108	100.00
SB4VS-10	10.047	8.120	0.057	1.046	0.069	0.095	0.027	10.604	0.151	0.049	4.640	0.992	2.218	12.668	0.706	0.042	0.611	44.536	0.029	0.012	3.131	0.045	0.107	100.00
SB4VS-11	10.422	8.120	0.048	0.937	0.058	0.080	0.023	10.604	0.127	0.041	4.640	0.992	2.333	12.329	0.706	0.035	0.559	44.536	0.024	0.010	3.251	0.038	0.090	100.00
SB4VS-12	9.926	8.400	0.054	0.892	0.066	0.091	0.026	10.408	0.144	0.046	4.800	1.049	2.222	11.423	0.672	0.040	0.532	46.046	0.027	0.011	2.982	0.043	0.102	100.00
SB4VS-13	9.926	8.400	0.046	0.996	0.055	0.076	0.022	10.611	0.121	0.039	4.800	1.049	2.112	11.423	0.570	0.033	0.532	45.939	0.023	0.010	3.096	0.036	0.085	100.00
SB4VS-14	8.709	8.680	0.043	0.947	0.052	0.073	0.021	10.013	0.115	0.037	4.960	0.897	2.111	11.843	0.541	0.032	0.505	47.443	0.022	0.009	2.833	0.034	0.081	100.00
SB4VS-15	8.709	8.680	0.051	0.847	0.062	0.086	0.025	10.388	0.137	0.044	4.960	0.897	2.111	11.415	0.541	0.038	0.553	47.342	0.026	0.011	2.941	0.041	0.096	100.00
SB4VS-16	8.250	8.960	0.049	0.803	0.059	0.082	0.024	9.588	0.129	0.042	5.120	0.944	1.901	11.430	0.513	0.036	0.479	48.745	0.025	0.010	2.684	0.038	0.091	100.00
SB4VS-17	8.933	8.960	0.041	0.803	0.050	0.069	0.020	9.700	0.109	0.035	5.120	0.850	1.901	10.681	0.513	0.030	0.524	48.841	0.021	0.009	2.684	0.032	0.077	100.00
SB4VS-18	8.036	9.240	0.039	0.847	0.047	0.065	0.019	9.294	0.103	0.033	5.280	0.892	1.889	10.310	0.572	0.028	0.495	50.148	0.020	0.008	2.535	0.031	0.073	100.00
SB4VS-19	7.792	9.240	0.039	0.758	0.047	0.065	0.019	8.825	0.103	0.033	5.280	0.892	1.796	11.017	0.572	0.028	0.495	50.239	0.020	0.008	2.632	0.031	0.073	100.00
SB4VS-20	7.516	9.520	0.043	0.797	0.052	0.073	0.021	8.748	0.115	0.037	5.440	0.756	1.690	9.939	0.538	0.032	0.426	51.637	0.022	0.009	2.477	0.034	0.081	100.00
SB4VS-21	7.941	9.520	0.043	0.797	0.052	0.073	0.021	8.079	0.115	0.037	5.440	0.839	1.778	10.053	0.456	0.032	0.466	51.637	0.022	0.009	2.477	0.034	0.081	100.00
SB4VS-22	10.820	8.120	0.061	0.882	0.074	0.103	0.030	10.165	0.163	0.052	4.640	0.937	2.391	12.459	0.544	0.045	0.533	44.704	0.031	0.013	3.072	0.048	0.115	100.00
SB4VS-23	9.286	8.400	0.058	1.048	0.071	0.098	0.028	9.681	0.155	0.050	4.800	1.101	2.058	12.672	0.724	0.043	0.507	46.099	0.030	0.012	2.925	0.046	0.110	100.00
SB4VS-24	8.788	8.400	0.041	1.048	0.050	0.069	0.020	10.571	0.110	0.035	4.800	0.892	2.058	12.672	0.518	0.030	0.507	46.099	0.021	0.009	3.153	0.033	0.077	100.00
SB4VS-25	8.696	8.680	0.039	0.798	0.047	0.066	0.019	9.197	0.104	0.034	4.960	1.046	2.163	12.238	0.687	0.029	0.577	47.494	0.020	0.008	2.995	0.031	0.074	100.00
SB4VS-26	8.348	8.680	0.055	0.996	0.067	0.093	0.027	9.644	0.147	0.047	4.960	1.046	2.163	12.238	0.492	0.041	0.482	47.291	0.028	0.012	2.995	0.044	0.104	100.00
SB4VS-27	8.821	8.960	0.037	0.944	0.045	0.062	0.018	8.713	0.099	0.032	5.120	0.803	2.049	11.804	0.466	0.027	0.546	48.697	0.019	0.008	2.633	0.029	0.070	100.00
SB4VS-28	7.909	8.960	0.053	0.756	0.064	0.088	0.025	10.217	0.140	0.045	5.120	0.991	1.852	11.031	0.466	0.038	0.546	48.889	0.027	0.011	2.633	0.041	0.099	100.00
SB4VS-29	8.151	9.240	0.050	0.714	0.060	0.083	0.024	8.229	0.132	0.042	5.280	0.758	1.749	11.371	0.615	0.036	0.516	50.102	0.025	0.011	2.680	0.039	0.093	100.00
SB4VS-30	7.470	9.240	0.035	0.714	0.042	0.059	0.017	9.650	0.093	0.030	5.280	0.758	1.935	10.898	0.615	0.026	0.431	50.102	0.018	0.007	2.486	0.028	0.066	100.00
SB4VS-31	7.030	9.520	0.047	0.839	0.057	0.078	0.023	9.082	0.124	0.040	5.440	0.714	1.821	9.728	0.579	0.034	0.485	51.679	0.024	0.010	2.522	0.037	0.088	100.00
SB4VS-32	8.400	8.400	0.067	1.200	0.081	0.112	0.032	10.800	0.177	0.057	4.800	0.800	2.000	12.800	0.800	0.049	0.800	45.600	0.034	0.014	2.800	0.053	0.125	100.00
SB4VS-33	9.880	8.680	0.032	1.140	0.038	0.053	0.015	9.120	0.084	0.027	4.960	1.140	2.280	10.460	0.760	0.023	0.760	47.780	0.016	0.007	2.660	0.025	0.060	100.00
SB4VS-34	9.360	8.960	0.030	0.720	0.036	0.050	0.015	10.080	0.080	0.026	5.120	1.080	1.800	10.120	0.360	0.022	0.720	48.440	0.015	0.006	2.880	0.024	0.056	100.00
SB4VS-35	7.140	9.240	0.057	0.680	0.069	0.095	0.027	8.500	0.151	0.048	5.280	0.680	2.040	11.480	0.340	0.042	0.680	50.540	0.029	0.012	2.720	0.045	0.106	100.00

Table E2. Measured Elemental Concentrations (wt%) for Samples Prepared Using Lithium Metaborate

Glass ID	Laboratory ID	Block	Sub-Block	Analytical Sequence	Ba	Ca	Ce	Cr	Cu	K	La	Mg	Mn	Na	Pb	S	Th	Ti	Zn	Zr
Batch 1	BCHLM111	1	1	1	0.119	0.863	0.002	0.064	0.318	3.16	<0.010	0.774	1.38	7.18	<0.010	<0.100	<0.100	0.375	<0.010	0.065
U std	UstdLM111	1	1	2	<0.010	0.909	<0.010	0.153	0.006	2.7	<0.010	0.647	2.21	8.63	<0.010	<0.100	<0.100	0.53	<0.010	<0.010
SB4VS-18	U02LM11	1	1	3	0.028	0.6	0.016	0.043	0.018	<0.100	0.025	0.503	1.5	8.02	0.028	0.145	<0.100	<0.010	0.023	0.045
SB4VS-12	U14LM11	1	1	4	0.04	0.638	0.032	0.053	0.025	0.133	0.032	0.551	1.72	8.69	0.032	0.164	0.107	<0.010	0.031	0.058
LRM-02	U33LM11	1	1	5	<0.010	0.367	<0.010	0.124	0.001	1.32	<0.010	0.054	0.051	15.5	0.073	0.077	<0.100	0.054	<0.010	0.66
SB4VS-12	U14LM21	1	1	6	0.04	0.646	0.031	0.052	0.025	0.138	0.032	0.549	1.69	8.75	0.031	0.147	0.106	<0.010	0.039	0.059
LRM-08	U31LM11	1	1	7	<0.010	0.383	<0.010	0.112	0.003	1.33	<0.010	0.05	0.047	15.4	0.063	0.089	<0.100	0.05	0.003	0.595
LRM-06	U36LM21	1	1	8	<0.010	0.352	<0.010	0.121	0.003	1.27	<0.010	0.054	0.052	15	0.071	0.071	<0.100	0.054	0.001	0.671
SB4VS-26	U29LM21	1	1	9	0.047	0.671	0.05	0.064	0.024	0.111	0.031	0.584	1.66	8.7	0.037	0.137	0.118	0.01	0.031	0.071
SB4VS-20	U42LM11	1	1	10	0.032	0.58	0.029	0.044	0.018	0.102	0.027	0.407	1.29	7.67	0.023	0.111	<0.100	<0.010	0.025	0.046
LRM-08	U31LM21	1	1	11	<0.010	0.354	<0.010	0.121	0.003	1.3	<0.010	0.054	0.052	15.2	0.073	0.071	<0.100	0.054	<0.010	0.661
LRM-06	U36LM11	1	1	12	<0.010	0.36	<0.010	0.122	0.002	1.31	<0.010	0.054	0.052	15.4	0.073	0.086	<0.100	0.055	<0.010	0.648
SB4VS-05	U13LM21	1	1	13	0.027	0.509	0.029	0.038	0.016	<0.100	0.022	0.41	1.25	7.47	0.024	0.109	<0.100	<0.010	0.025	0.045
Batch 1	BCHLM112	1	1	14	0.119	0.851	<0.010	0.063	0.316	3.11	<0.010	0.766	1.31	6.96	<0.010	<0.100	<0.100	0.37	<0.010	0.065
U std	USTDLM112	1	1	15	<0.010	0.898	<0.010	0.15	0.006	2.79	<0.010	0.629	2.11	8.81	<0.010	<0.100	<0.100	0.525	<0.010	<0.010
SB4VS-07	U27LM11	1	1	16	0.034	0.639	0.032	0.038	0.019	0.114	0.028	0.495	1.54	8.56	0.028	0.153	0.102	<0.010	0.027	0.056
SB4VS-18	U02LM21	1	1	17	0.026	0.67	0.015	0.046	0.019	0.1	0.022	0.448	1.42	7.95	0.021	0.130	<0.100	<0.010	0.024	0.043
SB4VS-20	U42LM21	1	1	18	0.033	0.56	0.029	0.045	0.017	<0.100	0.027	0.415	1.27	7.63	0.029	0.108	<0.100	<0.010	0.025	0.046
SB4VS-27	U05LM11	1	1	19	0.028	0.659	0.026	0.044	0.016	<0.100	0.021	0.431	1.54	8.95	0.024	0.151	<0.100	<0.010	0.021	0.046
LRM-02	U33LM21	1	1	20	<0.010	0.352	<0.010	0.119	0.002	1.31	<0.010	0.053	0.051	15.4	0.072	0.065	<0.100	0.054	<0.010	0.662
SB4VS-31	U17LM21	1	1	21	0.033	0.607	0.032	0.046	0.019	0.105	0.028	0.374	1.36	7.6	0.026	0.132	<0.100	<0.010	0.026	0.06
SB4VS-26	U29LM11	1	1	22	0.042	0.704	0.046	0.059	0.022	0.13	0.028	0.52	1.58	8.62	0.032	0.126	0.108	<0.010	0.028	0.066
SB4VS-31	U17LM11	1	1	23	0.032	0.618	0.032	0.044	0.018	0.119	0.027	0.357	1.37	7.62	0.02	0.121	<0.100	<0.010	0.027	0.057
SB4VS-05	U13LM11	1	1	24	0.027	0.51	0.029	0.037	0.016	<0.100	0.022	0.412	1.23	7.56	0.023	0.119	<0.100	<0.010	0.027	0.044
SB4VS-07	U27LM21	1	1	25	0.033	0.675	0.031	0.037	0.019	0.126	0.027	0.469	1.53	8.59	0.023	0.134	<0.100	<0.010	0.027	0.056
SB4VS-27	U05LM21	1	1	26	0.026	0.685	0.025	0.042	0.017	<0.100	0.02	0.407	1.52	8.89	0.023	0.150	<0.100	<0.010	0.024	0.045
Batch 1	BCHLM113	1	1	27	0.112	0.855	<0.010	0.061	0.315	3.15	<0.010	0.73	1.3	7.07	<0.010	<0.100	<0.100	0.356	<0.010	0.063
U std	USTDLM113	1	1	28	<0.010	0.892	<0.010	0.148	0.006	2.72	<0.010	0.626	2.13	8.75	<0.010	<0.100	<0.100	0.516	<0.010	<0.010
Batch 1	BCHLM121	1	2	1	0.122	0.857	<0.010	0.066	0.317	3.14	<0.010	0.785	1.36	7.17	<0.010	<0.100	<0.100	0.374	<0.010	0.066
U std	USTDLM121	1	2	2	<0.010	0.905	<0.010	0.159	0.005	2.78	<0.010	0.657	2.2	8.92	<0.010	<0.100	<0.100	0.539	0.004	0.002
LRM-02	U33LM12	1	2	3	<0.010	0.368	<0.010	0.128	0.001	1.33	<0.010	0.058	0.053	15.8	0.073	0.086	<0.100	0.057	<0.010	0.667
SB4VS-07	U27LM12	1	2	4	0.037	0.643	0.033	0.041	0.018	0.111	0.03	0.514	1.65	8.64	0.032	0.149	0.108	0.01	0.029	0.059
LRM-08	U31LM22	1	2	5	<0.010	0.357	<0.010	0.124	0.002	1.28	<0.010	0.058	0.054	15.5	0.073	0.074	<0.100	0.057	0.004	0.665
SB4VS-12	U14LM22	1	2	6	0.043	0.648	0.032	0.055	0.024	0.134	0.034	0.56	1.76	8.94	0.03	0.150	0.111	0.011	0.04	0.06
LRM-06	U36LM22	1	2	7	<0.010	0.356	<0.010	0.123	0.002	1.28	<0.010	0.058	0.054	15.4	0.075	0.070	<0.100	0.057	<0.010	0.677
SB4VS-20	U42LM12	1	2	8	0.034	0.588	0.029	0.047	0.017	0.1	0.028	0.415	1.36	7.77	0.027	0.121	<0.100	0.01	0.026	0.047
SB4VS-18	U02LM22	1	2	9	0.029	0.676	0.016	0.049	0.018	<0.100	0.024	0.466	1.49	8.05	0.024	0.127	<0.100	<0.010	0.025	0.044
LRM-08	U31LM12	1	2	10	<0.010	0.383	<0.010	0.116	0.002	1.32	<0.010	0.054	0.05	15.7	0.067	0.078	<0.100	0.053	0.004	0.593
SB4VS-27	U05LM22	1	2	11	0.03	0.695	0.026	0.046	0.016	<0.100	0.023	0.436	1.61	8.99	0.023	0.150	<0.100	<0.010	0.026	0.048
SB4VS-12	U14LM12	1	2	12	0.042	0.641	0.032	0.054	0.024	0.129	0.033	0.555	1.74	8.85	0.033	0.147	0.112	0.011	0.032	0.059
SB4VS-31	U17LM12	1	2	13	0.036	0.631	0.033	0.047	0.018	0.116	0.029	0.367	1.43	7.69	0.028	0.135	<0.100	<0.010	0.028	0.059
Batch 1	BCHLM122	1	2	14	0.122	0.862	<0.010	0.066	0.316	3.1	<0.010	0.79	1.37	7.09	<0.010	<0.100	<0.100	0.379	<0.010	0.067
U std	USTDLM122	1	2	15	<0.010	0.912	<0.010	0.156	0.006	2.73	<0.010	0.648	2.21	8.91	<0.010	<0.100	<0.100	0.529	<0.010	<0.010
SB4VS-26	U29LM22	1	2	16	0.048	0.676	0.05	0.066	0.024	0.107	0.032	0.579	1.72	8.98	0.039	0.130	0.125	0.012	0.031	0.07

Table E2. Measured Elemental Concentrations (wt%) for Samples Prepared Using Lithium Metaborate (continued)

Glass ID	Laboratory ID	Block	Sub-Block	Analytical Sequence	Ba	Ca	Ce	Cr	Cu	K	La	Mg	Mn	Na	Pb	S	Th	Ti	Zn	Zr
SB4VS-31	U17LM22	1	2	17	0.036	0.616	0.033	0.047	0.018	0.103	<0.010	0.376	1.42	7.73	0.027	0.128	<0.100	<0.010	0.027	0.06
SB4VS-07	U27LM22	1	2	18	0.035	0.682	0.032	0.04	0.019	0.123	0.028	0.482	1.58	8.8	0.024	0.136	0.102	0.01	0.029	0.058
SB4VS-18	U02LM12	1	2	19	0.03	0.599	0.016	0.044	0.018	<0.100	0.026	0.506	1.51	8.11	0.031	0.131	0.1	<0.010	0.024	0.046
SB4VS-26	U29LM12	1	2	20	0.045	0.713	0.047	0.062	0.021	0.128	0.03	0.53	1.65	8.67	0.034	0.127	0.115	0.011	0.029	0.068
SB4VS-05	U13LM12	1	2	21	0.03	0.518	0.029	0.039	0.015	<0.100	0.024	0.422	1.29	7.73	0.026	0.104	<0.100	0.01	0.028	0.045
LRM-02	U33LM22	1	2	22	<0.010	0.356	<0.010	0.123	0.002	1.3	<0.010	0.057	0.053	15.7	0.075	0.076	<0.100	0.057	<0.010	0.671
LRM-06	U36LM12	1	2	23	<0.010	0.364	<0.010	0.125	0.001	1.35	<0.010	0.057	0.054	16.1	0.073	0.074	<0.100	0.057	<0.010	0.65
SB4VS-27	U05LM12	1	2	24	0.029	0.673	0.026	0.047	0.016	<0.100	0.022	0.429	1.6	9.09	0.025	0.140	<0.100	<0.010	0.022	0.047
SB4VS-20	U42LM22	1	2	25	0.034	0.569	0.03	0.047	0.017	<0.100	0.029	0.419	1.32	7.9	0.027	0.106	<0.100	0.01	0.026	0.047
SB4VS-05	U13LM22	1	2	26	0.03	0.515	0.029	0.04	0.015	<0.100	0.024	0.42	1.26	7.87	0.027	0.125	<0.100	0.01	0.026	0.045
Batch 1	BCHLM123	1	2	27	0.118	0.868	<0.010	0.065	0.317	3.21	<0.010	0.761	1.31	7.39	<0.010	<0.100	<0.100	0.37	<0.010	0.065
U std	USTDLM123	1	2	28	<0.010	0.911	<0.010	0.156	0.005	2.83	<0.010	0.646	2.14	9.24	<0.010	<0.100	<0.100	0.53	<0.010	<0.010
Batch 1	BCHLM211	2	1	1	0.124	0.852	<0.010	0.068	0.317	3.08	<0.010	0.806	1.27	6.84	<0.010	<0.100	<0.100	0.382	<0.010	0.067
U std	USTDLM211	2	1	2	<0.010	0.908	<0.010	0.159	0.006	2.7	<0.010	0.665	2.07	8.61	<0.010	<0.100	<0.100	0.55	<0.010	<0.010
SB4VS-13	U32LM11	2	1	3	0.036	0.717	0.033	0.048	0.02	<0.100	0.028	0.584	1.59	8.91	0.031	0.135	0.115	<0.010	0.026	0.049
LRM-05	U03LM21	2	1	4	<0.010	0.404	<0.010	0.125	0.001	1.32	<0.010	0.061	0.052	14.9	0.073	0.083	<0.100	0.056	0.02	0.641
SB4VS-13	U32LM21	2	1	5	0.035	0.753	0.032	0.046	0.019	<0.100	0.027	0.566	1.57	8.65	0.03	0.154	0.112	<0.010	0.032	0.05
SB4VS-24	U12LM11	2	1	6	0.034	0.745	0.033	0.046	0.019	<0.100	0.024	0.492	1.52	9.55	0.025	0.157	0.117	<0.010	0.025	0.052
SB4VS-34	U04LM21	2	1	7	0.024	0.526	0.022	0.039	0.014	<0.100	0.019	0.613	1.31	7.55	0.026	0.175	0.107	<0.010	0.02	0.042
LRM-07	U40LM11	2	1	8	<0.010	0.364	<0.010	0.126	0.001	1.28	<0.010	0.055	0.053	14.4	0.073	0.082	<0.100	0.057	<0.010	0.683
SB4VS-04	U21LM21	2	1	9	0.044	0.728	0.032	0.055	0.022	0.126	0.034	0.625	1.75	11.1	0.034	0.171	0.131	0.021	0.032	0.079
SB4VS-30	U20LM21	2	1	10	0.028	0.523	0.028	0.038	0.014	<0.100	0.038	0.424	1.45	8.18	0.021	0.128	<0.100	<0.010	0.022	0.041
SB4VS-14	U09LM11	2	1	11	0.033	0.681	0.032	0.047	0.018	<0.100	0.025	0.501	1.6	8.92	0.028	0.130	0.108	<0.010	0.025	0.05
SB4VS-34	U04LM11	2	1	12	0.024	0.51	0.023	0.037	0.015	<0.100	0.019	0.62	1.36	7.51	0.025	0.186	0.108	<0.010	0.017	0.043
LRM-04	U08LM21	2	1	13	<0.010	0.376	<0.010	0.128	0.002	1.34	<0.010	0.055	0.053	15.2	0.076	0.069	<0.100	0.057	<0.010	0.668
Batch 1	BCHLM212	2	1	14	0.12	0.864	<0.010	0.065	0.318	3.1	<0.010	0.774	1.26	6.93	<0.010	<0.100	<0.100	0.377	<0.010	0.067
U std	USTDLM212	2	1	15	<0.010	0.914	<0.010	0.155	0.006	2.74	<0.010	0.647	2	8.69	<0.010	<0.100	<0.100	0.536	<0.010	0.002
SB4VS-14	U09LM21	2	1	16	0.032	0.696	0.031	0.046	0.021	<0.100	0.024	0.473	1.53	8.97	0.022	0.140	0.102	<0.010	0.025	0.053
LRM-07	U40LM21	2	1	17	<0.010	0.367	<0.010	0.122	0.002	1.31	<0.010	0.054	0.052	15	0.072	0.071	<0.100	0.057	<0.010	0.652
SB4VS-28	U35LM21	2	1	18	0.043	0.555	0.039	0.053	0.022	0.118	0.033	0.575	1.49	8.46	0.04	0.153	0.109	0.01	0.032	0.072
SB4VS-30	U20LM11	2	1	19	0.028	0.516	0.029	0.039	0.016	<0.100	0.038	0.432	1.52	8.19	0.02	0.110	<0.100	<0.010	0.02	0.042
SB4VS-04	U21LM11	2	1	20	0.044	0.75	0.088	0.056	0.02	0.134	0.034	0.601	1.88	11.3	0.031	0.174	0.126	<0.010	0.032	0.068
LRM-05	U03LM11	2	1	21	<0.010	0.497	<0.010	0.116	0.001	1.32	<0.010	0.052	0.048	15.2	0.06	0.079	<0.100	0.053	0.022	0.598
SB4VS-24	U12LM21	2	1	22	0.032	0.751	0.032	0.044	0.018	0.094	0.024	0.478	1.62	9.37	0.027	0.113	0.113	<0.010	0.024	0.052
SB4VS-35	U41LM11	2	1	23	0.043	0.488	0.043	0.065	0.024	0.123	0.037	0.392	1.63	8.71	0.039	0.177	0.115	0.011	0.032	0.074
SB4VS-28	U35LM11	2	1	24	0.041	0.572	0.038	0.05	0.022	0.128	0.032	0.536	1.46	8.5	0.039	0.148	0.103	0.01	0.03	0.067
LRM-04	U08LM11	2	1	25	<0.010	0.373	<0.010	0.127	0.002	1.29	<0.010	0.053	0.05	15.2	0.069	0.072	<0.100	0.055	<0.010	0.645
SB4VS-35	U41LM21	2	1	26	0.042	0.494	0.043	0.064	0.024	0.126	0.036	0.384	1.56	8.98	0.034	0.176	0.112	0.013	0.033	0.074
Batch 1	BCHLM213	2	1	27	0.119	0.864	<0.010	0.065	0.317	3.05	<0.010	0.775	1.3	7.01	<0.010	<0.100	<0.100	0.374	<0.010	0.066
U std	USTDLM213	2	1	28	<0.010	0.907	<0.010	0.154	0.005	2.71	<0.010	0.649	2.07	8.81	<0.010	<0.100	<0.100	0.524	<0.010	<0.010
Batch 1	BCHLM221	2	2	1	0.119	0.894	<0.010	0.064	0.323	3.12	<0.010	0.785	1.31	6.92	<0.010	<0.100	<0.100	0.379	<0.010	0.065
U std	USTDLM221	2	2	2	<0.010	0.933	<0.010	0.152	0.005	2.71	<0.010	0.636	2.17	8.65	<0.010	<0.100	<0.100	0.539	<0.010	<0.010
LRM-05	U03LM22	2	2	3	<0.010	0.437	<0.010	0.115	0.001	1.31	<0.010	0.053	0.046	15.1	0.062	0.059	<0.100	0.053	0.017	0.619
SB4VS-28	U35LM12	2	2	4	0.036	0.59	0.036	0.047	0.021	0.132	0.028	0.517	1.51	8.45	0.029	0.127	0.107	<0.010	0.027	0.065
SB4VS-28	U35LM22	2	2	5	0.037	0.572	0.037	0.049	0.022	0.122	0.029	0.548	1.56	8.44	0.035	0.139	0.113	<0.010	0.028	0.069

Table E2. Measured Elemental Concentrations (wt%) for Samples Prepared Using Lithium Metaborate (continued)

Glass ID	Laboratory ID	Block	Sub-Block	Analytical Sequence	Ba	Ca	Ce	Cr	Cu	K	La	Mg	Mn	Na	Pb	S	Th	Ti	Zn	Zr
SB4VS-13	U32LM12	2	2	6	0.03	0.761	0.031	0.044	0.019	<0.100	0.024	0.543	1.76	9.15	0.024	0.139	0.12	<0.010	0.023	0.047
SB4VS-30	U20LM22	2	2	7	0.023	0.549	0.026	0.035	0.014	<0.100	0.033	0.399	1.63	8.36	0.016	0.110	<0.100	<0.010	0.019	0.039
SB4VS-30	U20LM12	2	2	8	0.024	0.534	0.027	0.037	0.016	<0.100	0.035	0.422	1.62	8.3	0.017	0.118	<0.100	<0.010	0.017	0.04
SB4VS-35	U41LM12	2	2	9	0.039	0.509	0.041	0.063	0.024	0.126	0.033	0.384	1.73	8.82	0.033	0.165	0.12	0.01	0.029	0.072
SB4VS-35	U41LM22	2	2	10	0.038	0.517	0.041	0.062	0.023	0.13	0.032	0.373	1.75	8.81	0.033	0.157	0.115	0.012	0.03	0.071
SB4VS-34	U04LM22	2	2	11	0.019	0.546	0.02	0.038	0.014	<0.100	0.016	0.593	1.52	7.59	0.02	0.178	0.114	<0.010	0.017	0.04
SB4VS-04	U21LM22	2	2	12	0.04	0.758	0.03	0.053	0.022	0.13	0.031	0.612	2.02	11.5	0.027	0.169	0.138	0.019	0.03	0.075
SB4VS-34	U04LM12	2	2	13	0.019	0.534	0.02	0.035	0.014	<0.100	0.016	0.603	1.56	7.91	0.023	0.186	0.113	<0.010	0.015	0.041
Batch 1	BCHLM222	2	2	14	0.114	0.891	<0.010	0.063	0.319	3.12	<0.010	0.765	1.42	7.11	<0.010	<0.100	<0.100	0.372	0.005	0.064
U std	USTDLM222	2	2	15	<0.010	0.929	<0.010	0.151	0.005	2.73	<0.010	0.641	2.25	9	<0.010	<0.100	<0.100	0.531	0.001	0.001
SB4VS-14	U09LM22	2	2	16	0.027	0.73	0.029	0.043	0.021	<0.100	0.021	0.453	1.69	9.3	0.017	0.120	0.109	<0.010	0.022	0.05
SB4VS-24	U12LM12	2	2	17	0.028	0.788	0.03	0.042	0.019	<0.100	0.02	0.461	1.65	10.1	0.02	0.124	0.12	<0.010	0.022	0.048
LRM-05	U03LM12	2	2	18	<0.010	0.523	<0.010	0.113	0.001	1.36	<0.010	0.049	0.045	16	0.057	0.078	<0.100	0.052	0.02	0.594
LRM-07	U40LM22	2	2	19	<0.010	0.387	<0.010	0.116	0.001	1.32	<0.010	0.049	0.048	15.8	0.067	0.069	<0.100	0.054	<0.010	0.642
LRM-04	U08LM22	2	2	20	<0.010	0.401	<0.010	0.122	0.001	1.35	<0.010	0.049	0.048	16	0.065	0.062	<0.100	0.055	<0.010	0.655
LRM-04	U08LM12	2	2	21	<0.010	0.399	<0.010	0.125	0.002	1.33	<0.010	0.048	0.047	15.7	0.063	0.073	<0.100	0.053	<0.010	0.636
SB4VS-14	U09LM12	2	2	22	0.028	0.717	0.03	0.045	0.017	<0.100	0.021	0.481	1.66	9.58	0.023	0.131	0.113	<0.010	0.022	0.05
SB4VS-04	U21LM12	2	2	23	0.039	0.775	0.086	0.053	0.02	0.138	0.03	0.582	1.85	11.8	0.026	0.156	0.131	<0.010	0.029	0.066
SB4VS-24	U12LM22	2	2	24	0.028	0.785	0.03	0.042	0.017	0.098	0.02	0.458	1.54	9.96	0.022	0.141	0.123	<0.010	0.021	0.049
LRM-07	U40LM12	2	2	25	<0.010	0.385	<0.010	0.12	0	1.31	<0.010	0.049	0.049	15.7	0.067	0.090	<0.100	0.055	<0.010	0.669
SB4VS-13	U32LM22	2	2	26	0.03	0.796	0.029	0.042	0.019	<0.100	0.023	0.528	1.61	9.24	0.023	0.135	0.115	<0.010	0.029	0.047
Batch 1	BCHLM223	2	2	27	0.113	0.89	<0.010	0.061	0.319	3.14	<0.010	0.74	1.29	7.3	<0.010	<0.100	<0.100	0.373	<0.010	0.064
U std	USTDLM223	2	2	28	<0.010	0.94	<0.010	0.15	0.005	2.85	<0.010	0.623	2.05	9.31	<0.010	<0.100	<0.100	0.525	<0.010	<0.010
Batch 1	BCHLM311	3	1	1	0.123	0.88	<0.010	0.066	0.316	3.04	<0.010	0.803	1.41	6.91	<0.010	<0.100	<0.100	0.384	<0.010	0.066
U std	USTDLM311	3	1	2	<0.010	0.922	<0.010	0.158	0.005	2.67	<0.010	0.653	2.28	8.75	<0.010	<0.100	<0.100	0.546	<0.010	<0.010
SB4VS-03	U22LM21	3	1	3	0.04	0.667	0.032	0.062	0.019	0.102	0.031	0.594	1.7	11.1	0.028	0.151	0.13	<0.010	0.027	0.062
SB4VS-11	U28LM21	3	1	4	0.036	0.727	0.025	0.05	0.019	0.122	0.027	0.525	1.8	9.48	0.027	0.140	0.126	<0.010	0.034	0.058
SB4VS-23	U19LM11	3	1	5	0.046	0.749	0.042	0.07	0.021	0.128	0.036	0.649	1.61	9.81	0.034	0.126	0.13	0.01	0.033	0.075
SB4VS-06	U24LM11	3	1	6	0.032	0.597	0.024	0.055	0.018	<0.100	0.024	0.482	1.44	8.32	0.027	0.140	0.106	<0.010	0.025	0.047
SB4VS-21	U01LM11	3	1	7	0.034	0.601	0.027	0.057	0.015	0.102	0.026	0.476	1.35	8.06	0.023	0.122	0.102	<0.010	0.024	0.049
SB4VS-10	U39LM11	3	1	8	0.044	0.808	0.038	0.058	0.023	0.149	0.033	0.529	1.7	9.95	0.03	0.163	0.127	<0.010	0.035	0.069
SB4VS-10	U39LM21	3	1	9	0.045	0.822	0.039	0.058	0.023	0.138	0.034	0.55	1.68	9.88	0.03	0.163	0.133	<0.010	0.041	0.071
SB4VS-15	U25LM11	3	1	10	0.036	0.633	0.036	0.049	0.019	<0.100	0.028	0.476	1.6	8.96	0.024	0.134	0.118	<0.010	0.03	0.061
SB4VS-16	U11LM21	3	1	11	0.037	0.629	0.027	0.052	0.02	0.117	0.027	0.524	1.45	8.94	0.027	0.135	0.11	<0.010	0.032	0.062
SB4VS-09	U06LM11	3	1	12	0.045	0.784	0.036	0.057	0.025	0.126	0.033	0.707	1.85	10	0.034	0.203	0.157	0.01	0.103	0.077
SB4VS-19	U18LM11	3	1	13	0.028	0.584	0.026	0.042	0.015	0.092	0.021	0.498	1.43	8.65	0.018	0.125	0.107	<0.010	0.023	0.043
Batch 1	BCHLM312	3	1	14	0.126	0.877	<0.010	0.068	0.316	3.07	<0.010	0.822	1.35	7.12	<0.010	<0.100	<0.100	0.398	<0.010	0.067
U std	USTDLM312	3	1	15	<0.010	0.92	<0.010	0.164	0.004	2.78	<0.010	0.688	2.13	9.09	<0.010	<0.100	<0.100	0.553	<0.010	<0.010
SB4VS-16	U11LM11	3	1	16	0.038	0.641	0.027	0.054	0.02	0.124	0.028	0.525	1.49	9.04	0.026	0.120	0.113	<0.010	0.033	0.061
SB4VS-19	U18LM21	3	1	17	0.03	0.565	0.027	0.044	0.015	<0.100	0.022	0.528	1.41	8.75	0.02	0.132	0.111	<0.010	0.027	0.045
SB4VS-15	U25LM21	3	1	18	0.04	0.642	0.038	0.053	0.019	<0.100	0.03	0.513	1.62	9.02	0.025	0.139	0.126	<0.010	0.031	0.065
SB4VS-21	U01LM21	3	1	19	0.035	0.591	0.027	0.056	0.015	<0.100	0.027	0.491	1.4	7.96	0.025	0.137	0.106	<0.010	0.025	0.05
LRM-01	U26LM21	3	1	20	<0.010	0.38	<0.010	0.131	0.001	1.3	<0.010	0.06	0.054	15.9	0.073	0.071	<0.100	0.058	<0.010	0.674
SB4VS-23	U19LM21	3	1	21	0.046	0.741	0.043	0.066	0.021	0.127	0.036	0.646	1.59	9.74	0.036	0.149	0.129	0.01	0.034	0.075
SB4VS-06	U24LM21	3	1	22	0.034	0.604	0.058	0.056	0.018	<0.100	0.025	0.5	1.49	8.38	0.028	0.130	0.11	<0.010	0.025	0.049

Table E2. Measured Elemental Concentrations (wt%) for Samples Prepared Using Lithium Metaborate (continued)

Glass ID	Laboratory ID	Block	Sub-Block	Analytical Sequence	Ba	Ca	Ce	Cr	Cu	K	La	Mg	Mn	Na	Pb	S	Th	Ti	Zn	Zr
SB4VS-11	U28LM11	3	1	23	0.038	0.703	0.026	0.052	0.019	0.113	0.029	0.577	1.9	9.83	0.031	0.148	0.135	<0.010	0.028	0.063
SB4VS-03	U22LM11	3	1	24	0.04	0.679	0.032	0.062	0.019	0.108	0.031	0.603	1.74	11.3	0.027	0.162	0.131	<0.010	0.027	0.067
LRM-01	U26LM11	3	1	25	<0.010	0.419	<0.010	0.128	0.001	1.3	<0.010	0.057	0.053	15.9	0.07	0.082	<0.100	0.057	0.005	0.65
SB4VS-09	U06LM21	3	1	26	0.046	0.784	0.036	0.058	0.025	0.127	0.033	0.684	2.01	10.3	0.033	0.178	0.153	0.01	0.033	0.078
Batch 1	BCHLM313	3	1	27	0.129	0.881	<0.010	0.069	0.319	3.21	<0.010	0.831	1.38	7.52	<0.010	<0.100	<0.100	0.401	<0.010	0.068
U std	USTDLM313	3	1	28	<0.010	0.919	<0.010	0.167	0.004	2.75	<0.010	0.691	2.18	9.27	<0.010	<0.100	<0.100	0.557	<0.010	<0.010
Batch 1	BCHLM321	3	2	1	0.124	0.863	<0.010	0.067	0.318	3.06	<0.010	0.792	1.37	6.96	<0.010	<0.100	<0.100	0.377	<0.010	0.066
U std	USTDLM321	3	2	2	<0.010	0.907	<0.010	0.159	0.005	2.65	<0.010	0.662	2.21	8.71	<0.010	<0.100	<0.100	0.545	<0.010	<0.010
SB4VS-06	U24LM12	3	2	3	0.034	0.589	0.025	0.053	0.02	<0.100	0.027	0.476	1.49	8.17	0.027	0.149	0.101	0.01	0.027	0.047
SB4VS-11	U28LM12	3	2	4	0.038	0.691	<0.010	0.05	0.02	0.115	0.031	0.545	1.9	9.5	0.032	0.165	0.124	0.01	0.029	0.061
SB4VS-06	U24LM22	3	2	5	0.034	0.597	0.058	0.051	0.019	0.103	0.027	0.47	1.48	8.31	0.031	0.139	<0.100	0.01	0.026	0.047
SB4VS-10	U39LM12	3	2	6	0.045	0.788	0.039	0.057	0.024	0.153	0.035	0.514	1.74	9.95	0.033	0.165	0.118	0.01	0.037	0.068
SB4VS-19	U18LM12	3	2	7	0.03	0.583	0.027	0.041	0.017	<0.100	0.023	0.484	1.43	8.51	0.022	0.151	<0.100	<0.010	0.025	0.043
SB4VS-16	U11LM12	3	2	8	0.039	0.631	0.027	0.052	0.021	0.127	0.03	0.508	1.54	9.08	0.03	0.140	0.101	<0.010	0.034	0.061
SB4VS-09	U06LM22	3	2	9	0.046	0.762	0.035	0.055	0.026	0.127	0.034	0.654	1.98	10	0.036	0.191	0.139	0.012	0.035	0.076
SB4VS-11	U28LM22	3	2	10	0.038	0.702	0.026	0.049	0.02	0.123	0.029	0.516	1.82	9.7	0.026	0.164	0.114	<0.010	0.036	0.058
SB4VS-15	U25LM12	3	2	11	0.038	0.609	0.037	0.049	0.02	<0.100	0.03	0.473	1.7	8.88	0.029	0.142	0.112	0.01	0.031	0.062
SB4VS-21	U01LM22	3	2	12	0.036	0.581	0.028	0.054	0.016	<0.100	0.03	0.477	1.44	7.85	0.028	0.139	<0.100	<0.010	0.027	0.05
SB4VS-15	U25LM22	3	2	13	0.04	0.623	0.038	0.05	0.02	<0.100	0.032	0.49	1.67	8.94	0.027	0.160	0.114	0.011	0.033	0.064
Batch 1	BCHLM322	3	2	14	0.125	0.871	<0.010	0.067	0.319	3.07	<0.010	0.809	1.34	7.09	<0.010	<0.100	<0.100	0.382	<0.010	0.067
U std	USTDLM322	3	2	15	<0.010	0.914	<0.010	0.16	0.006	2.76	<0.010	0.663	2.15	9.12	<0.010	<0.100	<0.100	0.546	<0.010	<0.010
SB4VS-16	U11LM22	3	2	16	0.041	0.606	0.027	0.053	0.021	0.117	0.03	0.536	1.49	9.13	0.031	0.144	0.103	0.01	0.035	0.062
SB4VS-03	U22LM22	3	2	17	0.042	0.662	0.033	0.062	0.02	0.104	0.033	0.585	1.69	11.1	0.028	0.160	0.12	0.011	0.029	0.063
LRM-01	U26LM22	3	2	18	<0.010	0.37	<0.010	0.13	0.002	1.3	<0.010	0.061	0.055	15.8	0.075	0.074	<0.100	0.058	<0.010	0.667
SB4VS-03	U22LM12	3	2	19	0.043	0.663	0.033	0.063	0.02	0.106	0.034	0.594	1.7	11.3	0.028	0.174	0.121	0.011	0.03	0.068
SB4VS-09	U06LM12	3	2	20	0.047	0.772	0.036	0.057	0.026	0.127	0.035	0.701	1.96	10.5	0.037	0.206	0.141	0.012	0.104	0.077
LRM-01	U26LM12	3	2	21	<0.010	0.402	<0.010	0.131	0.002	1.31	<0.010	0.061	0.056	16	0.071	0.080	<0.100	0.059	<0.010	0.648
SB4VS-10	U39LM22	3	2	22	0.049	0.795	0.04	0.06	0.024	0.135	0.038	0.575	1.76	10.3	0.037	0.171	0.125	0.011	0.045	0.075
SB4VS-23	U19LM22	3	2	23	0.049	0.728	0.044	0.066	0.022	0.127	0.038	0.652	1.61	10.1	0.04	0.142	0.121	0.012	0.037	0.076
SB4VS-19	U18LM22	3	2	24	0.032	0.557	0.028	0.045	0.016	0.088	0.024	0.536	1.44	8.92	0.022	0.154	0.103	0.01	0.03	0.046
SB4VS-21	U01LM12	3	2	25	0.038	0.581	0.028	0.059	0.016	0.101	0.03	0.494	1.38	8.32	0.031	0.139	<0.100	<0.010	0.028	0.051
SB4VS-23	U19LM12	3	2	26	0.05	0.743	0.044	0.07	0.023	0.129	0.039	0.658	1.64	10.2	0.037	0.164	0.124	0.012	0.037	0.077
Batch 1	BCHLM323	3	2	27	0.131	0.86	<0.010	0.071	0.319	3.17	<0.010	0.84	1.35	7.43	<0.010	<0.100	<0.100	0.388	<0.010	0.068
U std	USTDLM323	3	2	28	<0.010	0.909	<0.010	0.167	0.006	2.77	<0.010	0.697	2.17	9.4	<0.010	<0.100	<0.100	0.551	<0.010	<0.010
Batch 1	BCHLM411	4	1	1	0.122	0.864	<0.010	0.067	0.317	3.2	<0.010	0.784	1.33	7.12	<0.010	<0.100	<0.100	0.366	<0.010	0.065
U std	USTDLM411	4	1	2	<0.010	0.914	<0.010	0.156	0.005	2.72	<0.010	0.652	2.18	8.85	<0.010	<0.100	<0.100	0.537	<0.010	<0.010
SB4VS-08	U37LM11	4	1	3	0.042	0.704	0.04	0.056	0.02	0.117	0.034	0.588	1.84	9.41	0.034	0.163	0.128	0.011	0.034	0.069
SB4VS-22	U23LM21	4	1	4	0.049	0.628	0.041	0.065	0.021	0.137	0.038	0.524	1.89	9.51	0.037	0.148	0.123	0.01	0.036	0.08
SB4VS-29	U43LM21	4	1	5	0.038	0.526	0.039	0.051	0.019	0.118	0.032	0.411	1.4	8.56	0.033	0.141	0.101	0.01	0.029	0.056
SB4VS-17	U38LM11	4	1	6	0.031	0.615	0.021	0.044	0.018	0.107	0.026	0.452	1.55	8.52	0.023	0.142	0.097	<0.010	0.026	0.048
LRM-03	U34LM11	4	1	7	<0.010	0.368	<0.010	0.122	0.001	1.31	<0.010	0.056	0.052	15.5	0.071	0.089	<0.100	0.056	<0.010	0.628
SB4VS-22	U23LM11	4	1	8	0.047	0.623	0.042	0.061	0.021	0.138	0.038	0.511	1.89	9.43	0.037	0.154	0.121	0.01	0.035	0.078
SB4VS-02	U15LM11	4	1	9	0.032	0.581	0.026	0.06	0.014	<0.100	0.023	0.432	1.38	10.4	0.024	0.113	0.1	<0.010	0.025	0.048
SB4VS-01	U07LM21	4	1	10	0.037	0.596	0.026	0.05	0.017	<0.100	0.027	0.488	1.47	10.3	0.026	0.137	<0.100	0.011	0.024	0.051
LRM-03	U34LM21	4	1	11	<0.010	0.37	<0.010	0.121	0.001	1.33	<0.010	0.059	0.051	15.5	0.072	0.082	<0.100	0.056	<0.010	0.65

Table E2. Measured Elemental Concentrations (wt%) for Samples Prepared Using Lithium Metaborate (continued)

Glass ID	Laboratory ID	Block	Sub-Block	Analytical Sequence	Ba	Ca	Ce	Cr	Cu	K	La	Mg	Mn	Na	Pb	S	Th	Ti	Zn	Zr
SB4VS-29	U43LM11	4	1	12	0.038	0.526	0.039	0.05	0.018	0.118	0.031	0.408	1.3	8.86	0.03	0.136	0.1	0.01	0.03	0.056
SB4VS-25	U16LM11	4	1	13	0.032	0.571	0.017	0.05	0.015	<0.100	0.024	0.588	1.61	9.56	0.025	0.158	0.113	0.01	0.024	0.049
Batch 1	BCHLM412	4	1	14	0.122	0.877	<0.010	0.066	0.319	3.16	<0.010	0.782	1.29	7.16	<0.010	<0.100	<0.100	0.385	0.01	0.065
U std	USTDLM412	4	1	15	<0.010	0.914	<0.010	0.154	0.005	2.74	<0.010	0.64	2.12	8.9	<0.010	<0.100	<0.100	0.529	<0.010	0.002
SB4VS-33	U30LM21	4	1	16	0.024	0.849	0.022	0.033	0.014	<0.100	0.02	0.582	1.73	8.33	0.016	0.180	<0.100	0.013	0.019	0.041
SB4VS-32	U10LM21	4	1	17	0.053	0.877	0.053	0.06	0.024	0.163	0.041	0.433	1.55	10	0.039	0.225	0.114	0.01	0.041	0.083
SB4VS-32	U10LM11	4	1	18	0.054	0.853	0.053	0.062	0.024	0.153	0.042	0.446	1.54	9.88	0.037	0.207	0.117	0.011	0.04	0.085
SB4VS-02	U15LM21	4	1	19	0.034	0.565	0.031	0.064	0.013	<0.100	0.024	0.46	1.39	10.3	0.023	0.138	0.107	0.01	0.03	0.051
SB4VS-33	U30LM11	4	1	20	0.023	0.858	0.022	0.033	0.013	<0.100	0.02	0.563	1.72	8.22	0.015	0.187	<0.100	<0.010	0.026	0.04
SB4VS-25	U16LM22	4	1	21	0.031	0.582	0.017	0.05	0.015	<0.100	0.024	0.574	1.69	9.52	0.023	0.165	0.109	0.01	0.024	0.048
SB4VS-08	U37LM21	4	1	22	0.042	0.694	0.041	0.054	0.02	0.111	0.034	0.594	1.79	9.5	0.033	0.172	0.126	0.011	0.034	0.069
SB4VS-17	U38LM21	4	1	23	0.03	0.601	0.02	0.041	0.017	0.108	0.024	0.418	1.42	8.35	0.021	0.126	<0.100	<0.010	0.024	0.045
SB4VS-01	U07LM11	4	1	24	0.037	0.592	0.027	0.051	0.016	<0.100	0.027	0.489	1.48	10.3	0.026	0.141	<0.100	0.011	0.025	0.053
Batch 1	BCHLM413	4	1	25	0.118	0.871	<0.010	0.065	0.317	3.2	<0.010	0.763	1.31	7.3	<0.010	<0.100	<0.100	0.371	<0.010	0.065
U std	USTDLM413	4	1	26	<0.010	0.912	<0.010	0.155	0.005	2.78	<0.010	0.643	2.13	9.13	<0.010	<0.100	<0.100	0.525	<0.010	<0.010
Batch 1	BCHLM421	4	2	1	0.122	0.871	<0.010	0.067	0.318	3.1	<0.010	0.8	1.36	6.91	<0.010	<0.100	<0.100	0.381	<0.010	0.065
U std	USTDLM421	4	2	2	<0.010	0.911	<0.010	0.16	0.006	2.73	<0.010	0.677	2.17	8.79	<0.010	<0.100	<0.100	0.546	<0.010	<0.010
LRM-03	U34LM12	4	2	3	<0.010	0.368	<0.010	0.125	0.002	1.24	<0.010	0.058	0.053	14.6	0.074	0.089	<0.100	0.058	<0.010	0.637
SB4VS-32	U10LM12	4	2	4	0.054	0.848	0.053	0.062	0.025	0.153	0.042	0.464	1.63	9.38	0.038	0.231	0.119	0.011	0.04	0.087
SB4VS-33	U30LM22	4	2	5	0.023	0.844	0.023	0.034	0.014	<0.100	0.02	0.617	1.78	7.99	0.019	0.184	<0.100	0.013	0.02	0.042
LRM-03	U34LM22	4	2	6	<0.010	0.363	<0.010	0.126	0.002	1.27	<0.010	0.061	0.053	15	0.076	0.090	<0.100	0.057	<0.010	0.658
SB4VS-17	U38LM22	4	2	7	0.029	0.597	0.021	0.041	0.018	0.107	0.024	0.442	1.48	8	0.02	0.137	<0.100	<0.010	0.024	0.046
SB4VS-02	U15LM22	4	2	8	0.034	0.563	0.032	0.067	0.014	<0.100	0.023	0.488	1.41	9.94	0.026	0.136	0.109	0.01	0.031	0.052
SB4VS-02	U15LM12	4	2	9	0.032	0.575	0.027	0.063	0.014	<0.100	0.022	0.458	1.39	10	0.021	0.124	0.103	<0.010	0.025	0.049
SB4VS-01	U07LM22	4	2	10	0.037	0.592	0.027	0.052	0.017	<0.100	0.027	0.514	1.54	10	0.024	0.129	<0.100	0.011	0.025	0.051
SB4VS-22	U23LM12	4	2	11	0.048	0.618	0.042	0.064	0.022	0.136	0.038	0.545	1.87	9.32	0.039	0.140	0.126	0.01	0.036	0.08
SB4VS-01	U07LM12	4	2	12	0.037	0.595	0.027	0.053	0.017	<0.100	0.027	0.513	1.53	10	0.028	0.154	<0.100	0.011	0.025	0.055
SB4VS-25	U16LM22	4	2	13	0.031	0.583	0.017	0.05	0.015	<0.100	0.023	0.595	1.73	9.17	0.024	0.150	0.113	0.01	0.024	0.049
Batch 1	BCHLM422	4	2	14	0.123	0.878	<0.010	0.067	0.32	3.01	<0.010	0.803	1.37	6.83	<0.010	<0.100	<0.100	0.383	<0.010	0.066
U std	USTDLM422	4	2	15	<0.010	0.916	<0.010	0.16	0.006	2.7	<0.010	0.675	2.18	8.83	<0.010	<0.100	<0.100	0.54	<0.010	<0.010
SB4VS-08	U37LM12	4	2	16	0.042	0.706	0.041	0.057	0.02	0.116	0.034	0.622	1.78	9.5	0.032	0.176	0.13	0.011	0.034	0.07
SB4VS-25	U16LM12	4	2	17	0.031	0.568	0.017	0.052	0.016	<0.100	0.024	0.619	1.69	9.26	0.023	0.160	0.117	0.01	0.024	0.05
SB4VS-32	U10LM22	4	2	18	0.053	0.879	0.054	0.062	0.024	0.162	0.041	0.461	1.56	9.8	0.039	0.217	0.118	0.011	0.042	0.085
SB4VS-08	U37LM22	4	2	19	0.042	0.695	0.042	0.056	0.02	0.111	0.034	0.631	1.79	9.39	0.035	0.176	0.134	0.011	0.035	0.071
SB4VS-29	U43LM22	4	2	20	0.037	0.531	0.04	0.052	0.019	0.117	0.031	0.43	1.32	8.86	0.036	0.135	0.103	0.01	0.029	0.057
SB4VS-22	U23LM22	4	2	21	0.049	0.63	0.042	0.067	0.022	0.137	0.038	0.545	1.87	9.44	0.038	0.154	0.128	0.01	0.036	0.081
SB4VS-17	U38LM12	4	2	22	0.031	0.625	0.021	0.045	0.018	0.108	0.026	0.476	1.56	8.52	0.023	0.139	0.1	<0.010	0.026	0.049
SB4VS-33	U30LM12	4	2	23	0.023	0.855	0.023	0.033	0.014	<0.100	0.019	0.59	1.72	8.02	0.013	0.184	<0.100	<0.010	0.027	0.041
SB4VS-29	U43LM12	4	2	24	0.037	0.525	0.04	0.052	0.019	0.116	0.032	0.431	1.34	8.64	0.033	0.139	0.104	0.01	0.03	0.056
Batch 1	BCHLM423	4	2	25	0.123	0.917	<0.010	0.067	0.318	3.06	<0.010	0.811	1.36	6.99	<0.010	<0.100	<0.100	0.385	<0.010	0.065
U std	USTDLM423	4	2	26	<0.010	0.873	<0.010	0.158	0.005	2.72	<0.010	0.671	2.17	8.95	<0.010	<0.100	<0.100	0.547	<0.010	<0.010

Table E3. Measured Elemental Concentrations (wt%) for Samples Prepared Using Peroxide Fusion

Glass ID	PSAL ID	Block	Sub-Block	Analytical Sequence	Al	B	Fe	Li	Ni	Si	U
Batch 1	BCHPF111	1	1	1	2.53	2.65	8.83	2.06	0.544	23	<0.100
U std	USTDPF111	1	1	2	2.11	2.87	8.29	1.43	0.7	19.3	1.83
LRM-06	U36PF21	1	1	3	5.49	2.55	0.954	0.139	0.096	24.5	<0.100
SB4VS-02	U15PF21	1	1	4	4.23	1.78	6.01	2.41	0.374	23	2.14
SB4VS-09	U06PF11	1	1	5	5.97	2.4	7.54	2.02	0.448	19.1	2.75
LRM-02	U33PF11	1	1	6	5.26	2.5	0.928	0.147	0.104	24.7	<0.100
SB4VS-14	U09PF21	1	1	7	4.77	2.76	6.21	2.31	0.357	21.6	2.31
LRM-06	U36PF11	1	1	8	5.17	2.51	0.939	0.139	0.106	24.5	<0.100
SB4VS-12	U14PF21	1	1	9	5.29	2.62	6.16	2.21	0.43	20.7	2.3
SB4VS-16	U11PF11	1	1	10	4.47	2.81	5.81	2.38	0.325	22	2.12
SB4VS-30	U20PF11	1	1	11	3.99	2.8	5.76	2.38	0.386	21.8	1.92
SB4VS-09	U06PF21	1	1	12	5.95	2.37	7.3	2	0.428	18.8	2.77
SB4VS-14	U09PF11	1	1	13	4.71	2.77	6.29	2.3	0.362	21.6	2.31
Batch 1	BCHPF112	1	1	14	2.54	2.47	8.62	2.06	0.511	22.7	<0.100
U std	USTDPF112	1	1	15	2.14	2.99	8.26	1.43	0.728	19.6	1.91
LRM-04	U08PF11	1	1	16	5.27	2.51	0.884	0.137	0.099	24.1	<0.100
LRM-04	U08PF21	1	1	17	5.42	2.53	0.89	0.14	0.103	24.6	<0.100
SB4VS-30	U20PF21	1	1	18	4.08	2.92	5.95	2.43	0.4	22.6	2.06
LRM-03	U34PF21	1	1	19	5.25	2.5	0.91	0.137	0.098	24.6	<0.100
SB4VS-02	U15PF11	1	1	20	4.33	1.76	5.88	2.42	0.361	23	2.23
LRM-07	U40PF11	1	1	21	5.35	2.5	0.918	0.137	0.098	24.9	<0.100
LRM-02	U33PF21	1	1	22	5.26	2.53	0.936	0.138	0.111	24.6	<0.100
LRM-03	U34PF11	1	1	23	5.31	2.48	0.887	0.137	0.091	24.7	<0.100
LRM-07	U40PF21	1	1	24	5.31	2.5	0.911	0.138	0.108	23.8	<0.100
SB4VS-12	U14PF11	1	1	25	5.4	2.69	6.35	2.25	0.456	21	2.42
SB4VS-16	U11PF21	1	1	26	4.59	2.83	5.78	2.39	0.31	22.1	2.16
Batch 1	BCHPF113	1	1	27	2.71	2.51	8.56	2.07	0.532	22.8	<0.100
U std	USTDPF112	1	1	28	2.18	2.88	8.4	1.46	0.725	19.9	1.9
Batch 1	BCHPF121	1	2	1	2.51	2.7	8.91	2.03	0.524	22.9	<0.100
U std	USTDPF121	1	2	2	2.17	2.92	8.66	1.44	0.724	19.6	1.9
LRM-07	U40PF22	1	2	3	5.32	2.54	0.947	0.139	0.081	23.6	<0.100
LRM-04	U08PF12	1	2	4	5.2	2.44	0.904	0.138	0.086	24.1	<0.100
SB4VS-14	U09PF22	1	2	5	4.71	2.75	6.49	2.3	0.351	21.8	2.27
LRM-02	U33PF22	1	2	6	5.19	2.5	0.957	0.139	0.089	24.8	<0.100
SB4VS-16	U11PF12	1	2	7	4.49	2.8	6.07	2.37	0.324	22.3	2.16
SB4VS-16	U11PF22	1	2	8	4.56	2.82	6.11	2.38	0.326	22.5	2.16
SB4VS-02	U15PF12	1	2	9	4.32	1.73	6.09	2.43	0.362	23.4	2.21
SB4VS-02	U15PF22	1	2	10	4.25	1.71	6.16	2.39	0.377	23.2	2.14
LRM-04	U08PF22	1	2	11	5.4	2.46	0.93	0.141	0.089	25	<0.100
SB4VS-30	U20PF22	1	2	12	4.05	2.86	6.23	2.43	0.407	22.6	1.99
SB4VS-12	U14PF12	1	2	13	5.4	2.66	6.59	2.25	0.448	21.5	2.41
Batch 1	BCHPF122	1	2	14	2.54	2.45	8.96	2.05	0.541	23	<0.100
U std	USTDPF122	1	2	15	2.16	2.79	8.55	1.44	0.714	19.8	1.86
LRM-03	U34PF22	1	2	16	5.25	2.43	0.927	0.138	0.084	24.8	<0.100
LRM-07	U40PF12	1	2	17	5.36	2.48	0.939	0.138	0.101	25.3	<0.100
SB4VS-09	U06PF12	1	2	18	6	2.32	7.53	1.98	0.422	19.2	2.8
SB4VS-30	U20PF12	1	2	19	3.97	2.77	6.01	2.34	0.372	22.2	1.92
LRM-02	U33PF12	1	2	20	5.26	2.46	0.938	0.147	0.09	24.9	<0.100
LRM-06	U36PF22	1	2	21	5.68	2.46	0.94	0.139	0.094	24.5	<0.100
SB4VS-09	U06PF22	1	2	22	5.99	2.34	7.56	1.99	0.43	19.1	2.76
SB4VS-14	U09PF12	1	2	23	4.72	2.74	6.52	2.29	0.349	21.8	2.33
SB4VS-12	U14PF22	1	2	24	5.38	2.6	6.31	2.21	0.426	20.9	2.33
LRM-06	U36PF12	1	2	25	5.22	2.48	0.967	0.139	0.096	24.8	<0.100
LRM-03	U34PF12	1	2	26	5.34	2.44	0.918	0.139	0.086	24.8	<0.100
Batch 1	BCHPF123	1	2	27	2.7	2.45	9.07	2.04	0.549	23	<0.100
U std	USTDPF123	1	2	28	2.16	2.83	8.7	1.45	0.722	19.9	1.86
Batch 1	BCHPF211	2	1	1	2.58	2.6	8.85	2.06	0.526	23.8	<0.100
U std	USTDPF211	2	1	2	2.16	2.87	8.54	1.44	0.71	20.1	1.86
SB4VS-11	U28PF11	2	1	3	5.73	2.6	6.69	2.16	0.453	21.3	2.64
SB4VS-25	U16PF21	2	1	4	4.84	2.77	6.06	2.33	0.464	22.8	2.41
SB4VS-04	U21PF21	2	1	5	5.76	1.49	7.92	2.08	0.494	21.5	2.77
SB4VS-35	U41PF11	2	1	6	3.98	2.91	5.66	2.45	0.191	23.9	2.16
SB4VS-25	U16PF11	2	1	7	4.82	2.76	6.02	2.31	0.454	22.6	2.42
SB4VS-24	U12PF21	2	1	8	4.84	2.64	6.89	2.21	0.318	21.7	2.49

Table E3. Measured Elemental Concentrations (wt%) for Samples Prepared Using Peroxide Fusion (continued)

Glass ID	PSAL ID	Block	Sub-Block	Analytical Sequence	Al	B	Fe	Li	Ni	Si	U
SB4VS-32	U10PF21	2	1	9	4.63	2.51	6.53	2.18	0.485	21.1	2.11
SB4VS-28	U35PF21	2	1	10	4.41	2.79	6.25	2.39	0.276	23.1	2.02
SB4VS-15	U25PF21	2	1	11	4.75	2.65	6.49	2.28	0.318	22.3	2.27
SB4VS-07	U27PF11	2	1	12	5.12	2.75	6.82	2.34	0.38	22.8	2.28
SB4VS-04	U21PF11	2	1	13	5.79	1.44	7.5	2.1	0.472	21.2	2.61
Batch 1	BCHPF212	2	1	14	2.58	2.46	9.01	2.06	0.537	24	<0.100
U std	USTDPF212	2	1	15	2.17	2.89	8.68	1.43	0.728	20.9	1.88
SB4VS-31	U17PF11	2	1	16	3.92	3.09	6.22	2.52	0.382	24.1	2.07
SB4VS-07	U27PF21	2	1	17	5.44	2.8	6.61	2.33	0.392	23.5	2.28
SB4VS-27	U05PF21	2	1	18	4.95	2.82	5.82	2.36	0.281	23.1	2.06
SB4VS-15	U25PF11	2	1	19	4.87	2.75	6.68	2.34	0.331	22.6	2.29
SB4VS-32	U10PF11	2	1	20	4.82	2.67	7.05	2.27	0.512	21.7	2.15
SB4VS-28	U35PF11	2	1	21	4.4	2.9	6.74	2.41	0.299	23.7	2.09
SB4VS-35	U41PF21	2	1	22	4.28	2.95	5.56	2.49	0.198	24.2	2.14
SB4VS-27	U05PF11	2	1	23	4.82	2.79	5.58	2.33	0.277	22.8	2.03
SB4VS-24	U12PF11	2	1	24	4.87	2.7	7.12	2.23	0.32	21.8	2.55
SB4VS-11	U28PF21	2	1	25	5.71	2.61	6.81	2.15	0.464	21.4	2.6
SB4VS-31	U17PF21	2	1	26	3.93	3.04	6.05	2.54	0.387	24.4	1.97
Batch 1	BCHPF213	2	1	27	2.59	2.5	8.96	2.07	0.532	24.1	<0.100
U std	USTDPF213	2	1	28	2.17	2.86	8.81	1.44	0.73	21.2	1.82
Batch 1	BCHPF221	2	2	1	2.56	2.57	8.9	2.04	0.518	23.6	<0.100
U std	USTDPF221	2	2	2	2.16	2.83	8.6	1.42	0.718	20.1	1.92
SB4VS-27	U05PF12	2	2	3	4.73	2.69	5.42	2.28	0.273	22.2	2.06
SB4VS-31	U17PF22	2	2	4	3.87	2.96	5.93	2.49	0.368	24	2.07
SB4VS-07	U27PF22	2	2	5	5.38	2.69	6.46	2.3	0.373	23.1	2.31
SB4VS-07	U27PF12	2	2	6	5.06	2.67	6.74	2.3	0.384	22.5	2.3
SB4VS-24	U12PF12	2	2	7	4.82	2.59	6.98	2.2	0.319	21.3	2.57
SB4VS-35	U41PF22	2	2	8	4.23	2.85	5.5	2.46	0.193	23.8	2.14
SB4VS-27	U05PF22	2	2	9	4.93	2.73	5.75	2.35	0.274	22.8	2.09
SB4VS-28	U35PF12	2	2	10	4.38	2.78	6.44	2.38	0.288	22.9	2.14
SB4VS-15	U25PF12	2	2	11	4.84	2.59	6.24	2.29	0.313	21.8	2.31
SB4VS-04	U21PF22	2	2	12	5.71	1.39	7.58	2.04	0.477	20.8	2.78
SB4VS-24	U12PF22	2	2	13	4.79	2.54	6.76	2.19	0.308	21.4	2.51
Batch 1	BCHPF222	2	2	14	2.55	2.38	8.79	2.03	0.511	23.5	<0.100
U std	USTDPF222	2	2	15	2.15	2.8	8.44	1.41	0.678	20.2	1.91
SB4VS-25	U16PF22	2	2	16	4.8	2.66	5.77	2.28	0.427	22.2	2.46
SB4VS-15	U25PF22	2	2	17	4.69	2.56	6.27	2.24	0.303	21.6	2.26
SB4VS-31	U17PF12	2	2	18	3.96	2.95	6.02	2.48	0.372	23.4	2.1
SB4VS-32	U10PF22	2	2	19	4.62	2.45	6.48	2.16	0.482	21	2.14
SB4VS-04	U21PF12	2	2	20	5.81	1.36	7.27	2.07	0.453	20.9	2.67
SB4VS-11	U28PF12	2	2	21	5.71	2.48	6.64	2.14	0.446	20.9	2.62
SB4VS-11	U28PF22	2	2	22	5.64	2.46	6.46	2.11	0.43	20.7	2.62
SB4VS-35	U41PF12	2	2	23	3.98	2.78	5.34	2.41	0.176	23.3	2.16
SB4VS-32	U10PF12	2	2	24	4.75	2.49	6.74	2.22	0.498	21.2	2.18
SB4VS-28	U35PF22	2	2	25	4.35	2.66	6.12	2.36	0.266	22.5	2.03
SB4VS-25	U16PF12	2	2	26	4.82	2.63	5.97	2.29	0.45	22.4	2.46
Batch 1	BCHPF223	2	2	27	2.55	2.34	8.74	2.04	0.511	23.4	<0.100
U std	USTDPF223	2	2	28	2.14	2.7	8.43	1.4	0.691	20.7	1.86
Batch 1	BCHPF311	3	1	1	2.55	2.59	9.07	2.04	0.527	23.6	<0.100
U std	USTDPF311	3	1	2	2.16	2.82	8.59	1.43	0.703	20.8	1.86
SB4VS-22	U23PF11	3	1	3	6.09	2.6	6.83	2.19	0.348	21.6	2.52
SB4VS-08	U37PF11	3	1	4	5.5	2.57	7.23	2.14	0.445	20.9	2.65
SB4VS-19	U18PF21	3	1	5	4.31	2.88	5.6	2.46	0.363	23.5	2.08
SB4VS-10	U39PF11	3	1	6	5.56	2.5	6.75	2.12	0.447	20.7	2.46
SB4VS-05	U13PF11	3	1	7	4.06	3.06	5.23	2.56	0.305	25	1.89
SB4VS-05	U13PF21	3	1	8	4.01	3.07	5.2	2.59	0.296	25	1.86
SB4VS-21	U01PF21	3	1	9	4.47	2.96	5.21	2.55	0.31	24.8	1.99
SB4VS-13	U32PF21	3	1	10	5.49	2.64	7.01	2.1	0.362	21.8	2.5
LRM-01	U26PF21	3	1	11	5.36	2.46	0.966	0.123	0.091	24.9	<0.100
SB4VS-08	U37PF21	3	1	12	5.59	2.56	7.23	2.15	0.448	21.4	2.64
SB4VS-20	U42PF21	3	1	13	4.17	2.97	5.62	2.54	0.342	24.8	2
Batch 1	BCHPF312	3	1	14	2.6	2.44	8.97	2.04	0.532	23.8	<0.100
U std	USTDPF312	3	1	15	2.16	2.82	8.61	1.42	0.726	20.2	1.88
SB4VS-19	U18PF11	3	1	16	4.33	2.86	5.55	2.46	0.361	23.7	2.08
SB4VS-22	U23PF21	3	1	17	6	2.53	6.64	2.13	0.344	20.9	2.5

Table E3. Measured Elemental Concentrations (wt%) for Samples Prepared Using Peroxide Fusion (continued)

Glass ID	PSAL ID	Block	Sub-Block	Analytical Sequence	Al	B	Fe	Li	Ni	Si	U
SB4VS-33	U30PF21	3	1	18	5.55	2.78	6.15	2.31	0.529	23	2.28
SB4VS-20	U42PF11	3	1	19	4.16	2.95	5.51	2.51	0.345	24.2	2
SB4VS-13	U32PF11	3	1	20	5.57	2.63	6.66	2.13	0.358	22	2.52
SB4VS-10	U39PF21	3	1	21	5.67	2.52	7.22	2.16	0.504	20.8	2.5
LRM-05	U03PF11	3	1	22	5.44	2.49	0.966	0.123	0.094	26.1	<0.100
SB4VS-33	U30PF11	3	1	23	5.46	2.75	6.08	2.29	0.532	22.8	2.25
LRM-01	U26PF11	3	1	24	5.42	2.41	0.91	0.124	0.08	25.6	<0.100
SB4VS-21	U01PF11	3	1	25	4.33	2.78	4.75	2.48	0.263	23.6	1.91
LRM-05	U03PF21	3	1	26	5.48	2.39	0.91	0.124	0.085	24.7	<0.100
Batch 1	BCHPF313	3	1	27	2.57	2.4	8.83	2.03	0.52	23.5	<0.100
U std	USTDPF313	3	1	28	2.18	2.76	8.63	1.43	0.707	22.6	1.91
Batch 1	BCHPF321	3	2	1	2.54	2.58	9.15	2.03	0.532	23.6	<0.100
U std	USTDPF321	3	2	2	2.16	2.82	8.73	1.42	0.711	20.6	1.86
SB4VS-33	U30PF22	3	2	3	5.51	2.8	6.17	2.32	0.516	23.1	2.22
SB4VS-10	U39PF22	3	2	4	5.64	2.52	7.31	2.16	0.51	20.7	2.45
SB4VS-22	U23PF12	3	2	5	6.01	2.52	6.75	2.18	0.327	21.3	2.45
SB4VS-33	U30PF12	3	2	6	5.45	2.75	6.11	2.29	0.519	22.8	2.24
SB4VS-10	U39PF12	3	2	7	5.65	2.43	6.9	2.16	0.468	21.1	2.46
SB4VS-08	U37PF22	3	2	8	5.57	2.49	7.28	2.17	0.425	21.4	2.57
SB4VS-21	U01PF22	3	2	9	4.48	2.89	5.14	2.54	0.291	24.4	1.99
SB4VS-19	U18PF22	3	2	10	4.4	2.81	5.48	2.48	0.364	23.7	2.08
SB4VS-08	U37PF12	3	2	11	5.57	2.5	7.1	2.14	0.428	21.1	2.65
SB4VS-21	U01PF12	3	2	12	4.24	2.7	4.72	2.44	0.25	23.2	1.86
LRM-05	U03PF12	3	2	13	5.38	2.42	0.957	0.107	0.078	25.7	<0.100
Batch 1	BCHPF322	3	2	14	2.56	2.32	8.69	2.01	0.506	23.2	<0.100
U std	USTDPF322	3	2	15	2.15	2.77	8.49	1.4	0.692	20	1.88
LRM-01	U26PF12	3	2	16	5.34	2.38	0.905	0.106	0.076	25	<0.100
LRM-05	U03PF22	3	2	17	5.46	2.36	0.92	0.107	0.075	24.6	<0.100
SB4VS-13	U32PF22	3	2	18	5.38	2.53	6.81	2.04	0.35	21.2	2.47
LRM-01	U26PF22	3	2	19	5.26	2.41	0.953	0.107	0.081	24.5	<0.100
SB4VS-05	U13PF22	3	2	20	3.97	2.94	4.97	2.55	0.279	24.4	1.8
SB4VS-20	U42PF12	3	2	21	4.17	2.9	5.38	2.51	0.326	24	2.01
SB4VS-20	U42PF22	3	2	22	4.12	2.89	5.41	2.52	0.334	24.2	2
SB4VS-05	U13PF12	3	2	23	4.02	2.96	5.1	2.53	0.286	24.4	1.83
SB4VS-19	U18PF12	3	2	24	4.37	2.77	5.4	2.45	0.36	23.4	2.1
SB4VS-13	U32PF12	3	2	25	5.6	2.58	6.52	2.11	0.347	21.9	2.54
SB4VS-22	U23PF22	3	2	26	5.93	2.42	6.38	2.1	0.321	20.6	2.46
Batch 1	BCHPF323	3	2	27	2.54	2.34	8.61	2.01	0.486	23.2	<0.100
U std	USTDPF323	3	2	28	2.16	2.67	8.32	1.4	0.67	21.3	1.83
Batch 1	BCHPF411	4	1	1	2.54	2.58	9.05	2.04	0.497	23.8	<0.100
U std	USTDPF411	4	1	2	2.17	2.87	8.75	1.42	0.684	21.6	1.85
SB4VS-06	U24PF21	4	1	3	4.53	2.93	5.82	2.45	0.309	23.8	2.07
SB4VS-17	U38PF11	4	1	4	4.83	2.77	6.1	2.34	0.29	22.9	2.15
SB4VS-26	U29PF11	4	1	5	4.63	2.75	6.39	2.32	0.282	23	2.42
SB4VS-01	U07PF11	4	1	6	4.62	1.55	5.36	2.44	0.281	24.3	1.87
SB4VS-06	U24PF11	4	1	7	4.47	2.9	6.02	2.42	0.323	24.1	2.09
SB4VS-26	U29PF21	4	1	8	4.59	2.73	6.42	2.31	0.291	22.6	2.43
LRM-08	U31PF21	4	1	9	5.32	2.42	0.898	0.091	0.057	24.6	<0.100
SB4VS-18	U02PF11	4	1	10	4.35	2.74	5.95	2.39	0.348	22.6	1.97
SB4VS-34	U04PF11	4	1	11	5.22	2.76	6.41	2.38	0.165	22.8	2.27
SB4VS-01	U07PF21	4	1	12	4.73	1.54	5.26	2.5	0.275	24.3	1.88
SB4VS-23	U19PF11	4	1	13	5.13	2.57	6.31	2.2	0.447	21.8	2.31
Batch 1	BCHPF412	4	1	14	2.56	2.39	8.8	2.01	0.495	23.5	<0.100
U std	USTDPF412	4	1	15	2.19	2.82	8.41	1.4	0.659	20.5	1.92
SB4VS-17	U38PF21	4	1	16	4.9	2.77	5.99	2.37	0.281	23.1	2.14
SB4VS-23	U19PF21	4	1	17	5.08	2.6	6.43	2.2	0.449	21.8	2.28
SB4VS-29	U43PF21	4	1	18	4.45	2.79	5.27	2.38	0.355	23.1	2.13
SB4VS-29	U43PF11	4	1	19	4.46	2.81	5.26	2.4	0.356	23.1	2.12
SB4VS-34	U04PF21	4	1	20	5.39	2.77	6.54	2.34	0.168	23.5	2.3
LRM-08	U31PF11	4	1	21	5.33	2.37	0.862	0.092	0.05	25.5	<0.100
SB4VS-03	U22PF21	4	1	22	5.31	1.46	6.59	2.19	0.347	22.3	2.36
SB4VS-03	U22PF11	4	1	23	5.21	1.47	6.93	2.19	0.378	22.2	2.48
SB4VS-18	U02PF21	4	1	24	4.29	2.79	5.94	2.38	0.333	23.2	1.98
Batch 1	BCHPF413	4	1	25	2.53	2.36	8.79	2.02	0.484	23.3	<0.100
U std	USTDPF413	4	1	26	2.26	2.85	8.85	1.48	0.704	21.3	1.92

Table E3. Measured Elemental Concentrations (wt%) for Samples Prepared Using Peroxide Fusion (continued)

Glass ID	PSAL ID	Block	Sub-Block	Analytical Sequence	Al	B	Fe	Li	Ni	Si	U
Batch 1	BCHPF421	4	2	1	2.59	2.6	9.05	2.06	0.546	23.8	<0.100
U std	USTDPF421	4	2	2	2.21	2.86	8.63	1.44	0.735	21	1.88
SB4VS-06	U24PF12	4	2	3	4.54	2.93	5.97	2.44	0.365	23.6	2.13
SB4VS-01	U07PF12	4	2	4	4.66	1.54	5.2	2.45	0.316	24.1	1.91
SB4VS-01	U07PF22	4	2	5	4.77	1.56	5.27	2.5	0.309	24.3	1.88
SB4VS-18	U02PF12	4	2	6	4.38	2.77	6.05	2.42	0.393	22.6	1.95
SB4VS-29	U43PF12	4	2	7	4.41	2.81	5.37	2.39	0.413	23	2.14
SB4VS-03	U22PF22	4	2	8	5.38	1.48	6.77	2.22	0.412	22.4	2.39
SB4VS-06	U24PF22	4	2	9	4.57	2.87	5.8	2.45	0.356	23.5	2.08
SB4VS-17	U38PF22	4	2	10	5	2.78	6.02	2.39	0.34	23.2	2.18
SB4VS-34	U04PF12	4	2	11	5.28	2.76	6.48	2.39	0.218	23.3	2.34
SB4VS-29	U43PF22	4	2	12	4.46	2.8	5.44	2.38	0.416	23.1	2.14
SB4VS-17	U38PF12	4	2	13	4.92	2.77	6.1	2.36	0.352	22.9	2.15
Batch 1	BCHPF422	4	2	14	2.58	2.39	8.73	2.03	0.533	23.5	<0.100
U std	USTDPF422	4	2	15	2.25	2.81	8.46	1.43	0.708	20.3	1.87
SB4VS-23	U19PF12	4	2	16	5.15	2.62	6.37	2.22	0.488	21.6	2.36
LRM-08	U31PF12	4	2	17	5.42	2.41	0.908	0.13	0.097	25.5	<0.100
SB4VS-26	U29PF12	4	2	18	4.64	2.68	6.11	2.29	0.319	22.4	2.49
SB4VS-23	U19PF22	4	2	19	5.08	2.59	6.3	2.2	0.484	21.5	2.33
LRM-08	U31PF22	4	2	20	5.37	2.41	0.933	0.129	0.105	24.6	<0.100
SB4VS-03	U22PF12	4	2	21	5.26	1.49	6.96	2.21	0.424	22.2	2.51
SB4VS-18	U02PF22	4	2	22	4.41	2.81	5.89	2.43	0.359	23.5	2.09
SB4VS-34	U04PF22	4	2	23	5.42	2.75	6.48	2.36	0.204	23.4	2.3
SB4VS-26	U29PF22	4	2	24	4.67	2.72	6.32	2.32	0.33	22.5	2.47
Batch 1	BCHPF423	4	2	25	2.58	2.39	8.79	2.04	0.516	23.3	<0.100
U std	USTDPF423	4	2	26	2.14	2.68	8.13	1.4	0.685	19.5	1.86

Table E4. Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by SB4 Variability Study Glass

