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Durability Assessment of High Alkali Glasses in Support of the Accelerated Clean-Up Mission:

Experimental Results of the "ND" Glasses

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Executive Summary

In support of accelerated mission goals, glass formulation efforts have been focused on melt rate, waste loading, and waste throughput for the DWPF. With respect to melt rate, the general trend to improve melt rate has been to enhance the total alkali concentration in the glass system by increasing the alkali concentration in the frit, utilizing (or targeting) a less washed sludge, or using a combination of the two. In order to access these types of systems, an assessment of the PCT response in high alkali regions was needed. Thirty-one glasses, designated as ND01 – ND31, were selected (Cozzi et al. 2002) that intentionally challenged either the current durability model over an extremely broad compositional region or the Σalkali and Al_2O_3 criteria proposed by Herman et al. (2002). These glasses were batched, melted, and subjected to the PCT.

The objective of this task was to generate PCT /glass composition data in a potentially bounding compositional region of interest to DWPF to identify whether incentive exists to target higher alkali systems. The data indicate that higher alkali glasses can be produced which meet current Waste Acceptance Product Specifications (WAPS) durability criteria. More specifically, glasses were made with relatively high alkali contents (up to 25.3%), while the integrity of the product was maintained as measured by the PCT. This is in line with the high alkali glasses that are being developed for the Hanford LAW program. The 25.3% alkali content is dramatically higher than the current upper alkali contents for DWPF-type glasses. The results imply that increases in alkali content in the frit, transition to a less washed sludge, or a combination of the two can be successfully achieved from a durability perspective.

If these higher alkali systems provide advantages in terms of melt rate, waste loading, and/or waste throughput, the "ND" results provide incentive that access to higher alkali systems is a possibility. However, a more fundamental understanding of the complex glass component interactions is required to support the accelerated mission goals. The latter statement being based on the fact that the current durability model would not have allowed the majority of the high-alkali glasses to be processed strictly from a ΔG_P perspective – although measured NL [B] values were acceptable for some glasses.

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Acronyms

AES	atomic emission spectroscopy
ANOVA	analysis of variance
ARM	Approved Reference Material
ASTM	American Society for Testing and Materials
ccc	centerline canister cooled
ΔG_p(in kcal/mol)	Preliminary glass dissolution estimator based on free energy of hydration
DWPF	Defense Waste Processing Facility
EA	Environmental Assessment
EPAR	Expected Property Acceptability Region
EV	extreme vertice
ICP	Inductively coupled plasma
IL	inner layer
LAW	low-activity waste
LM	lithium-metaborate
MAR	Measurement Acceptability Region
MIL	modified inner layer
NL	Normalized leachate
OL	outer layer
PAR	Property Acceptability Region
PCCS	Product Composition Control System
PCT	Product Consistency Test
PF	(Sodium) Peroxide Fusion
PNNL	Pacific Northwest National Laboratory
SB	sludge batch
SME	Slurry Mix Evaporator
SRTC-ML	Savannah River Technology Center – Mobile Laboratory
T_L	liquidus temperature
TFA	Tanks Focus Area
THERMO™	Thermodynamic Hydration Energy Reaction Model
u_{STD}	uranium standard glass
WAPS	Waste Acceptance Product Specifications

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1.0 Introduction

In support of accelerated mission goals, glass formulation efforts have been focused on melt rate, waste loading, and waste throughput for the Defense Waste Processing Facility (DWPF). With respect to melt rate, the general trend to improve melt rate has been to enhance the total alkali concentration in the glass system by increasing the alkali concentration in the frit, utilizing (or targeting) a less washed sludge, or using a combination of the two approaches (Lambert et al. 2001). Previous studies (Peeler and Edwards 2002; Peeler and Edwards 2003a) have indicated that as higher alkali systems are pursued, a transition can occur in which predictions of durability begin limiting upper waste loading rather than predictions of liquidus temperature (T_L). Recent results (Peeler et al. 2001; Peeler and Edwards 2003b; and Cozzi et al. 2003) have also suggested that the current durability model can lead to conservative decisions during the Slurry Mix Evaporator (SME) acceptability process. More specifically, the model has restricted access to glass compositional regions that could potentially enhance melt rate, waste loading, or waste throughput by classifying a specific glass composition as "unacceptable" whose experimentally determined durability (as defined by the Product Consistency Test (PCT)) is "acceptable" relative to the Environmental Assessment (EA) glass. For example, Peeler et al. (2001) found that the Frit 304/Sludge Batch 2 (SB2) system was classified as unacceptable (based on model predictions) but when durability was experimentally determined, the results were well within the acceptance limits (i.e., the normalized boron release was 1.07 g/L). Melt rate assessments indicated that Frit 304 melted ~20% faster than Frit 320 for SB2 – a significant opportunity missed as a result of not being able to implement this frit in DWPF.

The incentive to access higher alkali systems to improve melt rate and/or waste loading is supported by the glass formulation efforts at Hanford for low-activity waste (LAW) (Feng et al. 1996). Certain immobilized LAW glass waste forms target a 20 wt% Na_2O content to meet contractual waste loading requirements (e.g., LAW is a high Na_2O content stream). Given one of the LAW glass product performance criteria is the PCT, technical inquisitiveness requires the need to explore the compositional region of interest to DWPF, while considering the high alkali regions more representative of Hanford LAW glasses. A glass compositional region of interest was defined by Herman (2002) who extended the alkali concentration beyond that previously tested for DWPF support. In general (and ignoring the multi-component interactions and their effects on durability), "higher" alkali glasses are expected to result in a lower durability product as compared to "lower" alkali glasses. However, the line of demarcation between "low" and "high" alkali products and their impact on durability is ill-defined, and a fundamental understanding of this distinction in classification (in terms of multi-component interactions) is needed. The research performed by colleagues at Pacific Northwest National Laboratory (PNNL) for the LAW program provides incentive to strive toward higher alkali systems in an effort to increase melt rate, waste loading, and ultimately waste throughput, while meeting current product performance criteria as defined by the Waste Acceptance Product Specifications (WAPS 1996).

Although durability is a complex function of the overall glass composition, the limits for an "acceptable" glass product are defined by the WAPS. The DWPF WAPS states (WAPS 1996): "For acceptance, the mean concentrations of lithium, sodium, and boron in the leachate, after normalizing for the concentrations in the glass, shall each be less than those of the benchmark glass described in the Environmental Assessment for selection of the DWPF waste form. One acceptable method of demonstrating that the acceptance criteria is met, would be to assure that the mean PCT results for each waste type are at least two standard deviations below the mean results of the EA glass." Table 1-1 shows the normalized releases for boron, lithium, and sodium for the EA glass as reported by Jantzen et al. (1993).

Table 1-1. Leachate Concentrations of the EA Glass as Reported by Jantzen et al. (1993)

	Leachate Concentrations		
	B (g/L)	**Li (g/L)**	**Na (g/L)**
Mean	16.695	9.565	13.346
Standard Deviation	1.222	0.735	0.902

In this report, the term "acceptable" (in reference to a PCT response) is defined as glasses whose log NL [B] (g/L) is less than 1.0 (or NL [B] < 10 g/L). This is consistent with the limit used by Edwards and Brown (1998) to set the Σalkali and Al_2O_3 criteria for relaxing the homogeneity constraint from the Measurement Acceptability Region (MAR) to the Property Acceptability Region (PAR) for Tank 42. This definition is also considered to be conservative relative to the EA glass as reported by Jantzen et al. (1993) with uncertainties considered as well as conservative to the requirements as specified in the WAPS.

Cozzi et al. (2002) defined thirty-one glasses that intentionally challenged either the current durability model over an extremely broad compositional region or the Σalkali and Al_2O_3 criteria proposed by Herman et al. (2002). These glasses were batched, melted, and subjected to the PCT. In this report, the results of both compositional analysis and PCT response are discussed.

2.0 Objective

The objective of this task is to generate PCT /glass composition data in a potentially bounding compositional region of interest to DWPF to identify if there is incentive to target higher alkali systems. Specifically, glasses for this study were targeted that challenged the current durability model predictions in the higher alkali regions in an effort to identify potential conservatism in the model. If such conservatism is identified, the incentive to explore this region will be established as the higher alkali systems could improve melt rate, waste loading, and/or waste throughput for DWPF.

This work was performed under the guidelines of "baseline R&D" scope per the Conduct of R&D Manual (SRTC 1997). It should be noted that the Tanks Focus Area (TFA) funded the experimental portion of this task. As stated in the Task Technical and QA Plan (Cozzi (2002)), although an off-site customer funded this work, the results can be used by the DWPF to establish a technical baseline as it was performed under RW-0333P requirements.

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3.0 Experimental

3.1 Test Matrix: Targeted Glass Compositions

Table 3-1 is a listing of the targeted compositions of the thirty-one glasses (referred to throughout this report as the "ND" series) selected for this study. Cozzi et al. (2002) provide a detailed discussion of the basis for selecting the 31 targeted compositions. As previously stated, the majority of the ND glasses were primarily selected to challenge the current durability model. Additional glasses were selected to assess the Al_2O_3 and Σalkali constraints proposed by Herman et al. (2002) to replace the homogeneity constraint.

Predictions from the current DWPF models that relate glass composition to product properties (such as durability) and processability properties (such as viscosity and liquidus temperature) were used to evaluate the feasibility of glass compositions of interest in this study. These models were also used (where possible) to restrict the glass composition region from which the feasible glass compositions were generated. Predictions at the PAR and/or Expected Property Acceptability Region (EPAR) were used to restrict the bounding glass composition region of interest.

In general, ND01 through ND20 are extreme vertices (EVs) from a potentially bounding compositional region defined by Herman et al. (2002). These 20 glasses are referred to as outer layer extreme vertices (OL EVs) throughput this report. ND21 through ND25 are based on a more "conservative" compositional region that reduced the upper and lower glass component limits by 20%. The five glasses selected were extreme vertices of this less conservative (or inner layer (IL)) region and are referred to as "IL EVs" throughout this report.

A second set of IL EV based glasses (ND26 through ND30) was selected from the more conservative compositional region using more restrictive criteria. More specifically, these glasses were restricted to 3 $\leq$ wt% Al_2O_3 $\leq$ 3.9 and the total alkali (Na_2O+Li_2O) was limited to greater than 19.3 wt%. The intent of these glasses was to assess the Al_2O_3-Al_2O_3+R_2O criteria proposed by Herman et al. (2002). These glasses are referred to as modified inner layer EV (MIL EV) glasses to distinguish them from the IL EVs. ND-31 is strictly based on the centroid of the OL EVs. The centroid of the glass compositional region is determined by averaging all of the EVs for that region.

Table 3-2 provides a summary of the predicted properties and an assessment of the acceptability of each glass using the PAR criteria. An assessment of the homogeneity criterion is included, but this criterion should be viewed in conjunction with the sum of alkali and alumina constraints prior to making an overall assessment of acceptability. Of the twenty OL EV-based glasses, eleven are predicted to be non-durable using the durability PAR criterion. Conversely, nine of the twenty are classified as "durable" with only ND08 satisfying all PAR constraints (i.e., from a PAR perspective, this is the only glass that would be "processable" in DWPF). It should be noted that application of the measurement uncertainty (i.e., MAR) would likely classify ND08 as "non-processable". Of the nine "durable" glasses, five fail the EPAR viscosity constraint while one (ND17) fails T_L predictions using the most recent model (Brown et al. 2001). ND19 fails both the viscosity and T_L criteria. ND06 is classified as inhomogeneous, which would not be a concern if the Al_2O_3 and sum of alkali met the >3.0% and <19.3% rules as proposed by Herman et al. (2002) to replace the homogeneity constraint. ND06 targets 3.01% Al_2O_3 and a total alkali content of 21% that is well above the 19.3% upper limit for Al_2O_3 concentrations between 3 and 4 wt%.

The ten inner layer glasses (both IL EVs (ND21-ND25) and MIL EVs (ND26-ND30)), as well as the centroid (ND31), are classified as “non-durable” based on model predictions. Recognizing that these glasses would not be processable in DWPF using the current Product Composition Control System (PCCS), one of the more interesting issues is an assessment of the Al_2O_3 and sum of alkali for these glasses. All of the IL EV-based glasses have targeted Al_2O_3 concentrations of 5.40 wt% or greater. Given the constraints proposed by Herman et al. (2002), these glasses would satisfy one of the alternative constraints (i.e., > 4 wt% Al_2O_3) without having an upper limit on the sum of alkali. The fact that no upper alkali limit was coupled with the > 4 wt% criteria is based on the data used to establish the alternative constraints. More specifically, the THERMO™ database (Jantzen et al. 1995) did not include glasses containing excessive total alkali content given this is a region that has not been explored in detail in previous DWPF studies. Therefore, one of the outcomes of this study could be an assessment of the need for an upper alkali limit for glasses containing a minimum of 4 wt% Al_2O_3. It should also be noted that ND21, ND27, and ND30 would not be processable in DWPF given they also fail the T_L of 1010°C (using the new model).

As previously discussed, the five MIL EV-based glasses (ND26 – ND30) were selected to assess the alternative constraints proposed by Herman et al. (2002) to replace the homogeneity constraint. Each of these glasses has targeted Al_2O_3 content of 3.0 wt% with a sum of alkali content exceeding the 19.3% upper limit.

Given the ND glasses were primarily selected to “challenge” the durability model predictions in a high alkali region, a review of the ΔG_P values is warranted. Based on targeted compositions, the ΔG_P values range from -22.3 kcal/mol for ND01 to -12.708 kcal/mol for ND07 and ND10. To put this in perspective, the current SME acceptability limit for durability in PCCS is approximately -12.78 kcal/mol (Brown, Postels, and Edwards (2002)) with EA having a predicted ΔG_P value of approximately -15.52 kcal/mol. Six of the ND glasses (ND01, ND02, ND03, ND13, ND14, and ND26) have ΔG_P values that are more negative than EA indicating that their durabilities should be unacceptable. For those glasses with ΔG_P values more positive than EA but more negative than the SME acceptability limit, there is a high probability that these glasses will be non-durable based on model predictions. However, given historical experimental results (e.g., Peeler et al. (2001)), there is the potential for select glasses (falling into either category with respect to relative ΔG_P values) to be acceptable (based on the measured PCT) yet classified as unacceptable or unprocessable by current model predictions. It is this set of glasses that is of most interest assuming they exist. More specifically, a fundamental understanding of the multi-component interactions could lead to adjustments in the current model or alternative approaches that would allow these higher alkali systems to be processed.

Table 3-1. Targeted Oxide Concentrations (as wt%'s) for the "ND" Glasses

ID	Description	Al_2O_3	B_2O_3	CaO	Fe_2O_3	Li_2O	MgO	MnO	Na_2O	NiO	SiO_2	TiO_2	U_3O_8	Others
ND01	OL	0.0300	0.0500	0.0400	0.0500	0.0300	0.0000	0.0800	0.2361	0.0000	0.4839	0.0000	0.0000	0.0000
ND02	OL	0.0300	0.1200	0.0050	0.0500	0.0300	0.0000	0.0800	0.1645	0.0000	0.4230	0.0175	0.0800	0.0000
ND03	OL	0.0300	0.0500	0.0050	0.0500	0.0700	0.0400	0.0800	0.1533	0.0000	0.4842	0.0175	0.0000	0.0200
ND04	OL	0.0300	0.1200	0.0050	0.0500	0.0700	0.0400	0.0050	0.1037	0.0000	0.4763	0.0000	0.0800	0.0200
ND05	OL	0.1348	0.0500	0.0400	0.0500	0.0700	0.0000	0.0800	0.1274	0.0000	0.4278	0.0000	0.0000	0.0200
ND06	OL	0.0301	0.0500	0.0050	0.0500	0.0700	0.0000	0.0050	0.1399	0.0000	0.6500	0.0000	0.0000	0.0000
ND07	OL	0.0300	0.0500	0.0400	0.0500	0.0300	0.0000	0.0050	0.1683	0.0000	0.6092	0.0175	0.0000	0.0000
ND08	OL	0.1119	0.1200	0.0050	0.0500	0.0300	0.0400	0.0800	0.1446	0.0000	0.4185	0.0000	0.0000	0.0000
ND09	OL	0.0915	0.0500	0.0050	0.0500	0.0300	0.0000	0.0050	0.1906	0.0000	0.4604	0.0175	0.0800	0.0200
ND10	OL	0.0300	0.1200	0.0400	0.1474	0.0300	0.0400	0.0050	0.1418	0.0000	0.4458	0.0000	0.0000	0.0000
ND11	OL	0.0300	0.0500	0.0400	0.1054	0.0700	0.0400	0.0800	0.0804	0.0000	0.4068	0.0175	0.0800	0.0000
ND12	OL	0.0300	0.0500	0.0400	0.1780	0.0300	0.0000	0.0050	0.1701	0.0000	0.4594	0.0175	0.0000	0.0200
ND13	OL	0.0300	0.0500	0.0050	0.0500	0.0300	0.0376	0.0050	0.2370	0.0500	0.4853	0.0000	0.0000	0.0200
ND14	OL	0.0493	0.0500	0.0400	0.0500	0.0300	0.0400	0.0050	0.2225	0.0500	0.4457	0.0175	0.0000	0.0000
ND15	OL	0.0300	0.1200	0.0400	0.0500	0.0700	0.0000	0.0800	0.0761	0.0474	0.4491	0.0175	0.0000	0.0200
ND16	OL	0.1089	0.0500	0.0400	0.0500	0.0700	0.0000	0.0050	0.1426	0.0431	0.4104	0.0000	0.0800	0.0000
ND17	OL	0.0300	0.0500	0.0050	0.0500	0.0300	0.0400	0.0800	0.1335	0.0489	0.5151	0.0175	0.0000	0.0000
ND18	OL	0.0300	0.0500	0.0400	0.0500	0.0300	0.0000	0.0800	0.1193	0.0488	0.4519	0.0000	0.0800	0.0200
ND19	OL	0.0300	0.0500	0.0050	0.1800	0.0412	0.0000	0.0800	0.1344	0.0376	0.4418	0.0000	0.0000	0.0000
ND20	OL	0.1145	0.0955	0.0050	0.0500	0.0700	0.0000	0.0050	0.1564	0.0440	0.4421	0.0175	0.0000	0.0000
ND21	IL	0.0540	0.1060	0.0120	0.0760	0.0620	0.0080	0.0200	0.1323	0.0400	0.4662	0.0035	0.0160	0.0040
ND22	IL	0.0540	0.1060	0.0330	0.0760	0.0380	0.0320	0.0200	0.1383	0.0100	0.4572	0.0035	0.0160	0.0160
ND23	IL	0.0540	0.0640	0.0120	0.1455	0.0380	0.0080	0.0200	0.1630	0.0100	0.4500	0.0035	0.0160	0.0160
ND24	IL	0.0540	0.0640	0.0120	0.0955	0.0620	0.0320	0.0200	0.1290	0.0100	0.4500	0.0035	0.0640	0.0040
ND25	IL	0.1025	0.0640	0.0120	0.0760	0.0380	0.0320	0.0200	0.1720	0.0100	0.4500	0.0035	0.0160	0.0040
ND26	MIL	0.0300	0.0640	0.0120	0.0760	0.0380	0.0080	0.0650	0.1755	0.0100	0.4500	0.0035	0.0640	0.0040
ND27	MIL	0.0300	0.1060	0.0330	0.0760	0.0380	0.0080	0.0200	0.1594	0.0400	0.4541	0.0035	0.0160	0.0160
ND28	MIL	0.0300	0.1060	0.0330	0.0760	0.0620	0.0080	0.0200	0.1323	0.0100	0.4887	0.0140	0.0160	0.0040
ND29	MIL	0.0300	0.0640	0.0120	0.1499	0.0380	0.0080	0.0200	0.1569	0.0100	0.4652	0.0140	0.0160	0.0160
ND30	MIL	0.0300	0.0640	0.0120	0.0760	0.0620	0.0320	0.0200	0.1325	0.0397	0.4603	0.0035	0.0640	0.0040
ND31	OL EV Centroid	0.0569	0.0811	0.0232	0.0698	0.0481	0.0184	0.0482	0.1413	0.0233	0.4324	0.0083	0.0398	0.0092

Table 3-2. Property Predictions for "ND" Glass Series.

ID	Property PAR Status	alkalis (wt fraction)	Al_2O_3	Viscosity (Poise)	Homogeneity wt %	PCCS ΔG_p (kcal/mol)	Old T_L (°C)	New T_L (°C)
ND01	Not Durable; Not Visc; T_L; Not Homo; New T_L; Al_2O_3; Not alkali	0.266	0.0300	19.99	196.1	-22.300	887.1	427.6
ND02	Not Durable; Not Visc; T_L; Not Homo; New T_L; Al_2O_3; Not alkali	0.195	0.0300	19.98	166.3	-16.635	900.4	529.1
ND03	Not Durable; Not Visc; T_L; Not Homo; New T_L; Al_2O_3; Not alkali	0.223	0.0300	20.00	169.5	-17.988	887.0	662.4
ND04	Not Durable; Visc; T_L; Not Homo; New T_L; Al_2O_3; alkali	0.174	0.0300	24.18	171.5	-12.839	888.6	822.9
ND05	Not Durable; Visc; T_L; Homo; New T_L; Al_2O_3; Not alkali	0.197	0.1348	46.06	235.2	-12.842	955.0	800.1
ND06	Durable; Visc; T_L; Not Homo; New T_L; Al_2O_3; Not alkali	0.210	0.0301	73.64	194.0	-12.711	864.4	498.5
ND07	Durable; Not Visc; T_L; Not Homo; New T_L; Al_2O_3; Not alkali	0.198	0.0300	109.34	205.3	-12.708	868.7	556.7
ND08	Durable; Visc; T_L; Not Homo; New T_L; Al_2O_3; alkali	0.175	0.1119	59.50	208.6	-12.717	942.5	831.4
ND09	Not Durable; Visc; T_L; Not Homo; New T_L; Al_2O_3; Not alkali	0.221	0.0915	54.40	200.0	-12.840	913.7	756.2
ND10	Durable; Not Visc; Not T_L; Homo; New T_L; Al_2O_3; alkali	0.172	0.0300	19.99	241.1	-12.708	1072.4	927.7
ND11	Durable; Not Visc; T_L; Not Homo; New T_L; Al_2O_3; alkali	0.150	0.0300	19.99	196.4	-12.714	1016.4	806.7
ND12	Not Durable; Not Visc; Not T_L; Homo; New T_L; Al_2O_3; Not alkali	0.200	0.0300	20.00	253.8	-12.833	1117.6	883.1
ND13	Not Durable; Not Visc; T_L; Not Homo; Not New T_L; Al_2O_3; Not alkali	0.267	0.0300	20.00	176.7	-19.640	886.8	1018.3
ND14	Not Durable; Not Visc; T_L; Not Homo; Not New T_L; Al_2O_3; Not alkali	0.253	0.0493	19.97	198.7	-18.366	901.3	1025.3
ND15	Not Durable; Visc; T_L; Not Homo; Not New T_L; Al_2O_3; alkali	0.146	0.0300	28.29	182.5	-12.843	894.2	1032.2
ND16	Durable; Visc; T_L; Homo; Not New T_L; Al_2O_3; Not alkali	0.213	0.1089	23.47	220.3	-12.710	944.6	1025.7
ND17	Durable; Visc; T_L; Not Homo; Not New T_L; Al_2O_3; alkali	0.164	0.0300	103.08	164.8	-12.712	881.6	1045.2
ND18	Not Durable; Visc; T_L; Not Homo; Not New T_L; Al_2O_3; alkali	0.149	0.0300	85.05	172.2	-12.841	893.6	1049.1
ND19	Durable; Not Visc; Not T_L; Homo; Not New T_L; Al_2O_3; alkali	0.176	0.0300	19.99	228.4	-12.711	1135.1	1028.6
ND20	Durable; Not Visc; T_L; Homo; New T_L; Al_2O_3; Not alkali	0.226	0.1145	20.01	218.2	-12.710	932.8	1008.2
ND21	Not Durable; Visc; T_L; Not Homo; Not New T_L; Al_2O_3; Not alkali	0.194	0.0540	21.59	203.1	-13.173	946.7	1050.8
ND22	Not Durable; Visc; T_L; Not Homo; New T_L; Al_2O_3; alkali	0.176	0.0540	38.09	210.6	-12.816	950.0	976.4
ND23	Not Durable; Visc; Not T_L; Homo; New T_L; Al_2O_3; Not alkali	0.201	0.0540	21.66	234.1	-12.809	1089.0	971.3
ND24	Not Durable; Visc; T_L; Not Homo; New T_L; Al_2O_3; alkali	0.191	0.0540	22.89	204.2	-12.734	990.9	925.3
ND25	Not Durable; Visc; T_L; Homo; New T_L; Al_2O_3; Not alkali	0.210	0.1025	44.60	223.7	-12.736	984.5	924.1
ND26	Not Durable; Visc; T_L; Not Homo; New T_L; Al_2O_3; Not alkali	0.214	0.0300	21.62	183.3	-17.010	940.9	662.6
ND27	Not Durable; Visc; T_L; Not Homo; Not New T_L; Al_2O_3; Not alkali	0.197	0.0300	21.65	200.0	-15.125	939.5	1041.3
ND28	Not Durable; Visc; T_L; Not Homo; New T_L; Al_2O_3; Not alkali	0.194	0.0300	21.62	205.0	-14.225	929.0	748.6
ND29	Not Durable; Visc; Not T_L; Homo; New T_L; Al_2O_3; Not alkali	0.195	0.0300	21.57	224.5	-12.818	1064.5	931.0
ND30	Not Durable; Visc; T_L; Not Homo; Not New T_L; Al_2O_3; Not alkali	0.195	0.0300	21.60	181.9	-14.014	937.5	1062.7
ND31	Not Durable; Visc; T_L; Not Homo; New T_L; Al_2O_3; alkali	0.189	0.0569	26.57	197.4	-14.052	949.0	943.9

3.2 Glass Preparation

Each glass was prepared from the proper proportions of reagent-grade metal oxides, carbonates, H_3BO_3, and salts in 150-g batches using SRTC technical procedure "Glass Batching – ITS-0001" (SRTC 2002a). Batch sheets were filled out as the materials were weighed.[1] Once batched, the glasses were melted using SRTC technical procedure "Glass Melting – ITS-0003" (SRTC 2002b). In general, the raw materials were thoroughly mixed and placed into a 95% Platinum/5% Gold 250-mL crucible. The batch was subsequently placed into a high-temperature furnace at the target melt temperature of 1150°C. After an isothermal hold at 1150°C for 1.0 h, the crucible was removed, and the glass was poured onto a clean stainless steel plate and allowed to air cool. Observations of the resulting pour patty and residual crucible glass were documented.

The pour patty and residual crucible glass were ground, and the crushed glass was subsequently transferred to its original 95% Platinum/5% Gold 250-mL crucible for a second melt. After an additional isothermal hold at 1150°C for 1.0 h, the crucible was removed, and the glass was poured onto a clean stainless steel plate and allowed to air cool. Observations of the resulting pour patty and residual crucible glass were again documented. Approximately 140 g of glass was removed (poured) from the crucible while ~10 g remained in the crucible along the walls. The pour patty was used as a sampling stock for the various heat treatments and property measurements (i.e., chemical composition and durability). It should be noted that these glasses were batched and fabricated under oxidizing conditions so this study does not include an assessment of the impact of redox on the PCT response.

To bound the effects of thermal history on the product performance, approximately 25 g of each ND glass was heat treated to simulate cooling along the centerline of a DWPF-type canister (Marra and Jantzen 1993). This cooling regime is commonly referred to as the centerline canister cooling (ccc) curve. This terminology will be used in this report to differentiate samples from the two different cooling regimes (quenched versus ccc).

3.3 Property Measurements

This section provides a general discussion of the analysis of chemical compositions and the PCTs for the ND glasses.

3.3.1 Chemical Composition Analysis

To confirm that the "as-fabricated" glasses corresponded to the defined target compositions, a representative sample from each ND glass pour patty was submitted to the Savannah River Technology Center Mobile Laboratory (SRTC-ML) for chemical analysis. Edwards (see Appendix A) provided analytical plans that accompanied these samples.[2] These plans identified the cations to be analyzed and the dissolution techniques (i.e., sodium peroxide fusion [PF] and lithium-metaborate [LM]) to be used. Each glass was prepared in duplicate for the cation dissolution techniques (PF and LM). Concentrations (as mass %) for the cations of interest were measured by inductively coupled plasma – atomic emission spectroscopy (ICP – AES). The analytical plans were developed in such a way as to provide the opportunity to evaluate potential

[1] Batch sheets can be found in WSRC-NB-96-742.

[2] Separate analytical plans governed the compositional analysis for radioactive and non-radioactive samples. It should be noted that the plans covered the "ND" glasses as well as the "RC" glasses reported by Herman et al. (2002).

sources of error. Glass standards were intermittently run to assess the performance of the ICP – AES over the course of these analyses and for potential bias-correction needs. The measurements were conducted to assess whether or not the targeted glass compositions were adequately met.

3.3.2 Product Consistency Test (PCT)

The PCT was performed in triplicate on each ND glass to assess chemical durability using technical procedure "Nuclear Waste Glass Product Consistency Test (PCT) Method – GTOP-3-025" (ASTM 2002). Also included in this experimental test matrix were the EA glass (Jantzen et al. 1993), the Approved Reference Material (ARM-1) glass, and blanks from the sample cleaning batch. Samples were ground, washed, and prepared according to procedure. Fifteen mL 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 for 7 days. The resulting solutions (once cooled) were sampled (filtered and acidified), labeled (according to the analytical plan), and analyzed. Edwards provided analytical plans for the SRTC-ML analysis (see Appendix B).[3] The overall philosophy of each plan was to provide an opportunity to assess the consistency (repeatability) of the PCT and analytical procedures in the effort to evaluate chemical durability of the ND glasses. Normalized release rates were calcula ted based on targeted, measured, and bias-corrected compositions using the average of the logs of the leachate concentrations.

[3] Separate analytical plans governed the PCT analysis for radioactive and non-radioactive samples. It should be notedd that the plans covered the ND glasses as well as the "RC" glasses reported by Herman et al. (2002).