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

Glass ID	Oxide	Measured (wt%)	Measured Bias-Corrected (wt%)	Targeted (wt%)	Diff of Measured (wt%)	Diff. of Meas BC (wt%)	% Diff of Measured	% Diff of Meas BC
SB4VS-01	Al_2O_3	8.8710	8.9330	7.6310	1.2400	1.3020	16.2%	17.1%
SB4VS-01	B_2O_3	4.9830	4.9090	5.4400	-0.4570	-0.5310	-8.4%	-9.8%
SB4VS-01	BaO	0.0410	0.0460	0.0400	0.0010	0.0060	2.5%	15.0%
SB4VS-01	CaO	0.8310	0.8240	0.7560	0.0750	0.0680	9.9%	9.0%
SB4VS-01	Ce_2O_3	0.0310	0.0310	0.0480	-0.0170	-0.0170	-35.4%	-35.4%
SB4VS-01	Cr_2O_3	0.0750	0.0830	0.0670	0.0080	0.0160	11.9%	23.9%
SB4VS-01	CuO	0.0210	0.0210	0.0190	0.0020	0.0020	10.5%	10.5%
SB4VS-01	Fe_2O_3	7.5380	7.6330	8.4070	-0.8690	-0.7740	-10.3%	-9.2%
SB4VS-01	K_2O	0.0600	0.0530	0.1060	-0.0460	-0.0530	-43.4%	-50.0%
SB4VS-01	La_2O_3	0.0320	0.0320	0.0340	-0.0020	-0.0020	-5.9%	-5.9%
SB4VS-01	Li_2O	5.3230	5.3860	5.4400	-0.1170	-0.0540	-2.2%	-1.0%
SB4VS-01	MgO	0.8310	0.8990	0.7970	0.0340	0.1020	4.3%	12.8%
SB4VS-01	MnO	1.9430	1.9430	1.7340	0.2090	0.2090	12.1%	12.1%
SB4VS-01	Na_2O	13.6820	12.9600	12.9890	0.6930	-0.0290	5.3%	-0.2%
SB4VS-01	NiO	0.3760	0.4330	0.4970	-0.1210	-0.0640	-24.3%	-12.9%
SB4VS-01	PbO	0.0280	0.0280	0.0290	-0.0010	-0.0010	-3.4%	-3.4%
SB4VS-01	SiO_2	51.8780	51.7490	52.9540	-1.0760	-1.2050	-2.0%	-2.3%
SB4VS-01	SO_4^{2-}	0.4200	0.4200	0.4460	-0.0260	-0.0260	-5.8%	-5.8%
SB4VS-01	ThO_2	0.0570	0.0570	0.0200	0.0370	0.0370	185.0%	185.0%
SB4VS-01	TiO_2	0.0180	0.0200	0.0080	0.0100	0.0120	125.0%	150.0%
SB4VS-01	U_3O_8	2.2230	2.4080	2.4310	-0.2080	-0.0230	-8.6%	-0.9%
SB4VS-01	ZnO	0.0310	0.0310	0.0310	0.0000	0.0000	0.0%	0.0%
SB4VS-01	ZrO_2	0.0710	0.0710	0.0750	-0.0040	-0.0040	-5.3%	-5.3%
SB4VS-01	Sum	99.3650	98.9700	99.9990	-0.6340	-1.0290	-0.6%	-1.0%
SB4VS-02	Al_2O_3	8.0920	8.0690	8.5850	-0.4930	-0.5160	-5.7%	-6.0%
SB4VS-02	B_2O_3	5.6190	5.3460	5.1200	0.4990	0.2260	9.7%	4.4%
SB4VS-02	BaO	0.0370	0.0410	0.0450	-0.0080	-0.0040	-17.8%	-8.9%
SB4VS-02	CaO	0.7990	0.7920	0.8500	-0.0510	-0.0580	-6.0%	-6.8%
SB4VS-02	Ce_2O_3	0.0340	0.0340	0.0540	-0.0200	-0.0200	-37.0%	-37.0%
SB4VS-02	Cr_2O_3	0.0930	0.1020	0.0750	0.0180	0.0270	24.0%	36.0%
SB4VS-02	CuO	0.0170	0.0170	0.0220	-0.0050	-0.0050	-22.7%	-22.7%
SB4VS-02	Fe_2O_3	8.6280	8.7800	9.4580	-0.8300	-0.6780	-8.8%	-7.2%
SB4VS-02	K_2O	0.0600	0.0530	0.1190	-0.0590	-0.0660	-49.6%	-55.5%
SB4VS-02	La_2O_3	0.0270	0.0270	0.0380	-0.0110	-0.0110	-28.9%	-28.9%
SB4VS-02	Li_2O	5.1940	5.2080	5.1200	0.0740	0.0880	1.4%	1.7%
SB4VS-02	MgO	0.7620	0.8250	0.8970	-0.1350	-0.0720	-15.1%	-8.0%
SB4VS-02	MnO	1.7980	1.7990	1.9510	-0.1530	-0.1520	-7.8%	-7.8%
SB4VS-02	Na_2O	13.6960	12.9720	13.6120	0.0840	-0.6400	0.6%	-4.7%
SB4VS-02	NiO	0.4690	0.5190	0.5590	-0.0900	-0.0400	-16.1%	-7.2%
SB4VS-02	PbO	0.0250	0.0250	0.0330	-0.0080	-0.0080	-24.2%	-24.2%
SB4VS-02	SiO_2	49.5250	50.7680	50.0730	-0.5480	0.6950	-1.1%	1.4%
SB4VS-02	SO_4^{2-}	0.3830	0.3830	0.5010	-0.1180	-0.1180	-23.6%	-23.6%
SB4VS-02	ThO_2	0.1190	0.1190	0.0230	0.0960	0.0960	417.4%	417.4%
SB4VS-02	TiO_2	0.0130	0.0130	0.0090	0.0040	0.0040	44.4%	44.4%
SB4VS-02	U_3O_8	2.5710	2.7950	2.7350	-0.1640	0.0600	-6.0%	2.2%
SB4VS-02	ZnO	0.0350	0.0350	0.0350	0.0000	0.0000	0.0%	0.0%
SB4VS-02	ZrO_2	0.0680	0.0680	0.0840	-0.0160	-0.0160	-19.0%	-19.0%
SB4VS-02	Sum	98.0610	98.7900	99.9980	-1.9370	-1.2080	-1.9%	-1.2%
SB4VS-03	Al_2O_3	9.9950	10.0650	9.5390	0.4560	0.5260	4.8%	5.5%
SB4VS-03	B_2O_3	4.7490	4.6790	4.8000	-0.0510	-0.1210	-1.1%	-2.5%
SB4VS-03	BaO	0.0460	0.0490	0.0500	-0.0040	-0.0010	-8.0%	-2.0%
SB4VS-03	CaO	0.9340	0.9340	0.9440	-0.0100	-0.0100	-1.1%	-1.1%
SB4VS-03	Ce_2O_3	0.0380	0.0380	0.0600	-0.0220	-0.0220	-36.7%	-36.7%
SB4VS-03	Cr_2O_3	0.0910	0.0980	0.0840	0.0070	0.0140	8.3%	16.7%
SB4VS-03	CuO	0.0240	0.0240	0.0240	0.0000	0.0000	0.0%	0.0%
SB4VS-03	Fe_2O_3	9.7400	9.8630	10.5090	-0.7690	-0.6460	-7.3%	-6.1%
SB4VS-03	K_2O	0.1260	0.1130	0.1320	-0.0060	-0.0190	-4.5%	-14.4%
SB4VS-03	La_2O_3	0.0380	0.0380	0.0430	-0.0050	-0.0050	-11.6%	-11.6%
SB4VS-03	Li_2O	4.7420	4.7970	4.8000	-0.0580	-0.0030	-1.2%	-0.1%
SB4VS-03	MgO	0.9850	1.0330	0.9970	-0.0120	0.0360	-1.2%	3.6%
SB4VS-03	MnO	2.2050	2.1560	2.1670	0.0380	-0.0110	1.8%	-0.5%
SB4VS-03	Na_2O	15.0980	14.0600	14.2360	0.8620	-0.1760	6.1%	-1.2%
SB4VS-03	NiO	0.4970	0.5720	0.6210	-0.1240	-0.0490	-20.0%	-7.9%

Table E4. Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by SB4 Variability Study Glass (continued)
(100 -Batch 1; 200 -U std; 300 - LRM)

Glass ID	Oxide	Measured (wt%)	Measured Bias-Corrected (wt%)	Targeted (wt%)	Diff of Measured (wt%)	Diff. of Meas BC (wt%)	% Diff of Measured	% Diff of Meas BC
SB4VS-03	PbO	0.0300	0.0300	0.0360	-0.0060	-0.0060	-16.7%	-16.7%
SB4VS-03	SiO_2	47.6530	47.5350	47.1920	0.4610	0.3430	1.0%	0.7%
SB4VS-03	SO_4^{2-}	0.4850	0.4850	0.5570	-0.0720	-0.0720	-12.9%	-12.9%
SB4VS-03	ThO_2	0.1430	0.1430	0.0250	0.1180	0.1180	472.0%	472.0%
SB4VS-03	TiO_2	0.0130	0.0140	0.0110	0.0020	0.0030	18.2%	27.3%
SB4VS-03	U_3O_8	2.8710	3.1110	3.0390	-0.1680	0.0720	-5.5%	2.4%
SB4VS-03	ZnO	0.0350	0.0350	0.0390	-0.0040	-0.0040	-10.3%	-10.3%
SB4VS-03	ZrO_2	0.0880	0.0880	0.0940	-0.0060	-0.0060	-6.4%	-6.4%
SB4VS-03	Sum	100.6260	99.9600	99.9990	0.6270	-0.0390	0.6%	0.0%
SB4VS-04	Al_2O_3	10.8980	10.9520	10.4930	0.4050	0.4590	3.9%	4.4%
SB4VS-04	B_2O_3	4.5720	4.4610	4.4800	0.0920	-0.0190	2.1%	-0.4%
SB4VS-04	BaO	0.0470	0.0530	0.0550	-0.0080	-0.0020	-14.5%	-3.6%
SB4VS-04	CaO	1.0530	1.0490	1.0390	0.0140	0.0100	1.3%	1.0%
SB4VS-04	Ce_2O_3	0.0690	0.0690	0.0660	0.0030	0.0030	4.5%	4.5%
SB4VS-04	Cr_2O_3	0.0790	0.0900	0.0920	-0.0130	-0.0020	-14.1%	-2.2%
SB4VS-04	CuO	0.0260	0.0260	0.0260	0.0000	0.0000	0.0%	0.0%
SB4VS-04	Fe_2O_3	10.8190	10.9470	11.5600	-0.7410	-0.6130	-6.4%	-5.3%
SB4VS-04	K_2O	0.1590	0.1420	0.1460	0.0130	-0.0040	8.9%	-2.7%
SB4VS-04	La_2O_3	0.0380	0.0380	0.0470	-0.0090	-0.0090	-19.1%	-19.1%
SB4VS-04	Li_2O	4.4620	4.4780	4.4800	-0.0180	-0.0020	-0.4%	0.0%
SB4VS-04	MgO	1.0030	1.1090	1.0960	-0.0930	0.0130	-8.5%	1.2%
SB4VS-04	MnO	2.4210	2.4730	2.3840	0.0370	0.0890	1.6%	3.7%
SB4VS-04	Na_2O	15.4010	14.6550	14.8590	0.5420	-0.2040	3.6%	-1.4%
SB4VS-04	NiO	0.6030	0.6810	0.6830	-0.0800	-0.0020	-11.7%	-0.3%
SB4VS-04	PbO	0.0320	0.0320	0.0400	-0.0080	-0.0080	-20.0%	-20.0%
SB4VS-04	SiO_2	45.1390	44.6470	44.3120	0.8270	0.3350	1.9%	0.8%
SB4VS-04	SO_4^{2-}	0.5020	0.5020	0.6130	-0.1110	-0.1110	-18.1%	-18.1%
SB4VS-04	ThO_2	0.1500	0.1500	0.0280	0.1220	0.1220	435.7%	435.7%
SB4VS-04	TiO_2	0.0210	0.0220	0.0120	0.0090	0.0100	75.0%	83.3%
SB4VS-04	U_3O_8	3.1930	3.4740	3.3430	-0.1500	0.1310	-4.5%	3.9%
SB4VS-04	ZnO	0.0380	0.0380	0.0430	-0.0050	-0.0050	-11.6%	-11.6%
SB4VS-04	ZrO_2	0.0970	0.0970	0.1030	-0.0060	-0.0060	-5.8%	-5.8%
SB4VS-04	Sum	100.8220	100.1850	100.0000	0.8220	0.1850	0.8%	0.2%
SB4VS-05	Al_2O_3	7.5860	7.6490	7.1540	0.4320	0.4950	6.0%	6.9%
SB4VS-05	B_2O_3	9.6840	9.5650	9.8000	-0.1160	-0.2350	-1.2%	-2.4%
SB4VS-05	BaO	0.0320	0.0360	0.0370	-0.0050	-0.0010	-13.5%	-2.7%
SB4VS-05	CaO	0.7180	0.7280	0.7080	0.0100	0.0200	1.4%	2.8%
SB4VS-05	Ce_2O_3	0.0340	0.0340	0.0450	-0.0110	-0.0110	-24.4%	-24.4%
SB4VS-05	Cr_2O_3	0.0560	0.0640	0.0630	-0.0070	0.0010	-11.1%	1.6%
SB4VS-05	CuO	0.0190	0.0200	0.0180	0.0010	0.0020	5.6%	11.1%
SB4VS-05	Fe_2O_3	7.3270	7.4040	7.8820	-0.5550	-0.4780	-7.0%	-6.1%
SB4VS-05	K_2O	0.0600	0.0530	0.0990	-0.0390	-0.0460	-39.4%	-46.5%
SB4VS-05	La_2O_3	0.0270	0.0270	0.0320	-0.0050	-0.0050	-15.6%	-15.6%
SB4VS-05	Li_2O	5.5060	5.5890	5.6000	-0.0940	-0.0110	-1.7%	-0.2%
SB4VS-05	MgO	0.6900	0.7690	0.7480	-0.0580	0.0210	-7.8%	2.8%
SB4VS-05	MnO	1.6240	1.6220	1.6260	-0.0020	-0.0040	-0.1%	-0.2%
SB4VS-05	Na_2O	10.3220	9.6500	9.8770	0.4450	-0.2270	4.5%	-2.3%
SB4VS-05	NiO	0.3710	0.4230	0.4660	-0.0950	-0.0430	-20.4%	-9.2%
SB4VS-05	PbO	0.0270	0.0270	0.0270	0.0000	0.0000	0.0%	0.0%
SB4VS-05	SiO_2	52.8410	52.8200	52.9940	-0.1530	-0.1740	-0.3%	-0.3%
SB4VS-05	SO_4^{2-}	0.3420	0.3420	0.4180	-0.0760	-0.0760	-18.2%	-18.2%
SB4VS-05	ThO_2	0.0570	0.0570	0.0190	0.0380	0.0380	200.0%	200.0%
SB4VS-05	TiO_2	0.0130	0.0140	0.0080	0.0050	0.0060	62.5%	75.0%
SB4VS-05	U_3O_8	2.1760	2.3740	2.2790	-0.1030	0.0950	-4.5%	4.2%
SB4VS-05	ZnO	0.0330	0.0330	0.0300	0.0030	0.0030	10.0%	10.0%
SB4VS-05	ZrO_2	0.0600	0.0600	0.0700	-0.0100	-0.0100	-14.3%	-14.3%
SB4VS-05	Sum	99.6050	99.3600	100.0000	-0.3950	-0.6400	-0.4%	-0.6%
SB4VS-06	Al_2O_3	8.5550	8.6140	8.1080	0.4470	0.5060	5.5%	6.2%
SB4VS-06	B_2O_3	9.3620	9.2230	9.2400	0.1220	-0.0170	1.3%	-0.2%
SB4VS-06	BaO	0.0370	0.0400	0.0420	-0.0050	-0.0020	-11.9%	-4.8%
SB4VS-06	CaO	0.8350	0.8350	0.8030	0.0320	0.0320	4.0%	4.0%
SB4VS-06	Ce_2O_3	0.0480	0.0480	0.0510	-0.0030	-0.0030	-5.9%	-5.9%
SB4VS-06	Cr_2O_3	0.0790	0.0850	0.0710	0.0080	0.0140	11.3%	19.7%
SB4VS-06	CuO	0.0230	0.0240	0.0210	0.0020	0.0030	9.5%	14.3%

Table E4. Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by SB4 Variability Study Glass (continued)
(100 -Batch 1; 200 -U std; 300 - LRM)

Glass ID	Oxide	Measured (wt%)	Measured Bias-Corrected (wt%)	Targeted (wt%)	Diff of Measured (wt%)	Diff. of Meas BC (wt%)	% Diff of Measured	% Diff of Meas BC
SB4VS-06	Fe_2O_3	8.4390	8.5450	8.9330	-0.4940	-0.3880	-5.5%	-4.3%
SB4VS-06	K_2O	0.0760	0.0680	0.1130	-0.0370	-0.0450	-32.7%	-39.8%
SB4VS-06	La_2O_3	0.0300	0.0300	0.0360	-0.0060	-0.0060	-16.7%	-16.7%
SB4VS-06	Li_2O	5.2530	5.3150	5.2800	-0.0270	0.0350	-0.5%	0.7%
SB4VS-06	MgO	0.7990	0.8380	0.8470	-0.0480	-0.0090	-5.7%	-1.1%
SB4VS-06	MnO	1.9050	1.8630	1.8420	0.0630	0.0210	3.4%	1.1%
SB4VS-06	Na_2O	11.1820	10.4130	10.6600	0.5220	-0.2470	4.9%	-2.3%
SB4VS-06	NiO	0.4300	0.4960	0.5280	-0.0980	-0.0320	-18.6%	-6.1%
SB4VS-06	PbO	0.0300	0.0300	0.0310	-0.0010	-0.0010	-3.2%	-3.2%
SB4VS-06	SiO_2	50.8080	50.6820	50.1940	0.6140	0.4880	1.2%	1.0%
SB4VS-06	SO_4^{2-}	0.4180	0.4180	0.4740	-0.0560	-0.0560	-11.8%	-11.8%
SB4VS-06	ThO_2	0.1040	0.1040	0.0210	0.0830	0.0830	395.2%	395.2%
SB4VS-06	TiO_2	0.0130	0.0130	0.0090	0.0040	0.0040	44.4%	44.4%
SB4VS-06	U_3O_8	2.4670	2.6730	2.5830	-0.1160	0.0900	-4.5%	3.5%
SB4VS-06	ZnO	0.0320	0.0320	0.0330	-0.0010	-0.0010	-3.0%	-3.0%
SB4VS-06	ZrO_2	0.0640	0.0640	0.0800	-0.0160	-0.0160	-20.0%	-20.0%
SB4VS-06	Sum	100.9910	100.4550	100.0000	0.9910	0.4550	1.0%	0.5%
SB4VS-07	Al_2O_3	9.9200	9.9690	9.0620	0.8580	0.9070	9.5%	10.0%
SB4VS-07	B_2O_3	8.7820	8.5710	8.6800	0.1020	-0.1090	1.2%	-1.3%
SB4VS-07	BaO	0.0390	0.0440	0.0470	-0.0080	-0.0030	-17.0%	-6.4%
SB4VS-07	CaO	0.9230	0.9370	0.8970	0.0260	0.0400	2.9%	4.5%
SB4VS-07	Ce_2O_3	0.0370	0.0370	0.0570	-0.0200	-0.0200	-35.1%	-35.1%
SB4VS-07	Cr_2O_3	0.0570	0.0650	0.0790	-0.0220	-0.0140	-27.8%	-17.7%
SB4VS-07	CuO	0.0230	0.0240	0.0230	0.0000	0.0010	0.0%	4.3%
SB4VS-07	Fe_2O_3	9.5180	9.6310	9.9840	-0.4660	-0.3530	-4.7%	-3.5%
SB4VS-07	K_2O	0.1430	0.1250	0.1260	0.0170	-0.0010	13.5%	-0.8%
SB4VS-07	La_2O_3	0.0330	0.0330	0.0400	-0.0070	-0.0070	-17.5%	-17.5%
SB4VS-07	Li_2O	4.9890	5.0070	4.9600	0.0290	0.0470	0.6%	0.9%
SB4VS-07	MgO	0.8130	0.9060	0.9470	-0.1340	-0.0410	-14.1%	-4.3%
SB4VS-07	MnO	2.0340	2.0310	2.0590	-0.0250	-0.0280	-1.2%	-1.4%
SB4VS-07	Na_2O	11.6570	10.8990	11.4440	0.2130	-0.5450	1.9%	-4.8%
SB4VS-07	NiO	0.4860	0.5490	0.5900	-0.1040	-0.0410	-17.6%	-6.9%
SB4VS-07	PbO	0.0290	0.0290	0.0350	-0.0060	-0.0060	-17.1%	-17.1%
SB4VS-07	SiO_2	49.1500	48.6160	47.3930	1.7570	1.2230	3.7%	2.6%
SB4VS-07	SO_4^{2-}	0.4280	0.4280	0.5290	-0.1010	-0.1010	-19.1%	-19.1%
SB4VS-07	ThO_2	0.1030	0.1030	0.0240	0.0790	0.0790	329.2%	329.2%
SB4VS-07	TiO_2	0.0130	0.0140	0.0100	0.0030	0.0040	30.0%	40.0%
SB4VS-07	U_3O_8	2.7030	2.9420	2.8870	-0.1840	0.0550	-6.4%	1.9%
SB4VS-07	ZnO	0.0350	0.0350	0.0370	-0.0020	-0.0020	-5.4%	-5.4%
SB4VS-07	ZrO_2	0.0770	0.0770	0.0890	-0.0120	-0.0120	-13.5%	-13.5%
SB4VS-07	Sum	101.9940	101.0730	99.9990	1.9950	1.0740	2.0%	1.1%
SB4VS-08	Al_2O_3	10.5010	10.5880	10.0160	0.4850	0.5720	4.8%	5.7%
SB4VS-08	B_2O_3	8.1460	8.0470	8.1200	0.0260	-0.0730	0.3%	-0.9%
SB4VS-08	BaO	0.0470	0.0520	0.0520	-0.0050	0.0000	-9.6%	0.0%
SB4VS-08	CaO	0.9790	0.9710	0.9920	-0.0130	-0.0210	-1.3%	-2.1%
SB4VS-08	Ce_2O_3	0.0480	0.0480	0.0630	-0.0150	-0.0150	-23.8%	-23.8%
SB4VS-08	Cr_2O_3	0.0810	0.0900	0.0880	-0.0070	0.0020	-8.0%	2.3%
SB4VS-08	CuO	0.0250	0.0250	0.0250	0.0000	0.0000	0.0%	0.0%
SB4VS-08	Fe_2O_3	10.3080	10.4170	11.0350	-0.7270	-0.6180	-6.6%	-5.6%
SB4VS-08	K_2O	0.1370	0.1210	0.1390	-0.0020	-0.0180	-1.4%	-12.9%
SB4VS-08	La_2O_3	0.0400	0.0400	0.0450	-0.0050	-0.0050	-11.1%	-11.1%
SB4VS-08	Li_2O	4.6290	4.6990	4.6400	-0.0110	0.0590	-0.2%	1.3%
SB4VS-08	MgO	1.0090	1.0930	1.0470	-0.0380	0.0460	-3.6%	4.4%
SB4VS-08	MnO	2.3240	2.3260	2.2760	0.0480	0.0500	2.1%	2.2%
SB4VS-08	Na_2O	12.7390	12.0700	12.2280	0.5110	-0.1580	4.2%	-1.3%
SB4VS-08	NiO	0.5550	0.6340	0.6520	-0.0970	-0.0180	-14.9%	-2.8%
SB4VS-08	PbO	0.0360	0.0360	0.0380	-0.0020	-0.0020	-5.3%	-5.3%
SB4VS-08	SiO_2	45.3530	45.3400	44.5920	0.7610	0.7480	1.7%	1.7%
SB4VS-08	SO_4^{2-}	0.5150	0.5150	0.5850	-0.0700	-0.0700	-12.0%	-12.0%
SB4VS-08	ThO_2	0.1470	0.1470	0.0270	0.1200	0.1200	444.4%	444.4%
SB4VS-08	TiO_2	0.0180	0.0200	0.0110	0.0070	0.0090	63.6%	81.8%
SB4VS-08	U_3O_8	3.0980	3.3810	3.1910	-0.0930	0.1900	-2.9%	6.0%
SB4VS-08	ZnO	0.0430	0.0430	0.0410	0.0020	0.0020	4.9%	4.9%
SB4VS-08	ZrO_2	0.0940	0.0940	0.0980	-0.0040	-0.0040	-4.1%	-4.1%

Table E4. Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by SB4 Variability Study Glass (continued)
(100 -Batch 1; 200 -U std; 300 - LRM)

Glass ID	Oxide	Measured (wt%)	Measured Bias-Corrected (wt%)	Targeted (wt%)	Diff of Measured (wt%)	Diff. of Meas BC (wt%)	% Diff of Measured	% Diff of Meas BC
SB4VS-08	Sum	100.8740	100.7940	100.0010	0.8730	0.7930	0.9%	0.8%
SB4VS-09	Al_2O_3	11.2940	11.2630	10.9700	0.3240	0.2930	3.0%	2.7%
SB4VS-09	B_2O_3	7.5910	7.2230	7.5600	0.0310	-0.3370	0.4%	-4.5%
SB4VS-09	BaO	0.0510	0.0550	0.0570	-0.0060	-0.0020	-10.5%	-3.5%
SB4VS-09	CaO	1.0850	1.0850	1.0860	-0.0010	-0.0010	-0.1%	-0.1%
SB4VS-09	Ce_2O_3	0.0420	0.0420	0.0690	-0.0270	-0.0270	-39.1%	-39.1%
SB4VS-09	Cr_2O_3	0.0830	0.0890	0.0960	-0.0130	-0.0070	-13.5%	-7.3%
SB4VS-09	CuO	0.0320	0.0320	0.0280	0.0040	0.0040	14.3%	14.3%
SB4VS-09	Fe_2O_3	10.6980	10.8880	12.0860	-1.3880	-1.1980	-11.5%	-9.9%
SB4VS-09	K_2O	0.1530	0.1360	0.1520	0.0010	-0.0160	0.7%	-10.5%
SB4VS-09	La_2O_3	0.0400	0.0400	0.0490	-0.0090	-0.0090	-18.4%	-18.4%
SB4VS-09	Li_2O	4.3000	4.3120	4.3200	-0.0200	-0.0080	-0.5%	-0.2%
SB4VS-09	MgO	1.1380	1.1940	1.1460	-0.0080	0.0480	-0.7%	4.2%
SB4VS-09	MnO	2.5180	2.4630	2.4930	0.0250	-0.0300	1.0%	-1.2%
SB4VS-09	Na_2O	13.7500	12.8050	13.0110	0.7390	-0.2060	5.7%	-1.6%
SB4VS-09	NiO	0.5500	0.6080	0.7140	-0.1640	-0.1060	-23.0%	-14.8%
SB4VS-09	PbO	0.0380	0.0380	0.0420	-0.0040	-0.0040	-9.5%	-9.5%
SB4VS-09	SiO_2	40.7540	41.7770	41.7910	-1.0370	-0.0140	-2.5%	0.0%
SB4VS-09	SO_4^{2-}	0.5830	0.5830	0.6410	-0.0580	-0.0580	-9.0%	-9.0%
SB4VS-09	ThO_2	0.1680	0.1680	0.0290	0.1390	0.1390	479.3%	479.3%
SB4VS-09	TiO_2	0.0180	0.0190	0.0120	0.0060	0.0070	50.0%	58.3%
SB4VS-09	U_3O_8	3.2660	3.5510	3.4950	-0.2290	0.0560	-6.6%	1.6%
SB4VS-09	ZnO	0.0860	0.0860	0.0450	0.0410	0.0410	91.1%	91.1%
SB4VS-09	ZrO_2	0.1040	0.1040	0.1080	-0.0040	-0.0040	-3.7%	-3.7%
SB4VS-09	Sum	98.3410	98.5590	100.0000	-1.6590	-1.4410	-1.7%	-1.4%
SB4VS-10	Al_2O_3	10.6380	10.7260	10.0470	0.5910	0.6790	5.9%	6.8%
SB4VS-10	B_2O_3	8.0260	7.9290	8.1200	-0.0940	-0.1910	-1.2%	-2.4%
SB4VS-10	BaO	0.0510	0.0550	0.0570	-0.0060	-0.0020	-10.5%	-3.5%
SB4VS-10	CaO	1.1240	1.1240	1.0460	0.0780	0.0780	7.5%	7.5%
SB4VS-10	Ce_2O_3	0.0460	0.0460	0.0690	-0.0230	-0.0230	-33.3%	-33.3%
SB4VS-10	Cr_2O_3	0.0850	0.0920	0.0950	-0.0100	-0.0030	-10.5%	-3.2%
SB4VS-10	CuO	0.0290	0.0290	0.0270	0.0020	0.0020	7.4%	7.4%
SB4VS-10	Fe_2O_3	10.0720	10.1800	10.6040	-0.5320	-0.4240	-5.0%	-4.0%
SB4VS-10	K_2O	0.1730	0.1540	0.1510	0.0220	0.0030	14.6%	2.0%
SB4VS-10	La_2O_3	0.0410	0.0410	0.0490	-0.0080	-0.0080	-16.3%	-16.3%
SB4VS-10	Li_2O	4.6290	4.6990	4.6400	-0.0110	0.0590	-0.2%	1.3%
SB4VS-10	MgO	0.8990	0.9420	0.9920	-0.0930	-0.0500	-9.4%	-5.0%
SB4VS-10	MnO	2.2210	2.1730	2.2180	0.0030	-0.0450	0.1%	-2.0%
SB4VS-10	Na_2O	13.5070	12.5790	12.6680	0.8390	-0.0890	6.6%	-0.7%
SB4VS-10	NiO	0.6140	0.7010	0.7060	-0.0920	-0.0050	-13.0%	-0.7%
SB4VS-10	PbO	0.0350	0.0350	0.0420	-0.0070	-0.0070	-16.7%	-16.7%
SB4VS-10	SiO_2	44.5510	44.5380	44.5360	0.0150	0.0020	0.0%	0.0%
SB4VS-10	SO_4^{2-}	0.4960	0.4960	0.6110	-0.1150	-0.1150	-18.8%	-18.8%
SB4VS-10	ThO_2	0.1430	0.1430	0.0290	0.1140	0.1140	393.1%	393.1%
SB4VS-10	TiO_2	0.0130	0.0140	0.0120	0.0010	0.0020	8.3%	16.7%
SB4VS-10	U_3O_8	2.9100	3.1750	3.1310	-0.2210	0.0440	-7.1%	1.4%
SB4VS-10	ZnO	0.0490	0.0490	0.0450	0.0040	0.0040	8.9%	8.9%
SB4VS-10	ZrO_2	0.0960	0.0960	0.1070	-0.0110	-0.0110	-10.3%	-10.3%
SB4VS-10	Sum	100.4460	100.0130	100.0020	0.4440	0.0110	0.4%	0.0%
SB4VS-11	Al_2O_3	10.7650	10.8190	10.4220	0.3430	0.3970	3.3%	3.8%
SB4VS-11	B_2O_3	8.1700	7.9720	8.1200	0.0500	-0.1480	0.6%	-1.8%
SB4VS-11	BaO	0.0420	0.0450	0.0480	-0.0060	-0.0030	-12.5%	-6.3%
SB4VS-11	CaO	0.9870	0.9870	0.9370	0.0500	0.0500	5.3%	5.3%
SB4VS-11	Ce_2O_3	0.0240	0.0240	0.0580	-0.0340	-0.0340	-58.6%	-58.6%
SB4VS-11	Cr_2O_3	0.0730	0.0790	0.0800	-0.0070	-0.0010	-8.8%	-1.3%
SB4VS-11	CuO	0.0240	0.0240	0.0230	0.0010	0.0010	4.3%	4.3%
SB4VS-11	Fe_2O_3	9.5080	9.6200	10.6040	-1.0960	-0.9840	-10.3%	-9.3%
SB4VS-11	K_2O	0.1420	0.1270	0.1270	0.0150	0.0000	11.8%	0.0%
SB4VS-11	La_2O_3	0.0340	0.0340	0.0410	-0.0070	-0.0070	-17.1%	-17.1%
SB4VS-11	Li_2O	4.6070	4.6230	4.6400	-0.0330	-0.0170	-0.7%	-0.4%
SB4VS-11	MgO	0.8970	0.9400	0.9920	-0.0950	-0.0520	-9.6%	-5.2%
SB4VS-11	MnO	2.3950	2.3430	2.3330	0.0620	0.0100	2.7%	0.4%
SB4VS-11	Na_2O	12.9780	12.0860	12.3290	0.6490	-0.2430	5.3%	-2.0%
SB4VS-11	NiO	0.5700	0.6440	0.7060	-0.1360	-0.0620	-19.3%	-8.8%

Table E4. Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by SB4 Variability Study Glass (continued)
(100 -Batch 1; 200 -U std; 300 - LRM)

Glass ID	Oxide	Measured (wt%)	Measured Bias-Corrected (wt%)	Targeted (wt%)	Diff of Measured (wt%)	Diff. of Meas BC (wt%)	% Diff of Measured	% Diff of Meas BC
SB4VS-11	PbO	0.0310	0.0310	0.0350	-0.0040	-0.0040	-11.4%	-11.4%
SB4VS-11	SiO_2	45.0860	44.5930	44.5360	0.5500	0.0570	1.2%	0.1%
SB4VS-11	SO_4^{2-}	0.4620	0.4620	0.5590	-0.0970	-0.0970	-17.4%	-17.4%
SB4VS-11	ThO_2	0.1420	0.1420	0.0240	0.1180	0.1180	491.7%	491.7%
SB4VS-11	TiO_2	0.0100	0.0110	0.0100	0.0000	0.0010	0.0%	10.0%
SB4VS-11	U_3O_8	3.0900	3.3620	3.2510	-0.1610	0.1110	-5.0%	3.4%
SB4VS-11	ZnO	0.0400	0.0400	0.0380	0.0020	0.0020	5.3%	5.3%
SB4VS-11	ZrO_2	0.0810	0.0810	0.0900	-0.0090	-0.0090	-10.0%	-10.0%
SB4VS-11	Sum	100.1600	99.0910	100.0030	0.1570	-0.9120	0.2%	-0.9%
SB4VS-12	Al_2O_3	10.1420	10.1140	9.9260	0.2160	0.1880	2.2%	1.9%
SB4VS-12	B_2O_3	8.5090	8.0960	8.4000	0.1090	-0.3040	1.3%	-3.6%
SB4VS-12	BaO	0.0460	0.0520	0.0540	-0.0080	-0.0020	-14.8%	-3.7%
SB4VS-12	CaO	0.9000	0.9130	0.8920	0.0080	0.0210	0.9%	2.4%
SB4VS-12	Ce_2O_3	0.0370	0.0370	0.0660	-0.0290	-0.0290	-43.9%	-43.9%
SB4VS-12	Cr_2O_3	0.0780	0.0890	0.0910	-0.0130	-0.0020	-14.3%	-2.2%
SB4VS-12	CuO	0.0310	0.0310	0.0260	0.0050	0.0050	19.2%	19.2%
SB4VS-12	Fe_2O_3	9.0820	9.2420	10.4080	-1.3260	-1.1660	-12.7%	-11.2%
SB4VS-12	K_2O	0.1610	0.1410	0.1440	0.0170	-0.0030	11.8%	-2.1%
SB4VS-12	La_2O_3	0.0380	0.0380	0.0460	-0.0080	-0.0080	-17.4%	-17.4%
SB4VS-12	Li_2O	4.8010	4.8140	4.8000	0.0010	0.0140	0.0%	0.3%
SB4VS-12	MgO	0.9180	1.0240	1.0490	-0.1310	-0.0250	-12.5%	-2.4%
SB4VS-12	MnO	2.2310	2.2280	2.2220	0.0090	0.0060	0.4%	0.3%
SB4VS-12	Na_2O	11.8730	11.1000	11.4230	0.4500	-0.3230	3.9%	-2.8%
SB4VS-12	NiO	0.5600	0.6190	0.6720	-0.1120	-0.0530	-16.7%	-7.9%
SB4VS-12	PbO	0.0340	0.0340	0.0400	-0.0060	-0.0060	-15.0%	-15.0%
SB4VS-12	SiO_2	44.9790	46.1070	46.0460	-1.0670	0.0610	-2.3%	0.1%
SB4VS-12	SO_4^{2-}	0.4550	0.4550	0.5320	-0.0770	-0.0770	-14.5%	-14.5%
SB4VS-12	ThO_2	0.1240	0.1240	0.0270	0.0970	0.0970	359.3%	359.3%
SB4VS-12	TiO_2	0.0130	0.0150	0.0110	0.0020	0.0040	18.2%	36.4%
SB4VS-12	U_3O_8	2.7890	3.0320	2.9820	-0.1930	0.0500	-6.5%	1.7%
SB4VS-12	ZnO	0.0440	0.0440	0.0430	0.0010	0.0010	2.3%	2.3%
SB4VS-12	ZrO_2	0.0800	0.0800	0.1020	-0.0220	-0.0220	-21.6%	-21.6%
SB4VS-12	Sum	97.9240	98.4310	100.0020	-2.0780	-1.5710	-2.1%	-1.6%
SB4VS-13	Al_2O_3	10.4110	10.4970	9.9260	0.4850	0.5710	4.9%	5.8%
SB4VS-13	B_2O_3	8.3560	8.2540	8.4000	-0.0440	-0.1460	-0.5%	-1.7%
SB4VS-13	BaO	0.0370	0.0420	0.0460	-0.0090	-0.0040	-19.6%	-8.7%
SB4VS-13	CaO	1.0590	1.0540	0.9960	0.0630	0.0580	6.3%	5.8%
SB4VS-13	Ce_2O_3	0.0370	0.0370	0.0550	-0.0180	-0.0180	-32.7%	-32.7%
SB4VS-13	Cr_2O_3	0.0660	0.0750	0.0760	-0.0100	-0.0010	-13.2%	-1.3%
SB4VS-13	CuO	0.0240	0.0240	0.0220	0.0020	0.0020	9.1%	9.1%
SB4VS-13	Fe_2O_3	9.6500	9.7520	10.6110	-0.9610	-0.8590	-9.1%	-8.1%
SB4VS-13	K_2O	0.0600	0.0540	0.1210	-0.0610	-0.0670	-50.4%	-55.4%
SB4VS-13	La_2O_3	0.0300	0.0300	0.0390	-0.0090	-0.0090	-23.1%	-23.1%
SB4VS-13	Li_2O	4.5100	4.5780	4.8000	-0.2900	-0.2220	-6.0%	-4.6%
SB4VS-13	MgO	0.9210	1.0170	1.0490	-0.1280	-0.0320	-12.2%	-3.1%
SB4VS-13	MnO	2.1080	2.1530	2.1120	-0.0040	0.0410	-0.2%	1.9%
SB4VS-13	Na_2O	12.1150	11.5280	11.4230	0.6920	0.1050	6.1%	0.9%
SB4VS-13	NiO	0.4510	0.5140	0.5700	-0.1190	-0.0560	-20.9%	-9.8%
SB4VS-13	PbO	0.0290	0.0290	0.0330	-0.0040	-0.0040	-12.1%	-12.1%
SB4VS-13	SiO_2	46.4760	46.4590	45.9390	0.5370	0.5200	1.2%	1.1%
SB4VS-13	SO_4^{2-}	0.4220	0.4220	0.5320	-0.1100	-0.1100	-20.7%	-20.7%
SB4VS-13	ThO_2	0.1310	0.1310	0.0230	0.1080	0.1080	469.6%	469.6%
SB4VS-13	TiO_2	0.0080	0.0090	0.0100	-0.0020	-0.0010	-20.0%	-10.0%
SB4VS-13	U_3O_8	2.9570	3.2260	3.0960	-0.1390	0.1300	-4.5%	4.2%
SB4VS-13	ZnO	0.0340	0.0340	0.0360	-0.0020	-0.0020	-5.6%	-5.6%
SB4VS-13	ZrO_2	0.0650	0.0650	0.0850	-0.0200	-0.0200	-23.5%	-23.5%
SB4VS-13	Sum	99.9570	99.9840	100.0000	-0.0430	-0.0160	0.0%	0.0%
SB4VS-14	Al_2O_3	8.9330	8.9080	8.7090	0.2240	0.1990	2.6%	2.3%
SB4VS-14	B_2O_3	8.8710	8.4410	8.6800	0.1910	-0.2390	2.2%	-2.8%
SB4VS-14	BaO	0.0330	0.0380	0.0430	-0.0100	-0.0050	-23.3%	-11.6%
SB4VS-14	CaO	0.9880	0.9830	0.9470	0.0410	0.0360	4.3%	3.8%
SB4VS-14	Ce_2O_3	0.0360	0.0360	0.0520	-0.0160	-0.0160	-30.8%	-30.8%
SB4VS-14	Cr_2O_3	0.0660	0.0750	0.0730	-0.0070	0.0020	-9.6%	2.7%
SB4VS-14	CuO	0.0240	0.0240	0.0210	0.0030	0.0030	14.3%	14.3%

Table E4. Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by SB4 Variability Study Glass (continued)
(100 -Batch 1; 200 -U std; 300 - LRM)

Glass ID	Oxide	Measured (wt%)	Measured Bias-Corrected (wt%)	Targeted (wt%)	Diff of Measured (wt%)	Diff. of Meas BC (wt%)	% Diff of Measured	% Diff of Meas BC
SB4VS-14	Fe_2O_3	9.1180	9.2780	10.0130	-0.8950	-0.7350	-8.9%	-7.3%
SB4VS-14	K_2O	0.0600	0.0540	0.1150	-0.0550	-0.0610	-47.8%	-53.0%
SB4VS-14	La_2O_3	0.0270	0.0270	0.0370	-0.0100	-0.0100	-27.0%	-27.0%
SB4VS-14	Li_2O	4.9520	4.9650	4.9600	-0.0080	0.0050	-0.2%	0.1%
SB4VS-14	MgO	0.7910	0.8740	0.8970	-0.1060	-0.0230	-11.8%	-2.6%
SB4VS-14	MnO	2.0920	2.1370	2.1110	-0.0190	0.0260	-0.9%	1.2%
SB4VS-14	Na_2O	12.3910	11.7900	11.8430	0.5480	-0.0530	4.6%	-0.4%
SB4VS-14	NiO	0.4510	0.4990	0.5410	-0.0900	-0.0420	-16.6%	-7.8%
SB4VS-14	PbO	0.0240	0.0240	0.0320	-0.0080	-0.0080	-25.0%	-25.0%
SB4VS-14	SiO_2	46.4230	47.5880	47.4430	-1.0200	0.1450	-2.1%	0.3%
SB4VS-14	SO_4^{2-}	0.3900	0.3900	0.5050	-0.1150	-0.1150	-22.8%	-22.8%
SB4VS-14	ThO_2	0.1230	0.1230	0.0220	0.1010	0.1010	459.1%	459.1%
SB4VS-14	TiO_2	0.0080	0.0090	0.0090	-0.0010	0.0000	-11.1%	0.0%
SB4VS-14	U_3O_8	2.7180	2.9550	2.8330	-0.1150	0.1220	-4.1%	4.3%
SB4VS-14	ZnO	0.0290	0.0290	0.0340	-0.0050	-0.0050	-14.7%	-14.7%
SB4VS-14	ZrO_2	0.0690	0.0690	0.0810	-0.0120	-0.0120	-14.8%	-14.8%
SB4VS-14	Sum	98.6170	99.3160	100.0010	-1.3840	-0.6850	-1.4%	-0.7%
SB4VS-15	Al_2O_3	9.0460	9.0910	8.7090	0.3370	0.3820	3.9%	4.4%
SB4VS-15	B_2O_3	8.4920	8.2870	8.6800	-0.1880	-0.3930	-2.2%	-4.5%
SB4VS-15	BaO	0.0430	0.0460	0.0510	-0.0080	-0.0050	-15.7%	-9.8%
SB4VS-15	CaO	0.8770	0.8770	0.8470	0.0300	0.0300	3.5%	3.5%
SB4VS-15	Ce_2O_3	0.0440	0.0440	0.0620	-0.0180	-0.0180	-29.0%	-29.0%
SB4VS-15	Cr_2O_3	0.0730	0.0790	0.0860	-0.0130	-0.0070	-15.1%	-8.1%
SB4VS-15	CuO	0.0240	0.0240	0.0250	-0.0010	-0.0010	-4.0%	-4.0%
SB4VS-15	Fe_2O_3	9.1790	9.2860	10.3880	-1.2090	-1.1020	-11.6%	-10.6%
SB4VS-15	K_2O	0.0600	0.0540	0.1370	-0.0770	-0.0830	-56.2%	-60.6%
SB4VS-15	La_2O_3	0.0350	0.0350	0.0440	-0.0090	-0.0090	-20.5%	-20.5%
SB4VS-15	Li_2O	4.9250	4.9420	4.9600	-0.0350	-0.0180	-0.7%	-0.4%
SB4VS-15	MgO	0.8090	0.8480	0.8970	-0.0880	-0.0490	-9.8%	-5.5%
SB4VS-15	MnO	2.1270	2.0810	2.1110	0.0160	-0.0300	0.8%	-1.4%
SB4VS-15	Na_2O	12.0650	11.2350	11.4150	0.6500	-0.1800	5.7%	-1.6%
SB4VS-15	NiO	0.4020	0.4540	0.5410	-0.1390	-0.0870	-25.7%	-16.1%
SB4VS-15	PbO	0.0280	0.0280	0.0380	-0.0100	-0.0100	-26.3%	-26.3%
SB4VS-15	SiO_2	47.2250	46.7080	47.3420	-0.1170	-0.6340	-0.2%	-1.3%
SB4VS-15	SO_4^{2-}	0.4310	0.4310	0.5530	-0.1220	-0.1220	-22.1%	-22.1%
SB4VS-15	ThO_2	0.1340	0.1340	0.0260	0.1080	0.1080	415.4%	415.4%
SB4VS-15	TiO_2	0.0130	0.0140	0.0110	0.0020	0.0030	18.2%	27.3%
SB4VS-15	U_3O_8	2.6920	2.9290	2.9410	-0.2490	-0.0120	-8.5%	-0.4%
SB4VS-15	ZnO	0.0390	0.0390	0.0410	-0.0020	-0.0020	-4.9%	-4.9%
SB4VS-15	ZrO_2	0.0850	0.0850	0.0960	-0.0110	-0.0110	-11.5%	-11.5%
SB4VS-15	Sum	98.8480	97.7520	100.0010	-1.1530	-2.2490	-1.2%	-2.2%
SB4VS-16	Al_2O_3	8.5550	8.5310	8.2500	0.3050	0.2810	3.7%	3.4%
SB4VS-16	B_2O_3	9.0640	8.6250	8.9600	0.1040	-0.3350	1.2%	-3.7%
SB4VS-16	BaO	0.0430	0.0460	0.0490	-0.0060	-0.0030	-12.2%	-6.1%
SB4VS-16	CaO	0.8770	0.8770	0.8030	0.0740	0.0740	9.2%	9.2%
SB4VS-16	Ce_2O_3	0.0320	0.0320	0.0590	-0.0270	-0.0270	-45.8%	-45.8%
SB4VS-16	Cr_2O_3	0.0770	0.0830	0.0820	-0.0050	0.0010	-6.1%	1.2%
SB4VS-16	CuO	0.0260	0.0260	0.0240	0.0020	0.0020	8.3%	8.3%
SB4VS-16	Fe_2O_3	8.4960	8.6440	9.5880	-1.0920	-0.9440	-11.4%	-9.8%
SB4VS-16	K_2O	0.1460	0.1300	0.1290	0.0170	0.0010	13.2%	0.8%
SB4VS-16	La_2O_3	0.0340	0.0340	0.0420	-0.0080	-0.0080	-19.0%	-19.0%
SB4VS-16	Li_2O	5.1240	5.1380	5.1200	0.0040	0.0180	0.1%	0.4%
SB4VS-16	MgO	0.8680	0.9100	0.9440	-0.0760	-0.0340	-8.1%	-3.6%
SB4VS-16	MnO	1.9270	1.8850	1.9010	0.0260	-0.0160	1.4%	-0.8%
SB4VS-16	Na_2O	12.1960	11.3580	11.4300	0.7660	-0.0720	6.7%	-0.6%
SB4VS-16	NiO	0.4090	0.4520	0.5130	-0.1040	-0.0610	-20.3%	-11.9%
SB4VS-16	PbO	0.0310	0.0310	0.0360	-0.0050	-0.0050	-13.9%	-13.9%
SB4VS-16	SiO_2	47.5460	48.7390	48.7450	-1.1990	-0.0060	-2.5%	0.0%
SB4VS-16	SO_4^{2-}	0.4040	0.4040	0.4790	-0.0750	-0.0750	-15.7%	-15.7%
SB4VS-16	ThO_2	0.1210	0.1210	0.0250	0.0960	0.0960	384.0%	384.0%
SB4VS-16	TiO_2	0.0100	0.0110	0.0100	0.0000	0.0010	0.0%	10.0%
SB4VS-16	U_3O_8	2.5350	2.7560	2.6840	-0.1490	0.0720	-5.6%	2.7%
SB4VS-16	ZnO	0.0420	0.0420	0.0380	0.0040	0.0040	10.5%	10.5%
SB4VS-16	ZrO_2	0.0830	0.0830	0.0910	-0.0080	-0.0080	-8.8%	-8.8%

Table E4. Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by SB4 Variability Study Glass (continued)
(100 -Batch 1; 200 -U std; 300 - LRM)

Glass ID	Oxide	Measured (wt%)	Measured Bias-Corrected (wt%)	Targeted (wt%)	Diff of Measured (wt%)	Diff. of Meas BC (wt%)	% Diff of Measured	% Diff of Meas BC
SB4VS-16	Sum	98.6450	98.9570	100.0020	-1.3570	-1.0450	-1.4%	-1.0%
SB4VS-17	Al_2O_3	9.2820	9.3460	8.9330	0.3490	0.4130	3.9%	4.6%
SB4VS-17	B_2O_3	8.9270	8.7950	8.9600	-0.0330	-0.1650	-0.4%	-1.8%
SB4VS-17	BaO	0.0340	0.0380	0.0410	-0.0070	-0.0030	-17.1%	-7.3%
SB4VS-17	CaO	0.8530	0.8450	0.8030	0.0500	0.0420	6.2%	5.2%
SB4VS-17	Ce_2O_3	0.0240	0.0240	0.0500	-0.0260	-0.0260	-52.0%	-52.0%
SB4VS-17	Cr_2O_3	0.0620	0.0690	0.0690	-0.0070	0.0000	-10.1%	0.0%
SB4VS-17	CuO	0.0220	0.0220	0.0200	0.0020	0.0020	10.0%	10.0%
SB4VS-17	Fe_2O_3	8.6530	8.7620	9.7000	-1.0470	-0.9380	-10.8%	-9.7%
SB4VS-17	K_2O	0.1290	0.1150	0.1090	0.0200	0.0060	18.3%	5.5%
SB4VS-17	La_2O_3	0.0290	0.0290	0.0350	-0.0060	-0.0060	-17.1%	-17.1%
SB4VS-17	Li_2O	5.0920	5.1510	5.1200	-0.0280	0.0310	-0.5%	0.6%
SB4VS-17	MgO	0.7410	0.8020	0.8500	-0.1090	-0.0480	-12.8%	-5.6%
SB4VS-17	MnO	1.9400	1.9400	1.9010	0.0390	0.0390	2.1%	2.1%
SB4VS-17	Na_2O	11.2520	10.6590	10.6810	0.5710	-0.0220	5.3%	-0.2%
SB4VS-17	NiO	0.4020	0.4620	0.5130	-0.1110	-0.0510	-21.6%	-9.9%
SB4VS-17	PbO	0.0230	0.0230	0.0300	-0.0070	-0.0070	-23.3%	-23.3%
SB4VS-17	SiO_2	49.2570	49.1350	48.8410	0.4160	0.2940	0.9%	0.6%
SB4VS-17	SO_4^{2-}	0.4070	0.4070	0.5240	-0.1170	-0.1170	-22.3%	-22.3%
SB4VS-17	ThO_2	0.0840	0.0840	0.0210	0.0630	0.0630	300.0%	300.0%
SB4VS-17	TiO_2	0.0080	0.0090	0.0090	-0.0010	0.0000	-11.1%	0.0%
SB4VS-17	U_3O_8	2.5410	2.7530	2.6840	-0.1430	0.0690	-5.3%	2.6%
SB4VS-17	ZnO	0.0310	0.0310	0.0320	-0.0010	-0.0010	-3.1%	-3.1%
SB4VS-17	ZrO_2	0.0630	0.0630	0.0770	-0.0140	-0.0140	-18.2%	-18.2%
SB4VS-17	Sum	99.8610	99.5690	100.0030	-0.1420	-0.4340	-0.1%	-0.4%
SB4VS-18	Al_2O_3	8.2330	8.2910	8.0360	0.1970	0.2550	2.5%	3.2%
SB4VS-18	B_2O_3	8.9430	8.8110	9.2400	-0.2970	-0.4290	-3.2%	-4.6%
SB4VS-18	BaO	0.0320	0.0360	0.0390	-0.0070	-0.0030	-17.9%	-7.7%
SB4VS-18	CaO	0.8900	0.9030	0.8470	0.0430	0.0560	5.1%	6.6%
SB4VS-18	Ce_2O_3	0.0180	0.0180	0.0470	-0.0290	-0.0290	-61.7%	-61.7%
SB4VS-18	Cr_2O_3	0.0670	0.0760	0.0650	0.0020	0.0110	3.1%	16.9%
SB4VS-18	CuO	0.0230	0.0230	0.0190	0.0040	0.0040	21.1%	21.1%
SB4VS-18	Fe_2O_3	8.5170	8.6250	9.2940	-0.7770	-0.6690	-8.4%	-7.2%
SB4VS-18	K_2O	0.0750	0.0660	0.1030	-0.0280	-0.0370	-27.2%	-35.9%
SB4VS-18	La_2O_3	0.0280	0.0280	0.0330	-0.0050	-0.0050	-15.2%	-15.2%
SB4VS-18	Li_2O	5.1780	5.2380	5.2800	-0.1020	-0.0420	-1.9%	-0.8%
SB4VS-18	MgO	0.7970	0.8890	0.8920	-0.0950	-0.0030	-10.7%	-0.3%
SB4VS-18	MnO	1.9110	1.9090	1.8890	0.0220	0.0200	1.2%	1.1%
SB4VS-18	Na_2O	10.8280	10.1240	10.3100	0.5180	-0.1860	5.0%	-1.8%
SB4VS-18	NiO	0.4560	0.5250	0.5720	-0.1160	-0.0470	-20.3%	-8.2%
SB4VS-18	PbO	0.0280	0.0280	0.0280	0.0000	0.0000	0.0%	0.0%
SB4VS-18	SiO_2	49.1500	49.0280	50.1480	-0.9980	-1.1200	-2.0%	-2.2%
SB4VS-18	SO_4^{2-}	0.3990	0.3990	0.4950	-0.0960	-0.0960	-19.4%	-19.4%
SB4VS-18	ThO_2	0.0710	0.0710	0.0200	0.0510	0.0510	255.0%	255.0%
SB4VS-18	TiO_2	0.0080	0.0090	0.0080	0.0000	0.0010	0.0%	12.5%
SB4VS-18	U_3O_8	2.3550	2.5520	2.5350	-0.1800	0.0170	-7.1%	0.7%
SB4VS-18	ZnO	0.0300	0.0300	0.0310	-0.0010	-0.0010	-3.2%	-3.2%
SB4VS-18	ZrO_2	0.0600	0.0600	0.0730	-0.0130	-0.0130	-17.8%	-17.8%
SB4VS-18	Sum	98.1000	97.7410	100.0040	-1.9040	-2.2630	-1.9%	-2.3%
SB4VS-19	Al_2O_3	8.2240	8.2920	7.7920	0.4320	0.5000	5.5%	6.4%
SB4VS-19	B_2O_3	9.1120	9.0010	9.2400	-0.1280	-0.2390	-1.4%	-2.6%
SB4VS-19	BaO	0.0330	0.0360	0.0390	-0.0060	-0.0030	-15.4%	-7.7%
SB4VS-19	CaO	0.8010	0.8010	0.7580	0.0430	0.0430	5.7%	5.7%
SB4VS-19	Ce_2O_3	0.0320	0.0320	0.0470	-0.0150	-0.0150	-31.9%	-31.9%
SB4VS-19	Cr_2O_3	0.0630	0.0680	0.0650	-0.0020	0.0030	-3.1%	4.6%
SB4VS-19	CuO	0.0200	0.0200	0.0190	0.0010	0.0010	5.3%	5.3%
SB4VS-19	Fe_2O_3	7.8740	7.9570	8.8250	-0.9510	-0.8680	-10.8%	-9.8%
SB4VS-19	K_2O	0.0840	0.0750	0.1030	-0.0190	-0.0280	-18.4%	-27.2%
SB4VS-19	La_2O_3	0.0260	0.0260	0.0330	-0.0070	-0.0070	-21.2%	-21.2%
SB4VS-19	Li_2O	5.3020	5.3820	5.2800	0.0220	0.1020	0.4%	1.9%
SB4VS-19	MgO	0.8480	0.8890	0.8920	-0.0440	-0.0030	-4.9%	-0.3%
SB4VS-19	MnO	1.8430	1.8030	1.7960	0.0470	0.0070	2.6%	0.4%
SB4VS-19	Na_2O	11.7380	10.9310	11.0170	0.7210	-0.0860	6.5%	-0.8%
SB4VS-19	NiO	0.4610	0.5260	0.5720	-0.1110	-0.0460	-19.4%	-8.0%

Table E4. Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by SB4 Variability Study Glass (continued)
(100 -Batch 1; 200 -U std; 300 - LRM)

Glass ID	Oxide	Measured (wt%)	Measured Bias-Corrected (wt%)	Targeted (wt%)	Diff of Measured (wt%)	Diff. of Meas BC (wt%)	% Diff of Measured	% Diff of Meas BC
SB4VS-19	PbO	0.0220	0.0220	0.0280	-0.0060	-0.0060	-21.4%	-21.4%
SB4VS-19	SiO_2	50.4340	50.4180	50.2390	0.1950	0.1790	0.4%	0.4%
SB4VS-19	SO_4^{2-}	0.4210	0.4210	0.4950	-0.0740	-0.0740	-14.9%	-14.9%
SB4VS-19	ThO_2	0.1060	0.1060	0.0200	0.0860	0.0860	430.0%	430.0%
SB4VS-19	TiO_2	0.0100	0.0110	0.0080	0.0020	0.0030	25.0%	37.5%
SB4VS-19	U_3O_8	2.4590	2.6830	2.6320	-0.1730	0.0510	-6.6%	1.9%
SB4VS-19	ZnO	0.0330	0.0330	0.0310	0.0020	0.0020	6.5%	6.5%
SB4VS-19	ZrO_2	0.0600	0.0600	0.0730	-0.0130	-0.0130	-17.8%	-17.8%
SB4VS-19	Sum	100.0050	99.5910	100.0040	0.0010	-0.4130	0.0%	-0.4%
SB4VS-20	Al_2O_3	7.8510	7.9160	7.5160	0.3350	0.4000	4.5%	5.3%
SB4VS-20	B_2O_3	9.4260	9.3120	9.5200	-0.0940	-0.2080	-1.0%	-2.2%
SB4VS-20	BaO	0.0370	0.0420	0.0430	-0.0060	-0.0010	-14.0%	-2.3%
SB4VS-20	CaO	0.8030	0.8150	0.7970	0.0060	0.0180	0.8%	2.3%
SB4VS-20	Ce_2O_3	0.0340	0.0340	0.0520	-0.0180	-0.0180	-34.6%	-34.6%
SB4VS-20	Cr_2O_3	0.0670	0.0760	0.0730	-0.0060	0.0030	-8.2%	4.1%
SB4VS-20	CuO	0.0220	0.0220	0.0210	0.0010	0.0010	4.8%	4.8%
SB4VS-20	Fe_2O_3	7.8350	7.9170	8.7480	-0.9130	-0.8310	-10.4%	-9.5%
SB4VS-20	K_2O	0.0910	0.0800	0.1150	-0.0240	-0.0350	-20.9%	-30.4%
SB4VS-20	La_2O_3	0.0330	0.0330	0.0370	-0.0040	-0.0040	-10.8%	-10.8%
SB4VS-20	Li_2O	5.4250	5.5070	5.4400	-0.0150	0.0670	-0.3%	1.2%
SB4VS-20	MgO	0.6870	0.7650	0.7560	-0.0690	0.0090	-9.1%	1.2%
SB4VS-20	MnO	1.6910	1.6890	1.6900	0.0010	-0.0010	0.1%	-0.1%
SB4VS-20	Na_2O	10.4370	9.7580	9.9390	0.4980	-0.1810	5.0%	-1.8%
SB4VS-20	NiO	0.4290	0.4890	0.5380	-0.1090	-0.0490	-20.3%	-9.1%
SB4VS-20	PbO	0.0290	0.0290	0.0320	-0.0030	-0.0030	-9.4%	-9.4%
SB4VS-20	SiO_2	51.9850	51.9660	51.6370	0.3480	0.3290	0.7%	0.6%
SB4VS-20	SO_4^{2-}	0.3340	0.3340	0.4260	-0.0920	-0.0920	-21.6%	-21.6%
SB4VS-20	ThO_2	0.0570	0.0570	0.0220	0.0350	0.0350	159.1%	159.1%
SB4VS-20	TiO_2	0.0130	0.0140	0.0090	0.0040	0.0050	44.4%	55.6%
SB4VS-20	U_3O_8	2.3610	2.5770	2.4770	-0.1160	0.1000	-4.7%	4.0%
SB4VS-20	ZnO	0.0320	0.0320	0.0340	-0.0020	-0.0020	-5.9%	-5.9%
SB4VS-20	ZrO_2	0.0630	0.0630	0.0810	-0.0180	-0.0180	-22.2%	-22.2%
SB4VS-20	Sum	99.7400	99.5260	100.0030	-0.2630	-0.4770	-0.3%	-0.5%
SB4VS-21	Al_2O_3	8.2760	8.3440	7.9410	0.3350	0.4030	4.2%	5.1%
SB4VS-21	B_2O_3	9.1200	9.0100	9.5200	-0.4000	-0.5100	-4.2%	-5.4%
SB4VS-21	BaO	0.0400	0.0430	0.0430	-0.0030	0.0000	-7.0%	0.0%
SB4VS-21	CaO	0.8230	0.8230	0.7970	0.0260	0.0260	3.3%	3.3%
SB4VS-21	Ce_2O_3	0.0320	0.0320	0.0520	-0.0200	-0.0200	-38.5%	-38.5%
SB4VS-21	Cr_2O_3	0.0830	0.0890	0.0730	0.0100	0.0160	13.7%	21.9%
SB4VS-21	CuO	0.0190	0.0190	0.0210	-0.0020	-0.0020	-9.5%	-9.5%
SB4VS-21	Fe_2O_3	7.0840	7.1590	8.0790	-0.9950	-0.9200	-12.3%	-11.4%
SB4VS-21	K_2O	0.0910	0.0810	0.1150	-0.0240	-0.0340	-20.9%	-29.6%
SB4VS-21	La_2O_3	0.0330	0.0330	0.0370	-0.0040	-0.0040	-10.8%	-10.8%
SB4VS-21	Li_2O	5.3880	5.4690	5.4400	-0.0520	0.0290	-1.0%	0.5%
SB4VS-21	MgO	0.8030	0.8420	0.8390	-0.0360	0.0030	-4.3%	0.4%
SB4VS-21	MnO	1.7980	1.7590	1.7780	0.0200	-0.0190	1.1%	-1.1%
SB4VS-21	Na_2O	10.8480	10.1030	10.0530	0.7950	0.0500	7.9%	0.5%
SB4VS-21	NiO	0.3540	0.4040	0.4560	-0.1020	-0.0520	-22.4%	-11.4%
SB4VS-21	PbO	0.0290	0.0290	0.0320	-0.0030	-0.0030	-9.4%	-9.4%
SB4VS-21	SiO_2	51.3430	51.3240	51.6370	-0.2940	-0.3130	-0.6%	-0.6%
SB4VS-21	SO_4^{2-}	0.4020	0.4020	0.4660	-0.0640	-0.0640	-13.7%	-13.7%
SB4VS-21	ThO_2	0.0880	0.0880	0.0220	0.0660	0.0660	300.0%	300.0%
SB4VS-21	TiO_2	0.0080	0.0090	0.0090	-0.0010	0.0000	-11.1%	0.0%
SB4VS-21	U_3O_8	2.2850	2.4930	2.4770	-0.1920	0.0160	-7.8%	0.6%
SB4VS-21	ZnO	0.0320	0.0320	0.0340	-0.0020	-0.0020	-5.9%	-5.9%
SB4VS-21	ZrO_2	0.0680	0.0680	0.0810	-0.0130	-0.0130	-16.0%	-16.0%
SB4VS-21	Sum	99.0490	98.6550	100.0020	-0.9530	-1.3470	-1.0%	-1.3%
SB4VS-22	Al_2O_3	11.3510	11.4450	10.8200	0.5310	0.6250	4.9%	5.8%
SB4VS-22	B_2O_3	8.1060	8.0070	8.1200	-0.0140	-0.1130	-0.2%	-1.4%
SB4VS-22	BaO	0.0540	0.0600	0.0610	-0.0070	-0.0010	-11.5%	-1.6%
SB4VS-22	CaO	0.8740	0.8670	0.8820	-0.0080	-0.0150	-0.9%	-1.7%
SB4VS-22	Ce_2O_3	0.0490	0.0490	0.0740	-0.0250	-0.0250	-33.8%	-33.8%
SB4VS-22	Cr_2O_3	0.0940	0.1030	0.1030	-0.0090	0.0000	-8.7%	0.0%
SB4VS-22	CuO	0.0270	0.0270	0.0300	-0.0030	-0.0030	-10.0%	-10.0%

Table E4. Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by SB4 Variability Study Glass (continued)
(100 -Batch 1; 200 -U std; 300 - LRM)

Glass ID	Oxide	Measured (wt%)	Measured Bias-Corrected (wt%)	Targeted (wt%)	Diff of Measured (wt%)	Diff. of Meas BC (wt%)	% Diff of Measured	% Diff of Meas BC
SB4VS-22	Fe_2O_3	9.5080	9.6070	10.1650	-0.6570	-0.5580	-6.5%	-5.5%
SB4VS-22	K_2O	0.1650	0.1460	0.1630	0.0020	-0.0170	1.2%	-10.4%
SB4VS-22	La_2O_3	0.0450	0.0450	0.0520	-0.0070	-0.0070	-13.5%	-13.5%
SB4VS-22	Li_2O	4.6290	4.6990	4.6400	-0.0110	0.0590	-0.2%	1.3%
SB4VS-22	MgO	0.8810	0.9530	0.9370	-0.0560	0.0160	-6.0%	1.7%
SB4VS-22	MnO	2.4270	2.4290	2.3910	0.0360	0.0380	1.5%	1.6%
SB4VS-22	Na_2O	12.7050	12.0370	12.4590	0.2460	-0.4220	2.0%	-3.4%
SB4VS-22	NiO	0.4260	0.4860	0.5440	-0.1180	-0.0580	-21.7%	-10.7%
SB4VS-22	PbO	0.0410	0.0410	0.0450	-0.0040	-0.0040	-8.9%	-8.9%
SB4VS-22	SiO_2	45.1390	45.1230	44.7040	0.4350	0.4190	1.0%	0.9%
SB4VS-22	SO_4^{2-}	0.4460	0.4460	0.5330	-0.0870	-0.0870	-16.3%	-16.3%
SB4VS-22	ThO_2	0.1420	0.1420	0.0310	0.1110	0.1110	358.1%	358.1%
SB4VS-22	TiO_2	0.0170	0.0180	0.0130	0.0040	0.0050	30.8%	38.5%
SB4VS-22	U_3O_8	2.9270	3.1940	3.0720	-0.1450	0.1220	-4.7%	4.0%
SB4VS-22	ZnO	0.0450	0.0450	0.0480	-0.0030	-0.0030	-6.3%	-6.3%
SB4VS-22	ZrO_2	0.1080	0.1080	0.1150	-0.0070	-0.0070	-6.1%	-6.1%
SB4VS-22	Sum	100.2050	100.0750	100.0020	0.2030	0.0730	0.2%	0.1%
SB4VS-23	Al_2O_3	9.6550	9.7230	9.2860	0.3690	0.4370	4.0%	4.7%
SB4VS-23	B_2O_3	8.3560	8.2320	8.4000	-0.0440	-0.1680	-0.5%	-2.0%
SB4VS-23	BaO	0.0530	0.0570	0.0580	-0.0050	-0.0010	-8.6%	-1.7%
SB4VS-23	CaO	1.0360	1.0360	1.0480	-0.0120	-0.0120	-1.1%	-1.1%
SB4VS-23	Ce_2O_3	0.0510	0.0510	0.0710	-0.0200	-0.0200	-28.2%	-28.2%
SB4VS-23	Cr_2O_3	0.0990	0.1070	0.0980	0.0010	0.0090	1.0%	9.2%
SB4VS-23	CuO	0.0270	0.0270	0.0280	-0.0010	-0.0010	-3.6%	-3.6%
SB4VS-23	Fe_2O_3	9.0820	9.1970	9.6810	-0.5990	-0.4840	-6.2%	-5.0%
SB4VS-23	K_2O	0.1540	0.1370	0.1550	-0.0010	-0.0180	-0.6%	-11.6%
SB4VS-23	La_2O_3	0.0440	0.0440	0.0500	-0.0060	-0.0060	-12.0%	-12.0%
SB4VS-23	Li_2O	4.7470	4.8030	4.8000	-0.0530	0.0030	-1.1%	0.1%
SB4VS-23	MgO	1.0800	1.1320	1.1010	-0.0210	0.0310	-1.9%	2.8%
SB4VS-23	MnO	2.0820	2.0370	2.0580	0.0240	-0.0210	1.2%	-1.0%
SB4VS-23	Na_2O	13.4290	12.5070	12.6720	0.7570	-0.1650	6.0%	-1.3%
SB4VS-23	NiO	0.5940	0.6850	0.7240	-0.1300	-0.0390	-18.0%	-5.4%
SB4VS-23	PbO	0.0400	0.0400	0.0430	-0.0030	-0.0030	-7.0%	-7.0%
SB4VS-23	SiO_2	46.3690	46.2540	46.0990	0.2700	0.1550	0.6%	0.3%
SB4VS-23	SO_4^{2-}	0.4350	0.4350	0.5070	-0.0720	-0.0720	-14.2%	-14.2%
SB4VS-23	ThO_2	0.1430	0.1430	0.0300	0.1130	0.1130	376.7%	376.7%
SB4VS-23	TiO_2	0.0180	0.0190	0.0120	0.0060	0.0070	50.0%	58.3%
SB4VS-23	U_3O_8	2.7360	2.9640	2.9250	-0.1890	0.0390	-6.5%	1.3%
SB4VS-23	ZnO	0.0440	0.0440	0.0460	-0.0020	-0.0020	-4.3%	-4.3%
SB4VS-23	ZrO_2	0.1020	0.1020	0.1100	-0.0080	-0.0080	-7.3%	-7.3%
SB4VS-23	Sum	100.3780	99.7760	100.0020	0.3760	-0.2260	0.4%	-0.2%
SB4VS-24	Al_2O_3	9.1260	9.1720	8.7880	0.3380	0.3840	3.8%	4.4%
SB4VS-24	B_2O_3	8.4280	8.2240	8.4000	0.0280	-0.1760	0.3%	-2.1%
SB4VS-24	BaO	0.0340	0.0390	0.0410	-0.0070	-0.0020	-17.1%	-4.9%
SB4VS-24	CaO	1.0740	1.0690	1.0480	0.0260	0.0210	2.5%	2.0%
SB4VS-24	Ce_2O_3	0.0370	0.0370	0.0500	-0.0130	-0.0130	-26.0%	-26.0%
SB4VS-24	Cr_2O_3	0.0640	0.0720	0.0690	-0.0050	0.0030	-7.2%	4.3%
SB4VS-24	CuO	0.0230	0.0230	0.0200	0.0030	0.0030	15.0%	15.0%
SB4VS-24	Fe_2O_3	9.9190	10.0360	10.5710	-0.6520	-0.5350	-6.2%	-5.1%
SB4VS-24	K_2O	0.0880	0.0780	0.1100	-0.0220	-0.0320	-20.0%	-29.1%
SB4VS-24	La_2O_3	0.0260	0.0260	0.0350	-0.0090	-0.0090	-25.7%	-25.7%
SB4VS-24	Li_2O	4.7530	4.7690	4.8000	-0.0470	-0.0310	-1.0%	-0.6%
SB4VS-24	MgO	0.7830	0.8650	0.8920	-0.1090	-0.0270	-12.2%	-3.0%
SB4VS-24	MnO	2.0430	2.0890	2.0580	-0.0150	0.0310	-0.7%	1.5%
SB4VS-24	Na_2O	13.1360	12.4980	12.6720	0.4640	-0.1740	3.7%	-1.4%
SB4VS-24	NiO	0.4020	0.4550	0.5180	-0.1160	-0.0630	-22.4%	-12.2%
SB4VS-24	PbO	0.0250	0.0250	0.0300	-0.0050	-0.0050	-16.7%	-16.7%
SB4VS-24	SiO_2	46.1020	45.6000	46.0990	0.0030	-0.4990	0.0%	-1.1%
SB4VS-24	SO_4^{2-}	0.4010	0.4010	0.5070	-0.1060	-0.1060	-20.9%	-20.9%
SB4VS-24	ThO_2	0.1350	0.1350	0.0210	0.1140	0.1140	542.9%	542.9%
SB4VS-24	TiO_2	0.0080	0.0090	0.0090	-0.0010	0.0000	-11.1%	0.0%
SB4VS-24	U_3O_8	2.9830	3.2470	3.1530	-0.1700	0.0940	-5.4%	3.0%
SB4VS-24	ZnO	0.0290	0.0290	0.0330	-0.0040	-0.0040	-12.1%	-12.1%
SB4VS-24	ZrO_2	0.0680	0.0680	0.0770	-0.0090	-0.0090	-11.7%	-11.7%

Table E4. Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by SB4 Variability Study Glass (continued)
(100 -Batch 1; 200 -U std; 300 - LRM)

Glass ID	Oxide	Measured (wt%)	Measured Bias-Corrected (wt%)	Targeted (wt%)	Diff of Measured (wt%)	Diff. of Meas BC (wt%)	% Diff of Measured	% Diff of Meas BC
SB4VS-24	Sum	99.6860	98.9650	100.0010	-0.3150	-1.0360	-0.3%	-1.0%
SB4VS-25	Al_2O_3	9.1070	9.1530	8.6960	0.4110	0.4570	4.7%	5.3%
SB4VS-25	B_2O_3	8.7100	8.4990	8.6800	0.0300	-0.1810	0.3%	-2.1%
SB4VS-25	BaO	0.0350	0.0390	0.0390	-0.0040	0.0000	-10.3%	0.0%
SB4VS-25	CaO	0.8060	0.7990	0.7980	0.0080	0.0010	1.0%	0.1%
SB4VS-25	Ce_2O_3	0.0200	0.0200	0.0470	-0.0270	-0.0270	-57.4%	-57.4%
SB4VS-25	Cr_2O_3	0.0740	0.0810	0.0660	0.0080	0.0150	12.1%	22.7%
SB4VS-25	CuO	0.0190	0.0190	0.0190	0.0000	0.0000	0.0%	0.0%
SB4VS-25	Fe_2O_3	8.5140	8.6140	9.1970	-0.6830	-0.5830	-7.4%	-6.3%
SB4VS-25	K_2O	0.0600	0.0530	0.1040	-0.0440	-0.0510	-42.3%	-49.0%
SB4VS-25	La_2O_3	0.0280	0.0280	0.0340	-0.0060	-0.0060	-17.6%	-17.6%
SB4VS-25	Li_2O	4.9570	4.9740	4.9600	-0.0030	0.0140	-0.1%	0.3%
SB4VS-25	MgO	0.9850	1.0660	1.0460	-0.0610	0.0200	-5.8%	1.9%
SB4VS-25	MnO	2.1690	2.1690	2.1630	0.0060	0.0060	0.3%	0.3%
SB4VS-25	Na_2O	12.6410	11.9730	12.2380	0.4030	-0.2650	3.3%	-2.2%
SB4VS-25	NiO	0.5710	0.6450	0.6870	-0.1160	-0.0420	-16.9%	-6.1%
SB4VS-25	PbO	0.0260	0.0260	0.0290	-0.0030	-0.0030	-10.3%	-10.3%
SB4VS-25	SiO_2	48.1340	47.6110	47.4940	0.6400	0.1170	1.3%	0.2%
SB4VS-25	SO_4^{2-}	0.4740	0.4740	0.5770	-0.1030	-0.1030	-17.9%	-17.9%
SB4VS-25	ThO_2	0.1290	0.1290	0.0200	0.1090	0.1090	545.0%	545.0%
SB4VS-25	TiO_2	0.0170	0.0180	0.0080	0.0090	0.0100	112.5%	125.0%
SB4VS-25	U_3O_8	2.8740	3.1280	2.9950	-0.1210	0.1330	-4.0%	4.4%
SB4VS-25	ZnO	0.0300	0.0300	0.0310	-0.0010	-0.0010	-3.2%	-3.2%
SB4VS-25	ZrO_2	0.0660	0.0660	0.0740	-0.0080	-0.0080	-10.8%	-10.8%
SB4VS-25	Sum	100.4460	99.6140	100.0020	0.4440	-0.3880	0.4%	-0.4%
SB4VS-26	Al_2O_3	8.7530	8.8140	8.3480	0.4050	0.4660	4.9%	5.6%
SB4VS-26	B_2O_3	8.7580	8.6290	8.6800	0.0780	-0.0510	0.9%	-0.6%
SB4VS-26	BaO	0.0510	0.0580	0.0550	-0.0040	0.0030	-7.3%	5.5%
SB4VS-26	CaO	0.9670	0.9810	0.9960	-0.0290	-0.0150	-2.9%	-1.5%
SB4VS-26	Ce_2O_3	0.0570	0.0570	0.0670	-0.0100	-0.0100	-14.9%	-14.9%
SB4VS-26	Cr_2O_3	0.0920	0.1050	0.0930	-0.0010	0.0120	-1.1%	12.9%
SB4VS-26	CuO	0.0280	0.0290	0.0270	0.0010	0.0020	3.7%	7.4%
SB4VS-26	Fe_2O_3	9.0210	9.1350	9.6440	-0.6230	-0.5090	-6.5%	-5.3%
SB4VS-26	K_2O	0.1430	0.1260	0.1470	-0.0040	-0.0210	-2.7%	-14.3%
SB4VS-26	La_2O_3	0.0350	0.0350	0.0470	-0.0120	-0.0120	-25.5%	-25.5%
SB4VS-26	Li_2O	4.9730	5.0320	4.9600	0.0130	0.0720	0.3%	1.5%
SB4VS-26	MgO	0.9170	1.0230	1.0460	-0.1290	-0.0230	-12.3%	-2.2%
SB4VS-26	MnO	2.1340	2.1310	2.1630	-0.0290	-0.0320	-1.3%	-1.5%
SB4VS-26	Na_2O	11.7850	11.0190	12.2380	-0.4530	-1.2190	-3.7%	-10.0%
SB4VS-26	NiO	0.3890	0.4480	0.4920	-0.1030	-0.0440	-20.9%	-8.9%
SB4VS-26	PbO	0.0380	0.0380	0.0410	-0.0030	-0.0030	-7.3%	-7.3%
SB4VS-26	SiO_2	48.4020	48.2820	47.2910	1.1110	0.9910	2.3%	2.1%
SB4VS-26	SO_4^{2-}	0.3890	0.3890	0.4820	-0.0930	-0.0930	-19.3%	-19.3%
SB4VS-26	ThO_2	0.1330	0.1330	0.0280	0.1050	0.1050	375.0%	375.0%
SB4VS-26	TiO_2	0.0160	0.0170	0.0120	0.0040	0.0050	33.3%	41.7%
SB4VS-26	U_3O_8	2.8920	3.1340	2.9950	-0.1030	0.1390	-3.4%	4.6%
SB4VS-26	ZnO	0.0370	0.0370	0.0440	-0.0070	-0.0070	-15.9%	-15.9%
SB4VS-26	ZrO_2	0.0930	0.0930	0.1040	-0.0110	-0.0110	-10.6%	-10.6%
SB4VS-26	Sum	100.1030	99.7420	100.0000	0.1030	-0.2580	0.1%	-0.3%
SB4VS-27	Al_2O_3	9.1780	9.2240	8.8210	0.3570	0.4030	4.0%	4.6%
SB4VS-27	B_2O_3	8.8790	8.6650	8.9600	-0.0810	-0.2950	-0.9%	-3.3%
SB4VS-27	BaO	0.0320	0.0360	0.0370	-0.0050	-0.0010	-13.5%	-2.7%
SB4VS-27	CaO	0.9490	0.9630	0.9440	0.0050	0.0190	0.5%	2.0%
SB4VS-27	Ce_2O_3	0.0300	0.0300	0.0450	-0.0150	-0.0150	-33.3%	-33.3%
SB4VS-27	Cr_2O_3	0.0650	0.0750	0.0620	0.0030	0.0130	4.8%	21.0%
SB4VS-27	CuO	0.0200	0.0200	0.0180	0.0020	0.0020	11.1%	11.1%
SB4VS-27	Fe_2O_3	8.0670	8.1630	8.7130	-0.6460	-0.5500	-7.4%	-6.3%
SB4VS-27	K_2O	0.0600	0.0530	0.0990	-0.0390	-0.0460	-39.4%	-46.5%
SB4VS-27	La_2O_3	0.0250	0.0250	0.0320	-0.0070	-0.0070	-21.9%	-21.9%
SB4VS-27	Li_2O	5.0160	5.0340	5.1200	-0.1040	-0.0860	-2.0%	-1.7%
SB4VS-27	MgO	0.7060	0.7870	0.8030	-0.0970	-0.0160	-12.1%	-2.0%
SB4VS-27	MnO	2.0240	2.0210	2.0490	-0.0250	-0.0280	-1.2%	-1.4%
SB4VS-27	Na_2O	12.1050	11.3180	11.8040	0.3010	-0.4860	2.5%	-4.1%
SB4VS-27	NiO	0.3520	0.3970	0.4660	-0.1140	-0.0690	-24.5%	-14.8%

Table E4. Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by SB4 Variability Study Glass (continued)
(100 -Batch 1; 200 -U std; 300 - LRM)