4.0 Results

4.1 A Statistical Review of the Chemical Composition Measurements

In this section, the measured versus targeted compositions of the 31 ND glasses (ND01 through ND31) are presented and compared. The targeted compositions for these glasses are provided in Table 3-1. Chemical composition measurements for these glasses were conducted by the SRTC-ML following the two analytical plans provided in Appendix A. The first analytical plan covered the non-radioactive ND glasses and the RC glasses discussed in Herman et al. (2002). The second analytical plan covered the radioactive glasses from both of these studies. It should be noted that both sets of data are shown throughout the appendices.

Two dissolution methods were utilized in each plan: samples prepared from glasses in the non-radioactive group by lithium metaborate (LM) dissolution were used to measure elemental concentrations of calcium (Ca), chromium (Cr), iron (Fe), magnesium (Mg), manganese (Mn), sodium (Na), nickel (Ni), phosphorous (P), silicon (Si), titanium (Ti), and zirconium (Zr) while samples from glasses in both the non-radioactive and radioactive groups prepared by peroxide fusion (PF) dissolution were used to measure elemental concentrations of aluminum (Al), boron (B), and lithium (Li). The LM dissolution was also used to measure for thorium (Th) and uranium (U) in glasses in the radioactive group. Notice that beyond the minor components of Cr, P, Ti, and Zr, there is an "Others" grouping of additional minor components whose concentrations were not measured. For each study glass, measurements were obtained from samples prepared in duplicate by each of these dissolution methods. All of the prepared samples were analyzed (twice for each element of interest) by ICP-AES (with the instrumentation being re-calibrated between the duplicate analyses).

Tables C.1 and C.2 in Appendix C provide the elemental concentration measurements derived from the samples prepared using LM for the non-radioactive and radioactive glasses, and Tables C.3 and C.4 in Appendix C provide the measurements derived from the samples prepared using PF for both groups of glasses. Measurements for standards (Batch 1 in both groups and a uranium standard, U_{std}, glass in the radioactive group), that were included in the SRTC-ML analytical plans along with the ND glasses, are also provided in these 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 SRTC-ML was reduced to half of that detection limit as the oxide concentration was determined.

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

4.1.1 Measurements in Analytical Sequence

Exhibit C.1 in Appendix C provides plots of the measurements generated by the SRTC-ML for samples prepared from the non-radioactive glasses using the LM method. These plots are in analytical sequence with different symbols and colors being used to represent each of the ND and standard glasses. Similar plots for samples prepared from the non-radioactive glasses using the PF method are provided in Exhibit C.2 in Appendix C. Exhibits C.3 and C.4 in Appendix C provide similar plots for the radioactive glasses. These plots include all of the measurement data from Tables C.1 through C.4. A review of these plots indicates no significant patterns or trends in the analytical process over the course of these measurements, and there appear to be no obvious outliers in these chemical composition measurements.[4]

4.1.2 Batch 1 and Uranium Standard Results

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

Exhibit C.5 in Appendix C provides statistical analyses of the Batch 1 results generated by the LM prep method by analytical block for the non-radioactive group of glasses. The results include analysis of variance (ANOVA) investigations looking for statistically significant differences among the block means for each of the standards. The results from these statistical tests for the Batch 1 standard may be summarized as follows: the Cr, Fe, Mn, Na, Si, and Zr measurements indicate a significant ICP calibration effect on these 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 C.6 in Appendix C provides a similar set of analyses for the measurements derived from samples of the non-radioactive glasses prepared via the PF method. In this exhibit, there is no indication of a statistically significant (at the 5% significance level) difference among the ICP analytical/calibration block averages for these data.

Exhibit C.7 in Appendix C provides a similar set of analyses for the measurements derived from samples of the radioactive glasses prepared via the LM method. For the radioactive glasses, two standards (Batch 1 and U_{std}) were used. The results from these statistical tests may be summarized as follows: for the Batch 1 standard – the Ca, Cr, Fe, Mg, Mn, Na, Ni, Si, and Zr measurements indicate a significant ICP calibration effect on these averages at the 5% significance level and for the U_{std} – the Ca, Cr, Fe, Mg, Mn, Na, Ni, Th, Ti, and U measurements indicate a significant ICP calibration effect on these averages at the 5% significance level.

Exhibit C.8 in Appendix C provides a similar set of analyses for the measurements derived from samples of the radioactive glasses prepared via the PF method. The results from these statistical tests indicate a significant ICP calibration effect at the 5% significance level for the Al measurements for both Batch 1 and U_{std}.

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[4] The lack of significant variation in the oxide measurements is also reflected in Exhibits C.11 and C.12. It should be noted that one RC glass did show significant scatter in the ZrO_2 values (as noted by the orange blocks in Exhibit C.1). The results of this glass are not addressed in this report.

The results suggest that it may be helpful to bias correct the oxide measurements of the ND glasses for the effect of the ICP calibration on each of the analytical blocks. The basis for this bias correction is presented as part of Exhibits C.5 through C.8 – the average measurement for Batch 1 for each ICP block for Al, Ca, Cr, Fe, Mg, Mn, Na, Ni, P, Si, Ti, and Zr and the average measurement for U_{std} for each ICP block for U. 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, Ca, Cr, Fe, Mg, Mn, Na, Ni, Si, and Ti measurements. No bias correction was conducted for P, Th, or Zr.

The bias correction was conducted as follows. For each oxide, let $\bar{a}_{ij}$ be the average measurement for the i^{th} oxide at analytical block j for Batch 1 (or U_{std} for uranium), and let t_i be the reference value for the i^{th} oxide for Batch 1 (or for U_{std} if uranium). (The averages and reference values are provided in Exhibits C.5 through C.8.) Let $\bar{c}_{ijk}$ be the average measurement for the i^{th} oxide at analytical block j for the k^{th} glass. The bias adjustment was conducted as follows

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

Bias-corrected measurements are indicated by a “bc” suffix, and such adjustments were performed for all of the oxides of this study except P_2O_5, ThO_2, and ZrO_2. Both measured and measured “bc” values are included in the discussion that follows. In these discussions bias-corrected values for P_2O_5, ThO_2, and ZrO_2 are included for completeness (e.g., to allow a sum of oxides to be computed for the bias-corrected results). These bias-corrected values are the same as the original P_2O_5, ThO_2, and ZrO_2 values (i.e., once again, no bias correction was performed for these three oxides).

4.1.3 Composition Measurements by Glass Number

Exhibits C.9 through C.12 in Appendix C provide plots of the oxide concentration measurements by Glass ID # (including both the Batch 1, labeled as glass number 0 for the non-radioactive group and 100 for the radioactive group, and U_{std}, labeled as glass number 101, glasses) for the measured and bias-corrected (bc) values for the LM and PF preparation methods for both the non-radioactive and the radioactive glass groups. Different symbols are used to represent the different glasses. These plots show the individual measurements across the duplicates of each preparation method and the two ICP calibrations. A review of the plots presented in these exhibits reveals the repeatability of the four individual oxide values for each glass. No problems are evident in these plots.

More detailed discussions of the average, measured chemical compositions of the ND glasses are provided in the sections that follow.

4.1.4 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 C.13 provides plots 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 C.13 are offered: With the exception of ND11, ND30, and ND31 no major issues are observed indicating that targeted compositions were met for the ND glasses. There are individual oxide values for select glasses that are suspect and should be mentioned. These include: the Al_2O_3 value for ND10; the B_2O_3 value for ND20; the Fe_2O_3 value for ND19 and ND20, MnO values for ND19, NiO values for ND14 and ND16, and the SiO_2 values for ND06, ND19, and ND20. Finally, for those glasses containing ZrO_2, the measured levels for this oxide were consistently below their respective targets except for ND30, which was above. With respect to ND30 and ND31, a close review of these results suggests that the identifiers for the glasses may have been switched. However, the timing of the switch is not clear (e.g., upon fabrication or upon sampling for the compositional analysis). Therefore, it is not known how the possible switch may have affected the labeling of the subsequent property measurements. More specifically, the PCT values for these two glasses should be viewed cautiously. With respect to ND11, several of the oxides appear to be suspect – in particular the Al_2O_3, Fe_2O_3 MgO, NiO, and TiO_2 values. As with the results for ND30 and ND31, the PCT response for ND11 should be viewed accordingly and used with caution.

Table C.5 in Appendix C 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 glasses do not sum to 100% due to the “Others” component of the ND glasses and an incomplete coverage of the oxides in the Batch 1 (glass # 0 for the non-radioactive group and #100 for the radioactive group) and U_{std} (glass # 101) 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 C.5 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 that targeted compositions were in general obtained. However, the results do indicate there were some difficulties in batching or compositional measurements associated with ND11 and ND19, while ND30 and ND31 were more than likely switched during some point of the fabrication or testing program.

4.2 A Statistical Review of the PCT Measurements

The ND glasses, after being batched and fabricated, were subjected to the 7-day PCT as an assessment of their durabilities. The PCTs were conducted in triplicate for both heat treatments (quenched and centerline-canister cooled) of each glass. In addition, PCTs were conducted in triplicate for samples of the EA glass and for samples of the ARM glass. Blanks (samples consisting only of ASTM Type I water) and samples of a multi-element, standard solution were also included in the analytical plans for these measurements (see Appendix D). In this and the following sections, the measurements generated by the SRTC-ML for these PCTs are presented and reviewed.

Table D.1 in Appendix D provides the elemental leachate concentration measurements determined by the SRTC-ML for the solution samples generated by the PCTs.[5] The PCT results for the centerline, canister-cooled glasses are indicated by a "ccc" suffix. 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 D.1 below the detection limit of the analytical procedure (indicated by a "<") was replaced by ½ of the detection limit in subsequent analyses. Beyond the adjustments for detection limits, no other corrections were performed to these data.

In the sections that follow, the analytical sequence of the measurements is explored, the measurements of the standards are investigated and used to assess the overall accuracy of the ICP measurement process, the measurements for each glass are reviewed, the quenched versus centerline-cooled results are compared, the PCTs are normalized using the compositions (targeted, measured, and bias-corrected) presented in Table C.5, and the normalized PCTs are compared to durability predictions for these compositions generated from the current DWPF models (Jantzen et al. 1995).

4.2.1 Measurements in Analytical Sequence

Exhibits D.1 through D.2 in Appendix D provide plots of the leachate (ppm) concentrations in analytical sequence as generated by the SRTC-ML including all of the standards for the two groups (non-radioactive and radioactive) of PCTs. Different colors are used for each glass with a "+" being used to represent results from quenched glasses while a solid circle represents ccc results. No problems are seen in these plots with one exception. Based on a review of the ppm values, it appears that one of the replicates for ND01[6] produced higher ppm values for Na, B, Li, and Si. For example, consider the Na value for analytical sequence 37 appears to be substantially higher (approximately 3800 ppm) than its duplicate counterpart values (approximately 1600 ppm). Given all the data were used in the PCT normalization process and assuming the 3800 ppm value is misrepresentative, this would have resulted in a normalized Na release bias high for ND01. The same could be said about the Li, B, and Si values and the normalization process.

4.2.2 Results for the Samples of the Multi-Element Solution Standard

Exhibits D.3 and D.4 provide analyses of the SRTC-ML measurements of the samples of the multi-element solution standard by ICP analytical (or calibration) block for the non-radioactive and radioactive groups, respectively. An ANOVA investigating for statistically significant differences among the block averages for these samples for each element of interest for the two groups of PCTs is included in these exhibits. These results indicate a statistically significant (at the 5% level) difference among the Li and Si average measurements over these blocks for the non-radioactive group and among the Li, Na, and Si average measurements over these blocks for the radioactive group. 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 blocks. Averaging the ppm's for each set of triplicates helps to minimize the impact of the ICP effects.

[5] The data presented in Table D.1 also contains the results of the RC glasses that are not discussed in this report.
[6] ND01 was identified using the supplemental information presented in Exhibit D.5 and Exhibit D.6.

Table 4-1 summarizes the average measurements and the reference values for the 4 elements. The results indicate consistent and accurate measurements from the SRTC-ML processes used to conduct these analyses.

Table 4-1. Results from Samples of the Multi-Element Solution Standard

PCT Group	Analytical Block	Avg B (ppm)	Avg Li (ppm)	Avg Na (ppm)	Avg Si (ppm)
Non-rad Group	1	21.2	9.8	84.9	50.1
	2	21.3	9.8	86.4	50.1
	3	21.3	9.9	86.9	50.3
	4	20.7	9.9	84.4	50.1
	5	20.9	9.7	88.3	50.1
	6	21.3	9.6	86.7	49.8
	7	20.9	9.6	86.7	49.9
	8	21.7	9.7	86.9	51
	9	21.9	9.5	84.5	51.6
	Grand Average	21.3	9.7	86.2	50.3
	Reference Value	20	10	81	50
	% difference	6.30%	-2.90%	6.40%	0.60%
Rad Group	1	21.0	9.2	82.6	50.4
	2	20.2	10.0	84.8	51.3
	3	20.0	10.0	86.4	50.4
	4	20.5	10.1	87.2	50.5
	5	20.4	9.9	85.3	49.7
	6	20.3	9.6	83.7	48.4
	7	20.5	9.7	84.9	49.1
	8	20.4	9.7	83.7	49.5
	9	20.4	9.5	82.4	48.9
	Grand Average	20.4	9.7	84.6	49.8
	Reference Value	20	10	81	50
	% difference	1.98%	-2.56%	4.39%	-0.42%

4.2.3 Measurements by Glass Number

Exhibits D.5 and D.6 provide plots of the leachate concentrations for each type of submitted sample: the standards (multi-element solution standard, EA, ARM, and blanks), centerline, canister-cooled ND glasses, and quenched ND glasses for both groups of PCTs. These plots allow for the assessment of the repeatability of the measurements, which suggests no obvious outliers among these data with the exception of the ND01 ppm values. As previous noted, one of the replicates for ND01 resulted in higher ppm values Na, B, Li, and Si. Given no adjustments to the data were made (e.g., that replicate was not removed prior to the normalization process), the results normalized releases could be inflated. However, the differences are of little practical concern.

4.2.4 Quenched versus Centerline-Cooled Results

Exhibits D.7 and D.8 provide a closer look at the quenched versus centerline-cooled PCT results for the ND glasses, including a statistical comparison of the average differences due to heat treatment for each element of interest. The first exhibit is in ppm while the second is in log ppm. These paired-t statistical tests indicate no statistically significant (at the 5% level) differences between the PCTs for the two heat treatments for any element of interest (i.e., B, Li, Na, and Si).

An additional look at the log NL [B (ppm)] values is provided in Figure 4-1, which provides a plot of the ccc versus quenched results for the ND glasses. Although no statistical difference is seen between the quenched and ccc average log NL [B(g/L)] results for these glasses, some of the individual glasses show differences between their quenched and ccc results. These glasses are labeled in Figure 4-1.

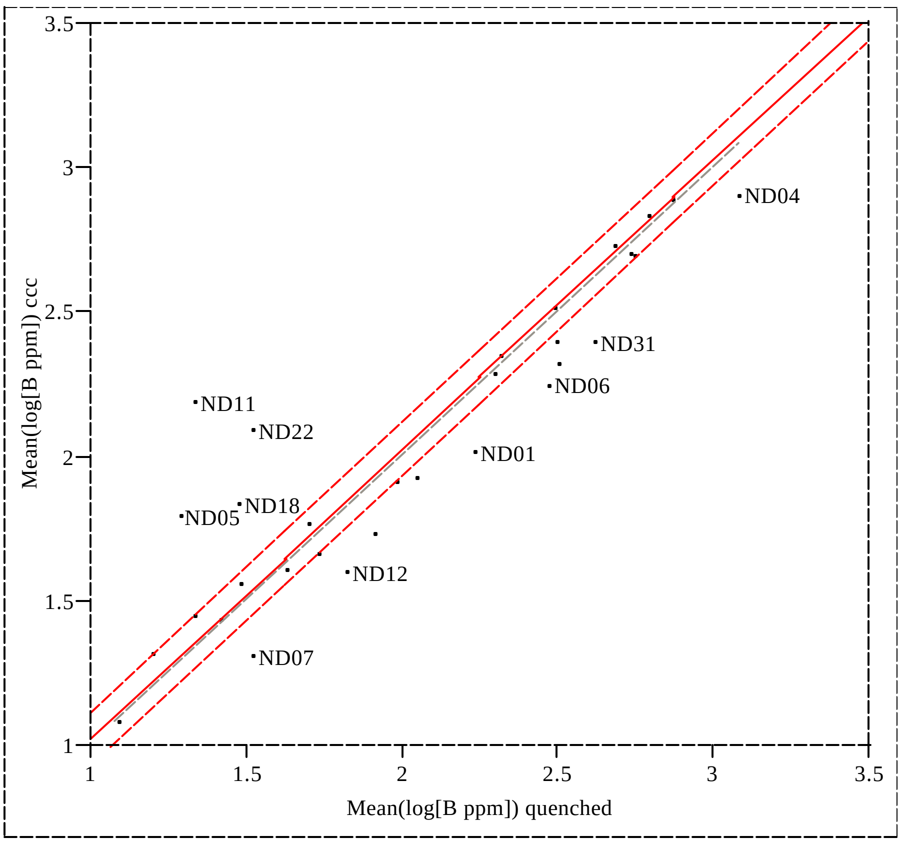

Figure 4-1. log [B (ppm)] for Quenched vs ccc Glasses

4.2.5 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 cation and the bias-corrected cation compositions will also be 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 will be determined and used for comparison. To accomplish this computation, one must

1. Determine the common logarithm of the elemental parts per million (ppm) leachate concentration for each of the triplicates and each of the elements of interest (these values are provided in Table D.1 of Appendix D),

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 D.9 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. Both quenched and ccc versions of the glasses are included in these scatter plots, and all normalizations of the PCTs (i.e., those generated using the targeted, measured, and bias-corrected compositional views) are represented as well.

Consistency in the leaching across the elements is typically demonstrated by a high degree of correlation among the values for pairs of these elements. A high degree of correlation is seen for these data for all pairs of the elements; the smallest correlation (~94%) is between Li and Si.

Table 4-2 summarizes the normalized PCTs for the glasses of this study.

Table 4-2. Normalized PCTs by Glass ID/Compositional View/Heat Treatment

		Results from quenched Glasses								Results from ccc Glasses							
Glass ID	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)	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	see [Jantzen et al. 1995]	-0.160	-0.193	-0.235	-0.519	0.692	0.641	0.583	0.303	-	-	-	-	-	-	-	-
ARM	see [Jantzen et al. 1995]	-0.230	-0.192	-0.240	-0.521	0.588	0.643	0.576	0.301	-	-	-	-	-	-	-	-
EA	see [Jantzen et al. 1995]	1.157	0.900	1.023	0.530	14.356	7.935	10.533	3.389	-	-	-	-	-	-	-	-
EA	see [Jantzen et al. 1995]	1.282	1.001	1.129	0.606	19.136	10.022	13.453	4.040	-	-	-	-	-	-	-	-
ND01	Measured	1.039	0.898	1.038	0.690	10.943	7.904	10.910	4.892	0.820	0.732	0.840	0.521	6.612	5.395	6.915	3.316
ND01	Measured bc	1.057	0.906	1.075	0.696	11.397	8.050	11.879	4.967	0.838	0.740	0.877	0.527	6.887	5.494	7.528	3.366
ND01	Targeted	1.049	0.920	1.045	0.690	11.187	8.310	11.103	4.899	0.830	0.754	0.847	0.521	6.760	5.672	7.037	3.320
ND02	Measured	0.928	0.808	0.748	0.275	8.478	6.432	5.598	1.884	0.956	0.842	0.782	0.323	9.043	6.949	6.058	2.104
ND02	Measured bc	0.933	0.814	0.777	0.259	8.562	6.520	5.980	1.815	0.961	0.848	0.811	0.307	9.133	7.044	6.471	2.026
ND02	Targeted	0.921	0.814	0.757	0.264	8.343	6.520	5.717	1.839	0.949	0.848	0.791	0.312	8.899	7.044	6.186	2.053
ND03	Measured	1.610	1.245	1.480	0.851	40.717	17.579	30.196	7.099	1.649	1.237	1.490	0.895	44.526	17.242	30.915	7.852
ND03	Measured bc	1.627	1.253	1.517	0.858	42.406	17.902	32.876	7.207	1.666	1.244	1.527	0.902	46.374	17.558	33.659	7.972
ND03	Targeted	1.607	1.246	1.494	0.851	40.446	17.612	31.198	7.096	1.646	1.237	1.504	0.895	44.232	17.274	31.942	7.849
ND04	Measured	1.524	1.284	1.275	0.716	33.419	19.246	18.849	5.197	1.345	1.130	1.118	0.603	22.136	13.500	13.114	4.013
ND04	Measured bc	1.528	1.290	1.306	0.702	33.751	19.509	20.239	5.034	1.349	1.136	1.149	0.590	22.356	13.685	14.081	3.887
ND04	Targeted	1.517	1.266	1.300	0.705	32.910	18.453	19.975	5.075	1.338	1.112	1.143	0.593	21.799	12.945	13.897	3.919
ND05	Measured	0.097	0.012	0.001	-0.291	1.249	1.028	1.002	0.511	0.609	0.502	0.212	-0.027	4.061	3.174	1.629	0.939
ND05	Measured bc	0.114	0.020	0.038	-0.285	1.300	1.047	1.091	0.519	0.626	0.510	0.249	-0.021	4.228	3.233	1.773	0.953
ND05	Targeted	0.099	0.012	0.032	-0.285	1.257	1.029	1.076	0.518	0.611	0.502	0.243	-0.021	4.086	3.178	1.749	0.952
ND06	Measured	1.295	1.135	1.151	0.967	19.734	13.653	14.157	9.267	1.071	0.941	0.939	0.770	11.773	8.734	8.686	5.885
ND06	Measured bc	1.313	1.143	1.188	0.974	20.551	13.903	15.414	9.408	1.088	0.949	0.976	0.776	12.260	8.895	9.458	5.975
ND06	Targeted	1.285	1.142	1.167	0.941	19.285	13.857	14.698	8.738	1.061	0.948	0.955	0.744	11.505	8.865	9.018	5.549
ND07	Measured	0.340	0.306	0.345	0.040	2.190	2.021	2.214	1.096	0.131	0.203	0.228	-0.116	1.351	1.595	1.689	0.766
ND07	Measured bc	0.358	0.314	0.382	0.046	2.280	2.059	2.411	1.113	0.148	0.211	0.265	-0.109	1.407	1.624	1.839	0.778
ND07	Targeted	0.331	0.304	0.366	0.039	2.143	2.013	2.323	1.095	0.121	0.201	0.249	-0.116	1.322	1.588	1.773	0.765
ND08	Measured	0.490	0.349	0.303	-0.316	3.093	2.235	2.007	0.483	0.372	0.252	0.197	-0.361	2.355	1.785	1.574	0.436
ND08	Measured bc	0.508	0.357	0.340	-0.310	3.221	2.276	2.186	0.490	0.390	0.260	0.234	-0.354	2.453	1.818	1.714	0.442
ND08	Targeted	0.476	0.353	0.320	-0.311	2.994	2.253	2.091	0.489	0.358	0.255	0.215	-0.355	2.280	1.800	1.640	0.441
ND09	Measured	-0.089	-0.172	0.171	-0.188	0.815	0.673	1.484	0.649	-0.099	-0.144	0.105	-0.216	0.796	0.717	1.275	0.607
ND09	Measured bc	-0.084	-0.166	0.200	-0.204	0.824	0.682	1.585	0.625	-0.095	-0.138	0.134	-0.233	0.804	0.727	1.362	0.585
ND09	Targeted	-0.097	-0.176	0.177	-0.198	0.800	0.667	1.504	0.633	-0.108	-0.148	0.111	-0.227	0.780	0.712	1.292	0.593
ND10	Measured	1.186	0.913	1.061	0.271	15.356	8.179	11.498	1.867	1.138	0.866	1.012	0.238	13.752	7.345	10.269	1.730
ND10	Measured bc	1.204	0.921	1.098	0.278	15.989	8.329	12.518	1.895	1.156	0.874	1.048	0.245	14.319	7.481	11.181	1.757
ND10	Targeted	1.178	0.914	1.084	0.275	15.060	8.202	12.132	1.886	1.130	0.867	1.035	0.243	13.487	7.367	10.836	1.748

		Results from quenched Glasses								Results from ccc Glasses							
Glass ID	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)	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)
ND11	Measured	0.161	0.205	0.184	-0.146	1.450	1.605	1.528	0.715	1.019	0.687	0.748	0.248	10.443	4.864	5.599	1.770
ND11	Measured bc	0.166	0.211	0.211	-0.164	1.465	1.627	1.624	0.685	1.023	0.693	0.775	0.230	10.547	4.931	5.952	1.696
ND11	Targeted	0.149	0.178	0.269	-0.155	1.408	1.507	1.859	0.699	1.006	0.660	0.833	0.238	10.138	4.567	6.810	1.731
ND12	Measured	0.645	0.535	0.529	0.147	4.413	3.425	3.382	1.404	0.423	0.373	0.368	0.014	2.648	2.358	2.334	1.033
ND12	Measured bc	0.656	0.536	0.563	0.150	4.525	3.433	3.658	1.414	0.434	0.373	0.402	0.017	2.715	2.363	2.524	1.040
ND12	Targeted	0.637	0.529	0.540	0.146	4.334	3.380	3.471	1.401	0.415	0.367	0.379	0.013	2.600	2.327	2.395	1.030
ND13	Measured	1.685	1.299	1.504	1.128	48.470	19.915	31.886	13.418	1.703	1.276	1.515	1.152	50.450	18.896	32.717	14.178
ND13	Measured bc	1.696	1.300	1.538	1.131	49.699	19.957	34.485	13.509	1.714	1.277	1.549	1.155	51.735	18.940	35.384	14.274
ND13	Targeted	1.685	1.294	1.512	1.124	48.381	19.687	32.508	13.294	1.702	1.271	1.523	1.148	50.359	18.682	33.356	14.047
ND14	Measured	0.772	0.696	0.826	0.373	5.914	4.969	6.692	2.363	0.707	0.642	0.765	0.320	5.097	4.387	5.817	2.090
ND14	Measured bc	0.783	0.697	0.860	0.376	6.064	4.980	7.238	2.379	0.718	0.643	0.799	0.323	5.225	4.396	6.291	2.104
ND14	Targeted	0.792	0.718	0.860	0.396	6.198	5.224	7.247	2.490	0.728	0.664	0.799	0.343	5.341	4.612	6.299	2.202
ND15	Measured	1.179	1.023	1.015	0.458	15.112	10.548	10.343	2.869	1.148	1.015	1.006	0.527	14.062	10.341	10.143	3.365
ND15	Measured bc	1.190	1.024	1.049	0.461	15.496	10.570	11.186	2.888	1.159	1.015	1.040	0.530	14.419	10.363	10.969	3.388
ND15	Targeted	1.166	1.024	1.032	0.453	14.649	10.559	10.764	2.836	1.135	1.015	1.023	0.522	13.631	10.353	10.556	3.326
ND16	Measured	0.015	0.083	0.207	-0.226	1.034	1.211	1.611	0.594	0.133	0.234	0.227	-0.184	1.359	1.715	1.685	0.655
ND16	Measured bc	0.019	0.089	0.238	-0.240	1.044	1.227	1.730	0.575	0.137	0.240	0.258	-0.197	1.372	1.738	1.809	0.635
ND16	Targeted	0.014	0.078	0.221	-0.233	1.032	1.197	1.665	0.585	0.132	0.229	0.241	-0.190	1.356	1.696	1.741	0.646
ND17	Measured	1.143	0.830	0.968	0.517	13.901	6.756	9.281	3.289	1.176	0.891	0.962	0.550	14.981	7.788	9.172	3.544
ND17	Measured bc	1.154	0.831	1.002	0.520	14.254	6.770	10.038	3.311	1.186	0.892	0.997	0.552	15.360	7.804	9.921	3.568
ND17	Targeted	1.132	0.826	0.988	0.514	13.540	6.703	9.723	3.264	1.164	0.888	0.983	0.546	14.592	7.726	9.609	3.518
ND18	Measured	0.282	0.204	0.189	-0.079	1.913	1.601	1.546	0.833	0.649	0.582	0.476	0.163	4.458	3.819	2.995	1.454
ND18	Measured bc	0.286	0.210	0.218	-0.095	1.932	1.623	1.651	0.803	0.653	0.588	0.505	0.146	4.503	3.870	3.200	1.401
ND18	Targeted	0.286	0.205	0.210	-0.090	1.931	1.603	1.623	0.812	0.653	0.582	0.498	0.152	4.499	3.822	3.146	1.418
ND19	Measured	1.255	1.000	1.132	0.752	17.972	9.996	13.555	5.651	1.158	0.910	1.029	0.667	14.380	8.124	10.690	4.645
ND19	Measured bc	1.265	1.001	1.166	0.755	18.428	10.018	14.661	5.690	1.169	0.911	1.063	0.670	14.745	8.142	11.561	4.676
ND19	Targeted	1.307	1.052	1.203	0.808	20.283	11.269	15.941	6.431	1.210	0.962	1.099	0.723	16.229	9.160	12.571	5.285
ND20	Measured	0.071	-0.036	0.083	-0.147	1.177	0.921	1.211	0.714	0.153	0.149	0.137	-0.111	1.424	1.410	1.371	0.775
ND20	Measured bc	0.082	-0.035	0.117	-0.144	1.207	0.923	1.310	0.718	0.164	0.150	0.171	-0.108	1.460	1.414	1.483	0.781
ND20	Targeted	0.011	-0.081	0.046	-0.197	1.027	0.830	1.112	0.635	0.094	0.104	0.100	-0.161	1.242	1.270	1.258	0.690
ND21	Measured	0.409	0.320	0.341	0.033	2.562	2.087	2.195	1.079	0.229	0.164	0.186	-0.088	1.694	1.460	1.533	0.816
ND21	Measured bc	0.413	0.325	0.372	0.019	2.589	2.116	2.357	1.045	0.233	0.170	0.216	-0.102	1.711	1.480	1.646	0.791
ND21	Targeted	0.401	0.279	0.369	0.022	2.520	1.903	2.340	1.052	0.222	0.124	0.213	-0.099	1.666	1.331	1.634	0.796
ND22	Measured	0.017	-0.022	0.022	-0.306	1.040	0.951	1.052	0.495	0.596	0.532	0.443	-0.066	3.946	3.403	2.773	0.858
ND22	Measured bc	0.022	-0.016	0.053	-0.319	1.051	0.964	1.130	0.479	0.601	0.538	0.474	-0.080	3.986	3.450	2.977	0.832
ND22	Targeted	0.003	-0.019	0.035	-0.318	1.007	0.957	1.085	0.480	0.582	0.535	0.456	-0.079	3.821	3.428	2.858	0.834

		Results from quenched Glasses								Results from ccc Glasses							
Glass ID	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)	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)
ND23	Measured	0.133	0.032	0.168	-0.129	1.359	1.076	1.472	0.742	0.152	0.062	0.106	-0.160	1.420	1.153	1.276	0.691
ND23	Measured bc	0.138	0.038	0.199	-0.143	1.373	1.091	1.581	0.719	0.157	0.068	0.137	-0.174	1.434	1.169	1.370	0.669
ND23	Targeted	0.124	0.022	0.184	-0.137	1.332	1.052	1.527	0.730	0.143	0.052	0.122	-0.168	1.391	1.127	1.324	0.680
ND24	Measured	0.411	0.305	0.309	0.068	2.574	2.018	2.035	1.170	0.480	0.398	0.392	0.141	3.020	2.498	2.469	1.385
ND24	Measured bc	0.415	0.311	0.337	0.052	2.600	2.046	2.174	1.127	0.484	0.403	0.421	0.125	3.050	2.532	2.637	1.334
ND24	Targeted	0.403	0.294	0.332	0.057	2.528	1.966	2.145	1.141	0.472	0.386	0.415	0.130	2.966	2.433	2.603	1.350
ND25	Measured	0.053	-0.064	0.068	-0.241	1.131	0.862	1.170	0.573	0.169	0.061	0.138	-0.174	1.476	1.151	1.374	0.669
ND25	Measured bc	0.058	-0.058	0.095	-0.260	1.142	0.874	1.244	0.549	0.174	0.067	0.164	-0.193	1.491	1.167	1.460	0.641
ND25	Targeted	0.040	-0.074	0.067	-0.260	1.096	0.844	1.168	0.550	0.156	0.052	0.137	-0.193	1.432	1.127	1.371	0.642
ND26	Measured	1.023	0.852	0.878	0.549	10.555	7.117	7.545	3.537	1.014	0.847	0.864	0.552	10.330	7.030	7.309	3.567
ND26	Measured bc	1.028	0.858	0.904	0.530	10.661	7.214	8.020	3.389	1.018	0.853	0.890	0.534	10.434	7.125	7.770	3.418
ND26	Targeted	1.004	0.839	0.880	0.532	10.090	6.895	7.592	3.403	0.995	0.833	0.867	0.536	9.875	6.810	7.355	3.432
ND27	Measured	1.178	0.993	1.029	0.577	15.062	9.831	10.695	3.773	1.228	1.033	1.079	0.628	16.907	10.801	11.994	4.244
ND27	Measured bc	1.182	0.999	1.056	0.558	15.214	9.966	11.369	3.615	1.232	1.039	1.105	0.609	17.077	10.950	12.750	4.066
ND27	Targeted	1.170	0.997	1.037	0.568	14.778	9.928	10.880	3.701	1.220	1.038	1.086	0.619	16.588	10.909	12.202	4.164
ND28	Measured	0.998	0.885	0.891	0.518	9.953	7.674	7.784	3.299	0.816	0.711	0.712	0.392	6.551	5.144	5.153	2.464
ND28	Measured bc	1.002	0.891	0.920	0.502	10.052	7.780	8.317	3.178	0.821	0.717	0.741	0.375	6.617	5.215	5.505	2.374
ND28	Targeted	0.992	0.872	0.921	0.512	9.810	7.441	8.328	3.250	0.810	0.698	0.741	0.385	6.457	4.988	5.512	2.427
ND29	Measured	0.449	0.329	0.391	0.119	2.813	2.132	2.459	1.314	0.380	0.274	0.325	0.079	2.397	1.880	2.112	1.200
ND29	Measured bc	0.453	0.335	0.417	0.100	2.841	2.161	2.614	1.259	0.384	0.280	0.351	0.061	2.421	1.906	2.245	1.150
ND29	Targeted	0.438	0.324	0.397	0.103	2.742	2.108	2.495	1.269	0.369	0.269	0.331	0.064	2.337	1.859	2.143	1.159
ND30	Measured	0.244	0.164	0.218	-0.088	1.755	1.458	1.653	0.817	0.225	0.133	0.163	-0.105	1.679	1.360	1.455	0.785
ND30	Measured bc	0.249	0.170	0.245	-0.106	1.773	1.478	1.758	0.783	0.229	0.139	0.189	-0.124	1.696	1.378	1.547	0.752
ND30	Targeted	0.336	0.038	0.258	-0.129	2.168	1.093	1.811	0.743	0.317	0.008	0.202	-0.146	2.074	1.019	1.594	0.714
ND31	Measured	1.320	1.083	1.146	0.715	20.882	12.097	13.999	5.190	1.103	0.888	0.958	0.575	12.682	7.721	9.073	3.761
ND31	Measured bc	1.324	1.089	1.177	0.701	21.097	12.262	15.031	5.028	1.108	0.894	0.989	0.561	12.813	7.827	9.742	3.643
ND31	Targeted	1.220	1.199	1.139	0.733	16.582	15.824	13.764	5.409	1.003	1.004	0.950	0.593	10.071	10.101	8.920	3.919

There are numerous comparisons that could be made from the results presented in Table 4-2. For convenience, the following discussion will divide the 31 glasses into 4 sets to aid in the analysis of the results. The four sets will be based on the strategy used during the glass selection process: (1) OL EVs, (2) IL EVs, (3) MIL EVs, and (4) the centroid. In addition, comparisons to be focused on will center on the objective of the task – to identify potential conservatism in the ΔG_P model which could allow for higher alkali glasses to be targeted while meeting the WAPS product performance specifications. In the discussions that follow, only the quenched values for the ND glasses will be evaluated given the higher potential for the formation of crystallization in the ccc versions which would render the ΔG_P model inapplicable.

4.2.5.1 OL EVs

Table 4-3 summarizes the predicted properties, measured NL [B] (based on target composition), target Al_2O_3, and target sum of alkali values for the quenched OL EVs glasses (ND01 through ND20). As noted by the "Property PAR Status", 11 of the 20 OL EV-based glasses are predicted to be "non-durable" by the current model. Based on the definition of "acceptable" as defined by Edwards and Brown (1998) (e.g., log NL [B] < 1.0 or NL [B] < 10 g/L), the measured NL [B] values (quenched versions only) indicate that 5 (ND01, 03, 04, 13, and 15) of the 11 were "classified" correctly. That is, the current ΔG_P model predicted these five glasses to be "non-durable" and the measured responses exceeded the 10-g/L criteria. All five glasses targeted the minimum Al_2O_3 concentration of 3.0 wt% with the sum of alkali contents ranging from 14.6% – 26.6%. ND04 and ND15 were also classified as inhomogeneous but met the proposed alternative constraints of > 3% Al_2O_3 and < 19.3% sum of alkali and still resulted in a "non-durable" product. At the PAR, the only constraint that would have restricted these two glasses from being processed in DWPF would be the ΔG_P model. It should be mentioned that the application of the measurement uncertainty for Al_2O_3 would have also restricted these glasses from being processed. ND01, ND03, and ND13 (all three predicted and measured to be non-durable) also target the minimum Al_2O_3 concentration of 3% and have sum of alkali contents ranging from 22.3% – 26.7%. The data suggest that coupling the low Al_2O_3 contents with the higher sum of alkali values can result in non-durable products which is consistent with the observations by Edwards and Brown (2002) and formed the basis for the alternative constraints for homogeneity they established.

Although five of the eleven glasses were classified correctly, six (ND02, 05, 09, 12, 14, and 18 which are shaded in Table 1-1) of the predicted "non-durable" glasses were misclassified. That is, their measured NL [B] releases were acceptable although they were predicted to be "non-durable". With respect to the task objectives, the sums of alkali for these six glasses range from a target of 14.9% (ND18) – 25.3% (ND14) in glass. The Al_2O_3 target values for these six glasses range from a minimum of 3.0% (ND02, 12, and 18) to a high of 13.48% (ND05).

The PCT responses for ND05, ND09, and ND18 that indicate that these glasses are highly durable (i.e., NL [B] < 2 g/L) and are in-line with glasses previously and currently being made in DWPF. ND09 and ND05 have targeted alkali concentrations of 22.1% and 19.7%, respectively. The high durability of these two glasses may be attributed to the higher Al_2O_3 content, 9.15% and 4.93%, respectively. In the case of ND18, although predicted to be a non-durable glass, the measured NL [B] was 1.931 g/L which was likely a result of the low total alkali content (14.9%) given the minimum Al_2O_3 concentration (3%). Although predicted to be inhomogeneous, ND18 meets the alternative constraints proposed by Herman et al. (2002) to replace the homogeneity constraint.

These data suggest that the combination of alkali and Al_2O_3 can have a significant role in determining the PCT response of multi-component glasses. This does not imply that these two components are the only contributors to durability but that they are key to ensuring a durable product is produced. These data also indicate that higher alkali glasses can meet current WAPS durability criteria – in line with observations by Feng et al. (1996) for Hanford LAW glasses.

Given that both successful and unsuccessful classifications occurred over essentially the same range of alkali and Al_2O_3 concentrations, these data also suggest that other components or component interactions should be considered in the classification process. These data are consistent with the observations by Peeler and Edwards (2003) that there appears to be interactive effects in the data that are not accounted for by the model leading to conservatism in the predictions. If these higher alkali systems do provide advantages for melt rate, waste loading, and/or waste throughput, then the current durability model would not have allowed these six glasses to be processed in DWPF – although their measured NL [B] values are acceptable.

Nine of the 20 OL EV-based glasses were predicted to be "durable" by the current model. Based on the measured NL [B] values, five of the glasses (ND07, 08, 11, 16, and 20) meet the 10-g/L criteria for "acceptability". Three (ND08, 16, and 20) of the five glasses have Al_2O_3 contents of 10.89% or higher with sum of alkali contents ranging from 17.5% to 22.6%. Of particular interest are ND16 and ND20 with total alkali contents of 21.3% and 22.6%, respectively. With NL[B] of 1.032 and 1.027 g/L, respectively, these glasses provide additional incentive to target higher alkali systems in support of the accelerated clean-up mission. A key common denominator between these glasses is the high Al_2O_3 concentration (10.89% and 11.45%, respectively). These data also suggest that as alkali contents are increased, higher Al_2O_3 concentrations may be required to meet current durability requirements. It should be noted that the results of ND11 should be viewed cautiously given the potential batching issues discussed in the previous section.

Four glasses (ND06, 10, 17, and 19) were predicted to be "durable" but the measured PCT response indicated they were unacceptable (e.g., > 10 g/L). This "misclassification" is perhaps of most concern given the current model would allow these glasses to be processed yet they were not durable when formally measured. It should be noted that only one (ND06) of these four glasses actually met all the PAR criteria. ND10 and ND17 failed the viscosity and T_L model predictions, respectively. ND19 failed both viscosity and T_L model predictions. Application of measurement uncertainties would most likely keep ND06 from being processed in DWPF. A key common denominator for these glasses is a low Al_2O_3 (target of 3.0 wt%) – note that application of the Al_2O_3 MAR may also restrict these glasses from being processed in DWPF.

As previously mentioned, based on targeted compositions, the ΔG_P values of the ND glasses range from -22.3 for ND01 to -12.708 for ND07 and ND10 (the OL EVs bound the ΔG_P values). To put this in perspective, the current SME Acceptability limit for durability in PCCS is approximately -12.78 kcal/mol with EA having a predicted ΔG_P value of approximately -15.52 kcal/mol. Of the six of the ND glasses that have ΔG_P values more negative than EA, only ND02 and ND14 were acceptable (8.343 g/L and 6.198 g/L, respectively). ND14 is of particular interest given the sum of alkali targets 25.3%. Although this glass has a more negative ΔG_P value than the EA glass, its release is approximately ½ that of EA. The difference probably resides in the interactions among the various oxides (e.g., the relatively high Al_2O_3 content) and their concentrations or redox differences (see Peeler and Edwards 2003b for more details).

Another interesting comparison is the PCT response from ND07 and ND10 that have essentially the same ΔG_P value (-12.708 kcal/mol). The PCT response from the ND07 and ND10 are quite different – 2.143 g/L versus 15.060 g/L. In terms of composition both target a low Al_2O_3 content (3.0 wt%), and with ND07 targeting a higher total alkali content, ND07 would be expected to result in a lower durability product. Since this was not the case, additional insight is provided into the complexity of the multi-component systems and the possible interactions that ultimately define the overall durability.

Again, numerous comparisons could be made among these data. With respect to the task objectives, these glasses add incentive that access to higher alkali systems does exist but a more fundamental understanding of the interactions among the components is required. More specifically, glasses were made as part of this study with relatively high alkali content (up to 25.3%) while maintaining the integrity of the product as measured by the PCT. This is in line with the high alkali glasses that are being developed for the Hanford LAW program. If a more fundamental understanding were attained, access to a larger compositional region of interest could be accessed in support of the accelerated mission goals.

Table 4-3. Measured Durability and Various Compositional Information for the OL EVs Glasses.[7]

ID	Property PAR Status	NL [B] (g/L)	Σalkali	Al_2O_3
ND01	Not Durable; Not Visc; T_L; Not Homo; New T_L; Al_2O_3; Not alkali	11.187	0.266	0.0300
ND02	Not Durable; Not Visc; T_L; Not Homo; New T_L; Al_2O_3; Not alkali	8.343	0.195	0.0300
ND03	Not Durable; Not Visc; T_L; Not Homo; New T_L; Al_2O_3; Not alkali	40.446	0.223	0.0300
ND04	Not Durable; Visc; T_L; Not Homo; New T_L; Al_2O_3; alkali	32.910	0.174	0.0300
ND05	Not Durable; Visc; T_L; Homo; New T_L; Al_2O_3; Not alkali	1.257	0.197	0.1348
ND06	Durable; Visc; T_L; Not Homo; New T_L; Al_2O_3; Not alkali	19.285	0.210	0.0301
ND07	Durable; Not Visc; T_L; Not Homo; New T_L; Al_2O_3; Not alkali	2.143	0.198	0.0300
ND08	Durable; Visc; T_L; Not Homo; New T_L; Al_2O_3; alkali	2.994	0.175	0.1119
ND09	Not Durable; Visc; T_L; Not Homo; New T_L; Al_2O_3; Not alkali	0.800	0.221	0.0915
ND10	Durable; Not Visc; Not T_L; Homo; New T_L; Al_2O_3; alkali	15.060	0.172	0.0300
ND11	Durable; Not Visc; T_L; Not Homo; New T_L; Al_2O_3; alkali	1.408	0.150	0.0300
ND12	Not Durable; Not Visc; Not T_L; Homo; New T_L; Al_2O_3; Not alkali	4.334	0.200	0.0300
ND13	Not Durable; Not Visc; T_L; Not Homo; Not New T_L; Al_2O_3; Not alkali	48.381	0.267	0.0300
ND14	Not Durable; Not Visc; T_L; Not Homo; Not New T_L; Al_2O_3; Not alkali	6.198	0.253	0.0493
ND15	Not Durable; Visc; T_L; Not Homo; Not New T_L; Al_2O_3; alkali	14.649	0.146	0.0300
ND16	Durable; Visc; T_L; Homo; Not New T_L; Al_2O_3; Not alkali	1.032	0.213	0.1089
ND17	Durable; Visc; T_L; Not Homo; Not New T_L; Al_2O_3; alkali	13.540	0.164	0.0300
ND18	Not Durable; Visc; T_L; Not Homo; Not New T_L; Al_2O_3; alkali	1.931	0.149	0.0300
ND19	Durable; Not Visc; Not T_L; Homo; Not New T_L; Al_2O_3; alkali	20.283	0.176	0.0300
ND20	Durable; Not Visc; T_L; Homo; New T_L; Al_2O_3; Not alkali	1.027	0.226	0.1145

4.2.5.2 IL EVs

These five ND glasses were based on the more conservative compositional range (20% reduction in the minimum and maximum bounds for each major glass component). All five of the IL EV-based glasses were predicted to be "non-durable" by the current ΔG_P model with three of the five glasses having targeted alkali contents greater than 20 wt%. It should be noted that ND21 also fails with respect to the applied T_L model limit. Regardless of their model-based classification,

[7] The NL [B] values shown are based on targeted compositions.

all of the measured NL [B] values are acceptable (see Table 4-4). In fact, ND-24 is the least durable product observed with a measured NL [B] of 2.538 g/L (compared to 16.695 for EA or the 10 g/L acceptance criteria being used in this report). With targeted alkali contents ranging from 17.6 (ND22) – 21.0% (ND25) in glass, these glasses also provide incentive that higher alkali containing glasses could be made in DWPF to support the accelerated mission – assuming issues associated with durability predictions were addressed. All of the IL EV-based glasses target a relatively high Al_2O_3 content of 5.4% or greater. This may indicate that setting a higher minimum Al_2O_3 limit may allow for higher alkali glasses to be targeted while ensuring a durable product at a high confidence level. Again, it should be noted that both alkali and Al_2O_3 are a primary focus of this discussion but other components and interactions are also critical in determining the ultimate durability of the waste form.

Table 4-4. Measured Durability and Various Compositional Information for the IL EVs Glasses.

ID	Property PAR Status	NL [B] (g/L)	Σalkali	Al_2O_3
ND21	Not Durable; Visc; T_L; Not Homo; Not New T_L; Al_2O_3; Not alkali	2.520	0.194	0.0540
ND22	Not Durable; Visc; T_L; Not Homo; New T_L; Al_2O_3; alkali	1.007	0.176	0.0540
ND23	Not Durable; Visc; Not T_L; Homo; New T_L; Al_2O_3; Not alkali	1.332	0.201	0.0540
ND24	Not Durable; Visc; T_L; Not Homo; New T_L; Al_2O_3; alkali	2.528	0.191	0.0540
ND25	Not Durable; Visc; T_L; Homo; New T_L; Al_2O_3; Not alkali	1.096	0.210	0.1025

4.2.5.3 MIL EV Glasses

The MIL EV-based glasses (ND26 through ND30) were also selected from the more conservative compositional region but used an additional constraint to restrict the compositional pool from which EVs could be based. More specifically, these glasses were restricted to $3 \leq$ wt% $Al_2O_3 \leq 3.9$ and a total alkali ($Na_2O + Li_2O$) >19.3 wt%. The intent of these glasses was to assess the Al_2O_3-Al_2O_3+R_2O criteria proposed by Herman et al. (2002). These glasses would not be classified as processable based on the alternative constraints proposed by Herman et al. (2002) and because of the assumed high probability of producing a non-durable glass. However, they would allow an assessment if higher alkali systems, with relatively low Al_2O_3 contents, could be implemented in DWPF. It should be reiterated that these glasses would not be processable in DWPF given the use of the current ΔG_P model and the PCCS constraints.

Table 4-5 summarizes the measured NL [B] values along with other critical compositional information. Again, note that all of the glasses were predicted to be "non-durable" by the current model. The measured NL [B] release values suggest that ND26 and ND27 were in fact "unacceptable" (> 10 g/L). The PCT response of ND28, ND29, and ND30 indicate that these glasses are acceptable, although ND28 is extremely close to the 10-g/L criteria. Given the uncertainty with respect to the ND30 sample (i.e., a possible switch with ND31), the results should be used with caution. In fact, a closer review of the compositions and NL [B] results (see Table 4-6) suggest that these glasses were switched during the fabrication process. The column labeled "measured switched" assumes that the glasses were switched during the fabrication process. With this assumption, the target and measured oxides values are in general agreement.

The NL [B] release values reported for these two glasses are 2.168 (ND30) and 16.582 g/L (ND31) – a significant difference. Based on the targeted compositions (and results shown thus far for the ND glasses), it would be expected that the higher Al_2O_3 (5.69%) and lower sum of alkali (18.9%) content of ND31 would produce a more durable glass – the 2.168 g/L result not the 16.582 g/L result. Therefore, ND30 with higher measured Al_2O_3 would correspond to the lower PCT response and ND31 with the lower measured Al_2O_3 would correspond to the higher PCT response. This supports the switch occurring during fabrication as opposed to upon chemical composition submittal. Given this assumption, the durability results of ND30 and ND31 as targeted would also be misrepresented. Thus, the PCT results for the measured ND31 are truly representative of the target ND30 glass, and the ND30 target glass would also be classified as "non-durable" which would add support to the use of the Al_2O_3 and sum of alkali constraints proposed by Herman et al. (2002). This being the case, ND29 would be the only MIL EV that would "challenge" the alternative criteria indicating that other components or interactions may not be accounted for in this durable product.

Table 4-5. Measured Durability and Various Compositional Information for the MIL EVs Glasses.

ID	Property PAR Status	NL [B] (g/L)	Σalkali	Al_2O_3
ND26	Not Durable; Visc; T_L; Not Homo; New T_L; Al_2O_3; Not alkali	10.090	0.214	0.0300
ND27	Not Durable; Visc; T_L; Not Homo; Not New T_L; Al_2O_3; Not alkali	14.778	0.197	0.0300
ND28	Not Durable; Visc; T_L; Not Homo; New T_L; Al_2O_3; Not alkali	9.810	0.194	0.0300
ND29	Not Durable; Visc; Not T_L; Homo; New T_L; Al_2O_3; Not alkali	2.742	0.195	0.0300
ND30	Not Durable; Visc; T_L; Not Homo; Not New T_L; Al_2O_3; Not alkali	2.168	0.195	0.0300

Table 4-6. Compositional and Property Information for ND30 and ND31.

Glass	Oxide	Measured	Measured Switched	Targeted	NL [B] (g/L)	Σalkali (target)
ND30	Al_2O_3	5.7252	3.2925	3.0000	2.168	0.195
ND30	B_2O_3	7.9049	6.4398	6.4000		
ND30	CaO	2.4347	1.2670	1.2000		
ND30	Cr_2O_3	0.1153	0.0680	0.0528		
ND30	Fe_2O_3	6.5322	6.7077	7.6000		
ND30	Li_2O	4.6449	6.2919	6.2000		
ND30	MgO	1.8182	3.1247	3.2000		
ND30	MnO	4.9390	1.9415	2.0000		
ND30	Na_2O	14.5153	13.8925	13.2500		
ND30	NiO	2.1360	3.7206	3.9700		
ND30	P_2O_5	0.4170	0.2086	0.1997		
ND30	SiO_2	41.8838	45.0590	46.0300		
ND30	ThO_2	0.1055	0.1742	0.0000		
ND30	TiO_2	0.8247	0.3532	0.3500		
ND30	U_3O_8	3.8958	6.3041	6.4000		
ND30	ZrO_2	0.0304	0.0068	0.0192		
ND30	Sum of Oxides	97.9227	98.8520	99.8717		
					NL [B] (g/L)	Σalkali (target)
ND31	Al_2O_3	3.2925	5.7252	5.6900	16.582	0.189
ND31	B_2O_3	6.4398	7.9049	8.1100		
ND31	CaO	1.2670	2.4347	2.3200		
ND31	Cr_2O_3	0.0680	0.1153	0.1216		
ND31	Fe_2O_3	6.7077	6.5322	6.9800		
ND31	Li_2O	6.2919	4.6449	4.8100		
ND31	MgO	3.1247	1.8182	1.8400		
ND31	MnO	1.9415	4.9390	4.8200		
ND31	Na_2O	13.8925	14.5153	14.1300		
ND31	NiO	3.7206	2.1360	2.3300		
ND31	P_2O_5	0.2086	0.4170	0.4601		
ND31	SiO_2	45.0590	41.8838	43.2400		
ND31	ThO_2	0.1742	0.1055	0.0000		
ND31	TiO_2	0.3532	0.8247	0.8300		
ND31	U_3O_8	6.3041	3.8958	3.9800		
ND31	ZrO_2	0.0068	0.0304	0.0442		
ND31	Sum of Oxides	98.8520	97.9227	99.7059		

4.2.5.4 Centroid-Based Glass

ND31 is the centroid of the more conservative compositional region. Based on the target composition, it is predicted to be a non-durable glass. Given the discussion in the previous section (see Table 4-6 for more details), the probability of a switch with ND30 is high. Assuming this is the case, the NL [B] release for the ND31 target (reported as fabricated ND30 in previous tables) would be 2.168 g/L. Again, based on the relatively high Al_2O_3 concentration, and the results presented thus far for the ND glasses, this response is reasonable. This adds to the list of glasses that challenge the existing durability model.

4.2.6 Predicted versus Measured PCTs

Although the focus of this report has been on "acceptability" of the PCT response, insight into the applicability or predictability of the model is also of interest. Predictability is based on the 95% two-sided confidence interval for an individual PCT response as generated by the THERMO™ ΔG_P model (Jantzen et al. 1995). This definition is consistent with that used in recent variability studies (e.g., Harbour et al. 2000; Herman et al. 2001). The durability of a glass is considered predictable if its PCT response is within the 95% confidence interval.

Exhibit D.10 provides plots of the DWPF models that relate the logarithm of the normalized PCT (for each element of interest) to a linear function of a free energy of hydration term (ΔG_P, kcal/g glass) derived from all of the glass compositional views (Jantzen et al. 1995). The open circles ("o") represent the quenched glasses, while the pluses ("+") represent the ccc versions. 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 also indicated on these plots. Exhibit D.11 shows these same results plotted for each individualstudy glass.

Given the higher potential for crystallization to have occurred in the ccc samples, the following discussion will focus solely on the predictability of (or applicability of the model to) the quenched glasses (represented by a "+" in Appendix D.11.) Of the 31 glasses (or 93 different compositional views), approximately ½ of the ND glasses (18 of the 31) were predictable by the current model based on all three compositional views. An additional 5 were predictable for at least two of the three compositional views.

Of the 8 glass systems in which the model was not applicable (i.e., the durabilities were not predictable), only two of the decisions were on the "conservative" side. That is, the model would predict a release that was higher than the actual measurement. For the other 6 glasses, the model was not conservative (i.e., the actual releases are greater than predicted by the model) – a condition which should be avoided. Continued use of the current model and its associated ΔG_P SME acceptability limit would avoid this scenario. However, the data suggests that using either the current model and/or the SME acceptability cut-off limit for ΔG_P does restrict access to compositional regions of highly durable or acceptable glasses.

5.0 Summary

In support of accelerated mission goals, glass formulation efforts have been focused on melt rate, waste loading, and waste throughput for the DWPF. With respect to melt rate, the general trend to improve melt rate has been to enhance the total alkali concentration in the glass system by increasing the alkali concentration in the frit, utilizing (or targeting) a less washed sludge, or using a combination of the two (Lambert et al. 2001). In order to more readily access these types of systems, an assessment of the PCT response in high alkali regions was needed. Thirty-one glasses were selected (Cozzi et al. 2002) that intentionally challenged either the current durability model or the Σalkali and Al_2O_3 criteria proposed by Herman et al. (2002) over an extremely broad compositional region. These glasses were batched, melted, and subjected to the PCT.

The objective of this task was to generate PCT /glass composition data in a potentially bounding compositional region of interest to DWPF to identify whether incentive exists to target higher alkali systems. Specifically, 31 glasses were targeted that challenged the current durability model predictions in the higher alkali regions in an effort to identify potential conservatism in the model. If such conservatism were identified, the incentive to explore this region would be established since the higher alkali systems could improve melt rate, waste loading, and/or waste throughput for DWPF.

The following conclusions are made based on the experimental results:

Composition Analysis

Overall, the comparisons between the measured and targeted compositions suggest that targeted compositions were obtained. However, the results do indicate there were some difficulties in batching or compositional measurements associated with ND11, ND14, and ND19, while ND30 and ND31 were more than likely switched during some point of the fabrication or testing program. The results suggest that the switch occurred during the fabrication process based not only on the measured compositions but also from a glass science perspective in terms of the PCT response.

PCT Assessment

The PCT data suggest that the combination of alkali and Al_2O_3 can have a significant role in determining the PCT response of multi-component glasses. Although a primary focus, this does not imply that these two components are the only contributors to durability (quite the contrary) but that they are key to ensuring a durable product is produced. The latter statement is based on the fact that both successful and unsuccessful classifications occurred over essentially the same range of alkali and Al_2O_3 concentrations, which suggests that consideration of these interactions may reduce the conservatism in the current model. The data also suggest that setting a higher minimum Al_2O_3 limit may allow for higher alkali glasses to be targeted while ensuring a durable product at a high confidence level.

With respect to the task objectives, the data do indicate that higher alkali glasses can be produced that meet current WAPS durability criteria. More specifically, glasses were made as part of this study with relatively high alkali content (up to 25.3%) while maintaining the integrity of the product as measured by the PCT. This is in line with the high alkali glasses that are being developed for the Hanford LAW program. The 25.3% alkali content is dramatically higher than current upper alkali targets, which implies that increases in alkali content in the frit, transitioning to a less washed sludge, or a combination of the two can be achieved.

If these higher alkali systems provide advantages in terms of melt rate, waste loading, and/or waste throughput, the ND results provide incentive that access to higher alkali systems does exist. However, a more fundamental understanding of the interactions among glass components is required to support the accelerated mission goals. The latter statement is based on the fact that the current durability model would not have allowed the majority of the high-alkali glasses in this study to be processed strictly from a ΔG_P perspective – although measured NL [B] values were acceptable for a portion of the glasses.

It should be noted that until a more fundamental understanding is in place, continued use of the current model and its associated ? G_p SME acceptability limit would avoid the production of "non-durable" glasses. However, the data do suggest that continuing to use either the current model and/or the SME acceptability cut-off limit for ΔG_P will restrict access to compositional regions of interest.

6.0 Recommendations

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

(1) Evaluate the potential to "redefine" the SME acceptability ΔG_P limit.
As currently established, excessive conservatism is believed to be factored into this limit that could potentially restrict the DWPF from accessing specific compositional regions that may be of interest. Redefining the limit may allow for higher alkali glasses to be processed while maintaining, at a high confidence level, the ability to produce a durable product. It should be noted that coupling a "shift" in the ΔG_P limit to a more negative value with an increased lower Al_2O_3 limit may be required to allow processing of certain systems (e.g., Frit 304/SB2).

(2) Assess the potential for alternative approaches to durability assessment.
Approaches to be considered include the use of empirical models (for well-known compositional regions) or non-model based approaches such as non-parametric studies or the definition of an acceptable glass composition region using the existing database.