Glass ID	Oxide	Measured (wt%)	Measured Bias-Corrected (wt%)	Targeted (wt%)	Diff of Measured (wt%)	Diff. of Meas BC (wt%)	% Diff of Measured	% Diff of Meas BC
SB4VS-27	PbO	0.0260	0.0260	0.0270	-0.0010	-0.0010	-3.7%	-3.7%
SB4VS-27	SiO_2	48.6160	48.0860	48.6970	-0.0810	-0.6110	-0.2%	-1.3%
SB4VS-27	SO_4^{2-}	0.4430	0.4430	0.5460	-0.1030	-0.1030	-18.9%	-18.9%
SB4VS-27	ThO_2	0.0570	0.0570	0.0190	0.0380	0.0380	200.0%	200.0%
SB4VS-27	TiO_2	0.0080	0.0090	0.0080	0.0000	0.0010	0.0%	12.5%
SB4VS-27	U_3O_8	2.4290	2.6440	2.6330	-0.2040	0.0110	-7.7%	0.4%
SB4VS-27	ZnO	0.0290	0.0290	0.0290	0.0000	0.0000	0.0%	0.0%
SB4VS-27	ZrO_2	0.0630	0.0630	0.0700	-0.0070	-0.0070	-10.0%	-10.0%
SB4VS-27	Sum	99.1790	98.1660	100.0020	-0.8230	-1.8360	-0.8%	-1.8%
SB4VS-28	Al_2O_3	8.2850	8.3270	7.9090	0.3760	0.4180	4.8%	5.3%
SB4VS-28	B_2O_3	8.9590	8.7430	8.9600	-0.0010	-0.2170	0.0%	-2.4%
SB4VS-28	BaO	0.0440	0.0500	0.0530	-0.0090	-0.0030	-17.0%	-5.7%
SB4VS-28	CaO	0.8010	0.7970	0.7560	0.0450	0.0410	6.0%	5.4%
SB4VS-28	Ce_2O_3	0.0440	0.0440	0.0640	-0.0200	-0.0200	-31.3%	-31.3%
SB4VS-28	Cr_2O_3	0.0730	0.0830	0.0880	-0.0150	-0.0050	-17.0%	-5.7%
SB4VS-28	CuO	0.0270	0.0270	0.0250	0.0020	0.0020	8.0%	8.0%
SB4VS-28	Fe_2O_3	9.1320	9.2400	10.2170	-1.0850	-0.9770	-10.6%	-9.6%
SB4VS-28	K_2O	0.1510	0.1340	0.1400	0.0110	-0.0060	7.9%	-4.3%
SB4VS-28	La_2O_3	0.0360	0.0360	0.0450	-0.0090	-0.0090	-20.0%	-20.0%
SB4VS-28	Li_2O	5.1350	5.1530	5.1200	0.0150	0.0330	0.3%	0.6%
SB4VS-28	MgO	0.9020	0.9970	0.9910	-0.0890	0.0060	-9.0%	0.6%
SB4VS-28	MnO	1.9430	1.9860	1.8520	0.0910	0.1340	4.9%	7.2%
SB4VS-28	Na_2O	11.4070	10.8580	11.0310	0.3760	-0.1730	3.4%	-1.6%
SB4VS-28	NiO	0.3590	0.4060	0.4660	-0.1070	-0.0600	-23.0%	-12.9%
SB4VS-28	PbO	0.0390	0.0390	0.0380	0.0010	0.0010	2.6%	2.6%
SB4VS-28	SiO_2	49.3110	48.7710	48.8890	0.4220	-0.1180	0.9%	-0.2%
SB4VS-28	SO_4^{2-}	0.4250	0.4250	0.5460	-0.1210	-0.1210	-22.2%	-22.2%
SB4VS-28	ThO_2	0.1230	0.1230	0.0270	0.0960	0.0960	355.6%	355.6%
SB4VS-28	TiO_2	0.0130	0.0130	0.0110	0.0020	0.0020	18.2%	18.2%
SB4VS-28	U_3O_8	2.4410	2.6560	2.6330	-0.1920	0.0230	-7.3%	0.9%
SB4VS-28	ZnO	0.0360	0.0360	0.0410	-0.0050	-0.0050	-12.2%	-12.2%
SB4VS-28	ZrO_2	0.0920	0.0920	0.0990	-0.0070	-0.0070	-7.1%	-7.1%
SB4VS-28	Sum	99.7770	99.0350	100.0010	-0.2240	-0.9660	-0.2%	-1.0%
SB4VS-29	Al_2O_3	8.3990	8.4580	8.1510	0.2480	0.3070	3.0%	3.8%
SB4VS-29	B_2O_3	9.0240	8.8900	9.2400	-0.2160	-0.3500	-2.3%	-3.8%
SB4VS-29	BaO	0.0420	0.0470	0.0500	-0.0080	-0.0030	-16.0%	-6.0%
SB4VS-29	CaO	0.7370	0.7310	0.7140	0.0230	0.0170	3.2%	2.4%
SB4VS-29	Ce_2O_3	0.0460	0.0460	0.0600	-0.0140	-0.0140	-23.3%	-23.3%
SB4VS-29	Cr_2O_3	0.0750	0.0820	0.0830	-0.0080	-0.0010	-9.6%	-1.2%
SB4VS-29	CuO	0.0230	0.0240	0.0240	-0.0010	0.0000	-4.2%	0.0%
SB4VS-29	Fe_2O_3	7.6270	7.7240	8.2290	-0.6020	-0.5050	-7.3%	-6.1%
SB4VS-29	K_2O	0.1410	0.1250	0.1320	0.0090	-0.0070	6.8%	-5.3%
SB4VS-29	La_2O_3	0.0370	0.0370	0.0420	-0.0050	-0.0050	-11.9%	-11.9%
SB4VS-29	Li_2O	5.1400	5.2010	5.2800	-0.1400	-0.0790	-2.7%	-1.5%
SB4VS-29	MgO	0.6960	0.7540	0.7580	-0.0620	-0.0040	-8.2%	-0.5%
SB4VS-29	MnO	1.7300	1.7310	1.7490	-0.0190	-0.0180	-1.1%	-1.0%
SB4VS-29	Na_2O	11.7680	11.1510	11.3710	0.3970	-0.2200	3.5%	-1.9%
SB4VS-29	NiO	0.4900	0.5640	0.6150	-0.1250	-0.0510	-20.3%	-8.3%
SB4VS-29	PbO	0.0360	0.0360	0.0360	0.0000	0.0000	0.0%	0.0%
SB4VS-29	SiO_2	49.3640	49.2420	50.1020	-0.7380	-0.8600	-1.5%	-1.7%
SB4VS-29	SO_4^{2-}	0.4130	0.4130	0.5160	-0.1030	-0.1030	-20.0%	-20.0%
SB4VS-29	ThO_2	0.1160	0.1160	0.0250	0.0910	0.0910	364.0%	364.0%
SB4VS-29	TiO_2	0.0170	0.0180	0.0110	0.0060	0.0070	54.5%	63.6%
SB4VS-29	U_3O_8	2.5150	2.7250	2.6800	-0.1650	0.0450	-6.2%	1.7%
SB4VS-29	ZnO	0.0370	0.0370	0.0390	-0.0020	-0.0020	-5.1%	-5.1%
SB4VS-29	ZrO_2	0.0760	0.0760	0.0930	-0.0170	-0.0170	-18.3%	-18.3%
SB4VS-29	Sum	98.5490	98.2250	100.0000	-1.4510	-1.7750	-1.5%	-1.8%
SB4VS-30	Al_2O_3	7.6010	7.5790	7.4700	0.1310	0.1090	1.8%	1.5%
SB4VS-30	B_2O_3	9.1360	8.6930	9.2400	-0.1040	-0.5470	-1.1%	-5.9%
SB4VS-30	BaO	0.0290	0.0330	0.0350	-0.0060	-0.0020	-17.1%	-5.7%
SB4VS-30	CaO	0.7420	0.7390	0.7140	0.0280	0.0250	3.9%	3.5%
SB4VS-30	Ce_2O_3	0.0320	0.0320	0.0420	-0.0100	-0.0100	-23.8%	-23.8%
SB4VS-30	Cr_2O_3	0.0540	0.0620	0.0590	-0.0050	0.0030	-8.5%	5.1%
SB4VS-30	CuO	0.0190	0.0190	0.0170	0.0020	0.0020	11.8%	11.8%

Table E4. Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by SB4 Variability Study Glass (continued)
(100 -Batch 1; 200 -U std; 300 - LRM)

Glass ID	Oxide	Measured (wt%)	Measured Bias-Corrected (wt%)	Targeted (wt%)	Diff of Measured (wt%)	Diff. of Meas BC (wt%)	% Diff of Measured	% Diff of Meas BC
SB4VS-30	Fe_2O_3	8.5600	8.7100	9.6500	-1.0900	-0.9400	-11.3%	-9.7%
SB4VS-30	K_2O	0.0600	0.0540	0.0930	-0.0330	-0.0390	-35.5%	-41.9%
SB4VS-30	La_2O_3	0.0420	0.0420	0.0300	0.0120	0.0120	40.0%	40.0%
SB4VS-30	Li_2O	5.1560	5.1700	5.2800	-0.1240	-0.1100	-2.3%	-2.1%
SB4VS-30	MgO	0.6950	0.7680	0.7580	-0.0630	0.0100	-8.3%	1.3%
SB4VS-30	MnO	2.0080	2.0500	1.9350	0.0730	0.1150	3.8%	5.9%
SB4VS-30	Na_2O	11.1310	10.5930	10.8980	0.2330	-0.3050	2.1%	-2.8%
SB4VS-30	NiO	0.4980	0.5510	0.6150	-0.1170	-0.0640	-19.0%	-10.4%
SB4VS-30	PbO	0.0200	0.0200	0.0260	-0.0060	-0.0060	-23.1%	-23.1%
SB4VS-30	SiO_2	47.7060	48.9040	50.1020	-2.3960	-1.1980	-4.8%	-2.4%
SB4VS-30	SO_4^{2-}	0.3490	0.3490	0.4310	-0.0820	-0.0820	-19.0%	-19.0%
SB4VS-30	ThO_2	0.0570	0.0570	0.0180	0.0390	0.0390	216.7%	216.7%
SB4VS-30	TiO_2	0.0080	0.0090	0.0070	0.0010	0.0020	14.3%	28.6%
SB4VS-30	U_3O_8	2.3260	2.5290	2.4860	-0.1600	0.0430	-6.4%	1.7%
SB4VS-30	ZnO	0.0240	0.0240	0.0280	-0.0040	-0.0040	-14.3%	-14.3%
SB4VS-30	ZrO_2	0.0550	0.0550	0.0660	-0.0110	-0.0110	-16.7%	-16.7%
SB4VS-30	Sum	96.3100	97.0430	100.0000	-3.6900	-2.9570	-3.7%	-3.0%
SB4VS-31	Al_2O_3	7.4070	7.4440	7.0300	0.3770	0.4140	5.4%	5.9%
SB4VS-31	B_2O_3	9.6920	9.4580	9.5200	0.1720	-0.0620	1.8%	-0.7%
SB4VS-31	BaO	0.0380	0.0440	0.0470	-0.0090	-0.0030	-19.1%	-6.4%
SB4VS-31	CaO	0.8650	0.8770	0.8390	0.0260	0.0380	3.1%	4.5%
SB4VS-31	Ce_2O_3	0.0380	0.0380	0.0570	-0.0190	-0.0190	-33.3%	-33.3%
SB4VS-31	Cr_2O_3	0.0670	0.0770	0.0780	-0.0110	-0.0010	-14.1%	-1.3%
SB4VS-31	CuO	0.0230	0.0230	0.0230	0.0000	0.0000	0.0%	0.0%
SB4VS-31	Fe_2O_3	8.6570	8.7590	9.0820	-0.4250	-0.3230	-4.7%	-3.6%
SB4VS-31	K_2O	0.1330	0.1170	0.1240	0.0090	-0.0070	7.3%	-5.6%
SB4VS-31	La_2O_3	0.0260	0.0260	0.0400	-0.0140	-0.0140	-35.0%	-35.0%
SB4VS-31	Li_2O	5.3980	5.4170	5.4400	-0.0420	-0.0230	-0.8%	-0.4%
SB4VS-31	MgO	0.6110	0.6810	0.7140	-0.1030	-0.0330	-14.4%	-4.6%
SB4VS-31	MnO	1.8010	1.7990	1.8210	-0.0200	-0.0220	-1.1%	-1.2%
SB4VS-31	Na_2O	10.3260	9.6550	9.7280	0.5980	-0.0730	6.1%	-0.8%
SB4VS-31	NiO	0.4800	0.5420	0.5790	-0.0990	-0.0370	-17.1%	-6.4%
SB4VS-31	PbO	0.0270	0.0270	0.0340	-0.0070	-0.0070	-20.6%	-20.6%
SB4VS-31	SiO_2	51.2900	50.7310	51.6790	-0.3890	-0.9480	-0.8%	-1.8%
SB4VS-31	SO_4^{2-}	0.3860	0.3860	0.4850	-0.0990	-0.0990	-20.4%	-20.4%
SB4VS-31	ThO_2	0.0570	0.0570	0.0240	0.0330	0.0330	137.5%	137.5%
SB4VS-31	TiO_2	0.0080	0.0090	0.0100	-0.0020	-0.0010	-20.0%	-10.0%
SB4VS-31	U_3O_8	2.4200	2.6340	2.5220	-0.1020	0.1120	-4.0%	4.4%
SB4VS-31	ZnO	0.0340	0.0340	0.0370	-0.0030	-0.0030	-8.1%	-8.1%
SB4VS-31	ZrO_2	0.0800	0.0800	0.0880	-0.0080	-0.0080	-9.1%	-9.1%
SB4VS-31	Sum	99.8650	98.9140	100.0010	-0.1360	-1.0870	-0.1%	-1.1%
SB4VS-32	Al_2O_3	8.8900	8.9340	8.4000	0.4900	0.5340	5.8%	6.4%
SB4VS-32	B_2O_3	8.1460	7.9490	8.4000	-0.2540	-0.4510	-3.0%	-5.4%
SB4VS-32	BaO	0.0600	0.0660	0.0670	-0.0070	-0.0010	-10.4%	-1.5%
SB4VS-32	CaO	1.2090	1.1990	1.2000	0.0090	-0.0010	0.8%	-0.1%
SB4VS-32	Ce_2O_3	0.0620	0.0620	0.0810	-0.0190	-0.0190	-23.5%	-23.5%
SB4VS-32	Cr_2O_3	0.0900	0.0990	0.1120	-0.0220	-0.0130	-19.6%	-11.6%
SB4VS-32	CuO	0.0300	0.0300	0.0320	-0.0020	-0.0020	-6.3%	-6.3%
SB4VS-32	Fe_2O_3	9.5790	9.6920	10.8000	-1.2210	-1.1080	-11.3%	-10.3%
SB4VS-32	K_2O	0.1900	0.1680	0.1770	0.0130	-0.0090	7.3%	-5.1%
SB4VS-32	La_2O_3	0.0490	0.0490	0.0570	-0.0080	-0.0080	-14.0%	-14.0%
SB4VS-32	Li_2O	4.7530	4.7690	4.8000	-0.0470	-0.0310	-1.0%	-0.6%
SB4VS-32	MgO	0.7480	0.8090	0.8000	-0.0520	0.0090	-6.5%	1.1%
SB4VS-32	MnO	2.0270	2.0270	2.0000	0.0270	0.0270	1.4%	1.4%
SB4VS-32	Na_2O	13.1630	12.4680	12.8000	0.3630	-0.3320	2.8%	-2.6%
SB4VS-32	NiO	0.6290	0.7110	0.8000	-0.1710	-0.0890	-21.4%	-11.1%
SB4VS-32	PbO	0.0410	0.0410	0.0490	-0.0080	-0.0080	-16.3%	-16.3%
SB4VS-32	SiO_2	45.4600	44.9660	45.6000	-0.1400	-0.6340	-0.3%	-1.4%
SB4VS-32	SO_4^{2-}	0.6590	0.6590	0.8000	-0.1410	-0.1410	-17.6%	-17.6%
SB4VS-32	ThO_2	0.1330	0.1330	0.0340	0.0990	0.0990	291.2%	291.2%
SB4VS-32	TiO_2	0.0180	0.0190	0.0140	0.0040	0.0050	28.6%	35.7%
SB4VS-32	U_3O_8	2.5290	2.7530	2.8000	-0.2710	-0.0470	-9.7%	-1.7%
SB4VS-32	ZnO	0.0510	0.0510	0.0530	-0.0020	-0.0020	-3.8%	-3.8%
SB4VS-32	ZrO_2	0.1150	0.1150	0.1250	-0.0100	-0.0100	-8.0%	-8.0%

Table E4. Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by SB4 Variability Study Glass (continued)
(100 -Batch 1; 200 -U std; 300 - LRM)

Glass ID	Oxide	Measured (wt%)	Measured Bias-Corrected (wt%)	Targeted (wt%)	Diff of Measured (wt%)	Diff. of Meas BC (wt%)	% Diff of Measured	% Diff of Meas BC
SB4VS-32	Sum	98.6320	97.7710	100.0010	-1.3690	-2.2300	-1.4%	-2.2%
SB4VS-33	Al_2O_3	10.3780	10.4640	9.8800	0.4980	0.5840	5.0%	5.9%
SB4VS-33	B_2O_3	8.9190	8.8120	8.6800	0.2390	0.1320	2.8%	1.5%
SB4VS-33	BaO	0.0260	0.0290	0.0320	-0.0060	-0.0030	-18.8%	-9.4%
SB4VS-33	CaO	1.1910	1.1810	1.1400	0.0510	0.0410	4.5%	3.6%
SB4VS-33	Ce_2O_3	0.0260	0.0260	0.0380	-0.0120	-0.0120	-31.6%	-31.6%
SB4VS-33	Cr_2O_3	0.0490	0.0530	0.0530	-0.0040	0.0000	-7.5%	0.0%
SB4VS-33	CuO	0.0170	0.0170	0.0150	0.0020	0.0020	13.3%	13.3%
SB4VS-33	Fe_2O_3	8.7600	8.8530	9.1200	-0.3600	-0.2670	-3.9%	-2.9%
SB4VS-33	K_2O	0.0600	0.0530	0.0840	-0.0240	-0.0310	-28.6%	-36.9%
SB4VS-33	La_2O_3	0.0230	0.0230	0.0270	-0.0040	-0.0040	-14.8%	-14.8%
SB4VS-33	Li_2O	4.9570	5.0320	4.9600	-0.0030	0.0720	-0.1%	1.5%
SB4VS-33	MgO	0.9750	1.0550	1.1400	-0.1650	-0.0850	-14.5%	-7.5%
SB4VS-33	MnO	2.2430	2.2440	2.2800	-0.0370	-0.0360	-1.6%	-1.6%
SB4VS-33	Na_2O	10.9730	10.3930	10.4600	0.5130	-0.0670	4.9%	-0.6%
SB4VS-33	NiO	0.6670	0.7610	0.7600	-0.0930	0.0010	-12.2%	0.1%
SB4VS-33	PbO	0.0170	0.0170	0.0230	-0.0060	-0.0060	-26.1%	-26.1%
SB4VS-33	SiO_2	49.0430	49.0280	47.7800	1.2630	1.2480	2.6%	2.6%
SB4VS-33	SO_4^{2-}	0.5500	0.5500	0.7600	-0.2100	-0.2100	-27.6%	-27.6%
SB4VS-33	ThO_2	0.0570	0.0570	0.0160	0.0410	0.0410	256.3%	256.3%
SB4VS-33	TiO_2	0.0150	0.0160	0.0070	0.0080	0.0090	114.3%	128.6%
SB4VS-33	U_3O_8	2.6500	2.8920	2.6600	-0.0100	0.2320	-0.4%	8.7%
SB4VS-33	ZnO	0.0290	0.0290	0.0250	0.0040	0.0040	16.0%	16.0%
SB4VS-33	ZrO_2	0.0550	0.0550	0.0600	-0.0050	-0.0050	-8.3%	-8.3%
SB4VS-33	Sum	101.6830	101.6430	100.0000	1.6830	1.6430	1.7%	1.6%
SB4VS-34	Al_2O_3	10.0660	10.1360	9.3600	0.7060	0.7760	7.5%	8.3%
SB4VS-34	B_2O_3	8.8870	8.7550	8.9600	-0.0730	-0.2050	-0.8%	-2.3%
SB4VS-34	BaO	0.0240	0.0270	0.0300	-0.0060	-0.0030	-20.0%	-10.0%
SB4VS-34	CaO	0.7400	0.7370	0.7200	0.0200	0.0170	2.8%	2.4%
SB4VS-34	Ce_2O_3	0.0250	0.0250	0.0360	-0.0110	-0.0110	-30.6%	-30.6%
SB4VS-34	Cr_2O_3	0.0540	0.0620	0.0500	0.0040	0.0120	8.0%	24.0%
SB4VS-34	CuO	0.0180	0.0180	0.0150	0.0030	0.0030	20.0%	20.0%
SB4VS-34	Fe_2O_3	9.2610	9.3780	10.0800	-0.8190	-0.7020	-8.1%	-7.0%
SB4VS-34	K_2O	0.0600	0.0540	0.0800	-0.0200	-0.0260	-25.0%	-32.5%
SB4VS-34	La_2O_3	0.0210	0.0210	0.0260	-0.0050	-0.0050	-19.2%	-19.2%
SB4VS-34	Li_2O	5.0970	5.1570	5.1200	-0.0230	0.0370	-0.4%	0.7%
SB4VS-34	MgO	1.0070	1.1130	1.0800	-0.0730	0.0330	-6.8%	3.1%
SB4VS-34	MnO	1.8560	1.8940	1.8000	0.0560	0.0940	3.1%	5.2%
SB4VS-34	Na_2O	10.2990	9.8000	10.1200	0.1790	-0.3200	1.8%	-3.2%
SB4VS-34	NiO	0.2400	0.2760	0.3600	-0.1200	-0.0840	-33.3%	-23.3%
SB4VS-34	PbO	0.0250	0.0250	0.0220	0.0030	0.0030	13.6%	13.6%
SB4VS-34	SiO_2	49.7390	49.6150	48.4400	1.2990	1.1750	2.7%	2.4%
SB4VS-34	SO_4^{2-}	0.5430	0.5430	0.7200	-0.1770	-0.1770	-24.6%	-24.6%
SB4VS-34	ThO_2	0.1260	0.1260	0.0150	0.1110	0.1110	740.0%	740.0%
SB4VS-34	TiO_2	0.0080	0.0090	0.0060	0.0020	0.0030	33.3%	50.0%
SB4VS-34	U_3O_8	2.7150	2.9420	2.8800	-0.1650	0.0620	-5.7%	2.2%
SB4VS-34	ZnO	0.0210	0.0210	0.0240	-0.0030	-0.0030	-12.5%	-12.5%
SB4VS-34	ZrO_2	0.0560	0.0560	0.0560	0.0000	0.0000	0.0%	0.0%
SB4VS-34	Sum	100.8890	100.7910	100.0000	0.8890	0.7910	0.9%	0.8%
SB4VS-35	Al_2O_3	7.7800	7.8190	7.1400	0.6400	0.6790	9.0%	9.5%
SB4VS-35	B_2O_3	9.2490	9.0260	9.2400	0.0090	-0.2140	0.1%	-2.3%
SB4VS-35	BaO	0.0450	0.0520	0.0570	-0.0120	-0.0050	-21.1%	-8.8%
SB4VS-35	CaO	0.7020	0.6990	0.6800	0.0220	0.0190	3.2%	2.8%
SB4VS-35	Ce_2O_3	0.0490	0.0490	0.0690	-0.0200	-0.0200	-29.0%	-29.0%
SB4VS-35	Cr_2O_3	0.0930	0.1060	0.0950	-0.0020	0.0110	-2.1%	11.6%
SB4VS-35	CuO	0.0300	0.0300	0.0270	0.0030	0.0030	11.1%	11.1%
SB4VS-35	Fe_2O_3	7.8850	7.9780	8.5000	-0.6150	-0.5220	-7.2%	-6.1%
SB4VS-35	K_2O	0.1520	0.1350	0.1510	0.0010	-0.0160	0.7%	-10.6%
SB4VS-35	La_2O_3	0.0400	0.0400	0.0480	-0.0080	-0.0080	-16.7%	-16.7%
SB4VS-35	Li_2O	5.2800	5.2990	5.2800	0.0000	0.0190	0.0%	0.4%
SB4VS-35	MgO	0.6360	0.7020	0.6800	-0.0440	0.0220	-6.5%	3.2%
SB4VS-35	MnO	2.1530	2.1990	2.0400	0.1130	0.1590	5.5%	7.8%
SB4VS-35	Na_2O	11.9030	11.3290	11.4800	0.4230	-0.1510	3.7%	-1.3%
SB4VS-35	NiO	0.2410	0.2720	0.3400	-0.0990	-0.0680	-29.1%	-20.0%

Table E4. Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by SB4 Variability Study Glass (continued)
(100 -Batch 1; 200 -U std; 300 - LRM)

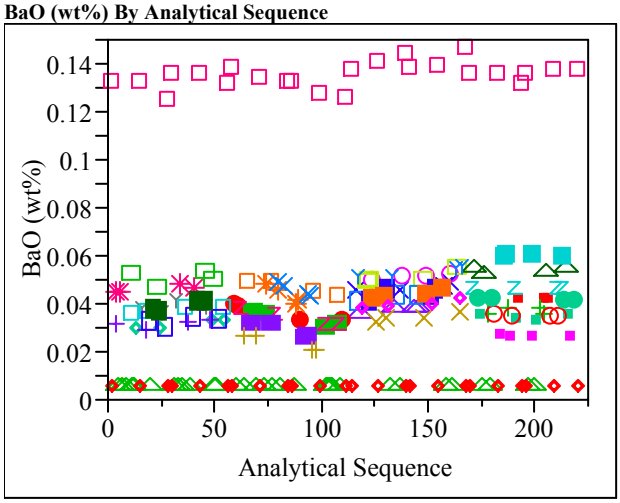
Glass ID	Oxide	Measured (wt%)	Measured Bias-Corrected (wt%)	Targeted (wt%)	Diff of Measured (wt%)	Diff. of Meas BC (wt%)	% Diff of Measured	% Diff of Meas BC
SB4VS-35	PbO	0.0370	0.0370	0.0420	-0.0050	-0.0050	-11.9%	-11.9%
SB4VS-35	SiO_2	50.9150	50.3610	50.5400	0.3750	-0.1790	0.7%	-0.4%
SB4VS-35	SO_4^{2-}	0.5060	0.5060	0.6800	-0.1740	-0.1740	-25.6%	-25.6%
SB4VS-35	ThO_2	0.1310	0.1310	0.0290	0.1020	0.1020	351.7%	351.7%
SB4VS-35	TiO_2	0.0190	0.0210	0.0120	0.0070	0.0090	58.3%	75.0%
SB4VS-35	U_3O_8	2.5350	2.7590	2.7200	-0.1850	0.0390	-6.8%	1.4%
SB4VS-35	ZnO	0.0390	0.0390	0.0450	-0.0060	-0.0060	-13.3%	-13.3%
SB4VS-35	ZrO_2	0.0980	0.0980	0.1060	-0.0080	-0.0080	-7.5%	-7.5%
SB4VS-35	Sum	100.5200	99.6870	100.0010	0.5190	-0.3140	0.5%	-0.3%
Batch 1	Al_2O_3	4.8560	4.8770	4.8770	-0.0210	0.0000	-0.4%	0.0%
Batch 1	B_2O_3	7.9770	7.7770	7.7770	0.2000	0.0000	2.6%	0.0%
Batch 1	BaO	0.1350	0.1510	0.1510	-0.0160	0.0000	-10.6%	0.0%
Batch 1	CaO	1.2200	1.2200	1.2200	0.0000	0.0000	0.0%	0.0%
Batch 1	Ce_2O_3	0.0060	0.0060	0.0000	0.0060	0.0060		
Batch 1	Cr_2O_3	0.0960	0.1070	0.1070	-0.0110	0.0000	-10.3%	0.0%
Batch 1	CuO	0.3980	0.3990	0.3990	-0.0010	0.0000	-0.3%	0.0%
Batch 1	Fe_2O_3	12.6730	12.8390	12.8390	-0.1660	0.0000	-1.3%	0.0%
Batch 1	K_2O	3.7560	3.3270	3.3270	0.4290	0.0000	12.9%	0.0%
Batch 1	La_2O_3	0.0060	0.0060	0.0000	0.0060	0.0060		
Batch 1	Li_2O	4.3930	4.4290	4.4290	-0.0360	0.0000	-0.8%	0.0%
Batch 1	MgO	1.3050	1.4190	1.4190	-0.1140	0.0000	-8.0%	0.0%
Batch 1	MnO	1.7270	1.7260	1.7260	0.0010	0.0000	0.1%	0.0%
Batch 1	Na_2O	9.5660	9.0030	9.0030	0.5630	0.0000	6.3%	0.0%
Batch 1	NiO	0.6630	0.7510	0.7510	-0.0880	0.0000	-11.7%	0.0%
Batch 1	PbO	0.0050	0.0050	0.0000	0.0050	0.0050		
Batch 1	SiO_2	50.0860	50.2200	50.2200	-0.1340	0.0000	-0.3%	0.0%
Batch 1	SO_4^{2-}	0.1500	0.1500	0.0000	0.1500	0.1500		
Batch 1	ThO_2	0.0570	0.0570	0.0000	0.0570	0.0570		
Batch 1	TiO_2	0.6310	0.6770	0.6770	-0.0460	0.0000	-6.8%	0.0%
Batch 1	U_3O_8	0.0590	0.0640	0.0000	0.0590	0.0640		
Batch 1	ZnO	0.0060	0.0060	0.0000	0.0060	0.0060		
Batch 1	ZrO_2	0.0890	0.0890	0.0980	-0.0090	-0.0090	-9.2%	-9.2%
Batch 1	Sum	99.8600	99.3050	99.0200	0.8400	0.2850	0.8%	0.3%
U std	Al_2O_3	4.0990	4.1170	4.1000	-0.0010	0.0170	0.0%	0.4%
U std	B_2O_3	9.0940	8.8660	9.2090	-0.1150	-0.3430	-1.2%	-3.7%
U std	BaO	0.0060	0.0060	0.0000	0.0060	0.0060		
U std	CaO	1.2760	1.2770	1.3010	-0.0250	-0.0240	-1.9%	-1.8%
U std	Ce_2O_3	0.0060	0.0060	0.0000	0.0060	0.0060		
U std	Cr_2O_3	0.2290	0.2550	0.0000	0.2290	0.2550		
U std	CuO	0.0070	0.0070	0.0000	0.0070	0.0070		
U std	Fe_2O_3	12.2100	12.3700	13.1960	-0.9860	-0.8260	-7.5%	-6.3%
U std	K_2O	3.3010	2.9240	2.9990	0.3020	-0.0750	10.1%	-2.5%
U std	La_2O_3	0.0060	0.0060	0.0000	0.0060	0.0060		
U std	Li_2O	3.0730	3.0990	3.0570	0.0160	0.0420	0.5%	1.4%
U std	MgO	1.0870	1.1810	1.2100	-0.1230	-0.0290	-10.2%	-2.4%
U std	MnO	2.7800	2.7790	2.8920	-0.1120	-0.1130	-3.9%	-3.9%
U std	Na_2O	12.0260	11.3200	11.7950	0.2310	-0.4750	2.0%	-4.0%
U std	NiO	0.8990	1.0180	1.1200	-0.2210	-0.1020	-19.7%	-9.1%
U std	PbO	0.0050	0.0050	0.0000	0.0050	0.0050		
U std	SiO_2	43.7670	43.8790	45.3530	-1.5860	-1.4740	-3.5%	-3.3%
U std	SO_4^{2-}	0.1500	0.1500	0.0000	0.1500	0.1500		
U std	ThO_2	0.0570	0.0570	0.0000	0.0570	0.0570		
U std	TiO_2	0.8960	0.9610	1.0490	-0.1530	-0.0880	-14.6%	-8.4%
U std	U_3O_8	2.2120	2.4060	2.4060	-0.1940	0.0000	-8.1%	0.0%
U std	ZnO	0.0060	0.0060	0.0000	0.0060	0.0060		
U std	ZrO_2	0.0060	0.0060	0.0000	0.0060	0.0060		
U std	Sum	97.1960	96.7000	99.6870	-2.4910	-2.9870	-2.5%	-3.0%
LRM	Al_2O_3	10.0910	10.1030	10.0000	0.0910	0.1030	0.9%	1.0%
LRM	B_2O_3	7.9220	7.6410	8.0000	-0.0780	-0.3590	-1.0%	-4.5%
LRM	BaO	0.0060	0.0060	0.0050	0.0010	0.0010	20.0%	20.0%
LRM	CaO	0.5380	0.5390	0.5000	0.0380	0.0390	7.6%	7.8%
LRM	Ce_2O_3	0.0060	0.0060	0.0000	0.0060	0.0060		
LRM	Cr_2O_3	0.1790	0.2020	0.2000	-0.0210	0.0020	-10.5%	1.0%
LRM	CuO	0.0020	0.0020	0.0000	0.0020	0.0020		

Table E4. Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by SB4 Variability Study Glass (continued)
(100 -Batch 1; 200 -U std; 300 - LRM)

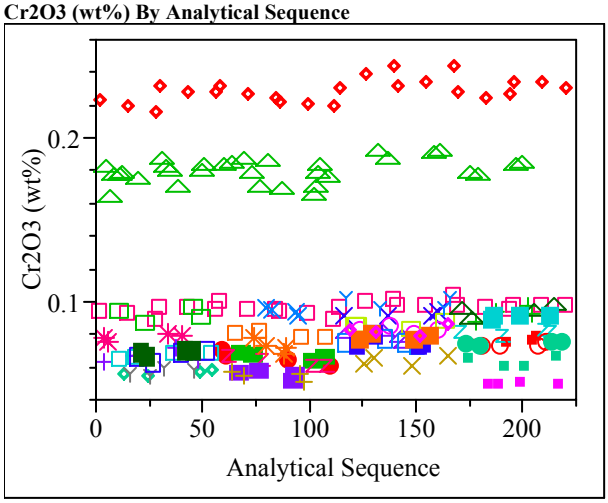
Glass ID	Oxide	Measured (wt%)	Measured Bias-Corrected (wt%)	Targeted (wt%)	Diff of Measured (wt%)	Diff. of Meas BC (wt%)	% Diff of Measured	% Diff of Meas BC
LRM	Fe_2O_3	1.3230	1.3430	1.0000	0.3230	0.3430	32.3%	34.3%
LRM	K_2O	1.5770	1.3960	1.5000	0.0770	-0.1040	5.1%	-6.9%
LRM	La_2O_3	0.0060	0.0060	0.0000	0.0060	0.0060		
LRM	Li_2O	0.2790	0.2810	0.1000	0.1790	0.1810	179.0%	181.0%
LRM	MgO	0.0910	0.1000	0.1000	-0.0090	0.0000	-9.0%	0.0%
LRM	MnO	0.0660	0.0670	0.1000	-0.0340	-0.0330	-34.0%	-33.0%
LRM	Na_2O	20.8310	19.6250	20.0000	0.8310	-0.3750	4.2%	-1.9%
LRM	NiO	0.1140	0.1280	0.1000	0.0140	0.0280	14.0%	28.0%
LRM	PbO	0.0760	0.0760	0.1000	-0.0240	-0.0240	-24.0%	-24.0%
LRM	SiO_2	53.0080	53.8110	54.3700	-1.3620	-0.5590	-2.5%	-1.0%
LRM	SO_4^{2-}	0.2300	0.2300	0.2400	-0.0100	-0.0100	-4.2%	-4.2%
LRM	ThO_2	0.0570	0.0570	0.0000	0.0570	0.0570		
LRM	TiO_2	0.0930	0.1000	0.1000	-0.0070	0.0000	-7.0%	0.0%
LRM	U_3O_8	0.0590	0.0640	0.0000	0.0590	0.0640		
LRM	ZnO	0.0080	0.0080	0.0000	0.0080	0.0080		
LRM	ZrO_2	0.8750	0.8750	1.0000	-0.1250	-0.1250	-12.5%	-12.5%
LRM	Sum	97.437	96.667	97.415	0.0220	-0.748	0.0%	-0.8%

Exhibit E1. Oxide Measurements in Analytical Sequence for Samples Prepared Using the LM Method

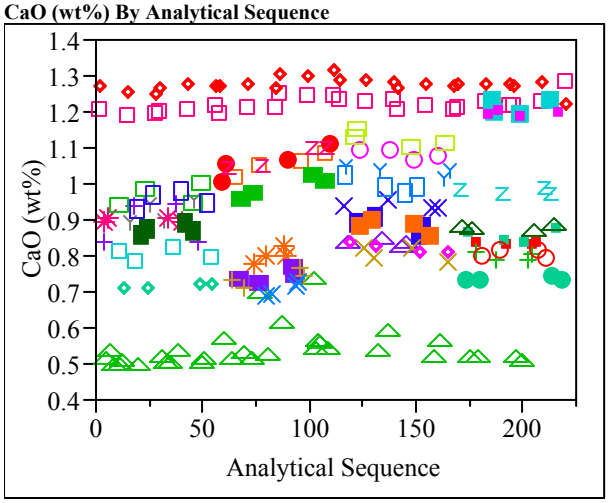
BaO (wt%) By Analytical Sequence



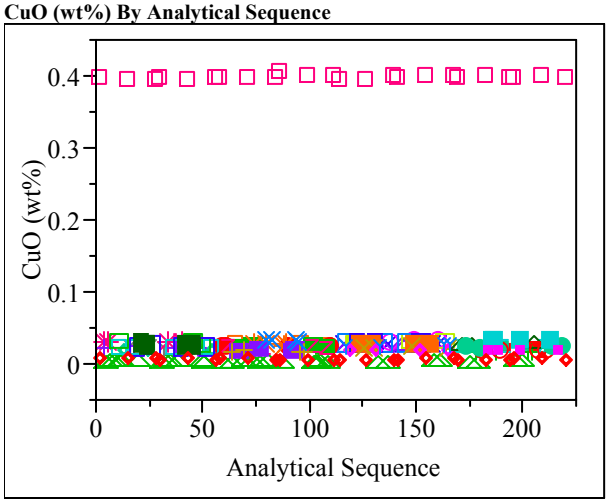
Cr2O3 (wt%) By Analytical Sequence



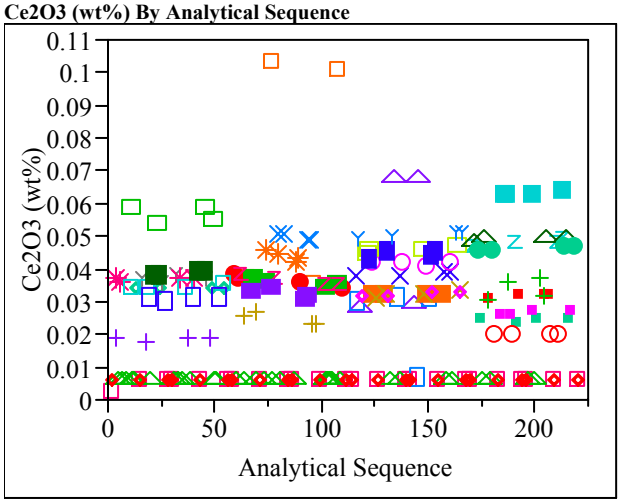
CaO (wt%) By Analytical Sequence



CuO (wt%) By Analytical Sequence



Ce2O3 (wt%) By Analytical Sequence



K2O (wt%) By Analytical Sequence

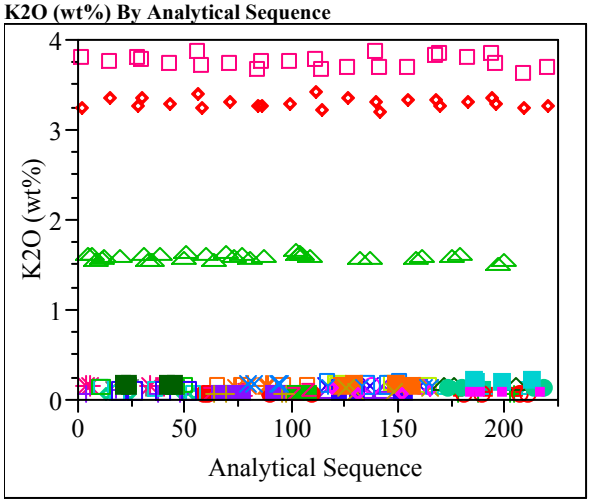
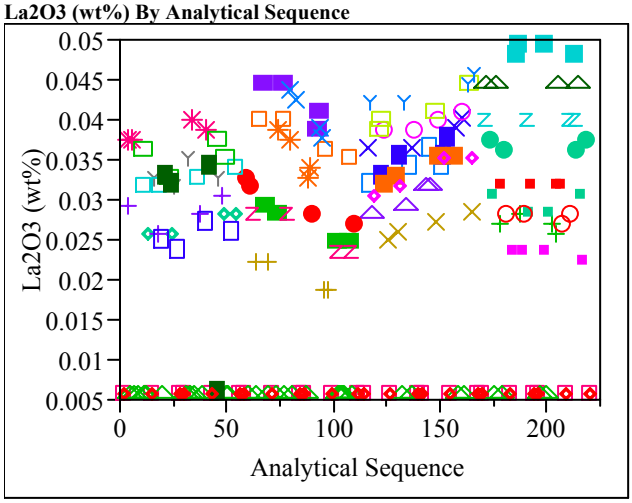
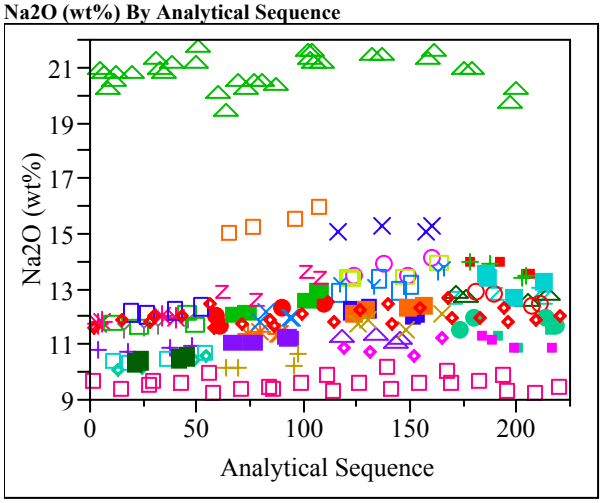


Exhibit E1. Oxide Measurements in Analytical Sequence for Samples Prepared Using the LM Method (continued)

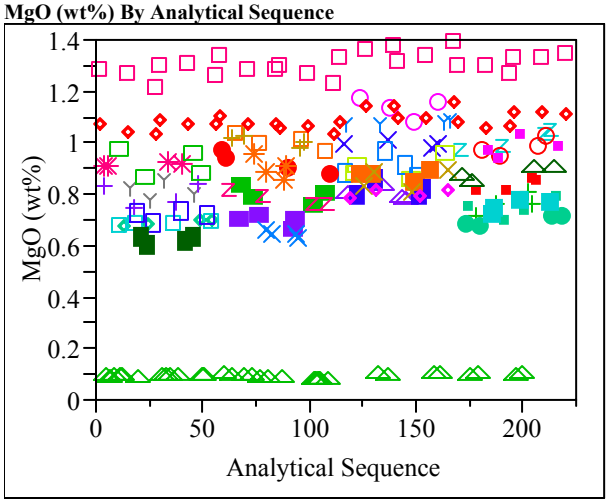
La2O3 (wt%) By Analytical Sequence



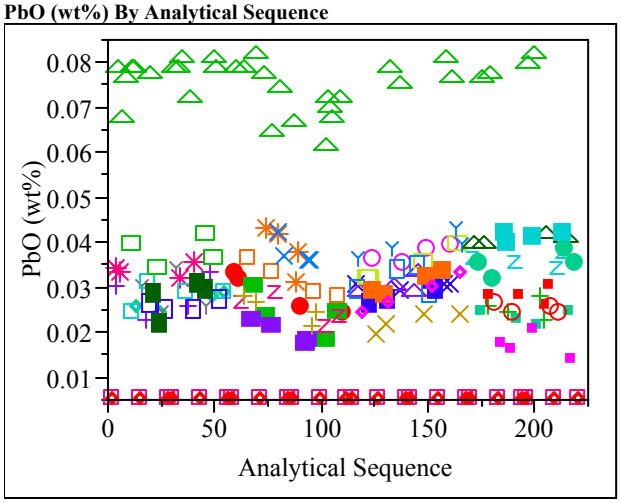
Na2O (wt%) By Analytical Sequence



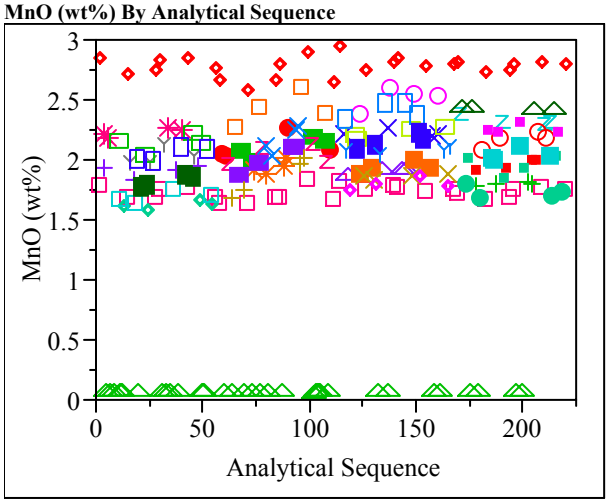
MgO (wt%) By Analytical Sequence



PbO (wt%) By Analytical Sequence



MnO (wt%) By Analytical Sequence



SO4 (wt%) By Analytical Sequence

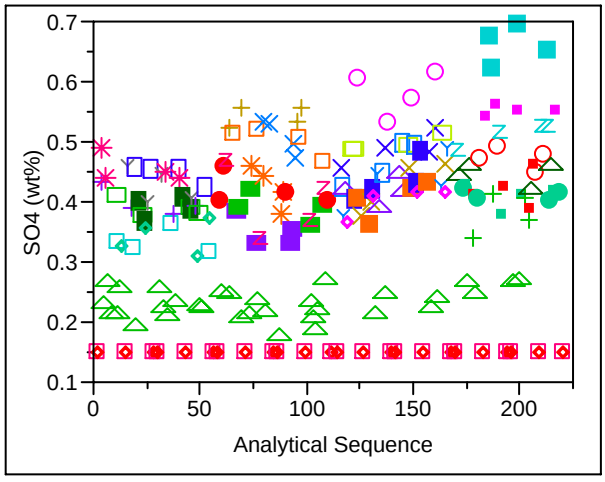
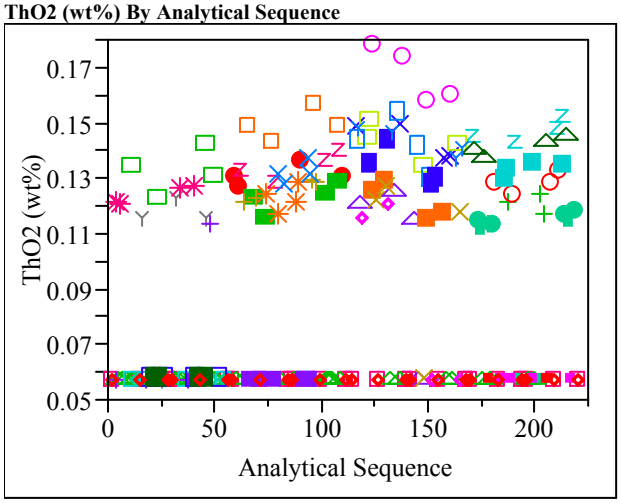
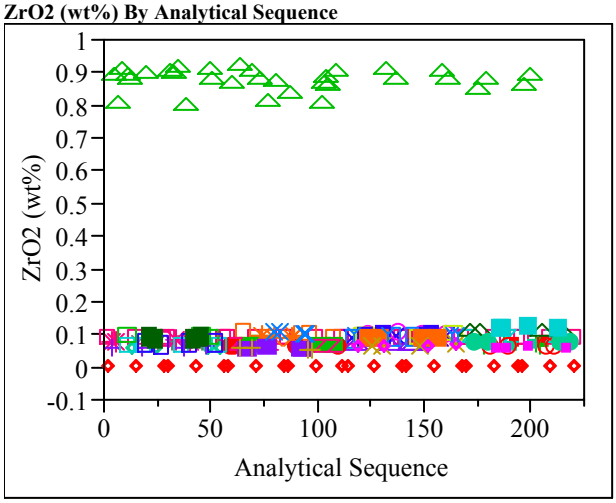


Exhibit E1. Oxide Measurements in Analytical Sequence for Samples Prepared Using the LM Method (continued)

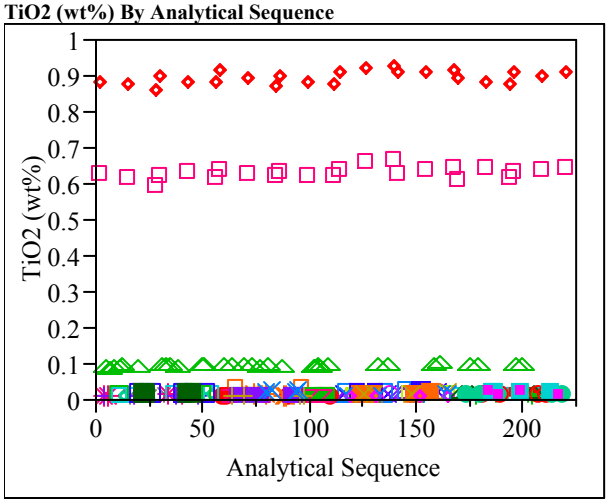
ThO2 (wt%) By Analytical Sequence



ZrO2 (wt%) By Analytical Sequence



TiO2 (wt%) By Analytical Sequence



ZnO (wt%) By Analytical Sequence

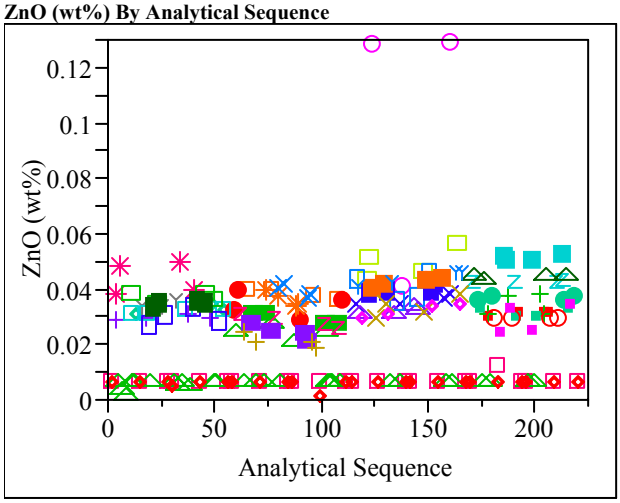
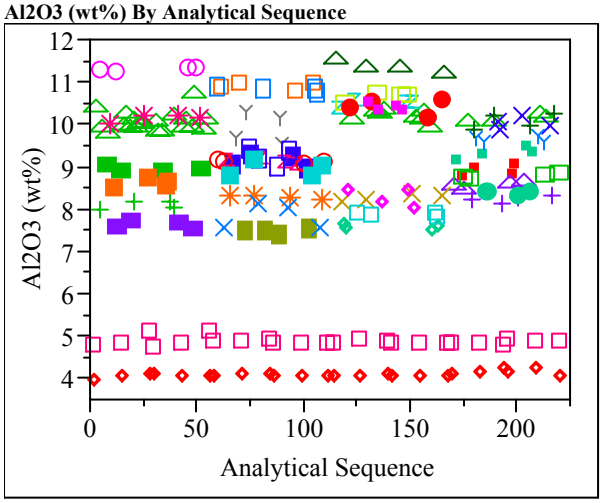
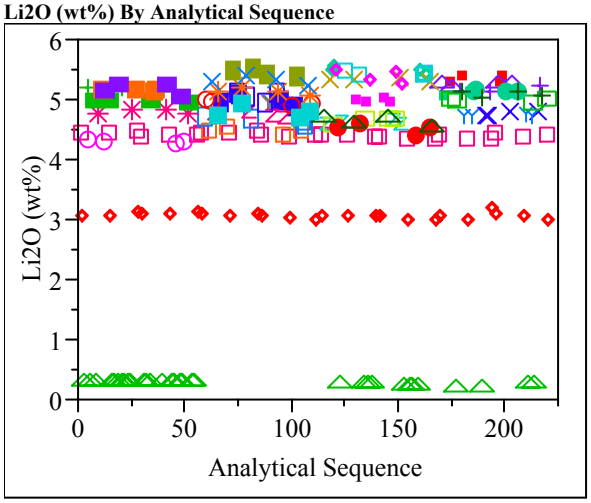


Exhibit E2. Oxide Measurements in Analytical Sequence for Samples Prepared Using the PF Method

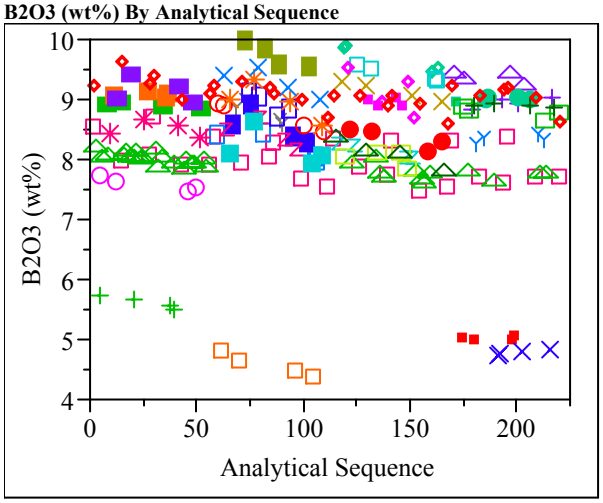
Al2O3 (wt%) By Analytical Sequence



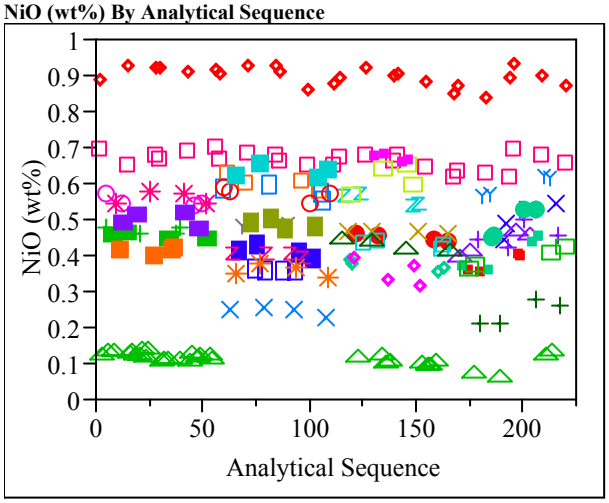
Li2O (wt%) By Analytical Sequence



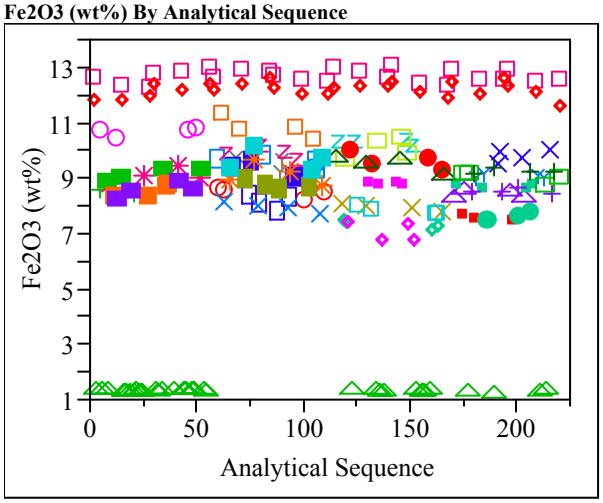
B2O3 (wt%) By Analytical Sequence



NiO (wt%) By Analytical Sequence



Fe2O3 (wt%) By Analytical Sequence



SiO2 (wt%) By Analytical Sequence

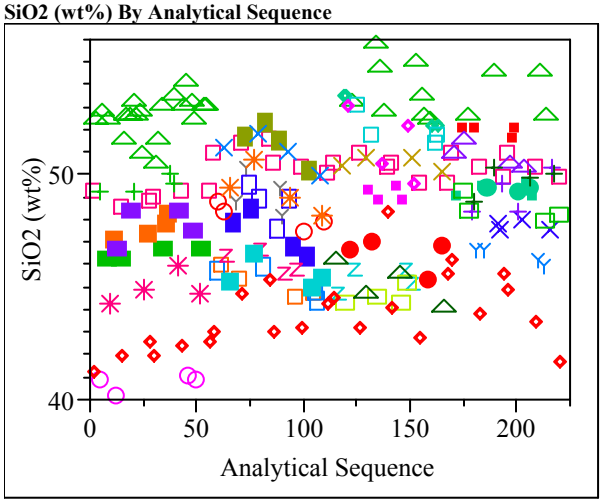


Exhibit E2. Oxide Measurements in Analytical Sequence for Samples Prepared Using the PF Method (continued)

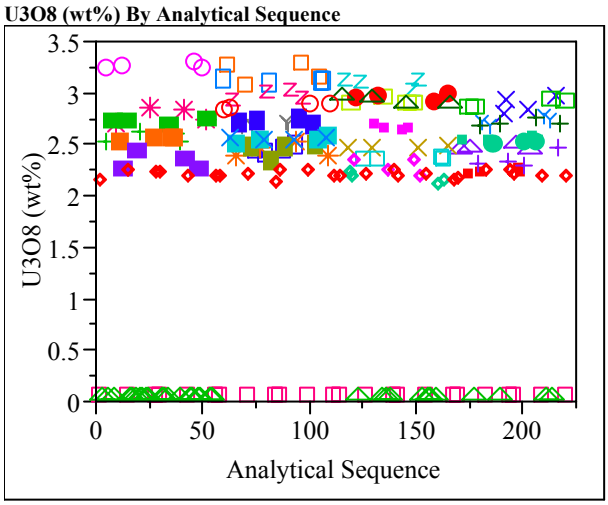
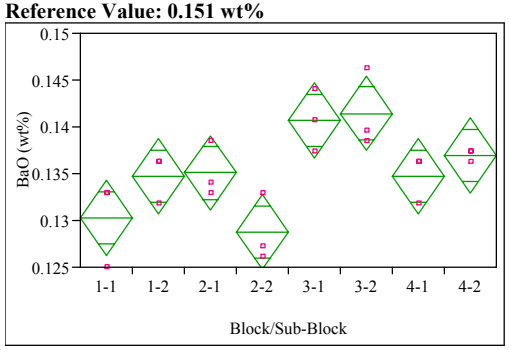


Exhibit E3. PSAL Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the LM Method

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

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



Oneway Anova
Summary of Fit

Rsquare	0.709376
Adj Rsquare	0.582228
Root Mean Square Error	0.003255
Mean of Response	0.135329
Observations (or Sum Wgts)	24

Analysis of Variance

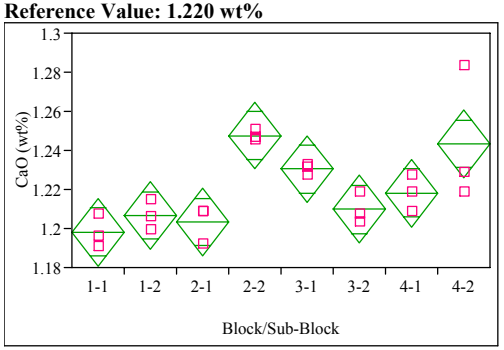
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Block	7	0.00041381	0.000059	5.5791	0.0021
Error	16	0.00016953	0.000011		
C. Total	23	0.00058334			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	0.130258	0.00188	0.12627	0.13424
1-2	3	0.134724	0.00188	0.13074	0.13871
2-1	3	0.135097	0.00188	0.13111	0.13908
2-2	3	0.128770	0.00188	0.12479	0.13275
3-1	3	0.140679	0.00188	0.13669	0.14466
3-2	3	0.141423	0.00188	0.13744	0.14541
4-1	3	0.134724	0.00188	0.13074	0.13871
4-2	3	0.136957	0.00188	0.13297	0.14094

Std Error uses a pooled estimate of error variance

Glass #=100
Oneway Analysis of CaO (wt%) By Block/Sub-Block Study
Reference Value: 1.220 wt%



Oneway Anova
Summary of Fit

Rsquare	0.698484
Adj Rsquare	0.566571
Root Mean Square Error	0.014108
Mean of Response	1.219694
Observations (or Sum Wgts)	24

Analysis of Variance

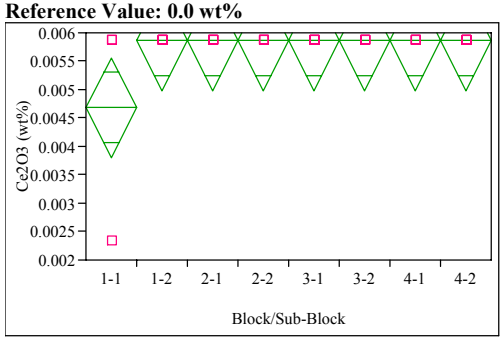
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Block	7	0.00737741	0.001054	5.2950	0.0028
Error	16	0.00318462	0.000199		
C. Total	23	0.01056204			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	1.19818	0.00815	1.1809	1.2154
1-2	3	1.20658	0.00815	1.1893	1.2238
2-1	3	1.20331	0.00815	1.1860	1.2206
2-2	3	1.24762	0.00815	1.2304	1.2649
3-1	3	1.23036	0.00815	1.2131	1.2476
3-2	3	1.20984	0.00815	1.1926	1.2271
4-1	3	1.21824	0.00815	1.2010	1.2355
4-2	3	1.24342	0.00815	1.2262	1.2607

Std Error uses a pooled estimate of error variance

Glass #=100
Oneway Analysis of Ce2O3 (wt%) By Block/Sub-Block Study
Reference Value: 0.0 wt%



Oneway Anova
Summary of Fit

Rsquare	0.304348
Adj Rsquare	-8.9e-16
Root Mean Square Error	0.000717
Mean of Response	0.00571
Observations (or Sum Wgts)	24

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Block	7	0.00000360	5.1448e-7	1.0000	0.4663
Error	16	0.00000823	5.1448e-7		
C. Total	23	0.00001183			

Means for Oneway Anova

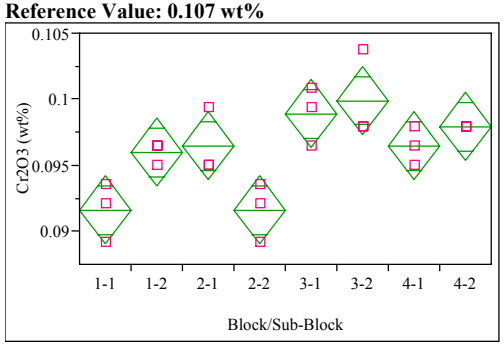
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	0.004685	0.00041	0.00381	0.00556
1-2	3	0.005857	0.00041	0.00498	0.00673
2-1	3	0.005857	0.00041	0.00498	0.00673
2-2	3	0.005857	0.00041	0.00498	0.00673
3-1	3	0.005857	0.00041	0.00498	0.00673
3-2	3	0.005857	0.00041	0.00498	0.00673
4-1	3	0.005857	0.00041	0.00498	0.00673
4-2	3	0.005857	0.00041	0.00498	0.00673

Std Error uses a pooled estimate of error variance

Exhibit E3. PSAL Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the LM Method (continued)

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

Glass #=100
Oneway Analysis of Cr2O3 (wt%) By Block/Sub-Block Study
Reference Value: 0.107 wt%



Oneway Anova
Summary of Fit

Rsquare	0.736495
Adj Rsquare	0.621212
Root Mean Square Error	0.00211
Mean of Response	0.0961
Observations (or Sum Wgts)	24

Analysis of Variance

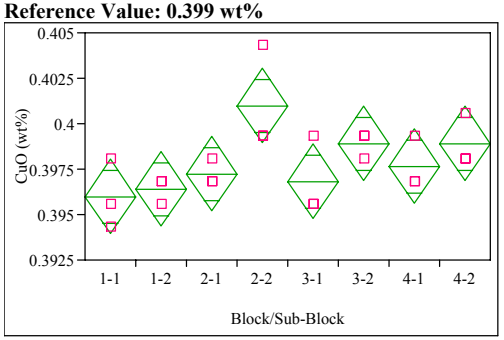
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Block	7	0.00019903	0.000028	6.3886	0.0011
Error	16	0.00007121	4.451e-6		
C. Total	23	0.00027024			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	0.091594	0.00122	0.08901	0.09418
1-2	3	0.095978	0.00122	0.09340	0.09856
2-1	3	0.096466	0.00122	0.09388	0.09905
2-2	3	0.091594	0.00122	0.08901	0.09418
3-1	3	0.098902	0.00122	0.09632	0.10148
3-2	3	0.099876	0.00122	0.09729	0.10246
4-1	3	0.096466	0.00122	0.09388	0.09905
4-2	3	0.097927	0.00122	0.09535	0.10051

Std Error uses a pooled estimate of error variance

Glass #=100
Oneway Analysis of CuO (wt%) By Block/Sub-Block Study
Reference Value: 0.399 wt%



Oneway Anova
Summary of Fit

Rsquare	0.561224
Adj Rsquare	0.36926
Root Mean Square Error	0.001676
Mean of Response	0.397864
Observations (or Sum Wgts)	24

Analysis of Variance

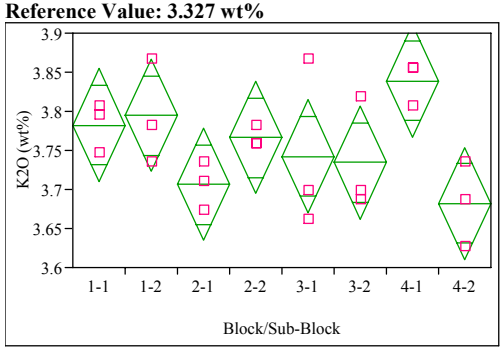
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Block	7	0.00005746	8.2081e-6	2.9236	0.0358
Error	16	0.00004492	2.8075e-6		
C. Total	23	0.00010238			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	0.395986	0.00097	0.39394	0.39804
1-2	3	0.396403	0.00097	0.39435	0.39845
2-1	3	0.397238	0.00097	0.39519	0.39929
2-2	3	0.400993	0.00097	0.39894	0.40304
3-1	3	0.396821	0.00097	0.39477	0.39887
3-2	3	0.398907	0.00097	0.39686	0.40096
4-1	3	0.397655	0.00097	0.39560	0.39971
4-2	3	0.398907	0.00097	0.39686	0.40096

Std Error uses a pooled estimate of error variance

Glass #=100
Oneway Analysis of K2O (wt%) By Block/Sub-Block Study
Reference Value: 3.327 wt%



Oneway Anova
Summary of Fit

Rsquare	0.490168
Adj Rsquare	0.267116
Root Mean Square Error	0.058808
Mean of Response	3.755842
Observations (or Sum Wgts)	24

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Block	7	0.05319953	0.007600	2.1976	0.0911
Error	16	0.05533380	0.003458		
C. Total	23	0.10853333			

Means for Oneway Anova

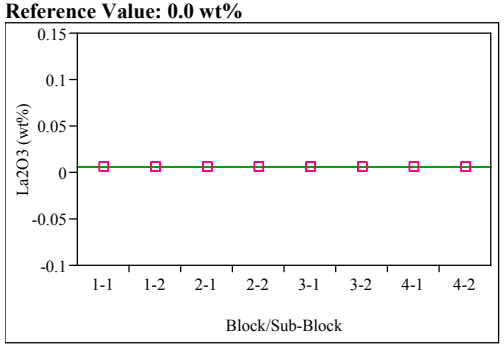
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	3.78244	0.03395	3.7105	3.8544
1-2	3	3.79449	0.03395	3.7225	3.8665
2-1	3	3.70615	0.03395	3.6342	3.7781
2-2	3	3.76638	0.03395	3.6944	3.8384
3-1	3	3.74229	0.03395	3.6703	3.8143
3-2	3	3.73426	0.03395	3.6623	3.8062
4-1	3	3.83866	0.03395	3.7667	3.9106
4-2	3	3.68206	0.03395	3.6101	3.7540

Std Error uses a pooled estimate of error variance

Exhibit E3. PSAL Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the LM Method (continued)

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

Glass #=100
Oneway Analysis of La2O3 (wt%) By Block/Sub-Block Study
Reference Value: 0.0 wt%



Oneway Anova
Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	0.005864
Observations (or Sum Wgts)	24

Analysis of Variance

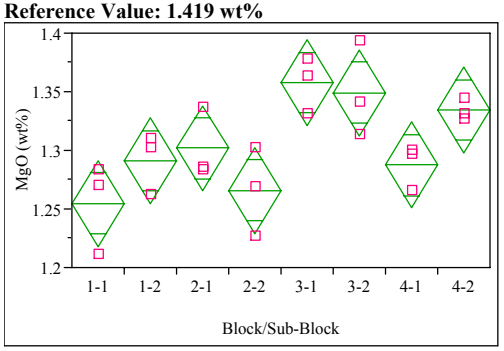
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Block	7	0	0	.	.
Error	16	0	0		
C. Total	23	0			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	0.005864	0	0.00586	0.00586
1-2	3	0.005864	0	0.00586	0.00586
2-1	3	0.005864	0	0.00586	0.00586
2-2	3	0.005864	0	0.00586	0.00586
3-1	3	0.005864	0	0.00586	0.00586
3-2	3	0.005864	0	0.00586	0.00586
4-1	3	0.005864	0	0.00586	0.00586
4-2	3	0.005864	0	0.00586	0.00586

Std Error uses a pooled estimate of error variance

Glass #=100
Oneway Analysis of MgO (wt%) By Block/Sub-Block Study
Reference Value: 1.419 wt%



Oneway Anova
Summary of Fit

Rsquare	0.68123
Adj Rsquare	0.541769
Root Mean Square Error	0.029851
Mean of Response	1.305289
Observations (or Sum Wgts)	24

Analysis of Variance

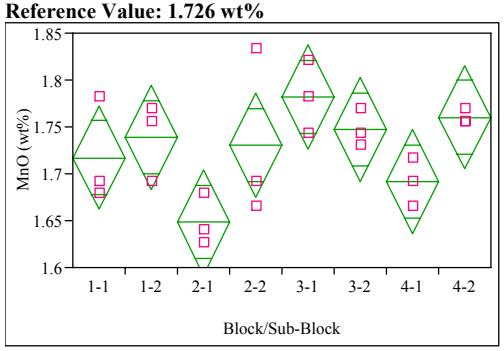
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Block	7	0.03046943	0.004353	4.8847	0.0041
Error	16	0.01425762	0.000891		
C. Total	23	0.04472705			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	1.25478	0.01723	1.2182	1.2913
1-2	3	1.29126	0.01723	1.2547	1.3278
2-1	3	1.30177	0.01723	1.2652	1.3383
2-2	3	1.26584	0.01723	1.2293	1.3024
3-1	3	1.35759	0.01723	1.3211	1.3941
3-2	3	1.34930	0.01723	1.3128	1.3858
4-1	3	1.28739	0.01723	1.2509	1.3239
4-2	3	1.33438	0.01723	1.2978	1.3709

Std Error uses a pooled estimate of error variance

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



Oneway Anova
Summary of Fit

Rsquare	0.527811
Adj Rsquare	0.321228
Root Mean Square Error	0.045269
Mean of Response	1.72698
Observations (or Sum Wgts)	24

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Block	7	0.03665056	0.005236	2.5550	0.0570
Error	16	0.03278822	0.002049		
C. Total	23	0.06943877			

Means for Oneway Anova

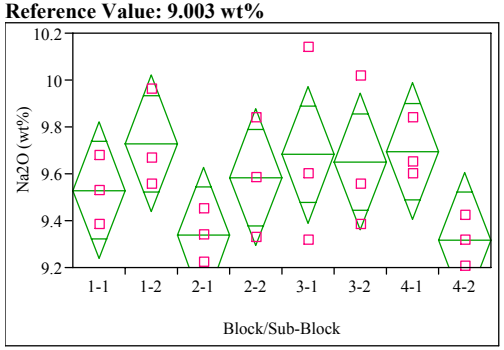
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	1.71730	0.02614	1.6619	1.7727
1-2	3	1.73882	0.02614	1.6834	1.7942
2-1	3	1.64843	0.02614	1.5930	1.7038
2-2	3	1.73021	0.02614	1.6748	1.7856
3-1	3	1.78186	0.02614	1.7265	1.8373
3-2	3	1.74742	0.02614	1.6920	1.8028
4-1	3	1.69147	0.02614	1.6361	1.7469
4-2	3	1.76034	0.02614	1.7049	1.8157

Std Error uses a pooled estimate of error variance

Exhibit E3. PSAL Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the LM Method (continued)

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

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



Oneway Anova
Summary of Fit

Rsquare	0.374919
Adj Rsquare	0.101445
Root Mean Square Error	0.238216
Mean of Response	9.565745
Observations (or Sum Wgts)	24

Analysis of Variance

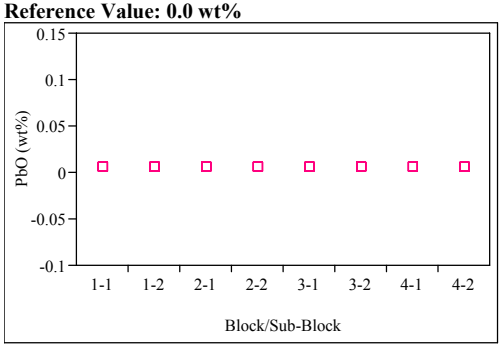
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Block	7	0.5445785	0.077797	1.3710	0.2827
Error	16	0.9079463	0.056747		
C. Total	23	1.4525248			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	9.53036	0.13753	9.2388	9.822
1-2	3	9.72807	0.13753	9.4365	10.020
2-1	3	9.33715	0.13753	9.0456	9.629
2-2	3	9.58428	0.13753	9.2927	9.876
3-1	3	9.68313	0.13753	9.3916	9.975
3-2	3	9.65168	0.13753	9.3601	9.943
4-1	3	9.69661	0.13753	9.4051	9.988
4-2	3	9.31468	0.13753	9.0231	9.606

Std Error uses a pooled estimate of error variance

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



Oneway Anova
Summary of Fit

Rsquare	4
Adj Rsquare	5.3125
Root Mean Square Error	.
Mean of Response	0.005386
Observations (or Sum Wgts)	24

Analysis of Variance

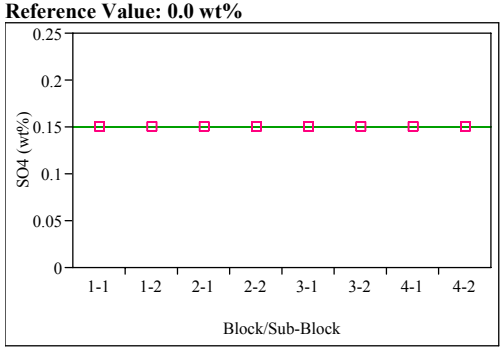
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Block	7	7.2222e-35	1.032e-35	-3.0476	0.0000
Error	16	-5.417e-35	-3.39e-36		
C. Total	23	1.8056e-35			

Means for Oneway Anova

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

Std Error uses a pooled estimate of error variance

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



Oneway Anova
Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	0.149795
Observations (or Sum Wgts)	24

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Block	7	0	0	.	.
Error	16	0	0		
C. Total	23	0			

Means for Oneway Anova

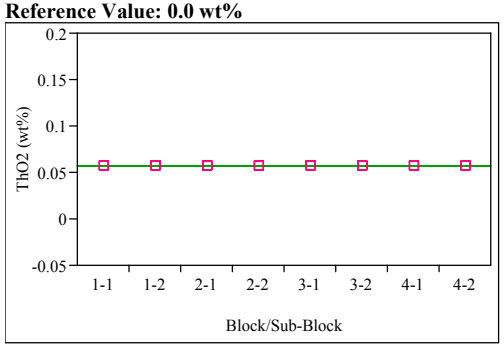
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	0.149795	0	0.14980	0.14980
1-2	3	0.149795	0	0.14980	0.14980
2-1	3	0.149795	0	0.14980	0.14980
2-2	3	0.149795	0	0.14980	0.14980
3-1	3	0.149795	0	0.14980	0.14980
3-2	3	0.149795	0	0.14980	0.14980
4-1	3	0.149795	0	0.14980	0.14980
4-2	3	0.149795	0	0.14980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

Std Error uses a pooled estimate of error variance

Exhibit E3. PSAL Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the LM Method (continued)

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

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



Oneway Anova
Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	0.056895
Observations (or Sum Wgts)	24

Analysis of Variance

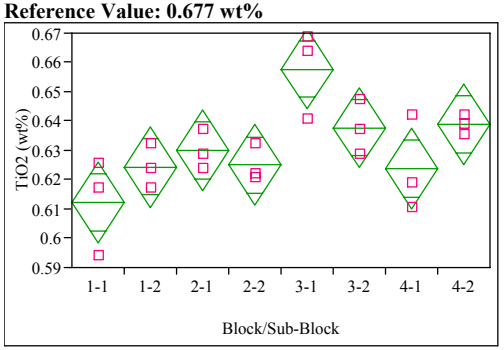
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Block	7	0	0	.	.
Error	16	0	0		
C. Total	23	0			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	0.056895	0	0.05690	0.05690
1-2	3	0.056895	0	0.05690	0.05690
2-1	3	0.056895	0	0.05690	0.05690
2-2	3	0.056895	0	0.05690	0.05690
3-1	3	0.056895	0	0.05690	0.05690
3-2	3	0.056895	0	0.05690	0.05690
4-1	3	0.056895	0	0.05690	0.05690
4-2	3	0.056895	0	0.05690	0.05690

Std Error uses a pooled estimate of error variance

Glass #=100
Oneway Analysis of TiO2 (wt%) By Block/Sub-Block Study
Reference Value: 0.677 wt%



Oneway Anova
Summary of Fit

Rsquare	0.661334
Adj Rsquare	0.513168
Root Mean Square Error	0.011215
Mean of Response	0.631199
Observations (or Sum Wgts)	24

Analysis of Variance

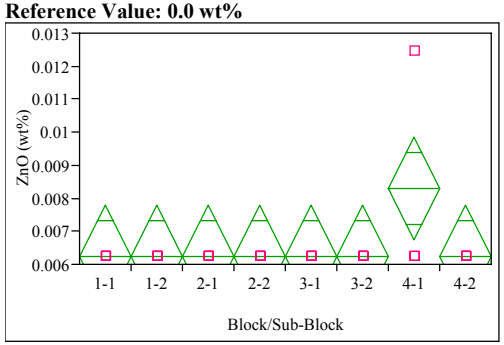
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Block	7	0.00392989	0.000561	4.4635	0.0063
Error	16	0.00201248	0.000126		
C. Total	23	0.00594237			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	0.612156	0.00648	0.59843	0.62588
1-2	3	0.624388	0.00648	0.61066	0.63811
2-1	3	0.629948	0.00648	0.61622	0.64367
2-2	3	0.624944	0.00648	0.61122	0.63867
3-1	3	0.657748	0.00648	0.64402	0.67147
3-2	3	0.637732	0.00648	0.62401	0.65146
4-1	3	0.623832	0.00648	0.61011	0.63756
4-2	3	0.638844	0.00648	0.62512	0.65257

Std Error uses a pooled estimate of error variance

Glass #=100
Oneway Analysis of ZnO (wt%) By Block/Sub-Block Study
Reference Value: 0.0 wt%



Oneway Anova
Summary of Fit

Rsquare	0.304348
Adj Rsquare	1.11e-16
Root Mean Square Error	0.00127
Mean of Response	0.006483
Observations (or Sum Wgts)	24

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Block	7	0.00001130	1.6141e-6	1.0000	0.4663
Error	16	0.00002583	1.6141e-6		
C. Total	23	0.00003712			

Means for Oneway Anova

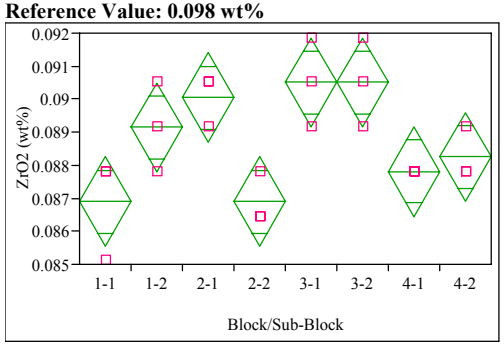
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	0.006224	0.00073	0.00467	0.00778
1-2	3	0.006224	0.00073	0.00467	0.00778
2-1	3	0.006224	0.00073	0.00467	0.00778
2-2	3	0.006224	0.00073	0.00467	0.00778
3-1	3	0.006224	0.00073	0.00467	0.00778
3-2	3	0.006224	0.00073	0.00467	0.00778
4-1	3	0.008299	0.00073	0.00674	0.00985
4-2	3	0.006224	0.00073	0.00467	0.00778

Std Error uses a pooled estimate of error variance

Exhibit E3. PSAL Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the LM Method (continued)

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

Glass #=100
Oneway Analysis of ZrO2 (wt%) By Block/Sub-Block Study
Reference Value: 0.098 wt%



Oneway Anova
Summary of Fit

Rsquare	0.711387
Adj Rsquare	0.585118
Root Mean Square Error	0.001103
Mean of Response	0.088759
Observations (or Sum Wgts)	24

Analysis of Variance

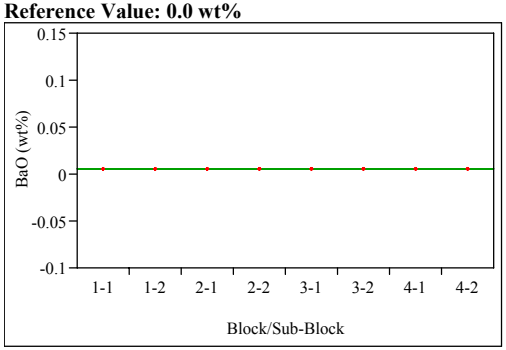
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Block	7	0.00004797	6.8533e-6	5.6339	0.0020
Error	16	0.00001946	1.2164e-6		
C. Total	23	0.00006744			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	0.086901	0.00064	0.08555	0.08825
1-2	3	0.089153	0.00064	0.08780	0.09050
2-1	3	0.090053	0.00064	0.08870	0.09140
2-2	3	0.086901	0.00064	0.08555	0.08825
3-1	3	0.090504	0.00064	0.08915	0.09185
3-2	3	0.090504	0.00064	0.08915	0.09185
4-1	3	0.087802	0.00064	0.08645	0.08915
4-2	3	0.088252	0.00064	0.08690	0.08960

Std Error uses a pooled estimate of error variance

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



Oneway Anova
Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	0.005583
Observations (or Sum Wgts)	24

Analysis of Variance

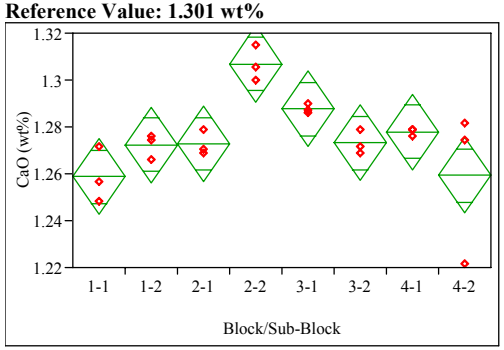
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Block	7	0	0	.	.
Error	16	0	0		
C. Total	23	0			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	0.005583	0	0.00558	0.00558
1-2	3	0.005583	0	0.00558	0.00558
2-1	3	0.005583	0	0.00558	0.00558
2-2	3	0.005583	0	0.00558	0.00558
3-1	3	0.005583	0	0.00558	0.00558
3-2	3	0.005583	0	0.00558	0.00558
4-1	3	0.005583	0	0.00558	0.00558
4-2	3	0.005583	0	0.00558	0.00558

Std Error uses a pooled estimate of error variance

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



Oneway Anova
Summary of Fit

Rsquare	0.649128
Adj Rsquare	0.495621
Root Mean Square Error	0.013123
Mean of Response	1.276129
Observations (or Sum Wgts)	24

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Block	7	0.00509727	0.000728	4.2287	0.0081
Error	16	0.00275522	0.000172		
C. Total	23	0.00785250			

Means for Oneway Anova

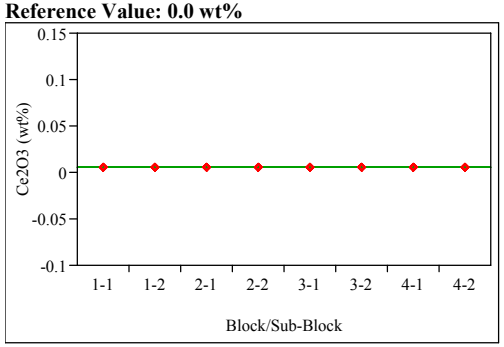
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	1.25881	0.00758	1.2428	1.2749
1-2	3	1.27234	0.00758	1.2563	1.2884
2-1	3	1.27281	0.00758	1.2567	1.2889
2-2	3	1.30685	0.00758	1.2908	1.3229
3-1	3	1.28773	0.00758	1.2717	1.3038
3-2	3	1.27327	0.00758	1.2572	1.2893
4-1	3	1.27794	0.00758	1.2619	1.2940
4-2	3	1.25928	0.00758	1.2432	1.2753

Std Error uses a pooled estimate of error variance

Exhibit E3. PSAL Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the LM Method (continued)

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

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



Oneway Anova
Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	0.005857
Observations (or Sum Wgts)	24

Analysis of Variance

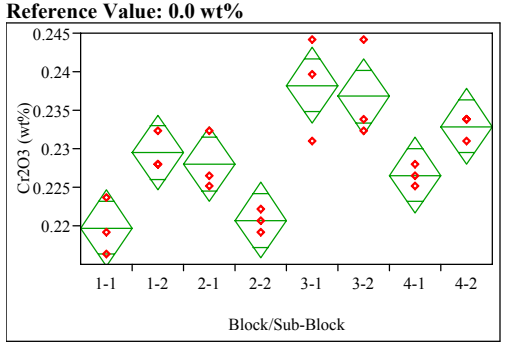
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Block	7	0	0	.	.
Error	16	0	0		
C. Total	23	0			

Means for Oneway Anova

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

Std Error uses a pooled estimate of error variance

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



Oneway Anova
Summary of Fit

Rsquare	0.791724
Adj Rsquare	0.700604
Root Mean Square Error	0.003992
Mean of Response	0.229045
Observations (or Sum Wgts)	24

Analysis of Variance

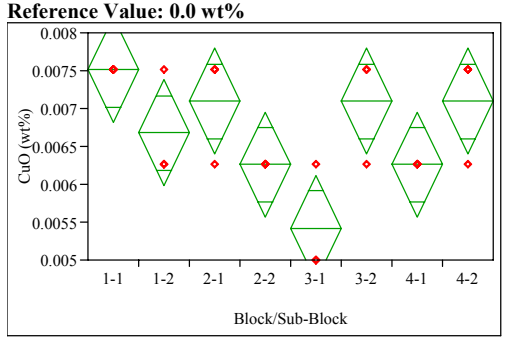
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Block	7	0.00096907	0.000138	8.6887	0.0002
Error	16	0.00025493	0.000016		
C. Total	23	0.00122400			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	0.219727	0.00230	0.21484	0.22461
1-2	3	0.229471	0.00230	0.22459	0.23436
2-1	3	0.228010	0.00230	0.22312	0.23290
2-2	3	0.220702	0.00230	0.21582	0.22559
3-1	3	0.238241	0.00230	0.23336	0.24313
3-2	3	0.236779	0.00230	0.23189	0.24166
4-1	3	0.226548	0.00230	0.22166	0.23143
4-2	3	0.232882	0.00230	0.22800	0.23777

Std Error uses a pooled estimate of error variance

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



Oneway Anova
Summary of Fit

Rsquare	0.642857
Adj Rsquare	0.486607
Root Mean Square Error	0.000571
Mean of Response	0.006676
Observations (or Sum Wgts)	24

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Block	7	0.00000940	1.3431e-6	4.1143	0.0091
Error	16	0.00000522	3.2646e-7		
C. Total	23	0.00001463			

Means for Oneway Anova

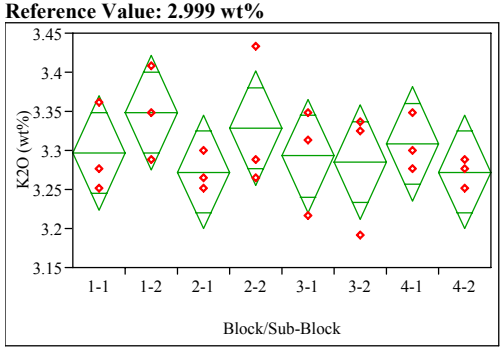
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	0.007511	0.00033	0.00681	0.00821
1-2	3	0.006676	0.00033	0.00598	0.00738
2-1	3	0.007094	0.00033	0.00639	0.00779
2-2	3	0.006259	0.00033	0.00556	0.00696
3-1	3	0.005424	0.00033	0.00473	0.00612
3-2	3	0.007094	0.00033	0.00639	0.00779
4-1	3	0.006259	0.00033	0.00556	0.00696
4-2	3	0.007094	0.00033	0.00639	0.00779

Std Error uses a pooled estimate of error variance

Exhibit E3. PSAL Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the LM Method (continued)

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

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



Oneway Anova
Summary of Fit

Rsquare	0.210667
Adj Rsquare	-0.13467
Root Mean Square Error	0.059827
Mean of Response	3.300604
Observations (or Sum Wgts)	24

Analysis of Variance

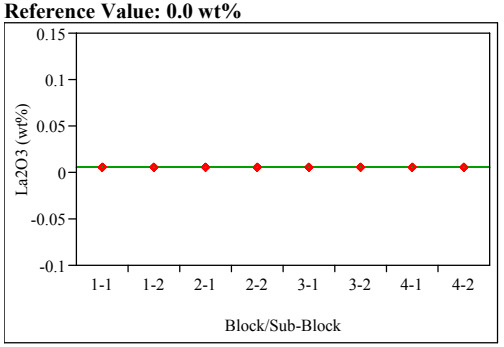
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Block	7	0.01528451	0.002184	0.6100	0.7398
Error	16	0.05726855	0.003579		
C. Total	23	0.07255306			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	3.29659	0.03454	3.2234	3.3698
1-2	3	3.34879	0.03454	3.2756	3.4220
2-1	3	3.27250	0.03454	3.1993	3.3457
2-2	3	3.32871	0.03454	3.2555	3.4019
3-1	3	3.29257	0.03454	3.2193	3.3658
3-2	3	3.28454	0.03454	3.2113	3.3578
4-1	3	3.30863	0.03454	3.2354	3.3819
4-2	3	3.27250	0.03454	3.1993	3.3457

Std Error uses a pooled estimate of error variance

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



Oneway Anova
Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	0.005864
Observations (or Sum Wgts)	24

Analysis of Variance

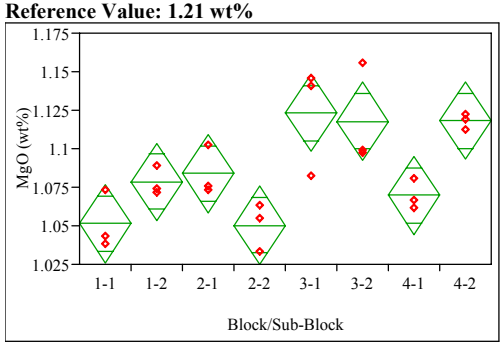
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Block	7	0	0	.	.
Error	16	0	0		
C. Total	23	0			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	0.005864	0	0.00586	0.00586
1-2	3	0.005864	0	0.00586	0.00586
2-1	3	0.005864	0	0.00586	0.00586
2-2	3	0.005864	0	0.00586	0.00586
3-1	3	0.005864	0	0.00586	0.00586
3-2	3	0.005864	0	0.00586	0.00586
4-1	3	0.005864	0	0.00586	0.00586
4-2	3	0.005864	0	0.00586	0.00586

Std Error uses a pooled estimate of error variance

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



Oneway Anova
Summary of Fit

Rsquare	0.733003
Adj Rsquare	0.616192
Root Mean Square Error	0.020635
Mean of Response	1.086601
Observations (or Sum Wgts)	24

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Block	7	0.01870293	0.002672	6.2751	0.0012
Error	16	0.00681256	0.000426		
C. Total	23	0.02551549			

Means for Oneway Anova

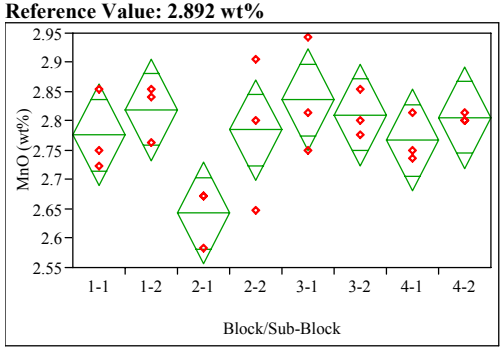
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	1.05136	0.01191	1.0261	1.0766
1-2	3	1.07845	0.01191	1.0532	1.1037
2-1	3	1.08398	0.01191	1.0587	1.1092
2-2	3	1.05026	0.01191	1.0250	1.0755
3-1	3	1.12322	0.01191	1.0980	1.1485
3-2	3	1.11769	0.01191	1.0924	1.1429
4-1	3	1.06960	0.01191	1.0443	1.0949
4-2	3	1.11825	0.01191	1.0930	1.1435

Std Error uses a pooled estimate of error variance

Exhibit E3. PSAL Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the LM Method (continued)

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

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



Oneway Anova
Summary of Fit

Rsquare	0.489286
Adj Rsquare	0.265848
Root Mean Square Error	0.070476
Mean of Response	2.780384
Observations (or Sum Wgts)	24

Analysis of Variance

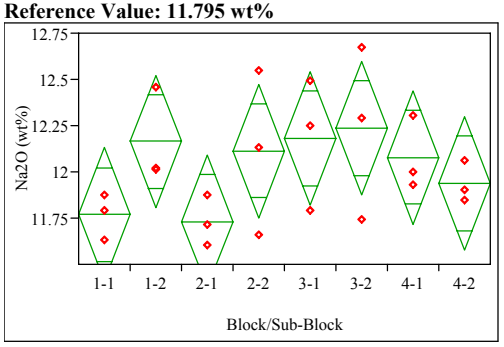
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Block	7	0.07613535	0.010876	2.1898	0.0921
Error	16	0.07946974	0.004967		
C. Total	23	0.15560509			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	2.77608	0.04069	2.6898	2.8623
1-2	3	2.81912	0.04069	2.7329	2.9054
2-1	3	2.64266	0.04069	2.5564	2.7289
2-2	3	2.78469	0.04069	2.6984	2.8709
3-1	3	2.83634	0.04069	2.7501	2.9226
3-2	3	2.81051	0.04069	2.7243	2.8968
4-1	3	2.76747	0.04069	2.6812	2.8537
4-2	3	2.80621	0.04069	2.7200	2.8925

Std Error uses a pooled estimate of error variance

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



Oneway Anova
Summary of Fit

Rsquare	0.357719
Adj Rsquare	0.076721
Root Mean Square Error	0.294639
Mean of Response	12.02641
Observations (or Sum Wgts)	24

Analysis of Variance

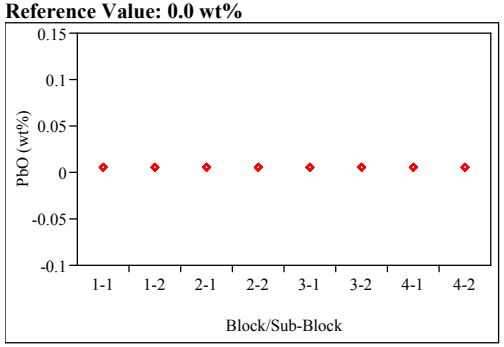
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Block	7	0.7736017	0.110515	1.2730	0.3235
Error	16	1.3889943	0.086812		
C. Total	23	2.1625960			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	11.7680	0.17011	11.407	12.129
1-2	3	12.1635	0.17011	11.803	12.524
2-1	3	11.7321	0.17011	11.371	12.093
2-2	3	12.1140	0.17011	11.753	12.475
3-1	3	12.1814	0.17011	11.821	12.542
3-2	3	12.2353	0.17011	11.875	12.596
4-1	3	12.0781	0.17011	11.717	12.439
4-2	3	11.9388	0.17011	11.578	12.299

Std Error uses a pooled estimate of error variance

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



Oneway Anova
Summary of Fit

Rsquare	4
Adj Rsquare	5.3125
Root Mean Square Error	.
Mean of Response	0.005386
Observations (or Sum Wgts)	24

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Block	7	7.2222e-35	1.032e-35	-3.0476	0.0000
Error	16	-5.417e-35	-3.39e-36		
C. Total	23	1.8056e-35			

Means for Oneway Anova

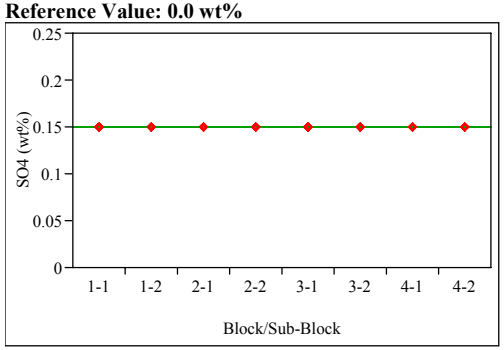
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	0.005386	.	.	.
1-2	3	0.005386	.	.	.
2-1	3	0.005386	.	.	.
2-2	3	0.005386	.	.	.
3-1	3	0.005386	.	.	.
3-2	3	0.005386	.	.	.
4-1	3	0.005386	.	.	.
4-2	3	0.005386	.	.	.

Std Error uses a pooled estimate of error variance

Exhibit E3. PSAL Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the LM Method (continued)

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

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



Oneway Anova
Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	0.149795
Observations (or Sum Wgts)	24

Analysis of Variance

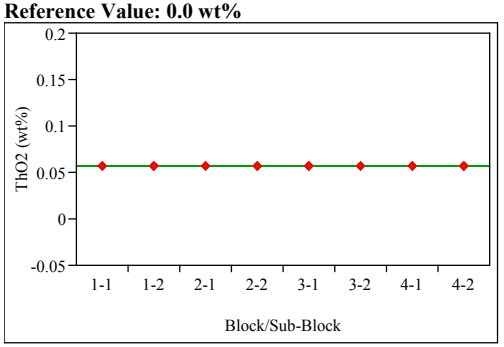
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Block	7	0	0	.	.
Error	16	0	0		
C. Total	23	0			

Means for Oneway Anova

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

Std Error uses a pooled estimate of error variance

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



Oneway Anova
Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	0.056895
Observations (or Sum Wgts)	24

Analysis of Variance

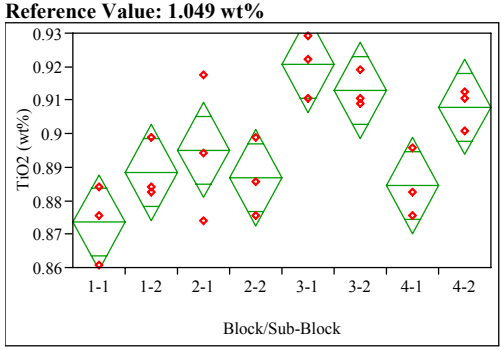
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Block	7	0	0	.	.
Error	16	0	0		
C. Total	23	0			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	0.056895	0	0.05690	0.05690
1-2	3	0.056895	0	0.05690	0.05690
2-1	3	0.056895	0	0.05690	0.05690
2-2	3	0.056895	0	0.05690	0.05690
3-1	3	0.056895	0	0.05690	0.05690
3-2	3	0.056895	0	0.05690	0.05690
4-1	3	0.056895	0	0.05690	0.05690
4-2	3	0.056895	0	0.05690	0.05690

Std Error uses a pooled estimate of error variance

Glass #=200
Oneway Analysis of TiO2 (wt%) By Block/Sub-Block Study
Reference Value: 1.049 wt%



Oneway Anova
Summary of Fit

Rsquare	0.71439
Adj Rsquare	0.589435
Root Mean Square Error	0.011681
Mean of Response	0.896272
Observations (or Sum Wgts)	24

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Block	7	0.00546058	0.000780	5.7172	0.0019
Error	16	0.00218312	0.000136		
C. Total	23	0.00764370			

Means for Oneway Anova

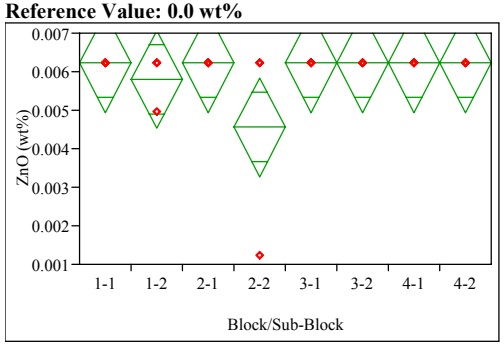
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	0.873476	0.00674	0.85918	0.88777
1-2	3	0.888488	0.00674	0.87419	0.90278
2-1	3	0.895160	0.00674	0.88086	0.90946
2-2	3	0.886820	0.00674	0.87252	0.90112
3-1	3	0.920736	0.00674	0.90644	0.93503
3-2	3	0.912952	0.00674	0.89866	0.92725
4-1	3	0.884596	0.00674	0.87030	0.89889
4-2	3	0.907948	0.00674	0.89365	0.92224

Std Error uses a pooled estimate of error variance

Exhibit E3. PSAL Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the LM Method (continued)

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

Glass #=200
Oneway Analysis of ZnO (wt%) By Block/Sub-Block Study
Reference Value: 0.0 wt%



Oneway Anova
Summary of Fit

Rsquare	0.289817
Adj Rsquare	-0.02089
Root Mean Square Error	0.001048
Mean of Response	0.005965
Observations (or Sum Wgts)	24

Analysis of Variance

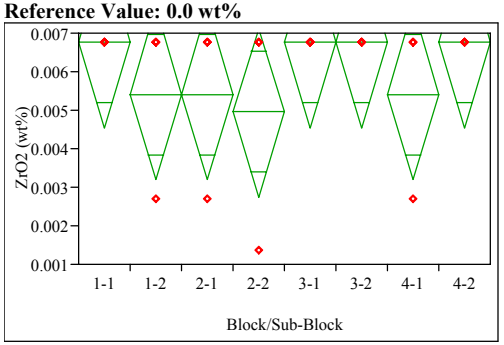
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Block	7	0.00000717	1.0238e-6	0.9328	0.5084
Error	16	0.00001756	1.0976e-6		
C. Total	23	0.00002473			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	0.006224	0.00060	0.00494	0.00751
1-2	3	0.005809	0.00060	0.00453	0.00709
2-1	3	0.006224	0.00060	0.00494	0.00751
2-2	3	0.004564	0.00060	0.00328	0.00585
3-1	3	0.006224	0.00060	0.00494	0.00751
3-2	3	0.006224	0.00060	0.00494	0.00751
4-1	3	0.006224	0.00060	0.00494	0.00751
4-2	3	0.006224	0.00060	0.00494	0.00751

Std Error uses a pooled estimate of error variance

Glass #=200
Oneway Analysis of ZrO2 (wt%) By Block/Sub-Block Study
Reference Value: 0.0 wt%



Oneway Anova
Summary of Fit

Rsquare	0.202781
Adj Rsquare	-0.146
Root Mean Square Error	0.001808
Mean of Response	0.006022
Observations (or Sum Wgts)	24

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Block	7	0.00001330	0.0000019	0.5814	0.7613
Error	16	0.00005231	3.2692e-6		
C. Total	23	0.00006561			

Means for Oneway Anova

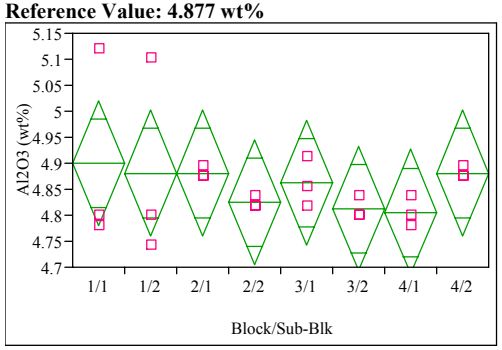
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	0.006754	0.00104	0.00454	0.00897
1-2	3	0.005403	0.00104	0.00319	0.00762
2-1	3	0.005403	0.00104	0.00319	0.00762
2-2	3	0.004953	0.00104	0.00274	0.00717
3-1	3	0.006754	0.00104	0.00454	0.00897
3-2	3	0.006754	0.00104	0.00454	0.00897
4-1	3	0.005403	0.00104	0.00319	0.00762
4-2	3	0.006754	0.00104	0.00454	0.00897

Std Error uses a pooled estimate of error variance

Exhibit E4: PSAL Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the PF Method

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

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



Oneway Anova
Summary of Fit

Rsquare	0.153048
Adj Rsquare	-0.21749
Root Mean Square Error	0.098559
Mean of Response	4.856015
Observations (or Sum Wgts)	24

Analysis of Variance

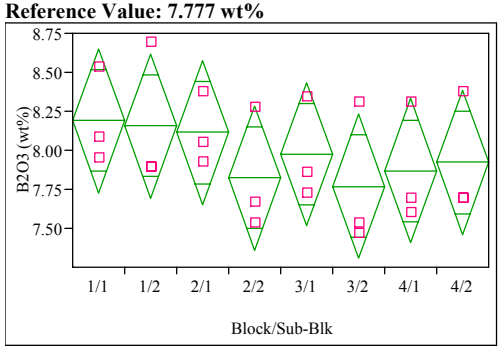
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Blk	7	0.02808565	0.004012	0.4130	0.8803
Error	16	0.15542315	0.009714		
C. Total	23	0.18350881			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	4.90010	0.05690	4.7795	5.0207
1/2	3	4.88121	0.05690	4.7606	5.0018
2/1	3	4.88121	0.05690	4.7606	5.0018
2/2	3	4.82452	0.05690	4.7039	4.9452
3/1	3	4.86231	0.05690	4.7417	4.9829
3/2	3	4.81193	0.05690	4.6913	4.9326
4/1	3	4.80563	0.05690	4.6850	4.9263
4/2	3	4.88121	0.05690	4.7606	5.0018

Std Error uses a pooled estimate of error variance

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



Oneway Anova
Summary of Fit

Rsquare	0.189186
Adj Rsquare	-0.16555
Root Mean Square Error	0.37751
Mean of Response	7.977302
Observations (or Sum Wgts)	24

Analysis of Variance

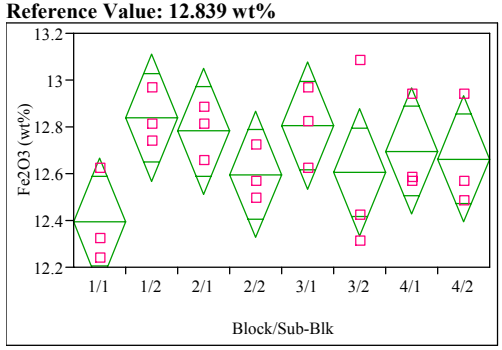
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Blk	7	0.5320387	0.076006	0.5333	0.7970
Error	16	2.2802151	0.142513		
C. Total	23	2.8122538			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	8.18928	0.21796	7.7272	8.6513
1/2	3	8.15708	0.21796	7.6950	8.6191
2/1	3	8.11415	0.21796	7.6521	8.5762
2/2	3	7.82436	0.21796	7.3623	8.2864
3/1	3	7.97462	0.21796	7.5126	8.4367
3/2	3	7.77069	0.21796	7.3086	8.2327
4/1	3	7.86729	0.21796	7.4052	8.3293
4/2	3	7.92095	0.21796	7.4589	8.3830

Std Error uses a pooled estimate of error variance

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



Oneway Anova
Summary of Fit

Rsquare	0.358571
Adj Rsquare	0.077946
Root Mean Square Error	0.220505
Mean of Response	12.6725
Observations (or Sum Wgts)	24

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Blk	7	0.4348955	0.062128	1.2778	0.3214
Error	16	0.7779624	0.048623		
C. Total	23	1.2128579			

Means for Oneway Anova

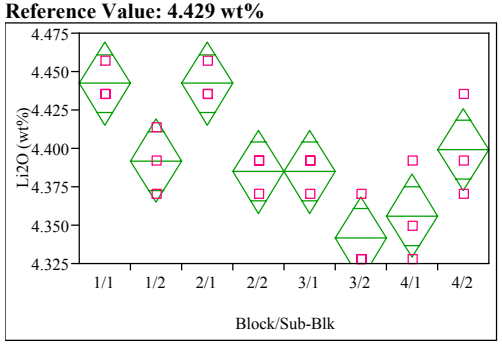
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	12.3955	0.12731	12.126	12.665
1/2	3	12.8387	0.12731	12.569	13.109
2/1	3	12.7815	0.12731	12.512	13.051
2/2	3	12.5957	0.12731	12.326	12.866
3/1	3	12.8053	0.12731	12.535	13.075
3/2	3	12.6052	0.12731	12.335	12.875
4/1	3	12.6957	0.12731	12.426	12.966
4/2	3	12.6624	0.12731	12.392	12.932

Std Error uses a pooled estimate of error variance

Exhibit E4: PSAL Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the PF Method (continued)

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

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



Oneway Anova
Summary of Fit

Rsquare	0.777654
Adj Rsquare	0.680378
Root Mean Square Error	0.021973
Mean of Response	4.392813
Observations (or Sum Wgts)	24

Analysis of Variance

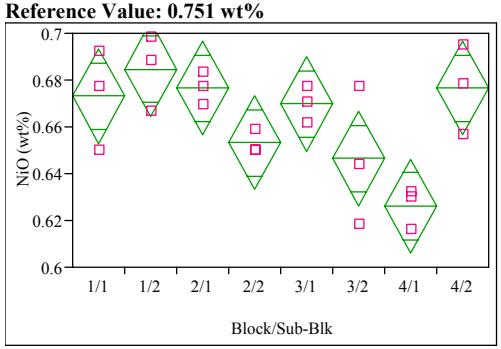
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Blk	7	0.02701806	0.003860	7.9943	0.0003
Error	16	0.00772496	0.000483		
C. Total	23	0.03474303			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	4.44215	0.01269	4.4153	4.4690
1/2	3	4.39192	0.01269	4.3650	4.4188
2/1	3	4.44215	0.01269	4.4153	4.4690
2/2	3	4.38474	0.01269	4.3578	4.4116
3/1	3	4.38474	0.01269	4.3578	4.4116
3/2	3	4.34168	0.01269	4.3148	4.3686
4/1	3	4.35603	0.01269	4.3291	4.3829
4/2	3	4.39909	0.01269	4.3722	4.4260

Std Error uses a pooled estimate of error variance

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



Oneway Anova
Summary of Fit

Rsquare	0.653782
Adj Rsquare	0.502312
Root Mean Square Error	0.016422
Mean of Response	0.663291
Observations (or Sum Wgts)	24

Analysis of Variance

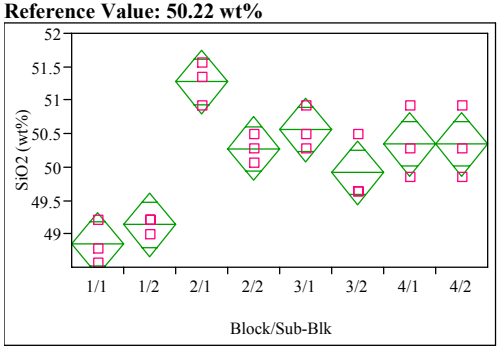
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Blk	7	0.00814783	0.001164	4.3162	0.0073
Error	16	0.00431478	0.000270		
C. Total	23	0.01246261			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	0.673153	0.00948	0.65305	0.69325
1/2	3	0.684605	0.00948	0.66451	0.70470
2/1	3	0.676546	0.00948	0.65645	0.69664
2/2	3	0.653217	0.00948	0.63312	0.67332
3/1	3	0.669759	0.00948	0.64966	0.68986
3/2	3	0.646430	0.00948	0.62633	0.66653
4/1	3	0.626070	0.00948	0.60597	0.64617
4/2	3	0.676546	0.00948	0.65645	0.69664

Std Error uses a pooled estimate of error variance

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



Oneway Anova
Summary of Fit

Rsquare	0.841664
Adj Rsquare	0.772391
Root Mean Square Error	0.388132
Mean of Response	50.08636
Observations (or Sum Wgts)	24

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Blk	7	12.812586	1.83037	12.1501	<.0001
Error	16	2.410345	0.15065		
C. Total	23	15.222931			

Means for Oneway Anova

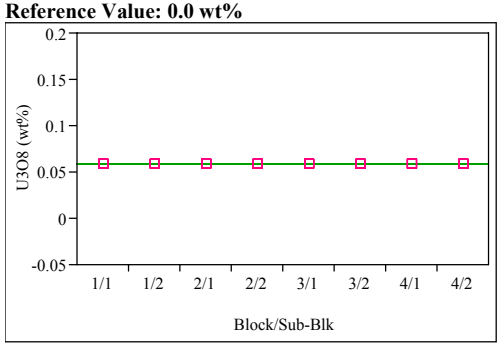
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	48.8474	0.22409	48.372	49.322
1/2	3	49.1326	0.22409	48.658	49.608
2/1	3	51.2719	0.22409	50.797	51.747
2/2	3	50.2736	0.22409	49.799	50.749
3/1	3	50.5588	0.22409	50.084	51.034
3/2	3	49.9170	0.22409	49.442	50.392
4/1	3	50.3449	0.22409	49.870	50.820
4/2	3	50.3449	0.22409	49.870	50.820

Std Error uses a pooled estimate of error variance

Exhibit E4: PSAL Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the PF Method (continued)

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

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



Oneway Anova
Summary of Fit

Rsquare	1
Adj Rsquare	1
Root Mean Square Error	0
Mean of Response	0.05896
Observations (or Sum Wgts)	24

Analysis of Variance

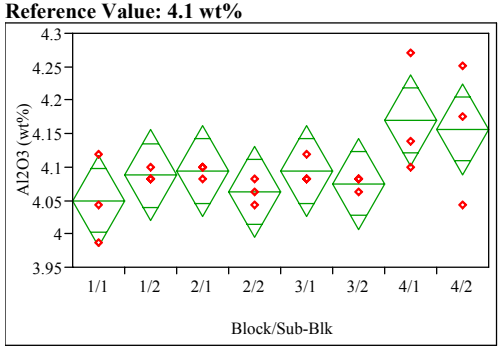
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Blk	7	4.6222e-33	6.603e-34	.	.
Error	16	0	0		
C. Total	23	4.6222e-33			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	0.058960	0	0.05896	0.05896
1/2	3	0.058960	0	0.05896	0.05896
2/1	3	0.058960	0	0.05896	0.05896
2/2	3	0.058960	0	0.05896	0.05896
3/1	3	0.058960	0	0.05896	0.05896
3/2	3	0.058960	0	0.05896	0.05896
4/1	3	0.058960	0	0.05896	0.05896
4/2	3	0.058960	0	0.05896	0.05896

Std Error uses a pooled estimate of error variance

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



Oneway Anova
Summary of Fit

Rsquare	0.438644
Adj Rsquare	0.193051
Root Mean Square Error	0.055491
Mean of Response	4.09864
Observations (or Sum Wgts)	24

Analysis of Variance

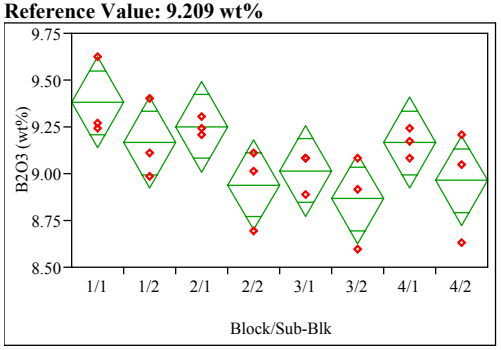
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Blk	7	0.03849877	0.005500	1.7861	0.1593
Error	16	0.04926890	0.003079		
C. Total	23	0.08776767			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	4.04983	0.03204	3.9819	4.1177
1/2	3	4.08762	0.03204	4.0197	4.1555
2/1	3	4.09392	0.03204	4.0260	4.1618
2/2	3	4.06243	0.03204	3.9945	4.1303
3/1	3	4.09392	0.03204	4.0260	4.1618
3/2	3	4.07502	0.03204	4.0071	4.1429
4/1	3	4.16950	0.03204	4.1016	4.2374
4/2	3	4.15690	0.03204	4.0890	4.2248

Std Error uses a pooled estimate of error variance

Glass #=200
Oneway Analysis of B2O3 (wt%) By Block/Sub-Blk
Reference Value: 9.209 wt%



Oneway Anova
Summary of Fit

Rsquare	0.510791
Adj Rsquare	0.296763
Root Mean Square Error	0.197287
Mean of Response	9.093534
Observations (or Sum Wgts)	24

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Blk	7	0.6502311	0.092890	2.3866	0.0709
Error	16	0.6227565	0.038922		
C. Total	23	1.2729876			

Means for Oneway Anova

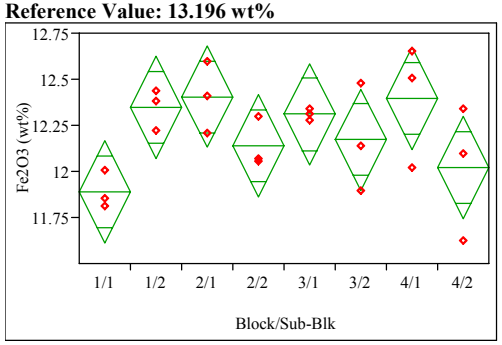
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	9.38064	0.11390	9.1392	9.6221
1/2	3	9.16598	0.11390	8.9245	9.4074
2/1	3	9.25185	0.11390	9.0104	9.4933
2/2	3	8.94059	0.11390	8.6991	9.1821
3/1	3	9.01572	0.11390	8.7743	9.2572
3/2	3	8.86546	0.11390	8.6240	9.1069
4/1	3	9.16598	0.11390	8.9245	9.4074
4/2	3	8.96206	0.11390	8.7206	9.2035

Std Error uses a pooled estimate of error variance

Exhibit E4: PSAL Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the PF Method (continued)

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

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



Oneway Anova
Summary of Fit

Rsquare	0.475777
Adj Rsquare	0.24643
Root Mean Square Error	0.225754
Mean of Response	12.20964
Observations (or Sum Wgts)	24

Analysis of Variance

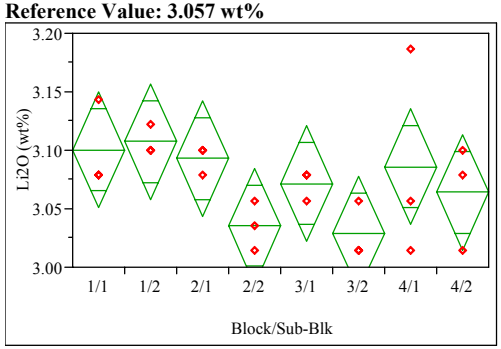
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Blk	7	0.7400795	0.105726	2.0745	0.1075
Error	16	0.8154365	0.050965		
C. Total	23	1.5555160			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	11.8903	0.13034	11.614	12.167
1/2	3	12.3478	0.13034	12.072	12.624
2/1	3	12.4050	0.13034	12.129	12.681
2/2	3	12.1382	0.13034	11.862	12.414
3/1	3	12.3097	0.13034	12.033	12.586
3/2	3	12.1715	0.13034	11.895	12.448
4/1	3	12.3955	0.13034	12.119	12.672
4/2	3	12.0190	0.13034	11.743	12.295

Std Error uses a pooled estimate of error variance

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



Oneway Anova
Summary of Fit

Rsquare	0.407407
Adj Rsquare	0.148148
Root Mean Square Error	0.040277
Mean of Response	3.073265
Observations (or Sum Wgts)	24

Analysis of Variance

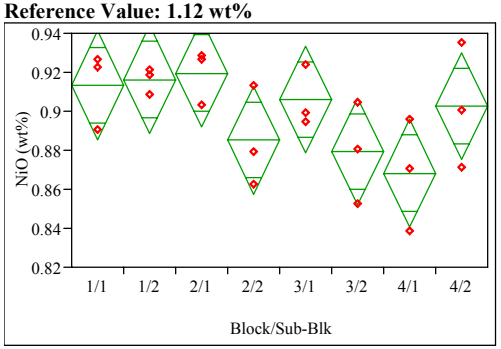
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Blk	7	0.01784467	0.002549	1.5714	0.2143
Error	16	0.02595588	0.001622		
C. Total	23	0.04380055			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	3.10018	0.02325	3.0509	3.1495
1/2	3	3.10735	0.02325	3.0581	3.1566
2/1	3	3.09300	0.02325	3.0437	3.1423
2/2	3	3.03559	0.02325	2.9863	3.0849
3/1	3	3.07147	0.02325	3.0222	3.1208
3/2	3	3.02841	0.02325	2.9791	3.0777
4/1	3	3.08582	0.02325	3.0365	3.1351
4/2	3	3.06429	0.02325	3.0150	3.1136

Std Error uses a pooled estimate of error variance

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



Oneway Anova
Summary of Fit

Rsquare	0.480679
Adj Rsquare	0.253476
Root Mean Square Error	0.022534
Mean of Response	0.898809
Observations (or Sum Wgts)	24

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Blk	7	0.00751983	0.001074	2.1156	0.1017
Error	16	0.00812435	0.000508		
C. Total	23	0.01564417			

Means for Oneway Anova

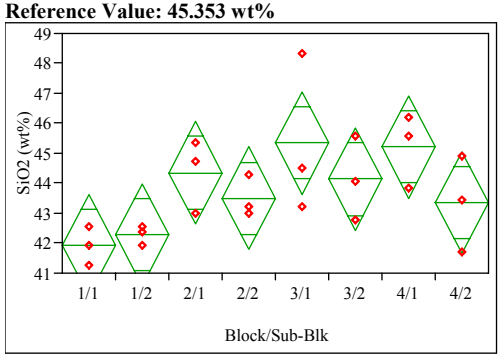
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	0.913231	0.01301	0.88565	0.94081
1/2	3	0.916200	0.01301	0.88862	0.94378
2/1	3	0.919593	0.01301	0.89201	0.94717
2/2	3	0.885236	0.01301	0.85766	0.91282
3/1	3	0.906020	0.01301	0.87844	0.93360
3/2	3	0.879298	0.01301	0.85172	0.90688
4/1	3	0.868269	0.01301	0.84069	0.89585
4/2	3	0.902627	0.01301	0.87505	0.93021

Std Error uses a pooled estimate of error variance

Exhibit E4: PSAL Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the PF Method (continued)

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

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



Oneway Anova
Summary of Fit

Rsquare	0.511403
Adj Rsquare	0.297642
Root Mean Square Error	1.396702
Mean of Response	43.76651
Observations (or Sum Wgts)	24

Analysis of Variance

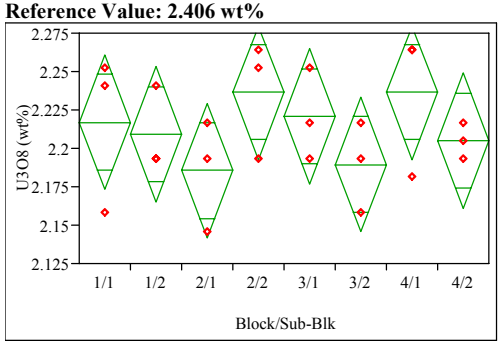
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Blk	7	32.669328	4.66705	2.3924	0.0704
Error	16	31.212443	1.95078		
C. Total	23	63.881771			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	41.9303	0.80639	40.221	43.640
1/2	3	42.2868	0.80639	40.577	43.996
2/1	3	44.3548	0.80639	42.645	46.064
2/2	3	43.4991	0.80639	41.790	45.209
3/1	3	45.3532	0.80639	43.644	47.063
3/2	3	44.1409	0.80639	42.431	45.850
4/1	3	45.2105	0.80639	43.501	46.920
4/2	3	43.3565	0.80639	41.647	45.066

Std Error uses a pooled estimate of error variance

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



Oneway Anova
Summary of Fit

Rsquare	0.273174
Adj Rsquare	-0.04481
Root Mean Square Error	0.035864
Mean of Response	2.212474
Observations (or Sum Wgts)	24

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Blk	7	0.00773473	0.001105	0.8591	0.5575
Error	16	0.02057959	0.001286		
C. Total	23	0.02831431			

Means for Oneway Anova

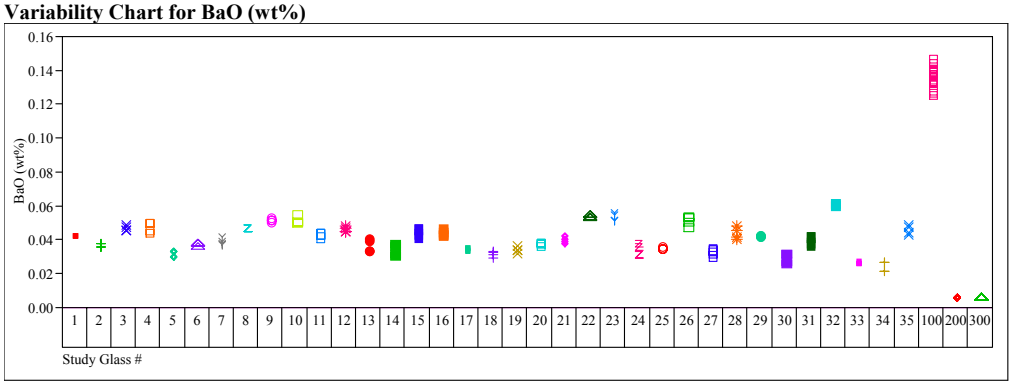
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	2.21690	0.02071	2.1730	2.2608
1/2	3	2.20903	0.02071	2.1651	2.2529
2/1	3	2.18545	0.02071	2.1416	2.2293
2/2	3	2.23655	0.02071	2.1927	2.2804
3/1	3	2.22083	0.02071	2.1769	2.2647
3/2	3	2.18938	0.02071	2.1455	2.2333
4/1	3	2.23655	0.02071	2.1927	2.2804
4/2	3	2.20510	0.02071	2.1612	2.2490

Std Error uses a pooled estimate of error variance

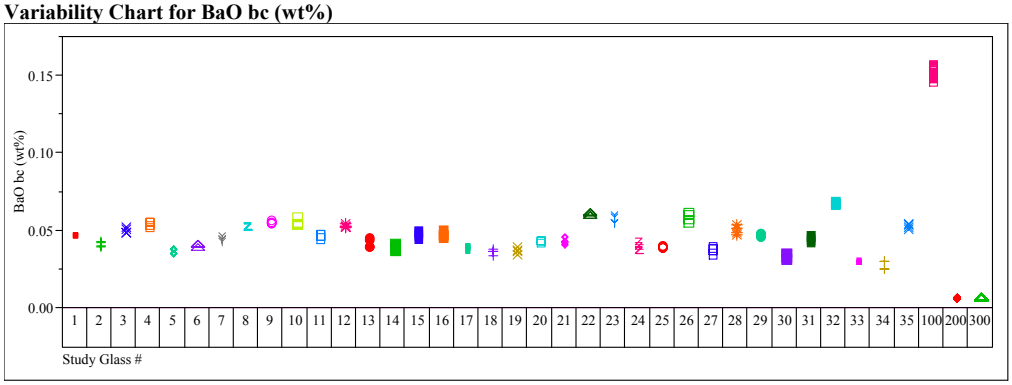
Exhibit E5. Measured and Measured Bias-Corrected Oxide Weight Percents by Glass # for the Glasses Prepared Using the LM Method

(100 – Batch 1; 200 – Ustd)

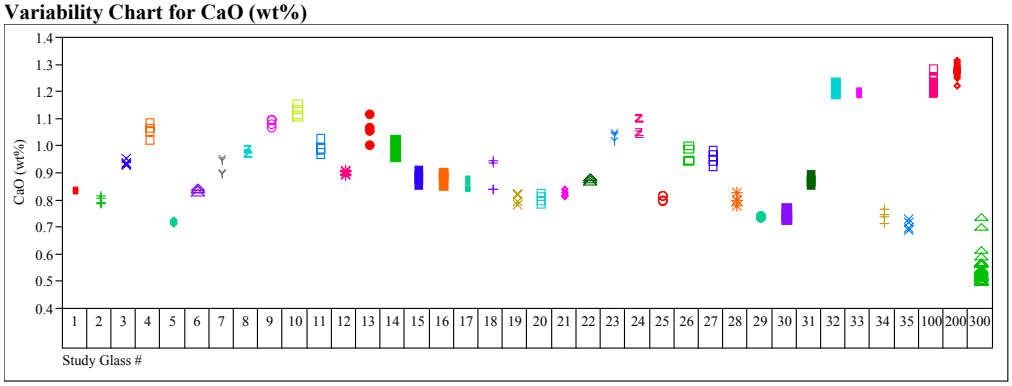
Variability Chart for BaO (wt%)



Variability Chart for BaO bc (wt%)



Variability Chart for CaO (wt%)



Variability Chart for CaO bc (wt%)

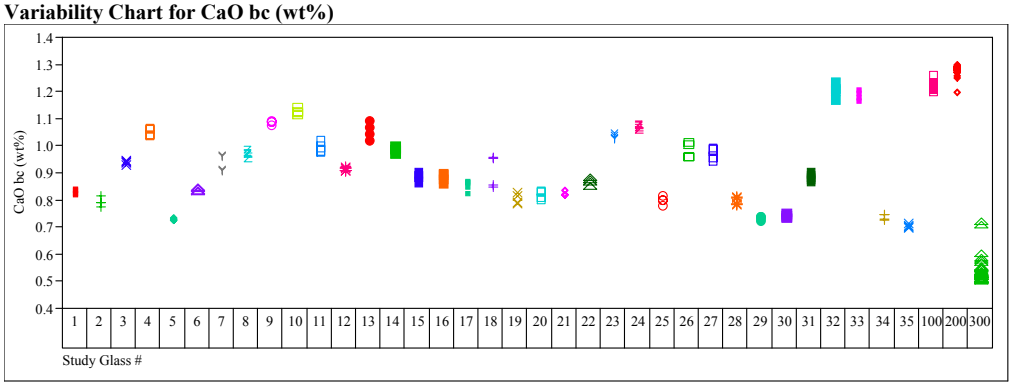
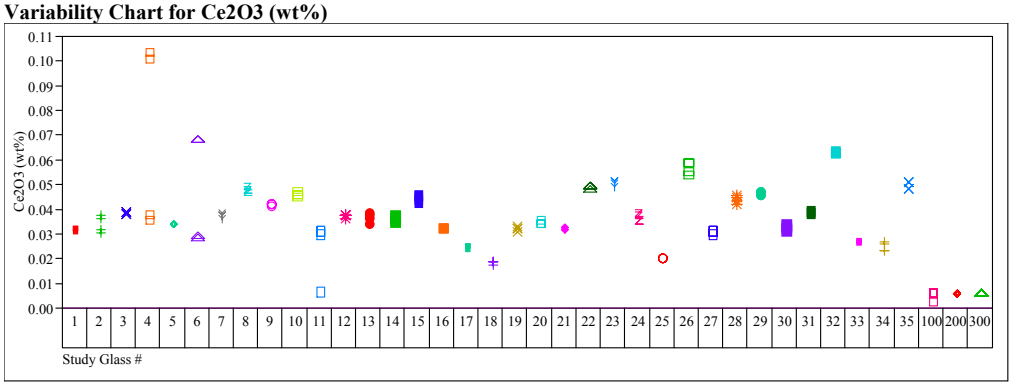


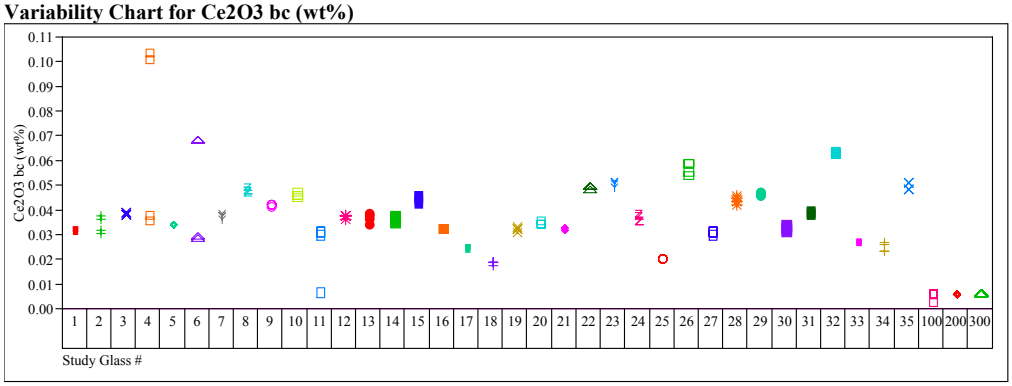
Exhibit E5. Measured and Measured Bias-Corrected Oxide Weight Percents by Glass # for the Glasses Prepared Using the LM Method (continued)

(100 – Batch 1; 200 – Ustd)

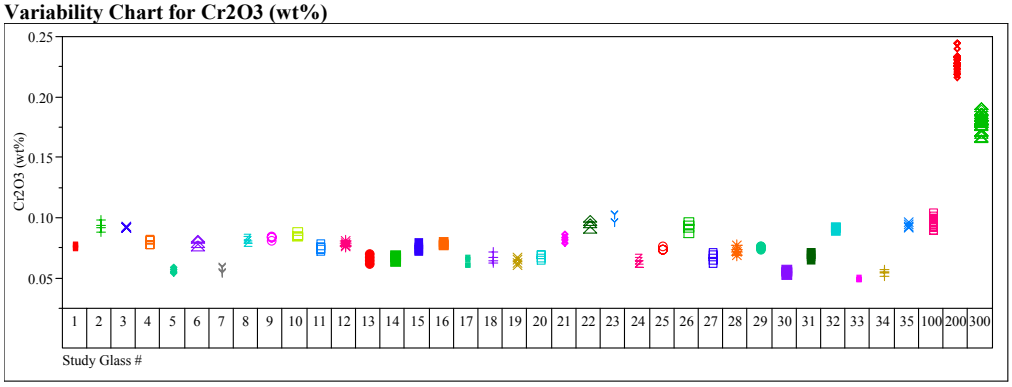
Variability Chart for Ce2O3 (wt%)



Variability Chart for Ce2O3 bc (wt%)



Variability Chart for Cr2O3 (wt%)



Variability Chart for Cr2O3 bc (wt%)

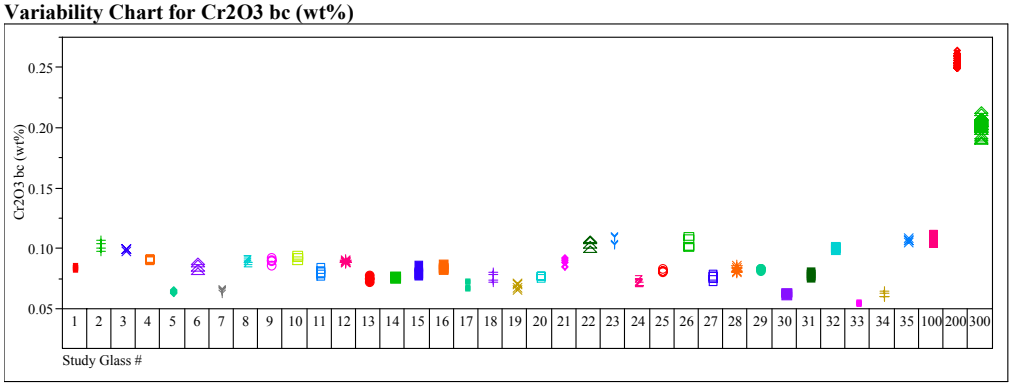
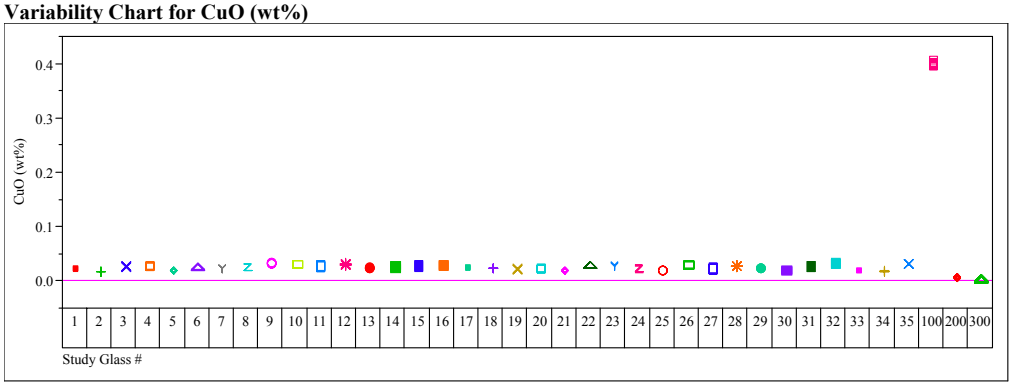


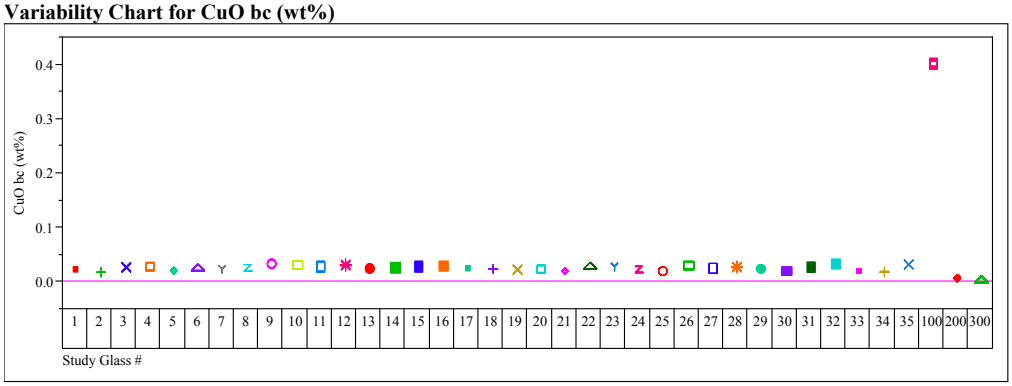
Exhibit E5. Measured and Measured Bias-Corrected Oxide Weight Percents by Glass # for the Glasses Prepared Using the LM Method (continued)

(100 – Batch 1; 200 – Ustd)

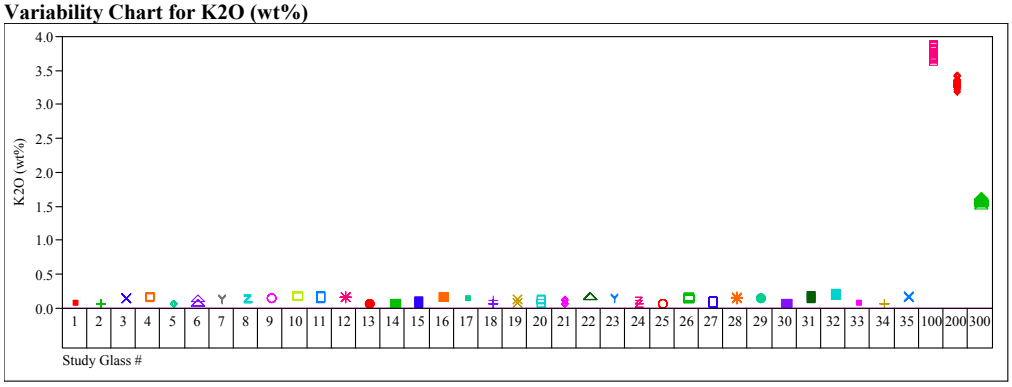
Variability Chart for CuO (wt%)



Variability Chart for CuO bc (wt%)



Variability Chart for K2O (wt%)



Variability Chart for K2O bc (wt%)

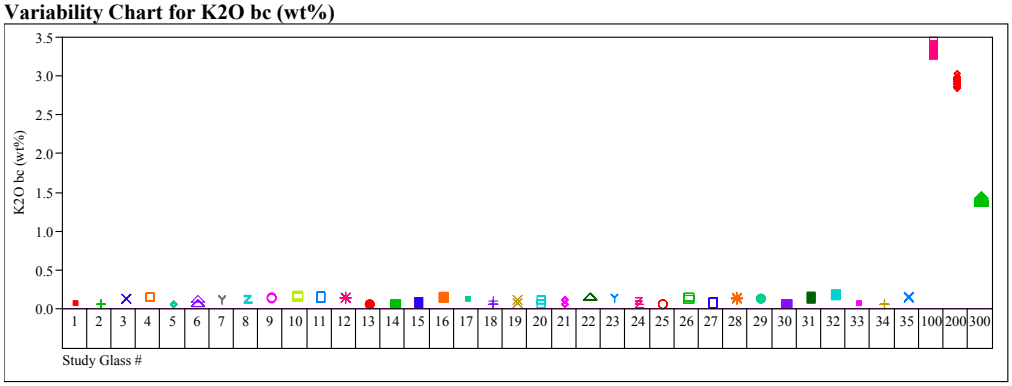
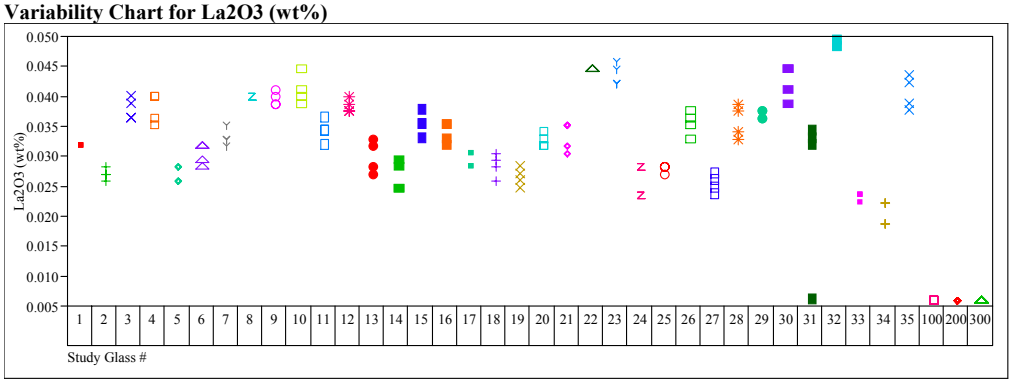


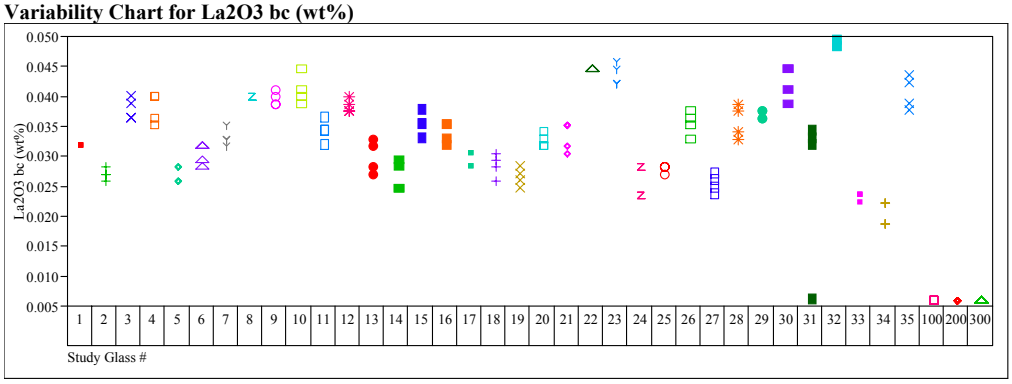
Exhibit E5. Measured and Measured Bias-Corrected Oxide Weight Percents by Glass # for the Glasses Prepared Using the LM Method (continued)

(100 – Batch 1; 200 – Ustd)

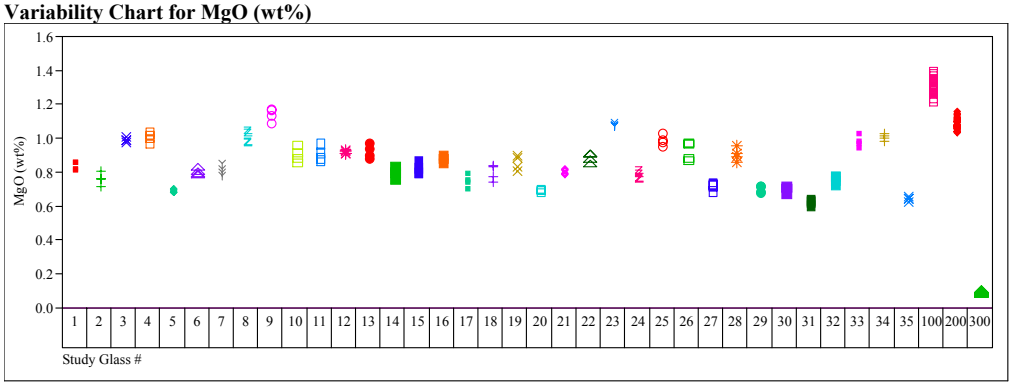
Variability Chart for La2O3 (wt%)



Variability Chart for La2O3 bc (wt%)



Variability Chart for MgO (wt%)



Variability Chart for MgO bc (wt%)

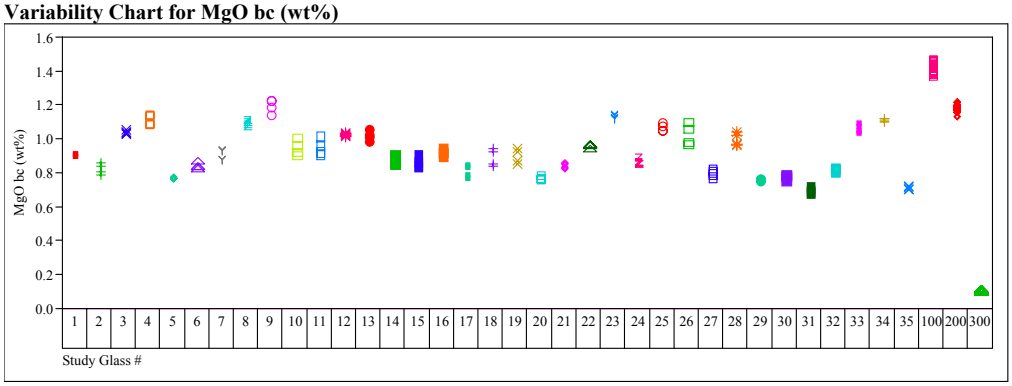
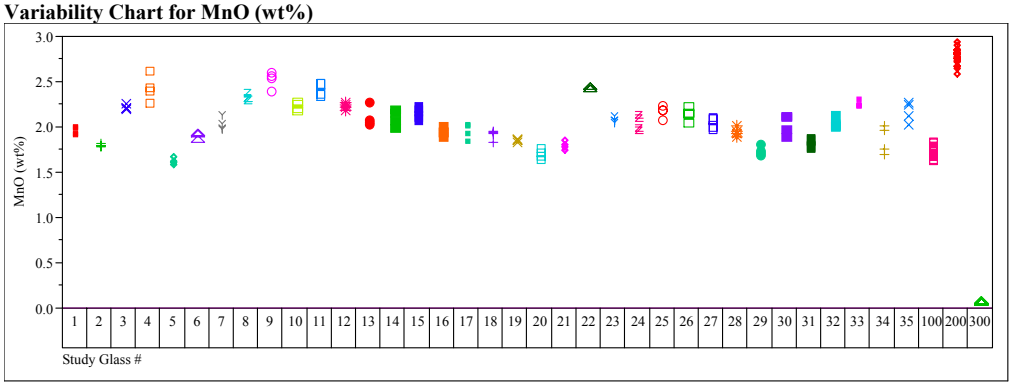


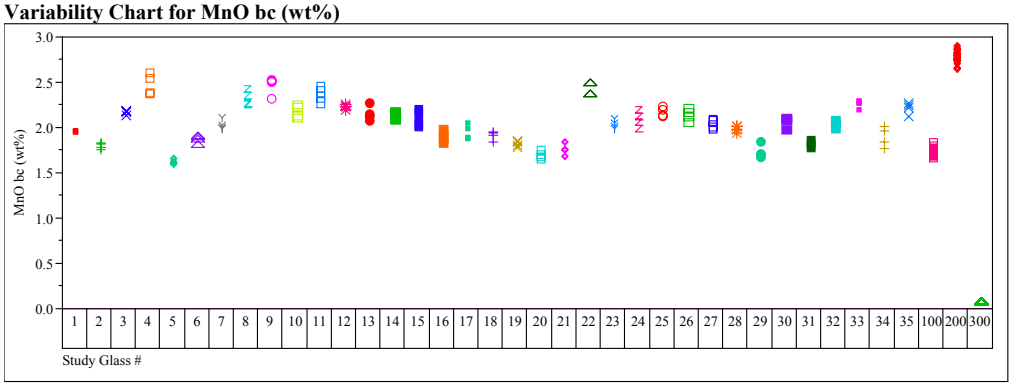
Exhibit E5. Measured and Measured Bias-Corrected Oxide Weight Percents by Glass # for the Glasses Prepared Using the LM Method (continued)

(100 – Batch 1; 200 – Ustd)

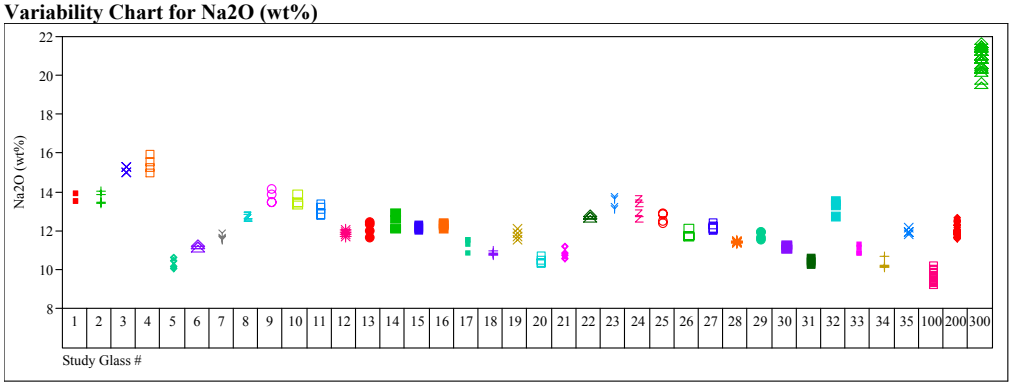
Variability Chart for MnO (wt%)



Variability Chart for MnO bc (wt%)



Variability Chart for Na2O (wt%)



Variability Chart for Na2O bc (wt%)

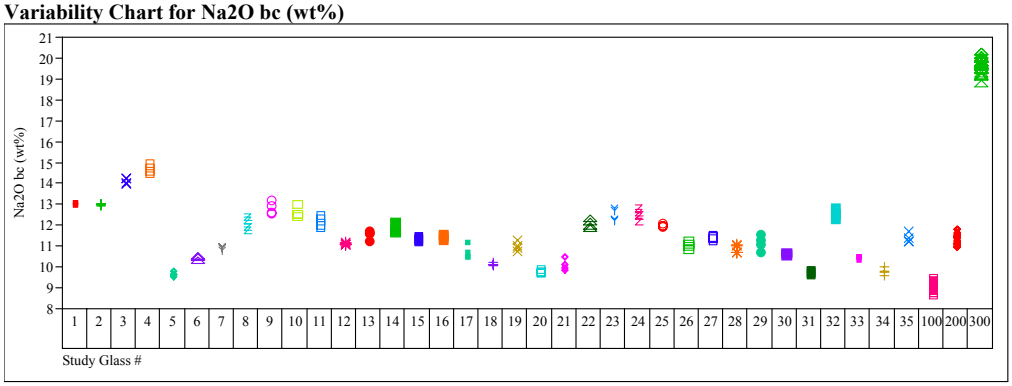
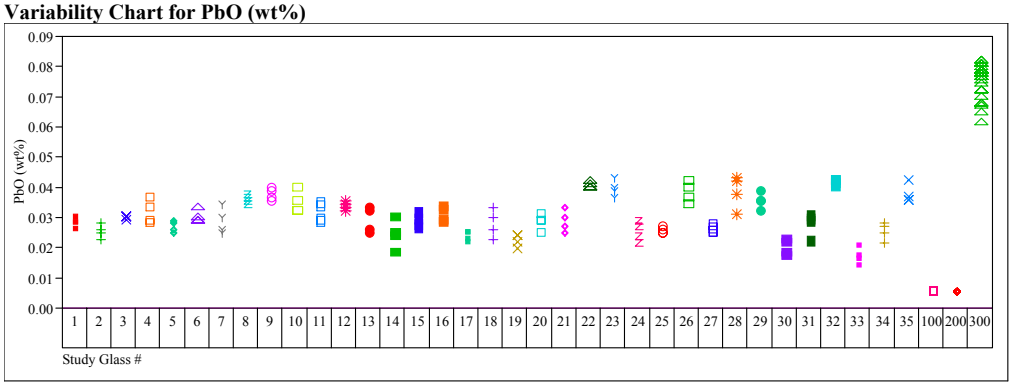


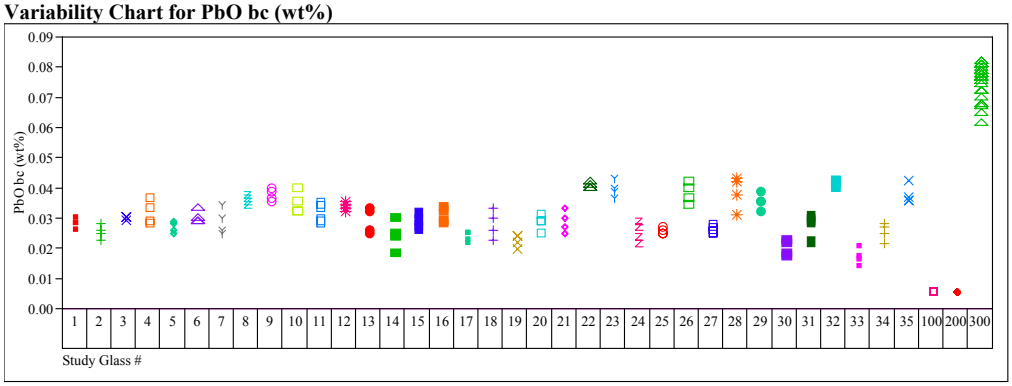
Exhibit E5. Measured and Measured Bias-Corrected Oxide Weight Percents by Glass # for the Glasses Prepared Using the LM Method (continued)

(100 – Batch 1; 200 – Ustd)

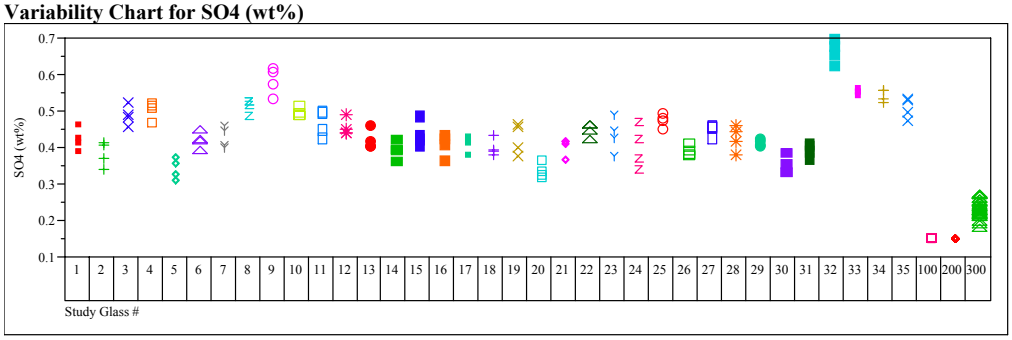
Variability Chart for PbO (wt%)



Variability Chart for PbO bc (wt%)



Variability Chart for SO4 (wt%)



Variability Chart for SO4 bc (wt%)

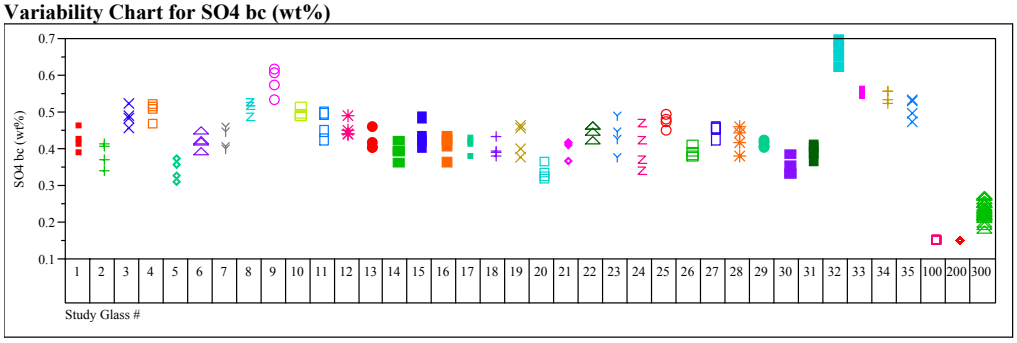
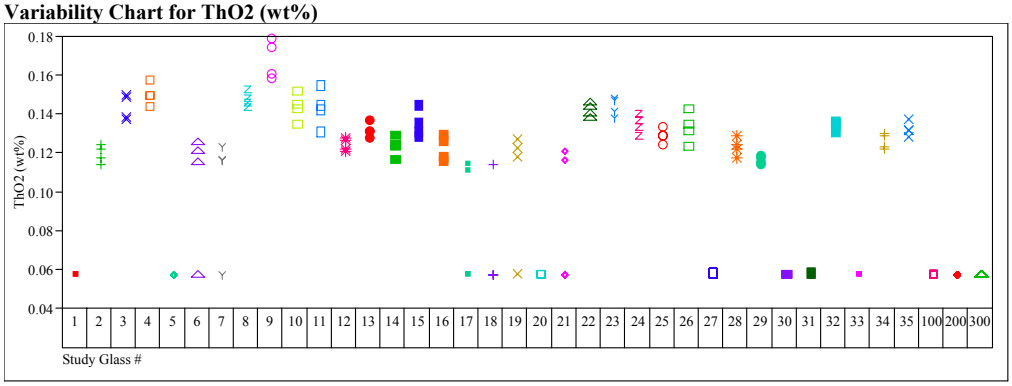


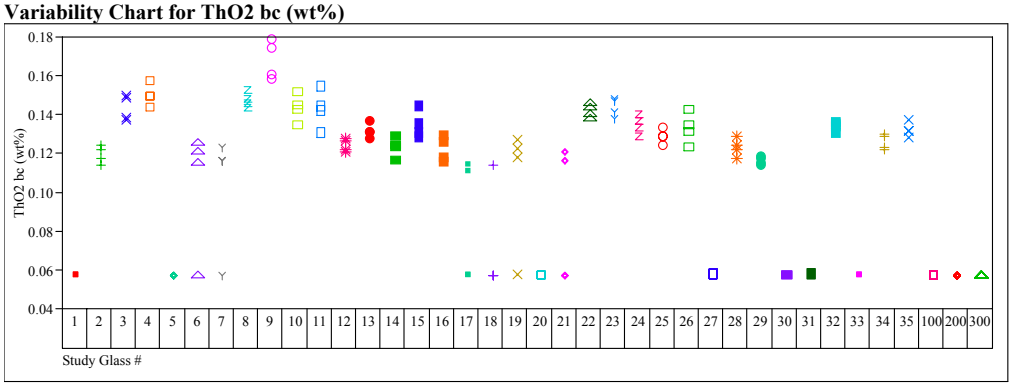
Exhibit E5. Measured and Measured Bias-Corrected Oxide Weight Percents by Glass # for the Glasses Prepared Using the LM Method (continued)

(100 – Batch 1; 200 – Ustd)

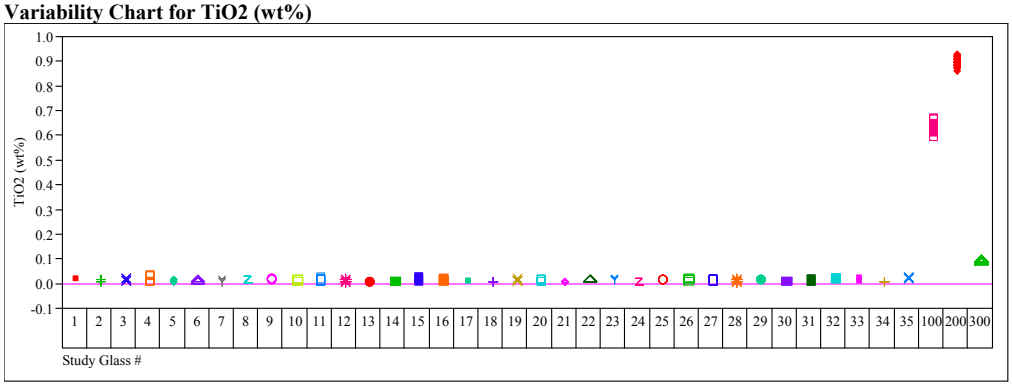
Variability Chart for ThO2 (wt%)



Variability Chart for ThO2 bc (wt%)



Variability Chart for TiO2 (wt%)



Variability Chart for TiO2 bc (wt%)

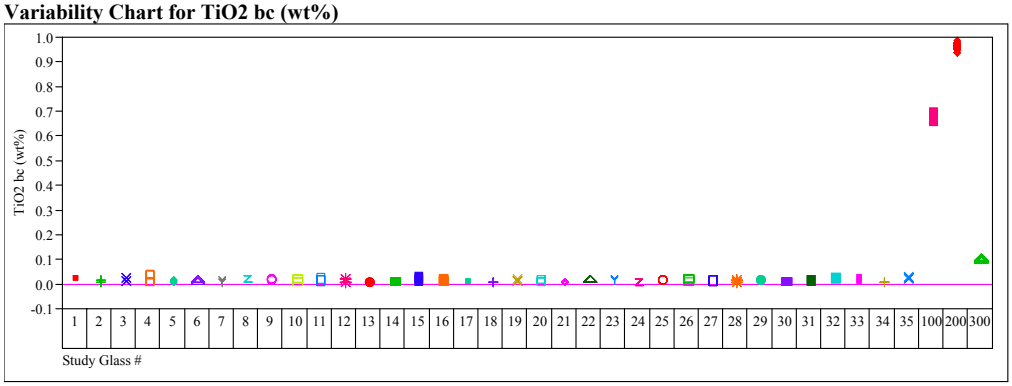
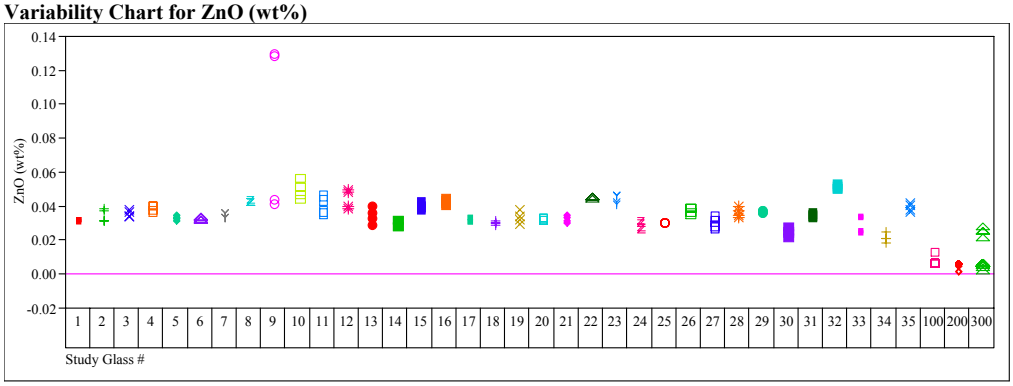


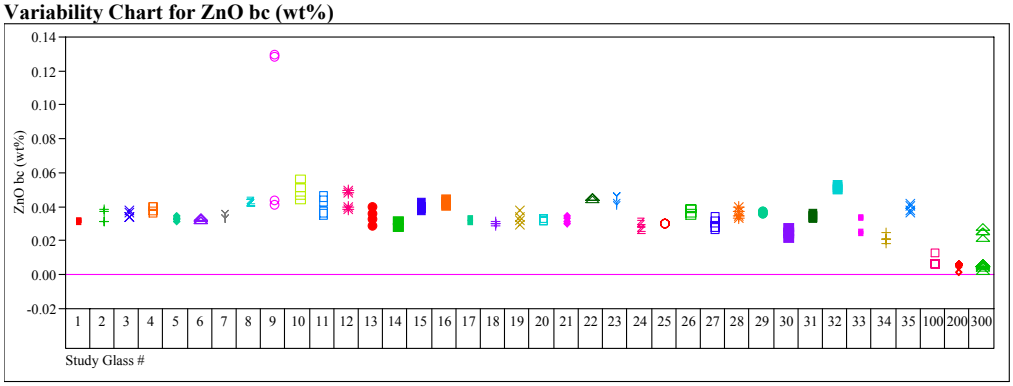
Exhibit E5. Measured and Measured Bias-Corrected Oxide Weight Percents by Glass # for the Glasses Prepared Using the LM Method (continued)

(100 – Batch 1; 200 – Ustd)

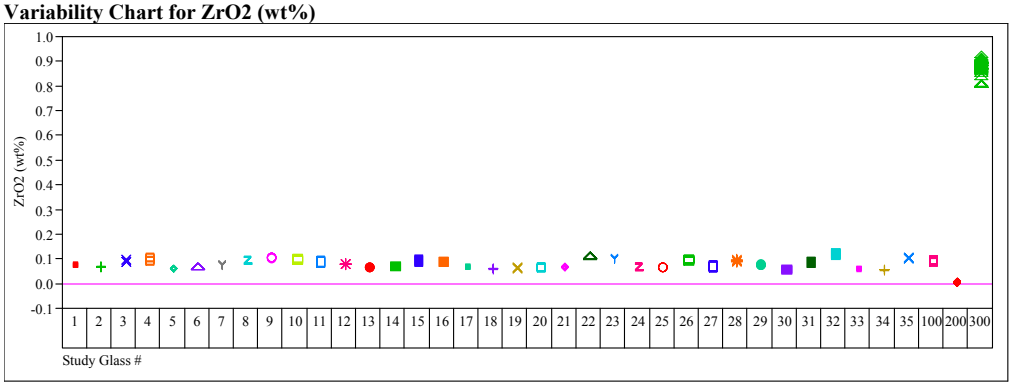
Variability Chart for ZnO (wt%)



Variability Chart for ZnO bc (wt%)



Variability Chart for ZrO2 (wt%)



Variability Chart for ZrO2 bc (wt%)

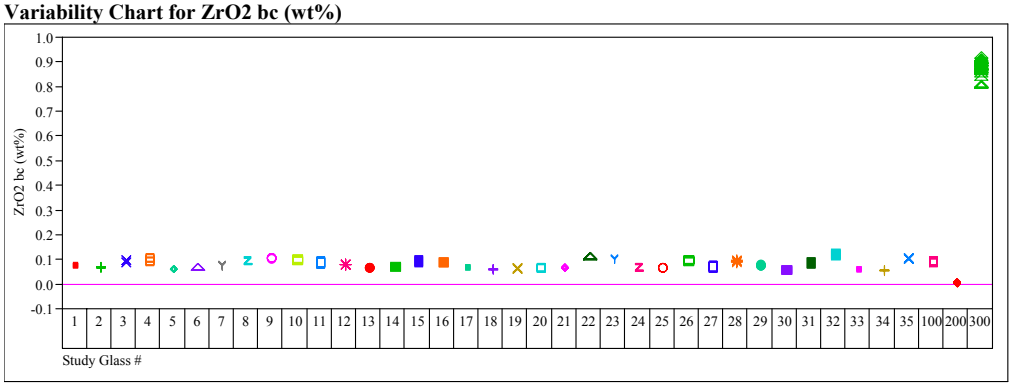
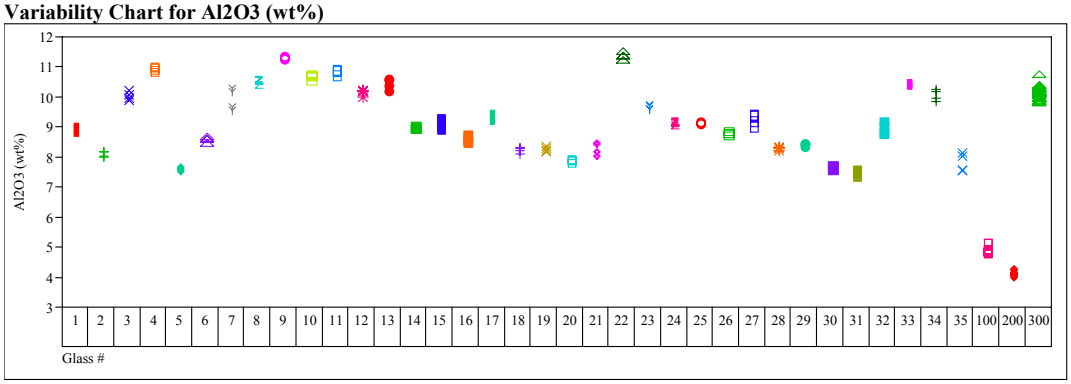