(3) Assess the possibility of coupling a higher minimum Al_2O_3 with other single component constraints to define an acceptable glass composition region in which access to higher alkali content glasses could be obtained.

Although challenging, these approaches could potentially have a high payoff in terms of waste throughput for DWPF especially if it is shown that an improved melt rate would be gained.

In accordance with the goal of higher alkali systems, DWPF Process Engineering (DWPF PE) issued a Technical Task Request (TTR) requesting the Savannah River Technology Center (SRTC) to assess alternative durability options that may provide access to compositional regions of interest in support of the accelerated clean-up mission (Occhipinti 2003). In response to the TTR, Peeler and Edwards (2003c) outlined four alternatives that could potentially be implemented in the DWPF process control strategy and provide a technical basis for achieving accelerate mission goals.

The four options outlined were:

(1) reassessing and/or redefining the current ΔG_P limit in PCCS (model-based),
(2) a non-parametric approach (non-model based),
(3) an empirical modeling approach (model-based), and
(4) defining an Acceptable Glass Composition Region (AGCR) (non-model based).

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7.0 References

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

Brown KG, CM Jantzen, and G Ritzhaupt. 2001. *Relating Liquidus Temperature to Composition for Defense Waste Processing Facility (DWPF) Process Control*, WSRC-TR-2001-00520, Westinghouse Savannah River Company, Aiken, SC.

Brown, KG, RL Postles, and TB Edwards, 2002. *SME Acceptability Determination for DWPF Process Control*, WSRC-TR-95-0364, Revision 4, Westinghouse Savannah River Company, Aiken, South Carolina.

Cozzi, AD. 2002. *Task Technical and QA Plan: PCT Assessment*, WSRC-RP-2002-00269, Rev. 0, Westinghouse Savannah River Company, Aiken, South Carolina.

Cozzi, AD, KG Brown, DK Peeler, and TB Edwards. 2002. *Selecting Compositions for the Phase 1 of the PCT Assessment Study,* WSRC-RP-2002-00297, Rev. 0, Westinghouse Savannah River Company, Aiken, South Carolina.

Cozzi, AD, TB Edwards. DK Peeler, and DR Best. 2003. *The Impact of Redox on Durability for Sludge Batch 2: Part II. Experimental Results and Recommendations*, WSRC-TR-2003-00246, Revision 0, Westinghouse Savannah River Company, Aiken, South Carolina.

Edwards TB, and KG Brown. 1998. *Evaluating the Glasses Batched for the Tank 42 Variability Study (U),* SRT-SCS-98-017, Revision 0, Westinghouse Savannah River Company, Aiken, South Carolina.

Feng, X, PR Hrma, JH Westsik, NR Brown, MJ Schweiger, H Li, JD Vienna, G Chen, GF Piepel, DE Smith, BR McGrail, SE Palmer, DS Kim, Y Peng, WK Hahn, AJ Bakel, WL Ebert, DK Peeler, C Chang. 1996. *Glass Optimization for Vitrification of Hanford Site Low-Level Tank Waste*, PNNL-10918, Pacific Northwest National Laboratory, Richland, Washington.

Herman, CC, TB Edwards, DR Best, DM Marsh, and RJ Workman. 2002. *Reduction of Constraints: Phase 2 Experimental Assessment for Sludge-Only Processing*, WSRC-TR-2002-00482, Rev. 0, Westinghouse Savannah River Company, Aiken, South Carolina.

Herman, CC, TB Edwards, and DM Marsh. 2001. *Summary of Results for the Expanded Macrobatch 3 Variability Study*, WSRC-TR-2001-00511, Revision 0, Westinghouse Savannah River Company, Aiken, South Carolina.

Herman, CC, KG Brown, DK Peeler, and TB Edwards. 2002. Selecting Glass Compositions for Phase 2 of the Reduction of Constraints Study, WSRC-RP-2002-00236, Revision 0, , Westinghouse Savannah River Company, Aiken, South Carolina.

Jantzen CM, NE Bibler, DC Beam, CL Crawford, and MA Pickett. 1993. *Characterization of the DWPF Environmental Assessment (EA) Glass Standard Reference Material (U)*, WSRC-TR-92-346, Rev. 1, Westinghouse Savannah River Company, Aiken, SC.

Jantzen, CM, JB Pickett, KG Brown, TB Edwards, and DC Beam. 1995. *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)*, WSRC-TR-93-672, Revision 1, Volume 1, Westinghouse Savannah River Company, Aiken, South Carolina.

Lambert, DP, TH Lorier, DK Peeler, and ME Stone. 2001. *Melt Rate Improvement for DWPF MB3: Summary and Recommendations*, WSRC-TR-2001-00148, Westinghouse Savannah River Company, Aiken, South Carolina.

Marra SL, and CM Jantzen. 1993. *Characterization of Projected DWPF Glasses Heat Treated to Simulate Canister Centerline Cooling (U),* WSRC-TR-92-142, Rev. 1.

Occhipinti, JE. 2003. Durability Model/Waste Loading Studies for DWPF, Technical Task Request (TTR), HLW/DWPF/TTR-03-0012, June 18, 2003.

Peeler, DK, TH Lorier, DF Bickford, DC Witt, TB Edwards, KG Brown, IA Reamer, RJ Workman. 2001. *Melt Rate Improvements for DWPF MB3: Frit Development and Model Assessment*, WSRC-TR-2001-00131, Revision 0, Westinghouse Savannah River Company, Aiken, South Carolina.

Peeler, DK and TB Edwards. 2003. *The Impact of Redox on Durability for Sludge Batch 2: Part I. Model-Based Predictions and Glass Selections*, WSRC-TR-2003-00173, Revision 0, Westinghouse Savannah River Company, Aiken, South Carolina.

Peeler, DK and TB Edwards. 2002. *Frit Development for Sludge Batch 3*, WSRC-TR-2002-00491, Revision 0, Westinghouse Savannah River Company, Aiken, South Carolina.

Peeler, DK and TB Edwards. 2003a. *Sludge Batch 2/3 Case #6 and Case #7 Washing and Blending Strategies: A Model-Based Assessment for Projected Operating Windows*, WSRC-TR-2003-00286, Revision 0, Westinghouse Savannah River Company, Aiken, South Carolina.

Peeler, DK and TB Edwards. 2003b. *The Impact of Redox on Durability for Sludge Batch 2: Part I. Model-Based Predictions and Glass Selections*, WSRC-TR-2003-00173, Revision 0, Westinghouse Savannah River Company, Aiken, South Carolina.

Peeler, DK and TB Edwards. 2003c. *Durability Model/Waste Loading Studies for DWPF, Task Technical and QA Plan*, WSRC-RP-2003-00495, Revision 0, Westinghouse Savannah River Company, Aiken, South Carolina.

SRTC 1997. Savannah River Technology Center Conduct of Research and Development Manual, WSRC-IM-97-00024, Rev 2, Westinghouse Savannah River Company, Aiken, South Carolina.

Savannah River Technology Center (SRTC). 2002a. "Glass Batching," SRTC Procedure Manual, L29, ITS-0001, Westinghouse Savannah River Company, Aiken, South Carolina.

Savannah River Technology Center (SRTC). 2002b. "Glass Melting," SRTC Procedure Manual, L29, ITS-0003, Westinghouse Savannah River Company, Aiken, South Carolina.

SAS Institute, Inc., JMP® Statistics and Graphics Guide: JMP Version 5.0, SAS Institute, Inc, Cary, North Carolina, 2002.

Waste Acceptance Product Specifications (WAPS). 1996. **Office of Environmental Management, Waste Acceptance Product Specifications for Vitrified High-Level Waste Forms**, Revision 1, USDOE Document EM-WAPS, U.S. Department of Energy, Germantown, MD.

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Appendix A

Analytical Plans for the Measurement of Chemical Compositions

SRT-SCS-2002-00029

May 22, 2002

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From: T. B. Edwards, 773-42A (5-5148)
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wo – without glass identifiers
es – executive summary only

S. P. Harris, Technical Reviewer — Date: 5/23/2002

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AN ANALYTICAL PLAN FOR MEASURING THE CHEMICAL COMPOSITIONS OF NON-RADIOACTIVE GLASSES FROM THE REDUCTION OF CONSTRAINTS AND PCT ASSESSMENT STUDIES (U)

1.0 EXECUTIVE SUMMARY

Studies are being conducted by the Savannah River Technology Center (SRTC) in support of two Tanks Focus Area tasks, which are generating glass property-composition data for the Defense Waste Processing Facility (DWPF). These studies are the Reduction of Constraints Task (Phase 2) and the PCT Assessment Task (Phase 1). The first study involves investigating the constraints associated with product quality while the second focuses on generating data to further the investigation of models relating PCT (Product Consistency Test) response to glass composition. Forty glass compositions were selected for batching and testing for the Reduction of Constraints task while thirty-one glass compositions were selected for batching and testing to support the PCT assessment study. Twenty-one of these 71 glasses are non-radioactive, 7 in the Reduction of Constraints Task and 14 in the PCT Assessment Task.

The chemical compositions of the 21 non-radioactive glasses from these two studies are to be determined by the Savannah River Technology Center – Mobile Laboratory (SRTC-ML). This memorandum provides an analytical plan to direct and support these measurements at the SRTC-ML.

2.0 INTRODUCTION

Studies are being conducted by the Savannah River Technology Center (SRTC) in support of two Tanks Focus Area tasks, which are generating glass property-composition data for the Defense Waste Processing Facility (DWPF). A study [1] of the constraints associated with product quality (i.e., glass durability) acceptance is being conducted by the Savannah River Technology Center (SRTC) for the Defense Waste Processing Facility (DWPF). Specifically, the application of the homogeneity discriminator for projected "sludge-only" glasses is being investigated. Forty (40) glass compositions were selected for batching and testing to support Phase 2 of this effort. Seven (7) of these glasses are non-radioactive.

A second study [2] involving an assessment of PCT response versus the current DWPF durability models is also underway. Thirty-one (31) glass compositions were selected for batching and testing in support of the first phase of this task. Of these thirty-one glasses, fourteen (14) are non-radioactive.

The chemical compositions of the 21 non-radioactive glasses from these two studies are to be determined by the Savannah River Technology Center – Mobile Laboratory (SRTC-ML). This memorandum provides an analytical plan to direct and support these measurements at the SRTC-ML. The non-radioactive glasses from both studies are being included in a single analytical plan to facilitate these measurements at the SRTC-ML.

3.0 ANALYTICAL PLAN

The analytical procedures used by the SRTC-ML 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 (LM) and sodium peroxide (SP).

The primary measurements of interest are to be acquired as follows: the samples prepared by lithium metaborate (LM) are to be measured for aluminum (Al), calcium (Ca), chromium (Cr), iron (Fe), magnesium (Mg), manganese (Mn), sodium (Na), nickel (Ni), phosphorous (P), silicon (Si), titanium (Ti), and zirconium (Zr) concentrations. Samples prepared by sodium peroxide (SP) are to be measured for boron (B) and lithium (Li). Samples dissolved by either of these two preparation methods are to be measured using Inductively Coupled Plasma – Atomic Emission Spectrometry (ICP-AES). It should be noted that there are minor components associated with these study glasses that will not be measured due to their concentration being below detection limits of the ICP-AES. These minor components include Ba, Cd, Co, Cu, La, Mo, Pb, Ru, Sn, Sr, V, and Zn.

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 the SRTC-ML to determine the cation concentrations for the submitted glass samples primarily involve the dissolution step in the preparation of the sample and the calibrations of the ICP-AES.

Samples of a standard glass will be included in the analytical plan to provide an opportunity for checking the performance of the instrumentation over the course of the analyses and for potential bias correction. Specifically, several samples of Waste Compliance Plan (WCP) Batch 1 (BCH) [3] are included in this analytical plan. The reference composition of this glass is provided in Table 1. These standards will be referred to using the short identifier provided in Table 1 in the remainder of this memo.

Table 1: Oxide Compositions of WCP Batch 1 (BCH) (in wt%).

Oxide/ Anion	BCH (wt%)
Al_2O_3	4.877
B_2O_3	7.777
BaO	0.151
CaO	1.220
CdO	0.00
Cl	0.00
Cr_2O_3	0.107
Cs_2O	0.060
CuO	0.399
F	0.00
Fe_2O_3	12.839
K_2O	3.327
Li_2O	4.429
MgO	1.419
MnO	1.726
MoO_3	0.00
Na_2O	9.003
Nd_2O_3	0.147
NiO	0.751
P_2O_5	0.00
PbO	0.00
RuO_2	0.0214
SiO_2	50.22
SnO_2	0.00
SO_3	0.00
TiO_2	0.677
U_3O_8	0.00
ZrO_2	0.098

Each glass sample submitted to the SRTC-ML will be prepared in duplicate by the LM and SP dissolution methods. Each sample prepared using LM or SP 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, X01 through X21, for the 21 non-radioactive glasses batched as part of the studies. The table provides a naming convention that is to be used in analyzing the glasses and reporting the measurements of their compositions.[8]

[8] Renaming these samples helps to ensure that they will be processed as blind samples within the SRTC-ML. Table 2 is not shown in its entirety in those copies going to the SRTC-ML.

Table 2: Identifiers to Establish Blind Samples for the SRTC-ML

Glass ID	Sample ID	Glass ID	Sample ID	Glass ID	Sample ID
RC58	X08	ND01	X20	ND12	X09
RC63	X17	ND03	X12	ND13	X19
RC65	X05	ND05	X01	ND14	X15
RC66	X03	ND06	X16	ND15	X06
RC69	X18	ND07	X07	ND17	X02
RC71	X13	ND08	X14	ND19	X04
RC72	X11	ND10	X10	ND20	X21

3.1 *PREPARATION OF THE SAMPLES*

Each of the 21 non-radioactive glasses included in this analytical plan is to be prepared in duplicate by the LM and SP dissolution method. Thus, the total number of prepared glass samples is determined by $21 \cdot 2 \cdot 2 = 84$, not including the samples of the BCH and UST glass standards that are to be prepared.

Tables 3a-3b provide blocking and (random) sequencing schema for conducting the preparation steps of the analytical procedures. Three 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 3a: LM
(Lithium Metaborate)
Preparation Blocks

1	2	3
X13LM1	X10LM1	X21LM1
X17LM1	X14LM1	X21LM2
X13LM2	X01LM1	X04LM1
X11LM1	X10LM2	X15LM1
X05LM1	X20LM1	X04LM2
X05LM2	X01LM2	X09LM1
X18LM1	X20LM2	X15LM2
X11LM2	X14LM2	X09LM2
X17LM2	X07LM1	X02LM1
X03LM1	X12LM1	X19LM1
X03LM2	X16LM1	X06LM1
X08LM1	X12LM2	X19LM2
X18LM2	X07LM2	X06LM2
X08LM2	X16LM2	X02LM2

Table 3b: SP
(Sodium Peroxide)
Preparation Blocks

1	2	3
X18SP1	X01SP1	X19SP1
X18SP2	X01SP2	X15SP1
X05SP1	X20SP1	X04SP1
X05SP2	X10SP1	X15SP2
X13SP1	X20SP2	X19SP2
X11SP1	X10SP2	X09SP1
X13SP2	X12SP1	X09SP2
X08SP1	X14SP1	X04SP2
X03SP1	X16SP1	X06SP1
X17SP1	X16SP2	X21SP1
X17SP2	X12SP2	X02SP1
X11SP2	X14SP2	X21SP2
X08SP2	X07SP1	X02SP2
X03SP2	X07SP2	X06SP2

3.2 ICP-AES Calibration Blocks

The glass samples prepared by LM and SP 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 SP-prepared samples are provided in Tables 4 and 5, respectively. The cations to be measured are specified in the header of each of these tables. In these tables, the sample identifiers for the 21 non-radioactive 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) ICP-AES calibration group. The identifiers for the BCH samples have been modified to indicate 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 and Calibration Groups for Samples Prepared Using LM
(Used to Measure Elemental Al, Ca, Cr, Fe, Mg, Mn, Na, Ni, P, Si, Ti, and Zr)

ICP-AES Block 1		ICP-AES Block 2		ICP-AES Block 3	
Calibration 1	Calibration 2	Calibration 1	Calibration 2	Calibration 1	Calibration 2
BCHLM111	BCHLM121	BCHLM211	BCHLM221	BCHLM311	BCHLM321
X05LM21	X08LM22	X14LM11	X16LM12	X04LM11	X02LM12
X05LM11	X11LM12	X14LM21	X01LM22	X19LM21	X04LM12
X11LM11	X13LM22	X12LM21	X12LM12	X06LM11	X21LM12
X17LM21	X17LM22	X01LM11	X14LM12	X06LM21	X06LM22
X17LM11	X03LM12	X16LM21	X14LM22	X19LM11	X19LM22
X08LM11	X17LM12	X12LM11	X10LM22	X02LM21	X06LM12
X13LM11	X13LM12	X01LM21	X12LM22	X15LM11	X04LM22
BCHLM112	BCHLM122	BCHLM212	BCHLM222	BCHLM312	BCHLM322
X11LM21	X18LM12	X20LM11	X07LM12	X09LM21	X09LM22
X18LM11	X11LM22	X07LM11	X16LM22	X04LM21	X02LM22
X13LM21	X05LM12	X10LM21	X10LM12	X02LM11	X21LM22
X08LM21	X08LM12	X07LM21	X07LM22	X21LM11	X09LM12
X18LM21	X18LM22	X20LM21	X20LM12	X15LM21	X15LM12
X03LM11	X03LM22	X10LM11	X20LM22	X21LM21	X19LM12
X03LM21	X05LM22	X16LM11	X01LM12	X09LM11	X15LM22
BCHLM113	BCHLM123	BCHLM213	BCHLM223	BCHLM313	BCHLM323

Table 5: ICP-AES Blocks and Calibration Groups for Samples Prepared Using SP
(Used to Measure Elemental B and Li)

ICP-AES Block 1		ICP-AES Block 2		ICP-AES Block 3	
Calibration 1	Calibration 2	Calibration 1	Calibration 2	Calibration 1	Calibration 2
BCHSP111	BCHSP121	BCHSP211	BCHSP221	BCHSP311	BCHSP321
X03SP21	X03SP12	X16SP21	X01SP12	X19SP11	X15SP12
X05SP11	X18SP22	X12SP11	X20SP12	X21SP11	X19SP12
X08SP21	X08SP22	X10SP21	X14SP12	X04SP11	X09SP22
X17SP11	X05SP22	X10SP11	X12SP22	X09SP21	X02SP12
X03SP11	X11SP22	X01SP11	X12SP12	X15SP11	X15SP22
X13SP21	X11SP12	X07SP11	X20SP22	X02SP11	X21SP22
X13SP11	X17SP12	X16SP11	X16SP12	X06SP21	X19SP22
BCHSP112	BCHSP122	BCHSP212	BCHSP222	BCHSP312	BCHSP322
X05SP21	X17SP22	X12SP21	X07SP22	X04SP21	X04SP22
X08SP11	X05SP12	X14SP21	X10SP12	X21SP21	X06SP22
X11SP11	X08SP12	X20SP11	X14SP22	X15SP21	X04SP12
X18SP21	X18SP12	X07SP21	X10SP22	X09SP11	X09SP12
X11SP21	X13SP12	X01SP21	X07SP12	X02SP21	X02SP22
X17SP21	X03SP22	X20SP21	X01SP22	X19SP21	X21SP12
X18SP11	X13SP22	X14SP11	X16SP22	X06SP11	X06SP12
BCHSP113	BCHSP123	BCHSP213	BCHSP223	BCHSP313	BCHSP323

4.0 CONCLUDING COMMENTS

In summary, this analytical plan identifies several ICP-AES calibration blocks in Tables 4 – 5 as well as six preparation blocks in Tables 3a-3b for use by the SRTC-ML. 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 SRTC-ML 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] Herman, C. C., "Task Technical/Quality Assurance Plan: Reduction of Constraints – Phase 2," WSRC-RP-2002-00150, Revision 0, March 11, 2002.

[2] Cozzi, A. D., "Task Technical and QA Plan: PCT Assessment" WSRC-RP-2002-00269, May 1, 2002.

[3] 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™) (U)," WSRC-TR-93-673, Rev. 1, Volume 2, Table B.1, pp. B.9, 1995.

SRT-SCS-2002-00033

May 28, 2002

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wo – without glass identifiers
es – executive summary only

S. P. Harris, Technical Reviewer — Date: 6/3/2002

R. C. Tuckfield, Manager
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AN ANALYTICAL PLAN FOR MEASURING THE CHEMICAL COMPOSITIONS OF RADIOACTIVE GLASSES FROM THE REDUCTION OF CONSTRAINTS AND PCT ASSESSMENT STUDIES (U)

1.0 EXECUTIVE SUMMARY

Studies are being conducted by the Savannah River Technology Center (SRTC) in support of two Tanks Focus Area tasks, which are generating glass property-composition data for the Defense Waste Processing Facility (DWPF). These studies are the Reduction of Constraints Task (Phase 2) and the PCT Assessment Task (Phase 1). The first study involves investigating the constraints associated with product quality while the second focuses on generating data to further the investigation of models relating PCT (Product Consistency Test) response to glass composition. Forty glass compositions were selected for batching and testing for the Reduction of Constraints task while thirty-one glass compositions were selected for batching and testing to support the PCT assessment study. Fifty of these 71 glasses are radioactive, 33 in the Reduction of Constraints Task and 17 in the PCT Assessment Task.

The chemical compositions of the 50 radioactive glasses from these two studies are to be determined by the Savannah River Technology Center – Mobile Laboratory (SRTC-ML). This memorandum provides an analytical plan to direct and support these measurements at the SRTC-ML.

2.0 INTRODUCTION

Studies are being conducted by the Savannah River Technology Center (SRTC) in support of two Tanks Focus Area tasks, which are generating glass property-composition data for the Defense Waste Processing Facility (DWPF). A study [1] of the constraints associated with product quality (i.e., glass durability) acceptance is being conducted by the Savannah River Technology Center (SRTC) for the Defense Waste Processing Facility (DWPF). Specifically, the application of the homogeneity discriminator for projected "sludge-only" glasses is being investigated. Forty (40) glass compositions were selected for batching and testing to support Phase 2 of this effort. Thirty-three (33) of these glasses are radioactive.

A second study [2] involving an assessment of PCT response versus the current DWPF durability models is also underway. Thirty-one (31) glass compositions were selected for batching and testing in support of the first phase of this task. Of these thirty-one glasses, seventeen (17) are radioactive.

The chemical compositions of the 50 radioactive glasses from these two studies are to be determined by the Savannah River Technology Center – Mobile Laboratory (SRTC-ML). This memorandum provides an analytical plan to direct and support these measurements at the SRTC-ML. The radioactive glasses from both studies are being included in a single analytical plan to facilitate these measurements at the SRTC-ML.

3.0 ANALYTICAL PLAN

The analytical procedures used by the SRTC-ML 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 (LM) and sodium peroxide (SP).

The primary measurements of interest are to be acquired as follows: the samples prepared by lithium metaborate (LM) are to be measured for aluminum (Al), calcium (Ca), chromium (Cr), iron (Fe), magnesium (Mg), manganese (Mn), sodium (Na), nickel (Ni), phosphorous (P), silicon (Si), titanium (Ti), thorium (Th), uranium (U), and zirconium (Zr) concentrations. Samples prepared by sodium peroxide (SP) are to be measured for boron (B) and lithium (Li). Samples dissolved by either of these two preparation methods are to be measured using Inductively Coupled Plasma – Atomic Emission Spectrometry (ICP-AES). It should be noted that there are minor components associated with these study glasses that will not be measured due to their concentration being below detection limits of the ICP-AES. These minor components include Ba, Cd, Co, Cu, La, Mo, Pb, Ru, Sn, Sr, V, and Zn.

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 the SRTC-ML to determine the cation concentrations for the submitted glass samples primarily involve the dissolution step in the preparation of the sample and the calibrations of the ICP-AES.

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

Table 1: Oxide Compositions of WCP Batch 1 (BCH) and Uranium Standard (UST) Glasses (wt%).

Oxide/ Anion	BCH (wt%)	UST (wt%)
Al_2O_3	4.877	4.1
B_2O_3	7.777	9.209
BaO	0.151	0.00
CaO	1.220	1.301
CdO	0.00	0.00
Cl	0.00	0.00
Cr_2O_3	0.107	0.00
Cs_2O	0.060	0.00
CuO	0.399	0.00
F	0.00	0.00
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
MoO_3	0.00	0.00
Na_2O	9.003	11.795
Nd_2O_3	0.147	0.00
NiO	0.751	1.12
P_2O_5	0.00	0.00
PbO	0.00	0.00
RuO_2	0.0214	0.00
SiO_2	50.22	45.353
SnO_2	0.00	0.00
SO_3	0.00	0.00
TiO_2	0.677	1.049
U_3O_8	0.00	2.406
ZrO_2	0.098	0.00

Each glass sample submitted to the SRTC-ML will be prepared in duplicate by the LM and SP dissolution methods. Each sample prepared using LM or SP 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 u50, for the 50 radioactive glasses batched as part of the studies. The table provides a naming convention that is to be used in analyzing the glasses and reporting the measurements of their compositions.[9]

[9] Renaming these samples helps to ensure that they will be processed as blind samples within the SRTC-ML. Table 2 is not shown in its entirety in those copies going to the SRTC-ML.

Table 2: Identifiers to Establish Blind Samples for the SRTC-ML

Glass ID	Sample ID	Glass ID	Sample ID	Glass ID	Sample ID
RC59	u02	RC82	u14	ND04	u17
RC60	u38	RC83	u11	ND09	u30
RC61	u47	RC84	u44	ND11	u13
RC62	u33	RC85	u24	ND16	u08
RC64	u26	RC86	u42	ND18	u34
RC67	u06	RC87	u07	ND21	u31
RC68	u46	RC88	u03	ND22	u50
RC70	u01	RC89	u29	ND23	u16
RC73	u25	RC90	u05	ND24	u41
RC74	u23	RC91	u21	ND25	u48
RC75	u45	RC92	u28	ND26	u35
RC76	u27	RC93	u32	ND27	u18
RC77	u04	RC94	u43	ND28	u36
RC78	u40	RC95	u49	ND29	u20
RC79	u39	RC96	u15	ND30	u09
RC80	u12	RC97	u19	ND31	u37
RC81	u10	ND02	u22		

3.1 Preparation of the Samples

Each of the 50 radioactive glasses included in this analytical plan is to be prepared in duplicate by the LM and SP dissolution method. Thus, the total number of prepared glass samples is determined by $50 \cdot 2 \cdot 2 = 200$, not including the samples of the BCH and UST glass standards that are to be prepared.