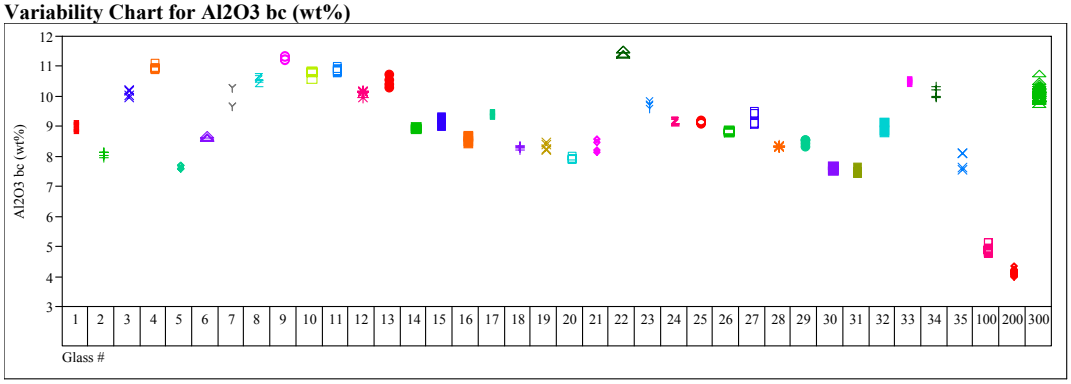
Exhibit E6. Measured and Measured Bias-Corrected Oxide Weight Percents by Glass # for the Glasses Prepared Using the PF Method

(100 – Batch 1; 200 – Ustd)

Variability Chart for Al2O3 (wt%)



Variability Chart for Al2O3 bc (wt%)



Variability Chart for B2O3 (wt%)

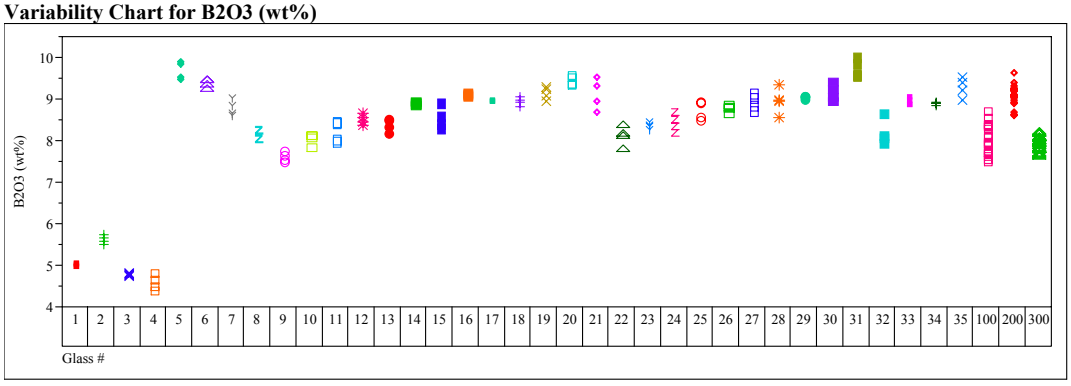
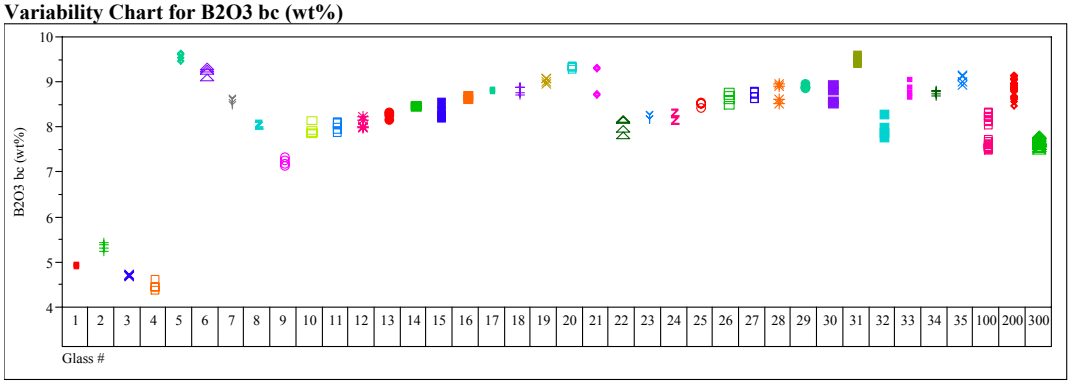


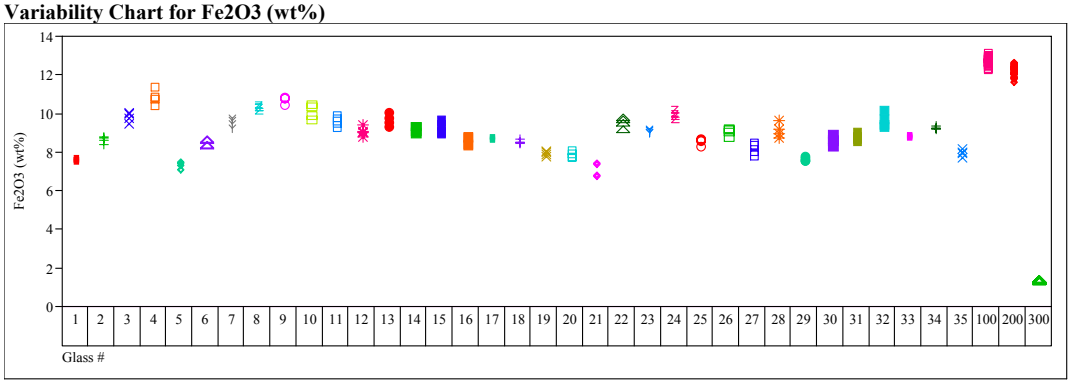
Exhibit E6. Measured and Measured Bias-Corrected Oxide Weight Percents by Glass # for the Glasses Prepared Using the PF Method (continued)

(100 – Batch 1; 200 – Ustd)

Variability Chart for B2O3 bc (wt%)



Variability Chart for Fe2O3 (wt%)



Variability Chart for Fe2O3 bc (wt%)

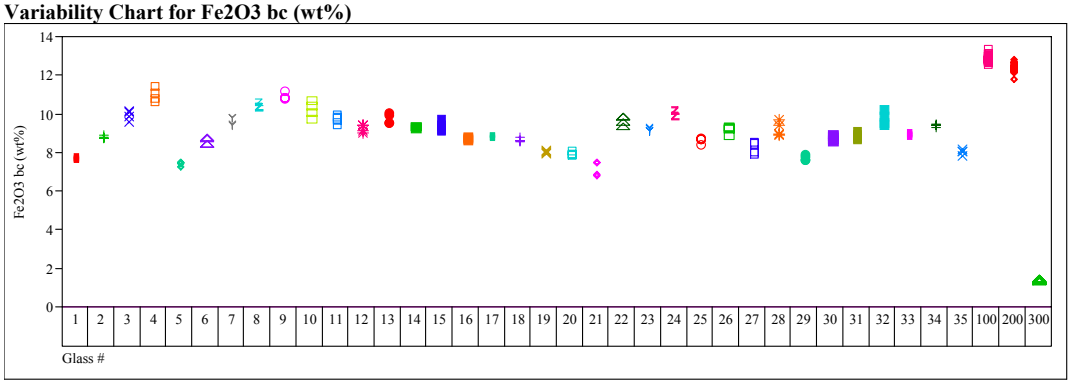
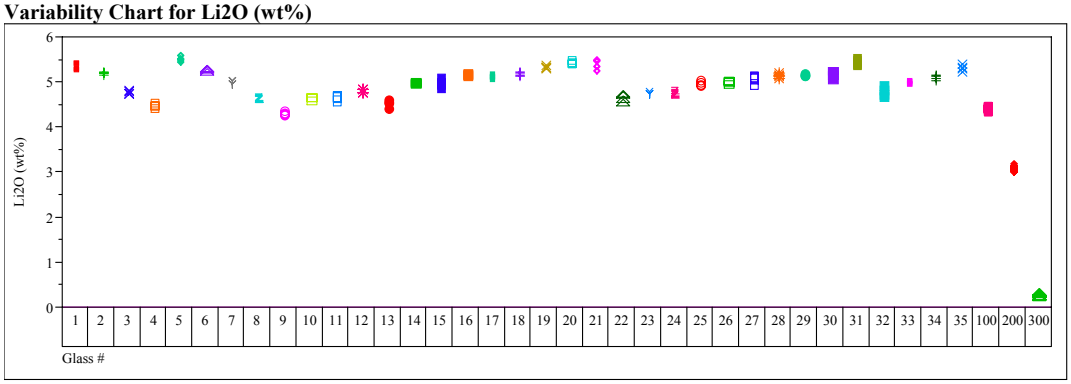


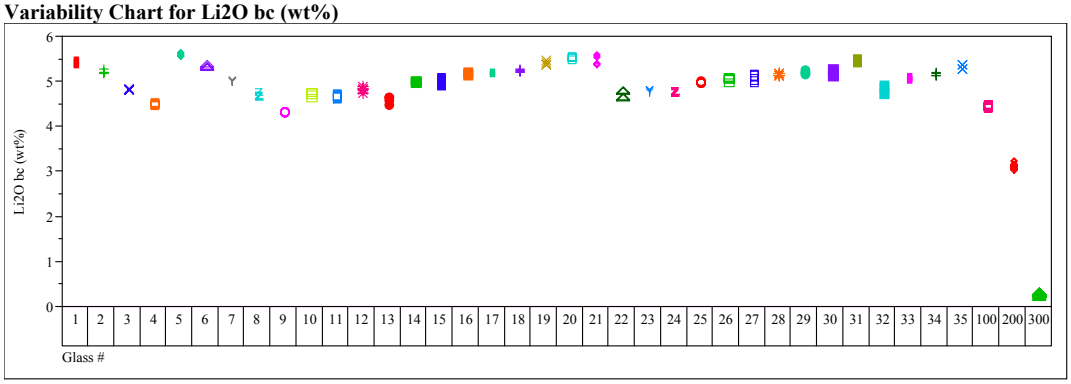
Exhibit E6. Measured and Measured Bias-Corrected Oxide Weight Percents by Glass # for the Glasses Prepared Using the PF Method (continued)

(100 – Batch 1; 200 – Ustd)

Variability Chart for Li2O (wt%)



Variability Chart for Li2O bc (wt%)



Variability Chart for NiO (wt%)

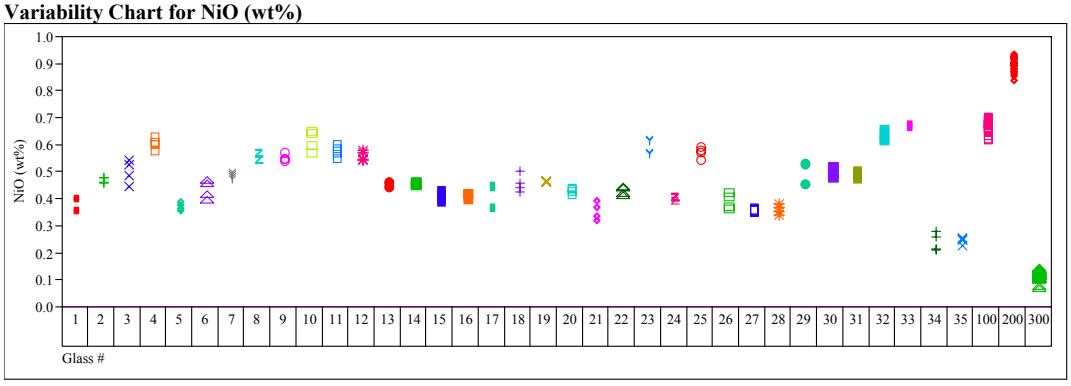
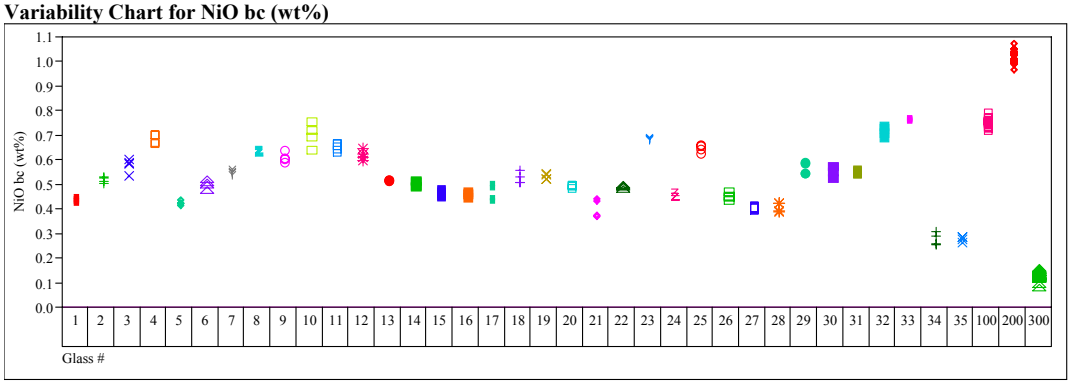


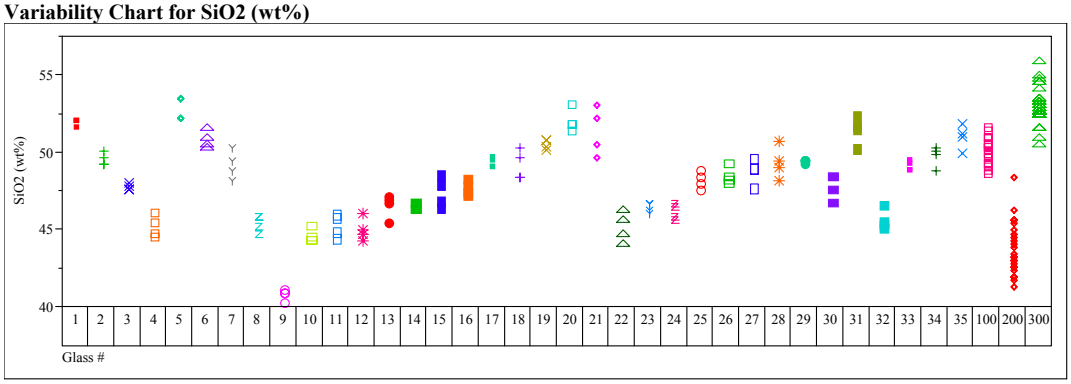
Exhibit E6. Measured and Measured Bias-Corrected Oxide Weight Percents by Glass # for the Glasses Prepared Using the PF Method (continued)

(100 – Batch 1; 200 – Ustd)

Variability Chart for NiO bc (wt%)



Variability Chart for SiO2 (wt%)



Variability Chart for SiO2 bc (wt%)

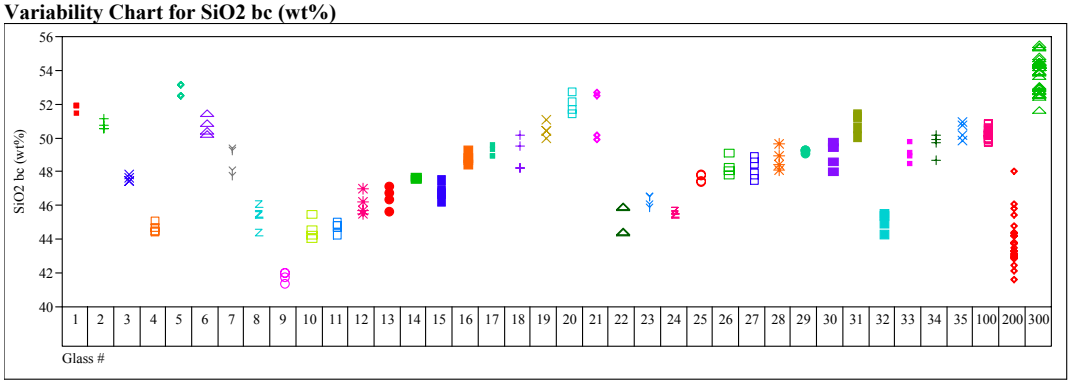
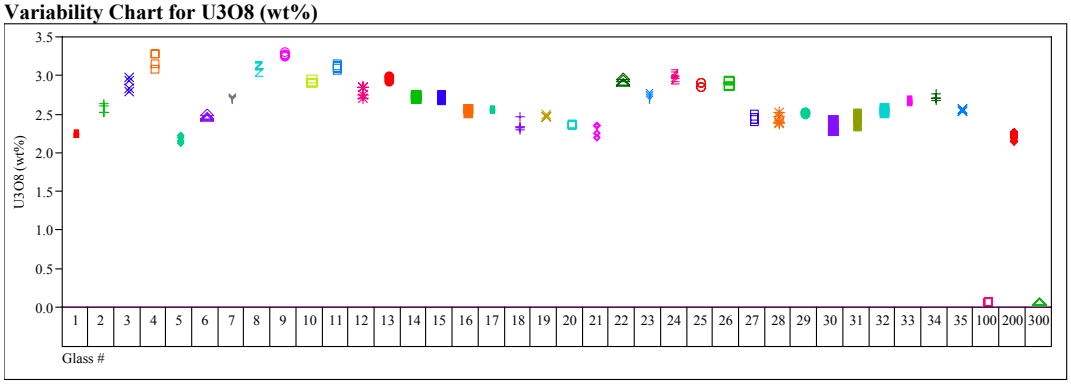


Exhibit E6. Measured and Measured Bias-Corrected Oxide Weight Percents by Glass # for the Glasses Prepared Using the PF Method (continued)

(100 – Batch 1; 200 – Ustd)

Variability Chart for U3O8 (wt%)



Variability Chart for U3O8 bc (wt%)

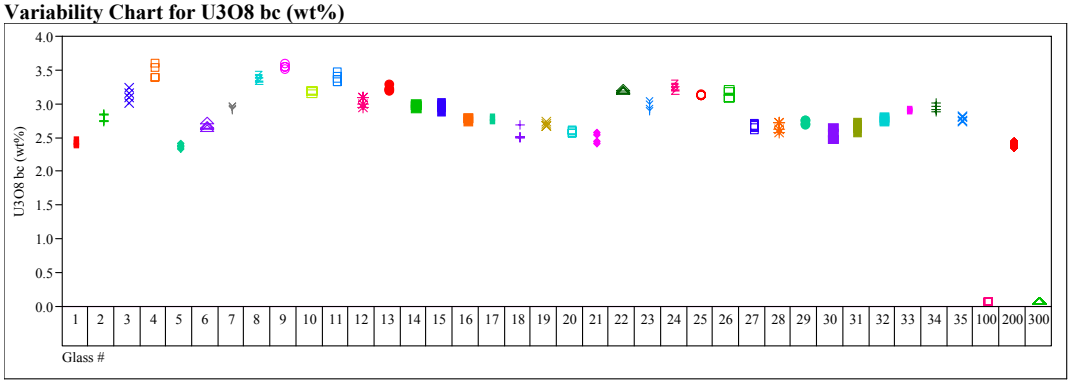
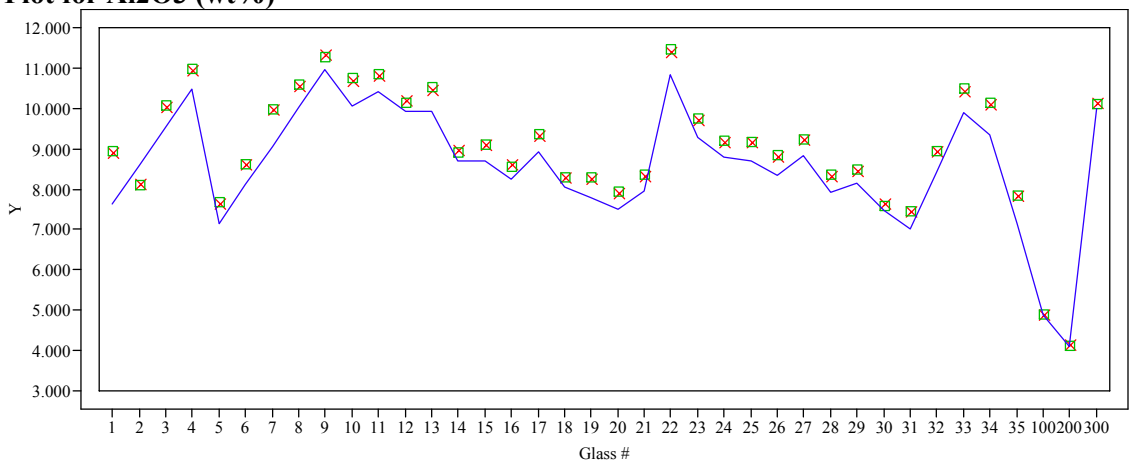


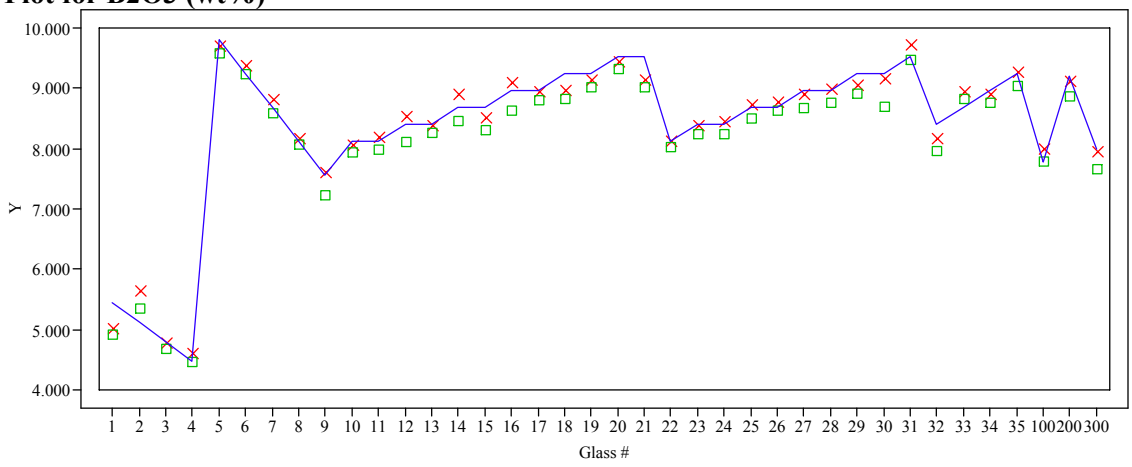
Exhibit E7. Average Measured and Bias-Corrected (bc) Versus Targeted Compositions by Glass # by Oxide

(100 – Batch 1; 200 – Ustd)

Plot for Al2O3 (wt%)



Plot for B2O3 (wt%)



Plot for BaO (wt%)

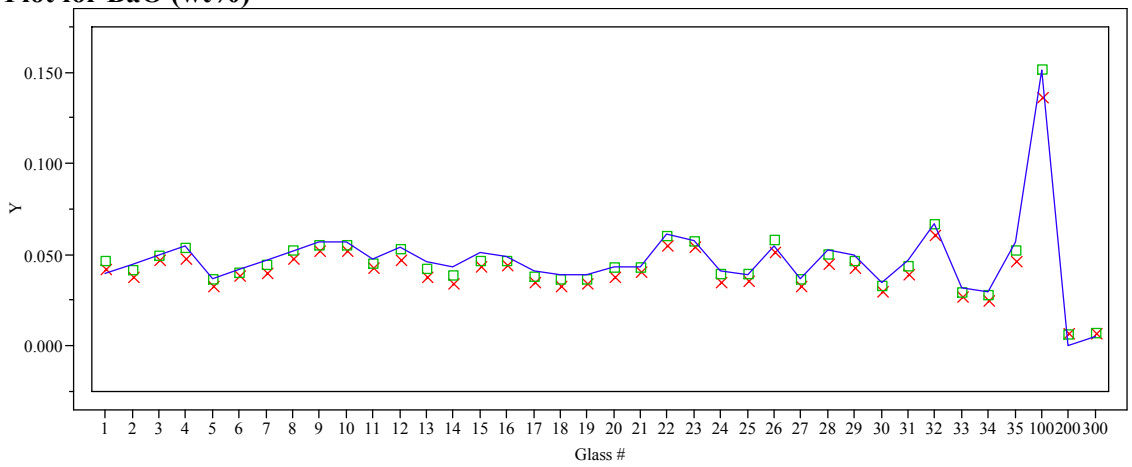
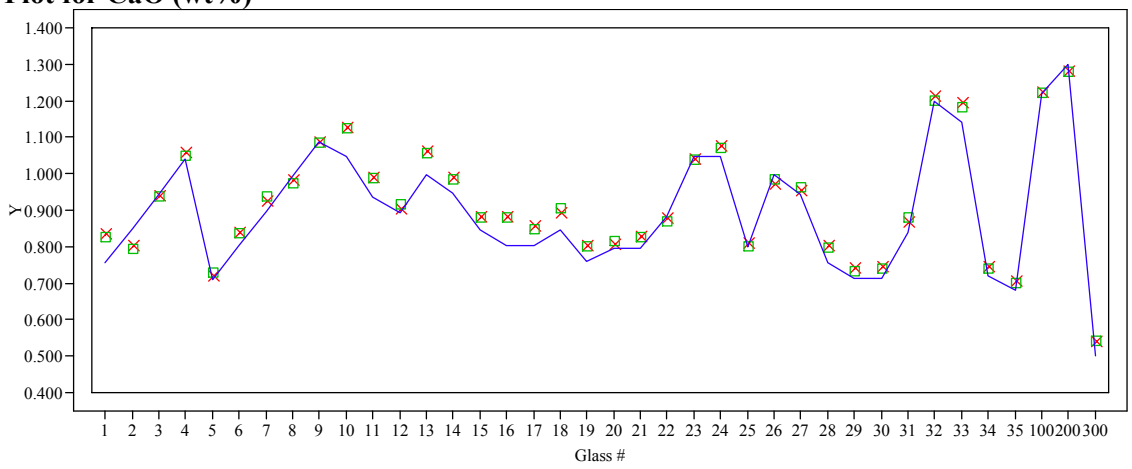


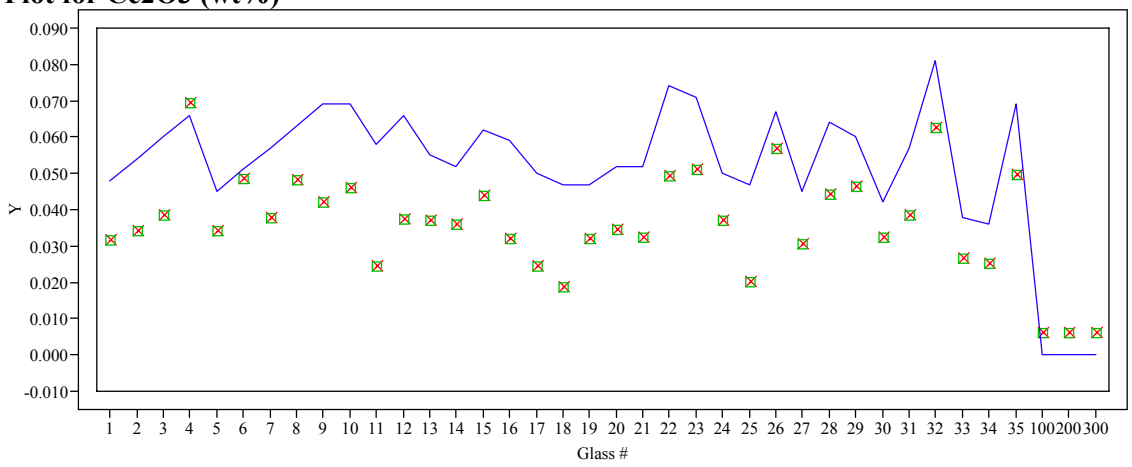
Exhibit E7. Average Measured and Bias-Corrected (bc) Versus Targeted Compositions by Glass # by Oxide (continued)

(100 – Batch 1; 200 – Ustd)

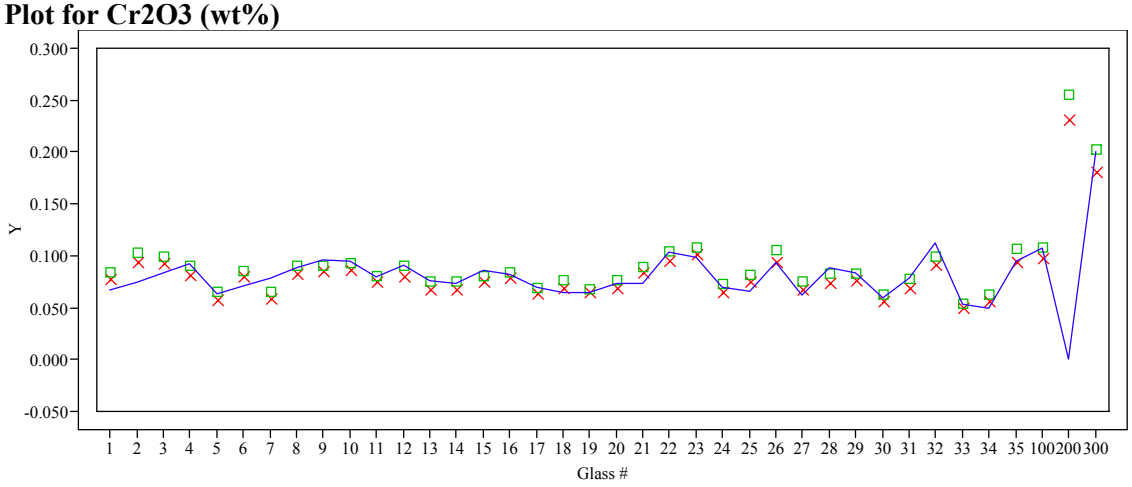
Plot for CaO (wt%)



Plot for Ce2O3 (wt%)



Plot for Cr2O3 (wt%)

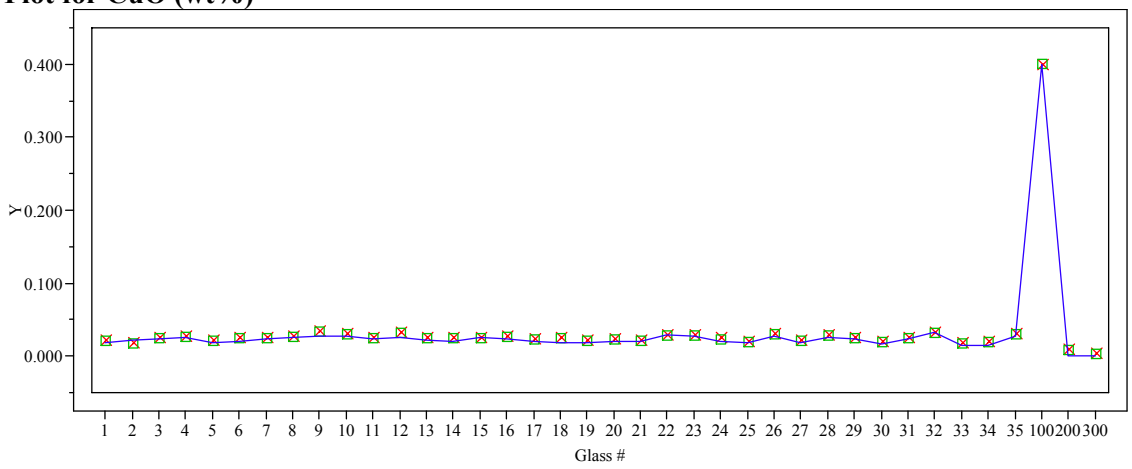


Y × Measured (wt%) ▫ Measured bc (wt%) — Targeted (wt%)

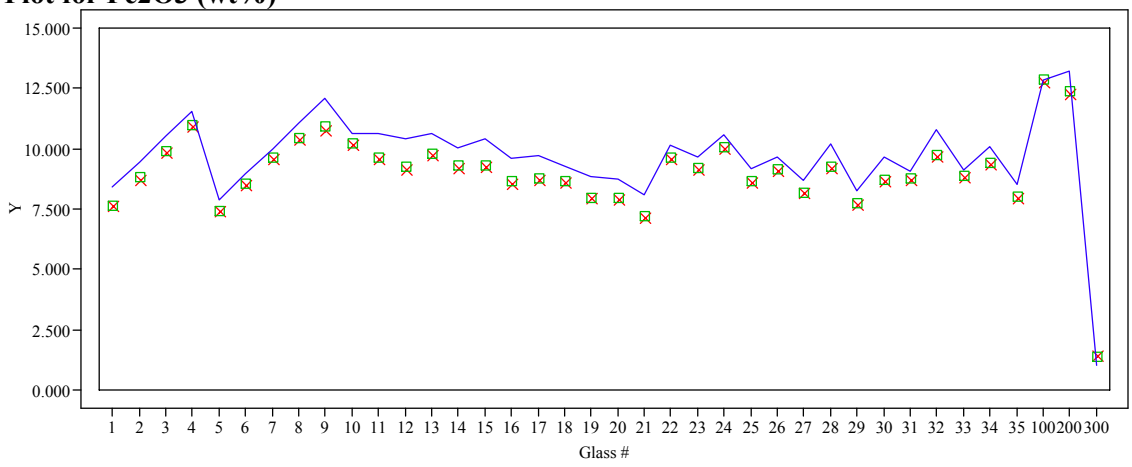
Exhibit E7. Average Measured and Bias-Corrected (bc) Versus Targeted Compositions by Glass # by Oxide (continued)

(100 – Batch 1; 200 – Ustd)

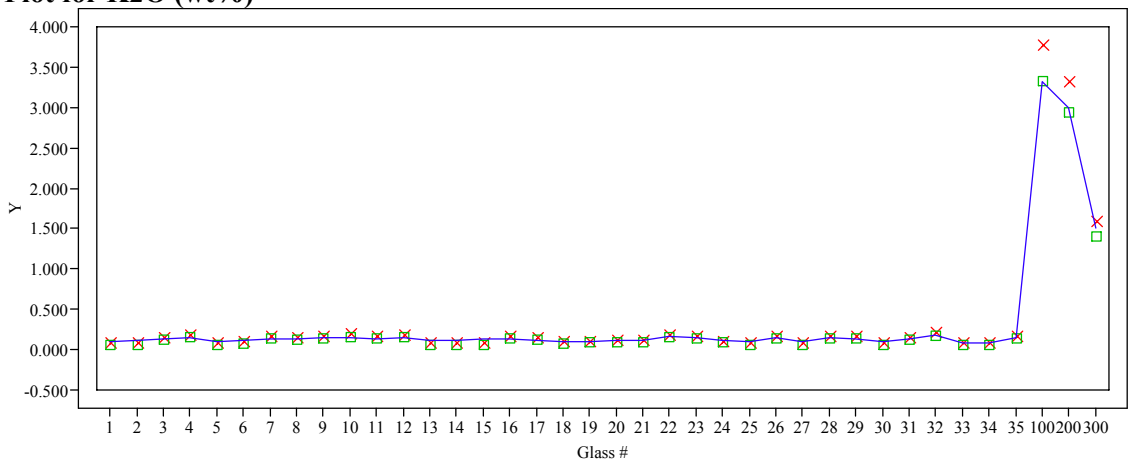
Plot for CuO (wt%)



Plot for Fe2O3 (wt%)



Plot for K2O (wt%)

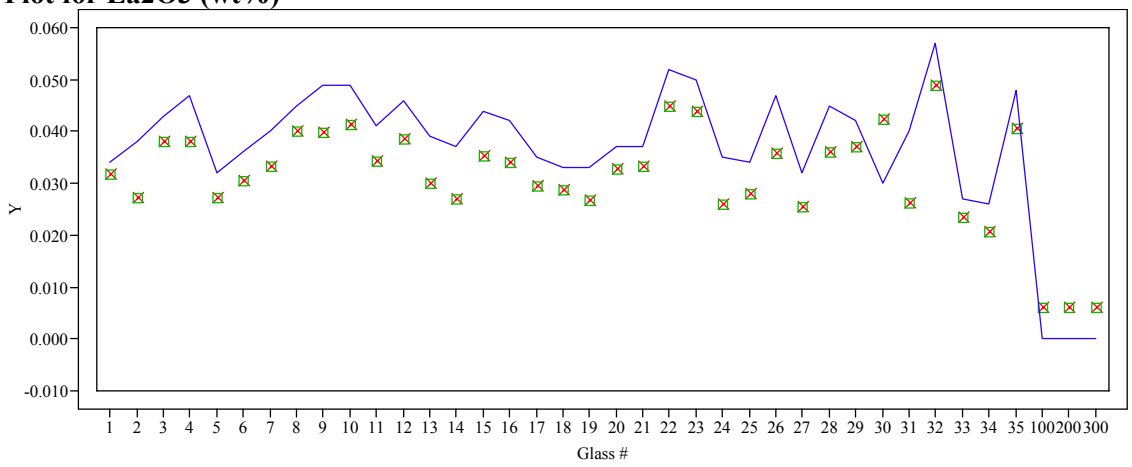


Y Measured (wt%) Measured bc (wt%) Targeted (wt%)

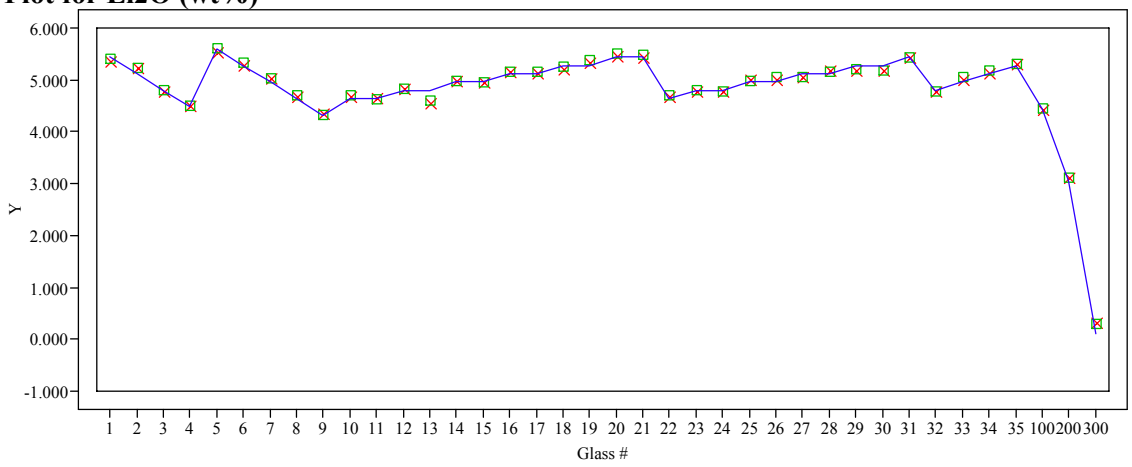
Exhibit E7. Average Measured and Bias-Corrected (bc) Versus Targeted Compositions by Glass # by Oxide (continued)

(100 – Batch 1; 200 – Ustd)

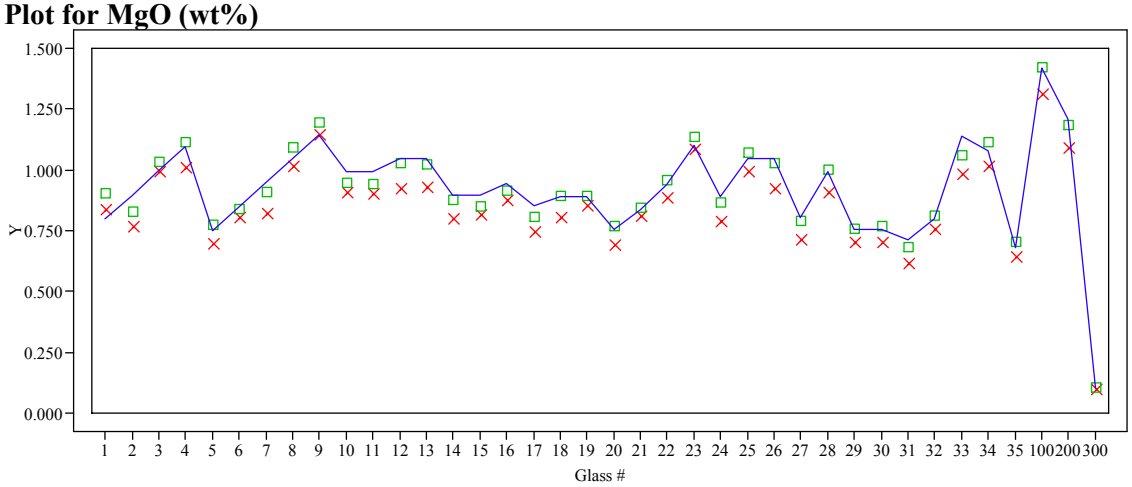
Plot for La2O3 (wt%)



Plot for Li2O (wt%)



Plot for MgO (wt%)

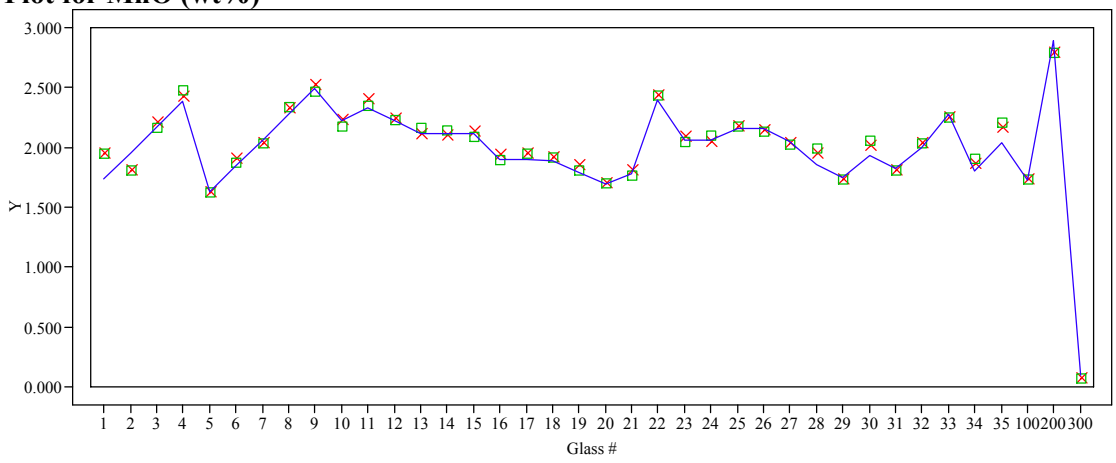


Y × Measured (wt%) ▫ Measured bc (wt%) — Targeted (wt%)

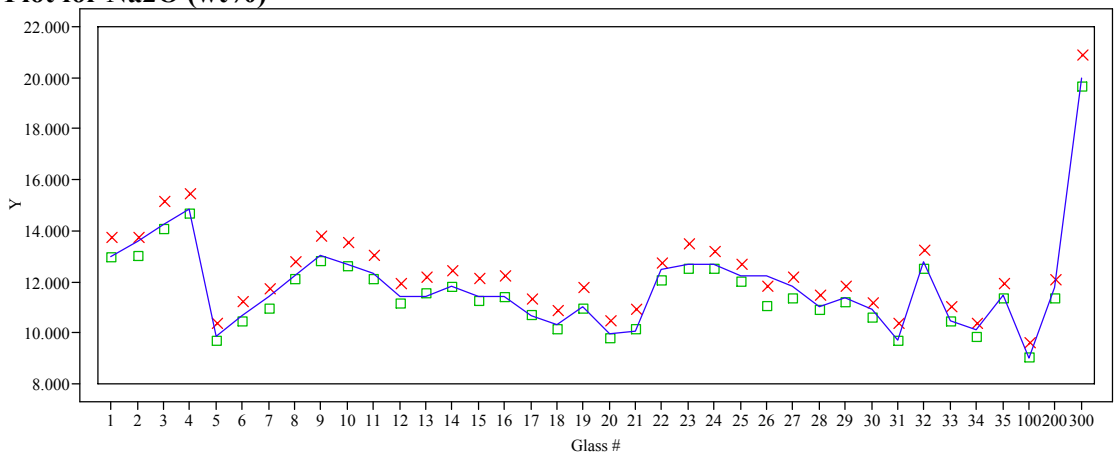
Exhibit E7. Average Measured and Bias-Corrected (bc) Versus Targeted Compositions by Glass # by Oxide (continued)

(100 – Batch 1; 200 – Ustd)

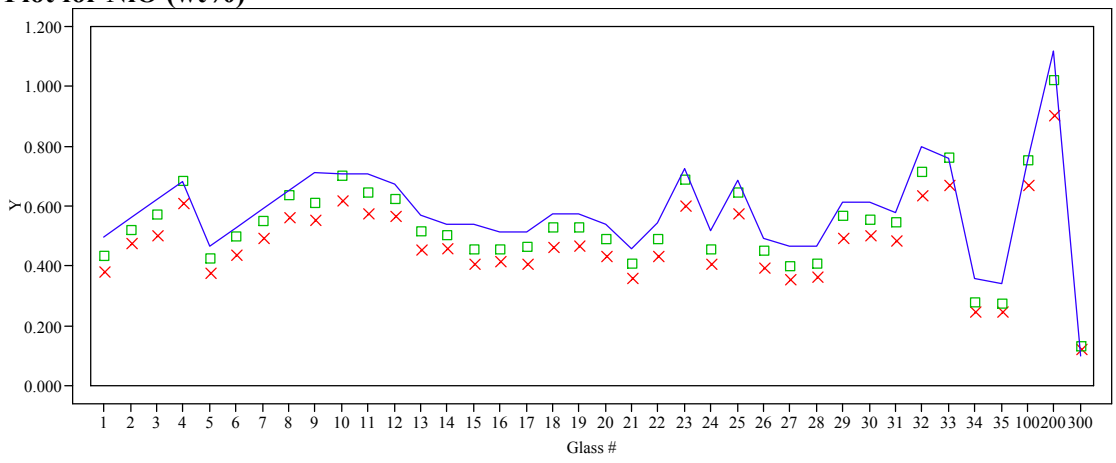
Plot for MnO (wt%)



Plot for Na2O (wt%)



Plot for NiO (wt%)



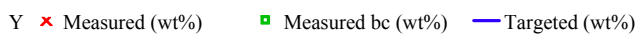
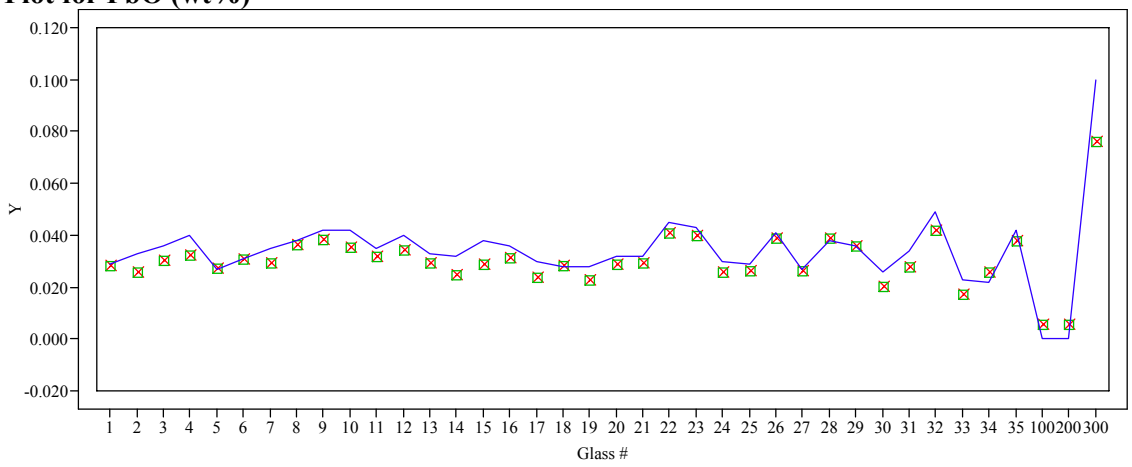


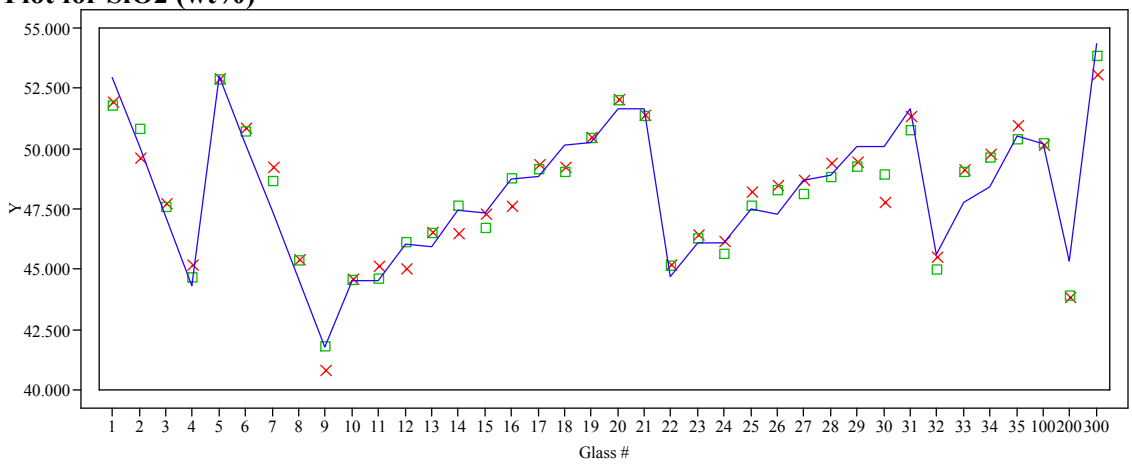
Exhibit E7. Average Measured and Bias-Corrected (bc) Versus Targeted Compositions by Glass # by Oxide (continued)

(100 – Batch 1; 200 – Ustd)

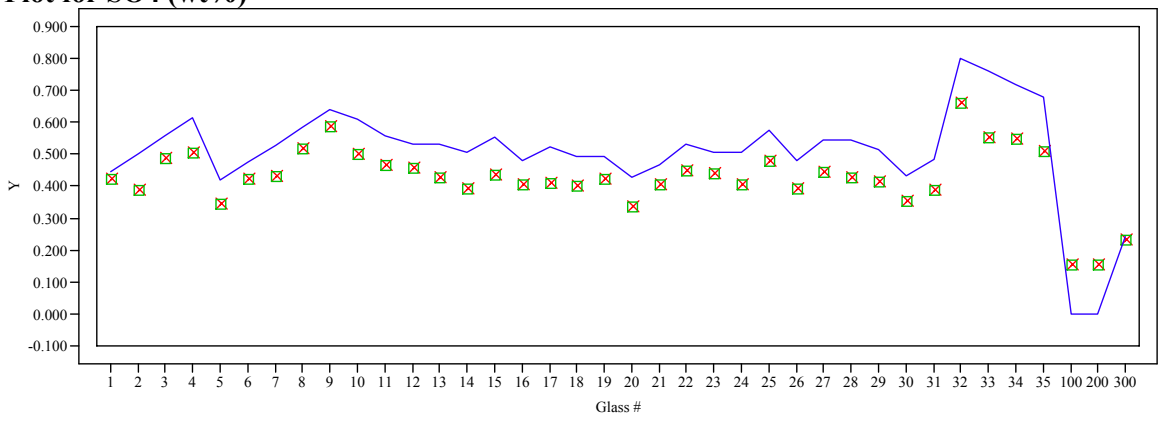
Plot for PbO (wt%)



Plot for SiO2 (wt%)



Plot for SO4 (wt%)

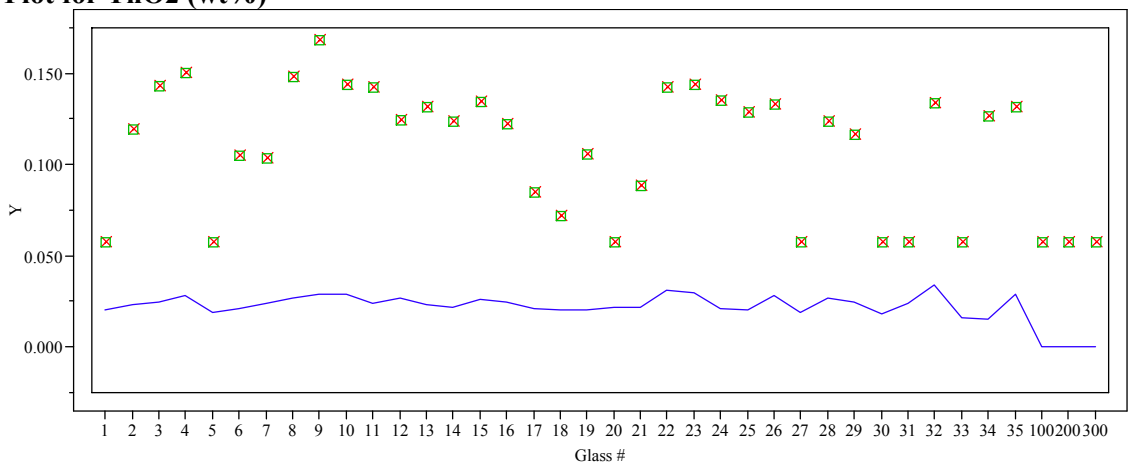


Y × Measured (wt%) ▫ Measured bc (wt%) — Targeted (wt%)

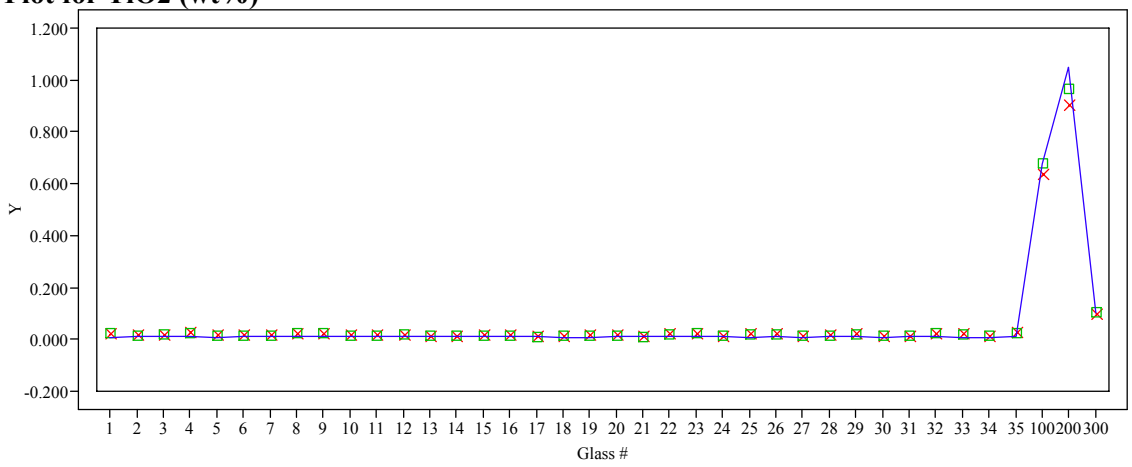
Exhibit E7. Average Measured and Bias-Corrected (bc) Versus Targeted Compositions by Glass # by Oxide (continued)

(100 – Batch 1; 200 – Ustd)

Plot for ThO2 (wt%)



Plot for TiO2 (wt%)



Plot for U3O8 (wt%)

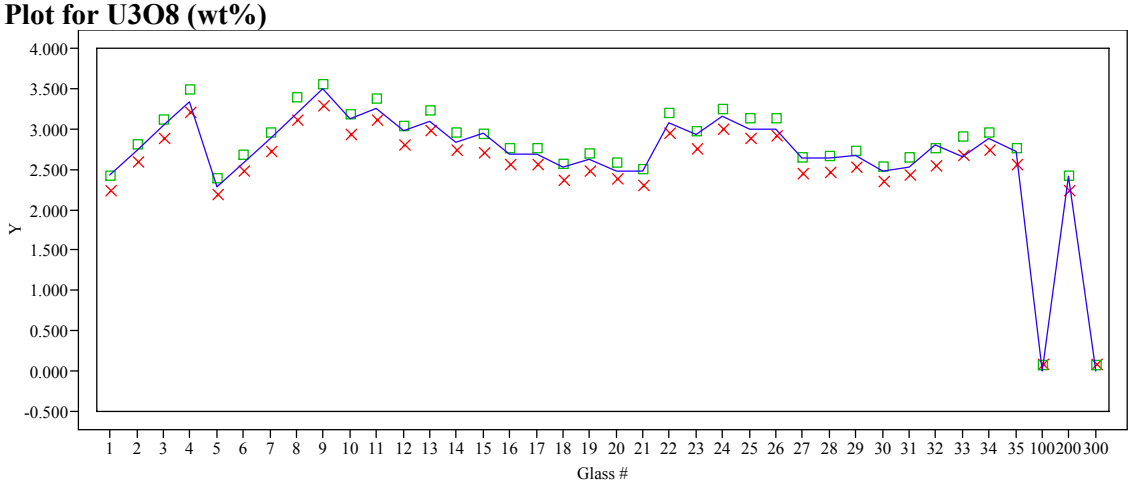
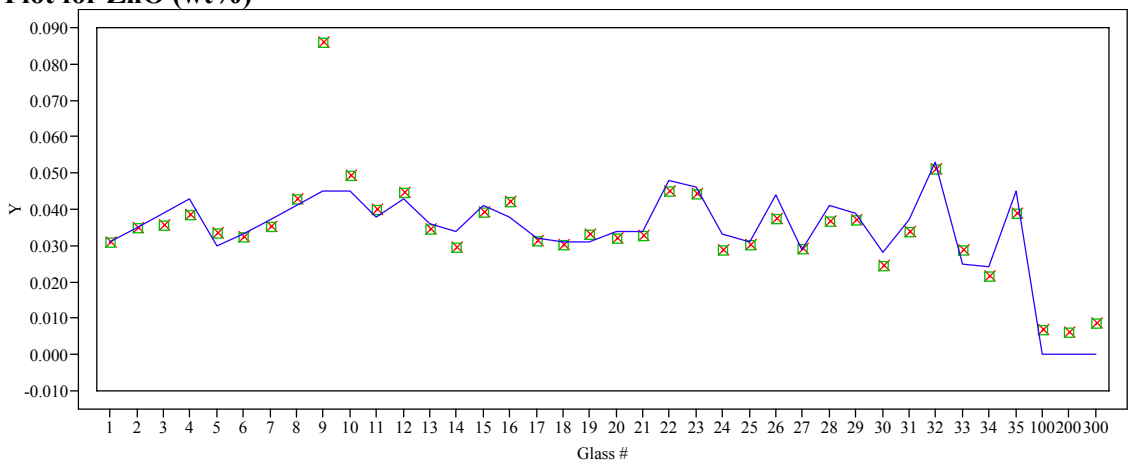


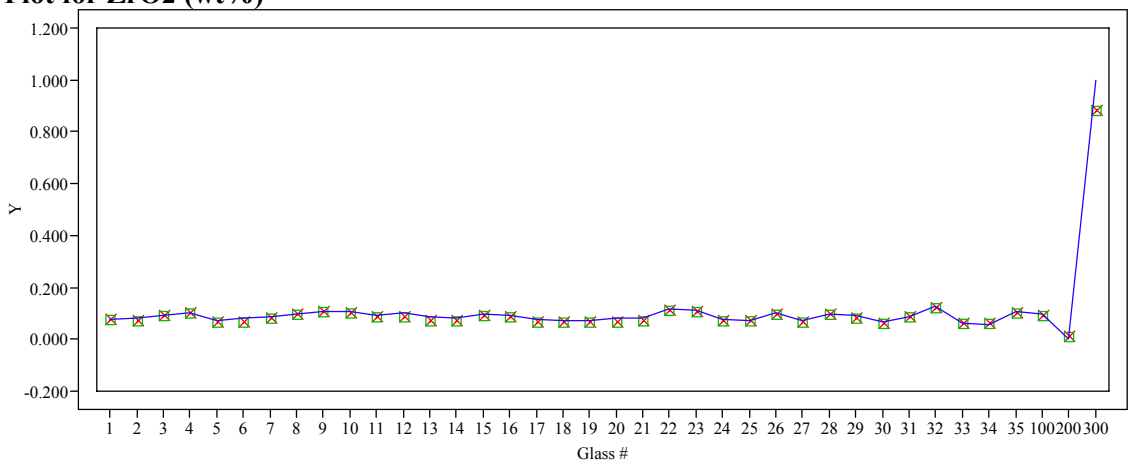
Exhibit E7. Average Measured and Bias-Corrected (bc) Versus Targeted Compositions by Glass # by Oxide (continued)

(100 – Batch 1; 200 – Ustd)

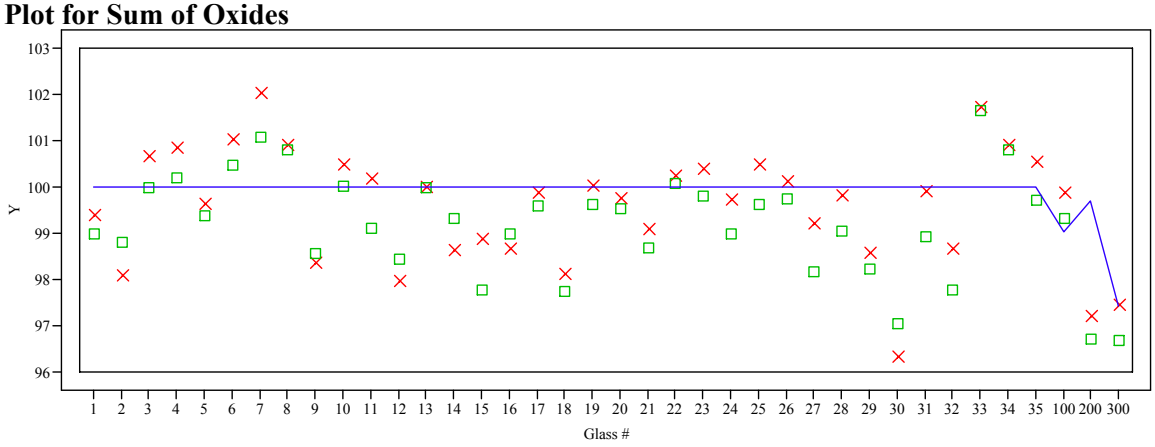
Plot for ZnO (wt%)



Plot for ZrO2 (wt%)



Plot for Sum of Oxides



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

Appendix F

Tables and Exhibits Supporting the Analysis of the PCT Results for the SB4 Variability Study Glasses

Table F1. Laboratory Measurements of the PCT Solutions for the Nepheline Study Glasses

Set	Glass ID	Heat Treatment	Laboratory ID	Block	Seq	Al (ppm)	B (ppm)	Fe (ppm)	Li (ppn)	Na (ppm)	Si (ppm)	Th (ppm)	U (ppm)
1	Soln Std		Soln Std	1	1	3.85	22.0	3.98	9.76	82.9	49.1	<0.100	<0.100
1	SB4VS-06	quenched	R38	1	2	10.4	11.2	3.57	10.3	26.3	61.3	<0.100	2.02
1	SB4VS-06ccc	ccc	R40	1	3	10.6	11.1	3.26	10.1	27.6	61.7	<0.100	2.30
1	SB4VS-01	quenched	R29	1	4	12.8	6.53	6.30	11.7	50.8	74.7	<0.100	2.58
1	SB4VS-01ccc	ccc	R08	1	5	13.0	6.33	5.70	11.9	48.7	74.7	<0.100	2.50
1	blank		R49	1	6	<0.100	<0.100	<0.100	<0.500	<0.100	<0.100	<0.100	<0.100
1	SB4VS-08	quenched	R51	1	7	13.8	10.4	3.22	9.14	36.4	54.6	<0.100	1.49
1	SB4VS-08ccc	ccc	R23	1	8	13.7	10.2	3.23	8.95	36.0	54.3	<0.100	1.76
1	SB4VS-02	quenched	R46	1	9	12.1	7.62	6.59	11.6	51.9	76.3	<0.100	2.16
1	SB4VS-03	quenched	R55	1	10	12.0	7.45	6.43	11.8	49.0	76.1	<0.100	2.22
1	SB4VS-04	quenched	R13	1	11	18.2	7.37	5.18	10.4	70.6	69.5	<0.100	1.91
1	Soln Std		Soln Std	1	12	4.01	21.0	4.01	9.85	82.5	50.1	<0.100	<0.100
1	SB4VS-04ccc	ccc	R52	1	13	18.3	8.15	4.73	11.2	67.4	70.8	<0.100	1.77
1	SB4VS-07	quenched	R17	1	14	12.0	11.3	3.04	9.83	32.6	58.6	<0.100	1.54
1	SB4VS-07ccc	ccc	R43	1	15	12.1	10.7	2.81	9.41	31.2	57.5	<0.100	1.87
1	SB4VS-05	quenched	R42	1	16	9.40	11.6	4.03	11.1	23.6	66.9	<0.100	3.66
1	SB4VS-05ccc	ccc	R19	1	17	10.9	12.0	6.53	11.6	24.0	69.2	<0.100	3.04
1	EA		R30	1	18	<0.100	25.0	<0.100	8.42	70.2	42.0	<0.100	<0.100
1	ARM-1		R05	1	19	3.16	11.1	<0.100	8.44	22.9	37.1	<0.100	<0.100
1	SB4VS-09	quenched	R22	1	20	16.4	11.0	3.04	8.86	45.0	53.3	<0.100	1.76
1	SB4VS-09ccc	ccc	R60	1	21	15.1	24.6	4.43	18.1	66.3	68.4	<0.100	2.31
1	SB4VS-03	quenched	R32	1	22	16.7	7.94	6.44	11.4	64.0	75.6	<0.100	2.00
1	SB4VS-03ccc	ccc	R06	1	23	16.1	7.34	5.35	11.5	59.5	73.3	<0.100	1.98
1	Soln Std		Soln Std	1	24	4.15	21.2	3.98	9.94	83.5	50.5	<0.100	<0.100
1	Soln Std		Soln Std	2	1	3.95	21.5	3.70	9.82	80.4	49.1	<0.100	<0.100
1	SB4VS-06	quenched	R39	2	2	10.1	11.4	3.12	10.2	25.1	60.6	<0.100	2.02
1	SB4VS-06ccc	ccc	R04	2	3	10.1	10.9	2.93	9.83	25.9	60.3	<0.100	2.10
1	SB4VS-01	quenched	R45	2	4	13.0	6.57	5.95	11.8	48.9	75.7	<0.100	2.54
1	SB4VS-01ccc	ccc	R21	2	5	12.5	6.10	5.52	11.7	44.7	73.4	<0.100	2.44
1	SB4VS-08	quenched	R16	2	6	13.5	10.0	2.72	9.00	34.7	53.1	<0.100	1.60
1	SB4VS-08ccc	ccc	R10	2	7	13.1	9.76	2.39	8.71	33.2	51.7	<0.100	1.82
1	SB4VS-02	quenched	R37	2	8	12.0	7.24	6.16	11.5	48.3	74.5	<0.100	2.05
1	SB4VS-01ccc	ccc	R57	2	9	11.7	7.17	5.64	11.7	45.2	74.8	<0.100	2.06
1	SB4VS-04	quenched	R48	2	10	18.1	7.01	4.23	10.3	66.8	67.4	<0.100	1.84
1	SB4VS-04ccc	ccc	R36	2	11	18.4	7.50	4.65	11.3	65.5	71.1	<0.100	1.81
1	Soln Std		Soln Std	2	12	4.05	21.0	3.71	9.95	79.8	49.9	<0.100	<0.100
1	SB4VS-07	quenched	R62	2	13	12.1	11.3	2.76	9.94	31.0	58.7	<0.100	1.70
1	SB4VS-07ccc	ccc	R47	2	14	11.9	10.6	2.46	9.38	30.6	57.4	<0.100	1.94
1	SB4VS-05	quenched	R12	2	15	9.06	11.2	3.52	10.9	23.4	64.5	<0.100	3.45

Table F1. Laboratory Measurements of the PCT Solutions for the Nepheline Study Glasses (continued)

Set	Glass ID	Heat Treatment	Laboratory ID	Block	Seq	Al (ppm)	B (ppm)	Fe (ppm)	Li (ppm)	Na (ppm)	Si (ppm)	Th (ppm)	U (ppm)
1	SB4VS-09ccc	ccc	R59	2	16	9.35	11.4	4.31	11.3	22.3	65.8	<0.100	3.12
1	EA		R20	2	17	<0.100	27.0	<0.100	8.96	72.6	44.0	<0.100	<0.100
1	ARM-1		R61	2	18	3.06	11.6	<0.100	8.77	23.7	37.6	<0.100	<0.100
1	SB4VS-09	quenched	R11	2	19	16.4	10.9	2.92	9.08	44.3	53.7	<0.100	1.48
1	SB4VS-09ccc	ccc	R27	2	20	15.7	25.1	4.85	18.5	67.4	71.0	<0.100	1.87
1	SB4VS-03	quenched	R50	2	21	15.7	7.24	5.13	11.0	61.4	72.2	<0.100	1.90
1	SB4VS-03ccc	ccc	R01	2	22	15.6	7.06	4.90	11.4	57.2	72.4	<0.100	2.00
1	Soln Std		Soln Std	2	23	4.05	21.1	3.76	10.0	81.8	50.4	<0.100	<0.100
1	Soln Std		Soln Std	3	1	4.01	21.4	3.60	9.83	81.6	48.8	<0.100	<0.100
1	SB4VS-06	quenched	R24	3	2	10.5	11.8	3.26	10.5	26.9	62.0	<0.100	1.99
1	SB4VS-06ccc	ccc	R33	3	3	10.2	11.0	2.87	9.84	25.8	60.0	<0.100	2.30
1	blank		R03	3	4	<0.100	<0.100	<0.100	<0.500	<0.100	<0.100	<0.100	<0.100
1	SB4VS-01	quenched	R35	3	5	12.6	6.34	5.83	11.8	49.7	74.0	<0.100	2.16
1	SB4VS-05ccc	ccc	R58	3	6	12.5	6.13	5.70	11.8	47.6	73.4	<0.100	2.98
1	SB4VS-08	quenched	R34	3	7	13.4	10.1	2.73	8.97	35.4	52.9	<0.100	1.42
1	SB4VS-08ccc	ccc	R31	3	8	13.8	10.5	2.45	9.18	36.8	54.5	<0.100	1.40
1	SB4VS-02	quenched	R18	3	9	12.2	7.46	7.00	11.8	51.3	76.6	<0.100	2.27
1	SB4VS-02ccc	ccc	R14	3	10	12.0	7.42	6.31	11.8	47.2	76.3	<0.100	2.15
1	SB4VS-04	quenched	R15	3	11	18.0	7.34	4.54	10.3	66.5	69.1	<0.100	1.74
1	Soln Std		Soln Std	3	12	4.09	21.4	3.87	10.0	83.5	50.9	<0.100	<0.100
1	SB4VS-04ccc	ccc	R02	3	13	20.8	8.48	6.83	11.7	67.7	74.8	<0.100	1.79
1	SB4VS-07	quenched	R26	3	14	11.9	10.8	3.20	9.54	30.2	57.6	<0.100	1.88
1	SB4VS-07ccc	ccc	R41	3	15	11.9	10.8	2.90	9.47	31.1	58.3	<0.100	1.97
1	SB4VS-05	quenched	R44	3	16	9.74	11.6	4.00	11.1	23.5	66.8	<0.100	3.78
1	SB4VS-05ccc	ccc	R53	3	17	9.48	12.0	4.65	11.5	22.7	68.2	<0.100	3.22
1	EA		R25	3	18	<0.100	37.1	<0.100	10.7	94.4	52.1	<0.100	<0.100
1	ARM-1		R09	3	19	3.17	12.0	<0.100	8.69	24.0	39.9	<0.100	<0.100
1	SB4VS-09	quenched	R07	3	20	16.3	11.2	3.23	9.18	45.2	54.4	<0.100	1.51
1	SB4VS-02ccc	ccc	R54	3	21	15.4	25.5	4.91	18.3	66.0	71.0	<0.100	2.29
1	SB4VS-02ccc	ccc	R56	3	22	15.8	7.69	6.06	11.3	61.8	75.4	<0.100	2.15
1	SB4VS-03ccc	ccc	R28	3	23	15.8	7.58	5.87	11.6	60.2	74.8	<0.100	1.97
1	Soln Std		Soln Std	3	24	4.44	21.5	4.17	10.0	82.3	51.3	<0.100	<0.100
2	Soln Std		Soln Std	1	1	3.75	21.2	3.95	9.80	79.6	47.6	<0.100	<0.100
2	SB4VS-18ccc	ccc	S79	1	2	9.75	11.0	2.77	9.84	23.4	57.2	<0.100	2.83
2	blank		S26	1	3	0.656	0.351	<0.100	<1.00	<0.100	0.287	<0.100	<0.100
2	SB4VS-19	quenched	S51	1	4	9.24	11.2	3.01	10.4	27.0	58.9	<0.100	2.32
2	SB4VS-21	quenched	S29	1	5	9.42	10.3	2.87	10.1	20.4	57.0	<0.100	2.51
2	SB4VS-12ccc	ccc	S80	1	6	12.6	10.4	2.31	9.49	30.1	53.6	<0.100	1.56
2	EA		S07	1	7	<0.100	37.5	<0.100	11.1	99.7	50.1	<0.100	<0.100
2	SB4VS-13	quenched	S04	1	8	13.0	10.4	2.74	9.07	29.3	51.7	<0.100	1.83

Table F1. Laboratory Measurements of the PCT Solutions for the Nepheline Study Glasses (continued)

Set	Glass ID	Heat Treatment	Laboratory ID	Block	Seq	Al (ppm)	B (ppm)	Fe (ppm)	Li (ppm)	Na (ppm)	Si (ppm)	Th (ppm)	U (ppm)
2	Soln Std		Soln Std	1	9	3.79	20.4	4.06	9.81	81.4	47.7	<0.100	<0.100
2	SB4VS-11	quenched	S20	1	10	14.2	11.0	2.56	9.41	36.9	53.0	<0.100	1.61
2	SB4VS-21ccc	ccc	S01	1	11	9.47	10.5	2.46	9.98	21.8	57.5	<0.100	2.71
2	SB4VS-18	quenched	S56	1	12	9.78	10.8	2.53	10.3	23.4	57.2	<0.100	2.04
2	SB4VS-11ccc	ccc	S48	1	13	14.4	10.5	2.64	9.39	36.2	53.1	<0.100	1.56
2	SB4VS-13ccc	ccc	S66	1	14	13.2	10.2	2.50	8.90	29.5	53.2	<0.100	1.73
2	SB4VS-12	quenched	S25	1	15	14.3	10.7	2.52	9.89	31.7	54.0	<0.100	1.60
2	SB4VS-19ccc	ccc	S65	1	16	9.43	10.5	2.59	9.91	27.3	58.6	<0.100	2.53
2	Soln Std		Soln Std	1	17	3.86	19.9	3.99	9.79	82.1	47.0	<0.100	<0.100
2	Soln Std		Soln Std	2	1	3.97	20.5	3.77	10.1	84.9	50.7	<0.100	<0.100
2	SB4VS-11	quenched	S13	2	2	15.0	11.2	4.11	9.90	40.4	57.9	<0.100	1.61
2	SB4VS-11ccc	ccc	S34	2	3	13.9	10.8	2.62	9.31	36.6	54.0	<0.100	1.55
2	SB4VS-12ccc	ccc	S57	2	4	12.9	10.7	2.19	9.62	32.0	54.5	<0.100	1.64
2	SB4VS-21ccc	ccc	S45	2	5	9.35	10.2	2.78	9.88	22.6	58.6	<0.100	2.62
2	SB4VS-18	quenched	S53	2	6	9.72	10.8	2.77	10.5	24.7	58.5	<0.100	2.16
2	SB4VS-12	quenched	S54	2	7	13.7	11.0	3.05	10.1	33.7	56.4	<0.100	1.67
2	SB4VS-21	quenched	S16	2	8	9.49	10.6	2.51	10.5	22.8	58.1	<0.100	2.51
2	Soln Std		Soln Std	2	9	3.88	20.6	3.71	9.94	85.7	47.8	<0.100	<0.100
2	SB4VS-19ccc	ccc	S50	2	10	9.72	11.0	2.75	10.1	28.3	61.2	<0.100	2.59
2	SB4VS-13	quenched	S69	2	11	13.2	10.7	2.44	9.55	32.6	55.5	<0.100	1.74
2	EA		S30	2	12	0.182	36.1	0.143	10.9	99.2	51.3	<0.100	<0.100
2	SB4VS-13ccc	ccc	S02	2	13	12.9	10.4	2.60	8.88	30.4	54.8	<0.100	1.77
2	SB4VS-18ccc	ccc	S19	2	14	10.1	10.1	2.13	9.77	24.6	57.3	<0.100	2.49
2	SB4VS-19	quenched	S15	2	15	9.63	11.1	4.22	10.5	29.2	60.1	<0.100	2.38
2	Soln Std		Soln Std	2	16	3.98	20.2	3.73	10.0	86.8	49.2	<0.100	<0.100
2	Soln Std		Soln Std	3	1	4.03	22.0	3.99	10.1	82.9	49.5	<0.100	<0.100
2	SB4VS-11	quenched	S31	3	2	14.3	11.2	2.82	9.35	36.7	54.2	<0.100	1.52
2	SB4VS-12ccc	ccc	S70	3	3	13.5	11.4	2.65	9.98	31.9	57.4	<0.100	1.62
2	SB4VS-19ccc	ccc	S73	3	4	10.2	11.2	3.18	10.1	27.7	60.3	<0.100	2.41
2	SB4VS-13	quenched	S55	3	5	13.2	11.1	2.87	9.55	30.9	55.5	<0.100	1.53
2	SB4VS-21	quenched	S63	3	6	9.70	11.3	4.06	10.8	22.4	61.7	<0.100	2.33
2	SB4VS-13ccc	ccc	S23	3	7	13.5	10.4	2.75	8.82	29.5	53.6	<0.100	1.51
2	SB4VS-12	quenched	S59	3	8	13.4	11.2	2.61	10.1	32.8	57.1	<0.100	1.60
2	Soln Std		Soln Std	3	9	4.14	21.1	3.93	9.89	84.0	49.3	<0.100	<0.100
2	SB4VS-19	quenched	S72	3	10	10.7	11.8	4.76	10.5	28.3	61.2	<0.100	1.94
2	SB4VS-21ccc	ccc	S09	3	11	9.29	10.4	2.79	9.75	21.4	58.5	<0.100	2.41
2	SB4VS-18ccc	ccc	S39	3	12	9.89	11.0	2.72	10.1	24.9	59.6	<0.100	1.65
2	EA		S68	3	13	1.31	37.5	1.12	10.9	101	51.9	<0.100	<0.100
2	SB4VS-11ccc	ccc	S77	3	14	14.7	11.4	2.62	9.65	37.9	56.2	<0.100	1.48
2	SB4VS-18	quenched	S22	3	15	10.1	11.0	3.13	10.3	23.5	58.4	<0.100	2.09

Table F1. Laboratory Measurements of the PCT Solutions for the Nepheline Study Glasses (continued)

Set	Glass ID	Heat Treatment	Laboratory ID	Block	Seq	Al (ppm)	B (ppm)	Fe (ppm)	Li (ppm)	Na (ppm)	Si (ppm)	Th (ppm)	U (ppm)
2	Soln Std		Soln Std	3	16	4.08	21.2	4.01	10.1	85.9	49.8	<0.100	<0.100
2	Soln Std		Soln Std	4	1	3.78	21.8	3.95	9.95	80.9	48.8	<0.100	<0.100
2	SB4VS-16ccc	ccc	S61	4	2	10.3	11.3	3.20	9.70	29.9	59.1	<0.100	2.60
2	SB4VS-14ccc	ccc	S05	4	3	11.3	11.6	2.95	10.1	34.0	61.5	<0.100	1.89
2	SB4VS-20ccc	ccc	S78	4	4	8.80	10.9	2.88	10.2	22.1	61.2	<0.100	3.00
2	SB4VS-17ccc	ccc	S44	4	5	10.8	9.9	3.00	9.24	25.1	55.6	<0.100	2.73
2	SB4VS-10	quenched	S52	4	6	13.5	11.3	2.68	9.64	41.3	55.3	<0.100	1.67
2	SB4VS-10ccc	ccc	S10	4	7	13.4	10.6	2.43	9.21	38.6	54.6	<0.100	1.55
2	SB4VS-14	quenched	S41	4	8	11.7	11.9	3.42	10.7	35.9	61.5	<0.100	2.11
2	Soln Std		Soln Std	4	9	3.85	21.3	4.02	9.73	81.7	48.7	<0.100	<0.100
2	SB4VS-20	quenched	S33	4	10	9.10	11.1	3.73	10.5	21.8	61.8	<0.100	2.63
2	SB4VS-16	quenched	S12	4	11	11.2	12.7	3.82	11.4	34.7	64.9	<0.100	2.44
2	SB4VS-15ccc	ccc	S40	4	12	11.3	11.0	3.42	9.84	31.1	58.5	<0.100	2.09
2	SB4VS-15	quenched	S74	4	13	11.5	11.5	3.21	10.5	32.8	59.8	<0.100	1.98
2	SB4VS-17	quenched	S28	4	14	11.3	9.9	2.85	9.46	24.3	55.5	<0.100	2.39
2	ARM-1		S37	4	15	2.66	10.5	<0.100	7.90	20.7	34.9	<0.100	<0.100
2	Soln Std		Soln Std	4	16	3.86	20.5	4.11	9.76	83.0	48.7	<0.100	<0.100
2	Soln Std		Soln Std	5	1	3.94	21.2	3.94	9.80	80.8	48.0	<0.100	<0.100
2	SB4VS-10ccc	ccc	S03	5	2	13.8	11.0	2.22	9.04	37.6	52.9	<0.100	1.42
2	SB4VS-20ccc	ccc	S06	5	3	9.79	10.9	5.48	10.3	22.9	61.5	<0.100	2.96
2	SB4VS-17ccc	ccc	S38	5	4	11.1	10.0	3.45	9.28	24.6	55.5	<0.100	2.55
2	SB4VS-10	quenched	S24	5	5	13.5	11.1	2.44	9.47	40.7	54.1	<0.100	1.47
2	SB4VS-14ccc	ccc	S64	5	6	11.6	10.8	2.68	9.67	32.7	56.8	<0.100	1.76
2	SB4VS-14	quenched	S60	5	7	11.3	11.6	2.95	10.4	34.9	59.5	<0.100	1.87
2	SB4VS-20	quenched	S42	5	8	8.88	10.4	3.45	10.3	21.8	58.4	<0.100	2.52
2	Soln Std		Soln Std	5	9	4.14	20.4	3.83	9.68	81.2	47.7	<0.100	<0.100
2	SB4VS-15ccc	ccc	S36	5	10	11.9	11.4	3.17	10.1	31.3	58.7	<0.100	1.92
2	SB4VS-17	quenched	S58	5	11	11.1	9.9	3.09	9.50	25.1	54.8	<0.100	2.20
2	SB4VS-15	quenched	S27	5	12	11.9	11.4	3.46	10.5	33.0	59.6	<0.100	1.83
2	SB4VS-16ccc	ccc	S14	5	13	10.6	10.9	2.77	9.99	31.2	60.0	<0.100	2.55
2	SB4VS-16	quenched	S75	5	14	10.5	11.1	3.35	10.3	31.9	58.3	<0.100	2.38
2	ARM-1		S67	5	15	2.85	9.9	<0.100	7.92	21.1	35.1	<0.100	<0.100
2	Soln Std		Soln Std	5	16	4.17	20.5	3.91	9.71	82.0	48.1	<0.100	<0.100
2	Soln Std		Soln Std	6	1	3.97	21.4	4.20	10.0	80.1	46.7	<0.100	<0.100
2	SB4VS-17ccc	ccc	S11	6	2	11.0	10.5	3.44	9.48	24.4	54.8	<0.100	2.38
2	SB4VS-15ccc	ccc	S46	6	3	11.9	12.0	3.27	10.7	32.4	60.4	<0.100	2.13
2	SB4VS-20ccc	ccc	S32	6	4	8.91	10.8	4.52	10.3	21.8	58.2	<0.100	3.11
2	SB4VS-14	quenched	S62	6	5	11.3	11.8	3.03	10.7	34.9	58.6	<0.100	2.00
2	SB4VS-10ccc	ccc	S08	6	6	14.0	10.5	2.57	9.38	38.6	51.8	<0.100	1.51
2	SB4VS-10	quenched	S47	6	7	13.3	11.1	2.33	9.75	40.9	52.5	<0.100	1.59

Table F1. Laboratory Measurements of the PCT Solutions for the Nepheline Study Glasses (continued)

Set	Glass ID	Heat Treatment	Laboratory ID	Block	Seq	Al (ppm)	B (ppm)	Fe (ppm)	Li (ppm)	Na (ppm)	Si (ppm)	Th (ppm)	U (ppm)
2	SB4VS-14ccc	ccc	S17	6	8	11.1	11.0	4.51	10.1	33.4	57.2	<0.100	1.82
2	Soln Std		Soln Std	6	9	4.11	20.4	3.98	9.99	80.4	46.0	<0.100	<0.100
2	SB4VS-16ccc	ccc	S35	6	10	9.69	10.6	2.96	9.34	28.2	54.8	<0.100	2.43
2	SB4VS-16	quenched	S18	6	11	10.5	11.4	2.78	10.5	31.0	57.5	<0.100	2.51
2	SB4VS-20	quenched	S71	6	12	8.98	11.1	3.11	10.9	22.3	58.8	<0.100	2.55
2	blank		S21	6	13	<0.100	<0.100	<0.100	<1.00	<0.100	<0.100	<0.100	<0.100
2	SB4VS-15	quenched	S49	6	14	11.5	11.1	3.40	10.5	31.8	57.1	<0.100	1.89
2	SB4VS-17	quenched	S43	6	15	11.0	10.0	3.04	9.96	24.7	53.5	<0.100	2.43
2	ARM-1		S76	6	16	3.02	10.4	0.24	8.34	21.9	33.2	<0.100	<0.100
2	Soln Std		Soln Std	6	17	4.15	20.2	4.04	10.0	81.8	45.6	<0.100	<0.100
3	Soln Std		Soln Std	1	1	3.92	21.2	3.84	9.68	81.2	49.9	<0.100	<0.100
3	SB4VS-24	quenched	T48	1	2	11.6	11.6	2.94	9.59	39.8	58.9	<0.100	1.66
3	SB4VS-30	quenched	T01	1	3	9.20	11.5	3.64	10.5	27.6	61.9	<0.100	3.08
3	EA		T77	1	4	<0.100	37.5	<0.100	11.1	98.2	53.7	<0.100	<0.100
3	SB4VS-33ccc	ccc	T37	1	5	11.3	10.4	1.72	9.17	24.1	53.6	<0.100	1.22
3	SB4VS-27	quenched	T26	1	6	11.0	11.1	2.59	9.85	31.5	58.8	<0.100	1.79
3	SB4VS-30ccc	ccc	T81	1	7	9.45	11.7	3.74	10.6	29.0	64.5	<0.100	2.79
3	SB4VS-32ccc	ccc	T89	1	8	10.7	12.0	2.60	10.1	42.9	59.4	<0.100	1.62
3	SB4VS-28	quenched	T88	1	9	9.85	11.4	2.96	10.3	29.0	60.5	<0.100	2.13
3	Soln Std		Soln Std	1	10	3.89	20.5	3.87	9.73	81.9	49.7	<0.100	<0.100
3	SB4VS-25ccc	ccc	T71	1	11	10.9	12.0	2.49	9.69	35.0	58.5	<0.100	1.72
3	SB4VS-24ccc	ccc	T16	1	12	12.0	11.6	3.68	9.74	39.6	60.9	<0.100	2.00
3	SB4VS-28ccc	ccc	T82	1	13	9.38	10.6	2.75	9.40	27.3	57.3	<0.100	2.50
3	SB4VS-27ccc	ccc	T76	1	14	11.3	11.0	2.53	9.69	31.8	59.6	<0.100	1.77
3	SB4VS-32	quenched	T09	1	15	10.7	11.7	2.95	9.81	42.9	58.6	<0.100	1.69
3	SB4VS-33	quenched	T31	1	16	11.8	10.5	2.06	9.92	24.7	55.4	<0.100	1.53
3	SB4VS-25	quenched	T52	1	17	10.9	11.3	2.56	9.68	35.3	59.0	<0.100	1.67
3	blank		T14	1	18	<0.100	0.154	<0.100	<1.00	<0.100	<0.100	<0.100	<0.100
3	Soln Std		Soln Std	1	19	3.92	20.6	3.97	9.72	82.5	50.1	<0.100	<0.100
3	Soln Std		Soln Std	2	1	3.86	21.0	3.50	9.71	81.9	49.6	<0.100	<0.100
3	SB4VS-25	quenched	T87	2	2	10.8	11.4	1.99	9.38	34.8	57.1	<0.100	1.39
3	EA		T66	2	3	<0.100	36.3	<0.100	10.6	95.5	51.4	<0.100	<0.100
3	SB4VS-30	quenched	T84	2	4	9.32	12.1	3.44	10.6	27.8	62.7	<0.100	2.90
3	SB4VS-28	quenched	T03	2	5	9.61	11.2	2.31	9.90	27.6	59.3	<0.100	2.29
3	SB4VS-25ccc	ccc	T30	2	6	11.0	11.4	2.08	9.74	35.5	59.3	<0.100	1.50
3	SB4VS-30ccc	ccc	T24	2	7	9.38	11.6	3.33	10.5	28.6	63.9	<0.100	3.01
3	SB4VS-24ccc	ccc	T57	2	8	11.0	10.6	2.30	9.07	36.5	56.0	<0.100	1.34
3	SB4VS-33ccc	ccc	T92	2	9	11.2	9.81	1.24	8.95	23.6	52.7	<0.100	1.22
3	Soln Std		Soln Std	2	10	3.79	20.6	3.62	9.64	80.6	49.8	<0.100	<0.100
3	SB4VS-32ccc	ccc	T17	2	11	10.7	12.7	2.11	10.1	43.2	58.9	<0.100	1.59

Table F1. Laboratory Measurements of the PCT Solutions for the Nepheline Study Glasses (continued)

Set	Glass ID	Heat Treatment	Laboratory ID	Block	Seq	Al (ppm)	B (ppm)	Fe (ppm)	Li (ppm)	Na (ppm)	Si (ppm)	Th (ppm)	U (ppm)
3	SB4VS-24	quenched	T72	2	12	11.2	11.3	2.27	9.35	47.9	57.1	<0.100	1.41
3	SB4VS-32	quenched	T04	2	13	10.3	11.6	2.53	9.54	41.9	56.9	<0.100	1.50
3	SB4VS-28ccc	ccc	T41	2	14	9.42	10.8	2.47	9.48	26.6	58.3	<0.100	2.19
3	SB4VS-27ccc	ccc	T02	2	15	10.5	10.2	2.34	8.96	29.6	56.4	<0.100	1.87
3	SB4VS-27	quenched	T49	2	16	11.0	10.9	2.39	9.78	31.4	59.0	<0.100	1.68
3	SB4VS-33	quenched	T38	2	17	11.4	10.3	1.52	9.74	24.1	54.3	<0.100	1.28
3	Soln Std		Soln Std	2	18	3.83	20.7	3.49	9.62	81.6	49.5	<0.100	<0.100
3	Soln Std		Soln Std	3	1	3.83	21.1	4.00	9.67	81.8	49.4	<0.100	<0.100
3	SB4VS-25ccc	ccc	T34	3	2	11.1	11.9	2.48	9.93	36.1	59.8	<0.100	1.58
3	SB4VS-24ccc	ccc	T64	3	3	11.6	11.4	2.94	9.53	38.1	58.9	<0.100	1.55
3	SB4VS-30ccc	ccc	T32	3	4	9.27	11.6	3.83	10.4	28.2	63.5	<0.100	2.21
3	SB4VS-30	quenched	T62	3	5	9.54	11.9	3.88	10.9	29.0	64.2	<0.100	3.00
3	SB4VS-28	quenched	T20	3	6	9.71	10.7	3.27	9.68	27.3	57.2	<0.100	1.86
3	SB4VS-33	quenched	T40	3	7	11.4	10.3	1.92	9.76	23.9	53.6	<0.100	1.28
3	SB4VS-27	quenched	T28	3	8	11.2	11.1	2.67	9.99	32.4	59.6	<0.100	1.80
3	EA		T12	3	9	<0.100	35.8	<0.100	10.4	95.6	50.2	<0.100	<0.100
3	Soln Std		Soln Std	3	10	3.85	20.5	3.83	9.67	83.2	48.9	<0.100	<0.100
3	SB4VS-28ccc	ccc	T46	3	11	9.77	11.2	2.69	9.72	28.7	59.1	<0.100	2.82
3	SB4VS-24	quenched	T39	3	12	11.4	11.3	2.88	9.49	39.8	57.3	<0.100	1.44
3	SB4VS-32ccc	ccc	T23	3	13	10.7	11.9	2.50	9.98	42.8	59.0	<0.100	1.54
3	SB4VS-27ccc	ccc	T42	3	14	11.0	10.4	2.41	9.36	31.0	57.1	<0.100	1.74
3	SB4VS-32	quenched	T22	3	15	10.6	11.8	2.41	9.94	43.8	58.0	<0.100	1.56
3	SB4VS-33ccc	ccc	T53	3	16	11.7	9.88	1.68	9.18	25.6	53.2	<0.100	1.33
3	SB4VS-25	quenched	T59	3	17	10.7	10.7	2.32	9.35	35.7	56.3	<0.100	1.59
3	Soln Std		Soln Std	3	18	3.85	19.9	3.69	9.52	84.2	48.1	<0.100	<0.100
3	Soln Std		Soln Std	4	1	3.79	20.4	3.74	9.77	81.1	50.0	<0.100	<0.100
3	SB4VS-23ccc	ccc	T05	4	2	11.7	11.1	2.11	9.55	42.1	56.4	<0.100	1.39
3	SB4VS-34ccc	ccc	T21	4	3	12.4	10.8	2.93	10.2	23.7	59.0	<0.100	1.98
3	SB4VS-35	quenched	T11	4	4	9.20	12.2	3.55	11.0	32.5	64.7	<0.100	2.57
3	SB4VS-34	quenched	T61	4	5	12.4	10.8	3.32	10.6	22.5	59.2	<0.100	1.87
3	SB4VS-31ccc	ccc	T55	4	6	8.31	11.0	2.75	10.5	22.2	61.8	<0.100	2.97
3	SB4VS-29	quenched	T18	4	7	10.2	10.9	3.18	10.3	29.4	60.4	<0.100	2.02
3	SB4VS-26ccc	ccc	T29	4	8	10.2	10.8	1.97	9.68	33.5	57.7	<0.100	1.41
3	SB4VS-22ccc	ccc	T35	4	9	14.4	9.77	2.58	8.70	35.0	52.5	<0.100	1.64
3	Soln Std		Soln Std	4	10	3.90	19.9	3.67	9.74	83.1	48.8	<0.100	<0.100
3	SB4VS-26	quenched	T85	4	11	10.5	11.3	2.13	9.67	34.5	56.2	<0.100	1.65
3	SB4VS-23	quenched	T47	4	12	11.6	10.7	1.81	9.18	40.0	53.8	<0.100	1.34
3	SB4VS-22	quenched	T15	4	13	14.2	9.52	1.99	8.50	34.8	50.3	<0.100	1.39
3	SB4VS-31	quenched	T65	4	14	8.27	10.9	2.88	10.7	21.5	60.5	<0.100	3.04
3	SB4VS-29ccc	ccc	T13	4	15	10.1	10.7	2.99	10.0	29.8	59.6	<0.100	1.90

Table F1. Laboratory Measurements of the PCT Solutions for the Nepheline Study Glasses (continued)

Set	Glass ID	Heat Treatment	Laboratory ID	Block	Seq	Al (ppm)	B (ppm)	Fe (ppm)	Li (ppm)	Na (ppm)	Si (ppm)	Th (ppm)	U (ppm)
3	SB4VS-35ccc	ccc	T70	4	16	8.95	11.7	3.26	10.7	32.5	63.0	<0.100	2.43
3	ARM-1		T91	4	17	2.82	11.0	<0.100	8.42	22.8	36.4	<0.100	<0.100
3	Soln Std		Soln Std	4	18	4.01	20.0	3.61	9.75	84.2	48.4	<0.100	<0.100
3	Soln Std		Soln Std	5	1	4.01	21.0	3.69	9.79	82.2	50.0	<0.100	<0.100
3	SB4VS-31	quenched	T67	5	2	8.39	11.6	3.03	11.1	21.3	66.6	<0.100	3.23
3	SB4VS-29ccc	ccc	T79	5	3	10.2	11.3	3.08	10.1	29.3	62.2	<0.100	2.11
3	SB4VS-22ccc	ccc	T36	5	4	14.7	10.3	2.21	9.05	35.5	54.3	<0.100	1.71
3	SB4VS-26ccc	ccc	T07	5	5	10.4	11.1	2.05	9.69	33.2	59.3	<0.100	1.68
3	SB4VS-31ccc	ccc	T60	5	6	8.41	11.4	2.77	10.6	22.1	63.4	<0.100	3.09
3	SB4VS-22	quenched	T69	5	7	14.3	10.1	2.06	8.69	34.7	53.0	<0.100	1.66
3	SB4VS-29	quenched	T63	5	8	10.2	11.3	3.38	10.4	29.1	61.4	<0.100	2.12
3	SB4VS-35ccc	ccc	T43	5	9	8.79	11.5	3.36	10.2	30.8	62.0	<0.100	2.67
3	Soln Std		Soln Std	5	10	4.04	20.7	3.82	9.84	82.5	50.7	<0.100	<0.100
3	SB4VS-35	quenched	T27	5	11	9.38	12.9	3.65	11.1	32.8	65.9	<0.100	2.90
3	SB4VS-23	quenched	T08	5	12	11.7	11.0	2.57	8.99	38.5	56.4	<0.100	1.85
3	ARM-1		T83	5	13	2.96	11.2	<0.100	8.37	22.2	37.2	<0.100	<0.100
3	SB4VS-34ccc	ccc	T06	5	14	12.6	11.1	3.12	10.3	23.6	60.6	<0.100	2.26
3	SB4VS-26	quenched	T19	5	15	10.5	11.4	2.18	10.0	34.5	59.7	<0.100	1.67
3	SB4VS-23ccc	ccc	T75	5	16	11.8	11.2	2.22	9.58	39.0	57.8	<0.100	1.50
3	SB4VS-34	quenched	T25	5	17	13.2	11.8	3.47	11.3	23.9	64.6	<0.100	2.13
3	Soln Std		Soln Std	5	18	3.99	20.8	3.96	10.0	83.4	53.1	<0.100	<0.100
3	Soln Std		Soln Std	6	1	3.84	20.9	3.84	9.70	83.0	49.8	<0.100	<0.100
3	SB4VS-22	quenched	T50	6	2	14.0	9.88	2.54	8.22	34.1	51.5	<0.100	1.73
3	SB4VS-31	quenched	T56	6	3	8.11	10.8	3.25	10.2	20.9	60.2	<0.100	2.50
3	SB4VS-22ccc	ccc	T44	6	4	14.3	10.1	2.34	8.78	34.9	53.1	<0.100	1.60
3	ARM-1		T74	6	5	2.73	10.9	<0.100	8.10	21.5	37.0	<0.100	<0.100
3	SB4VS-35	quenched	T51	6	6	8.99	12.0	3.54	10.7	31.9	63.3	<0.100	2.67
3	SB4VS-29	quenched	T58	6	7	10.2	11.2	3.48	10.3	29.6	60.7	<0.100	2.18
3	SB4VS-34ccc	ccc	T33	6	8	12.4	11.0	3.36	10.2	23.5	60.2	<0.100	2.00
3	blank		T90	6	9	<0.100	<0.100	<0.100	<1.00	<0.100	<0.100	<0.100	<0.100
3	Soln Std		Soln Std	6	10	3.83	20.3	3.87	9.62	82.1	50.1	<0.100	<0.100
3	SB4VS-34	quenched	T80	6	11	12.6	11.7	3.38	10.8	22.6	61.8	<0.100	2.12
3	SB4VS-23ccc	ccc	T10	6	12	11.6	11.1	2.19	9.38	38.9	56.5	<0.100	1.41
3	SB4VS-29ccc	ccc	T73	6	13	10.2	11.1	3.18	9.97	29.2	60.9	<0.100	2.06
3	SB4VS-23	quenched	T54	6	14	11.7	11.1	2.06	9.31	39.7	56.9	<0.100	1.42
3	SB4VS-26ccc	ccc	T45	6	15	10.2	11.0	2.06	9.51	33.5	58.2	<0.100	1.75
3	SB4VS-31ccc	ccc	T78	6	16	8.44	11.3	2.86	10.5	23.0	62.9	<0.100	2.82
3	SB4VS-26	quenched	T86	6	17	10.2	11.0	2.45	9.63	33.6	57.9	<0.100	1.67
3	SB4VS-35ccc	ccc	T68	6	18	9.31	12.1	3.55	10.7	32.8	66.5	<0.100	2.85
3	Soln Std		Soln Std	6	19	3.81	20.9	4.16	9.87	84.0	52.8	<0.100	<0.100

Table F2. PSAL Measurements of the PCT Solutions for the Study Glasses After Appropriate Adjustments

Set	Glass ID	Heat Treatment	Laboratory ID	Block	Seq	Al (ppm)	B (ppm)	Fe (ppm)	Li (ppm)	Na (ppm)	Si (ppm)	Th (ppm)	U (ppm)
1	Soln Std		Soln Std	1	1	3.85	22	3.98	9.76	82.9	49.1	0.05	0.05
1	SB4VS-06	quenched	R38	1	2	17.33368	18.66704	5.950119	17.16701	43.83421	102.16871	0.083335	3.366734
1	SB4VS-06ccc	ccc	R40	1	3	17.66702	18.50037	5.433442	16.83367	46.00092	102.83539	0.083335	3.83341
1	SB4VS-01	quenched	R29	1	4	21.33376	10.883551	10.50021	19.50039	84.66836	124.50249	0.083335	4.300086
1	SB4VS-01ccc	ccc	R08	1	5	21.6671	10.550211	9.50019	19.83373	81.16829	124.50249	0.083335	4.16675
1	blank		R49	1	6	0.083335	0.083335	0.083335	0.416675	0.083335	0.083335	0.083335	0.083335
1	SB4VS-08	quenched	R51	1	7	23.00046	17.33368	5.366774	15.233638	60.66788	91.00182	0.083335	2.483383
1	SB4VS-08ccc	ccc	R23	1	8	22.83379	17.00034	5.383441	14.916965	60.0012	90.50181	0.083335	2.933392
1	SB4VS-02	quenched	R46	1	9	20.16707	12.700254	10.983553	19.33372	86.50173	127.16921	0.083335	3.600072
1	SB4VS-03	quenched	R55	1	10	20.0004	12.416915	10.716881	19.66706	81.6683	126.83587	0.083335	3.700074
1	SB4VS-04	quenched	R13	1	11	30.33394	12.283579	8.633506	17.33368	117.66902	115.83565	0.083335	3.183397
1	Soln Std		Soln Std	1	12	4.01	21	4.01	9.85	82.5	50.1	0.05	0.05
1	SB4VS-04ccc	ccc	R52	1	13	30.50061	13.583605	7.883491	18.66704	112.33558	118.00236	0.083335	2.950059
1	SB4VS-07	quenched	R17	1	14	20.0004	18.83371	5.066768	16.383661	54.33442	97.66862	0.083335	2.566718
1	SB4VS-07ccc	ccc	R43	1	15	20.16707	17.83369	4.683427	15.683647	52.00104	95.83525	0.083335	3.116729
1	SB4VS-05	quenched	R42	1	16	15.66698	19.33372	6.716801	18.50037	39.33412	111.50223	0.083335	6.100122
1	SB4VS-05ccc	ccc	R19	1	17	18.16703	20.0004	10.883551	19.33372	40.0008	115.33564	0.083335	5.066768
1	EA		R30	1	18	0.833335	416.6675	0.833335	140.33361	1170.00234	700.0014	0.833335	0.833335
1	ARM-1		R05	1	19	5.266772	18.50037	0.083335	14.066948	38.16743	61.83457	0.083335	0.083335
1	SB4VS-09	quenched	R22	1	20	27.33388	18.3337	5.066768	14.766962	75.0015	88.83511	0.083335	2.933392
1	SB4VS-09ccc	ccc	R60	1	21	25.16717	41.00082	7.383481	30.16727	110.50221	114.00228	0.083335	3.850077
1	SB4VS-03	quenched	R32	1	22	27.83389	13.233598	10.733548	19.00038	106.6688	126.00252	0.083335	3.3334
1	SB4VS-03ccc	ccc	R06	1	23	26.83387	12.233578	8.916845	19.16705	99.16865	122.16911	0.083335	3.300066
1	Soln Std		Soln Std	1	24	4.15	21.2	3.98	9.94	83.5	50.5	0.05	0.05
1	Soln Std		Soln Std	2	1	3.95	21.5	3.7	9.82	80.4	49.1	0.05	0.05
1	SB4VS-06	quenched	R39	2	2	16.83367	19.00038	5.200104	17.00034	41.83417	101.00202	0.083335	3.366734
1	SB4VS-06ccc	ccc	R04	2	3	16.83367	18.16703	4.883431	16.383661	43.16753	100.50201	0.083335	3.50007
1	SB4VS-01	quenched	R45	2	4	21.6671	10.950219	9.916865	19.66706	81.50163	126.16919	0.083335	4.233418
1	SB4VS-01ccc	ccc	R21	2	5	20.83375	10.16687	9.200184	19.50039	74.50149	122.33578	0.083335	4.066748

Table F2. PSAL Measurements of the PCT Solutions for the Study Glasses After Appropriate Adjustments (continued)

Set	Glass ID	Heat Treatment	Laboratory ID	Block	Seq	Al (ppm)	B (ppm)	Fe (ppm)	Li (ppm)	Na (ppm)	Si (ppm)	Th (ppm)	U (ppm)
1	SB4VS-08	quenched	R16	2	6	22.50045	16.667	4.533424	15.0003	57.83449	88.50177	0.083335	2.66672
1	SB4VS-08ccc	ccc	R10	2	7	21.83377	16.266992	3.983413	14.516957	55.33444	86.16839	0.083335	3.033394
1	SB4VS-02	quenched	R37	2	8	20.0004	12.066908	10.266872	19.16705	80.50161	124.16915	0.083335	3.416735
1	SB4VS-01ccc	ccc	R57	2	9	19.50039	11.950239	9.400188	19.50039	75.33484	124.66916	0.083335	3.433402
1	SB4VS-04	quenched	R48	2	10	30.16727	11.683567	7.050141	17.16701	111.33556	112.33558	0.083335	3.066728
1	SB4VS-04ccc	ccc	R36	2	11	30.66728	12.50025	7.750155	18.83371	109.16885	118.50237	0.083335	3.016727
1	Soln Std		Soln Std	2	12	4.05	21	3.71	9.95	79.8	49.9	0.05	0.05
1	SB4VS-07	quenched	R62	2	13	20.16707	18.83371	4.600092	16.566998	51.6677	97.83529	0.083335	2.83339
1	SB4VS-07ccc	ccc	R47	2	14	19.83373	17.66702	4.100082	15.633646	51.00102	95.66858	0.083335	3.233398
1	SB4VS-05	quenched	R12	2	15	15.100302	18.66704	5.866784	18.16703	39.00078	107.50215	0.083335	5.750115
1	SB4VS-09ccc	ccc	R59	2	16	15.583645	19.00038	7.183477	18.83371	37.16741	109.66886	0.083335	5.200104
1	EA		R20	2	17	0.833335	450.0009	0.833335	149.33363	1210.00242	733.3348	0.833335	0.833335
1	ARM-1		R61	2	18	5.100102	19.33372	0.083335	14.616959	39.50079	62.66792	0.083335	0.083335
1	SB4VS-09	quenched	R11	2	19	27.33388	18.16703	4.866764	15.133636	73.83481	89.50179	0.083335	2.466716
1	SB4VS-09ccc	ccc	R27	2	20	26.16719	41.83417	8.083495	30.83395	112.33558	118.3357	0.083335	3.116729
1	SB4VS-03	quenched	R50	2	21	26.16719	12.066908	8.550171	18.3337	102.33538	120.33574	0.083335	3.16673
1	SB4VS-03ccc	ccc	R01	2	22	26.00052	11.766902	8.16683	19.00038	95.33524	120.66908	0.083335	3.3334
1	Soln Std		Soln Std	2	23	4.05	21.1	3.76	10	81.8	50.4	0.05	0.05
1	Soln Std		Soln Std	3	1	4.01	21.4	3.6	9.83	81.6	48.8	0.05	0.05
1	SB4VS-06	quenched	R24	3	2	17.50035	19.66706	5.433442	17.50035	44.83423	103.3354	0.083335	3.316733
1	SB4VS-06ccc	ccc	R33	3	3	17.00034	18.3337	4.783429	16.400328	43.00086	100.002	0.083335	3.83341
1	blank		R03	3	4	0.083335	0.083335	0.083335	0.416675	0.083335	0.083335	0.083335	0.083335
1	SB4VS-01	quenched	R35	3	5	21.00042	10.566878	9.716861	19.66706	82.83499	123.3358	0.083335	3.600072
1	SB4VS-05ccc	ccc	R58	3	6	20.83375	10.216871	9.50019	19.66706	79.33492	122.33578	0.083335	4.966766
1	SB4VS-08	quenched	R34	3	7	22.33378	16.83367	4.550091	14.950299	59.00118	88.16843	0.083335	2.366714
1	SB4VS-08ccc	ccc	R31	3	8	23.00046	17.50035	4.083415	15.300306	61.33456	90.83515	0.083335	2.33338
1	SB4VS-02	quenched	R18	3	9	20.33374	12.433582	11.6669	19.66706	85.50171	127.66922	0.083335	3.783409
1	SB4VS-02ccc	ccc	R14	3	10	20.0004	12.366914	10.516877	19.66706	78.66824	127.16921	0.083335	3.583405
1	SB4VS-04	quenched	R15	3	11	30.0006	12.233578	7.566818	17.16701	110.83555	115.16897	0.083335	2.900058
1	Soln Std		Soln Std	3	12	4.09	21.4	3.87	10	83.5	50.9	0.05	0.05
1	SB4VS-04ccc	ccc	R02	3	13	34.66736	14.133616	11.383561	19.50039	112.83559	124.66916	0.083335	2.983393
1	SB4VS-07	quenched	R26	3	14	19.83373	18.00036	5.33344	15.900318	50.33434	96.00192	0.083335	3.133396

Table F2. PSAL Measurements of the PCT Solutions for the Study Glasses After Appropriate Adjustments (continued)

Set	Glass ID	Heat Treatment	Laboratory ID	Block	Seq	Al (ppm)	B (ppm)	Fe (ppm)	Li (ppm)	Na (ppm)	Si (ppm)	Th (ppm)	U (ppm)
1	SB4VS-07ccc	ccc	R41	3	15	19.83373	18.00036	4.83343	15.783649	51.83437	97.16861	0.083335	3.283399
1	SB4VS-05	quenched	R44	3	16	16.233658	19.33372	6.6668	18.50037	39.16745	111.33556	0.083335	6.300126
1	SB4VS-05ccc	ccc	R53	3	17	15.800316	20.0004	7.750155	19.16705	37.83409	113.66894	0.083335	5.366774
1	EA		R25	3	18	0.833335	618.33457	0.833335	178.33369	1573.33648	868.33507	0.833335	0.833335
1	ARM-1		R09	3	19	5.283439	20.0004	0.083335	14.483623	40.0008	66.50133	0.083335	0.083335
1	SB4VS-09	quenched	R07	3	20	27.16721	18.66704	5.383441	15.300306	75.33484	90.66848	0.083335	2.516717
1	SB4VS-02ccc	ccc	R54	3	21	25.66718	42.50085	8.183497	30.50061	110.0022	118.3357	0.083335	3.816743
1	SB4VS-02ccc	ccc	R56	3	22	26.33386	12.816923	10.100202	18.83371	103.00206	125.66918	0.083335	3.583405
1	SB4VS-03ccc	ccc	R28	3	23	26.33386	12.633586	9.783529	19.33372	100.33534	124.66916	0.083335	3.283399
1	Soln Std		Soln Std	3	24	4.44	21.5	4.17	10	82.3	51.3	0.05	0.05
2	Soln Std		Soln Std	1	1	3.75	21.2	3.95	9.8	79.6	47.6	0.05	0.05
2	SB4VS-18ccc	ccc	S79	1	2	16.250325	18.3337	4.616759	16.400328	39.00078	95.33524	0.083335	4.716761
2	blank		S26	1	3	1.0933552	0.5850117	0.083335	0.83335	0.083335	0.4783429	0.083335	0.083335
2	SB4VS-19	quenched	S51	1	4	15.400308	18.66704	5.016767	17.33368	45.0009	98.16863	0.083335	3.866744
2	SB4VS-21	quenched	S29	1	5	15.700314	17.16701	4.783429	16.83367	34.00068	95.0019	0.083335	4.183417
2	SB4VS-12ccc	ccc	S80	1	6	21.00042	17.33368	3.850077	15.816983	50.16767	89.33512	0.083335	2.600052
2	EA		S07	1	7	0.833335	625.00125	0.833335	185.00037	1661.66999	835.00167	0.833335	0.833335
2	SB4VS-13	quenched	S04	1	8	21.6671	17.33368	4.566758	15.116969	48.83431	86.16839	0.083335	3.050061
2	Soln Std		Soln Std	1	9	3.79	20.4	4.06	9.81	81.4	47.7	0.05	0.05
2	SB4VS-11	quenched	S20	1	10	23.66714	18.3337	4.266752	15.683647	61.50123	88.3351	0.083335	2.683387
2	SB4VS-21ccc	ccc	S01	1	11	15.783649	17.50035	4.100082	16.633666	36.33406	95.83525	0.083335	4.516757
2	SB4VS-18	quenched	S56	1	12	16.300326	18.00036	4.216751	17.16701	39.00078	95.33524	0.083335	3.400068
2	SB4VS-11ccc	ccc	S48	1	13	24.00048	17.50035	4.400088	15.650313	60.33454	88.50177	0.083335	2.600052
2	SB4VS-13ccc	ccc	S66	1	14	22.00044	17.00034	4.16675	14.83363	49.16765	88.66844	0.083335	2.883391
2	SB4VS-12	quenched	S25	1	15	23.83381	17.83369	4.200084	16.483663	52.83439	90.0018	0.083335	2.66672
2	SB4VS-19ccc	ccc	S65	1	16	15.716981	17.50035	4.316753	16.516997	45.50091	97.66862	0.083335	4.216751
2	Soln Std		Soln Std	1	17	3.86	19.9	3.99	9.79	82.1	47	0.05	0.05
2	Soln Std		Soln Std	2	1	3.97	20.5	3.77	10.1	84.9	50.7	0.05	0.05
2	SB4VS-11	quenched	S13	2	2	25.0005	18.66704	6.850137	16.50033	67.33468	96.50193	0.083335	2.683387
2	SB4VS-11ccc	ccc	S34	2	3	23.16713	18.00036	4.366754	15.516977	61.00122	90.0018	0.083335	2.583385
2	SB4VS-12ccc	ccc	S57	2	4	21.50043	17.83369	3.650073	16.033654	53.3344	90.83515	0.083335	2.733388
2	SB4VS-21ccc	ccc	S45	2	5	15.583645	17.00034	4.633426	16.466996	37.66742	97.66862	0.083335	4.366754

Table F2. PSAL Measurements of the PCT Solutions for the Study Glasses After Appropriate Adjustments (continued)

Set	Glass ID	Heat Treatment	Laboratory ID	Block	Seq	Al (ppm)	B (ppm)	Fe (ppm)	Li (ppm)	Na (ppm)	Si (ppm)	Th (ppm)	U (ppm)
2	SB4VS-18	quenched	S53	2	6	16.200324	18.00036	4.616759	17.50035	41.16749	97.50195	0.083335	3.600072
2	SB4VS-12	quenched	S54	2	7	22.83379	18.3337	5.083435	16.83367	56.16779	94.00188	0.083335	2.783389
2	SB4VS-21	quenched	S16	2	8	15.816983	17.66702	4.183417	17.50035	38.00076	96.83527	0.083335	4.183417
2	Soln Std		Soln Std	2	9	3.88	20.6	3.71	9.94	85.7	47.8	0.05	0.05
2	SB4VS-19ccc	ccc	S50	2	10	16.200324	18.3337	4.583425	16.83367	47.16761	102.00204	0.083335	4.316753
2	SB4VS-13	quenched	S69	2	11	22.00044	17.83369	4.066748	15.916985	54.33442	92.50185	0.083335	2.900058
2	EA		S30	2	12	3.0333394	601.66787	2.3833381	181.66703	1653.33664	855.00171	0.833335	0.833335
2	SB4VS-13ccc	ccc	S02	2	13	21.50043	17.33368	4.33342	14.800296	50.66768	91.33516	0.083335	2.950059
2	SB4VS-18ccc	ccc	S19	2	14	16.83367	16.83367	3.550071	16.283659	41.00082	95.50191	0.083335	4.150083
2	SB4VS-19	quenched	S15	2	15	16.050321	18.50037	7.033474	17.50035	48.66764	100.16867	0.083335	3.966746
2	Soln Std		Soln Std	2	16	3.98	20.2	3.73	10	86.8	49.2	0.05	0.05
2	Soln Std		Soln Std	3	1	4.03	22	3.99	10.1	82.9	49.5	0.05	0.05
2	SB4VS-11	quenched	S31	3	2	23.83381	18.66704	4.700094	15.583645	61.16789	90.33514	0.083335	2.533384
2	SB4VS-12ccc	ccc	S70	3	3	22.50045	19.00038	4.416755	16.633666	53.16773	95.66858	0.083335	2.700054
2	SB4VS-19ccc	ccc	S73	3	4	17.00034	18.66704	5.300106	16.83367	46.16759	100.50201	0.083335	4.016747
2	SB4VS-13	quenched	S55	3	5	22.00044	18.50037	4.783429	15.916985	51.50103	92.50185	0.083335	2.550051
2	SB4VS-21	quenched	S63	3	6	16.16699	18.83371	6.766802	18.00036	37.33408	102.83539	0.083335	3.883411
2	SB4VS-13ccc	ccc	S23	3	7	22.50045	17.33368	4.583425	14.700294	49.16765	89.33512	0.083335	2.516717
2	SB4VS-12	quenched	S59	3	8	22.33378	18.66704	4.350087	16.83367	54.66776	95.16857	0.083335	2.66672
2	Soln Std		Soln Std	3	9	4.14	21.1	3.93	9.89	84	49.3	0.05	0.05
2	SB4VS-19	quenched	S72	3	10	17.83369	19.66706	7.933492	17.50035	47.16761	102.00204	0.083335	3.233398
2	SB4VS-21ccc	ccc	S09	3	11	15.483643	17.33368	4.650093	16.250325	35.66738	97.50195	0.083335	4.016747
2	SB4VS-18ccc	ccc	S39	3	12	16.483663	18.3337	4.533424	16.83367	41.50083	99.33532	0.083335	2.750055
2	EA		S68	3	13	21.833377	625.00125	18.666704	181.66703	1683.3367	865.00173	0.833335	0.833335
2	SB4VS-11ccc	ccc	S77	3	14	24.50049	19.00038	4.366754	16.083655	63.16793	93.66854	0.083335	2.466716
2	SB4VS-18	quenched	S22	3	15	16.83367	18.3337	5.216771	17.16701	39.16745	97.33528	0.083335	3.483403
2	Soln Std		Soln Std	3	16	4.08	21.2	4.01	10.1	85.9	49.8	0.05	0.05
2	Soln Std		Soln Std	4	1	3.78	21.8	3.95	9.95	80.9	48.8	0.05	0.05
2	SB4VS-16ccc	ccc	S61	4	2	17.16701	18.83371	5.33344	16.16699	49.83433	98.50197	0.083335	4.33342
2	SB4VS-14ccc	ccc	S05	4	3	18.83371	19.33372	4.916765	16.83367	56.6678	102.50205	0.083335	3.150063
2	SB4VS-20ccc	ccc	S78	4	4	14.66696	18.16703	4.800096	17.00034	36.83407	102.00204	0.083335	5.0001
2	SB4VS-17ccc	ccc	S44	4	5	18.00036	16.50033	5.0001	15.400308	41.83417	92.66852	0.083335	4.550091

Table F2. PSAL Measurements of the PCT Solutions for the Study Glasses After Appropriate Adjustments (continued)

Set	Glass ID	Heat Treatment	Laboratory ID	Block	Seq	Al (ppm)	B (ppm)	Fe (ppm)	Li (ppm)	Na (ppm)	Si (ppm)	Th (ppm)	U (ppm)
2	SB4VS-10	quenched	S52	4	6	22.50045	18.83371	4.466756	16.066988	68.83471	92.16851	0.083335	2.783389
2	SB4VS-10ccc	ccc	S10	4	7	22.33378	17.66702	4.050081	15.350307	64.33462	91.00182	0.083335	2.583385
2	SB4VS-14	quenched	S41	4	8	19.50039	19.83373	5.700114	17.83369	59.83453	102.50205	0.083335	3.516737
2	Soln Std		Soln Std	4	9	3.85	21.3	4.02	9.73	81.7	48.7	0.05	0.05
2	SB4VS-20	quenched	S33	4	10	15.16697	18.50037	6.216791	17.50035	36.33406	103.00206	0.083335	4.383421
2	SB4VS-16	quenched	S12	4	11	18.66704	21.16709	6.366794	19.00038	57.83449	108.16883	0.083335	4.066748
2	SB4VS-15ccc	ccc	S40	4	12	18.83371	18.3337	5.700114	16.400328	51.83437	97.50195	0.083335	3.483403
2	SB4VS-15	quenched	S74	4	13	19.16705	19.16705	5.350107	17.50035	54.66776	99.66866	0.083335	3.300066
2	SB4VS-17	quenched	S28	4	14	18.83371	16.50033	4.750095	15.766982	40.50081	92.50185	0.083335	3.983413
2	ARM-1		S37	4	15	4.433422	17.50035	0.083335	13.16693	34.50069	58.16783	0.083335	0.083335
2	Soln Std		Soln Std	4	16	3.86	20.5	4.11	9.76	83	48.7	0.05	0.05
2	Soln Std		Soln Std	5	1	3.94	21.2	3.94	9.8	80.8	48	0.05	0.05
2	SB4VS-10ccc	ccc	S03	5	2	23.00046	18.3337	3.700074	15.066968	62.66792	88.16843	0.083335	2.366714
2	SB4VS-20ccc	ccc	S06	5	3	16.316993	18.16703	9.133516	17.16701	38.16743	102.50205	0.083335	4.933432
2	SB4VS-17ccc	ccc	S38	5	4	18.50037	16.667	5.750115	15.466976	41.00082	92.50185	0.083335	4.250085
2	SB4VS-10	quenched	S24	5	5	22.50045	18.50037	4.066748	15.783649	67.83469	90.16847	0.083335	2.450049
2	SB4VS-14ccc	ccc	S64	5	6	19.33372	18.00036	4.466756	16.116989	54.50109	94.66856	0.083335	2.933392
2	SB4VS-14	quenched	S60	5	7	18.83371	19.33372	4.916765	17.33368	58.16783	99.16865	0.083335	3.116729
2	SB4VS-20	quenched	S42	5	8	14.800296	17.33368	5.750115	17.16701	36.33406	97.33528	0.083335	4.200084
2	Soln Std		Soln Std	5	9	4.14	20.4	3.83	9.68	81.2	47.7	0.05	0.05
2	SB4VS-15ccc	ccc	S36	5	10	19.83373	19.00038	5.283439	16.83367	52.16771	97.83529	0.083335	3.200064
2	SB4VS-17	quenched	S58	5	11	18.50037	16.50033	5.150103	15.83365	41.83417	91.33516	0.083335	3.66674
2	SB4VS-15	quenched	S27	5	12	19.83373	19.00038	5.766782	17.50035	55.0011	99.33532	0.083335	3.050061
2	SB4VS-16ccc	ccc	S14	5	13	17.66702	18.16703	4.616759	16.650333	52.00104	100.002	0.083335	4.250085
2	SB4VS-16	quenched	S75	5	14	17.50035	18.50037	5.583445	17.16701	53.16773	97.16861	0.083335	3.966746
2	ARM-1		S67	5	15	4.750095	16.50033	0.083335	13.200264	35.16737	58.50117	0.083335	0.083335
2	Soln Std		Soln Std	5	16	4.17	20.5	3.91	9.71	82	48.1	0.05	0.05
2	Soln Std		Soln Std	6	1	3.97	21.4	4.2	10	80.1	46.7	0.05	0.05
2	SB4VS-17ccc	ccc	S11	6	2	18.3337	17.50035	5.733448	15.800316	40.66748	91.33516	0.083335	3.966746
2	SB4VS-15ccc	ccc	S46	6	3	19.83373	20.0004	5.450109	17.83369	54.00108	100.66868	0.083335	3.550071
2	SB4VS-20ccc	ccc	S32	6	4	14.850297	18.00036	7.533484	17.16701	36.33406	97.00194	0.083335	5.183437
2	SB4VS-14	quenched	S62	6	5	18.83371	19.66706	5.050101	17.83369	58.16783	97.66862	0.083335	3.3334
2	SB4VS-10ccc	ccc	S08	6	6	23.3338	17.50035	4.283419	15.633646	64.33462	86.33506	0.083335	2.516717

Table F2. PSAL Measurements of the PCT Solutions for the Study Glasses After Appropriate Adjustments (continued)

Set	Glass ID	Heat Treatment	Laboratory ID	Block	Seq	Al (ppm)	B (ppm)	Fe (ppm)	Li (ppm)	Na (ppm)	Si (ppm)	Th (ppm)	U (ppm)
2	SB4VS-10	quenched	S47	6	7	22.16711	18.50037	3.883411	16.250325	68.16803	87.50175	0.083335	2.650053
2	SB4VS-14ccc	ccc	S17	6	8	18.50037	18.3337	7.516817	16.83367	55.66778	95.33524	0.083335	3.033394
2	Soln Std		Soln Std	6	9	4.11	20.4	3.98	9.99	80.4	46	0.05	0.05
2	SB4VS-16ccc	ccc	S35	6	10	16.150323	17.66702	4.933432	15.566978	47.00094	91.33516	0.083335	4.050081
2	SB4VS-16	quenched	S18	6	11	17.50035	19.00038	4.633426	17.50035	51.6677	95.83525	0.083335	4.183417
2	SB4VS-20	quenched	S71	6	12	14.966966	18.50037	5.183437	18.16703	37.16741	98.00196	0.083335	4.250085
2	blank		S21	6	13	0.083335	0.083335	0.083335	0.83335	0.083335	0.083335	0.083335	0.083335
2	SB4VS-15	quenched	S49	6	14	19.16705	18.50037	5.66678	17.50035	53.00106	95.16857	0.083335	3.150063
2	SB4VS-17	quenched	S43	6	15	18.3337	16.667	5.066768	16.600332	41.16749	89.16845	0.083335	4.050081
2	ARM-1		S76	6	16	5.033434	17.33368	0.400008	13.900278	36.50073	55.33444	0.083335	0.083335
2	Soln Std		Soln Std	6	17	4.15	20.2	4.04	10	81.8	45.6	0.05	0.05
3	Soln Std		Soln Std	1	1	3.92	21.2	3.84	9.68	81.2	49.9	0.05	0.05
3	SB4VS-24	quenched	T48	1	2	19.33372	19.33372	4.900098	15.983653	66.33466	98.16863	0.083335	2.766722
3	SB4VS-30	quenched	T01	1	3	15.33364	19.16705	6.066788	17.50035	46.00092	103.16873	0.083335	5.133436
3	EA		T77	1	4	0.833335	625.00125	0.833335	185.00037	1636.66994	895.00179	0.833335	0.833335
3	SB4VS-33ccc	ccc	T37	1	5	18.83371	17.33368	2.866724	15.283639	40.16747	89.33512	0.083335	2.033374
3	SB4VS-27	quenched	T26	1	6	18.3337	18.50037	4.316753	16.416995	52.50105	98.00196	0.083335	2.983393
3	SB4VS-30ccc	ccc	T81	1	7	15.750315	19.50039	6.233458	17.66702	48.3343	107.50215	0.083335	4.650093
3	SB4VS-32ccc	ccc	T89	1	8	17.83369	20.0004	4.33342	16.83367	71.50143	99.00198	0.083335	2.700054
3	SB4VS-28	quenched	T88	1	9	16.416995	19.00038	4.933432	17.16701	48.3343	100.83535	0.083335	3.550071
3	Soln Std		Soln Std	1	10	3.89	20.5	3.87	9.73	81.9	49.7	0.05	0.05
3	SB4VS-25ccc	ccc	T71	1	11	18.16703	20.0004	4.150083	16.150323	58.3345	97.50195	0.083335	2.866724
3	SB4VS-24ccc	ccc	T16	1	12	20.0004	19.33372	6.133456	16.233658	66.00132	101.50203	0.083335	3.3334
3	SB4VS-28ccc	ccc	T82	1	13	15.633646	17.66702	4.583425	15.66698	45.50091	95.50191	0.083335	4.16675
3	SB4VS-27ccc	ccc	T76	1	14	18.83371	18.3337	4.216751	16.150323	53.00106	99.33532	0.083335	2.950059
3	SB4VS-32	quenched	T09	1	15	17.83369	19.50039	4.916765	16.350327	71.50143	97.66862	0.083335	2.816723
3	SB4VS-33	quenched	T31	1	16	19.66706	17.50035	3.433402	16.533664	41.16749	92.33518	0.083335	2.550051
3	SB4VS-25	quenched	T52	1	17	18.16703	18.83371	4.266752	16.133656	58.83451	98.3353	0.083335	2.783389
3	blank		T14	1	18	0.083335	0.2566718	0.083335	0.83335	0.083335	0.083335	0.083335	0.083335
3	Soln Std		Soln Std	1	19	3.92	20.6	3.97	9.72	82.5	50.1	0.05	0.05
3	Soln Std		Soln Std	2	1	3.86	21	3.5	9.71	81.9	49.6	0.05	0.05
3	SB4VS-25	quenched	T87	2	2	18.00036	19.00038	3.316733	15.633646	58.00116	95.16857	0.083335	2.316713

Table F2. PSAL Measurements of the PCT Solutions for the Study Glasses After Appropriate Adjustments (continued)

Set	Glass ID	Heat Treatment	Laboratory ID	Block	Seq	Al (ppm)	B (ppm)	Fe (ppm)	Li (ppm)	Na (ppm)	Si (ppm)	Th (ppm)	U (ppm)
3	EA		T66	2	3	0.833335	605.00121	0.833335	176.66702	1591.66985	856.66838	0.833335	0.833335
3	SB4VS-30	quenched	T84	2	4	15.533644	20.16707	5.733448	17.66702	46.33426	104.50209	0.083335	4.83343
3	SB4VS-28	quenched	T03	2	5	16.016987	18.66704	3.850077	16.50033	46.00092	98.83531	0.083335	3.816743
3	SB4VS-25ccc	ccc	T30	2	6	18.3337	19.00038	3.466736	16.233658	59.16785	98.83531	0.083335	2.50005
3	SB4VS-30ccc	ccc	T24	2	7	15.633646	19.33372	5.550111	17.50035	47.66762	106.50213	0.083335	5.016767
3	SB4VS-24ccc	ccc	T57	2	8	18.3337	17.66702	3.83341	15.116969	60.83455	93.3352	0.083335	2.233378
3	SB4VS-33ccc	ccc	T92	2	9	18.66704	16.350327	2.066708	14.916965	39.33412	87.83509	0.083335	2.033374
3	Soln Std		Soln Std	2	10	3.79	20.6	3.62	9.64	80.6	49.8	0.05	0.05
3	SB4VS-32ccc	ccc	T17	2	11	17.83369	21.16709	3.516737	16.83367	72.00144	98.16863	0.083335	2.650053
3	SB4VS-24	quenched	T72	2	12	18.66704	18.83371	3.783409	15.583645	79.83493	95.16857	0.083335	2.350047
3	SB4VS-32	quenched	T04	2	13	17.16701	19.33372	4.216751	15.900318	69.83473	94.83523	0.083335	2.50005
3	SB4VS-28ccc	ccc	T41	2	14	15.700314	18.00036	4.116749	15.800316	44.33422	97.16861	0.083335	3.650073
3	SB4VS-27ccc	ccc	T02	2	15	17.50035	17.00034	3.900078	14.933632	49.33432	94.00188	0.083335	3.116729
3	SB4VS-27	quenched	T49	2	16	18.3337	18.16703	3.983413	16.300326	52.33438	98.3353	0.083335	2.800056
3	SB4VS-33	quenched	T38	2	17	19.00038	17.16701	2.533384	16.233658	40.16747	90.50181	0.083335	2.133376
3	Soln Std		Soln Std	2	18	3.83	20.7	3.49	9.62	81.6	49.5	0.05	0.05
3	Soln Std		Soln Std	3	1	3.83	21.1	4	9.67	81.8	49.4	0.05	0.05
3	SB4VS-25ccc	ccc	T34	3	2	18.50037	19.83373	4.133416	16.550331	60.16787	99.66866	0.083335	2.633386
3	SB4VS-24ccc	ccc	T64	3	3	19.33372	19.00038	4.900098	15.883651	63.50127	98.16863	0.083335	2.583385
3	SB4VS-30ccc	ccc	T32	3	4	15.450309	19.33372	6.383461	17.33368	47.00094	105.83545	0.083335	3.683407
3	SB4VS-30	quenched	T62	3	5	15.900318	19.83373	6.466796	18.16703	48.3343	107.00214	0.083335	5.0001
3	SB4VS-28	quenched	T20	3	6	16.183657	17.83369	5.450109	16.133656	45.50091	95.33524	0.083335	3.100062
3	SB4VS-33	quenched	T40	3	7	19.00038	17.16701	3.200064	16.266992	39.83413	89.33512	0.083335	2.133376
3	SB4VS-27	quenched	T28	3	8	18.66704	18.50037	4.450089	16.650333	54.00108	99.33532	0.083335	3.00006
3	EA		T12	3	9	0.833335	596.66786	0.833335	173.33368	1593.33652	836.66834	0.833335	0.833335
3	Soln Std		Soln Std	3	10	3.85	20.5	3.83	9.67	83.2	48.9	0.05	0.05
3	SB4VS-28ccc	ccc	T46	3	11	16.283659	18.66704	4.483423	16.200324	47.83429	98.50197	0.083335	4.700094
3	SB4VS-24	quenched	T39	3	12	19.00038	18.83371	4.800096	15.816983	66.33466	95.50191	0.083335	2.400048
3	SB4VS-32ccc	ccc	T23	3	13	17.83369	19.83373	4.16675	16.633666	71.33476	98.3353	0.083335	2.566718
3	SB4VS-27ccc	ccc	T42	3	14	18.3337	17.33368	4.016747	15.600312	51.6677	95.16857	0.083335	2.900058
3	SB4VS-32	quenched	T22	3	15	17.66702	19.66706	4.016747	16.566998	73.00146	96.6686	0.083335	2.600052

Table F2. PSAL Measurements of the PCT Solutions for the Study Glasses After Appropriate Adjustments (continued)

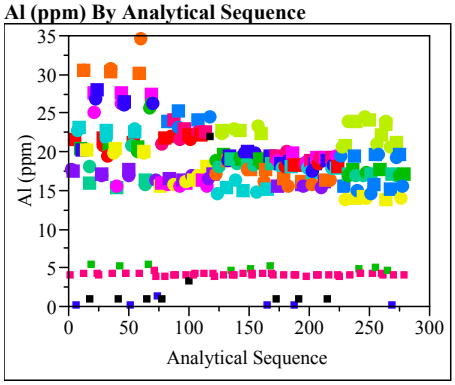
Set	Glass ID	Heat Treatment	Laboratory ID	Block	Seq	Al (ppm)	B (ppm)	Fe (ppm)	Li (ppm)	Na (ppm)	Si (ppm)	Th (ppm)	U (ppm)
3	SB4VS-33ccc	ccc	T53	3	16	19.50039	16.466996	2.800056	15.300306	42.66752	88.66844	0.083335	2.216711
3	SB4VS-25	quenched	T59	3	17	17.83369	17.83369	3.866744	15.583645	59.50119	93.83521	0.083335	2.650053
3	Soln Std		Soln Std	3	18	3.85	19.9	3.69	9.52	84.2	48.1	0.05	0.05
3	Soln Std		Soln Std	4	1	3.79	20.4	3.74	9.77	81.1	50	0.05	0.05
3	SB4VS-23ccc	ccc	T05	4	2	19.50039	18.50037	3.516737	15.916985	70.16807	94.00188	0.083335	2.316713
3	SB4VS-34ccc	ccc	T21	4	3	20.66708	18.00036	4.883431	17.00034	39.50079	98.3353	0.083335	3.300066
3	SB4VS-35	quenched	T11	4	4	15.33364	20.33374	5.916785	18.3337	54.16775	107.83549	0.083335	4.283419
3	SB4VS-34	quenched	T61	4	5	20.66708	18.00036	5.533444	17.66702	37.50075	98.66864	0.083335	3.116729
3	SB4VS-31ccc	ccc	T55	4	6	13.850277	18.3337	4.583425	17.50035	37.00074	103.00206	0.083335	4.950099
3	SB4VS-29	quenched	T18	4	7	17.00034	18.16703	5.300106	17.16701	49.00098	100.66868	0.083335	3.366734
3	SB4VS-26ccc	ccc	T29	4	8	17.00034	18.00036	3.283399	16.133656	55.83445	96.16859	0.083335	2.350047
3	SB4VS-22ccc	ccc	T35	4	9	24.00048	16.283659	4.300086	14.50029	58.3345	87.50175	0.083335	2.733388
3	Soln Std		Soln Std	4	10	3.9	19.9	3.67	9.74	83.1	48.8	0.05	0.05
3	SB4VS-26	quenched	T85	4	11	17.50035	18.83371	3.550071	16.116989	57.50115	93.66854	0.083335	2.750055
3	SB4VS-23	quenched	T47	4	12	19.33372	17.83369	3.016727	15.300306	66.668	89.66846	0.083335	2.233378
3	SB4VS-22	quenched	T15	4	13	23.66714	15.866984	3.316733	14.16695	58.00116	83.83501	0.083335	2.316713
3	SB4VS-31	quenched	T65	4	14	13.783609	18.16703	4.800096	17.83369	35.83405	100.83535	0.083335	5.066768
3	SB4VS-29ccc	ccc	T13	4	15	16.83367	17.83369	4.983433	16.667	49.66766	99.33532	0.083335	3.16673
3	SB4VS-35ccc	ccc	T70	4	16	14.916965	19.50039	5.433442	17.83369	54.16775	105.0021	0.083335	4.050081
3	ARM-1		T91	4	17	4.700094	18.3337	0.083335	14.033614	38.00076	60.66788	0.083335	0.083335
3	Soln Std		Soln Std	4	18	4.01	20	3.61	9.75	84.2	48.4	0.05	0.05
3	Soln Std		Soln Std	5	1	4.01	21	3.69	9.79	82.2	50	0.05	0.05
3	SB4VS-31	quenched	T67	5	2	13.983613	19.33372	5.050101	18.50037	35.50071	111.00222	0.083335	5.383441
3	SB4VS-29ccc	ccc	T79	5	3	17.00034	18.83371	5.133436	16.83367	48.83431	103.66874	0.083335	3.516737
3	SB4VS-22ccc	ccc	T36	5	4	24.50049	17.16701	3.683407	15.083635	59.16785	90.50181	0.083335	2.850057
3	SB4VS-26ccc	ccc	T07	5	5	17.33368	18.50037	3.416735	16.150323	55.33444	98.83531	0.083335	2.800056
3	SB4VS-31ccc	ccc	T60	5	6	14.016947	19.00038	4.616759	17.66702	36.83407	105.66878	0.083335	5.150103
3	SB4VS-22	quenched	T69	5	7	23.83381	16.83367	3.433402	14.483623	57.83449	88.3351	0.083335	2.766722
3	SB4VS-29	quenched	T63	5	8	17.00034	18.83371	5.633446	17.33368	48.50097	102.33538	0.083335	3.533404
3	SB4VS-35ccc	ccc	T43	5	9	14.650293	19.16705	5.600112	17.00034	51.33436	103.3354	0.083335	4.450089

Table F2. PSAL Measurements of the PCT Solutions for the Study Glasses After Appropriate Adjustments (continued)

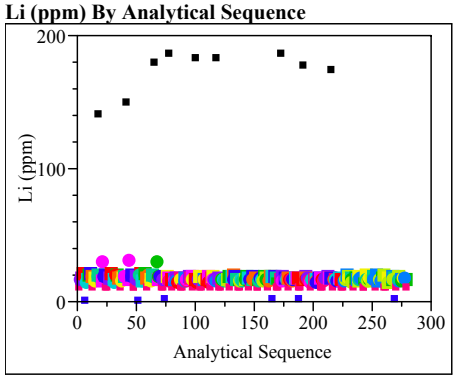
Set	Glass ID	Heat Treatment	Laboratory ID	Block	Seq	Al (ppm)	B (ppm)	Fe (ppm)	Li (ppm)	Na (ppm)	Si (ppm)	Th (ppm)	U (ppm)
3	Soln Std		Soln Std	5	10	4.04	20.7	3.82	9.84	82.5	50.7	0.05	0.05
3	SB4VS-35	quenched	T27	5	11	15.633646	21.50043	6.083455	18.50037	54.66776	109.83553	0.083335	4.83343
3	SB4VS-23	quenched	T08	5	12	19.50039	18.3337	4.283419	14.983633	64.16795	94.00188	0.083335	3.083395
3	ARM-1		T83	5	13	4.933432	18.66704	0.083335	13.950279	37.00074	62.00124	0.083335	0.083335
3	SB4VS-34ccc	ccc	T06	5	14	21.00042	18.50037	5.200104	17.16701	39.33412	101.00202	0.083335	3.766742
3	SB4VS-26	quenched	T19	5	15	17.50035	19.00038	3.633406	16.667	57.50115	99.50199	0.083335	2.783389
3	SB4VS-23ccc	ccc	T75	5	16	19.66706	18.66704	3.700074	15.966986	65.0013	96.33526	0.083335	2.50005
3	SB4VS-34	quenched	T25	5	17	22.00044	19.66706	5.783449	18.83371	39.83413	107.66882	0.083335	3.550071
3	Soln Std		Soln Std	5	18	3.99	20.8	3.96	10	83.4	53.1	0.05	0.05
3	Soln Std		Soln Std	6	1	3.84	20.9	3.84	9.7	83	49.8	0.05	0.05
3	SB4VS-22	quenched	T50	6	2	23.3338	16.466996	4.233418	13.700274	56.83447	85.83505	0.083335	2.883391
3	SB4VS-31	quenched	T56	6	3	13.516937	18.00036	5.416775	17.00034	34.83403	100.33534	0.083335	4.16675
3	SB4VS-22ccc	ccc	T44	6	4	23.83381	16.83367	3.900078	14.633626	58.16783	88.50177	0.083335	2.66672
3	ARM-1		T74	6	5	4.550091	18.16703	0.083335	13.50027	35.83405	61.6679	0.083335	0.083335
3	SB4VS-35	quenched	T51	6	6	14.983633	20.0004	5.900118	17.83369	53.16773	105.50211	0.083335	4.450089
3	SB4VS-29	quenched	T58	6	7	17.00034	18.66704	5.800116	17.16701	49.33432	101.16869	0.083335	3.633406
3	SB4VS-34ccc	ccc	T33	6	8	20.66708	18.3337	5.600112	17.00034	39.16745	100.33534	0.083335	3.3334
3	blank		T90	6	9	0.083335	0.083335	0.083335	0.83335	0.083335	0.083335	0.083335	0.083335
3	Soln Std		Soln Std	6	10	3.83	20.3	3.87	9.62	82.1	50.1	0.05	0.05
3	SB4VS-34	quenched	T80	6	11	21.00042	19.50039	5.633446	18.00036	37.66742	103.00206	0.083335	3.533404
3	SB4VS-23ccc	ccc	T10	6	12	19.33372	18.50037	3.650073	15.633646	64.83463	94.16855	0.083335	2.350047
3	SB4VS-29ccc	ccc	T73	6	13	17.00034	18.50037	5.300106	16.616999	48.66764	101.50203	0.083335	3.433402
3	SB4VS-23	quenched	T54	6	14	19.50039	18.50037	3.433402	15.516977	66.16799	94.83523	0.083335	2.366714
3	SB4VS-26ccc	ccc	T45	6	15	17.00034	18.3337	3.433402	15.850317	55.83445	97.00194	0.083335	2.916725
3	SB4VS-31ccc	ccc	T78	6	16	14.066948	18.83371	4.766762	17.50035	38.3341	104.83543	0.083335	4.700094
3	SB4VS-26	quenched	T86	6	17	17.00034	18.3337	4.083415	16.050321	56.00112	96.50193	0.083335	2.783389
3	SB4VS-35ccc	ccc	T68	6	18	15.516977	20.16707	5.916785	17.83369	54.66776	110.83555	0.083335	4.750095
3	Soln Std		Soln Std	6	19	3.81	20.9	4.16	9.87	84	52.8	0.05	0.05

Exhibit F1. Laboratory PCT Measurements in Analytical Sequence for Study Glasses, EA, ARM, Blanks, and Solution Standards

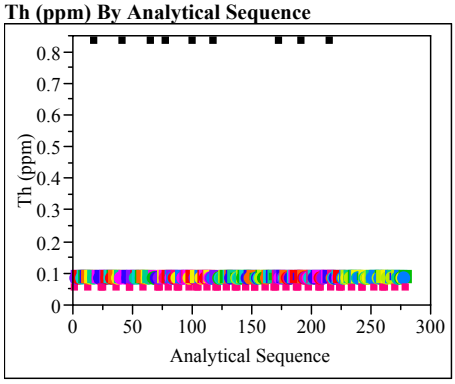
Al (ppm) By Analytical Sequence



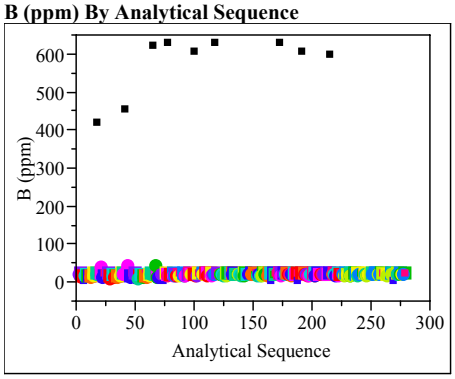
Li (ppm) By Analytical Sequence



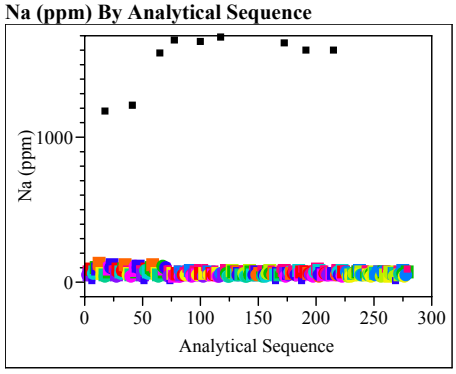
Th (ppm) By Analytical Sequence



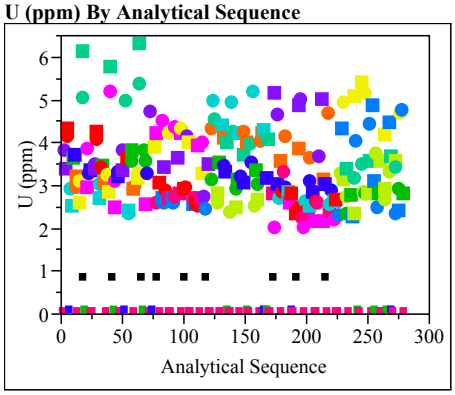
B (ppm) By Analytical Sequence



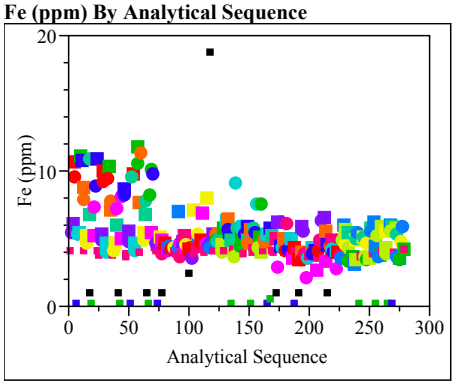
Na (ppm) By Analytical Sequence



U (ppm) By Analytical Sequence



Fe (ppm) By Analytical Sequence



Si (ppm) By Analytical Sequence

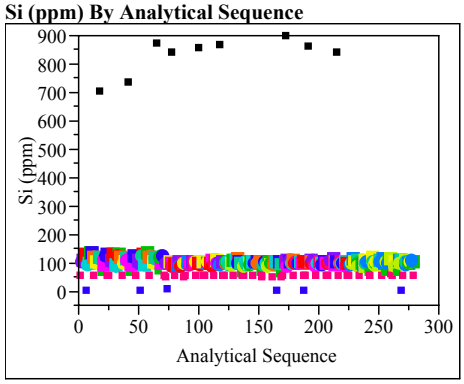
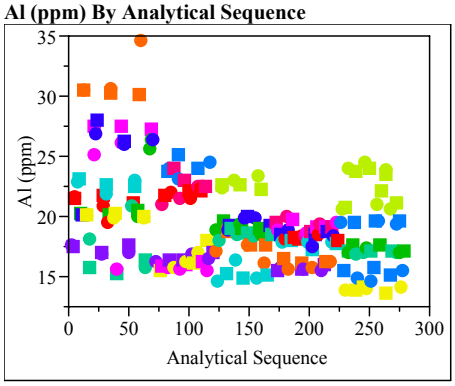
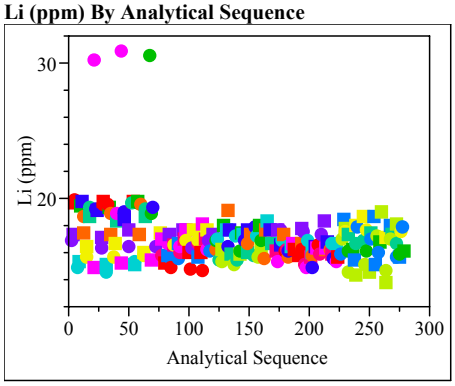


Exhibit F2. Laboratory PCT Measurements in Analytical Sequence for Study Glasses

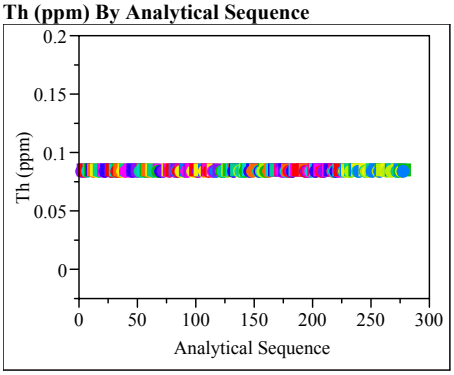
Al (ppm) By Analytical Sequence



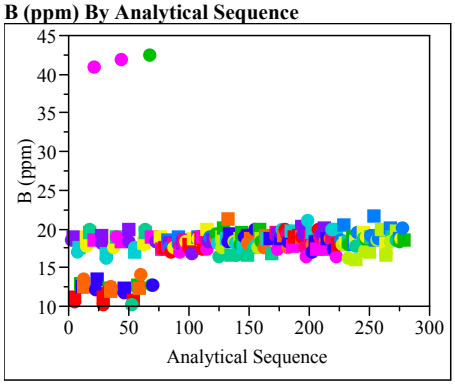
Li (ppm) By Analytical Sequence



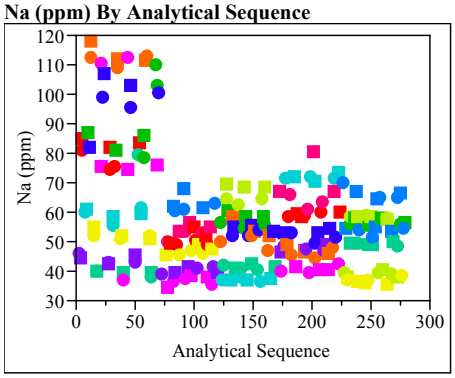
Th (ppm) By Analytical Sequence



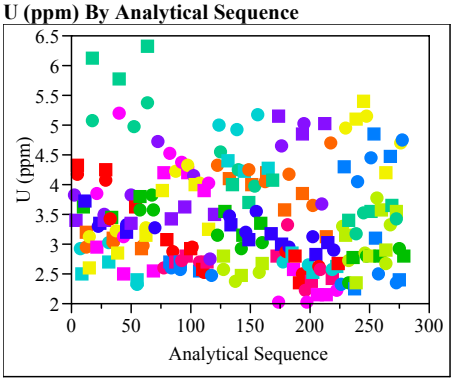
B (ppm) By Analytical Sequence



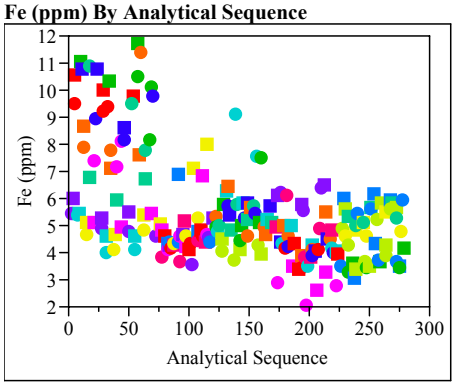
Na (ppm) By Analytical Sequence



U (ppm) By Analytical Sequence



Fe (ppm) By Analytical Sequence



Si (ppm) By Analytical Sequence

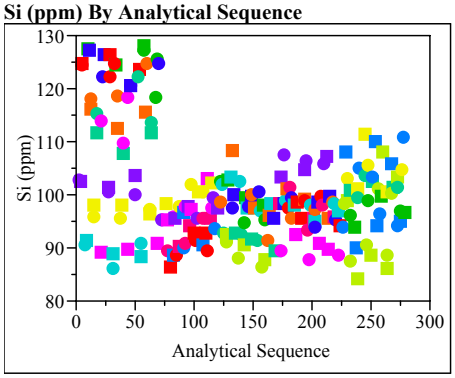
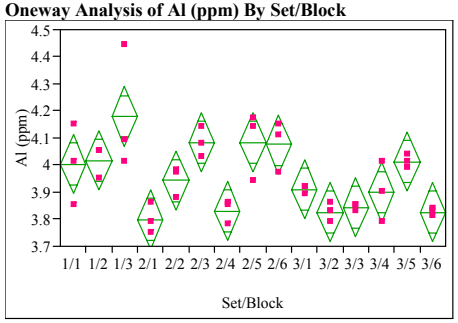


Exhibit F3. Measurements of the Multi-Element Solution Standard by Set and ICP Block

Oneway Analysis of Al (ppm) By Set/Block



Oneway Anova
Summary of Fit

Rsquare	0.698265
Adj Rsquare	0.557455
Root Mean Square Error	0.092532
Mean of Response	3.955778
Observations (or Sum Wgts)	45

Analysis of Variance

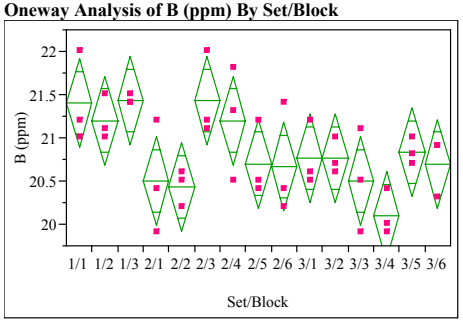
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Set/Block	14	0.59443111	0.042459	4.9589	0.0001
Error	30	0.25686667	0.008562		
C. Total	44	0.85129778			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	4.00333	0.05342	3.8942	4.1124
1/2	3	4.01667	0.05342	3.9076	4.1258
1/3	3	4.18000	0.05342	4.0709	4.2891
2/1	3	3.80000	0.05342	3.6909	3.9091
2/2	3	3.94333	0.05342	3.8342	4.0524
2/3	3	4.08333	0.05342	3.9742	4.1924
2/4	3	3.83000	0.05342	3.7209	3.9391
2/5	3	4.08333	0.05342	3.9742	4.1924
2/6	3	4.07667	0.05342	3.9676	4.1858
3/1	3	3.91000	0.05342	3.8009	4.0191
3/2	3	3.82667	0.05342	3.7176	3.9358
3/3	3	3.84333	0.05342	3.7342	3.9524
3/4	3	3.90000	0.05342	3.7909	4.0091
3/5	3	4.01333	0.05342	3.9042	4.1224
3/6	3	3.82667	0.05342	3.7176	3.9358

Std Error uses a pooled estimate of error variance

Oneway Analysis of B (ppm) By Set/Block



Oneway Anova
Summary of Fit

Rsquare	0.546574
Adj Rsquare	0.334976
Root Mean Square Error	0.436908
Mean of Response	20.84222
Observations (or Sum Wgts)	45

Analysis of Variance

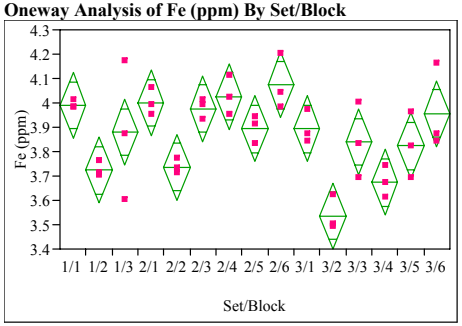
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Set/Block	14	6.903111	0.493079	2.5831	0.0143
Error	30	5.726667	0.190889		
C. Total	44	12.629778			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	21.4000	0.25225	20.885	21.915
1/2	3	21.2000	0.25225	20.685	21.715
1/3	3	21.4333	0.25225	20.918	21.948
2/1	3	20.5000	0.25225	19.985	21.015
2/2	3	20.4333	0.25225	19.918	20.948
2/3	3	21.4333	0.25225	20.918	21.948
2/4	3	21.2000	0.25225	20.685	21.715
2/5	3	20.7000	0.25225	20.185	21.215
2/6	3	20.6667	0.25225	20.152	21.182
3/1	3	20.7667	0.25225	20.252	21.282
3/2	3	20.7667	0.25225	20.252	21.282
3/3	3	20.5000	0.25225	19.985	21.015
3/4	3	20.1000	0.25225	19.585	20.615
3/5	3	20.8333	0.25225	20.318	21.348
3/6	3	20.7000	0.25225	20.185	21.215

Std Error uses a pooled estimate of error variance

Oneway Analysis of Fe (ppm) By Set/Block



Oneway Anova
Summary of Fit

Rsquare	0.700229
Adj Rsquare	0.560336
Root Mean Square Error	0.115085
Mean of Response	3.868222
Observations (or Sum Wgts)	45

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Set/Block	14	0.9281244	0.066295	5.0055	0.0001
Error	30	0.3973333	0.013244		
C. Total	44	1.3254578			

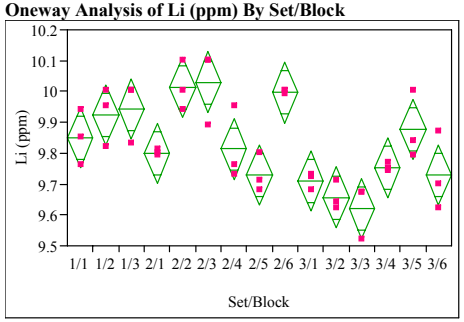
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	3.99000	0.06644	3.8543	4.1257
1/2	3	3.72333	0.06644	3.5876	3.8590
1/3	3	3.88000	0.06644	3.7443	4.0157
2/1	3	4.00000	0.06644	3.8643	4.1357
2/2	3	3.73667	0.06644	3.6010	3.8724
2/3	3	3.97667	0.06644	3.8410	4.1124
2/4	3	4.02667	0.06644	3.8910	4.1624
2/5	3	3.89333	0.06644	3.7576	4.0290
2/6	3	4.07333	0.06644	3.9376	4.2090
3/1	3	3.89333	0.06644	3.7576	4.0290
3/2	3	3.53667	0.06644	3.4010	3.6724
3/3	3	3.84000	0.06644	3.7043	3.9757
3/4	3	3.67333	0.06644	3.5376	3.8090
3/5	3	3.82333	0.06644	3.6876	3.9590
3/6	3	3.95667	0.06644	3.8210	4.0924

Std Error uses a pooled estimate of error variance

Exhibit F3. Measurements of the Multi-Element Solution Standard by Set and ICP Block (continued)

Oneway Analysis of Li (ppm) By Set/Block



Oneway Anova
Summary of Fit

Rsquare	0.775229
Adj Rsquare	0.670336
Root Mean Square Error	0.083613
Mean of Response	9.829778
Observations (or Sum Wgts)	45

Analysis of Variance

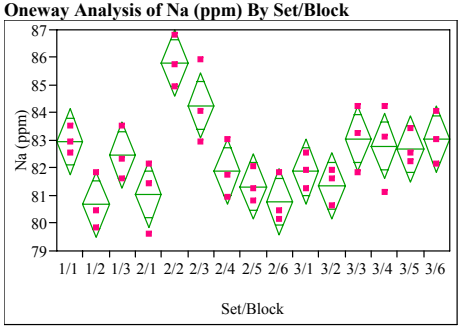
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Set/Block	14	0.72336444	0.051669	7.3907	<.0001
Error	30	0.20973333	0.006991		
C. Total	44	0.93309778			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	9.8500	0.04827	9.7514	9.949
1/2	3	9.9233	0.04827	9.8247	10.022
1/3	3	9.9433	0.04827	9.8447	10.042
2/1	3	9.8000	0.04827	9.7014	9.899
2/2	3	10.0133	0.04827	9.9147	10.112
2/3	3	10.0300	0.04827	9.9314	10.129
2/4	3	9.8133	0.04827	9.7147	9.912
2/5	3	9.7300	0.04827	9.6314	9.829
2/6	3	9.9967	0.04827	9.8981	10.095
3/1	3	9.7100	0.04827	9.6114	9.809
3/2	3	9.6567	0.04827	9.5581	9.755
3/3	3	9.6200	0.04827	9.5214	9.719
3/4	3	9.7533	0.04827	9.6547	9.852
3/5	3	9.8767	0.04827	9.7781	9.975
3/6	3	9.7300	0.04827	9.6314	9.829

Std Error uses a pooled estimate of error variance

Oneway Analysis of Na (ppm) By Set/Block



Oneway Anova
Summary of Fit

Rsquare	0.721185
Adj Rsquare	0.591071
Root Mean Square Error	1.017513
Mean of Response	82.4
Observations (or Sum Wgts)	45

Analysis of Variance

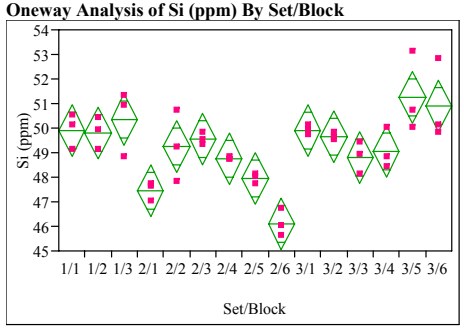
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Set/Block	14	80.34000	5.73857	5.5427	<.0001
Error	30	31.06000	1.03533		
C. Total	44	111.40000			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	82.9667	0.58746	81.767	84.166
1/2	3	80.6667	0.58746	79.467	81.866
1/3	3	82.4667	0.58746	81.267	83.666
2/1	3	81.0333	0.58746	79.834	82.233
2/2	3	85.8000	0.58746	84.600	87.000
2/3	3	84.2667	0.58746	83.067	85.466
2/4	3	81.8667	0.58746	80.667	83.066
2/5	3	81.3333	0.58746	80.134	82.533
2/6	3	80.7667	0.58746	79.567	81.966
3/1	3	81.8667	0.58746	80.667	83.066
3/2	3	81.3667	0.58746	80.167	82.566
3/3	3	83.0667	0.58746	81.867	84.266
3/4	3	82.8000	0.58746	81.600	84.000
3/5	3	82.7000	0.58746	81.500	83.900
3/6	3	83.0333	0.58746	81.834	84.233

Std Error uses a pooled estimate of error variance

Oneway Analysis of Si (ppm) By Set/Block



Oneway Anova
Summary of Fit

Rsquare	0.75637
Adj Rsquare	0.642676
Root Mean Square Error	0.893682
Mean of Response	49.23778
Observations (or Sum Wgts)	45

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Set/Block	14	74.385778	5.31327	6.6527	<.0001
Error	30	23.960000	0.79867		
C. Total	44	98.345778			

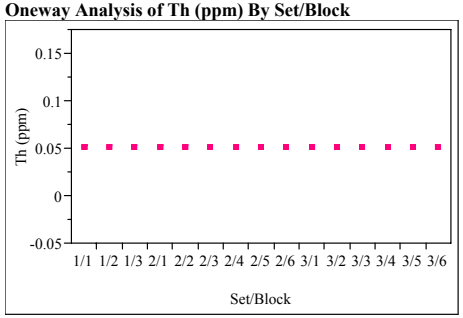
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	49.9000	0.51597	48.846	50.954
1/2	3	49.8000	0.51597	48.746	50.854
1/3	3	50.3333	0.51597	49.280	51.387
2/1	3	47.4333	0.51597	46.380	48.487
2/2	3	49.2333	0.51597	48.180	50.287
2/3	3	49.5333	0.51597	48.480	50.587
2/4	3	48.7333	0.51597	47.680	49.787
2/5	3	47.9333	0.51597	46.880	48.987
2/6	3	46.1000	0.51597	45.046	47.154
3/1	3	49.9000	0.51597	48.846	50.954
3/2	3	49.6333	0.51597	48.580	50.687
3/3	3	48.8000	0.51597	47.746	49.854
3/4	3	49.0667	0.51597	48.013	50.120
3/5	3	51.2667	0.51597	50.213	52.320
3/6	3	50.9000	0.51597	49.846	51.954

Std Error uses a pooled estimate of error variance

Exhibit F3. Measurements of the Multi-Element Solution Standard by Set and ICP Block (continued)

Oneway Analysis of Th (ppm) By Set/Block



Oneway Anova
Summary of Fit

Rsquare	2.25
Adj Rsquare	2.833333
Root Mean Square Error	.
Mean of Response	0.05
Observations (or Sum Wgts)	45

Analysis of Variance

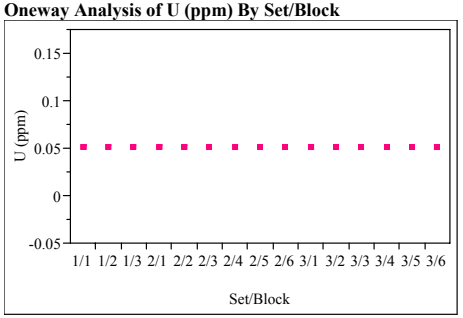
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Set/Block	14	1.95e-32	1.393e-33	-3.8571	0.0000
Error	30	-1.083e-32	-3.61e-34		
C. Total	44	8.6667e-33			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	0.050000	.	.	.
1/2	3	0.050000	.	.	.
1/3	3	0.050000	.	.	.
2/1	3	0.050000	.	.	.
2/2	3	0.050000	.	.	.
2/3	3	0.050000	.	.	.
2/4	3	0.050000	.	.	.
2/5	3	0.050000	.	.	.
2/6	3	0.050000	.	.	.
3/1	3	0.050000	.	.	.
3/2	3	0.050000	.	.	.
3/3	3	0.050000	.	.	.
3/4	3	0.050000	.	.	.
3/5	3	0.050000	.	.	.
3/6	3	0.050000	.	.	.