Tables 3a-3b provide blocking and (random) sequencing schema for conducting the preparation steps of the analytical procedures. Three 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 3a: LM
(Lithium Metaborate)
Preparation Blocks

1	2	3
u26LM1	u03LM1	u35LM1
u23LM1	u03LM2	u36LM1
u23LM2	u29LM1	u13LM1
u10LM1	u32LM1	u16LM1
u02LM1	u29LM2	u34LM1
u38LM1	u43LM1	u16LM2
u26LM2	u19LM1	u35LM2
u25LM1	u15LM1	u37LM1
u04LM1	u44LM1	u36LM2
u02LM2	u32LM2	u17LM1
u10LM2	u49LM1	u13LM2
u38LM2	u05LM1	u37LM2
u45LM1	u44LM2	u18LM1
u12LM1	u05LM2	u34LM2
u39LM1	u43LM2	u09LM1
u39LM2	u28LM1	u41LM1
u25LM2	u21LM1	u41LM2
u04LM2	u14LM1	u30LM1
u27LM1	u11LM1	u09LM2
u46LM1	u15LM2	u22LM1
u45LM2	u19LM2	u18LM2
u47LM1	u21LM2	u08LM1
u12LM2	u24LM1	u48LM1
u47LM2	u14LM2	u17LM2
u01LM1	u49LM2	u30LM2
u46LM2	u42LM1	u08LM2
u06LM1	u28LM2	u20LM1
u40LM1	u07LM1	u50LM1
u33LM1	u11LM2	u22LM2
u27LM2	u24LM2	u31LM1
u33LM2	u42LM2	u20LM2
u40LM2	u07LM2	u31LM2
u01LM2		u48LM2
u06LM2		u50LM2

Table 3b: SP
(Sodium Peroxide)
Preparation Blocks

1	2	3
u47SP1	u21SP1	u18SP1
u33SP1	u14SP1	u18SP2
u40SP1	u14SP2	u22SP1
u47SP2	u15SP1	u13SP1
u12SP1	u21SP2	u22SP2
u12SP2	u15SP2	u13SP2
u46SP1	u32SP1	u36SP1
u38SP1	u32SP2	u36SP2
u39SP1	u29SP1	u41SP1
u25SP1	u29SP2	u20SP1
u33SP2	u28SP1	u16SP1
u02SP1	u43SP1	u34SP1
u40SP2	u19SP1	u35SP1
u38SP2	u49SP1	u20SP2
u46SP2	u28SP2	u16SP2
u06SP1	u24SP1	u48SP1
u26SP1	u49SP2	u09SP1
u01SP1	u42SP1	u35SP2
u04SP1	u43SP2	u17SP1
u26SP2	u24SP2	u48SP2
u39SP2	u05SP1	u30SP1
u23SP1	u03SP1	u41SP2
u25SP2	u19SP2	u37SP1
u04SP2	u44SP1	u34SP2
u02SP2	u07SP1	u50SP1
u27SP1	u11SP1	u08SP1
u06SP2	u05SP2	u31SP1
u45SP1	u07SP2	u31SP2
u01SP2	u03SP2	u08SP2
u23SP2	u42SP2	u50SP2
u45SP2	u44SP2	u37SP2
u27SP2	u11SP2	u09SP2
u10SP1		u17SP2
u10SP2		u30SP2

3.2 ICP-AES Calibration Blocks

The glass samples prepared by LM and SP 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 SP-prepared samples are provided in Tables 4 and 5, respectively. The cations to be measured are specified in the header of each of these tables. In these tables, the sample identifiers for the 50 radioactive 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) ICP-AES calibration group. The identifiers for the BCH and UST samples have been modified to indicate 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 and Calibration Groups for Samples Prepared Using LM
(Used to Measure Elemental Al, Ca, Cr, Fe, Mg, Mn, Na, Ni, P, Si, Ti, Th, U and Zr)

ICP-AES Block 1		ICP-AES Block 2		ICP-AES Block 3		ICP-AES Block 4		ICP-AES Block 5		ICP-AES Block 6	
Calibration 1	Calibration 2	Calibration 1	Calibration 2	Calibration 1	Calibration 2	Calibration 1	Calibration 2	Calibration 1	Calibration 2	Calibration 1	Calibration 2
BCHLM111	BCHLM121	BCHLM211	BCHLM221	BCHLM311	BCHLM321	BCHLM411	BCHLM421	BCHLM511	BCHLM 521	BCHLM611	BCHLM621
USTLM111	USTLM121	USTLM211	USTLM221	USTLM311	USTLM321	USTLM411	USTLM421	USTLM511	USTLM521	USTLM611	USTLM621
u01LM11	u26LM12	u46LM21	u23LM12	u49LM21	u21LM12	u21LM21	u42LM12	u48LM21	u36LM22	u50LM21	u08LM22
u11LM11	u19LM12	u05LM11	u15LM22	u33LM21	u06LM12	u47LM21	u24LM22	u22LM21	u22LM22	u41LM11	u50LM12
u02LM11	u49LM12	u06LM21	u27LM22	u23LM21	u03LM12	u38LM21	u47LM22	u20LM11	u13LM22	u16LM11	u34LM22
u49LM11	u43LM22	u02LM21	u07LM12	u39LM11	u10LM22	u43LM11	u40LM22	u18LM11	u20LM22	u37LM21	u36LM12
u42LM21	u45LM12	u23LM11	u38LM12	u29LM21	u49LM22	u40LM11	u14LM12	u30LM21	u41LM22	u31LM21	u16LM22
u26LM11	u01LM12	u12LM11	u14LM22	u06LM11	u26LM22	u40LM21	u38LM22	u36LM21	u35LM22	u08LM11	u08LM12
u01LM21	u42LM22	u04LM21	u12LM12	u10LM21	u23LM22	u39LM21	u10LM12	u48LM11	u30LM22	u50LM11	u37LM22
u24LM11	u29LM12	u14LM21	u32LM12	u21LM11	u12LM22	u42LM11	u21LM22	u35LM21	u34LM12	u30LM11	u30LM12
BCHLM112	BCHLM122	BCHLM212	BCHLM222	BCHLM312	BCHLM322	BCHLM412	BCHLM422	BCHLM512	BCHLM522	BCHLM612	BCHLM622
USTLM112	USTLM122	USTLM212	USTLM222	USTLM312	USTLM322	USTLM412	USTLM422	USTLM512	USTLM522	USTLM612	USTLM622
u45LM11	u01LM22	u15LM21	u47LM12	u11LM21	u44LM22	u03LM21	u05LM22	u18LM21	u18LM12	u16LM21	u16LM12
u43LM21	u04LM12	u28LM11	u06LM22	u03LM11	u29LM22	u05LM21	u03LM22	u41LM21	u20LM12	u36LM11	u50LM22
u33LM11	u11LM12	u27LM21	u02LM22	u26LM21	u33LM22	u10LM11	u43LM12	u34LM11	u35LM12	u34LM21	u37LM12
u04LM11	u33LM12	u07LM21	u05LM12	u19LM21	u19LM22	u46LM11	u40LM12	u20LM21	u09LM12	u37LM11	u22LM12
u29LM11	u24LM12	u32LM11	u15LM12	u44LM21	u11LM22	u24LM21	u46LM12	u13LM21	u09LM22	u17LM21	u31LM12
u45LM21	u02LM12	u07LM11	u28LM12	u12LM21	u39LM12	u14LM11	u39LM22	u13LM11	u13LM12	u22LM11	u17LM22
u19LM11	u25LM22	u47LM11	u07LM22	u44LM11	u44LM12	u32LM21	u32LM22	u35LM11	u48LM12	u31LM11	u31LM22
u28LM21	u45LM22	u38LM11	u04LM22	u27LM11	u27LM12	u25LM11	u25LM12	u09LM11	u18LM22	u17LM11	u41LM12
u25LM21	u28LM22	u15LM11	u46LM22	BCHLM313	BCHLM323	BCHLM413	BCHLM423	u09LM21	u48LM22	u08LM21	u17LM12
BCHLM113	BCHLM123	BCHLM213	BCHLM223	USTLM313	USTLM323	USTLM413	USTLM423	BCHLM513	BCHLM523	BCHLM613	BCHLM623
USTLM113	USTLM123	USTLM213	USTLM223					USTLM513	USTLM523	USTLM613	USTLM623

Table 5: ICP-AES Blocks and Calibration Groups for Samples Prepared Using SP
(Used to Measure Elemental B and Li)

ICP-AES Block 1		ICP-AES Block 2		ICP-AES Block 3		ICP-AES Block 4		ICP-AES Block 5		ICP-AES Block 6	
Calibration 1	Calibration 2	Calibration 1	Calibration 2	Calibration 1	Calibration 2	Calibration 1	Calibration 2	Calibration 1	Calibration 2	Calibration 1	Calibration 2
BCHSP111	BCHSP121	BCHSP211	BCHSP221	BCHSP311	BCHSP321	BCHSP411	BCHSP421	BCHSP511	BCHSP521	BCHSP611	BCHSP621
USTSP111	USTSP121	USTSP211	USTSP221	USTSP311	USTSP321	USTSP411	USTSP421	USTSP511	USTSP521	USTSP611	USTSP621
u32SP11	u23SP12	u21SP21	u39SP22	u14SP11	u24SP12	u02SP21	u03SP22	u18SP11	u31SP12	u36SP21	u37SP22
u21SP11	u32SP12	u49SP21	u01SP22	u46SP11	u38SP12	u14SP21	u07SP22	u41SP11	u20SP12	u17SP21	u13SP22
u39SP11	u47SP12	u32SP21	u33SP22	u12SP11	u14SP12	u06SP21	u29SP22	u09SP11	u37SP12	u41SP21	u22SP22
u23SP11	u10SP12	u01SP21	u49SP22	u29SP11	u25SP12	u40SP21	u44SP22	u17SP11	u50SP12	u13SP21	u20SP22
u49SP11	u04SP12	u43SP21	u47SP22	u02SP11	u06SP12	u42SP21	u06SP22	u16SP11	u41SP12	u22SP21	u17SP22
u01SP11	u11SP12	u23SP21	u11SP22	u07SP11	u40SP12	u44SP21	u12SP22	u30SP11	u18SP12	u20SP21	u18SP22
u10SP11	u21SP12	u26SP21	u32SP22	u25SP11	u07SP12	u24SP21	u46SP22	u37SP11	u30SP12	u08SP21	u36SP22
u28SP11	u33SP12	u11SP21	u26SP22	u24SP11	u19SP12	u03SP21	u24SP22	u22SP11	u13SP12	u09SP21	u34SP22
BCHSP112	BCHSP122	BCHSP212	BCHSP222	BCHSP312	BCHSP322	BCHSP412	BCHSP422	BCHSP512	BCHSP522	BCHSP612	BCHSP622
USTSP112	USTSP122	USTSP212	USTSP222	USTSP312	USTSP322	USTSP412	USTSP422	USTSP512	USTSP522	USTSP612	USTSP622
u26SP11	u49SP12	u39SP21	u05SP22	u38SP11	u46SP12	u27SP21	u40SP22	u31SP11	u16SP12	u34SP21	u31SP22
u47SP11	u15SP12	u10SP21	u21SP22	u27SP11	u03SP12	u25SP21	u42SP22	u20SP11	u36SP12	u35SP21	u50SP22
u15SP11	u43SP12	u04SP21	u43SP22	u40SP11	u44SP12	u29SP21	u25SP22	u13SP11	u35SP12	u18SP21	u16SP22
u05SP11	u05SP12	u33SP21	u23SP22	u42SP11	u42SP12	u19SP21	u38SP22	u34SP11	u22SP12	u16SP21	u41SP22
u45SP11	u45SP12	u15SP21	u28SP22	u44SP11	u27SP12	u38SP21	u14SP22	u50SP11	u48SP12	u30SP21	u08SP22
u04SP11	u28SP12	u45SP21	u15SP22	u06SP11	u02SP12	u12SP21	u02SP22	u08SP11	u17SP12	u31SP21	u30SP22
u11SP11	u39SP12	u47SP21	u45SP22	u19SP11	u29SP12	u46SP21	u19SP22	u36SP11	u09SP12	u37SP21	u09SP22
u43SP11	u01SP12	u05SP21	u04SP22	u03SP11	u12SP12	u07SP21	u27SP22	u48SP11	u34SP12	u48SP21	u35SP22
u33SP11	u26SP12	u28SP21	u10SP22	BCHLM313	BCHLM323	BCHLM413	BCHLM423	u35SP11	u08SP12	u50SP21	u48SP22
BCHSP113	BCHSP123	BCHSP213	BCHSP223	USTSP313	USTSP323	USTSP413	USTSP423	BCHSP513	BCHSP523	BCHSP613	BCHSP623
USTSP113	USTSP123	USTSP213	USTSP223					USTSP513	USTSP523	USTSP613	USTSP623

4.0 CONCLUDING COMMENTS

In summary, this analytical plan identifies several ICP-AES calibration blocks in Tables 4 – 5 as well as six preparation blocks in Tables 3a-3b for use by the SRTC-ML. 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 SRTC-ML 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] Herman, C. C., "Task Technical/Quality Assurance Plan: Reduction of Constraints – Phase 2," WSRC-RP-2002-00150, Revision 0, March 11, 2002.

[2] Cozzi, A. D., "Task Technical and QA Plan: PCT Assessment" WSRC-RP-2002-00269, May 1, 2002.

[3] 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™) (U)," WSRC-TR-93-673, Rev. 1, Volume 2, Table B.1, pp. B.9, 1995.

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Appendix B

Analytical Plans for the Measurement of PCT Solutions

SRT-SCS-2002-00035

May 29, 2002

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wo – without glass identifiers
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AN ANALYTICAL PLAN FOR MEASURING PCT SOLUTIONS FOR NON-RADIOACTIVE GLASSES FROM THE REDUCTION OF CONSTRAINTS AND PCT ASSESSMENT STUDIES (U)

1.0 EXECUTIVE SUMMARY

Studies are being conducted by the Savannah River Technology Center (SRTC) in support of two Tanks Focus Area tasks. The studies, which are intended to generate glass property-composition data for the Defense Waste Processing Facility (DWPF), are the Reduction of Constraints study (Phase 2) and the PCT Assessment study (Phase 1). The first study involves investigating the constraints associated with product quality while the second focuses on generating data to further the investigation of models relating PCT (Product Consistency Test) response to glass composition. Forty glass compositions were selected for batching and testing for the Reduction of Constraints task, and thirty-one glass compositions were selected for batching and testing to support the PCT assessment study. Twenty-one of these 71 glasses are non-radioactive, 7 in the Reduction of Constraints Task and 14 in the PCT Assessment Task.

The twenty-one non-radioactive glasses are the focus of this analytical plan. These glasses were cooled both by quenching and centerline canister cooling, and the durabilities of the resulting forty-two glasses are to be measured in triplicate using the Product Consistency Test, or PCT. Its requirements are described in ASTM C1285-97 (Method A).

The Savannah River Technology Center-Mobile Laboratory (SRTC-ML) is to be used to measure elemental concentrations of the resulting leachate solutions from the PCTs. This memorandum provides an analytical plan for the SRTC-ML to follow in measuring the compositions of the leachate solutions resulting from the PCT procedures for the glasses.

2.0 INTRODUCTION

Studies are being conducted by the Savannah River Technology Center (SRTC) in support of two Tanks Focus Area tasks. The studies are intended to generate glass property-composition data for the Defense Waste Processing Facility (DWPF).

A study [1] of the constraints associated with product quality (i.e., glass durability) acceptance is being conducted by SRTC for DWPF. Specifically, the application of the homogeneity discriminator for projected "sludge-only" glasses is being investigated. Forty (40) glass compositions were selected for batching and testing to support Phase 2 of this effort. Seven (7) of these glasses are non-radioactive.

A second study [2] involving an assessment of PCT response versus the current DWPF durability models is also underway. Thirty-one (31) glass compositions were selected for batching and testing in support of the Phase 1 of this task. Of these thirty-one glasses, fourteen (14) are non-radioactive.

The twenty-one non-radioactive glasses are the focus of this analytical plan. These glasses were cooled both by quenching and by centerline canister cooling, and the durabilities of the resulting forty-two glasses are to be measured in triplicate using the Product Consistency Test, or PCT. Its requirements are described in ASTM C1285-97 (Method A) [3].

The identifiers for the study glasses are presented in Table 1. The centerline canister cooled glasses are denoted by a "ccc" suffix.

Table 1: Identifiers for the Non-Radioactive Study Glasses

Quenched	Centerline Canister Cooled	Quenched	Centerline Canister Cooled	Quenched	Centerline Canister Cooled
RC58	RC58ccc	ND01	ND01ccc	ND12	ND12ccc
RC63	RC63ccc	ND03	ND03ccc	ND13	ND13ccc
RC65	RC65ccc	ND05	ND05ccc	ND14	ND14ccc
RC66	RC66ccc	ND06	ND06ccc	ND15	ND15ccc
RC69	RC69ccc	ND07	ND07ccc	ND17	ND17ccc
RC71	RC71ccc	ND08	ND08ccc	ND19	ND19ccc
RC72	RC72ccc	ND10	ND10ccc	ND20	ND20ccc

This memorandum provides an analytical plan for the Savannah River Technology Center's Mobile Laboratory (SRTC-ML) to follow in measuring the compositions of the PCT leachate solutions for these glasses.

3.0 DISCUSSION

The quenched and centerline canister cooled versions of the study glasses are to be subjected to the PCT. The 2 different thermal histories for each of the 21 glasses lead to 42 glasses that are to be measured (in triplicate) using the PCT. In addition to those for the study glasses, triplicate PCTs are to be conducted on a sample of the Approved Reference Material (ARM) 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 134 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 the SRTC-ML. The EA leachates will be further diluted (1:10 v:v) with deionized water prior to submission to the SRTC-ML in order to prevent problems with the nebulizer.

Table 2 presents identifying codes, c001 through c134, for the individual solutions required for the PCTs of the study glasses and of the standards (EA, ARM, and blanks). This provides a naming convention that is to be used by the SRTC-ML in analyzing the solutions and reporting the relevant concentration measurements.[10]

Table 2: Identifiers for the PCT Solutions

Original Sample	Solution Identifier	Original Sample	Solution Identifier	Original Sample	Solution Identifier	Original Sample	Solution Identifier
ND01	c092	ND08ccc	c005	ND17	c063	RC66	c132
ND01	c001	ND08ccc	c107	ND17ccc	c112	RC66	c012
ND01	c033	ND10	c038	ND17ccc	c064	RC66	c133
ND01ccc	c006	ND10	c036	ND17ccc	c047	RC66ccc	c019
ND01ccc	c015	ND10	c023	ND19	c044	RC66ccc	c123
ND01ccc	c027	ND10ccc	c074	ND19	c056	RC66ccc	c014
ND03	c017	ND10ccc	c083	ND19	c114	RC69	c024
ND03	c089	ND10ccc	c129	ND19ccc	c131	RC69	c118
ND03	c103	ND12	c031	ND19ccc	c052	RC69	c072
ND03ccc	c088	ND12	c100	ND19ccc	c108	RC69ccc	c093
ND03ccc	c041	ND12	c032	ND20	c003	RC69ccc	c082
ND03ccc	c124	ND12ccc	c034	ND20	c060	RC69ccc	c077
ND05	c009	ND12ccc	c040	ND20	c119	RC71	c066
ND05	c080	ND12ccc	c109	ND20ccc	c125	RC71	c095
ND05	c099	ND13	c022	ND20ccc	c062	RC71	c117
ND05ccc	c086	ND13	c091	ND20ccc	c042	RC71ccc	c030
ND05ccc	c110	ND13	c111	RC58	c057	RC71ccc	c121
ND05ccc	c020	ND13ccc	c104	RC58	c046	RC71ccc	c013
ND06	c067	ND13ccc	c126	RC58	c075	RC72	c105
ND06	c026	ND13ccc	c098	RC58ccc	c090	RC72	c048
ND06	c025	ND14	c071	RC58ccc	c051	RC72	c053
ND06ccc	c122	ND14	c007	RC58ccc	c054	RC72ccc	c106
ND06ccc	c021	ND14	c127	RC63	c002	RC72ccc	c061
ND06ccc	c079	ND14ccc	c039	RC63	c076	RC72ccc	c069
ND07	c097	ND14ccc	c084	RC63	c029	EA	c043
ND07	c049	ND14ccc	c085	RC63ccc	c065	EA	c070
ND07	c050	ND15	c113	RC63ccc	c116	EA	c128
ND07ccc	c120	ND15	c081	RC63ccc	c134	ARM	c010
ND07ccc	c096	ND15	c059	RC65	c087	ARM	c078
ND07ccc	c037	ND15ccc	c102	RC65	c073	ARM	c018
ND08	c011	ND15ccc	c094	RC65	c008	blank	c045
ND08	c130	ND15ccc	c115	RC65ccc	c004	blank	c101
ND08	c058	ND17	c016	RC65ccc	c068		
ND08ccc	c035	ND17	c028	RC65ccc	c055		

10 Renaming these samples ensures that they will be processed as blind samples by the SRTC-ML. 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 the SRTC-ML is provided in this section. Each of the solution samples submitted to the SRTC-ML is to be analyzed only once for each of the following: aluminum, (Al), boron (B), calcium (Ca), iron (Fe), magnesium (Mg), manganese (Mn), lithium (Li), sodium (Na), nickel (Ni), and silicon (Si). The measurements are to be made in parts per million (ppm). The analytical procedure used by the SRTC-ML 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 nine ICP-AES blocks for processing by the SRTC-ML 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	Block 7	Block 8	Block 9
std-b1-1	std-b2-1	std-b3-1	std-b4-1	std-b5-1	std-b6-1	std-b7-1	std-b8-1	std-b9-1
c038	c118	c129	c003	c089	c059	c057	c061	c111
c122	c021	c085	c030	c049	c115	c112	c080	c058
c067	c036	c029	c097	c101	c008	c090	c005	c099
c002	c026	c114	c045	c096	c119	c016	c130	c133
c043	c070	c072	c102	c040	c055	c105	c012	c075
c006	c015	c018	c034	c094	c117	c035	c110	c047
c131	c007	c077	c125	c073	c013	c106	c123	c063
c065	c076	c134	c017	c062	c124	c132	c028	c020
std-b1-2	std-b2-2	std-b3-2	std-b4-2	std-b5-2	std-b6-2	std-b7-2	std-b8-2	std-b9-2
c044	c056	c079	c120	c121	c042	c019	c091	c054
c092	c052	c025	c004	c081	c032	c104	c126	c069
c024	c078	c027	c066	c095	c037	c022	c051	c053
c010	c116	c108	c087	c068	c109	c009	c046	c107
c074	c084	c128	c113	c041	c050	c011	c048	c098
c071	c082	c033	c088	c060	c103	c086	c064	c014
c093	c083	c127	c031	c100	std-b6-3	std-b7-3	std-b8-3	std-b9-3
c039	c001	c023	std-b4-3	std-b5-3				
std-b1-3	std-b2-3	std-b3-3						

A multi-element solution standard (denoted by "std-bi-j" where i=1 to 9 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 nine 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 nine ICP-AES calibration blocks in Table 3 for the SRTC-ML to use in conducting the aluminum, (Al), boron (B), calcium (Ca), iron (Fe), magnesium (Mg), manganese (Mn), lithium (Li), sodium (Na), nickel (Ni), and silicon (Si) 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 the 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 the SRTC-ML to include any calibration check standards and/or other standards that are part of their standard operating procedures.

6.0 REFERENCE

[1] Herman, C. C., "Task Technical/Quality Assurance Plan: Reduction of Constraints – Phase 2," WSRC-RP-2002-00150, Revision 0, March 11, 2002.

[2] Cozzi, A. D., "Task Technical and QA Plan: PCT Assessment," WSRC-RP-2002-00269, Revision 0, May 1, 2002.

[3] ASTM C1285-97, "Standard Test Methods for Determining Chemical Durability of Nuclear Waste Glasses: The Product Consistency Test (PCT)," 1997.

SRT-SCS-2002-00041

June 17, 2002

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wo – without glass identifiers
es – executive summary only

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AN ANALYTICAL PLAN FOR MEASURING PCT SOLUTIONS FOR RADIOACTIVE GLASSES FROM THE PCT ASSESSMENT STUDY (U)

1.0 EXECUTIVE SUMMARY

A study is being conducted by the Savannah River Technology Center (SRTC) in support of a Tanks Focus Area task that is intended to generate glass property-composition information for the Defense Waste Processing Facility (DWPF). The study is the PCT Assessment Task (Phase 1), which focuses on generating data to further the investigation of models relating PCT (Product Consistency Test) response to glass composition. Thirty-one glass compositions were selected for batching and testing to support the PCT assessment study. Seventeen of these 31 glasses are radioactive, and these glasses are the focus of this analytical plan.

The 17 study glasses were cooled both by quenching and centerline canister cooling, and the durabilities of the resulting thirty-four glasses are to be measured in triplicate using the Product Consistency Test, or PCT. Its requirements are described in ASTM C1285-97 (Method A).

The Savannah River Technology Center-Mobile Laboratory (SRTC-ML) is to be used to measure elemental concentrations of the resulting leachate solutions from the PCTs. This memorandum provides an analytical plan for the SRTC-ML to follow in measuring the compositions of the leachate solutions.

2.0 INTRODUCTION

A study is being conducted by the Savannah River Technology Center (SRTC) in support of a Tanks Focus Area task that is intended to generate glass property-composition information for the Defense Waste Processing Facility (DWPF). This PCT Assessment study [1] involves an evaluation of Product Consistency Test (PCT) response versus the current DWPF durability models. Thirty-one (31) glass compositions were selected for batching and testing in support of Phase 1 of this task. Of these thirty-one glasses, seventeen (17) are radioactive and are the focus of this analytical plan.

The seventeen study glasses were cooled both by quenching and by centerline canister cooling, and the durabilities of the resulting thirty-four glasses are to be measured in triplicate using the PCT method. Its requirements are described in ASTM C1285-97 (Method A) [2].

The identifiers for the study glasses are presented in Table 1. The centerline canister cooled glasses are denoted by a "ccc" suffix.

Table 1: Identifiers for the Radioactive Study Glasses

Quenched	Centerline Canister Cooled	Quenched	Centerline Canister Cooled
ND02	ND02ccc	ND24	ND24ccc
ND04	ND04ccc	ND25	ND25ccc
ND09	ND09ccc	ND26	ND26ccc
ND11	ND11ccc	ND27	ND27ccc
ND16	ND16ccc	ND28	ND28ccc
ND18	ND18ccc	ND29	ND29ccc
ND21	ND21ccc	ND30	ND30ccc
ND22	ND22ccc	ND31	ND31ccc
ND23	ND23ccc		

This memorandum provides an analytical plan for the Savannah River Technology Center's Mobile Laboratory (SRTC-ML) to follow in measuring the compositions of the PCT leachate solutions for the glasses.

3.0 DISCUSSION

The quenched and centerline canister cooled versions of the study glasses are to be subjected to the PCT. The 2 different thermal histories for each of the 17 glasses lead to 34 glasses that are to be measured (in triplicate) using the PCT. In addition to those for the study glasses, triplicate PCTs are to be conducted on a sample of the Approved Reference Material (ARM) 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 110 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 the SRTC-ML. The EA leachates will be further diluted (1:10 v:v) with deionized water prior to submission to the SRTC-ML in order to prevent problems with the nebulizer.

Table 2 presents identifying codes, F001 through F110, for the individual solutions required for the PCTs of the study glasses and of the standards (EA, ARM, and blanks). This provides a naming convention that is to be used by the SRTC-ML in analyzing the solutions and reporting the relevant concentration measurements.[11]

Table 2: Identifiers for the PCT Solutions

Original Sample	Solution Identifier	Original Sample	Solution Identifier	Original Sample	Solution Identifier	Original Sample	Solution Identifier
ND02	F036	ND18	F092	ND25	F058	ND30	F109
ND02	F014	ND18	F043	ND25	F108	ND30	F022
ND02	F095	ND18	F110	ND25	F097	ND30	F002
ND02ccc	F039	ND18ccc	F009	ND25ccc	F045	ND30ccc	F052
ND02ccc	F016	ND18ccc	F060	ND25ccc	F003	ND30ccc	F032
ND02ccc	F106	ND18ccc	F050	ND25ccc	F107	ND30ccc	F090
ND04	F048	ND21	F051	ND26	F057	ND31	F031
ND04	F006	ND21	F087	ND26	F028	ND31	F100
ND04	F053	ND21	F035	ND26	F080	ND31	F104
ND04ccc	F103	ND21ccc	F004	ND26ccc	F061	ND31ccc	F082
ND04ccc	F088	ND21ccc	F070	ND26ccc	F072	ND31ccc	F047
ND04ccc	F068	ND21ccc	F041	ND26ccc	F098	ND31ccc	F074
ND09	F038	ND22	F101	ND27	F069	EA	F086
ND09	F033	ND22	F010	ND27	F044	EA	F075
ND09	F034	ND22	F019	ND27	F059	EA	F023
ND09ccc	F076	ND22ccc	F017	ND27ccc	F081	ARM	F099
ND09ccc	F055	ND22ccc	F067	ND27ccc	F105	ARM	F026
ND09ccc	F085	ND22ccc	F064	ND27ccc	F083	ARM	F042
ND11	F030	ND23	F001	ND28	F018	blank	F049
ND11	F078	ND23	F089	ND28	F102	blank	F077
ND11	F066	ND23	F046	ND28	F029		
ND11ccc	F065	ND23ccc	F012	ND28ccc	F013		
ND11ccc	F027	ND23ccc	F021	ND28ccc	F093		
ND11ccc	F037	ND23ccc	F005	ND28ccc	F071		
ND16	F062	ND24	F094	ND29	F073		
ND16	F063	ND24	F008	ND29	F011		
ND16	F024	ND24	F025	ND29	F015		
ND16ccc	F079	ND24ccc	F020	ND29ccc	F091		
ND16ccc	F056	ND24ccc	F054	ND29ccc	F084		
ND16ccc	F040	ND24ccc	F007	ND29ccc	F096		

4.0 ANALYTICAL PLAN

The analytical plan for the SRTC-ML is provided in this section. Each of the solution samples submitted to the SRTC-ML is to be analyzed only once for each of the following: aluminum, (Al), boron (B), calcium (Ca), iron (Fe), lithium (Li), magnesium (Mg), manganese (Mn), sodium (Na), nickel (Ni), silicon (Si), and uranium (U). The measurements are to be made in parts per million (ppm). The analytical procedure used by the SRTC-ML 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 nine ICP-AES blocks for processing by the SRTC-ML in Table 3. Each block requires a different calibration of the ICP-AES.

[11] Renaming these samples ensures that they will be processed as blind samples by the SRTC-ML. 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 the Leachate Measurements

Block 1	Block 2	Block 3	Block 4	Block 5	Block 6	Block 7	Block 8	Block 9
std-b1-1	std-b2-1	std-b3-1	std-b4-1	std-b5-1	std-b6-1	std-b7-1	std-b8-1	std-b9-1
F058	F003	F029	F009	F022	F095	F076	F010	F066
F049	F054	F035	F103	F006	F110	F086	F021	F042
F018	F063	F096	F109	F105	F106	F012	F072	F023
F004	F070	F041	F048	F100	F090	F061	F055	F037
F045	F056	F015	F082	F044	F050	F057	F089	F005
F094	F008	F007	F052	F032	F068	F065	F027	F046
F079	F093	F107	F069	F088	F083	F099	F028	F080
std-b1-2	std-b2-2	std-b3-2	std-b4-2	std-b5-2	std-b6-2	std-b7-2	std-b8-2	std-b9-2
F051	F102	F024	F092	F060	F002	F001	F067	F098
F091	F084	F097	F039	F016	F053	F101	F078	F085
F062	F108	F040	F081	F047	F059	F038	F033	F019
F013	F077	F071	F031	F014	F074	F017	F026	F064
F020	F011	F025	F036	F043	F104	F030	F075	F034
F073	F087	std-b3-3	std-b4-3	std-b5-3	std-b6-3	std-b7-3	std-b8-3	std-b9-3
std-b1-3	std-b2-3							

A multi-element solution standard (denoted by "std-bi-j" where i=1 to 9 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 nine 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 nine ICP-AES calibration blocks in Table 3 for the SRTC-ML to use in conducting the aluminum, (Al), boron (B), calcium (Ca), iron (Fe), lithium (Li), magnesium (Mg), manganese (Mn), sodium (Na), nickel (Ni), silicon (Si), and uranium (U) concentration measurements for the 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 the 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 the SRTC-ML to include any calibration check standards and/or other standards that are part of their standard operating procedures.

6.0 REFERENCES

[1] Cozzi, A. D., "Task Technical and QA Plan: PCT Assessment," WSRC-RP-2002-00269, Revision 0, May 1, 2002.

[2] ASTM C1285-97, "Standard Test Methods for Determining Chemical Durability of Nuclear Waste Glasses: The Product Consistency Test (PCT)," 1997.