Std Error uses a pooled estimate of error variance

Oneway Analysis of U (ppm) By Set/Block



Oneway Anova
Summary of Fit

Rsquare	2.25
Adj Rsquare	2.833333
Root Mean Square Error	.
Mean of Response	0.05
Observations (or Sum Wgts)	45

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Set/Block	14	1.95e-32	1.393e-33	-3.8571	0.0000
Error	30	-1.083e-32	-3.61e-34		
C. Total	44	8.6667e-33			

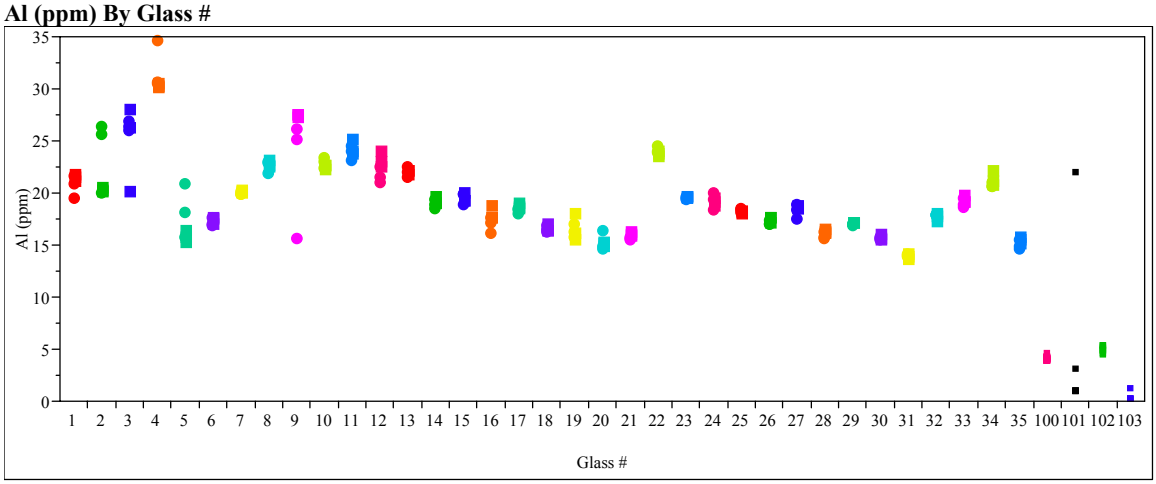
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	0.050000	.	.	.
1/2	3	0.050000	.	.	.
1/3	3	0.050000	.	.	.
2/1	3	0.050000	.	.	.
2/2	3	0.050000	.	.	.
2/3	3	0.050000	.	.	.
2/4	3	0.050000	.	.	.
2/5	3	0.050000	.	.	.
2/6	3	0.050000	.	.	.
3/1	3	0.050000	.	.	.
3/2	3	0.050000	.	.	.
3/3	3	0.050000	.	.	.
3/4	3	0.050000	.	.	.
3/5	3	0.050000	.	.	.
3/6	3	0.050000	.	.	.

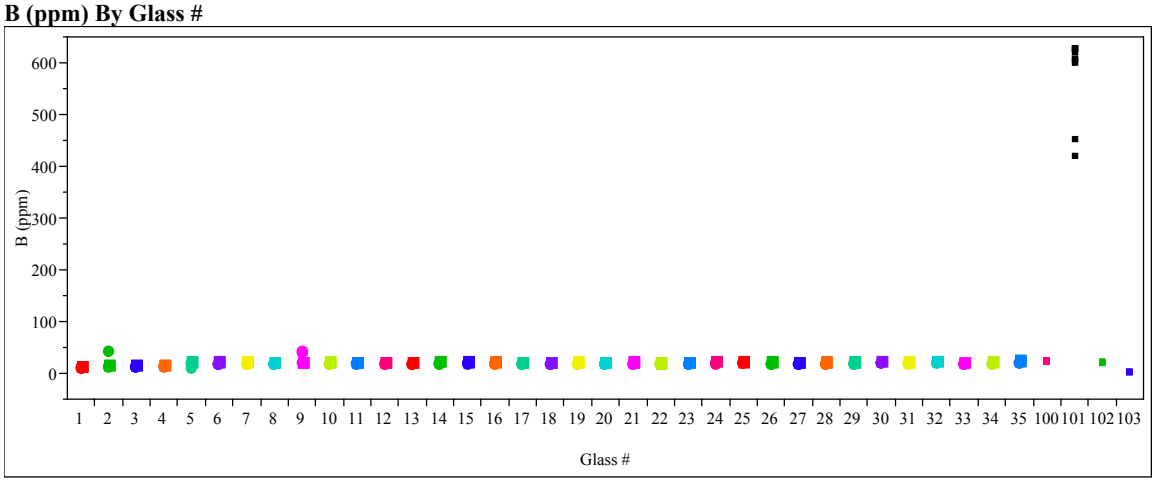
Std Error uses a pooled estimate of error variance

Exhibit F4. Laboratory PCT Measurements by Glass Number for Study Glasses and Standards
(100 – Solution Standard; 101 – EA; 102 – ARM; 103 – Blanks)

Al (ppm) By Glass #



B (ppm) By Glass #



Fe (ppm) By Glass #

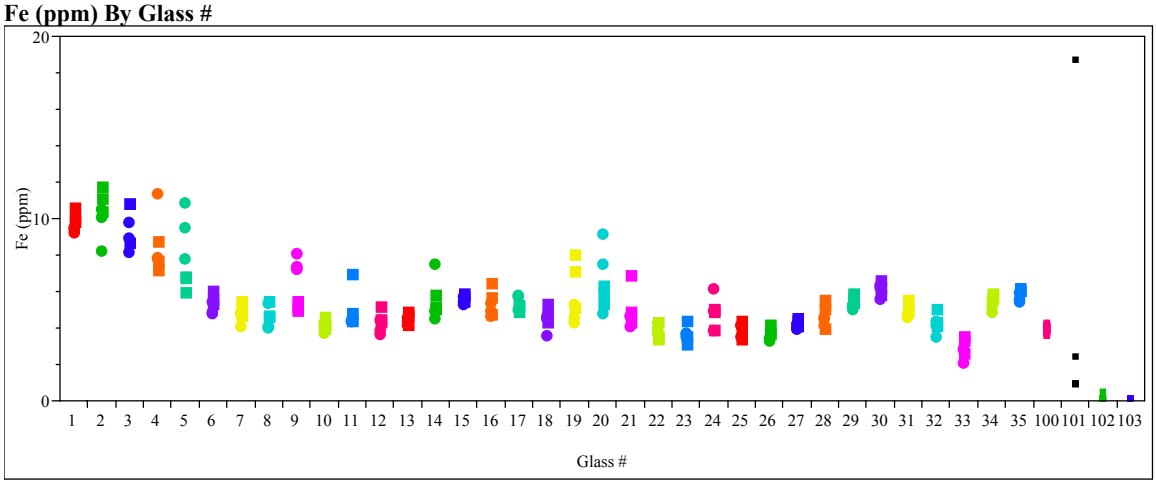
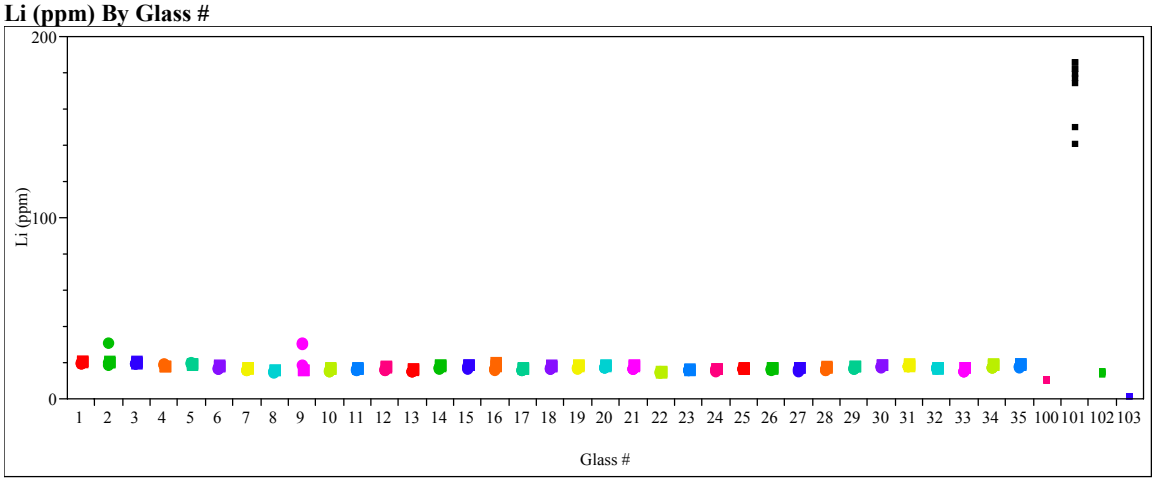


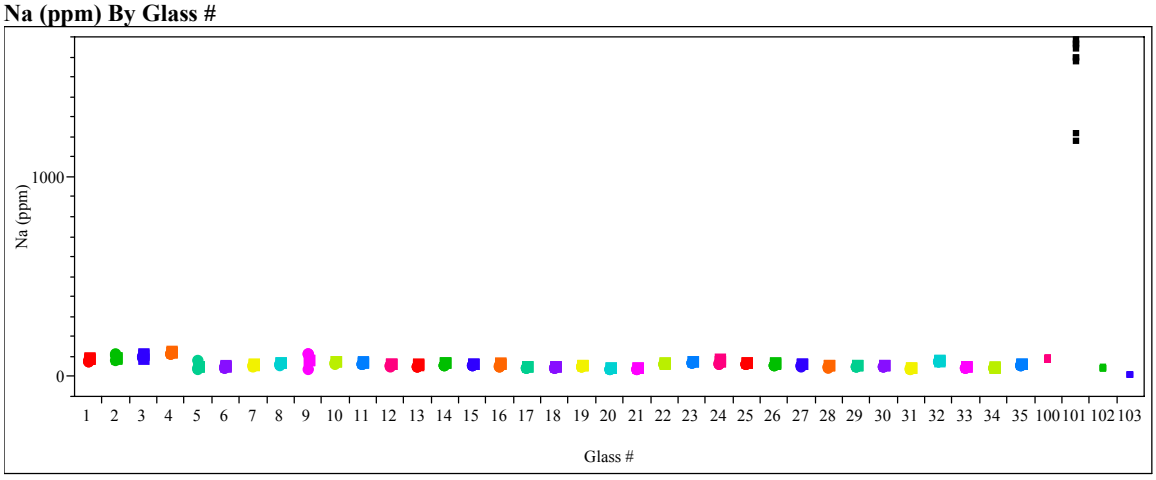
Exhibit F4. Laboratory PCT Measurements by Glass Number for Study Glasses and Standards (continued)

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

Li (ppm) By Glass #



Na (ppm) By Glass #



Si (ppm) By Glass #

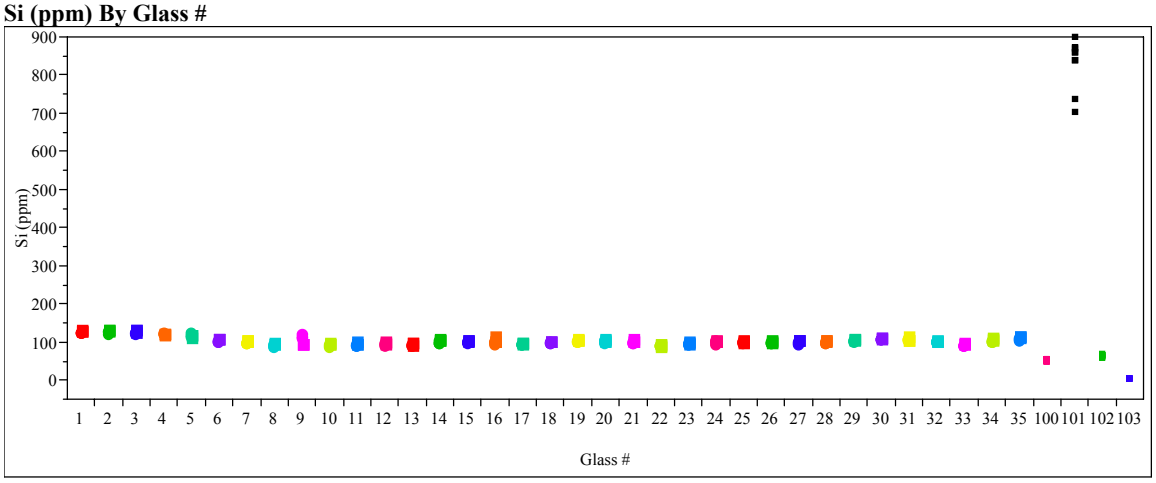
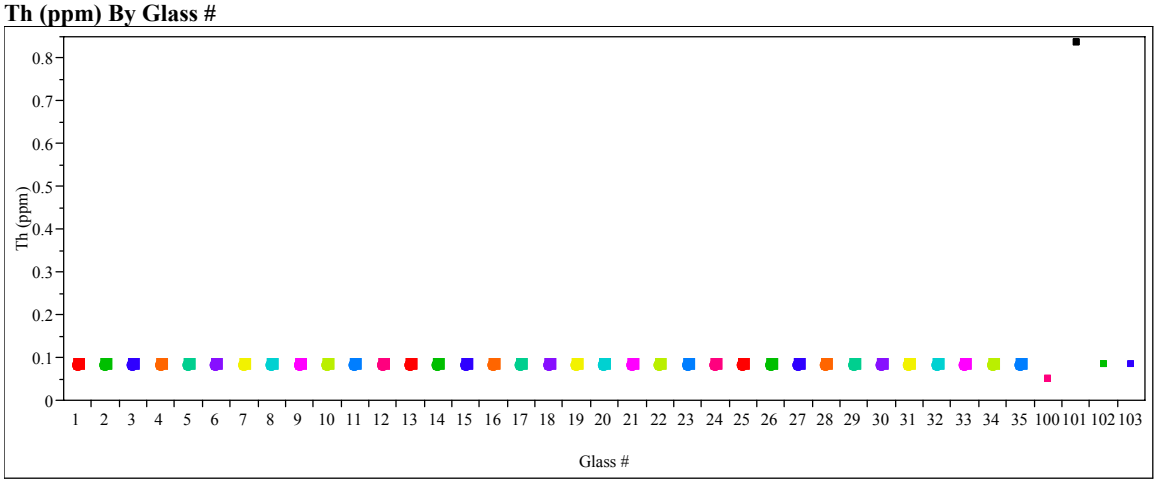


Exhibit F4. Laboratory PCT Measurements by Glass Number for Study Glasses and Standards (continued)
(100 – Solution Standard; 101 – EA; 102 – ARM; 103 – Blanks)

Th (ppm) By Glass #



U (ppm) By Glass #

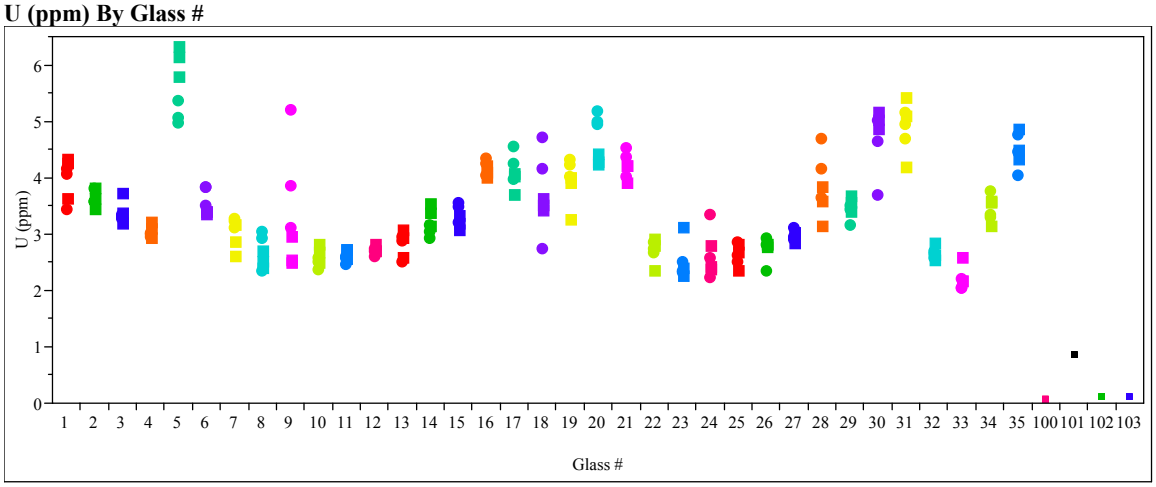
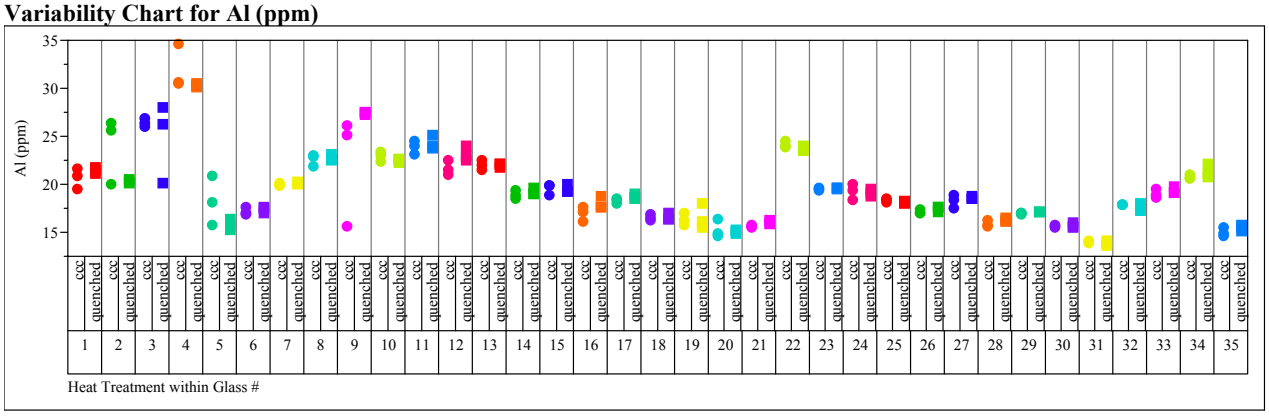
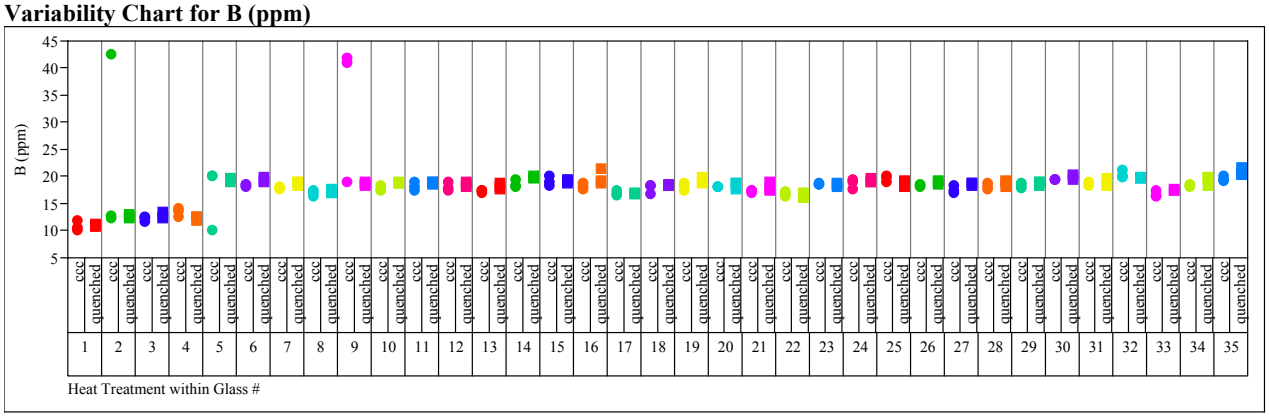


Exhibit F5. Laboratory PCT Measurements by Glass Number for Study Glasses

Variability Chart for Al (ppm)



Variability Chart for B (ppm)



Variability Chart for Fe (ppm)

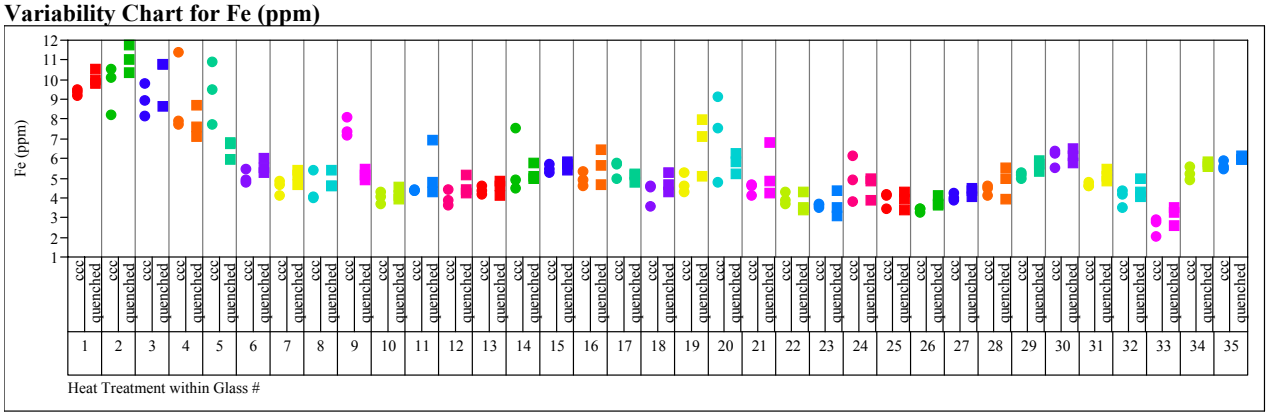
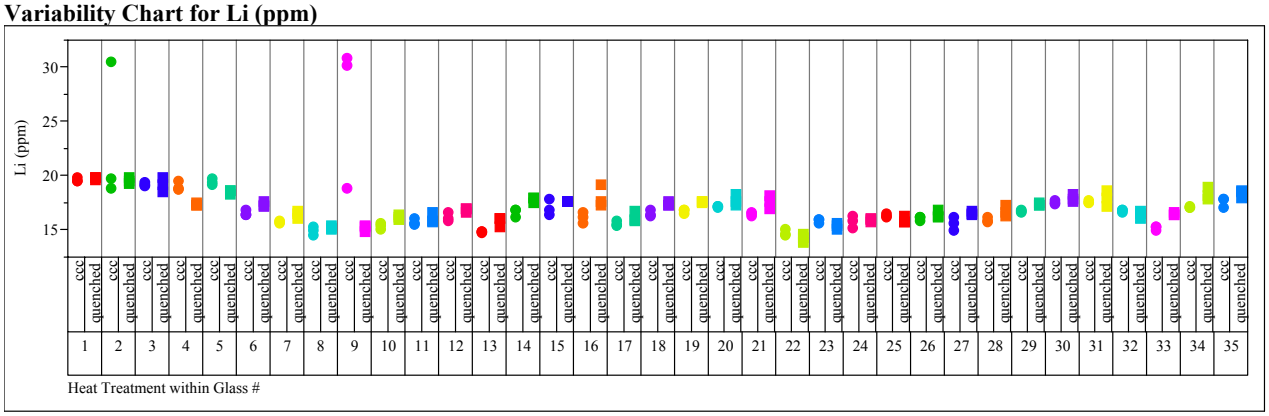
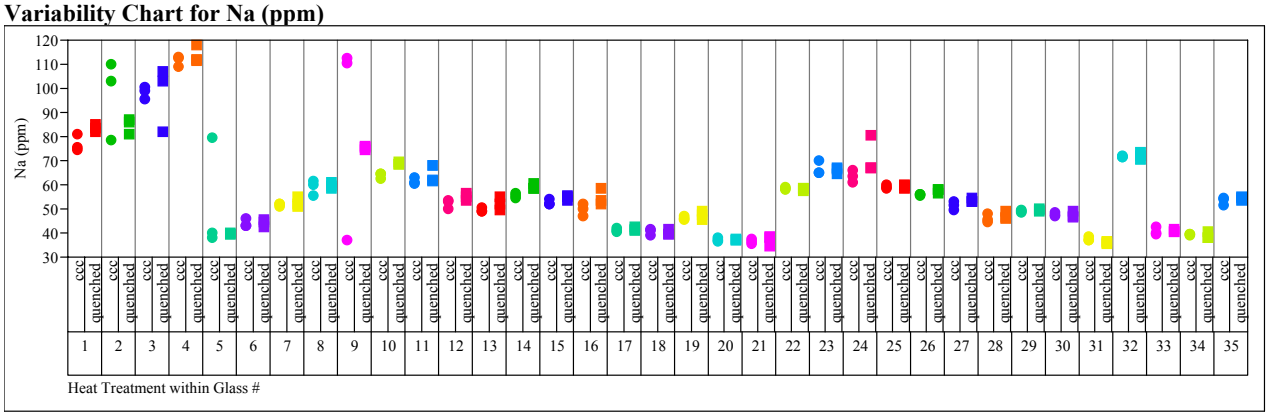


Exhibit F5. Laboratory PCT Measurements by Glass Number for Study Glasses (continued)

Variability Chart for Li (ppm)



Variability Chart for Na (ppm)



Variability Chart for Si (ppm)

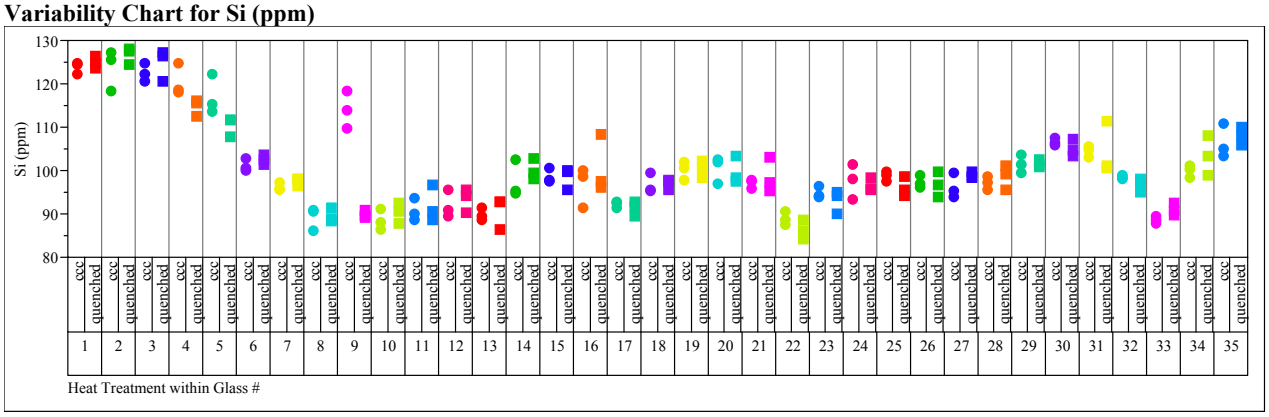
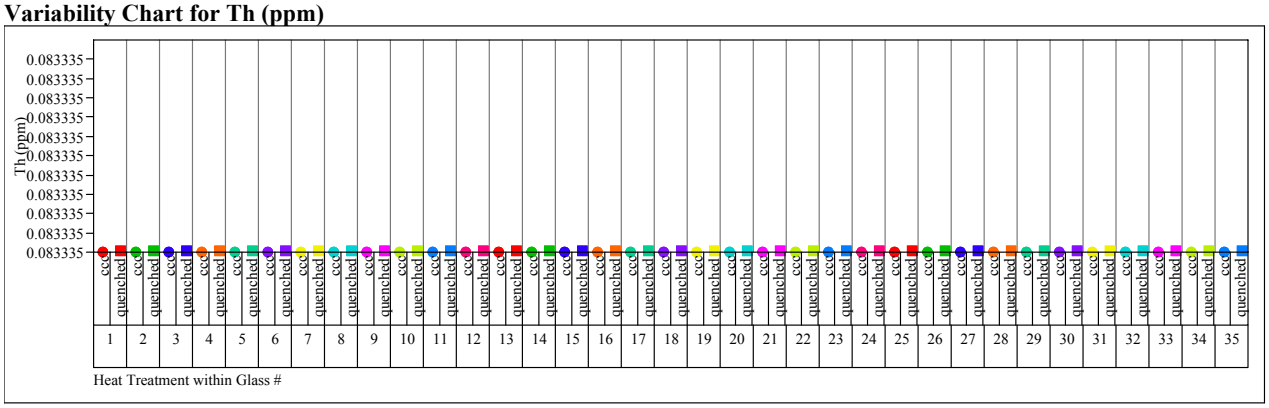


Exhibit F5. Laboratory PCT Measurements by Glass Number for Study Glasses (continued)

Variability Chart for Th (ppm)



Variability Chart for U (ppm)

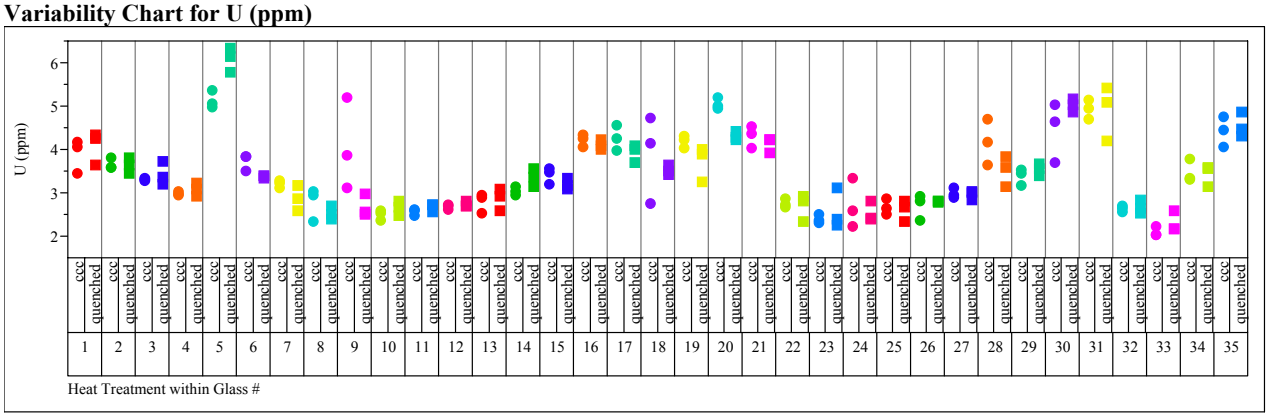


Exhibit F6. Correlations and Scatter Plots of Normalized PCTs Over All Compositional Views and Heat Treatments

Correlations

	log NL[B (g/L)]	log NL[Li (g/L)]	log NL[Na (g/L)]	log NL[Si (g/L)]
log NL[B (g/L)]	1.0000	0.9915	0.9584	0.9655
log NL[Li (g/L)]	0.9915	1.0000	0.9428	0.9693
log NL[Na (g/L)]	0.9584	0.9428	1.0000	0.9534
log NL[Si (g/L)]	0.9655	0.9693	0.9534	1.0000

Scatterplot Matrix

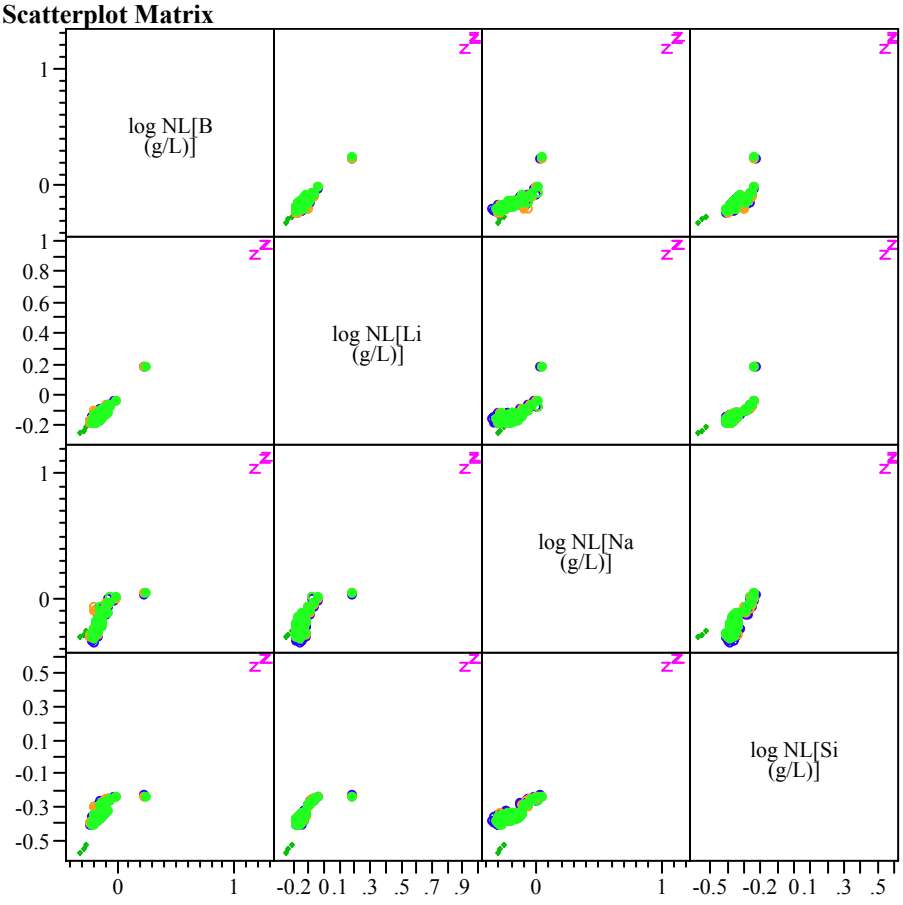
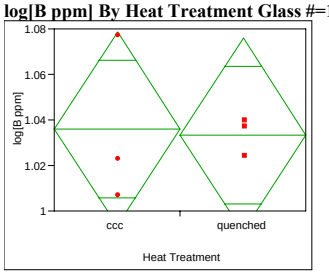


Exhibit F7. Heat Treatment Effect on log(ppm) PCT Response

t Test: quenched-ccc

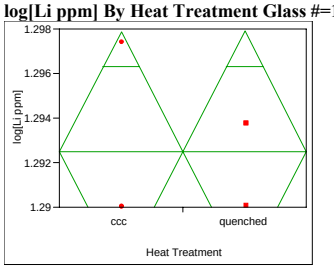
Assuming unequal variances

log[B ppm] By Heat Treatment Glass #=1



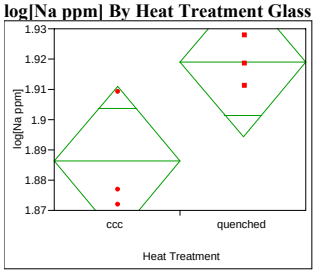
Difference	-0.00256	t Ratio	-0.11771
Std Err Dif	0.02176	DF	2.202108
Upper CL Dif	0.08330	Prob > |t|	0.9162
Lower CL Dif	-0.08842	Prob > t	0.5419
Confidence	0.95	Prob < t	0.4581

log[Li ppm] By Heat Treatment Glass #=1



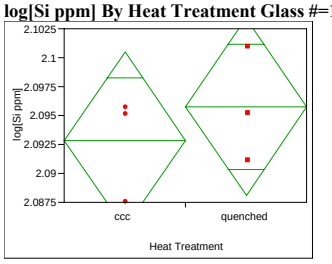
Difference	1.04e-5	t Ratio	0.003787
Std Err Dif	0.00275	DF	2.948218
Upper CL Dif	0.00884	Prob > |t|	0.9972
Lower CL Dif	-0.00881	Prob > t	0.4986
Confidence	0.95	Prob < t	0.5014

log[Na ppm] By Heat Treatment Glass #=1



Difference	0.03285	t Ratio	2.600724
Std Err Dif	0.01263	DF	2.655333
Upper CL Dif	0.07617	Prob > |t|	0.0910
Lower CL Dif	-0.01047	Prob > t	0.0455
Confidence	0.95	Prob < t	0.9545

log[Si ppm] By Heat Treatment Glass #=1

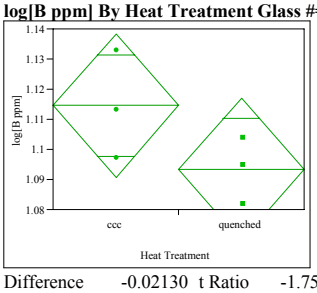


Difference	0.00291	t Ratio	0.746973
Std Err Dif	0.00390	DF	3.97521
Upper CL Dif	0.01375	Prob > |t|	0.4968
Lower CL Dif	-0.00793	Prob > t	0.2484
Confidence	0.95	Prob < t	0.7516

t Test: quenched-ccc

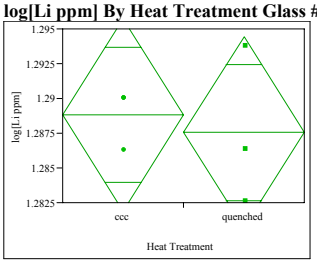
Assuming unequal variances

log[B ppm] By Heat Treatment Glass #=2



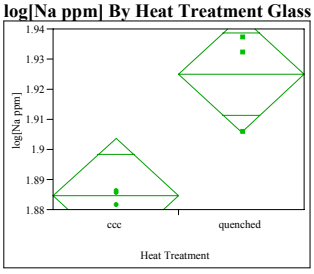
Difference	-0.02130	t Ratio	-1.75663
Std Err Dif	0.01213	DF	3.363201
Upper CL Dif	0.01504	Prob > |t|	0.1672
Lower CL Dif	-0.05764	Prob > t	0.9164
Confidence	0.95	Prob < t	0.0836

log[Li ppm] By Heat Treatment Glass #=2



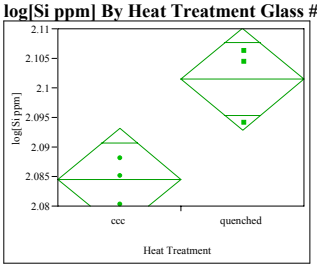
Difference	-0.00126	t Ratio	-0.3598
Std Err Dif	0.00351	DF	2.560603
Upper CL Dif	0.01108	Prob > |t|	0.7466
Lower CL Dif	-0.01361	Prob > t	0.6267
Confidence	0.95	Prob < t	0.3733

log[Na ppm] By Heat Treatment Glass #=2



Difference	0.04032	t Ratio	4.121988
Std Err Dif	0.00978	DF	2.089073
Upper CL Dif	0.08074	Prob > |t|	0.0502
Lower CL Dif	-9.35e-5	Prob > t	0.0251
Confidence	0.95	Prob < t	0.9749

log[Si ppm] By Heat Treatment Glass #=2

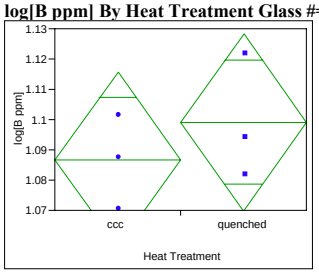


Difference	0.016921	t Ratio	3.848792
Std Err Dif	0.004396	DF	3.269891
Upper CL Dif	0.030281	Prob > |t|	0.0265
Lower CL Dif	0.003561	Prob > t	0.0133
Confidence	0.95	Prob < t	0.9867

t Test: quenched-ccc

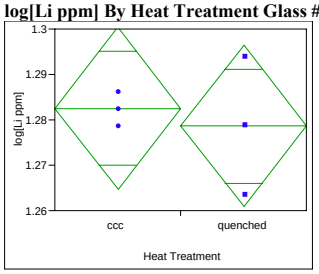
Assuming unequal variances

log[B ppm] By Heat Treatment Glass #=3



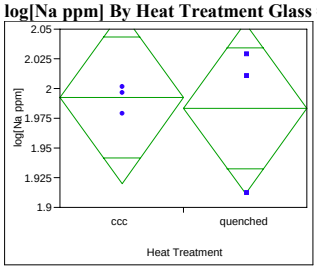
Difference	0.01252	t Ratio	0.843849
Std Err Dif	0.01483	DF	3.716801
Upper CL Dif	0.05496	Prob > |t|	0.4496
Lower CL Dif	-0.02993	Prob > t	0.2248
Confidence	0.95	Prob < t	0.7752

log[Li ppm] By Heat Treatment Glass #=3



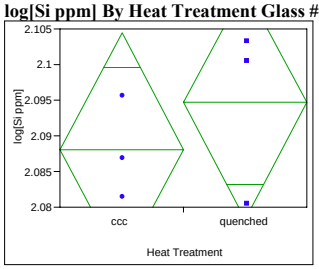
Difference	-0.00396	t Ratio	-0.43674
Std Err Dif	0.00907	DF	2.244537
Upper CL Dif	0.03125	Prob > |t|	0.7008
Lower CL Dif	-0.03917	Prob > t	0.6496
Confidence	0.95	Prob < t	0.3504

log[Na ppm] By Heat Treatment Glass #=3



Difference	-0.00899	t Ratio	-0.2452
Std Err Dif	0.03666	DF	2.138747
Upper CL Dif	0.13932	Prob > |t|	0.8278
Lower CL Dif	-0.15730	Prob > t	0.5861
Confidence	0.95	Prob < t	0.4139

log[Si ppm] By Heat Treatment Glass #=3



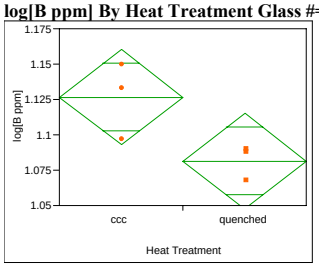
Difference	0.00657	t Ratio	0.792314
Std Err Dif	0.00829	DF	3.190412
Upper CL Dif	0.03207	Prob > |t|	0.4829
Lower CL Dif	-0.01894	Prob > t	0.2414
Confidence	0.95	Prob < t	0.7586

Exhibit F7. Heat Treatment Effect on log(ppm) PCT Response (continued)

t Test: quenched-ccc

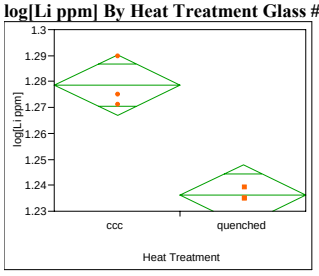
Assuming unequal variances

log[B ppm] By Heat Treatment Glass #=4



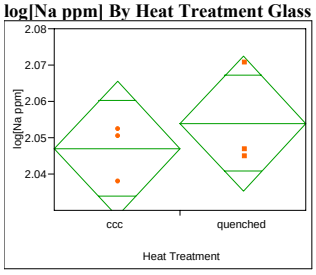
Difference	-0.04524	t Ratio	-2.63176
Std Err Dif	0.01719	DF	2.758318
Upper CL Dif	0.01228	Prob > |t|	0.0854
Lower CL Dif	-0.10277	Prob > t	0.9573
Confidence	0.95	Prob < t	0.0427

log[Li ppm] By Heat Treatment Glass #=4



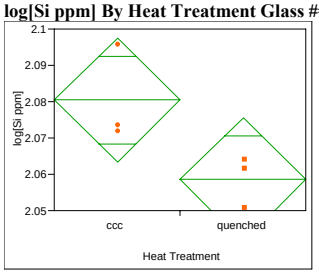
Difference	-0.04259	t Ratio	-7.15327
Std Err Dif	0.00595	DF	2.232835
Upper CL Dif	-0.01937	Prob > |t|	0.0140
Lower CL Dif	-0.06581	Prob > t	0.9930
Confidence	0.95	Prob < t	0.0070

log[Na ppm] By Heat Treatment Glass #=4



Difference	0.00697	t Ratio	0.734787
Std Err Dif	0.00949	DF	3.068678
Upper CL Dif	0.03678	Prob > |t|	0.5146
Lower CL Dif	-0.02284	Prob > t	0.2573
Confidence	0.95	Prob < t	0.7427

log[Si ppm] By Heat Treatment Glass #=4

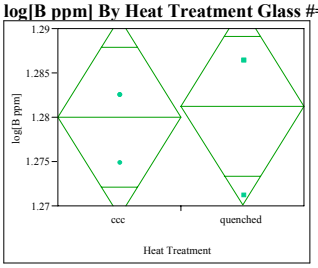


Difference	-0.02189	t Ratio	-2.51938
Std Err Dif	0.00869	DF	3.051991
Upper CL Dif	0.00550	Prob > |t|	0.0848
Lower CL Dif	-0.04929	Prob > t	0.9576
Confidence	0.95	Prob < t	0.0424

t Test: quenched-ccc

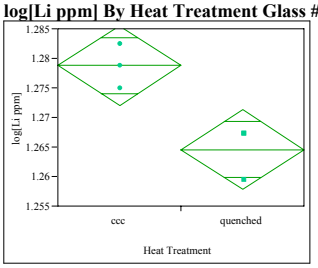
Assuming unequal variances

log[B ppm] By Heat Treatment Glass #=5



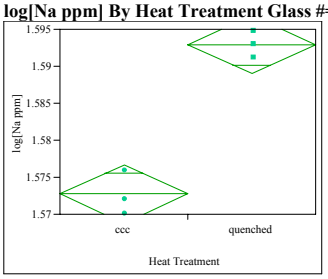
Difference	0.00122	t Ratio	0.2148
Std Err Dif	0.00568	DF	2.941049
Upper CL Dif	0.01950	Prob > |t|	0.8440
Lower CL Dif	-0.01706	Prob > t	0.4220
Confidence	0.95	Prob < t	0.5780

log[Li ppm] By Heat Treatment Glass #=5



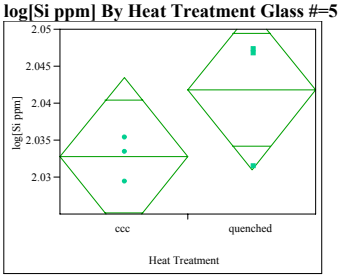
Difference	-0.01420	t Ratio	-4.14055
Std Err Dif	0.00343	DF	3.87762
Upper CL Dif	-0.00456	Prob > |t|	0.0153
Lower CL Dif	-0.02385	Prob > t	0.9923
Confidence	0.95	Prob < t	0.0077

log[Na ppm] By Heat Treatment Glass #=5



Difference	0.020178	t Ratio	10.02987
Std Err Dif	0.002012	DF	3.357547
Upper CL Dif	0.026212	Prob > |t|	0.0013
Lower CL Dif	0.014145	Prob > t	0.0006
Confidence	0.95	Prob < t	0.9994

log[Si ppm] By Heat Treatment Glass #=5

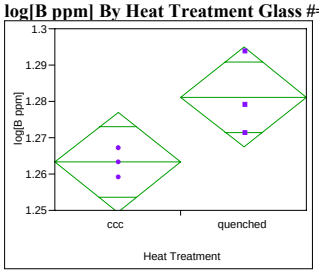


Difference	0.00902	t Ratio	1.64657
Std Err Dif	0.00548	DF	2.464096
Upper CL Dif	0.02882	Prob > |t|	0.2175
Lower CL Dif	-0.01077	Prob > t	0.1088
Confidence	0.95	Prob < t	0.8912

t Test: quenched-ccc

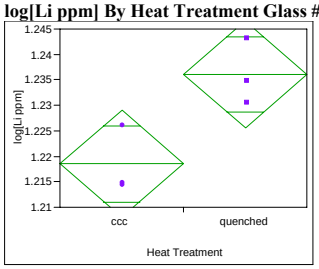
Assuming unequal variances

log[B ppm] By Heat Treatment Glass #=6



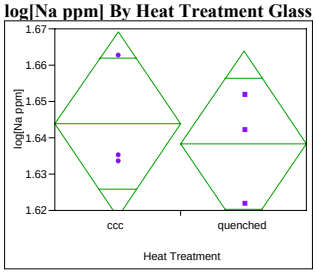
Difference	0.01795	t Ratio	2.55249
Std Err Dif	0.00703	DF	2.463011
Upper CL Dif	0.04337	Prob > |t|	0.1019
Lower CL Dif	-0.00746	Prob > t	0.0510
Confidence	0.95	Prob < t	0.9490

log[Li ppm] By Heat Treatment Glass #=6



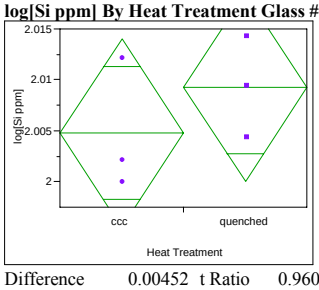
Difference	0.017586	t Ratio	3.293572
Std Err Dif	0.005339	DF	3.99346
Upper CL Dif	0.032420	Prob > |t|	0.0302
Lower CL Dif	0.002752	Prob > t	0.0151
Confidence	0.95	Prob < t	0.9849

log[Na ppm] By Heat Treatment Glass #=6



Difference	-0.00548	t Ratio	-0.4222
Std Err Dif	0.01299	DF	3.980776
Upper CL Dif	0.03064	Prob > |t|	0.6947
Lower CL Dif	-0.04160	Prob > t	0.6527
Confidence	0.95	Prob < t	0.3473

log[Si ppm] By Heat Treatment Glass #=6



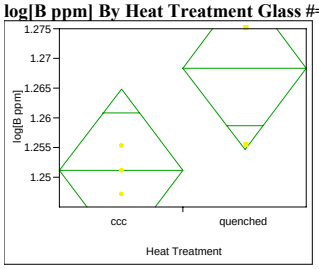
Difference	0.00452	t Ratio	0.960983
Std Err Dif	0.00471	DF	3.746752
Upper CL Dif	0.01795	Prob > |t|	0.3944
Lower CL Dif	-0.00890	Prob > t	0.1972
Confidence	0.95	Prob < t	0.8028

Exhibit F7. Heat Treatment Effect on log(ppm) PCT Response (continued)

t Test: quenched-ccc

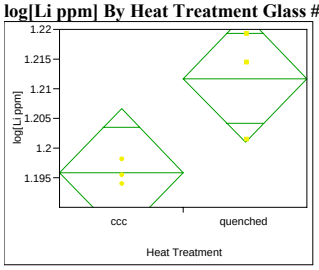
Assuming unequal variances

log[B ppm] By Heat Treatment Glass #=7



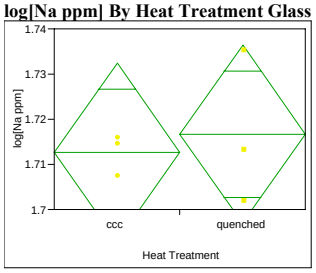
Difference	0.01716	t Ratio	2.465591
Std Err Dif	0.00696	DF	2.503532
Upper CL Dif	0.04200	Prob > |t|	0.1073
Lower CL Dif	-0.00769	Prob > t	0.0536
Confidence	0.95	Prob < t	0.9464

log[Li ppm] By Heat Treatment Glass #=7



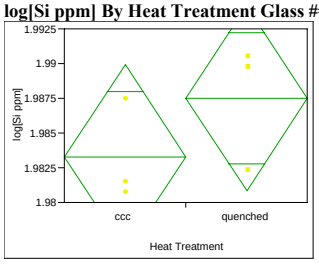
Difference	0.01578	t Ratio	2.888267
Std Err Dif	0.00546	DF	2.208883
Upper CL Dif	0.03729	Prob > |t|	0.0908
Lower CL Dif	-0.00572	Prob > t	0.0454
Confidence	0.95	Prob < t	0.9546

log[Na ppm] By Heat Treatment Glass #=7



Difference	0.00398	t Ratio	0.394815
Std Err Dif	0.01009	DF	2.285411
Upper CL Dif	0.04259	Prob > |t|	0.7268
Lower CL Dif	-0.03462	Prob > t	0.3634
Confidence	0.95	Prob < t	0.6366

log[Si ppm] By Heat Treatment Glass #=7

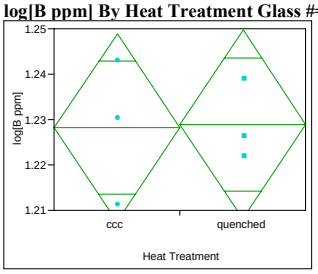


Difference	0.00424	t Ratio	1.251874
Std Err Dif	0.00338	DF	3.842846
Upper CL Dif	0.01379	Prob > |t|	0.2814
Lower CL Dif	-0.00531	Prob > t	0.1407
Confidence	0.95	Prob < t	0.8593

t Test: quenched-ccc

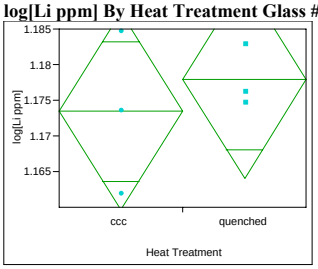
Assuming unequal variances

log[B ppm] By Heat Treatment Glass #=8



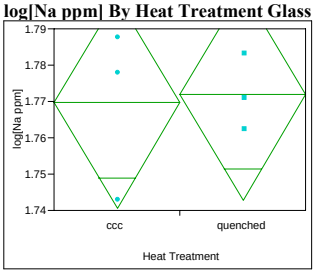
Difference	0.00071	t Ratio	0.066845
Std Err Dif	0.01055	DF	3.122013
Upper CL Dif	0.03355	Prob > |t|	0.9508
Lower CL Dif	-0.03214	Prob > t	0.4754
Confidence	0.95	Prob < t	0.5246

log[Li ppm] By Heat Treatment Glass #=8



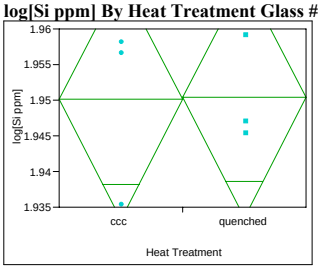
Difference	0.00443	t Ratio	0.628492
Std Err Dif	0.00705	DF	2.568885
Upper CL Dif	0.02917	Prob > |t|	0.5811
Lower CL Dif	-0.02030	Prob > t	0.2905
Confidence	0.95	Prob < t	0.7095

log[Na ppm] By Heat Treatment Glass #=8



Difference	0.00238	t Ratio	0.16019
Std Err Dif	0.01487	DF	2.756128
Upper CL Dif	0.05216	Prob > |t|	0.8837
Lower CL Dif	-0.04740	Prob > t	0.4419
Confidence	0.95	Prob < t	0.5581

log[Si ppm] By Heat Treatment Glass #=8

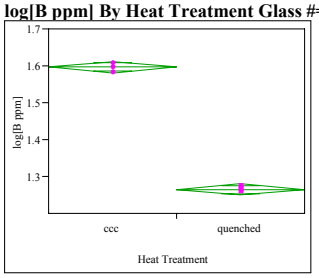


Difference	0.00035	t Ratio	0.041118
Std Err Dif	0.00856	DF	3.23092
Upper CL Dif	0.02653	Prob > |t|	0.9696
Lower CL Dif	-0.02582	Prob > t	0.4848
Confidence	0.95	Prob < t	0.5152

t Test: quenched-ccc

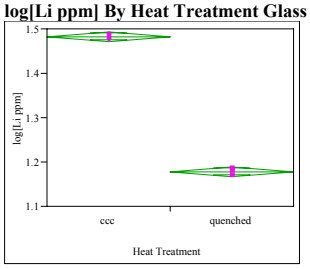
Assuming unequal variances

log[B ppm] By Heat Treatment Glass #=9



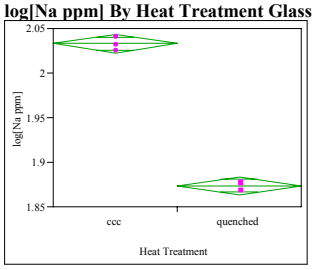
Difference	-0.33196	t Ratio	-42.6936
Std Err Dif	0.00778	DF	2.933376
Upper CL Dif	-0.30689	Prob > |t|	<.0001
Lower CL Dif	-0.35702	Prob > t	1.0000
Confidence	0.95	Prob < t	<.0001

log[Li ppm] By Heat Treatment Glass #=9



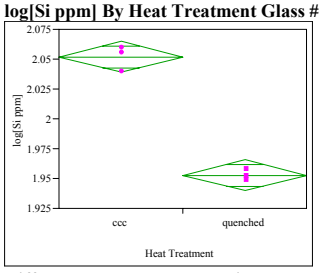
Difference	-0.30472	t Ratio	-53.2888
Std Err Dif	0.00572	DF	3.729543
Upper CL Dif	-0.28838	Prob > |t|	<.0001
Lower CL Dif	-0.32106	Prob > t	1.0000
Confidence	0.95	Prob < t	<.0001

log[Na ppm] By Heat Treatment Glass #=9



Difference	-0.15950	t Ratio	-30.7728
Std Err Dif	0.00518	DF	3.25768
Upper CL Dif	-0.14372	Prob > |t|	<.0001
Lower CL Dif	-0.17528	Prob > t	1.0000
Confidence	0.95	Prob < t	<.0001

log[Si ppm] By Heat Treatment Glass #=9



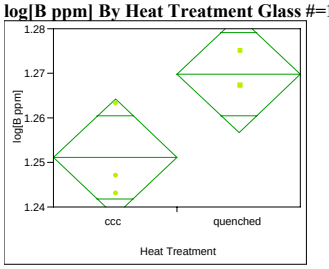
Difference	-0.09931	t Ratio	-15.0635
Std Err Dif	0.00659	DF	2.707395
Upper CL Dif	-0.07699	Prob > |t|	0.0011
Lower CL Dif	-0.12163	Prob > t	0.9995
Confidence	0.95	Prob < t	0.0005

Exhibit F7. Heat Treatment Effect on log(ppm) PCT Response (continued)

t Test: quenched-ccc

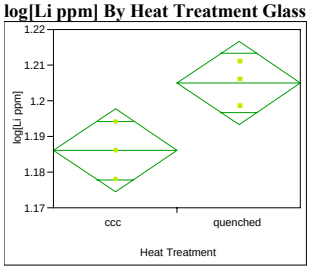
Assuming unequal variances

log[B ppm] By Heat Treatment Glass #=10



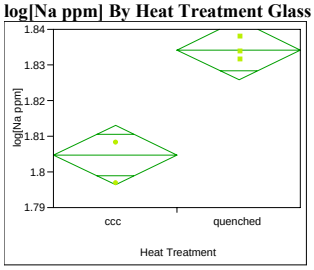
Difference	0.01861	t Ratio	2.784522
Std Err Dif	0.00668	DF	2.682456
Upper CL Dif	0.04138	Prob > |t|	0.0780
Lower CL Dif	-0.00416	Prob > t	0.0390
Confidence	0.95	Prob < t	0.9610

log[Li ppm] By Heat Treatment Glass #=10



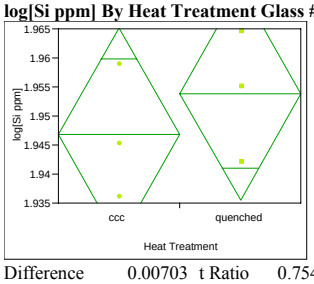
Difference	0.018934	t Ratio	3.200886
Std Err Dif	0.005915	DF	3.807691
Upper CL Dif	0.035689	Prob > |t|	0.0352
Lower CL Dif	0.002178	Prob > t	0.0176
Confidence	0.95	Prob < t	0.9824

log[Na ppm] By Heat Treatment Glass #=10



Difference	0.029635	t Ratio	6.999256
Std Err Dif	0.004234	DF	2.913115
Upper CL Dif	0.043340	Prob > |t|	0.0066
Lower CL Dif	0.015930	Prob > t	0.0033
Confidence	0.95	Prob < t	0.9967

log[Si ppm] By Heat Treatment Glass #=10

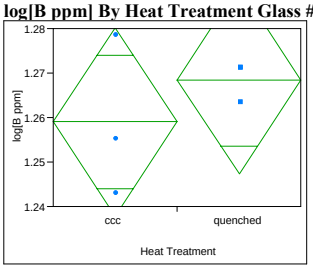


Difference	0.00703	t Ratio	0.754499
Std Err Dif	0.00932	DF	3.999002
Upper CL Dif	0.03292	Prob > |t|	0.4925
Lower CL Dif	-0.01885	Prob > t	0.2463
Confidence	0.95	Prob < t	0.7537

t Test: quenched-ccc

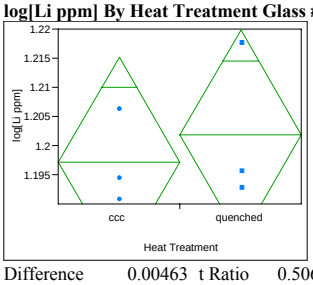
Assuming unequal variances

log[B ppm] By Heat Treatment Glass #=11



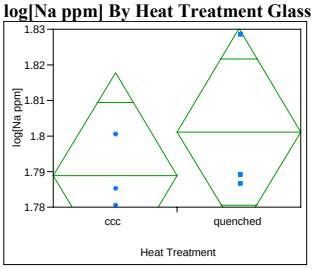
Difference	0.00944	t Ratio	0.873875
Std Err Dif	0.01080	DF	2.24689
Upper CL Dif	0.05134	Prob > |t|	0.4655
Lower CL Dif	-0.03246	Prob > t	0.2327
Confidence	0.95	Prob < t	0.7673

log[Li ppm] By Heat Treatment Glass #=11



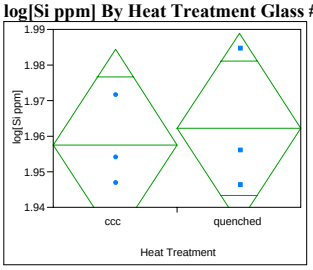
Difference	0.00463	t Ratio	0.506134
Std Err Dif	0.00915	DF	3.268861
Upper CL Dif	0.03244	Prob > |t|	0.6449
Lower CL Dif	-0.02318	Prob > t	0.3225
Confidence	0.95	Prob < t	0.6775

log[Na ppm] By Heat Treatment Glass #=11



Difference	0.01241	t Ratio	0.838679
Std Err Dif	0.01480	DF	2.759371
Upper CL Dif	0.06194	Prob > |t|	0.4681
Lower CL Dif	-0.03711	Prob > t	0.2340
Confidence	0.95	Prob < t	0.7660

log[Si ppm] By Heat Treatment Glass #=11

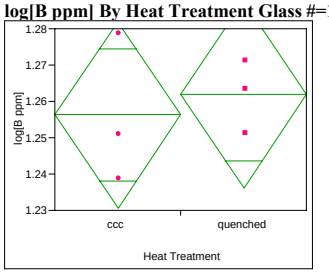


Difference	0.00458	t Ratio	0.335302
Std Err Dif	0.01365	DF	3.384035
Upper CL Dif	0.04535	Prob > |t|	0.7571
Lower CL Dif	-0.03620	Prob > t	0.3786
Confidence	0.95	Prob < t	0.6214

t Test: quenched-ccc

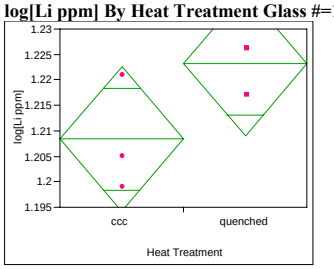
Assuming unequal variances

log[B ppm] By Heat Treatment Glass #=12



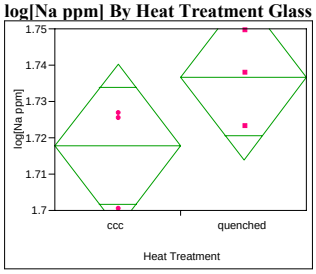
Difference	0.00556	t Ratio	0.423583
Std Err Dif	0.01312	DF	2.906264
Upper CL Dif	0.04808	Prob > |t|	0.7013
Lower CL Dif	-0.03697	Prob > t	0.3506
Confidence	0.95	Prob < t	0.6494

log[Li ppm] By Heat Treatment Glass #=12



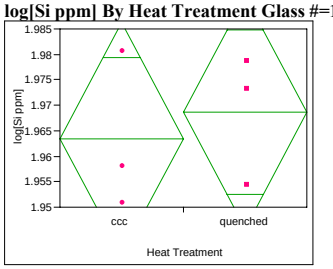
Difference	0.01476	t Ratio	2.04836
Std Err Dif	0.00720	DF	2.828865
Upper CL Dif	0.03849	Prob > |t|	0.1385
Lower CL Dif	-0.00897	Prob > t	0.0692
Confidence	0.95	Prob < t	0.9308

log[Na ppm] By Heat Treatment Glass #=12



Difference	0.01902	t Ratio	1.644164
Std Err Dif	0.01157	DF	3.946239
Upper CL Dif	0.05131	Prob > |t|	0.1765
Lower CL Dif	-0.01327	Prob > t	0.0882
Confidence	0.95	Prob < t	0.9118

log[Si ppm] By Heat Treatment Glass #=12



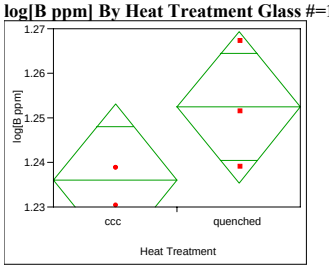
Difference	0.00528	t Ratio	0.455513
Std Err Dif	0.01159	DF	3.85363
Upper CL Dif	0.03794	Prob > |t|	0.6732
Lower CL Dif	-0.02738	Prob > t	0.3366
Confidence	0.95	Prob < t	0.6634

Exhibit F7. Heat Treatment Effect on log(ppm) PCT Response (continued)

t Test: quenched-ccc

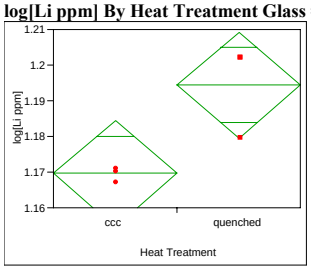
Assuming unequal variances

log[B ppm] By Heat Treatment Glass #=13



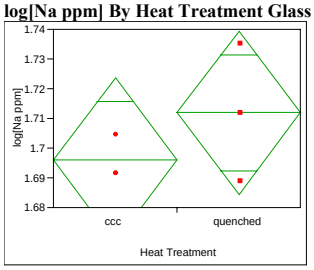
Difference	0.01636	t Ratio	1.889438
Std Err Dif	0.00866	DF	2.464955
Upper CL Dif	0.04762	Prob > |t|	0.1749
Lower CL Dif	-0.01491	Prob > t	0.0874
Confidence	0.95	Prob < t	0.9126

log[Li ppm] By Heat Treatment Glass #=13



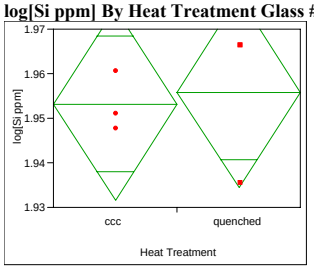
Difference	0.02478	t Ratio	3.278834
Std Err Dif	0.00756	DF	2.099628
Upper CL Dif	0.05586	Prob > |t|	0.0766
Lower CL Dif	-0.00630	Prob > t	0.0383
Confidence	0.95	Prob < t	0.9617

log[Na ppm] By Heat Treatment Glass #=13



Difference	0.01584	t Ratio	1.125973
Std Err Dif	0.01407	DF	2.418211
Upper CL Dif	0.06737	Prob > |t|	0.3594
Lower CL Dif	-0.03569	Prob > t	0.1797
Confidence	0.95	Prob < t	0.8203

log[Si ppm] By Heat Treatment Glass #=13

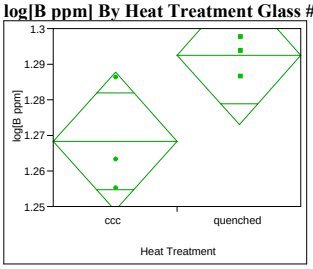


Difference	0.00274	t Ratio	0.249752
Std Err Dif	0.01097	DF	2.555183
Upper CL Dif	0.04136	Prob > |t|	0.8215
Lower CL Dif	-0.03588	Prob > t	0.4107
Confidence	0.95	Prob < t	0.5893

t Test: quenched-ccc

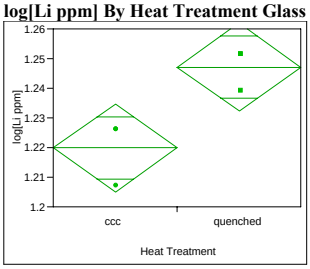
Assuming unequal variances

log[B ppm] By Heat Treatment Glass #=14



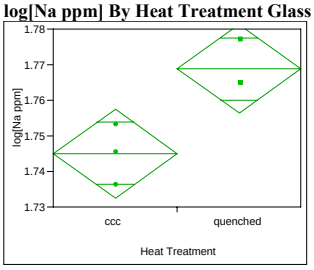
Difference	0.02420	t Ratio	2.454647
Std Err Dif	0.00986	DF	2.484179
Upper CL Dif	0.05961	Prob > |t|	0.1090
Lower CL Dif	-0.01121	Prob > t	0.0545
Confidence	0.95	Prob < t	0.9455

log[Li ppm] By Heat Treatment Glass #=14



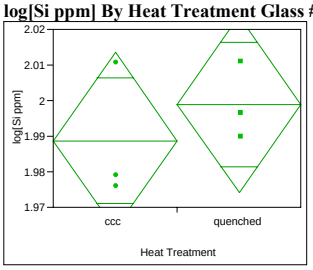
Difference	0.027244	t Ratio	3.620735
Std Err Dif	0.007524	DF	3.445176
Upper CL Dif	0.049531	Prob > |t|	0.0288
Lower CL Dif	0.004957	Prob > t	0.0144
Confidence	0.95	Prob < t	0.9856

log[Na ppm] By Heat Treatment Glass #=14



Difference	0.023657	t Ratio	3.709447
Std Err Dif	0.006378	DF	3.877714
Upper CL Dif	0.041587	Prob > |t|	0.0218
Lower CL Dif	0.005728	Prob > t	0.0109
Confidence	0.95	Prob < t	0.9891

log[Si ppm] By Heat Treatment Glass #=14

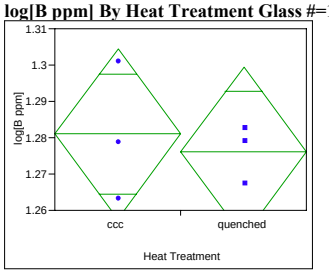


Difference	0.01022	t Ratio	0.807902
Std Err Dif	0.01265	DF	3.14551
Upper CL Dif	0.04946	Prob > |t|	0.4758
Lower CL Dif	-0.02901	Prob > t	0.2379
Confidence	0.95	Prob < t	0.7621

t Test: quenched-ccc

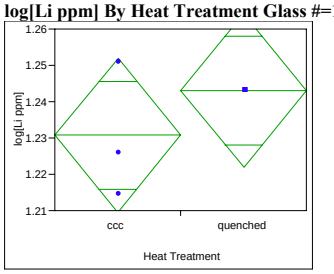
Assuming unequal variances

log[B ppm] By Heat Treatment Glass #=15



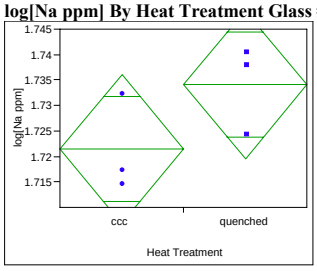
Difference	-0.00485	t Ratio	-0.40759
Std Err Dif	0.01190	DF	2.689413
Upper CL Dif	0.03562	Prob > |t|	0.7138
Lower CL Dif	-0.04533	Prob > t	0.6431
Confidence	0.95	Prob < t	0.3569

log[Li ppm] By Heat Treatment Glass #=15



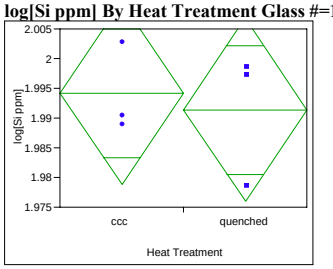
Difference	0.01229	t Ratio	1.143068
Std Err Dif	0.01075	DF	2
Upper CL Dif	0.05855	Prob > |t|	0.3714
Lower CL Dif	-0.03397	Prob > t	0.1857
Confidence	0.95	Prob < t	0.8143

log[Na ppm] By Heat Treatment Glass #=15



Difference	0.01266	t Ratio	1.701573
Std Err Dif	0.00744	DF	3.958056
Upper CL Dif	0.03339	Prob > |t|	0.1648
Lower CL Dif	-0.00808	Prob > t	0.0824
Confidence	0.95	Prob < t	0.9176

log[Si ppm] By Heat Treatment Glass #=15



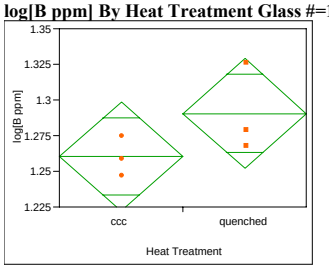
Difference	-0.00275	t Ratio	-0.35172
Std Err Dif	0.00782	DF	3.527539
Upper CL Dif	0.02015	Prob > |t|	0.7450
Lower CL Dif	-0.02565	Prob > t	0.6275
Confidence	0.95	Prob < t	0.3725

Exhibit F7. Heat Treatment Effect on log(ppm) PCT Response (continued)

t Test: quenched-ccc

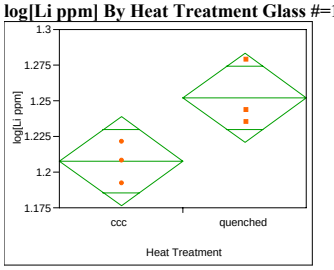
Assuming unequal variances

log[B ppm] By Heat Treatment Glass #=16



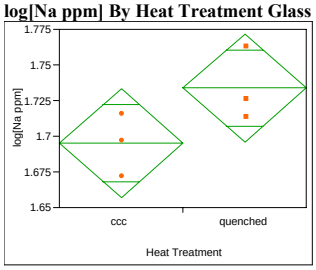
Difference	0.03007	t Ratio	1.534148
Std Err Dif	0.01960	DF	2.776922
Upper CL Dif	0.09539	Prob > |t|	0.2296
Lower CL Dif	-0.03524	Prob > t	0.1148
Confidence	0.95	Prob < t	0.8852

log[Li ppm] By Heat Treatment Glass #=16



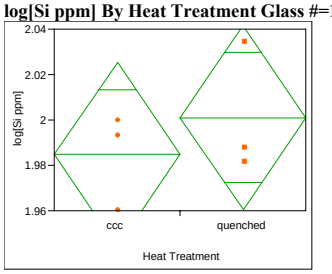
Difference	0.04475	t Ratio	2.807041
Std Err Dif	0.01594	DF	3.35803
Upper CL Dif	0.09256	Prob > |t|	0.0592
Lower CL Dif	-0.00306	Prob > t	0.0296
Confidence	0.95	Prob < t	0.9704

log[Na ppm] By Heat Treatment Glass #=16



Difference	0.03847	t Ratio	1.978774
Std Err Dif	0.01944	DF	3.92001
Upper CL Dif	0.09288	Prob > |t|	0.1204
Lower CL Dif	-0.01594	Prob > t	0.0602
Confidence	0.95	Prob < t	0.9398

log[Si ppm] By Heat Treatment Glass #=16

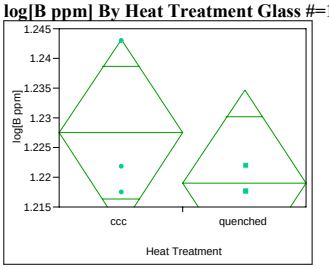


Difference	0.01635	t Ratio	0.793848
Std Err Dif	0.02060	DF	3.667471
Upper CL Dif	0.07566	Prob > |t|	0.4755
Lower CL Dif	-0.04295	Prob > t	0.2377
Confidence	0.95	Prob < t	0.7623

t Test: quenched-ccc

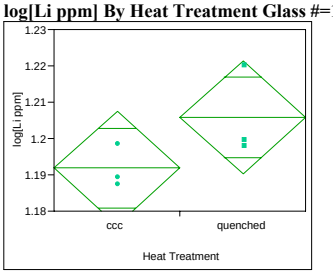
Assuming unequal variances

log[B ppm] By Heat Treatment Glass #=17



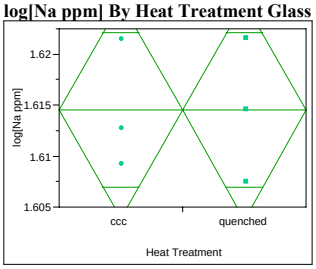
Difference	-0.00852	t Ratio	-1.06146
Std Err Dif	0.00802	DF	2.135798
Upper CL Dif	0.02399	Prob > |t|	0.3936
Lower CL Dif	-0.04103	Prob > t	0.8032
Confidence	0.95	Prob < t	0.1968

log[Li ppm] By Heat Treatment Glass #=17



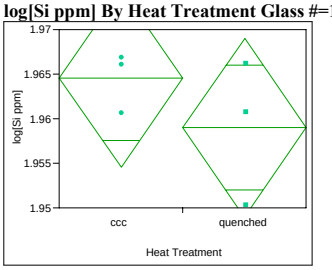
Difference	0.01395	t Ratio	1.753725
Std Err Dif	0.00795	DF	2.87543
Upper CL Dif	0.03989	Prob > |t|	0.1817
Lower CL Dif	-0.01200	Prob > t	0.0909
Confidence	0.95	Prob < t	0.9091

log[Na ppm] By Heat Treatment Glass #=17



Difference	-7.24e-6	t Ratio	-0.00133
Std Err Dif	0.00546	DF	3.955351
Upper CL Dif	0.01522	Prob > |t|	0.9990
Lower CL Dif	-0.01524	Prob > t	0.5005
Confidence	0.95	Prob < t	0.4995

log[Si ppm] By Heat Treatment Glass #=17

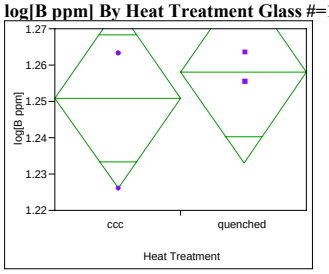


Difference	-0.00557	t Ratio	-1.09805
Std Err Dif	0.00508	DF	2.695983
Upper CL Dif	0.01166	Prob > |t|	0.3605
Lower CL Dif	-0.02281	Prob > t	0.8198
Confidence	0.95	Prob < t	0.1802

t Test: quenched-ccc

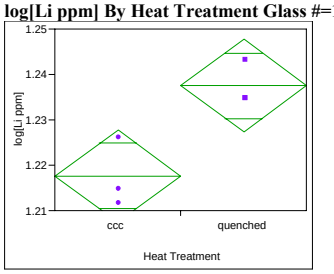
Assuming unequal variances

log[B ppm] By Heat Treatment Glass #=18



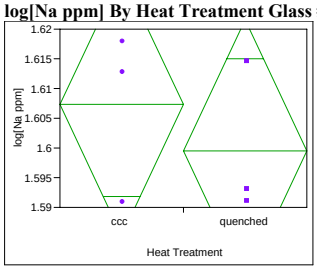
Difference	0.00704	t Ratio	0.557344
Std Err Dif	0.01264	DF	2.184441
Upper CL Dif	0.05726	Prob > |t|	0.6291
Lower CL Dif	-0.04317	Prob > t	0.3146
Confidence	0.95	Prob < t	0.6854

log[Li ppm] By Heat Treatment Glass #=18



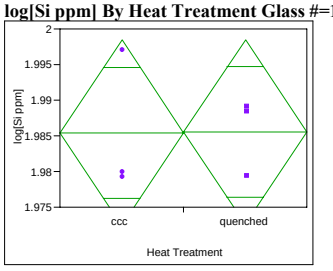
Difference	0.019884	t Ratio	3.828516
Std Err Dif	0.005194	DF	3.387233
Upper CL Dif	0.035394	Prob > |t|	0.0253
Lower CL Dif	0.004375	Prob > t	0.0126
Confidence	0.95	Prob < t	0.9874

log[Na ppm] By Heat Treatment Glass #=18



Difference	-0.00779	t Ratio	-0.69672
Std Err Dif	0.01118	DF	3.967093
Upper CL Dif	0.02335	Prob > |t|	0.5246
Lower CL Dif	-0.03893	Prob > t	0.7377
Confidence	0.95	Prob < t	0.2623

log[Si ppm] By Heat Treatment Glass #=18



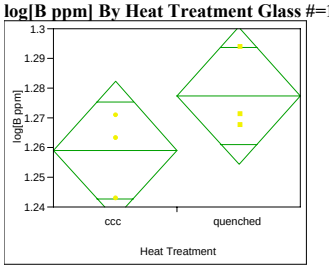
Difference	0.000056	t Ratio	0.008453
Std Err Dif	0.00662	DF	3.069113
Upper CL Dif	0.02085	Prob > |t|	0.9938
Lower CL Dif	-0.02074	Prob > t	0.4969
Confidence	0.95	Prob < t	0.5031