Appendix C

Chemical Composition Results

Table C.1: Measured Elemental Concentrations (wt%) for the ND Glasses Prepared Using Lithium Metaborate

Glass ID	SRTC-ML ID	Block	Sub-Block	Analytical Sequence	Ca	Cr	Fe	Mg	Mn	Na	Ni	P	Si	Ti	Zr
Batch 1	BCHLM111	1	1	1	0.921	0.074	9.26	0.889	1.33	6.97	0.585	<0.200	23.8	0.404	0.063
RC65	X05LM21	1	1	2	0.382	<0.020	3.75	<0.040	0.397	14.7	<0.100	<0.200	28.8	<0.070	<0.010
RC65	X05LM11	1	1	3	0.370	<0.020	3.70	<0.040	0.405	14.5	<0.100	<0.200	28.8	<0.070	<0.010
RC72	X11LM11	1	1	4	0.388	<0.020	8.57	<0.040	0.430	10.6	3.93	<0.200	24.5	1.04	<0.010
RC63	X17LM21	1	1	5	0.388	0.185	3.81	2.33	6.37	8.90	<0.100	0.401	19.8	1.04	0.010
RC63	X17LM11	1	1	6	0.377	0.185	3.69	2.27	6.16	8.58	<0.100	0.402	19.5	1.04	<0.010
RC58	X08LM11	1	1	7	0.378	0.174	3.67	2.29	0.412	5.77	<0.100	0.430	29.2	1.05	0.039
RC71	X13LM11	1	1	8	3.08	<0.020	3.72	2.30	6.66	6.37	3.58	<0.200	24.8	<0.070	<0.010
Batch 1	BCHLM112	1	1	9	0.917	0.075	9.27	0.907	1.32	6.89	0.592	<0.200	23.7	0.410	0.064
RC72	X11LM21	1	1	10	0.380	<0.020	8.55	<0.040	0.437	10.5	3.90	<0.200	24.2	1.06	<0.010
RC69	X18LM11	1	1	11	2.96	<0.020	3.55	<0.040	6.35	7.18	3.63	<0.200	18.9	1.04	<0.010
RC71	X13LM21	1	1	12	3.10	<0.020	3.61	2.23	6.47	6.38	3.40	<0.200	24.4	<0.070	<0.010
RC58	X08LM21	1	1	13	0.375	0.204	3.65	2.26	0.407	6.10	<0.100	0.432	27.8	1.03	0.074
RC69	X18LM21	1	1	14	3.00	<0.020	3.66	<0.040	6.51	7.28	3.81	<0.200	19.2	1.05	<0.010
RC66	X03LM11	1	1	15	2.99	0.198	7.02	<0.040	6.47	10.1	<0.100	0.4148	25.0	<0.070	0.019
RC66	X03LM21	1	1	16	3.10	0.201	7.11	<0.040	6.70	10.4	<0.100	0.412	25.6	<0.070	0.019
Batch 1	BCHLM113	1	1	17	0.917	0.075	9.27	0.907	1.32	6.94	0.591	<0.200	23.8	0.412	0.064
Batch 1	BCHLM121	1	2	1	0.923	0.070	9.20	0.882	1.31	7.25	0.578	<0.200	23.8	0.404	0.058
RC58	X08LM22	1	2	2	0.379	0.196	3.59	2.24	0.398	6.05	<0.100	0.423	27.7	1.01	0.070
RC72	X11LM12	1	2	3	0.380	<0.020	8.57	<0.040	0.423	11.2	3.95	<0.200	24.6	1.04	<0.010
RC71	X13LM22	1	2	4	3.15	<0.020	3.56	2.22	6.49	6.57	3.41	<0.200	24.4	<0.070	<0.010
RC63	X17LM22	1	2	5	0.388	0.181	3.76	2.31	6.36	9.17	<0.100	0.401	19.9	1.04	<0.010
RC66	X03LM12	1	2	6	3.08	0.191	6.99	<0.040	6.47	10.6	<0.100	0.405	24.9	<0.070	0.014
RC63	X17LM12	1	2	7	0.37	0.179	3.65	2.26	6.21	9.07	<0.100	0.399	19.5	1.04	<0.010
RC71	X13LM12	1	2	8	3.17	<0.020	3.67	2.29	6.68	6.59	3.59	<0.200	24.9	<0.070	<0.010
Batch 1	BCHLM122	1	2	9	0.92	0.071	9.20	0.890	1.31	7.28	0.583	<0.200	23.9	0.407	0.059
RC69	X18LM12	1	2	10	3.01	<0.020	3.54	<0.040	6.37	7.49	3.65	<0.200	18.8	1.04	<0.010
RC72	X11LM22	1	2	11	0.39	<0.020	8.48	<0.040	0.433	11.0	3.89	<0.200	24.3	1.06	<0.010
RC65	X05LM12	1	2	12	0.362	<0.020	3.68	<0.040	0.401	15.1	<0.100	<0.200	28.8	<0.070	<0.010
RC58	X08LM12	1	2	13	0.370	0.171	3.65	2.28	0.407	6.19	<0.100	0.422	29.3	1.05	0.032

Table C.1: Measured Elemental Concentrations (wt%) for the ND Glasses Prepared Using Lithium Metaborate *(continued)*

Glass ID	SRTC-ML ID	Block	Sub-Block	Analytical Sequence	Ca	Cr	Fe	Mg	Mn	Na	Ni	P	Si	Ti	Zr
RC69	X18LM22	1	2	14	3.06	<0.020	3.62	<0.040	6.50	7.54	3.80	<0.200	19.1	1.04	<0.010
RC66	X03LM22	1	2	15	3.19	0.191	7.00	<0.040	6.62	10.8	<0.100	0.405	25.6	<0.070	0.013
RC65	X05LM22	1	2	16	0.374	<0.020	3.70	<0.040	0.397	15.3	<0.100	<0.200	29.0	<0.070	<0.010
Batch 1	BCHLM123	1	2	17	0.921	0.071	9.13	0.890	1.31	7.38	0.584	<0.200	23.7	0.407	0.058
Batch 1	BCHLM211	2	1	1	0.930	0.070	9.22	0.890	1.33	7.18	0.580	<0.200	23.6	0.403	0.058
ND08	X14LM11	2	1	2	0.375	<0.020	3.60	2.21	6.39	11.0	<0.100	<0.200	19.8	<0.070	<0.010
ND08	X14LM21	2	1	3	0.358	<0.020	3.57	2.23	6.43	11.1	<0.100	<0.200	19.8	<0.070	<0.010
ND03	X12LM21	2	1	4	0.376	0.187	3.52	2.21	6.37	11.6	<0.100	0.416	22.5	1.04	0.045
ND05	X01LM11	2	1	5	3.02	0.189	3.61	<0.040	6.46	10.0	<0.100	0.426	20.3	<0.070	0.057
ND06	X16LM21	2	1	6	0.357	0.053	3.51	<0.040	0.392	10.6	<0.100	<0.200	28.8	<0.070	<0.010
ND03	X12LM11	2	1	7	0.376	0.186	3.53	2.21	6.41	11.9	<0.100	0.410	22.7	1.05	0.036
ND05	X01LM21	2	1	8	3.17	0.194	3.63	<0.040	6.45	10.3	<0.100	0.429	20.4	<0.070	0.045
Batch 1	BCHLM212	2	1	9	0.911	0.071	9.24	0.906	1.32	7.26	0.588	<0.200	23.8	0.406	0.058
ND01	X20LM11	2	1	10	3.01	<0.020	3.72	<0.040	6.18	17.4	<0.100	<0.200	22.6	<0.070	0.018
ND07	X07LM11	2	1	11	3.14	<0.020	3.56	<0.040	0.400	12.9	<0.100	<0.200	28.4	1.05	<0.010
ND10	X10LM21	2	1	12	3.22	<0.020	10.42	2.23	0.429	11.3	<0.100	<0.200	21.0	<0.070	<0.010
ND07	X07LM21	2	1	13	3.20	<0.020	3.55	<0.040	0.401	13.1	<0.100	<0.200	28.4	1.05	<0.010
ND01	X20LM21	2	1	14	3.08	<0.020	3.69	<0.040	6.30	17.9	<0.100	<0.200	22.8	<0.070	0.011
ND10	X10LM11	2	1	15	3.16	<0.020	10.48	2.25	0.429	10.9	<0.100	<0.200	21.1	<0.070	<0.010
ND06	X16LM11	2	1	16	0.348	0.059	3.46	<0.040	0.388	10.8	<0.100	<0.200	28.5	<0.070	<0.010
Batch 1	BCHLM213	2	1	17	0.917	0.071	9.26	0.911	1.34	7.30	0.594	<0.200	24.0	0.410	0.057
Batch 1	BCHLM221	2	2	1	0.923	0.071	9.25	0.894	1.34	7.27	0.584	<0.200	23.9	0.403	0.060
ND06	X16LM12	2	2	2	0.357	0.059	3.44	<0.040	0.384	10.8	<0.100	<0.200	27.9	<0.070	<0.010
ND05	X01LM22	2	2	3	3.12	0.194	3.61	<0.040	6.55	10.3	<0.100	0.432	20.4	<0.070	0.047
ND03	X12LM12	2	2	4	0.384	0.187	3.52	2.23	6.41	11.7	<0.100	0.421	22.6	1.06	0.041
ND08	X14LM12	2	2	5	0.368	<0.020	3.60	2.25	6.49	11.3	<0.100	<0.200	19.8	<0.070	<0.010
ND08	X14LM22	2	2	6	0.360	<0.020	3.56	2.25	6.51	11.3	<0.100	<0.200	19.8	<0.070	<0.010
ND10	X10LM22	2	2	7	3.10	<0.020	10.41	2.25	0.431	11.2	<0.100	<0.200	20.9	<0.070	<0.010
ND03	X12LM22	2	2	8	0.390	0.192	3.53	2.24	6.46	11.8	<0.100	0.430	22.7	1.06	0.048
Batch 1	BCHLM222	2	2	9	0.924	0.072	9.30	0.913	1.35	7.39	0.597	<0.200	23.9	0.408	0.061

Table C.1: Measured Elemental Concentrations (wt%) for the ND Glasses Prepared Using Lithium Metaborate *(continued)*

SRTC-ML ID	Glass ID	Block	Sub-Block	Analytical Sequence	Ca	Cr	Fe	Mg	Mn	Na	Ni	P	Si	Ti	Zr
ND07	X07LM12	2	2	10	3.17	<0.020	3.56	<0.040	0.410	13.2	<0.100	<0.200	28.5	1.07	<0.010
ND06	X16LM22	2	2	11	0.369	0.054	3.55	<0.040	0.400	10.9	<0.100	<0.200	29.4	<0.070	<0.010
ND10	X10LM12	2	2	12	3.13	<0.020	10.53	2.28	0.440	11.0	<0.100	<0.200	21.2	<0.070	<0.010
ND07	X07LM22	2	2	13	3.16	<0.020	3.60	<0.040	0.410	13.2	<0.100	<0.200	28.5	1.07	<0.010
ND01	X20LM12	2	2	14	2.92	<0.020	3.71	<0.040	6.28	17.7	<0.100	<0.200	22.5	<0.070	0.019
ND01	X20LM22	2	2	15	3.04	<0.020	3.68	<0.040	6.40	18.3	<0.100	<0.200	22.7	<0.070	0.015
ND05	X01LM12	2	2	16	2.91	0.195	3.50	<0.040	6.41	10.0	<0.100	0.445	20.0	<0.070	0.059
Batch 1	BCHLM223	2	2	17	0.942	0.074	9.22	0.933	1.34	7.23	0.610	<0.200	23.8	0.419	0.063
Batch 1	BCHSP311	3	1	1	0.919	0.070	9.18	0.902	1.33	7.38	0.587	<0.200	23.6	0.406	0.058
ND19	X04LM11	3	1	2	0.477	<0.020	4.04	<0.040	7.33	11.8	3.37	<0.200	23.6	<0.070	<0.010
ND13	X19LM21	3	1	3	0.372	0.180	3.66	2.06	0.401	17.9	3.97	0.449	22.5	<0.070	0.061
ND15	X06LM11	3	1	4	3.01	0.193	3.51	<0.040	6.32	5.82	3.69	0.440	20.7	1.05	0.065
ND15	X06LM21	3	1	5	3.07	0.193	3.56	<0.040	6.42	5.95	3.73	0.452	21.0	1.06	0.065
ND13	X19LM11	3	1	6	0.373	0.190	3.63	2.07	0.406	18.2	4.00	0.451	22.6	<0.070	0.061
ND17	X02LM21	3	1	7	0.367	<0.020	3.54	2.21	6.49	10.5	3.87	<0.200	24.3	1.07	<0.010
ND14	X15LM11	3	1	8	3.25	<0.020	3.74	2.34	0.429	18.3	<0.100	<0.200	22.2	1.13	<0.010
Batch 1	BCHLM312	3	1	9	0.917	0.070	9.19	0.91	1.32	7.25	0.593	<0.200	23.9	0.408	0.058
ND12	X09LM21	3	1	10	3.10	0.194	12.45	<0.040	0.426	13.2	<0.100	0.444	21.5	1.06	0.059
ND19	X04LM21	3	1	11	0.418	<0.020	4.21	<0.040	7.35	11.9	3.4	<0.200	23.7	<0.070	<0.010
ND17	X02LM11	3	1	12	0.370	<0.020	3.56	2.22	6.45	10.4	3.8	<0.200	23.9	1.07	<0.010
ND20	X21LM11	3	1	13	0.334	<0.020	10.97	<0.040	0.414	10.7	2.97	<0.200	18.4	0.948	<0.010
ND14	X15LM21	3	1	14	3.15	<0.020	3.72	2.33	0.429	17.7	<0.100	<0.200	21.9	1.13	<0.010
ND20	X21LM21	3	1	15	0.336	<0.020	11.10	<0.040	0.415	10.8	2.94	<0.200	18.6	0.953	<0.010
ND12	X09LM11	3	1	16	3.03	0.188	12.55	<0.040	0.434	12.9	<0.100	0.454	21.7	1.07	0.063
Batch 1	BCHLM313	3	1	17	0.901	0.072	9.30	0.916	1.34	7.23	0.602	<0.200	23.8	0.410	0.059
Batch 1	BCHLM321	3	2	1	0.918	0.070	9.09	0.87907	1.27	7.16	0.584	<0.200	23.4	0.407	0.058
ND17	X02LM12	3	2	2	0.374	<0.020	3.55	2.19	6.40	10.3	3.79	<0.200	23.5	1.05	<0.010
ND19	X04LM12	3	2	3	0.429	<0.020	4.03	<0.040	7.34	11.7	3.36	<0.200	23.4	<0.070	<0.010
ND20	X21LM12	3	2	4	0.329	<0.020	11.00	<0.040	0.409	10.5	2.94	<0.200	18.2	0.934	<0.010
ND15	X06LM22	3	2	5	3.08	0.192	3.55	<0.040	6.43	5.91	3.74	0.451	20.7	1.05	0.063

Table C.1: Measured Elemental Concentrations (wt%) for the ND Glasses Prepared Using Lithium Metaborate *(continued)*

Glass ID	SRTC-ML ID	Block	Sub-Block	Analytical Sequence	Ca	Cr	Fe	Mg	Mn	Na	Ni	P	Si	Ti	Zr
ND13	X19LM22	3	2	6	0.373	0.180	3.63	2.03	0.403	17.7	3.92	0.456	22.4	<0.070	0.061
ND15	X06LM12	3	2	7	3.03	0.192	3.53	<0.040	6.37	5.82	3.71	0.451	20.6	1.04	0.065
ND19	X04LM22	3	2	8	0.425	<0.020	4.17	<0.040	7.32	11.5	3.38	<0.200	23.3	<0.070	<0.010
Batch 1	BCHLM322	3	2	9	0.910	0.071	9.20	0.893	1.28	7.12	0.593	<0.200	23.6	0.408	0.058
ND12	X09LM22	3	2	10	3.05	0.194	12.40	<0.040	0.427	12.8	<0.100	0.453	21.2	1.05	0.059
ND17	X02LM22	3	2	11	0.370	<0.020	3.56	2.2	6.45	10.3	3.85	<0.200	23.9	1.07	<0.010
ND20	X21LM22	3	2	12	0.341	<0.020	11.1	<0.040	0.414	10.6	2.89	<0.200	18.4	0.954	<0.010
ND12	X09LM12	3	2	13	3.03	0.189	12.4	<0.040	0.437	12.9	<0.100	0.457	21.3	1.08	0.064
ND14	X15LM12	3	2	14	3.22	<0.020	3.80	2.37	0.432	17.8	<0.100	<0.200	21.9	1.14	<0.010
ND13	X19LM12	3	2	15	0.378	0.191	3.59	2.05	0.410	17.9	3.95	0.458	22.4	<0.070	0.060
ND14	X15LM22	3	2	16	3.21	<0.020	3.76	2.34	0.434	17.7	<0.100	<0.200	21.8	1.14	<0.010
Batch 1	BCHSP323	3	2	17	0.932	0.072	9.16	0.908	1.27	7.20	0.606	<0.200	23.5	0.418	0.059

Table C.2: Measured Elemental Concentrations (wt%) for the ND Glasses Prepared Using Lithium Metaborate

Glass ID	SRTC-ML ID	Block	Sub-Block	Analytical Sequence	Ca	Cr	Fe	Mg	Mn	Na	Ni	P	Si	Th	Ti	U	Zr
Batch 1	BCHLM111	1	1	1	0.87872	0.073048	8.9346	0.85245	1.2584	7.1095	0.55748	<0.040	22.728	<0.010	0.39292	<0.100	0.051883
U std	USTLM111	1	1	2	0.98389	0.15932	8.9977	0.70882	2.0899	8.9041	0.77361	<0.040	21.249	0.052987	0.56069	1.9289	<0.010
RC70	U01LM11	1	1	3	0.36448	0.007019	3.4432	2.3085	0.398	10.663	2.4799	<0.040	21.326	0.18118	<0.010	6.695	<0.010
RC83	U11LM11	1	1	4	2.3226	0.041317	5.038	0.48208	5.1444	10.3	2.839	0.089951	21.193	0.034184	0.21047	1.31	0.009848
RC59	U02LM11	1	1	5	0.37592	0.009221	3.4652	<0.010	6.594	6.4314	<0.010	<0.040	21.919	0.1806	1.039	6.7334	<0.010
RC95	U49LM11	1	1	6	0.72766	0.066998	7.2476	0.26256	1.7828	9.2222	0.37621	0.14371	25.017	0.057775	0.00829	1.7141	0.019278
RC86	U42LM21	1	1	7	0.89043	0.12804	4.7067	1.7551	5.1678	8.8289	0.71584	0.33168	20.857	0.036882	0.82021	1.3903	0.013914
RC64	U26LM11	1	1	8	0.39414	0.16708	9.2289	0.012356	0.416	5.8519	0.026872	0.39774	21.31	0.18054	<0.010	6.6253	<0.010
RC70	U01LM21	1	1	9	0.3631	0.007163	3.4094	2.2925	0.399	10.52	2.4629	<0.040	21.377	0.17926	<0.010	6.6964	<0.010
RC85	U24LM11	1	1	10	0.88867	0.041421	4.73	0.48605	1.51	8.5666	1.8133	0.094111	20.538	0.14195	0.80189	5.3072	<0.010
Batch 1	BCHLM112	1	1	11	0.88916	0.074876	8.9214	0.876	1.2668	7.1234	0.57387	<0.040	22.396	<0.010	0.40156	<0.100	0.052082
U std	USTLM112	1	1	12	0.96555	0.1609	8.9415	0.70694	2.0756	8.8471	0.77139	<0.040	20.855	0.053011	0.55976	1.9291	<0.010
RC75	U45LM11	1	1	13	2.3253	0.043759	5.4296	1.8925	1.5683	8.509	0.79311	0.092172	24.077	0.038815	0.81672	1.4243	0.010307
RC94	U43LM21	1	1	14	0.76291	0.072591	7.4424	0.19929	1.1592	9.6128	0.4605	0.14122	24.914	0.079253	<0.010	2.4375	0.020466
RC62	U33LM11	1	1	15	0.3571	0.006577	2.969	<0.010	6.1986	5.5956	1.7954	<0.040	19.095	0.18136	<0.010	6.772	<0.010
RC77	U04LM11	1	1	16	2.3105	0.039478	6.2035	1.8325	1.4813	8.6205	0.72641	0.082388	20.244	0.14434	0.20785	5.3624	<0.010
RC89	U29LM11	1	1	17	0.6996	0.090383	8.1501	0.021347	0.674	9.327	0.97817	0.20851	25.642	0.10122	0.013505	3.0609	0.030567
RC75	U45LM21	1	1	18	2.2377	0.042826	5.238	1.8223	1.57	8.36	0.76528	0.092411	23.8	0.037276	0.78034	1.46	<0.010
RC97	U19LM11	1	1	19	0.46506	0.11461	7.3367	0.99276	3.0769	10.011	2.0071	0.3118	20.003	0.14779	0.01518	4.5356	0.044749
RC92	U28LM21	1	1	20	0.71469	0.10284	7.9422	0.032628	4.0618	8.9871	0.10451	0.23763	23.045	0.10502	0.011856	3.1116	0.034883
RC73	U25LM21	1	1	21	2.3283	0.13171	5.3537	0.49481	1.6336	8.354	0.74836	0.33439	20.187	0.14176	0.82382	5.1245	0.013089
Batch 1	BCHLM113	1	1	22	0.90544	0.075092	8.941	0.87445	1.2588	7.0393	0.57304	<0.040	22.192	<0.010	0.4039	<0.100	0.051963
U std	USTLM113	1	1	23	0.98563	0.1612	9.0734	0.70853	2.1084	8.9024	0.77399	<0.040	20.828	0.053157	0.55729	1.9289	<0.010
Batch 1	BCHLM121	1	2	1	0.8949	0.075289	8.9898	0.87503	1.2453	7.2306	0.57223	<0.040	23.149	<0.010	0.40344	<0.100	0.052877
U std	USTLM121	1	2	2	0.99784	0.15984	9.0462	0.70626	2.0684	8.9467	0.7734	<0.040	21.458	0.053661	0.56324	1.8968	<0.010
RC64	U26LM12	1	2	3	0.40237	0.16675	9.3429	0.01261	0.419	5.9604	0.027238	0.39532	21.752	0.18151	<0.010	6.6772	<0.010
RC97	U19LM12	1	2	4	0.48069	0.11443	7.3932	0.99778	3.064	10.169	2.021	0.3133	20.72	0.14695	0.018359	4.5393	0.046105
RC95	U49LM12	1	2	5	0.74697	0.067436	7.4371	0.264	1.799	9.5586	0.37681	0.14575	25.874	0.059481	0.011655	1.7107	0.021378
RC94	U43LM22	1	2	6	0.77632	0.072814	7.5426	0.19998	1.149	9.763	0.4641	0.14092	25.65	0.079216	<0.010	2.4311	0.021527
RC75	U45LM12	1	2	7	2.3807	0.044666	5.5919	1.8843	1.5763	8.6123	0.80029	0.093522	24.868	0.039093	0.822	1.4051	0.011753

Table C.2: Measured Elemental Concentrations (wt%) for the ND Glasses Prepared Using Lithium Metaborate *(continued)*

Glass ID	SRTC-ML ID	Block	Sub-Block	Analytical Sequence	Ca	Cr	Fe	Mg	Mn	Na	Ni	P	Si	Th	Ti	U	Zr
RC70	U01LM12	1	2	8	0.37413	0.007122	3.495	2.2896	0.399	10.85	2.4675	<0.040	21.569	0.18002	0.004629	6.7334	<0.010
RC86	U42LM22	1	2	9	0.91616	0.12804	4.6849	1.751	5.1474	8.9809	0.7176	0.33209	21.02	0.037674	0.8246	1.3801	0.014344
RC89	U29LM12	1	2	10	0.7279	0.091496	8.4325	0.021728	0.68	9.4002	0.98121	0.21404	26.398	0.10243	0.017336	3.0388	0.032132
Batch 1	BCHLM122	1	2	11	0.92626	0.074766	9.0055	0.87777	1.2456	7.2415	0.57506	<0.040	22.915	<0.010	0.4091	<0.100	0.053034
U std	USTLM122	1	2	12	0.99632	0.15991	9.1045	0.71028	2.0842	9.0244	0.77842	<0.040	21.425	0.05421	0.56896	1.943	<0.010
RC70	U01LM22	1	2	13	0.37873	0.00725	3.4084	2.2917	0.402	10.631	2.4724	<0.040	21.614	0.17999	0.004697	6.7411	<0.010
RC77	U04LM12	1	2	14	2.3853	0.040432	6.2875	1.8511	1.4729	8.7641	0.73886	0.082298	20.76	0.14825	0.21364	5.3891	<0.010
RC83	U11LM12	1	2	15	2.3906	0.041901	5.07	0.48309	5.1418	10.474	2.8553	0.091111	21.337	0.035926	0.21608	1.3097	0.011432
RC62	U33LM12	1	2	16	0.37182	0.006695	2.9926	<0.010	6.208	5.7068	1.817	<0.040	19.473	0.18437	<0.010	6.7603	<0.010
RC85	U24LM12	1	2	17	0.91961	0.042262	4.7843	0.4895	1.4941	8.6744	1.8317	0.093318	20.755	0.14525	0.81502	5.3083	0.010512
RC59	U02LM12	1	2	18	0.3874	0.009765	3.5038	<0.010	6.6008	6.5591	<0.010	<0.040	22.081	0.18041	1.0307	6.7946	<0.010
RC73	U25LM22	1	2	19	2.3809	0.13245	5.2924	0.49809	1.6064	8.5513	0.7533	0.33591	20.646	0.14182	0.82431	5.1729	0.013457
RC75	U45LM22	1	2	20	2.2992	0.043185	5.3647	1.8142	1.5109	8.5386	0.76513	0.094418	23.974	0.03658	0.78986	1.3761	0.010297
RC92	U28LM22	1	2	21	0.74148	0.10354	7.9298	0.033145	4.0607	9.2339	0.10521	0.24009	23.569	0.10445	0.015678	3.1506	0.035499
Batch 1	BCHLM123	1	2	22	0.93602	0.074497	8.9355	0.87968	1.2322	7.1814	0.57785	<0.040	22.56	<0.010	0.40929	<0.100	0.053494
U std	USTLM123	1	2	23	1.0155	0.16103	9.0041	0.71313	2.0645	9.0253	0.77749	<0.040	21.098	0.052664	0.56894	1.9167	<0.010
Batch 1	BCHLM211	2	1	1	0.92821	0.075421	8.9837	0.87851	1.2853	7.1588	0.57449	<0.040	22.793	<0.010	0.40573	<0.100	0.050923
U std	USTLM211	2	1	2	0.99227	0.15959	9.0251	0.70738	2.1098	8.9245	0.77459	<0.040	21.241	0.050485	0.56089	1.9376	<0.010
RC68	U46LM21	2	1	3	0.396	0.1538	3.74	<0.010	6.2263	9.9943	3.3496	0.43173	20.35	0.17184	1.0101	6.4909	0.058772
RC90	U05LM11	2	1	4	0.59739	0.045958	6.39	0.026617	3.43	8.75	0.086047	0.099647	25.3	0.036482	<0.010	1.22	0.011012
RC67	U06LM21	2	1	5	2.6676	0.01559	5.5827	<0.010	0.401	5.5577	1.3899	<0.040	22.5	0.18352	0.98317	6.3184	<0.010
RC59	U02LM21	2	1	6	0.37018	0.009943	3.2847	<0.010	6.1976	6.084	<0.010	<0.040	20.493	0.17407	1.0148	6.3348	<0.010
RC74	U23LM11	2	1	7	0.89628	0.13229	4.9949	0.51722	1.4995	8.0827	0.77204	0.32035	24.515	0.035589	0.21111	1.3561	<0.010
RC80	U12LM11	2	1	8	1.003	0.15714	5.7352	1.9925	1.6346	13.334	0.82295	0.3687	21.896	0.079495	0.23365	2.9329	0.026002
RC77	U04LM21	2	1	9	2.347	0.042906	6.4738	1.8533	1.5634	9.1428	0.73441	0.081115	21.333	0.14128	0.2096	5.612	<0.010
RC82	U14LM21	2	1	10	0.92396	0.12818	4.6986	1.8759	4.9422	8.5538	1.8555	0.34889	19.604	0.035332	0.8223	1.3409	0.04646
Batch 1	BCHLM212	2	1	11	0.90813	0.074136	8.8967	0.87729	1.278	7.1233	0.57247	<0.040	22.483	<0.010	0.40267	<0.100	0.05025
U std	USTLM212	2	1	12	0.97791	0.16025	8.9611	0.70701	2.0973	8.915	0.77633	<0.040	20.966	0.050075	0.56089	1.923	<0.010
RC96	U15LM21	2	1	13	1.5328	0.084918	4.8285	1.2002	3.7868	8.6194	1.1136	0.20984	20.183	0.11069	0.56644	4.1732	0.024853
RC92	U28LM11	2	1	14	0.72638	0.10211	7.6727	0.032027	4.0034	8.7804	0.10415	0.23699	22.942	0.10338	0.013399	3.1184	0.032627

Table C.2: Measured Elemental Concentrations (wt%) for the ND Glasses Prepared Using Lithium Metaborate *(continued)*

Glass ID	SRTC-ML ID	Block	Sub-Block	Analytical Sequence	Ca	Cr	Fe	Mg	Mn	Na	Ni	P	Si	Th	Ti	U	Zr
RC76	U27LM21	2	1	15	0.8999	0.043976	4.9681	0.48578	4.942	10.508	0.76094	0.093017	19.815	0.14138	0.8111	5.1257	<0.010
RC87	U07LM21	2	1	16	0.90316	0.040693	6.5584	0.47601	1.526	11.937	2.4455	0.086125	20.518	0.03579	0.82256	1.3784	<0.010
RC93	U32LM11	2	1	17	0.76911	0.10767	7.9887	0.67129	1.3901	10.691	0.11008	0.23394	24.277	0.10598	0.011325	3.2843	0.032433
RC87	U07LM11	2	1	18	0.88046	0.040084	6.4003	0.46076	1.4823	11.601	2.3868	0.081929	19.946	0.032818	0.7871	1.328	<0.010
RC61	U47LM11	2	1	19	0.39036	0.009297	10.059	2.1314	5.9319	5.8263	0.087894	<0.040	19.888	0.13163	0.95622	4.9135	<0.010
RC60	U38LM11	2	1	20	2.7821	0.1781	3.4688	2.2414	0.382	9.9631	<0.010	0.41226	18.201	0.1741	1.0154	6.6715	0.01534
RC96	U15LM11	2	1	21	1.5332	0.083714	4.7535	1.1646	3.7463	8.6345	1.0721	0.20827	19.998	0.10764	0.5506	4.1453	0.024321
Batch 1	BCHLM213	2	1	22	0.92512	0.074601	8.9421	0.87351	1.2832	7.2273	0.57316	<0.040	22.458	<0.010	0.40659	<0.100	0.050321
U std	USTLM213	2	1	23	0.99978	0.16156	9.0246	0.71255	2.1092	9.012	0.78188	<0.040	20.995	0.050811	0.56809	1.9583	<0.010
Batch 1	BCHLM221	2	2	1	0.91836	0.071605	8.9289	0.87305	1.2547	7.136	0.57203	<0.040	22.933	<0.010	0.40435	<0.100	0.049021
U std	USTLM221	2	2	2	0.98219	0.15692	9.0758	0.70735	2.099	8.9957	0.77166	<0.040	21.611	0.048379	0.55439	1.9295	<0.010
RC92	U28LM12	2	2	3	0.90416	0.1304	7.66	0.51683	4.09	8.54	0.77402	0.32371	23.1	0.032223	0.2103	3.2	<0.010
RC96	U15LM22	2	2	4	1.5261	0.08232	4.9631	1.2046	3.8512	8.7606	1.1149	0.20907	21.004	0.10925	0.56057	4.2509	0.023646
RC76	U27LM22	2	2	5	0.88454	0.040635	5.3915	0.48386	5.2676	11.156	0.75919	0.091643	21.505	0.13726	0.79188	5.4321	<0.010
RC87	U07LM12	2	2	6	0.89316	0.038715	7.0298	0.47008	1.6041	12.314	2.4253	0.085753	21.911	0.032709	0.80695	1.3995	<0.010
RC60	U38LM12	2	2	7	2.7658	0.17639	3.4945	2.2341	0.382	9.9045	<0.010	0.41338	18.663	0.17347	1.0081	6.7026	0.013514
RC82	U14LM22	2	2	8	0.92707	0.12591	5.1802	1.88	5.4326	9.3539	1.859	0.34843	21.835	0.033822	0.83419	1.4581	0.045121
RC80	U12LM12	2	2	9	1.0083	0.15531	6.0814	2.0092	1.713	14.01	0.82652	0.37	23.358	0.078785	0.23277	3.093	0.024588
RC93	U32LM12	2	2	10	0.75648	0.10484	7.9663	0.66975	1.3548	10.587	0.10875	0.23281	24.598	0.10398	<0.010	3.2571	0.031171
Batch 1	BCHLM222	2	2	11	0.90396	0.071854	8.9937	0.87708	1.2623	7.2331	0.57097	<0.040	22.908	<0.010	0.40085	<0.100	0.048304
U std	USTLM222	2	2	12	0.97461	0.15718	9.0346	0.70439	2.0916	8.9767	0.7687	<0.040	21.326	0.049394	0.55895	1.944	<0.010
RC61	U47LM12	2	2	13	0.38907	0.006527	10.108	2.141	5.9506	5.8552	0.088328	<0.040	20.353	0.13193	0.95864	4.9532	<0.010
RC67	U06LM22	2	2	14	2.707	0.01297	6.0995	<0.010	0.404	6.0633	1.3968	<0.040	22.877	0.18431	0.98726	6.9065	<0.010
RC59	U02LM22	2	2	15	0.37502	0.006653	3.664	<0.010	6.8036	6.7337	<0.010	<0.040	22.637	0.17551	1.018	6.9616	<0.010
RC90	U05LM12	2	2	16	0.60116	0.043378	6.7561	0.027067	3.5109	9.3413	0.086105	0.098612	26.579	0.035449	<0.010	1.2024	<0.010
RC96	U15LM12	2	2	17	1.5287	0.080254	4.8189	1.1734	3.7499	8.649	1.0796	0.20896	20.314	0.10584	0.54881	4.1449	0.022639
RC74	U23LM12	2	2	18	0.485	0.133	5	0.52	1.56	8.21	0.777	0.321	25.3	0.033	0.212	1.45	<0.010
RC87	U07LM22	2	2	19	0.89773	0.037822	6.708	0.47521	1.5237	11.94	2.4382	0.08485	20.942	0.033309	0.81383	1.3615	<0.010
RC77	U04LM22	2	2	20	2.3991	0.040378	6.08	1.8576	1.52	8.69	0.73175	0.082411	20.5	0.14211	0.20839	5.55	<0.010
RC68	U46LM22	2	2	21	0.39564	0.15206	3.9459	<0.010	6.4403	10.406	3.3439	0.43477	21.207	0.17156	1.0033	6.7411	0.057411

Table C.2: Measured Elemental Concentrations (wt%) for the ND Glasses Prepared Using Lithium Metaborate *(continued)*

Glass ID	SRTC-ML ID	Block	Sub-Block	Analytical Sequence	Ca	Cr	Fe	Mg	Mn	Na	Ni	P	Si	Th	Ti	U	Zr
Batch 1	BCHLM223	2	2	22	0.91752	0.072638	8.9002	0.88105	1.2501	7.1432	0.57695	<0.040	22.7	<0.010	0.40414	<0.100	0.048842
U std	USTLM223	2	2	23	1.0177	0.15834	8.9924	0.71221	2.0832	9.0396	0.77659	<0.040	21.225	0.04929	0.56455	1.9334	<0.010
Batch 1	BCHLM311	3	1	1	0.92493	0.074612	8.9572	0.87786	1.2571	7.1606	0.56848	<0.040	22.906	<0.010	0.40342	<0.100	0.051803
U std	USTLM311	3	1	2	0.98784	0.15871	9.0008	0.70788	2.0895	8.9897	0.76773	<0.040	21.395	0.05214	0.55691	1.938	<0.010
RC95	U49LM21	3	1	3	0.75317	0.068052	7.15	0.25617	1.83	9.23	0.3663	0.13307	25.1	0.056397	0.010308	1.78	0.018387
RC62	U33LM21	3	1	4	0.37428	0.007324	2.77	<0.010	6.34	5.62	1.775	<0.040	19.5	0.17932	<0.010	6.98	<0.010
RC74	U23LM21	3	1	5	0.9353	0.13427	4.7048	0.52162	1.4	7.8034	0.7692	0.33032	23.823	0.036492	0.21285	1.2773	0.01017
RC79	U39LM11	3	1	6	0.82908	0.033023	4.2061	0.44396	4.2839	7.4444	0.61584	0.076246	19.4	0.031976	0.18987	1.1208	<0.010
RC89	U29LM21	3	1	7	0.67634	0.08259	7.35	0.014845	0.621	8.49	0.89453	0.19872	24.3	0.093076	0.012803	2.93	0.027207
RC67	U06LM11	3	1	8	2.7737	0.015282	5.7545	<0.010	0.386	5.7173	1.306	0.02622	22.2	0.18103	0.9365	6.5659	<0.010
RC81	U10LM21	3	1	9	0.94119	0.039987	5.0053	1.8801	2.5016	8.6457	1.3454	0.091303	20.752	0.14584	0.21515	5.3368	<0.010
RC91	U21LM11	3	1	10	0.93579	0.04934	6.5051	0.031709	1.1117	10.322	0.090487	0.091655	25.347	0.078529	0.009302	2.6941	0.010736
Batch 1	BCHLM312	3	1	11	0.92003	0.074949	8.8699	0.87886	1.2482	7.1574	0.57028	<0.040	22.577	<0.010	0.40257	<0.100	0.050583
U std	USTLM312	3	1	12	0.9996	0.15775	8.9837	0.69777	2.0862	9.0862	0.76059	<0.040	21.136	0.05211	0.55806	1.939	<0.010
RC83	U11LM21	3	1	13	2.3751	0.040809	4.95	0.47186	5.26	10.2	2.7834	0.089286	21.3	0.034514	0.20914	1.38	<0.010
RC88	U03LM11	3	1	14	0.69612	0.048286	7.22	0.011476	3.47	8.71	0.087998	0.093411	24.7	0.06023	<0.010	1.89	0.012369
RC64	U26LM21	3	1	15	0.41032	0.16369	9.13	0.007194	0.409	5.74	0.024579	0.40099	21.1	0.17952	<0.010	6.77	<0.010
RC97	U19LM21	3	1	16	0.48557	0.11443	7.21	1.0046	3.12	9.72	1.9956	0.32046	20.2	0.14772	0.017673	4.68	0.047948
RC84	U44LM21	3	1	17	0.94171	0.11831	7.25	0.48197	3.79	8.58	0.93143	0.34793	20.9	0.14499	0.21222	5.59	0.048181
RC80	U12LM21	3	1	18	1.0478	0.15529	6.003	1.969	1.714	14.196	0.81805	0.3615	23.373	0.083236	0.23746	3.1291	0.011059
RC84	U44LM11	3	1	19	0.95247	0.12661	7.3915	0.49168	3.7506	8.8498	0.99517	0.35109	20.915	0.15161	0.21881	5.4476	0.048493
RC76	U27LM11	3	1	20	0.89988	0.043925	5	0.48051	5.17	10.4	0.75613	0.095157	20.5	0.14355	0.80056	5.4	<0.010
Batch 1	BCHLM313	3	1	21	0.92175	0.073763	8.9264	0.86676	1.2576	7.262	0.5628	<0.040	22.727	<0.010	0.40342	<0.100	0.050991
U std	USTLM313	3	1	22	1.0092	0.15856	8.9489	0.70408	2.077	9.0074	0.76536	<0.040	21.075	0.051739	0.55649	1.922	<0.010
Batch 1	BCHLM321	3	2	1	0.89037	0.076242	8.9666	0.89751	1.2699	7.1445	0.57955	<0.040	22.97	<0.010	0.40312	<0.100	0.050836
U std	USTLM321	3	2	2	0.98223	0.16275	9.0465	0.72598	2.1089	9.0422	0.78516	<0.040	21.475	0.053451	0.56548	1.9511	<0.010
RC91	U21LM12	3	2	3	0.92807	0.049987	6.5194	0.034276	1.121	10.163	0.091365	0.092517	25.547	0.081008	<0.010	2.6798	0.010076
RC67	U06LM12	3	2	4	2.7245	0.015212	5.8515	<0.010	0.391	5.7742	1.3211	0.027647	22.1	0.18167	0.94169	6.6154	<0.010
RC88	U03LM12	3	2	5	0.67848	0.048835	7.8526	0.013842	3.692	9.5661	0.089818	0.093793	25.5	0.0613	<0.010	1.9564	0.01149
RC81	U10LM22	3	2	6	0.92599	0.039636	5.08	1.9011	2.5389	8.6925	1.3547	0.090819	21.041	0.14729	0.21249	5.3546	<0.010

Table C.2: Measured Elemental Concentrations (wt%) for the ND Glasses Prepared Using Lithium Metaborate *(continued)*

Glass ID	SRTC-ML ID	Block	Sub-Block	Analytical Sequence	Ca	Cr	Fe	Mg	Mn	Na	Ni	P	Si	Th	Ti	U	Zr
RC95	U49LM22	3	2	7	0.74729	0.070136	7.8746	0.26325	1.9661	10.251	0.37394	0.13464	24.4	0.058666	<0.010	1.8699	0.01849
RC64	U26LM22	3	2	8	0.39528	0.1666	9.775	0.009972	0.418	6.2593	0.025961	0.40379	22.835	0.18147	<0.010	7.039	<0.010
RC74	U23LM22	3	2	9	0.534	0.13708	5.01	0.322	1.57	8.38	0.77868	0.33139	25.7	0.037431	0.21441	1.48	0.009595
RC80	U12LM22	3	2	10	1.0174	0.15906	5.7	2.0171	1.69	13.4	0.83168	0.35777	22.4	0.084665	0.2336	3.1	0.00988
Batch 1	BCHLM322	3	2	11	0.90778	0.07526	8.9949	0.88499	1.2799	7.262	0.57421	<0.040	23.031	<0.010	0.40505	<0.100	0.050455
U std	USTLM322	3	2	12	1.0185	0.16665	9.0814	0.73961	2.1209	8.99	0.8032	<0.040	21.466	0.055823	0.58169	1.9501	<0.010
RC84	U44LM22	3	2	13	0.92158	0.12151	7.5148	0.49595	3.8301	8.903	0.95204	0.35259	21.517	0.14672	0.21331	5.4703	0.047044
RC89	U29LM22	3	2	14	0.66734	0.086506	7.9695	0.018053	0.639	9.2886	0.92426	0.19912	26.254	0.095174	0.01044	3.0295	0.027063
RC62	U33LM22	3	2	15	0.37333	0.00738	2.77	<0.010	6.3	5.6	1.8114	<0.040	19.1	0.18417	<0.010	6.89	<0.010
RC97	U19LM22	3	2	16	0.47156	0.11454	7.9005	1.0143	3.3415	10.719	2.0136	0.31698	22.201	0.14852	0.015011	4.8864	0.046711
RC83	U11LM22	3	2	17	2.3462	0.04286	5.3434	0.48893	5.3836	10.772	2.8615	0.091532	22.08	0.035081	0.20894	1.3587	<0.010
RC79	U39LM12	3	2	18	0.82778	0.033334	4.45	0.45442	4.69	7.89	0.6293	0.075913	19	0.032634	0.19078	1.25	<0.010
RC84	U44LM12	3	2	19	0.94502	0.12958	7.6961	0.51144	3.8915	8.9902	1.027	0.35832	21.695	0.1552	0.2229	5.4998	0.048367
RC76	U27LM12	3	2	20	0.89183	0.044943	5.4104	0.49867	5.3498	11.103	0.77934	0.096648	21.663	0.14602	0.81226	5.4311	<0.010
Batch 1	BCHLM323	3	2	21	0.91191	0.075617	9.0114	0.90324	1.2707	7.1046	0.58657	<0.040	22.935	<0.010	0.40979	<0.100	0.051042
U std	USTLM323	3	2	22	1.0093	0.16568	9.0806	0.73496	2.1123	8.8997	0.79444	<0.040	21.353	0.053633	0.57321	1.9319	<0.010
Batch 1	BCHLM411	4	1	1	0.91751	0.076026	8.8139	0.88209	1.2606	7.1126	0.57406	<0.040	22.889	<0.010	0.40697	<0.100	0.052277
U std	USTLM411	4	1	2	1.0129	0.16046	8.9141	0.70804	2.0997	8.8308	0.77247	<0.040	21.258	0.053247	0.56064	1.8907	<0.010
RC91	U21LM21	4	1	3	0.90582	0.050874	6.3771	0.036616	1.1104	9.976	0.091228	0.09081	25.197	0.083028	<0.010	2.6515	0.010257
RC61	U47LM21	4	1	4	0.38933	0.010368	9.9536	2.1219	5.9028	5.8114	0.086171	<0.040	20.239	0.13558	0.94021	4.8481	<0.010
RC60	U38LM21	4	1	5	2.7994	0.17771	3.4037	2.224	0.375	9.9993	<0.010	0.41474	18.658	0.18024	0.99463	6.6492	0.03258
RC94	U43LM11	4	1	6	0.76278	0.077984	7.2968	0.20087	1.1609	9.6698	0.46483	0.14253	25.419	0.080686	<0.010	2.4423	0.019036
RC78	U40LM11	4	1	7	0.84	0.036761	7.5241	1.7527	4.8407	8.1528	0.64297	0.082662	20.7	0.058049	0.77052	2.0992	<0.010
RC78	U40LM21	4	1	8	0.89412	0.039077	8.0347	1.8065	5.1614	8.5592	0.667	0.092068	20.776	0.061731	0.80566	2.2143	<0.010
RC79	U39LM21	4	1	9	0.79731	0.03311	4.4681	0.44555	4.6483	7.9201	0.62572	0.079071	19.314	0.030291	0.19076	1.1764	<0.010
RC86	U42LM11	4	1	10	0.90387	0.12743	4.5598	1.7748	5.196	8.8602	0.71991	0.34413	21.123	0.036683	0.82436	1.3455	0.048551
Batch 1	BCHLM412	4	1	11	0.91035	0.076496	8.8548	0.8813	1.2703	7.1779	0.57394	<0.040	22.882	<0.010	0.40367	<0.100	0.051787
U std	USTLM412	4	1	12	0.99384	0.16281	8.8143	0.71428	2.0847	8.8308	0.77852	<0.040	21.167	0.054415	0.561	1.8875	<0.010
RC88	U03LM21	4	1	13	0.67621	0.049035	7.243	0.014529	3.4396	8.8272	0.087992	0.09524	25.017	0.061521	<0.010	1.7718	0.013122
RC90	U05LM21	4	1	14	0.60429	0.048241	6.3751	0.028232	3.3701	8.8342	0.091431	0.10226	25.461	0.039278	<0.010	1.093	0.01103

Table C.2: Measured Elemental Concentrations (wt%) for the ND Glasses Prepared Using Lithium Metaborate *(continued)*

Glass ID	SRTC-ML ID	Block	Sub-Block	Analytical Sequence	Ca	Cr	Fe	Mg	Mn	Na	Ni	P	Si	Th	Ti	U	Zr
RC81	U10LM11	4	1	15	0.89358	0.039038	4.7245	1.8493	2.4158	8.1402	1.3017	0.089301	19.952	0.14734	0.20766	5.0799	<0.010
RC68	U46LM11	4	1	16	0.3778	0.15452	3.2314	<0.010	6.3637	9.8243	3.3995	0.40481	20.786	0.18267	1.0124	6.4625	0.012507
RC85	U24LM21	4	1	17	0.88723	0.042279	4.5919	0.48835	1.5131	8.3952	1.8067	0.091419	20.945	0.14626	0.79847	5.2122	<0.010
RC82	U14LM11	4	1	18	0.93337	0.1282	4.895	1.8661	5.283	9.0049	1.8208	0.3535	21.012	0.036418	0.82095	1.3889	0.048629
RC93	U32LM21	4	1	19	0.73653	0.10579	7.7171	0.66227	1.3397	10.224	0.10679	0.23715	23.941	0.10886	0.01	3.1828	0.032579
RC73	U25LM11	4	1	20	2.4159	0.13318	5.1786	0.4918	1.6535	8.3387	0.73212	0.33899	21.004	0.14519	0.81244	5.2169	0.021562
Batch 1	BCHLM412	4	1	21	0.91271	0.075873	8.9058	0.87382	1.2728	7.1151	0.56872	<0.040	22.897	<0.010	0.40308	<0.100	0.05101
U std	USTLM412	4	1	22	1.0099	0.16105	8.9788	0.70511	2.1096	8.8123	0.76763	<0.040	21.283	0.052735	0.5578	1.8823	<0.010
Batch 1	BCHLM421	4	2	1	0.91876	0.079498	8.8689	0.88229	1.2785	7.2989	0.5729	<0.040	23.018	<0.010	0.41006	<0.100	0.062242
U std	USTLM421	4	2	2	0.99234	0.16112	8.8486	0.70877	2.0785	8.9335	0.76922	<0.040	21.186	0.054411	0.56356	1.9139	<0.010
RC86	U42LM12	4	2	3	0.89509	0.12772	4.5028	1.7686	5.1687	9.0656	0.71813	0.34207	21.077	0.037554	0.82324	1.4115	0.048335
RC85	U24LM22	4	2	4	0.90153	0.042011	4.5653	0.48325	1.4974	8.603	1.7958	0.093363	20.906	0.14748	0.80285	5.2593	<0.010
RC61	U47LM22	4	2	5	0.38981	0.010968	9.9097	2.1085	5.8723	5.8924	0.087058	<0.040	20.194	0.13583	0.93683	4.8612	<0.010
RC78	U40LM22	4	2	6	0.91137	0.039815	7.9902	1.8075	5.1374	8.7636	0.66872	0.093912	20.859	0.063366	0.81323	2.2394	<0.010
RC82	U14LM12	4	2	7	0.93995	0.12806	4.842	1.8332	5.2174	9.2296	1.8068	0.34859	21.071	0.03677	0.81736	1.3847	0.048154
RC60	U38LM22	4	2	8	2.8024	0.17651	3.3071	2.1716	0.373	10.259	<0.010	0.41578	18.689	0.18153	0.9945	6.7494	0.033174
RC81	U10LM12	4	2	9	0.90361	0.038651	4.6511	1.8168	2.3914	8.363	1.285	0.092575	19.947	0.14834	0.20845	5.1215	0.006421
RC91	U21LM22	4	2	10	0.88962	0.051422	6.3553	0.037608	1.1013	10.077	0.092171	0.091724	25.171	0.082135	<0.010	2.6329	0.010841
Batch 1	BCHLM422	4	2	11	0.90763	0.080174	8.8141	0.88987	1.2596	7.2884	0.5753	<0.040	22.895	<0.010	0.40646	<0.100	0.060658
U std	USTLM422	4	2	12	0.96825	0.16077	8.9033	0.70539	2.0924	9.1144	0.76744	<0.040	21.419	0.054082	0.55812	1.945	<0.010
RC90	U05LM22	4	2	13	0.59378	0.048097	6.3747	0.029426	3.3758	9.2268	0.091224	0.10023	25.707	0.039339	0.004852	1.1592	0.011021
RC88	U03LM22	4	2	14	0.70466	0.049422	7.1654	0.016063	3.4223	9.032	0.088813	0.096944	25.104	0.062304	0.004821	1.7835	0.01325
RC94	U43LM12	4	2	15	0.76899	0.077992	7.2584	0.20102	1.155	9.8457	0.46326	0.14122	25.546	0.081897	0.006579	2.4448	0.01913
RC78	U40LM12	4	2	16	0.8479	0.037891	7.5346	1.7785	4.8601	8.1852	0.64895	0.087296	20.7	0.060395	0.78084	2.1029	<0.010
RC68	U46LM12	4	2	17	0.37944	0.1567	3.1947	<0.010	6.3342	10.111	3.42	0.40578	20.892	0.18201	1.016	6.5421	0.012357
RC79	U39LM22	4	2	18	0.79287	0.034346	4.4224	0.45638	4.633	8.035	0.63842	0.078048	19.383	0.031989	0.19361	1.1851	<0.010
RC93	U32LM22	4	2	19	0.72692	0.10707	7.6499	0.66667	1.3285	10.441	0.10858	0.23433	23.993	0.10871	0.010619	3.1809	0.032717
RC73	U25LM12	4	2	20	2.3821	0.13465	5.0718	0.49751	1.6239	8.4185	0.73845	0.33686	20.857	0.14445	0.81057	5.1782	0.020637
Batch 1	BCHLM423	4	2	21	0.90576	0.079312	8.8049	0.88045	1.2645	7.3209	0.56888	<0.040	23.032	<0.010	0.40388	<0.100	0.060486
U std	USTLM423	4	2	22	0.89903	0.15298	8.8051	0.66685	2.0964	9.081	0.7411	<0.040	21.296	0.051415	0.52446	1.9058	<0.010

Table C.2: Measured Elemental Concentrations (wt%) for the ND Glasses Prepared Using Lithium Metaborate *(continued)*

Glass ID	SRTC-ML ID	Block	Sub-Block	Analytical Sequence	Ca	Cr	Fe	Mg	Mn	Na	Ni	P	Si	Th	Ti	U	Zr
Batch 1	BCHLM511	5	1	1	0.90272	0.074501	8.8393	0.87447	1.2737	7.234	0.56624	<0.040	22.883	<0.010	0.40007	<0.100	0.049593
U std	USTLM511	5	1	2	0.91115	0.15454	8.9035	0.68122	2.1076	8.9825	0.75515	<0.040	21.286	0.050815	0.5302	1.9551	<0.010
ND25	U48LM21	5	1	3	0.88408	0.041824	4.8007	1.8546	1.4909	12.873	0.7278	0.086585	20.28	0.035166	0.20847	1.3155	<0.010
ND02	U22LM21	5	1	4	0.3692	0.008882	3.3234	<0.010	6.4601	12.483	<0.010	<0.040	19.368	0.18791	1.0143	6.6875	<0.010
ND29	U20LM11	5	1	5	0.90823	0.14344	10.197	0.49967	1.5206	12.078	0.73526	0.32187	21.219	0.039219	0.8446	1.3693	0.016201
ND27	U18LM11	5	1	6	2.399	0.14706	5.17	0.52681	1.5574	12.423	2.9799	0.34255	21.343	0.038984	0.23255	1.414	0.047055
ND09	U30LM21	5	1	7	0.42892	0.17387	3.2338	<0.010	0.533	14.512	0.080487	0.41412	21.1	0.18335	0.98878	6.5824	0.049495
ND28	U36LM21	5	1	8	2.4251	0.048735	5.145	0.46525	1.5378	10.474	0.72973	0.092345	22.444	0.034361	0.81242	1.3486	<0.010
ND25	U48LM11	5	1	9	0.87429	0.044532	4.8808	1.8631	1.5095	13.187	0.73102	0.08404	20.625	0.035183	0.20842	1.3623	<0.010
ND26	U35LM21	5	1	10	0.91562	0.041456	5.1177	0.47865	5.142	13.582	0.74976	0.089332	20.551	0.14899	0.20766	5.4412	<0.010
Batch 1	BCHLM512	5	1	11	0.91727	0.079268	8.775	0.892	1.2656	7.3402	0.57477	<0.040	22.814	<0.010	0.40501	<0.100	0.059183
U std	USTLM512	5	1	12	0.99839	0.1631	8.7647	0.72517	2.0754	9.0586	0.78408	<0.040	21.146	0.054704	0.56418	1.9583	<0.010
ND27	U18LM21	5	1	13	2.4043	0.14118	5.0117	0.50817	1.5033	12.281	2.8635	0.33389	20.852	0.036911	0.22463	1.3594	0.044512
ND24	U41LM21	5	1	14	0.9159	0.042248	6.4007	1.8316	1.5512	10.349	0.74072	0.083175	20.658	0.15015	0.20651	5.4678	<0.010
ND18	U34LM11	5	1	15	2.7913	0.15045	2.9003	0.021749	6.2057	9.6433	3.329	0.41307	20.783	0.18577	<0.010	6.667	0.05652
ND29	U20LM21	5	1	16	0.91976	0.1405	10.195	0.49262	1.5128	12.151	0.72559	0.32207	21.294	0.037629	0.83781	1.3777	0.021669
ND11	U13LM21	5	1	17	2.8722	0.008441	6.3944	1.8593	5.1733	7.3537	0.54253	<0.040	18.677	0.18519	0.82886	6.6888	<0.010
ND11	U13LM11	5	1	18	2.9306	0.007498	6.4804	1.8555	5.2458	7.5852	0.53708	<0.040	18.97	0.18461	0.83033	6.7654	<0.010
ND26	U35LM11	5	1	19	0.90381	0.042588	5.1024	0.4847	5.1232	13.401	0.76403	0.086341	20.421	0.15117	0.21101	5.3591	<0.010
ND30	U09LM11	5	1	20	1.7202	0.080167	4.5693	1.103	3.7997	11.015	1.6798	0.1833	19.801	0.091536	0.49094	3.3283	0.020691
ND30	U09LM21	5	1	21	1.7415	0.080853	4.7308	1.1107	3.8825	11.385	1.7006	0.18276	20.109	0.093101	0.49709	3.3118	0.021634
Batch 1	BCHLM513	5	1	22	0.92579	0.078222	8.8046	0.87781	1.277	7.2957	0.57001	<0.040	22.805	<0.010	0.40528	<0.100	0.059313
U std	USTLM513	5	1	23	1.0214	0.16079	8.8721	0.70726	2.1095	9.0411	0.76922	<0.040	21.094	0.053777	0.56018	1.9624	<0.010
Batch 1	BCHLM521	5	2	1	0.93988	0.075941	8.8848	0.87392	1.2808	7.1157	0.56549	<0.040	22.742	<0.010	0.40681	<0.100	0.062174
U std	USTLM521	5	2	2	0.90989	0.15052	8.9011	0.66939	2.0982	8.725	0.74533	<0.040	20.997	0.051662	0.52763	1.9346	<0.010
ND28	U36LM22	5	2	3	2.4313	0.045848	5.1671	0.45746	1.5423	10.021	0.72401	0.092734	22.19	0.036576	0.81436	1.3388	0.00981
ND02	U22LM22	5	2	4	0.37748	0.007066	3.2921	<0.010	6.4782	12.122	<0.010	<0.040	19.075	0.18813	1.0131	6.7188	<0.010
ND11	U13LM22	5	2	5	2.8639	0.006597	6.4206	1.8389	5.2223	7.0104	0.53352	<0.040	18.331	0.1857	0.82959	6.7004	<0.010
ND29	U20LM22	5	2	6	0.91667	0.13864	10.271	0.48948	1.5215	11.601	0.72076	0.31909	20.849	0.040045	0.84813	1.3245	0.022886
ND24	U41LM22	5	2	7	0.91153	0.041355	6.4197	1.8738	1.5536	9.7438	0.75135	0.084436	20.165	0.15266	0.21066	5.4627	<0.010

Table C.2: Measured Elemental Concentrations (wt%) for the ND Glasses Prepared Using Lithium Metaborate *(continued)*