Exhibit F7. Heat Treatment Effect on log(ppm) PCT Response (continued)

t Test: quenched-ccc

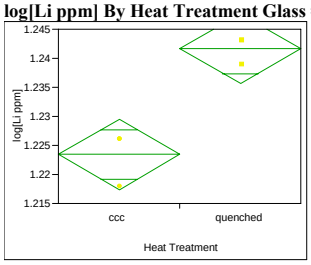
Assuming unequal variances

log[B ppm] By Heat Treatment Glass #=19



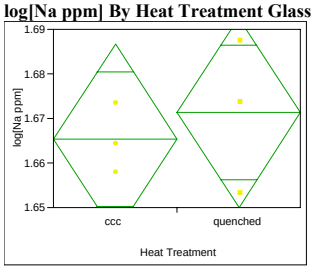
Difference	0.01821	t Ratio	1.54831
Std Err Dif	0.01176	DF	3.99972
Upper CL Dif	0.05086	Prob > |t|	0.1965
Lower CL Dif	-0.01444	Prob > t	0.0982
Confidence	0.95	Prob < t	0.9018

log[Li ppm] By Heat Treatment Glass #=19



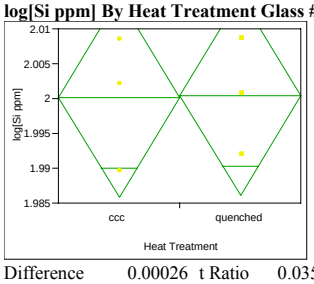
Difference	0.018232	t Ratio	5.922231
Std Err Dif	0.003079	DF	2.954118
Upper CL Dif	0.028116	Prob > |t|	0.0100
Lower CL Dif	0.008348	Prob > t	0.0050
Confidence	0.95	Prob < t	0.9950

log[Na ppm] By Heat Treatment Glass #=19



Difference	0.00603	t Ratio	0.554776
Std Err Dif	0.01088	DF	2.806874
Upper CL Dif	0.04204	Prob > |t|	0.6202
Lower CL Dif	-0.02997	Prob > t	0.3101
Confidence	0.95	Prob < t	0.6899

log[Si ppm] By Heat Treatment Glass #=19

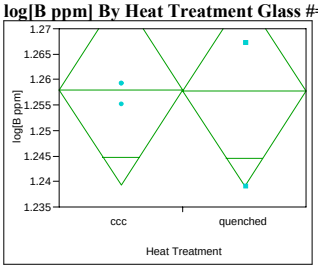


Difference	0.00026	t Ratio	0.035245
Std Err Dif	0.00733	DF	3.922826
Upper CL Dif	0.02076	Prob > |t|	0.9736
Lower CL Dif	-0.02025	Prob > t	0.4868
Confidence	0.95	Prob < t	0.5132

t Test: quenched-ccc

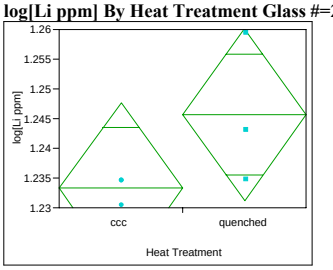
Assuming unequal variances

log[B ppm] By Heat Treatment Glass #=20



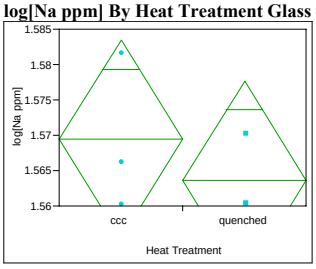
Difference	-0.00020	t Ratio	-0.02091
Std Err Dif	0.00952	DF	2.080047
Upper CL Dif	0.03930	Prob > |t|	0.9852
Lower CL Dif	-0.03970	Prob > t	0.5074
Confidence	0.95	Prob < t	0.4926

log[Li ppm] By Heat Treatment Glass #=20



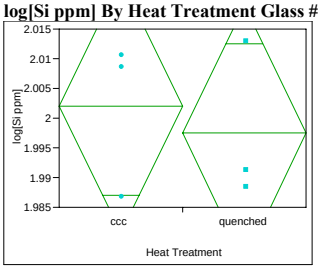
Difference	0.01239	t Ratio	1.684765
Std Err Dif	0.00736	DF	2.152884
Upper CL Dif	0.04198	Prob > |t|	0.2252
Lower CL Dif	-0.01720	Prob > t	0.1126
Confidence	0.95	Prob < t	0.8874

log[Na ppm] By Heat Treatment Glass #=20



Difference	-0.00582	t Ratio	-0.81227
Std Err Dif	0.00717	DF	2.991877
Upper CL Dif	0.01702	Prob > |t|	0.4763
Lower CL Dif	-0.02867	Prob > t	0.7619
Confidence	0.95	Prob < t	0.2381

log[Si ppm] By Heat Treatment Glass #=20

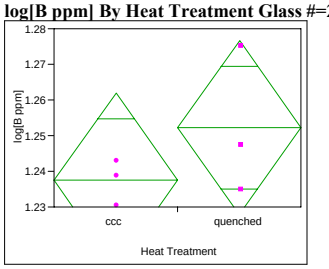


Difference	-0.00459	t Ratio	-0.42153
Std Err Dif	0.01089	DF	3.999447
Upper CL Dif	0.02565	Prob > |t|	0.6950
Lower CL Dif	-0.03483	Prob > t	0.6525
Confidence	0.95	Prob < t	0.3475

t Test: quenched-ccc

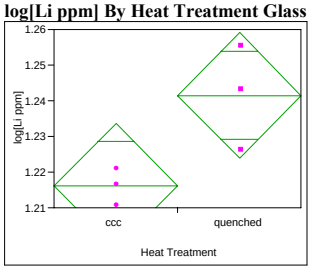
Assuming unequal variances

log[B ppm] By Heat Treatment Glass #=21



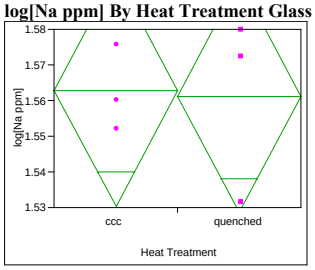
Difference	0.01480	t Ratio	1.188089
Std Err Dif	0.01246	DF	2.384232
Upper CL Dif	0.06091	Prob > |t|	0.3396
Lower CL Dif	-0.03131	Prob > t	0.1698
Confidence	0.95	Prob < t	0.8302

log[Li ppm] By Heat Treatment Glass #=21



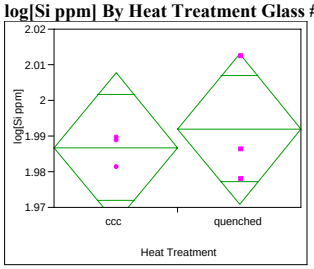
Difference	0.02535	t Ratio	2.837964
Std Err Dif	0.00893	DF	2.476215
Upper CL Dif	0.05750	Prob > |t|	0.0822
Lower CL Dif	-0.00680	Prob > t	0.0411
Confidence	0.95	Prob < t	0.9589

log[Na ppm] By Heat Treatment Glass #=21



Difference	-0.00172	t Ratio	-0.10422
Std Err Dif	0.01652	DF	2.823748
Upper CL Dif	0.05276	Prob > |t|	0.9240
Lower CL Dif	-0.05621	Prob > t	0.5380
Confidence	0.95	Prob < t	0.4620

log[Si ppm] By Heat Treatment Glass #=21



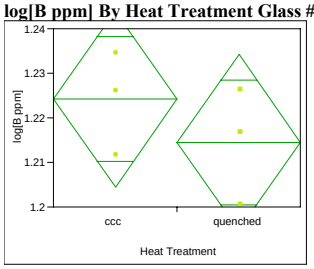
Difference	0.00520	t Ratio	0.486657
Std Err Dif	0.01070	DF	2.256041
Upper CL Dif	0.04656	Prob > |t|	0.6697
Lower CL Dif	-0.03615	Prob > t	0.3349
Confidence	0.95	Prob < t	0.6651

Exhibit F7. Heat Treatment Effect on log(ppm) PCT Response (continued)

t Test: quenched-ccc

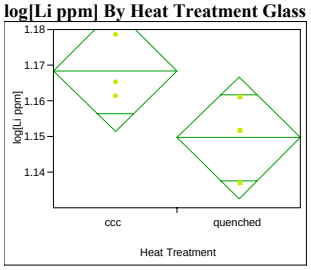
Assuming unequal variances

log[B ppm] By Heat Treatment Glass #=22



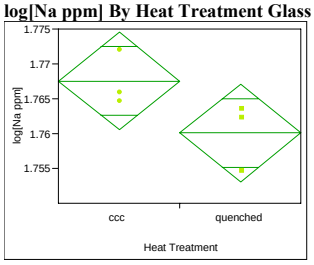
Difference	-0.00978	t Ratio	-0.97307
Std Err Dif	0.01005	DF	3.950261
Upper CL Dif	0.01826	Prob > |t|	0.3863
Lower CL Dif	-0.03782	Prob > t	0.8069
Confidence	0.95	Prob < t	0.1931

log[Li ppm] By Heat Treatment Glass #=22



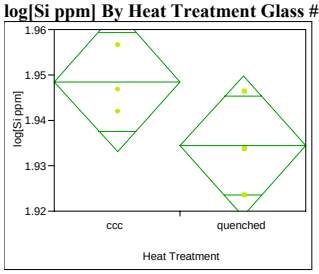
Difference	-0.01878	t Ratio	-2.15375
Std Err Dif	0.00872	DF	3.678645
Upper CL Dif	0.00629	Prob > |t|	0.1036
Lower CL Dif	-0.04386	Prob > t	0.9482
Confidence	0.95	Prob < t	0.0518

log[Na ppm] By Heat Treatment Glass #=22



Difference	-0.00749	t Ratio	-2.08921
Std Err Dif	0.00358	DF	3.869014
Upper CL Dif	0.00260	Prob > |t|	0.1073
Lower CL Dif	-0.01757	Prob > t	0.9464
Confidence	0.95	Prob < t	0.0536

log[Si ppm] By Heat Treatment Glass #=22

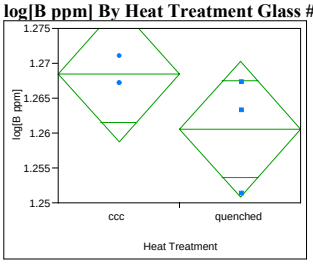


Difference	-0.01413	t Ratio	-1.80082
Std Err Dif	0.00785	DF	3.4493
Upper CL Dif	0.00910	Prob > |t|	0.1574
Lower CL Dif	-0.03737	Prob > t	0.9213
Confidence	0.95	Prob < t	0.0787

t Test: quenched-ccc

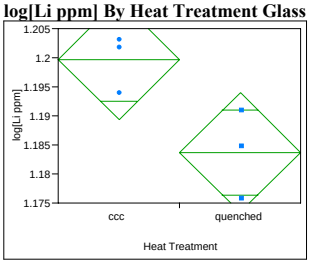
Assuming unequal variances

log[B ppm] By Heat Treatment Glass #=23



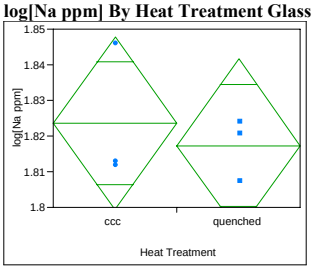
Difference	-0.00792	t Ratio	-1.59486
Std Err Dif	0.00497	DF	2.291796
Upper CL Dif	0.01104	Prob > |t|	0.2360
Lower CL Dif	-0.02689	Prob > t	0.8820
Confidence	0.95	Prob < t	0.1180

log[Li ppm] By Heat Treatment Glass #=23



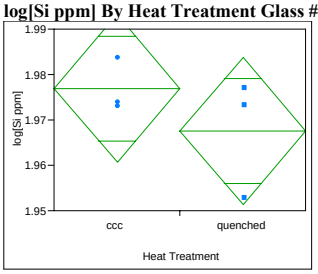
Difference	-0.01601	t Ratio	-3.0456
Std Err Dif	0.00526	DF	3.42424
Upper CL Dif	-0.00039	Prob > |t|	0.0468
Lower CL Dif	-0.03162	Prob > t	0.9766
Confidence	0.95	Prob < t	0.0234

log[Na ppm] By Heat Treatment Glass #=23



Difference	-0.00633	t Ratio	-0.51224
Std Err Dif	0.01235	DF	2.780459
Upper CL Dif	0.03480	Prob > |t|	0.6464
Lower CL Dif	-0.04746	Prob > t	0.6768
Confidence	0.95	Prob < t	0.3232

log[Si ppm] By Heat Treatment Glass #=23

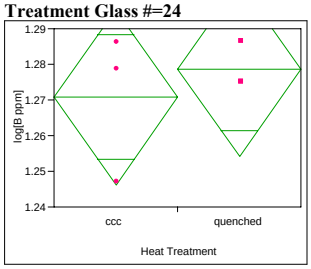


Difference	-0.00936	t Ratio	-1.12854
Std Err Dif	0.00829	DF	2.79072
Upper CL Dif	0.01819	Prob > |t|	0.3467
Lower CL Dif	-0.03691	Prob > t	0.8267
Confidence	0.95	Prob < t	0.1733

t Test: quenched-ccc

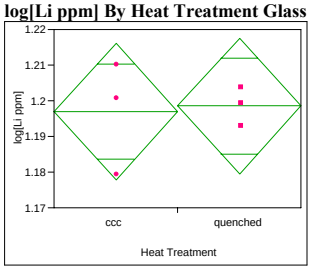
Assuming unequal variances

Treatment Glass #=24



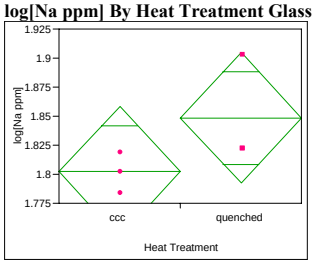
Difference	0.00798	t Ratio	0.634637
Std Err Dif	0.01258	DF	2.396257
Upper CL Dif	0.05437	Prob > |t|	0.5810
Lower CL Dif	-0.03840	Prob > t	0.2905
Confidence	0.95	Prob < t	0.7095

log[Li ppm] By Heat Treatment Glass #=24



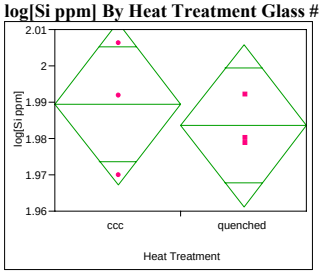
Difference	0.00155	t Ratio	0.159396
Std Err Dif	0.00970	DF	2.479353
Upper CL Dif	0.03642	Prob > |t|	0.8854
Lower CL Dif	-0.03333	Prob > t	0.4427
Confidence	0.95	Prob < t	0.5573

log[Na ppm] By Heat Treatment Glass #=24



Difference	0.04640	t Ratio	1.616566
Std Err Dif	0.02870	DF	2.569411
Upper CL Dif	0.14703	Prob > |t|	0.2193
Lower CL Dif	-0.05424	Prob > t	0.1096
Confidence	0.95	Prob < t	0.8904

log[Si ppm] By Heat Treatment Glass #=24



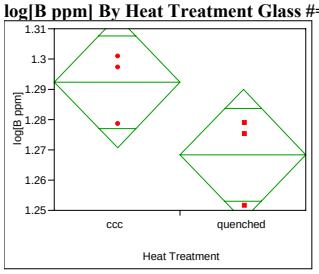
Difference	-0.00600	t Ratio	-0.52607
Std Err Dif	0.01141	DF	2.631617
Upper CL Dif	0.03337	Prob > |t|	0.6399
Lower CL Dif	-0.04538	Prob > t	0.6800
Confidence	0.95	Prob < t	0.3200

Exhibit F7. Heat Treatment Effect on log(ppm) PCT Response (continued)

t Test: quenched-ccc

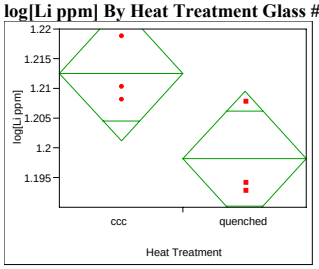
Assuming unequal variances

log[B ppm] By Heat Treatment Glass #=25



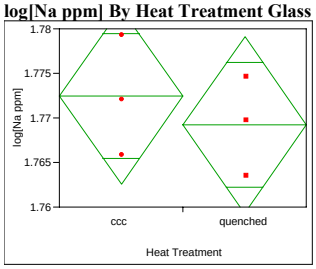
Difference	-0.02409	t Ratio	-2.18364
Std Err Dif	0.01103	DF	3.819258
Upper CL Dif	0.00712	Prob > |t|	0.0976
Lower CL Dif	-0.05530	Prob > t	0.9512
Confidence	0.95	Prob < t	0.0488

log[Li ppm] By Heat Treatment Glass #=25



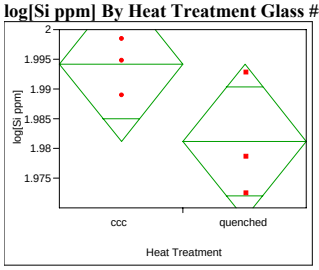
Difference	-0.01431	t Ratio	-2.47087
Std Err Dif	0.00579	DF	3.503163
Upper CL Dif	0.00271	Prob > |t|	0.0778
Lower CL Dif	-0.03134	Prob > t	0.9611
Confidence	0.95	Prob < t	0.0389

log[Na ppm] By Heat Treatment Glass #=25



Difference	-0.00326	t Ratio	-0.6472
Std Err Dif	0.00504	DF	3.862339
Upper CL Dif	0.01093	Prob > |t|	0.5540
Lower CL Dif	-0.01745	Prob > t	0.7230
Confidence	0.95	Prob < t	0.2770

log[Si ppm] By Heat Treatment Glass #=25

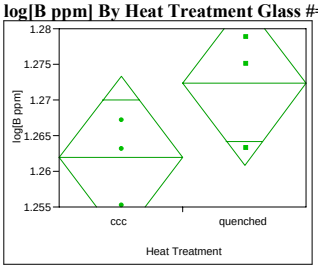


Difference	-0.01297	t Ratio	-1.95469
Std Err Dif	0.00664	DF	2.815076
Upper CL Dif	0.00895	Prob > |t|	0.1516
Lower CL Dif	-0.03490	Prob > t	0.9242
Confidence	0.95	Prob < t	0.0758

t Test: quenched-ccc

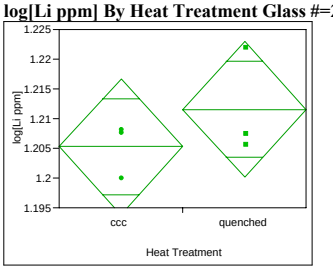
Assuming unequal variances

log[B ppm] By Heat Treatment Glass #=26



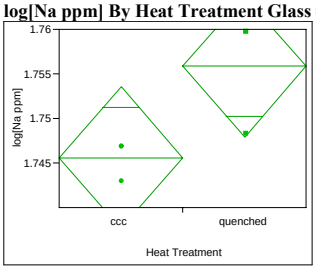
Difference	0.01041	t Ratio	1.785138
Std Err Dif	0.00583	DF	3.709765
Upper CL Dif	0.02712	Prob > |t|	0.1544
Lower CL Dif	-0.00629	Prob > t	0.0772
Confidence	0.95	Prob < t	0.9228

log[Li ppm] By Heat Treatment Glass #=26



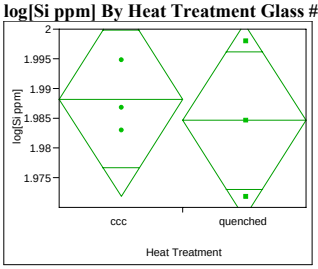
Difference	0.00622	t Ratio	1.069701
Std Err Dif	0.00582	DF	2.973846
Upper CL Dif	0.02483	Prob > |t|	0.3638
Lower CL Dif	-0.01239	Prob > t	0.1819
Confidence	0.95	Prob < t	0.8181

log[Na ppm] By Heat Treatment Glass #=26



Difference	0.01025	t Ratio	2.535778
Std Err Dif	0.00404	DF	2.457119
Upper CL Dif	0.02488	Prob > |t|	0.1035
Lower CL Dif	-0.00438	Prob > t	0.0517
Confidence	0.95	Prob < t	0.9483

log[Si ppm] By Heat Treatment Glass #=26

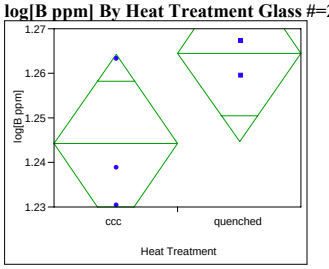


Difference	-0.00359	t Ratio	-0.42989
Std Err Dif	0.00835	DF	2.819439
Upper CL Dif	0.02396	Prob > |t|	0.6980
Lower CL Dif	-0.03114	Prob > t	0.6510
Confidence	0.95	Prob < t	0.3490

t Test: quenched-ccc

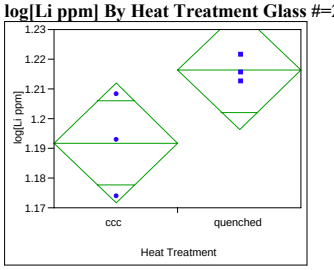
Assuming unequal variances

log[B ppm] By Heat Treatment Glass #=27



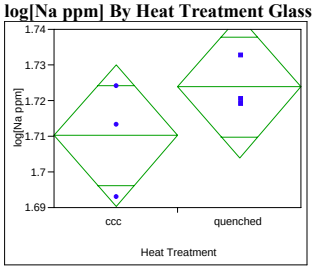
Difference	0.02035	t Ratio	1.99934
Std Err Dif	0.01018	DF	2.285247
Upper CL Dif	0.05930	Prob > |t|	0.1674
Lower CL Dif	-0.01860	Prob > t	0.0837
Confidence	0.95	Prob < t	0.9163

log[Li ppm] By Heat Treatment Glass #=27



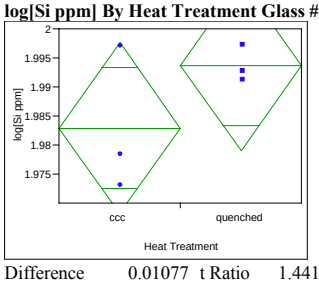
Difference	0.02448	t Ratio	2.397936
Std Err Dif	0.01021	DF	2.301808
Upper CL Dif	0.06332	Prob > |t|	0.1221
Lower CL Dif	-0.01436	Prob > t	0.0610
Confidence	0.95	Prob < t	0.9390

log[Na ppm] By Heat Treatment Glass #=27



Difference	0.01357	t Ratio	1.345057
Std Err Dif	0.01009	DF	2.85817
Upper CL Dif	0.04659	Prob > |t|	0.2754
Lower CL Dif	-0.01945	Prob > t	0.1377
Confidence	0.95	Prob < t	0.8623

log[Si ppm] By Heat Treatment Glass #=27



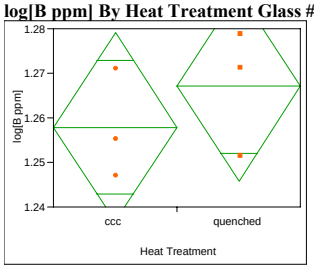
Difference	0.01077	t Ratio	1.441254
Std Err Dif	0.00747	DF	2.234808
Upper CL Dif	0.03990	Prob > |t|	0.2738
Lower CL Dif	-0.01835	Prob > t	0.1369
Confidence	0.95	Prob < t	0.8631

Exhibit F7. Heat Treatment Effect on log(ppm) PCT Response (continued)

t Test: quenched-ccc

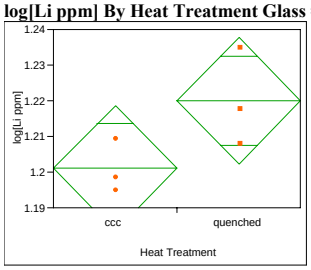
Assuming unequal variances

log[B ppm] By Heat Treatment Glass #=28



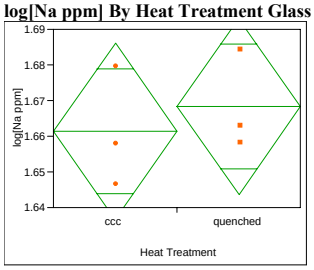
Difference	0.00919	t Ratio	0.851089
Std Err Dif	0.01079	DF	3.907446
Upper CL Dif	0.03944	Prob > |t|	0.4437
Lower CL Dif	-0.02106	Prob > t	0.2219
Confidence	0.95	Prob < t	0.7781

log[Li ppm] By Heat Treatment Glass #=28



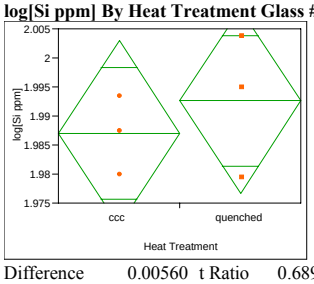
Difference	0.01892	t Ratio	2.099583
Std Err Dif	0.00901	DF	3.121005
Upper CL Dif	0.04697	Prob > |t|	0.1231
Lower CL Dif	-0.00914	Prob > t	0.0615
Confidence	0.95	Prob < t	0.9385

log[Na ppm] By Heat Treatment Glass #=28



Difference	0.00685	t Ratio	0.543203
Std Err Dif	0.01261	DF	3.874231
Upper CL Dif	0.04230	Prob > |t|	0.6167
Lower CL Dif	-0.02861	Prob > t	0.3084
Confidence	0.95	Prob < t	0.6916

log[Si ppm] By Heat Treatment Glass #=28

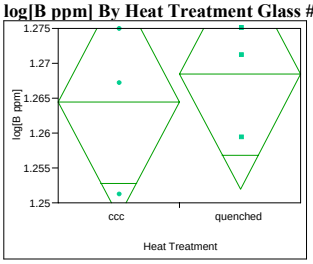


Difference	0.00560	t Ratio	0.689646
Std Err Dif	0.00812	DF	3.093033
Upper CL Dif	0.03100	Prob > |t|	0.5386
Lower CL Dif	-0.01980	Prob > t	0.2693
Confidence	0.95	Prob < t	0.7307

t Test: quenched-ccc

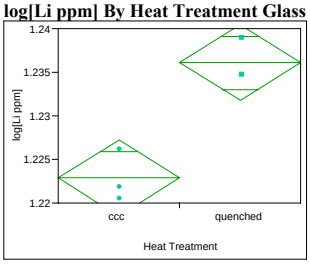
Assuming unequal variances

log[B ppm] By Heat Treatment Glass #=29



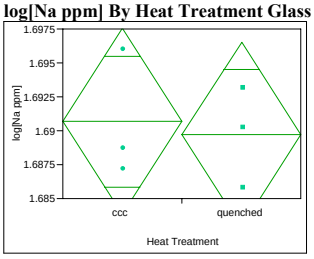
Difference	0.00398	t Ratio	0.472886
Std Err Dif	0.00841	DF	3.509104
Upper CL Dif	0.02869	Prob > |t|	0.6642
Lower CL Dif	-0.02073	Prob > t	0.3321
Confidence	0.95	Prob < t	0.6679

log[Li ppm] By Heat Treatment Glass #=29



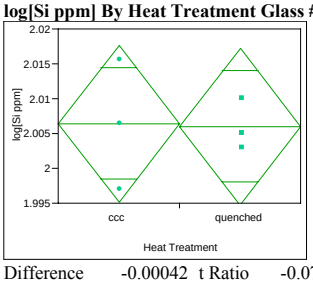
Difference	0.013230	t Ratio	6.009485
Std Err Dif	0.002202	DF	3.856717
Upper CL Dif	0.019434	Prob > |t|	0.0043
Lower CL Dif	0.007027	Prob > t	0.0022
Confidence	0.95	Prob < t	0.9978

log[Na ppm] By Heat Treatment Glass #=29



Difference	-0.00098	t Ratio	-0.28142
Std Err Dif	0.00348	DF	3.79163
Upper CL Dif	0.00889	Prob > |t|	0.7931
Lower CL Dif	-0.01084	Prob > t	0.6035
Confidence	0.95	Prob < t	0.3965

log[Si ppm] By Heat Treatment Glass #=29

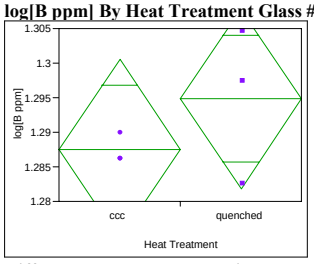


Difference	-0.00042	t Ratio	-0.07298
Std Err Dif	0.00575	DF	2.607823
Upper CL Dif	0.01956	Prob > |t|	0.9471
Lower CL Dif	-0.02040	Prob > t	0.5265
Confidence	0.95	Prob < t	0.4735

t Test: quenched-ccc

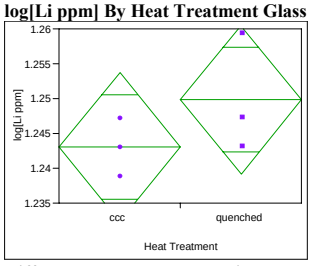
Assuming unequal variances

log[B ppm] By Heat Treatment Glass #=30



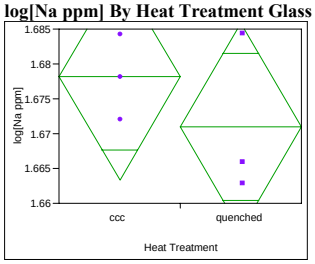
Difference	0.00731	t Ratio	1.104352
Std Err Dif	0.00662	DF	2.145946
Upper CL Dif	0.03401	Prob > |t|	0.3778
Lower CL Dif	-0.01939	Prob > t	0.1889
Confidence	0.95	Prob < t	0.8111

log[Li ppm] By Heat Treatment Glass #=30



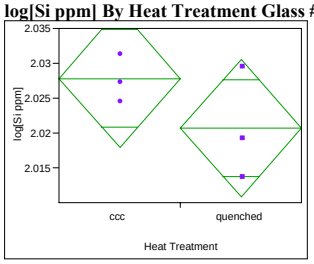
Difference	0.00680	t Ratio	1.252558
Std Err Dif	0.00543	DF	2.908127
Upper CL Dif	0.02438	Prob > |t|	0.3016
Lower CL Dif	-0.01079	Prob > t	0.1508
Confidence	0.95	Prob < t	0.8492

log[Na ppm] By Heat Treatment Glass #=30



Difference	-0.00722	t Ratio	-0.95458
Std Err Dif	0.00756	DF	3.018998
Upper CL Dif	0.01677	Prob > |t|	0.4098
Lower CL Dif	-0.03121	Prob > t	0.7951
Confidence	0.95	Prob < t	0.2049

log[Si ppm] By Heat Treatment Glass #=30



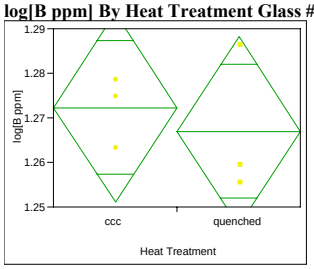
Difference	-0.00711	t Ratio	-1.41098
Std Err Dif	0.00504	DF	2.699269
Upper CL Dif	0.00999	Prob > |t|	0.2625
Lower CL Dif	-0.02422	Prob > t	0.8687
Confidence	0.95	Prob < t	0.1313

Exhibit F7. Heat Treatment Effect on log(ppm) PCT Response (continued)

t Test: quenched-ccc

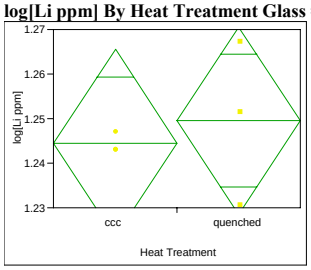
Assuming unequal variances

log[B ppm] By Heat Treatment Glass #=31



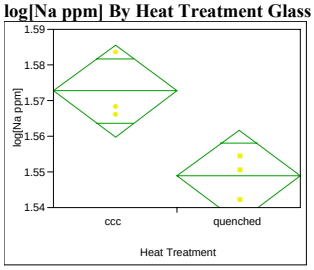
Difference	-0.00536	t Ratio	-0.49566
Std Err Dif	0.01081	DF	2.870899
Upper CL Dif	0.02992	Prob > |t|	0.6556
Lower CL Dif	-0.04064	Prob > t	0.6722
Confidence	0.95	Prob < t	0.3278

log[Li ppm] By Heat Treatment Glass #=31



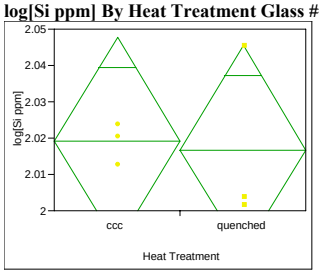
Difference	0.00521	t Ratio	0.48578
Std Err Dif	0.01072	DF	2.066614
Upper CL Dif	0.04994	Prob > |t|	0.6738
Lower CL Dif	-0.03952	Prob > t	0.3369
Confidence	0.95	Prob < t	0.6631

log[Na ppm] By Heat Treatment Glass #=31



Difference	-0.02384	t Ratio	-3.63004
Std Err Dif	0.00657	DF	3.463698
Upper CL Dif	-0.00444	Prob > |t|	0.0283
Lower CL Dif	-0.04324	Prob > t	0.9858
Confidence	0.95	Prob < t	0.0142

log[Si ppm] By Heat Treatment Glass #=31

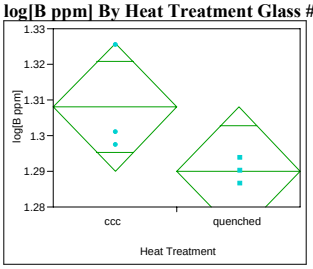


Difference	-0.00230	t Ratio	-0.15703
Std Err Dif	0.01465	DF	2.210574
Upper CL Dif	0.05532	Prob > |t|	0.8884
Lower CL Dif	-0.05992	Prob > t	0.5558
Confidence	0.95	Prob < t	0.4442

t Test: quenched-ccc

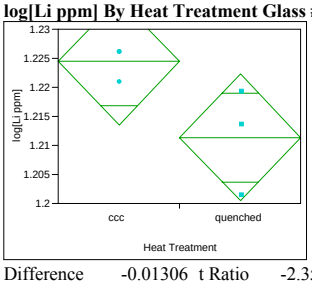
Assuming unequal variances

log[B ppm] By Heat Treatment Glass #=32



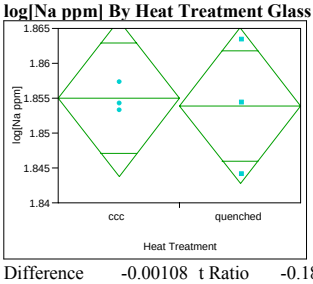
Difference	-0.01800	t Ratio	-1.97163
Std Err Dif	0.00913	DF	2.232438
Upper CL Dif	0.01761	Prob > |t|	0.1740
Lower CL Dif	-0.05362	Prob > t	0.9130
Confidence	0.95	Prob < t	0.0870

log[Li ppm] By Heat Treatment Glass #=32



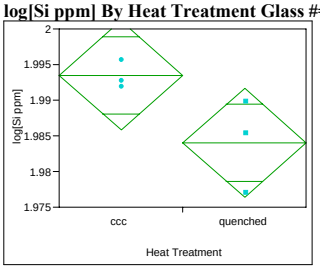
Difference	-0.01306	t Ratio	-2.35841
Std Err Dif	0.00554	DF	2.428011
Upper CL Dif	0.00716	Prob > |t|	0.1199
Lower CL Dif	-0.03327	Prob > t	0.9400
Confidence	0.95	Prob < t	0.0600

log[Na ppm] By Heat Treatment Glass #=32



Difference	-0.00108	t Ratio	-0.18962
Std Err Dif	0.00569	DF	2.189872
Upper CL Dif	0.02149	Prob > |t|	0.8657
Lower CL Dif	-0.02365	Prob > t	0.5671
Confidence	0.95	Prob < t	0.4329

log[Si ppm] By Heat Treatment Glass #=32

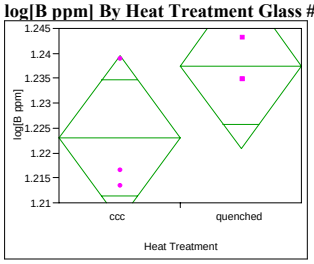


Difference	-0.00944	t Ratio	-2.4138
Std Err Dif	0.00391	DF	2.355524
Upper CL Dif	0.00517	Prob > |t|	0.1181
Lower CL Dif	-0.02405	Prob > t	0.9409
Confidence	0.95	Prob < t	0.0591

t Test: quenched-ccc

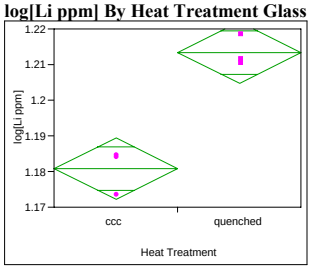
Assuming unequal variances

log[B ppm] By Heat Treatment Glass #=33



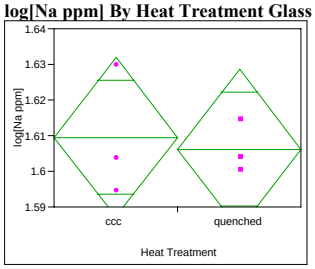
Difference	0.01447	t Ratio	1.709953
Std Err Dif	0.00846	DF	2.478583
Upper CL Dif	0.04490	Prob > |t|	0.2047
Lower CL Dif	-0.01597	Prob > t	0.1023
Confidence	0.95	Prob < t	0.8977

log[Li ppm] By Heat Treatment Glass #=33



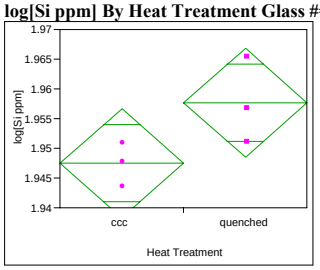
Difference	0.032495	t Ratio	7.403228
Std Err Dif	0.004389	DF	3.578796
Upper CL Dif	0.045269	Prob > |t|	0.0027
Lower CL Dif	0.019721	Prob > t	0.0014
Confidence	0.95	Prob < t	0.9986

log[Na ppm] By Heat Treatment Glass #=33



Difference	-0.00335	t Ratio	-0.29338
Std Err Dif	0.01143	DF	2.63986
Upper CL Dif	0.03599	Prob > |t|	0.7908
Lower CL Dif	-0.04269	Prob > t	0.6046
Confidence	0.95	Prob < t	0.3954

log[Si ppm] By Heat Treatment Glass #=33



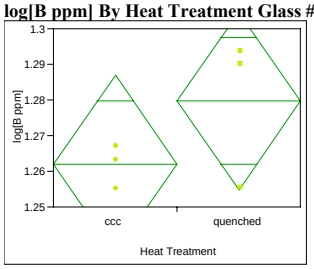
Difference	0.01020	t Ratio	2.176828
Std Err Dif	0.00468	DF	2.974174
Upper CL Dif	0.02518	Prob > |t|	0.1185
Lower CL Dif	-0.00478	Prob > t	0.0592
Confidence	0.95	Prob < t	0.9408

Exhibit F7. Heat Treatment Effect on log(ppm) PCT Response (continued)

t Test: quenched-ccc

Assuming unequal variances

log[B ppm] By Heat Treatment Glass #=34

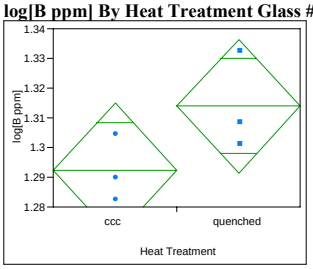


Difference	0.01778	t Ratio	1.395898
Std Err Dif	0.01274	DF	2.324433
Upper CL Dif	0.06588	Prob > |t|	0.2811
Lower CL Dif	-0.03032	Prob > t	0.1406
Confidence	0.95	Prob < t	0.8594

t Test: quenched-ccc

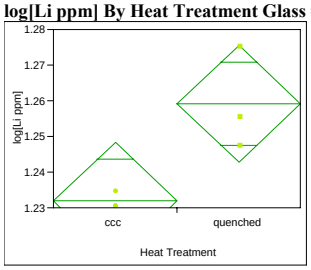
Assuming unequal variances

log[B ppm] By Heat Treatment Glass #=35



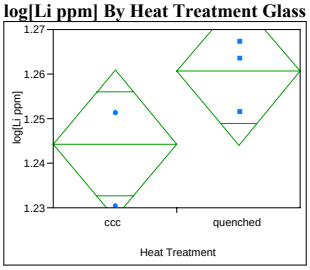
Difference	0.02149	t Ratio	1.867794
Std Err Dif	0.01150	DF	3.531144
Upper CL Dif	0.05517	Prob > |t|	0.1446
Lower CL Dif	-0.01220	Prob > t	0.0723
Confidence	0.95	Prob < t	0.9277

log[Li ppm] By Heat Treatment Glass #=34



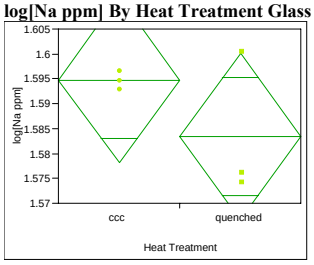
Difference	0.02726	t Ratio	3.258554
Std Err Dif	0.00836	DF	2.117282
Upper CL Dif	0.06140	Prob > |t|	0.0766
Lower CL Dif	-0.00689	Prob > t	0.0383
Confidence	0.95	Prob < t	0.9617

log[Li ppm] By Heat Treatment Glass #=35



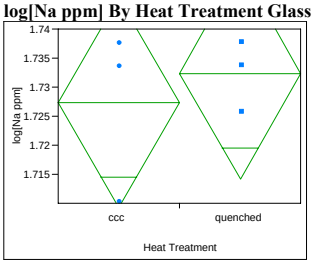
Difference	0.01624	t Ratio	1.928072
Std Err Dif	0.00842	DF	3.558203
Upper CL Dif	0.04083	Prob > |t|	0.1349
Lower CL Dif	-0.00834	Prob > t	0.0674
Confidence	0.95	Prob < t	0.9326

log[Na ppm] By Heat Treatment Glass #=34



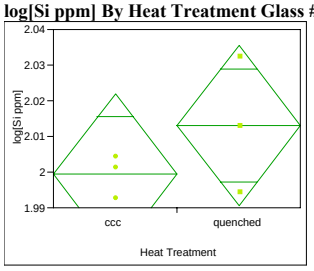
Difference	-0.01135	t Ratio	-1.33449
Std Err Dif	0.00850	DF	2.063435
Upper CL Dif	0.02418	Prob > |t|	0.3102
Lower CL Dif	-0.04687	Prob > t	0.8449
Confidence	0.95	Prob < t	0.1551

log[Na ppm] By Heat Treatment Glass #=35



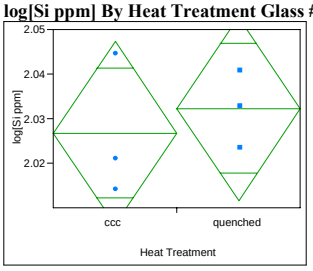
Difference	0.00508	t Ratio	0.550228
Std Err Dif	0.00923	DF	2.675601
Upper CL Dif	0.03658	Prob > |t|	0.6247
Lower CL Dif	-0.02642	Prob > t	0.3124
Confidence	0.95	Prob < t	0.6876

log[Si ppm] By Heat Treatment Glass #=34



Difference	0.01354	t Ratio	1.178604
Std Err Dif	0.01149	DF	2.403554
Upper CL Dif	0.05581	Prob > |t|	0.3420
Lower CL Dif	-0.02873	Prob > t	0.1710
Confidence	0.95	Prob < t	0.8290

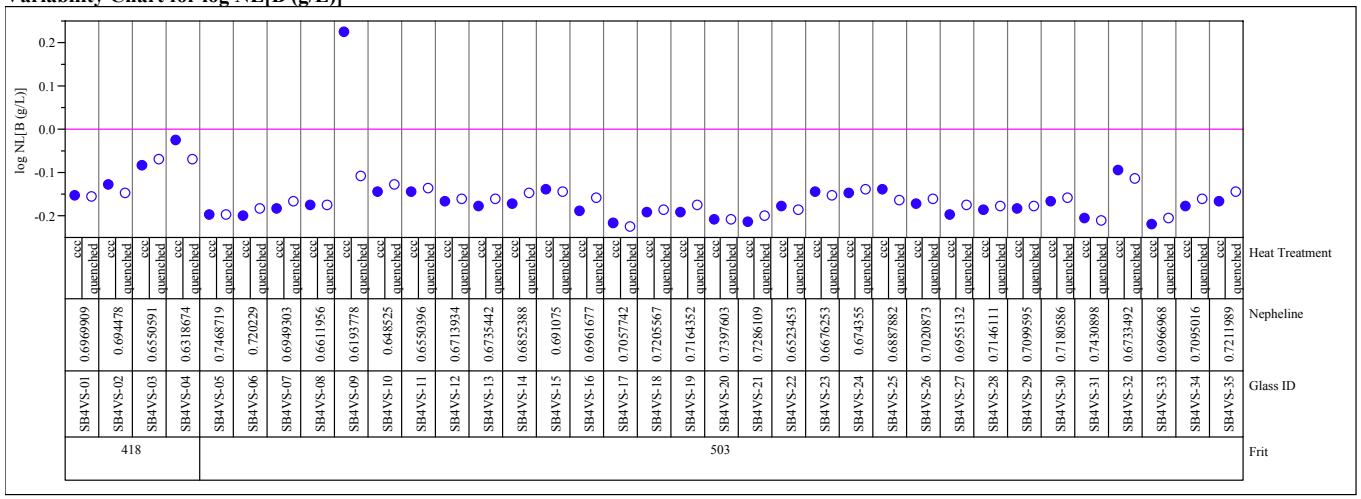
log[Si ppm] By Heat Treatment Glass #=35



Difference	0.00555	t Ratio	0.528146
Std Err Dif	0.01050	DF	3.104689
Upper CL Dif	0.03834	Prob > |t|	0.6328
Lower CL Dif	-0.02725	Prob > t	0.3164
Confidence	0.95	Prob < t	0.6836

Exhibit F8. Effects of Heat Treatment for Study Glasses by Compositional View (continued)

Composition=measured
Variability Chart for log NL[B (g/L)]



Variability Chart for log NL[Li (g/L)]

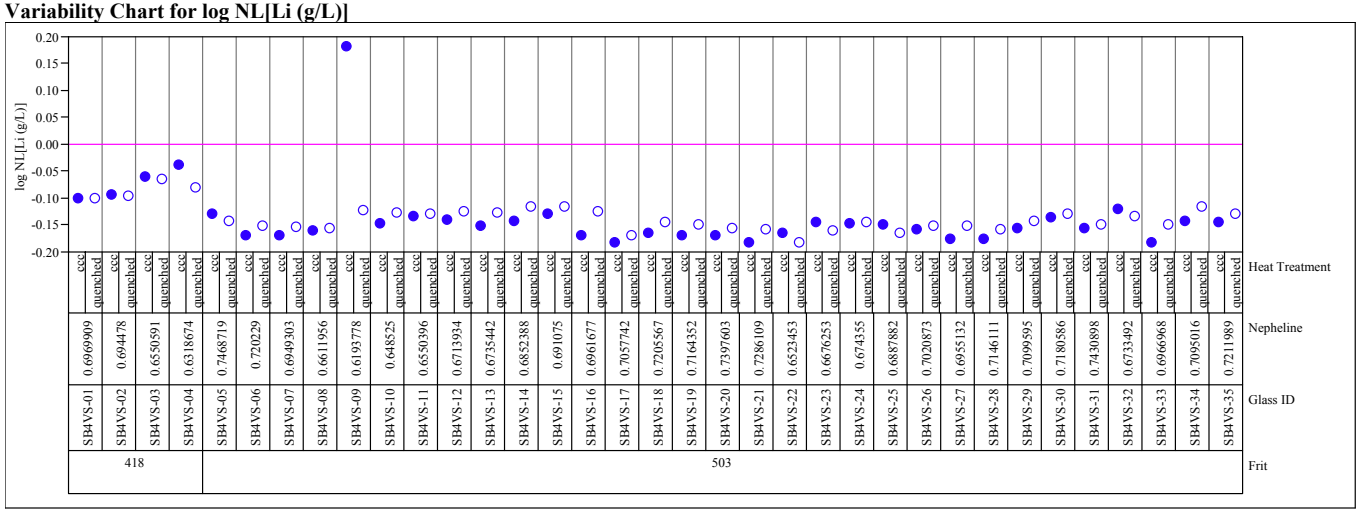
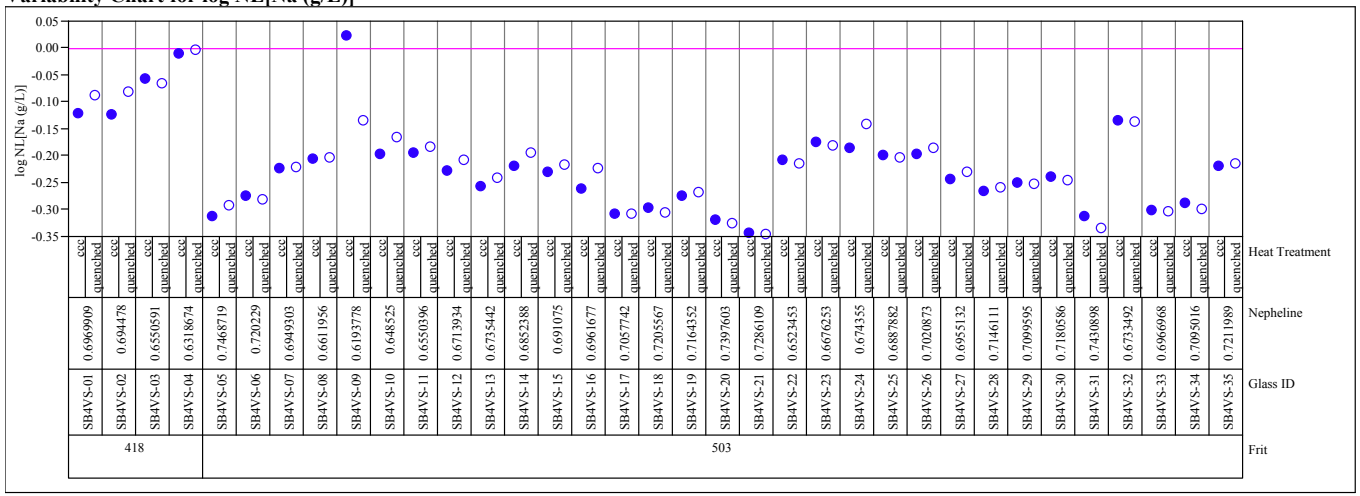


Exhibit F8. Effects of Heat Treatment for Study Glasses by Compositional View (continued)

Composition=measured

Variability Chart for log NL[Na (g/L)]



Variability Chart for log NL[Si (g/L)]

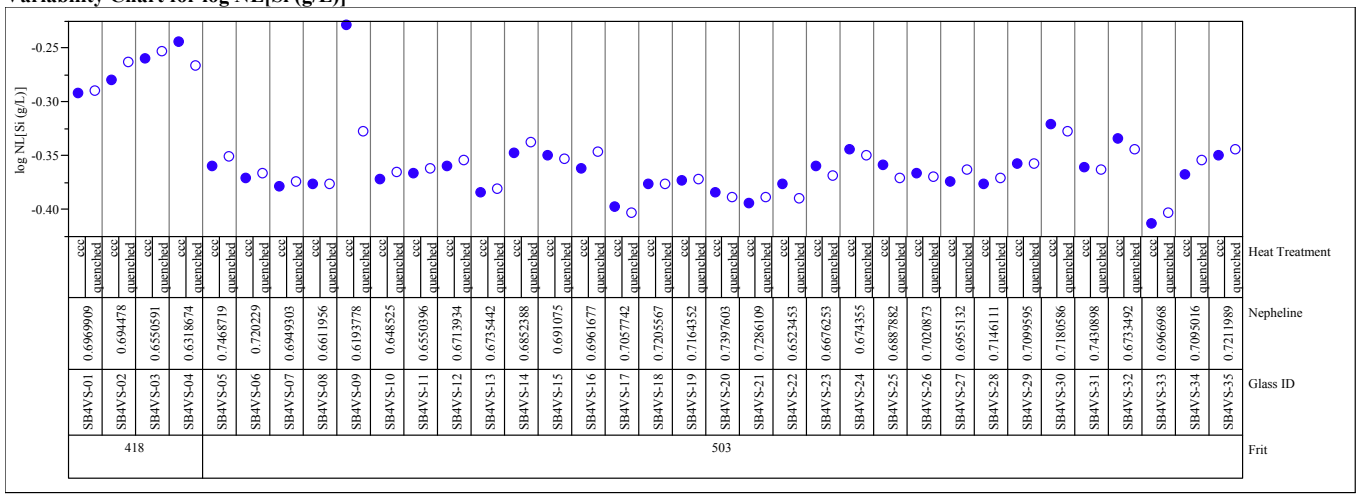
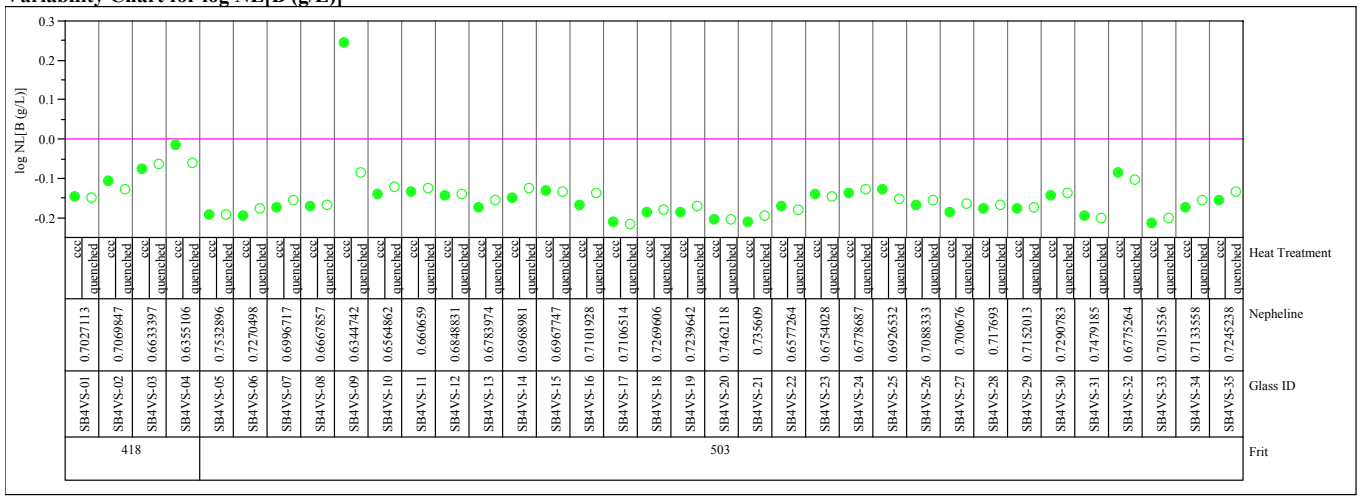


Exhibit F8. Effects of Heat Treatment for Study Glasses by Compositional View (continued)

Composition=measured bc

Variability Chart for log NL[B (g/L)]



Variability Chart for log NL[Li (g/L)]

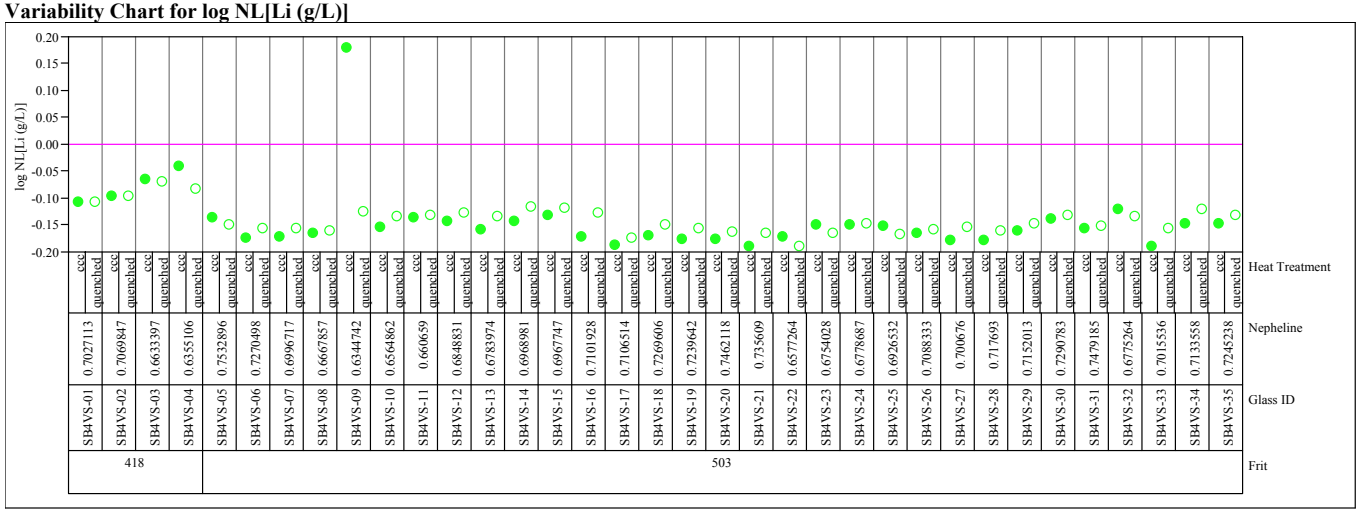
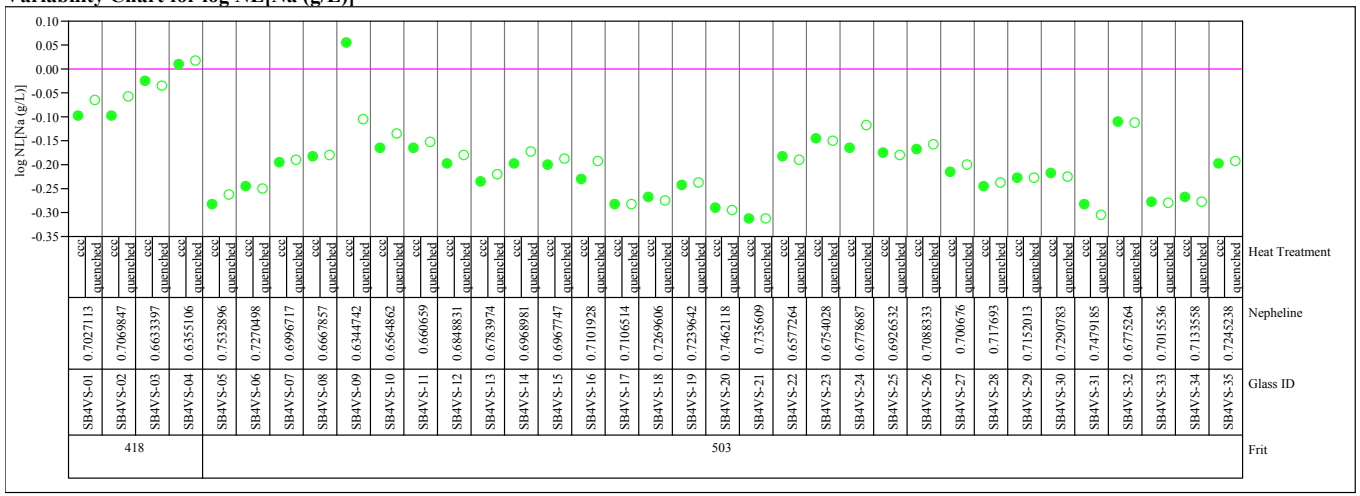


Exhibit F8. Effects of Heat Treatment for Study Glasses by Compositional View (continued)

Composition=measured bc

Variability Chart for log NL[Na (g/L)]



Variability Chart for log NL[Si (g/L)]

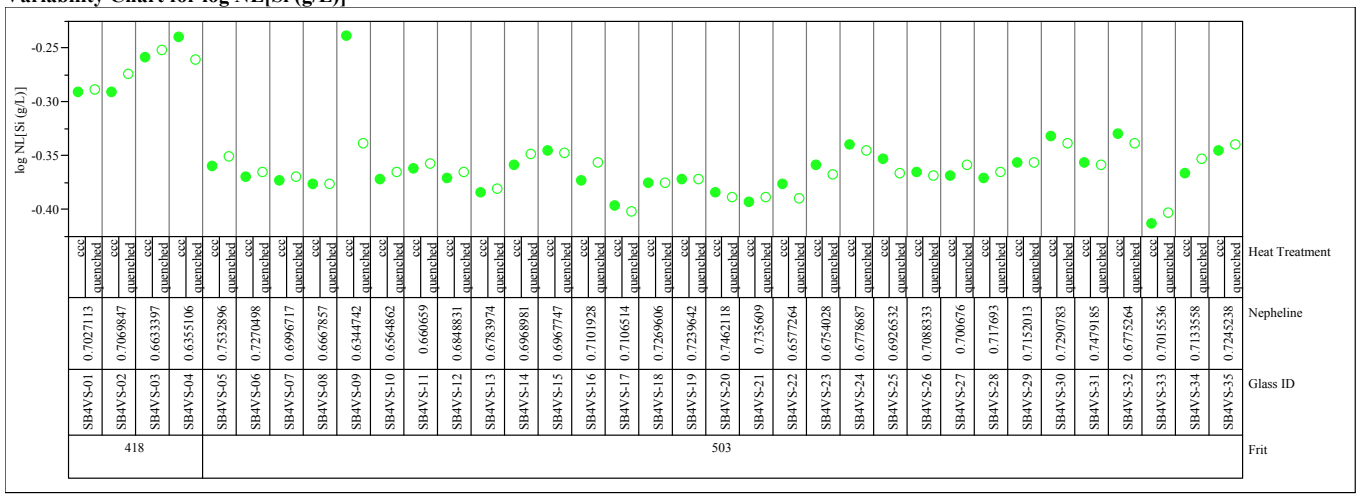
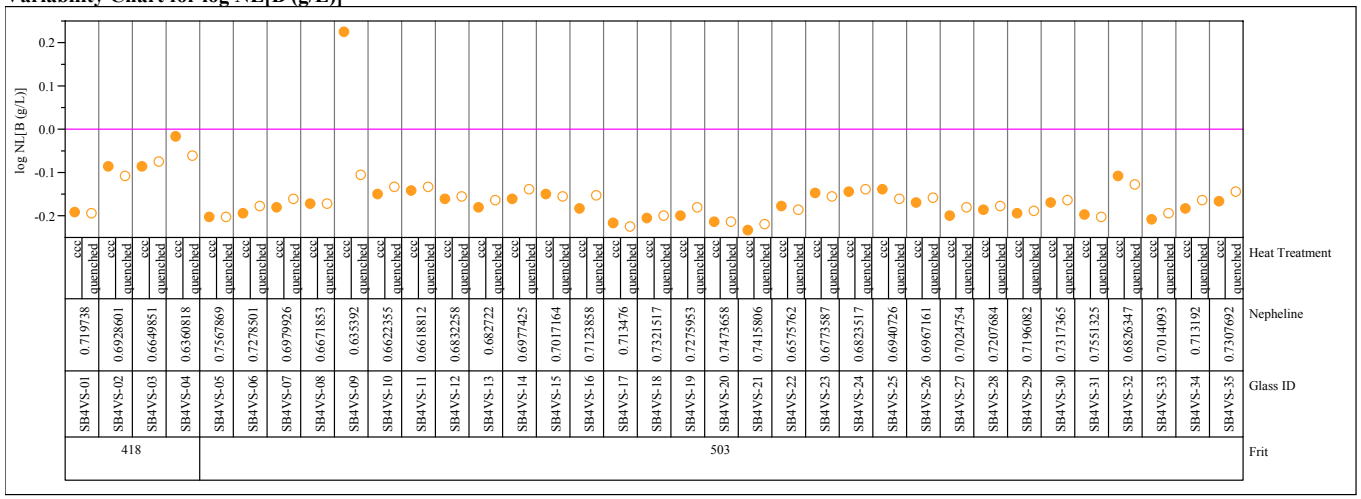


Exhibit F8. Effects of Heat Treatment for Study Glasses by Compositional View (continued)

Composition=targeted
Variability Chart for log NL[B (g/L)]



Variability Chart for log NL[Li (g/L)]

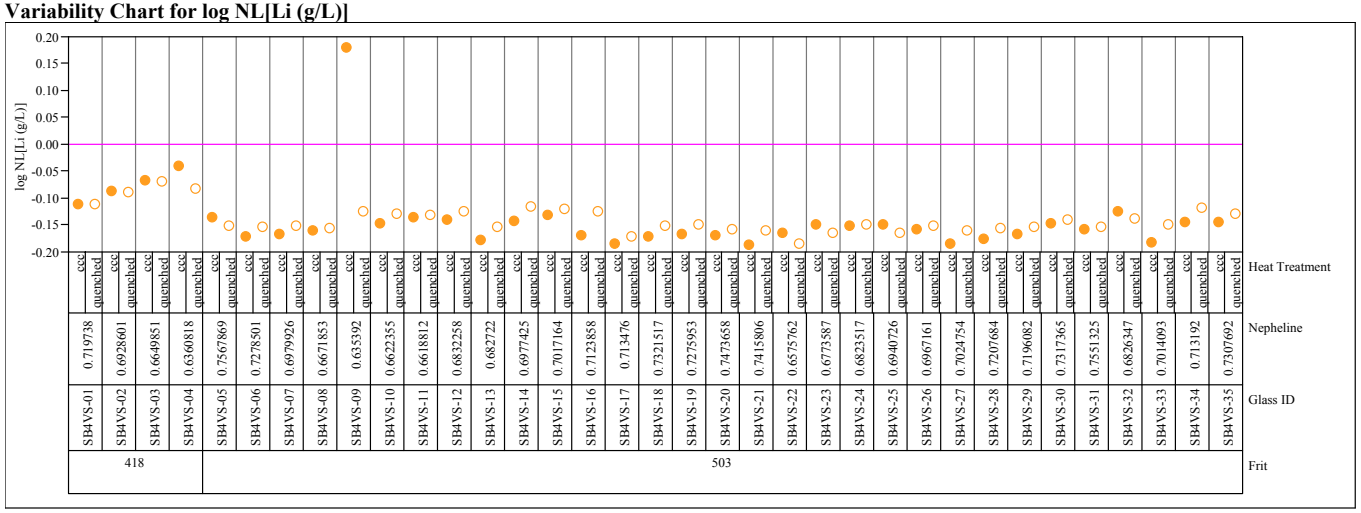
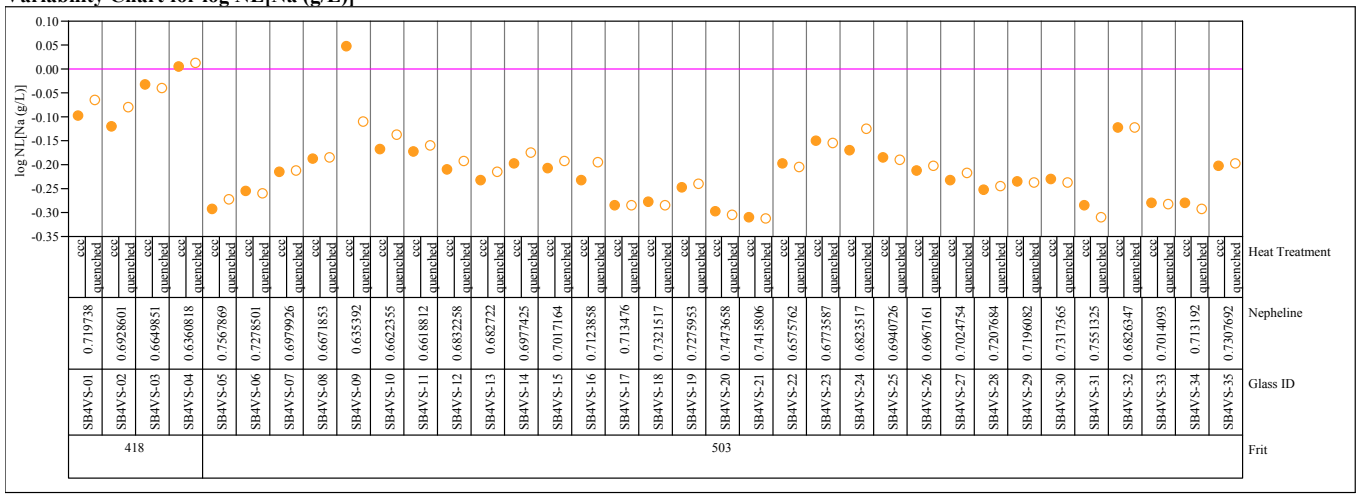


Exhibit F8. Effects of Heat Treatment for Study Glasses by Compositional View (continued)

Composition=targeted

Variability Chart for log NL[Na (g/L)]



Variability Chart for log NL[Si (g/L)]

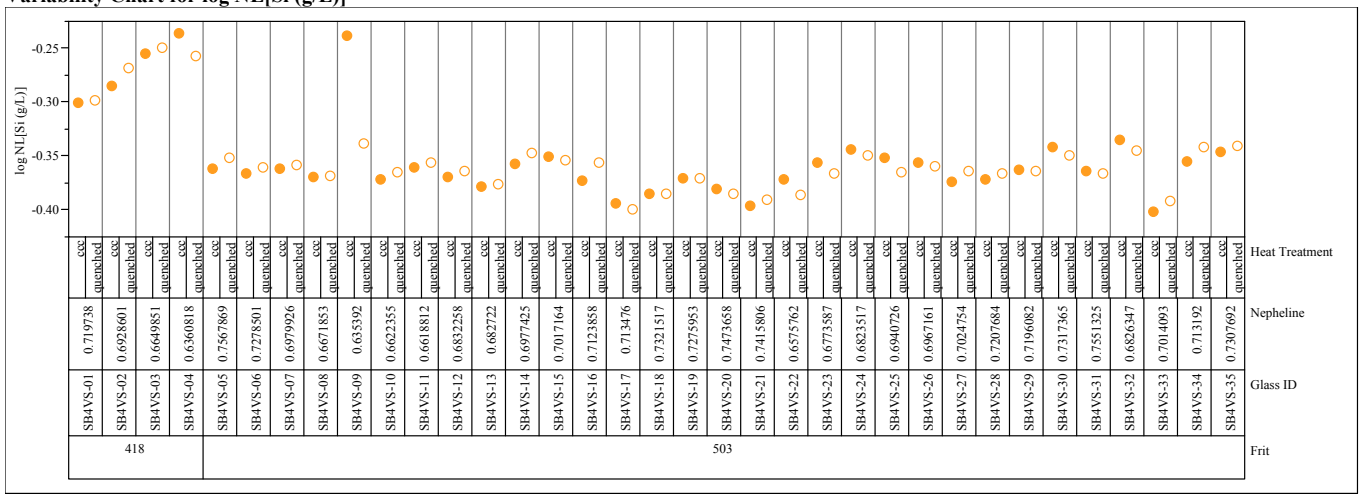
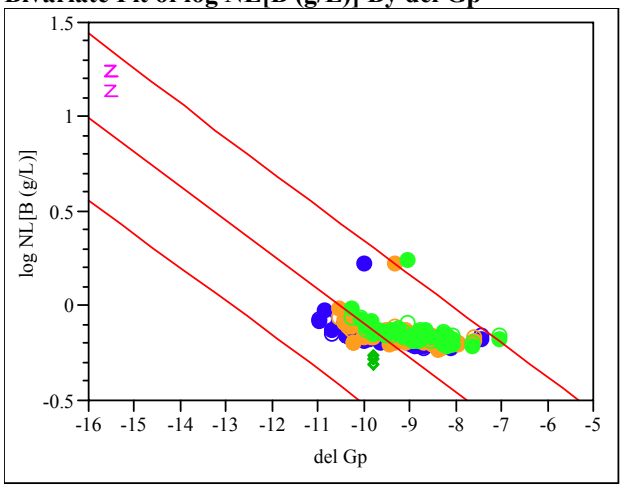


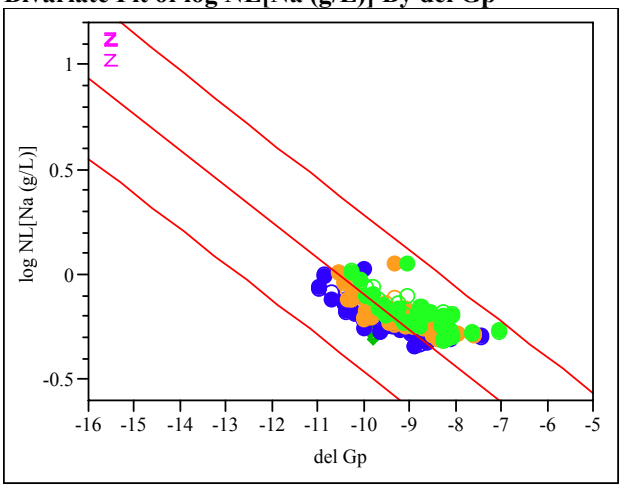
Exhibit F9. del Gp (ΔG_p) Predictions versus Common Logarithm Normalized Leachate (log NL[.]) for B, Li, Na, and Si Over All Compositional Views and Heat Treatments

Heat Treatment	Composition
1 ccc	measured
2 ccc	measured bc
3 ccc	targeted
4 quenched	measured
5 quenched	measured bc
6 quenched	targeted

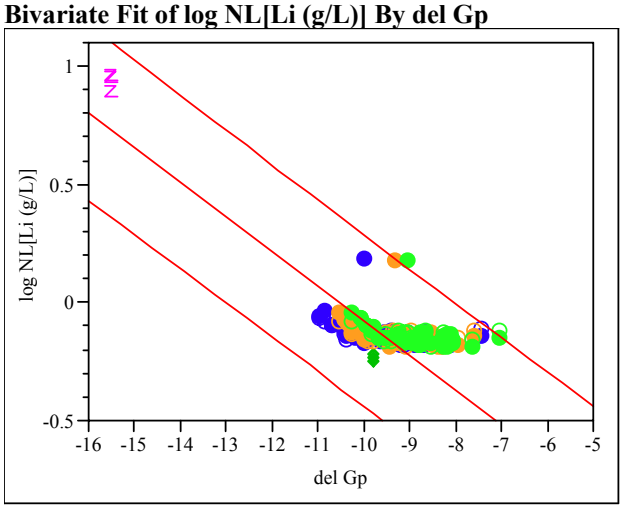
Bivariate Fit of log NL[B (g/L)] By del Gp



Bivariate Fit of log NL[Na (g/L)] By del Gp



Bivariate Fit of log NL[Li (g/L)] By del Gp



Bivariate Fit of log NL[Si (g/L)] By del Gp

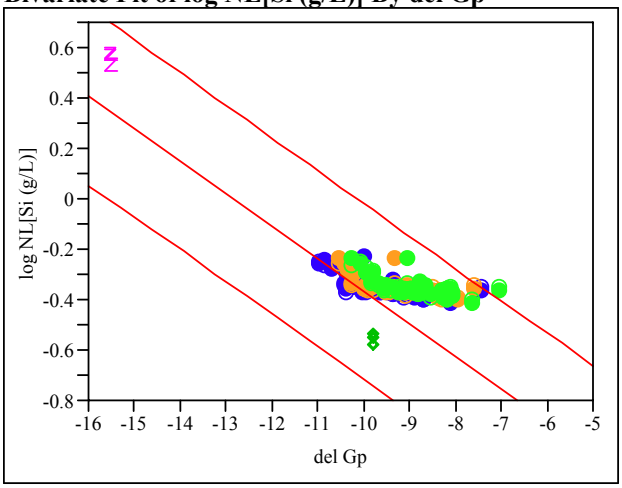
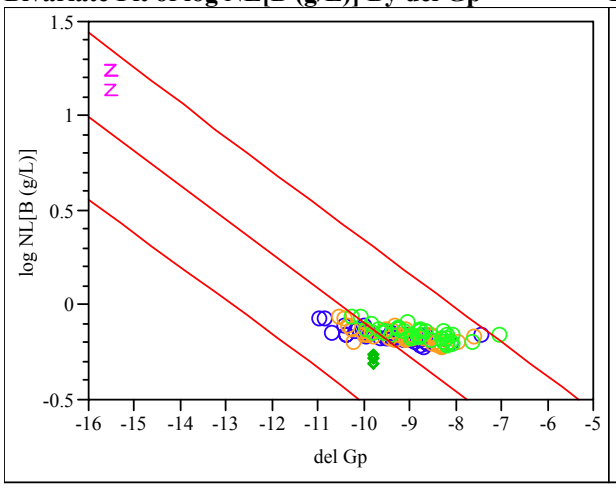


Exhibit F10. del Gp (ΔG_p) Predictions versus Common Logarithm Normalized Leachate (log NL[.]) for B, Li, Na, and Si Over All Compositional Views for Quenched Glasses

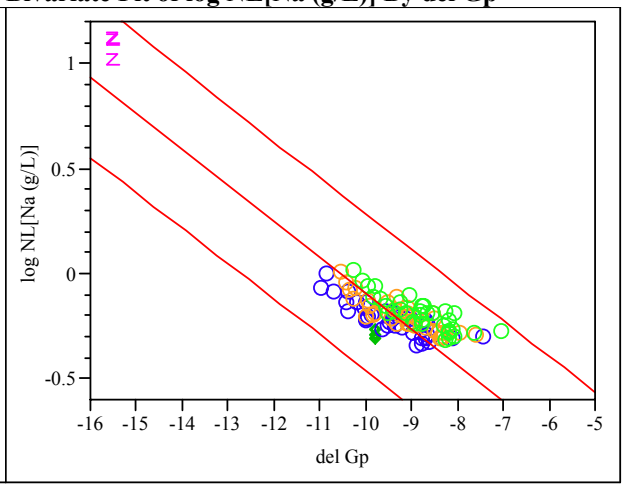
Legend

	Heat Treatment	Composition
1	ccc	measured
2	ccc	measured bc
3	ccc	targeted
4	quenched	measured
5	quenched	measured bc
6	quenched	targeted

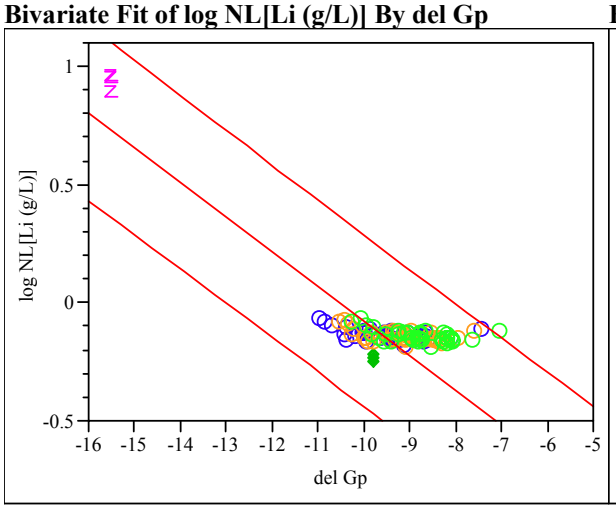
Bivariate Fit of log NL[B (g/L)] By del Gp



Bivariate Fit of log NL[Na (g/L)] By del Gp



Bivariate Fit of log NL[Li (g/L)] By del Gp



Bivariate Fit of log NL[Si (g/L)] By del Gp

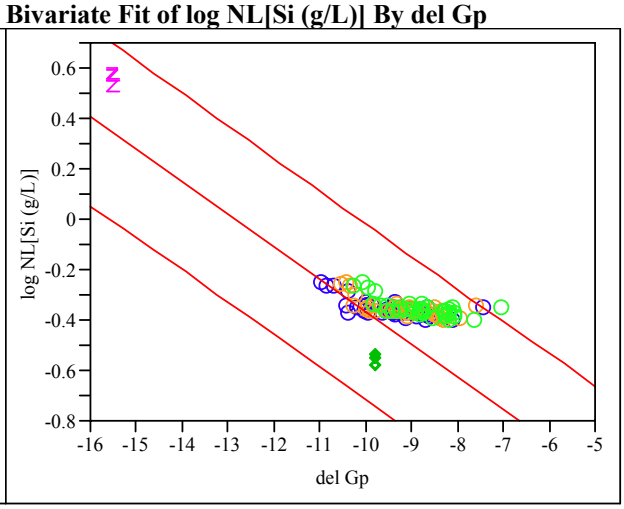
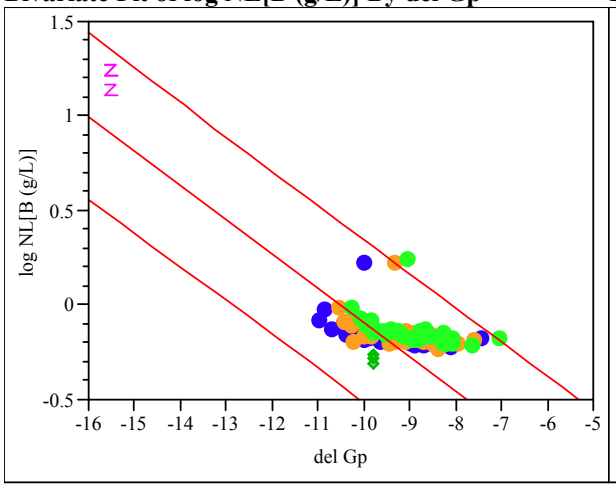


Exhibit F11. del Gp (ΔG_p) Predictions versus Common Logarithm Normalized Leachate (log NL[.]) for B, Li, Na, and Si Over All Compositional Views for ccc Glasses

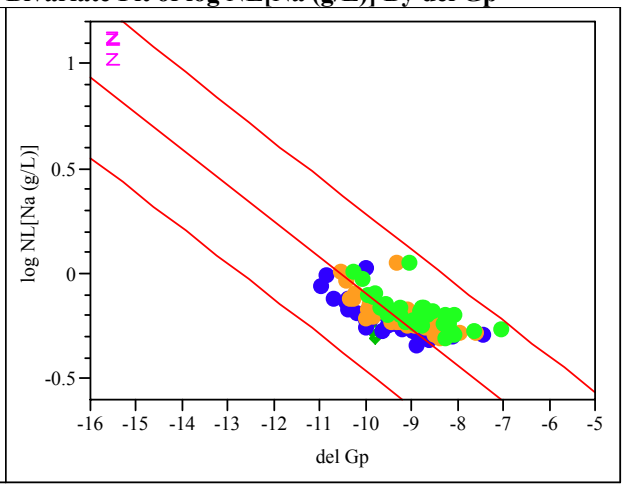
Legend

	Heat Treatment	Composition
1	ccc	measured
2	ccc	measured bc
3	ccc	targeted
4	quenched	measured
5	quenched	measured bc
6	quenched	targeted

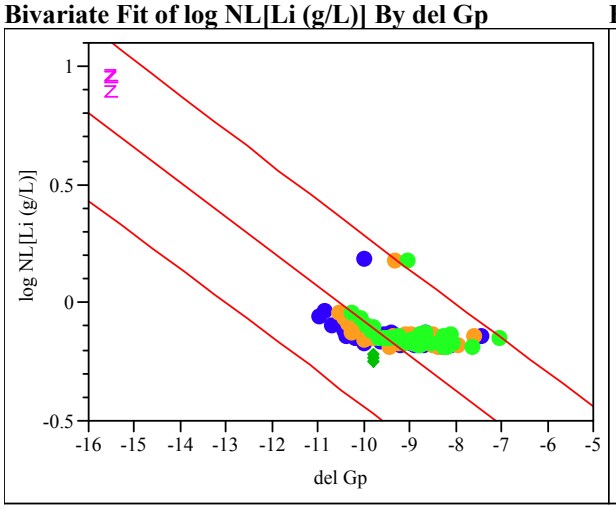
Bivariate Fit of log NL[B (g/L)] By del Gp



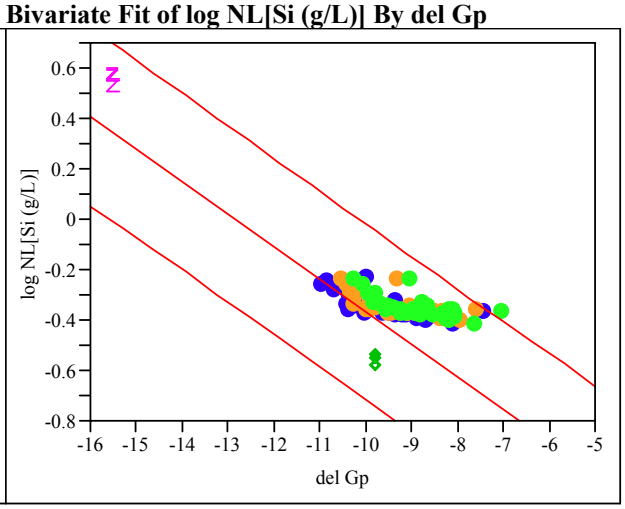
Bivariate Fit of log NL[Na (g/L)] By del Gp



Bivariate Fit of log NL[Li (g/L)] By del Gp



Bivariate Fit of log NL[Si (g/L)] By del Gp



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