Glass ID	SRTC-ML ID	Block	Sub-Block	Analytical Sequence	Ca	Cr	Fe	Mg	Mn	Na	Ni	P	Si	Th	Ti	U	Zr
ND26	U35LM22	5	2	8	0.91847	0.039112	5.1213	0.4716	5.1693	12.836	0.74239	0.088898	20.078	0.15017	0.20913	5.3683	<0.010
ND09	U30LM22	5	2	9	0.43972	0.1712	3.1517	<0.010	0.527	13.75	0.077791	0.41438	20.536	0.18449	0.99522	6.5737	0.049396
ND18	U34LM12	5	2	10	2.7957	0.14765	2.8597	0.017516	6.2423	8.9747	3.3049	0.40858	20.224	0.1884	<0.010	6.6073	0.059197
Batch 1	BCHLM522	5	2	11	0.93211	0.075988	8.8385	0.87809	1.2756	6.893	0.56986	<0.040	22.297	<0.010	0.40665	<0.100	0.061927
U std	USTLM522	5	2	12	0.91138	0.1536	8.8919	0.6777	2.1113	8.6303	0.75247	<0.040	20.774	0.052618	0.53224	1.9606	<0.010
ND27	U18LM12	5	2	13	2.3872	0.14482	5.1347	0.52419	1.5492	11.82	2.9908	0.34066	20.824	0.039165	0.23353	1.376	0.048945
ND29	U20LM12	5	2	14	0.90628	0.13999	10.208	0.49797	1.5068	11.405	0.73831	0.32452	20.644	0.03983	0.85163	1.3183	0.018748
ND26	U35LM12	5	2	15	0.90603	0.04112	5.1675	0.48281	5.1862	12.584	0.75985	0.086325	19.907	0.15223	0.21281	5.3776	<0.010
ND30	U09LM12	5	2	16	1.7477	0.07757	4.521	1.0897	3.828	10.27	1.6664	0.1805	19.265	0.093609	0.49357	3.2979	0.023824
ND30	U09LM22	5	2	17	1.751	0.076874	4.4545	1.0829	3.7902	10.402	1.6675	0.18135	19.138	0.092494	0.49603	3.2771	0.023992
ND11	U13LM12	5	2	18	2.9105	0.005627	6.5128	1.8115	5.2783	7.0681	0.52475	<0.040	18.407	0.18496	0.82507	6.8002	<0.010
ND25	U48LM12	5	2	19	0.90005	0.042751	4.8469	1.8577	1.5095	12.558	0.72988	0.085322	20.037	0.037135	0.21149	1.3242	<0.010
ND27	U18LM22	5	2	20	2.374	0.13992	4.9942	0.50368	1.5063	11.594	2.8598	0.32989	20.28	0.038509	0.22563	1.3348	0.047003
ND25	U48LM22	5	2	21	0.89282	0.039459	4.7876	1.8437	1.486	12.325	0.72809	0.086962	19.726	0.036717	0.21068	1.3081	<0.010
Batch 1	BCHLM523	5	2	22	0.92861	0.07628	8.4922	0.87755	1.2272	6.7175	0.56729	<0.040	21.416	<0.010	0.40716	<0.100	0.062149
U std	USTLM523	5	2	23	1.0399	0.15843	9.1984	0.70351	2.174	8.8657	0.76504	<0.040	21.421	0.055487	0.56557	2.0085	<0.010
Batch 1	BCHLM611	6	1	1	0.91679	0.076366	8.8379	0.86998	1.2813	7.2042	0.55698	<0.040	23.005	<0.010	0.40423	<0.100	0.060546
U std	USTLM611	6	1	2	0.90811	0.15035	8.8288	0.66089	2.0886	9.0068	0.72998	<0.040	21.24	0.050381	0.52478	1.9628	<0.010
ND22	U50LM21	6	1	3	2.2599	0.1332	4.9768	1.7795	1.527	10.628	0.8096	0.31647	20.965	0.036933	0.20858	1.3794	0.036839
ND24	U41LM11	6	1	4	0.87572	0.042215	6.3388	1.8479	1.5493	10.144	0.7378	0.08189	20.716	0.15	0.20671	5.3465	<0.010
ND23	U16LM11	6	1	5	0.88888	0.1445	9.5931	0.48856	1.5178	12.549	0.70806	0.33412	20.678	0.038707	0.21159	1.3507	0.045979
ND31	U37LM21	6	1	6	0.89624	0.045481	4.5673	1.8838	1.4596	10.043	2.9106	0.093898	20.698	0.15215	0.21104	5.1843	<0.010
ND21	U31LM21	6	1	7	1.1506	0.049851	5.0269	0.75304	1.5064	10.292	2.5509	0.10785	21.121	0.035055	0.20416	1.325	0.010276
ND16	U08LM11	6	1	8	2.7587	0.007239	3.2138	<0.010	0.4	10.817	2.6972	<0.040	18.871	0.18439	<0.010	6.6396	<0.010
ND22	U50LM11	6	1	9	2.2962	0.13305	4.9414	1.7997	1.5074	10.416	0.81707	0.32009	20.57	0.037143	0.21051	1.3427	0.02702
ND09	U30LM11	6	1	10	0.42202	0.1741	3.2526	<0.010	0.536	14.286	0.074857	0.42036	21.149	0.18522	1.0028	6.5734	0.052277
Batch 1	BCHLM612	6	1	11	0.90853	0.077298	8.7657	0.87998	1.2716	7.1795	0.56372	<0.040	22.942	<0.010	0.40374	<0.100	0.05993
U std	USTLM612	6	1	12	0.97823	0.16079	8.7741	0.71113	2.0846	8.8116	0.7692	<0.040	21.144	0.055252	0.55991	1.9341	<0.010
ND23	U16LM21	6	1	13	0.89852	0.14381	9.6135	0.49537	1.5221	12.368	0.69797	0.33575	20.724	0.038446	0.21351	1.345	0.046333
ND28	U36LM11	6	1	14	2.3959	0.046279	5.1885	0.46498	1.5573	10.734	0.73211	0.094415	22.665	0.03618	0.83014	1.3643	0.010917
ND18	U34LM21	6	1	15	2.7407	0.14888	2.8914	0.014614	6.1793	9.2152	3.3286	0.40696	20.66	0.18492	<0.010	6.5504	0.056508

Table C.2: Measured Elemental Concentrations (wt%) for the ND Glasses Prepared Using Lithium Metaborate *(continued)*

Glass ID	SRTC-ML ID	Block	Sub-Block	Analytical Sequence	Ca	Cr	Fe	Mg	Mn	Na	Ni	P	Si	Th	Ti	U	Zr
ND31	U37LM11	6	1	16	0.89705	0.049886	4.833	1.878	1.5379	10.39	2.9059	0.086791	21.5	0.15336	0.21109	5.4338	<0.010
ND04	U17LM21	6	1	17	0.37388	0.17821	3.3916	2.2851	0.412	8.1383	0.011	0.42841	21.901	0.18828	<0.010	6.7133	0.059312
ND02	U22LM11	6	1	18	0.36663	0.007917	3.2907	<0.010	6.4199	12.402	<0.010	<0.040	19.348	0.18379	0.99939	6.6051	<0.010
ND21	U31LM11	6	1	19	1.1719	0.049928	5.0626	0.75126	1.5206	10.432	2.5423	0.11213	21.466	0.035051	0.20378	1.3394	0.00987
ND04	U17LM11	6	1	20	0.37258	0.17674	3.2726	2.2668	0.407	8.0364	0.011734	0.42596	21.685	0.18427	<0.010	6.5797	0.056941
ND16	U08LM21	6	1	21	2.7404	0.007207	3.2593	<0.010	0.4	10.916	2.7225	<0.040	18.824	0.18515	<0.010	6.6074	<0.010
Batch 1	BCHLM613	6	1	22	0.89944	0.076342	8.7527	0.87388	1.274	7.1621	0.55949	<0.040	22.906	<0.010	0.40204	<0.100	0.059064
U std	USTLM613	6	1	23	0.89693	0.15153	8.7932	0.665	2.0882	8.8561	0.73423	<0.040	21.171	0.050667	0.52393	1.9341	<0.010
Batch 1	BCHLM621	6	2	1	0.97393	0.075738	8.8196	0.87762	1.2954	7.1964	0.56384	<0.040	22.86	<0.010	0.40271	<0.100	0.060893
U std	USTLM621	6	2	2	0.90193	0.14977	8.9113	0.66963	2.1231	9.0963	0.73979	<0.040	21.353	0.049252	0.52358	1.9635	<0.010
ND16	U08LM22	6	2	3	2.802	0.005465	3.2654	<0.010	0.399	11.007	2.707	0.004341	18.938	0.18584	<0.010	6.6783	<0.010
ND22	U50LM12	6	2	4	2.2803	0.13131	4.9159	1.7867	1.5119	10.508	0.81131	0.31397	20.52	0.036977	0.20758	1.3235	0.025592
ND18	U34LM22	6	2	5	2.7652	0.14814	2.9017	0.017658	6.1873	9.3437	3.3193	0.40905	20.704	0.18498	0.004259	6.5674	0.05739
ND28	U36LM12	6	2	6	2.3933	0.043693	5.1892	0.46495	1.5672	10.768	0.732	0.092628	22.716	0.03535	0.8195	1.3805	0.011464
ND23	U16LM22	6	2	7	0.91246	0.14283	9.6491	0.49468	1.5338	12.529	0.69881	0.33638	20.739	0.038508	0.21279	1.3619	0.047225
ND16	U08LM12	6	2	8	2.7817	0.005585	3.2239	<0.010	0.398	10.99	2.6986	<0.040	18.984	0.18518	<0.010	6.7156	<0.010
ND31	U37LM22	6	2	9	0.91009	0.042467	4.5822	1.8883	1.4828	10.242	2.9334	0.092892	20.735	0.15268	0.21151	5.2946	<0.010
ND09	U30LM12	6	2	10	0.42685	0.17327	3.3213	<0.010	0.54	14.767	0.078754	0.42419	21.24	0.18537	1.0114	6.6298	0.052549
Batch 1	BCHLM622	6	2	11	0.92585	0.075756	8.7366	0.88148	1.2816	7.2697	0.56722	<0.040	22.781	<0.010	0.40502	<0.100	0.060591
U std	USTLM622	6	2	12	0.91086	0.14957	8.7673	0.667	2.0911	8.9861	0.74068	<0.040	21.066	0.050931	0.52553	1.9574	<0.010
ND23	U16LM12	6	2	13	0.91042	0.14411	9.6243	0.49387	1.5428	12.717	0.72088	0.33665	20.632	0.038799	0.21403	1.358	0.046984
ND22	U50LM22	6	2	14	2.2746	0.1336	4.99	1.8059	1.5384	10.744	0.82748	0.32079	20.944	0.036947	0.20973	1.368	0.036451
ND31	U37LM12	6	2	15	0.91879	0.048162	4.7843	1.8879	1.5342	10.549	2.9455	0.090492	21.317	0.15429	0.21338	5.4717	<0.010
ND02	U22LM12	6	2	16	0.38075	0.005373	3.2919	<0.010	6.4312	12.841	<0.010	<0.040	19.408	0.18434	1.0016	6.7886	<0.010
ND21	U31LM12	6	2	17	1.1878	0.04689	5.0577	0.74557	1.5236	10.603	2.5329	0.10795	21.335	0.034992	0.20298	1.3599	0.010374
ND04	U17LM22	6	2	18	0.3846	0.17968	3.3083	2.3148	0.416	8.2493	0.014562	0.43436	21.819	0.18925	<0.010	6.8003	0.061061
ND21	U31LM22	6	2	19	1.1725	0.047641	5.0134	0.75308	1.5143	10.516	2.552	0.10937	21.057	0.035518	0.20453	1.3531	0.01152
ND24	U41LM12	6	2	20	0.88817	0.040645	6.2978	1.867	1.5435	10.123	0.74937	0.0825	20.469	0.15058	0.20804	5.3731	0.00828
ND04	U17LM12	6	2	21	0.38815	0.1769	3.2714	2.2474	0.408	8.185	0.014959	0.42276	21.566	0.18606	<0.010	6.7082	0.05756
Batch 1	BCHLM623	6	2	22	0.95626	0.075	9.1	0.88	1.2432	7.0166	0.568	<0.040	21.953	0.01	0.405	<0.100	0.061
U std	USTLM623	6	2	23	0.9191	0.156	8.48	0.688	2.1698	9.3259	0.76	<0.040	21.802	0.054	0.541	2.0317	<0.010

Table C.3: Measured Elemental Concentrations (wt%) for the ND Glasses Prepared Using Peroxide Fusion

Glass ID	SRTC -ML ID	Block	Sub-Block	Analytical Sequence	Al	B	Li
Batch 1	BCHSP111	1	1	1	2.60	2.52	2.09
RC66	X03SP21	1	1	2	1.66	1.59	1.40
RC65	X05SP11	1	1	3	3.84	1.54	1.39
RC58	X08SP21	1	1	4	1.69	2.32	3.20
RC63	X17SP11	1	1	5	6.95	3.68	1.38
RC66	X03SP11	1	1	6	1.64	1.56	1.36
RC71	X13SP21	1	1	7	1.68	1.59	3.18
RC71	X13SP11	1	1	8	1.66	1.58	3.16
Batch 1	BCHSP112	1	1	9	2.58	2.52	2.07
RC65	X05SP21	1	1	10	4.03	1.59	1.40
RC58	X08SP11	1	1	11	1.70	2.37	3.26
RC72	X11SP11	1	1	12	1.67	1.87	3.20
RC69	X18SP21	1	1	13	4.26	3.74	3.19
RC72	X11SP21	1	1	14	1.70	1.87	3.25
RC63	X17SP21	1	1	15	7.06	3.77	1.41
RC69	X18SP11	1	1	16	4.41	3.87	3.28
Batch 1	BCHSP113	1	1	17	2.67	2.58	2.13
Batch 1	BCHSP121	1	2	1	2.64	2.52	2.13
RC66	X03SP12	1	2	2	1.67	1.58	1.38
RC69	X18SP22	1	2	3	4.35	3.70	3.26
RC58	X08SP22	1	2	4	1.72	2.36	3.22
RC65	X05SP22	1	2	5	4.03	1.57	1.45
RC72	X11SP22	1	2	6	1.73	1.82	3.31
RC72	X11SP12	1	2	7	1.73	1.84	3.31
RC63	X17SP12	1	2	8	7.40	3.80	1.48
Batch 1	BCHSP122	1	2	9	2.62	2.60	2.10
RC63	X17SP22	1	2	10	7.39	3.81	1.43
RC65	X05SP12	1	2	11	4.00	1.64	1.43
RC58	X08SP12	1	2	12	1.80	2.51	3.42
RC69	X18SP12	1	2	13	4.43	3.86	3.32
RC71	X13SP12	1	2	14	1.69	1.68	3.18
RC66	X03SP22	1	2	15	1.72	1.66	1.42
RC71	X13SP22	1	2	16	1.78	1.69	3.26
Batch 1	BCHSP123	1	2	17	2.65	2.51	2.12
Batch 1	BCHSP211	2	1	1	2.60	2.47	2.07
ND06	X16SP21	2	1	2	1.95	1.55	3.29
ND03	X12SP11	2	1	3	1.69	1.57	3.28
ND10	X10SP21	2	1	4	2.57	3.67	1.37
ND10	X10SP11	2	1	5	2.68	3.68	1.41
ND05	X01SP11	2	1	6	7.31	1.56	3.23
ND07	X07SP11	2	1	7	1.72	1.53	1.39
ND06	X16SP11	2	1	8	1.75	1.55	3.29
Batch 1	BCHSP212	2	1	9	2.64	2.60	2.10
ND03	X12SP21	2	1	10	1.68	1.60	3.25
ND08	X14SP21	2	1	11	6.16	3.64	1.41
ND01	X20SP11	2	1	12	1.74	1.65	1.48
ND07	X07SP21	2	1	13	1.72	1.54	1.40
ND05	X01SP21	2	1	14	7.35	1.58	3.26
ND01	X20SP21	2	1	15	1.71	1.61	1.44
ND08	X14SP11	2	1	16	6.12	3.65	1.40
Batch 1	BCHSP213	2	1	17	2.69	2.56	2.12
Batch 1	BCHSP221	2	2	1	2.62	2.52	2.09
ND05	X01SP12	2	2	2	7.23	1.55	3.23
ND01	X20SP12	2	2	3	1.74	1.57	1.45
ND08	X14SP12	2	2	4	6.12	3.57	1.43

Table C.3: Measured Elemental Concentrations (wt%) for the ND Glasses Prepared Using Peroxide Fusion *(continued)*

Glass ID	SRTC -ML ID	Block	Sub-Block	Analytical Sequence	Al	B	Li
ND03	X12SP22	2	2	5	1.71	1.52	3.25
ND03	X12SP12	2	2	6	1.92	1.48	3.25
ND01	X20SP22	2	2	7	1.74	1.52	1.49
ND06	X16SP12	2	2	8	1.75	1.47	3.29
Batch 1	BCHSP222	2	2	9	2.64	2.54	2.10
ND07	X07SP22	2	2	10	1.71	1.54	1.40
ND10	X10SP12	2	2	11	2.87	3.71	1.42
ND08	X14SP22	2	2	12	5.93	3.57	1.38
ND10	X10SP22	2	2	13	2.59	3.56	1.39
ND07	X07SP12	2	2	14	1.68	1.47	1.36
ND05	X01SP22	2	2	15	7.43	1.56	3.30
ND06	X16SP22	2	2	16	1.77	1.50	3.33
Batch 1	BCHSP223	2	2	17	2.63	2.40	2.09
Batch 1	BCHSP311	3	1	1	2.65	2.50	2.10
ND13	X19SP11	3	1	2	1.69	1.51	1.38
ND20	X21SP11	3	1	3	5.55	2.55	2.93
ND19	X04SP11	3	1	4	1.93	1.67	2.16
ND12	X09SP21	3	1	5	1.70	1.47	1.38
ND14	X15SP11	3	1	6	2.86	1.55	1.48
ND17	X02SP11	3	1	7	1.72	1.45	1.39
ND15	X06SP21	3	1	8	1.77	3.63	3.36
Batch 1	BCHSP312	3	1	9	2.69	2.58	2.12
ND19	X04SP21	3	1	10	2.28	1.81	2.22
ND20	X21SP21	3	1	11	5.53	2.59	2.93
ND14	X15SP21	3	1	12	2.93	1.65	1.48
ND12	X09SP11	3	1	13	1.75	1.53	1.39
ND17	X02SP21	3	1	14	1.72	1.52	1.37
ND13	X19SP21	3	1	15	1.71	1.51	1.38
ND15	X06SP11	3	1	16	1.71	3.55	3.19
Batch 1	BCHSP313	3	1	17	2.57	2.36	2.01
Batch 1	BCHSP321	3	2	1	2.59	2.55	2.06
ND14	X15SP12	3	2	2	2.80	1.67	1.44
ND13	X19SP12	3	2	3	1.71	1.64	1.40
ND12	X09SP22	3	2	4	1.71	1.57	1.39
ND17	X02SP12	3	2	5	1.69	1.56	1.37
ND14	X15SP22	3	2	6	2.86	1.64	1.46
ND20	X21SP22	3	2	7	5.57	2.61	2.94
ND13	X19SP22	3	2	8	1.65	1.54	1.35
Batch 1	BCHSP322	3	2	9	2.63	2.46	2.07
ND19	X04SP22	3	2	10	1.92	1.76	2.11
ND15	X06SP22	3	2	11	1.72	3.71	3.28
ND19	X04SP12	3	2	12	1.91	1.77	2.14
ND12	X09SP12	3	2	13	1.67	1.53	1.34
ND17	X02SP22	3	2	14	1.71	1.52	1.40
ND20	X21SP12	3	2	15	5.53	2.60	2.91
ND15	X06SP12	3	2	16	1.68	3.56	3.19
Batch 1	BCHSP323	3	2	17	2.55	2.41	2.01

Table C.3: Measured Elemental Concentrations (wt%) for the ND Glasses Prepared Using Peroxide Fusion ***(continued)***

Glass ID	SRTC -ML ID	Block	Sub-Block	Analytical Sequence	Al	B	Li
ustsp311	U std	3	1	1	2.68	1.29	22.9
f02sp11	RC-47	3	1	2	1.54	2.35	22.3
f12sp21	RC-34	3	1	3	2.06	2.21	22.7
f26sp21	RC-42	3	1	4	2.44	1.55	23.1
f14sp21	RC-54	3	1	5	1.66	2.54	24.2
f15sp21	RC-29	3	1	6	2.10	2.25	23.2
f22sp11	RC-43	3	1	7	2.37	1.52	23.2
f11sp11	RC-32	3	1	8	1.96	2.10	21.8
f23sp11	RC-49	3	1	9	1.65	2.51	24.2
f06sp11	RC-48	3	1	10	1.47	2.27	22.2
f08sp21	RC-40	3	1	11	2.25	1.45	21.7
f12sp11	RC-34	3	1	12	2.07	2.25	22.7
bchsp312	Batch 1	3	1	13	2.41	2.05	24
ustsp312	U std	3	1	14	2.71	1.31	23
f19sp21	RC-50	3	1	15	1.54	2.33	22.6
f16sp21	RC-28	3	1	16	2.02	2.15	22.8
f10sp21	RC-55	3	1	17	1.48	2.28	22
f28sp21	RC-27	3	1	18	2.12	2.30	23.7
f13sp21	RC-37	3	1	19	2.21	2.37	23.8
f08sp11	RC-40	3	1	20	2.34	1.49	22.2
f32sp21	RC-57	3	1	21	1.67	2.53	24.8
f05sp11	RC-56	3	1	22	1.74	2.66	24.9
f24sp11	RC-33	3	1	23	1.87	2.02	21.9
f15sp11	RC-29	3	1	24	2.05	2.19	22.7
f22sp21	RC-43	3	1	25	2.36	1.51	23.9
bchsp313	Batch 1	3	1	26	2.42	2.06	24
bchsp321	Batch 1	3	2	1	2.51	2.06	24
ustsp321	U std	3	2	2	2.73	1.30	22.9
f24sp12	RC-33	3	2	3	1.93	2.03	21.8
f08sp12	RC-40	3	2	4	2.41	1.53	22.7
f19sp22	RC-50	3	2	5	1.56	2.35	22.6
f23sp12	RC-49	3	2	6	1.68	2.53	24.3
f14sp22	RC-54	3	2	7	1.69	2.55	24.3
f32sp22	RC-57	3	2	8	1.69	2.54	24.7
f12sp12	RC-34	3	2	9	2.08	2.26	22.6
f12sp22	RC-34	3	2	10	2.07	2.21	22.7
f16sp22	RC-28	3	2	11	2.04	2.17	22.7
f15sp12	RC-29	3	2	12	2.06	2.20	22.6
f06sp12	RC-48	3	2	13	1.48	2.25	22
bchsp322	Batch 1	3	2	14	2.42	2.05	24
ustsp322	U std	3	2	15	2.70	1.30	22.9
f22sp12	RC-43	3	2	16	2.39	1.51	23.1
f10sp22	RC-55	3	2	17	1.50	2.27	22
f26sp22	RC-42	3	2	18	2.45	1.56	23
f22sp22	RC-43	3	2	19	2.37	1.50	23.7
f28sp22	RC-27	3	2	20	2.16	2.29	23.7
f05sp12	RC-56	3	2	21	1.75	2.66	24.9
f02sp12	RC-47	3	2	22	1.55	2.35	22.4
f11sp12	RC-32	3	2	23	2.00	2.12	22
f15sp22	RC-29	3	2	24	2.12	2.25	23.3
f13sp22	RC-37	3	2	25	2.24	2.37	23.9
f08sp22	RC-40	3	2	26	2.30	1.46	21.8
bchsp323	Batch 1	3	2	27	2.45	2.08	24.3
ustsp323	U std	3	2	28	2.71	1.31	23.3

Table C.4: Measured Elemental Concentrations (wt%) for the ND Glasses Prepared Using Peroxide Fusion *(continued)*

Glass ID	SRTC -ML ID	Block	Sub-Block	Analytical Sequence	Al	B	Li
Batch 1	BCHSP11	1	1	1	2.57	2.53	2.08
U std	USTSP111	1	1	2	1.96	2.69	1.32
RC93	U32SP11	1	1	3	1.67	1.72	2.50
RC91	U21SP11	1	1	4	1.90	1.84	2.72
RC79	U39SP11	1	1	5	7.88	3.00	2.61
RC74	U23SP11	1	1	6	2.92	1.98	2.25
RC95	U49SP11	1	1	7	1.69	1.83	2.71
RC70	U01SP11	1	1	8	1.66	3.61	1.39
RC81	U10SP11	1	1	9	2.90	3.18	1.75
RC92	U28SP11	1	1	10	1.72	1.73	2.54
Batch 1	BCHSP112	1	1	11	2.55	2.43	2.06
U std	USTSP112	1	1	12	1.99	2.74	1.33
RC64	U26SP11	1	1	13	1.61	3.58	3.10
RC61	U47SP11	1	1	14	1.82	1.66	1.42
RC96	U15SP11	1	1	15	3.48	2.60	2.30
RC90	U05SP11	1	1	16	2.40	1.84	2.69
RC75	U45SP11	1	1	17	2.85	1.97	1.91
RC77	U04SP11	1	1	18	2.93	1.97	2.80
RC83	U11SP11	1	1	19	2.92	1.95	1.74
RC94	U43SP11	1	1	20	1.71	1.81	2.69
RC62	U33SP11	1	1	21	7.64	1.57	3.20
Batch 1	BCHSP113	1	1	22	2.54	2.44	2.06
U std	USTSP113	1	1	23	2.00	2.69	1.33
Batch 1	BCHSP121	1	2	1	2.48	2.50	2.02
U std	USTSP121	1	2	2	1.92	2.69	1.29
RC74	U23SP12	1	2	3	2.89	1.95	2.22
RC93	U32SP12	1	2	4	1.63	1.66	2.48
RC61	U47SP12	1	2	5	1.78	1.57	1.40
RC81	U10SP12	1	2	6	2.87	3.16	1.74
RC77	U04SP12	1	2	7	2.85	1.91	2.76
RC83	U11SP12	1	2	8	2.90	1.91	1.74
RC91	U21SP12	1	2	9	1.88	1.78	2.71
RC62	U33SP12	1	2	10	7.51	1.50	3.14
Batch 1	BCHSP122	1	2	11	2.49	2.37	2.03
U std	USTSP122	1	2	12	1.96	2.73	1.31
RC95	U49SP12	1	2	13	1.67	1.82	2.71
RC96	U15SP12	1	2	14	3.46	2.57	2.29
RC94	U43SP12	1	2	15	1.69	1.78	2.69
RC90	U05SP12	1	2	16	2.43	1.82	2.75
RC75	U45SP12	1	2	17	3.08	1.94	2.16
RC92	U28SP12	1	2	18	1.77	1.68	2.69
RC79	U39SP12	1	2	19	8.06	2.98	2.70
RC70	U01SP12	1	2	20	1.70	3.64	1.44
RC64	U26SP12	1	2	21	1.62	3.52	3.19
Batch 1	BCHSP123	1	2	22	2.54	2.38	2.09
U std	USTSP123	1	2	23	1.96	2.62	1.32
Batch 1	BCHSP211	2	1	1	2.61	2.54	2.11
U std	USTSP211	2	1	2	2.01	2.73	1.35
RC91	U21SP21	2	1	3	1.95	1.83	2.77
RC95	U49SP21	2	1	4	1.70	1.81	2.74
RC93	U32SP21	2	1	5	1.64	1.65	2.50
RC70	U01SP21	2	1	6	1.65	3.63	1.37
RC94	U43SP21	2	1	7	1.68	1.76	2.65
RC74	U23SP21	2	1	8	2.90	1.94	2.25
RC64	U26SP21	2	1	9	1.63	3.56	3.12

Table C.4: Measured Elemental Concentrations (wt%) for the ND Glasses Prepared Using Peroxide Fusion *(continued)*

Glass ID	SRTC -ML ID	Block	Sub-Block	Analytical Sequence	Al	B	Li
RC83	U11SP21	2	1	10	3.24	2.02	1.70
Batch 1	BCHSP212	2	1	11	2.53	2.39	2.05
U std	USTSP212	2	1	12	1.97	2.72	1.31
RC79	U39SP21	2	1	13	7.63	2.97	2.54
RC81	U10SP21	2	1	14	2.86	3.20	1.74
RC77	U04SP21	2	1	15	2.85	1.93	2.76
RC62	U33SP21	2	1	16	7.56	1.53	3.22
RC96	U15SP21	2	1	17	3.31	2.45	2.20
RC75	U45SP21	2	1	18	2.78	1.89	1.89
RC61	U47SP21	2	1	19	1.74	1.50	1.36
RC90	U05SP21	2	1	20	2.39	1.78	2.69
RC92	U28SP21	2	1	21	1.70	1.65	2.53
Batch 1	BCHSP213	2	1	22	2.52	2.39	2.05
U std	USTSP213	2	1	23	1.92	2.63	1.29
Batch 1	BCHSP221	2	2	1	2.55	2.50	2.07
U std	USTSP221	2	2	2	1.99	2.75	1.34
RC79	U39SP22	2	2	3	7.74	2.96	2.56
RC70	U01SP22	2	2	4	1.65	3.65	1.36
RC62	U33SP22	2	2	5	7.64	1.56	3.22
RC95	U49SP22	2	2	6	1.66	1.80	2.70
RC61	U47SP22	2	2	7	1.73	1.53	1.36
RC83	U11SP22	2	2	8	3.29	2.03	1.71
RC93	U32SP22	2	2	9	1.64	1.65	2.51
RC64	U26SP22	2	2	10	1.60	3.53	3.11
Batch 1	BCHSP222	2	2	11	2.51	2.41	2.04
U std	USTSP222	2	2	12	1.89	2.68	1.28
RC90	U05SP22	2	2	13	2.39	1.82	2.70
RC91	U21SP22	2	2	14	1.90	1.80	2.72
RC94	U43SP22	2	2	15	1.67	1.76	2.67
RC74	U23SP22	2	2	16	2.88	1.93	2.23
RC92	U28SP22	2	2	17	1.68	1.67	2.54
RC96	U15SP22	2	2	18	3.28	2.44	2.17
RC75	U45SP22	2	2	19	2.70	1.86	1.83
RC77	U04SP22	2	2	20	2.83	1.88	2.73
RC81	U10SP22	2	2	21	2.85	3.16	1.72
Batch 1	BCHSP223	2	2	22	2.55	2.42	2.07
U std	USTSP223	2	2	23	1.95	2.66	1.30
Batch 1	BCHSP311	3	1	1	2.56	2.51	2.09
U std	USTSP311	3	1	2	2.01	2.73	1.37
RC82	U14SP11	3	1	3	2.86	1.93	2.78
RC68	U46SP11	3	1	4	1.69	1.51	1.41
RC80	U12SP11	3	1	5	0.18	2.10	1.91
RC89	U29SP11	3	1	6	1.98	1.79	2.75
RC59	U02SP11	3	1	7	1.73	3.61	3.18
RC87	U07SP11	3	1	8	2.97	2.98	1.78
RC73	U25SP11	3	1	9	2.80	3.12	1.75
RC85	U24SP11	3	1	10	4.66	1.90	2.78
Batch 1	BCHSP312	3	1	11	2.55	2.37	2.07
U std	USTSP312	3	1	12	1.94	2.65	1.32
RC60	U38SP11	3	1	13	4.67	1.51	3.08
RC76	U27SP11	3	1	14	2.84	1.87	1.73
RC78	U40SP11	3	1	15	2.82	1.85	1.70
RC86	U42SP11	3	1	16	5.07	1.91	1.76
RC84	U44SP11	3	1	17	2.81	1.87	1.71
RC67	U06SP11	3	1	18	1.60	3.35	1.40

Table C.4: Measured Elemental Concentrations (wt%) for the ND Glasses Prepared Using Peroxide Fusion *(continued)*

Glass ID	SRTC -ML ID	Block	Sub-Block	Analytical Sequence	Al	B	Li
RC97	U19SP11	3	1	19	1.70	1.91	2.06
RC88	U03SP11	3	1	20	1.59	1.67	2.54
Batch 1	BCHSP313	3	1	21	2.43	2.28	1.99
U std	USTSP313	3	1	22	1.89	2.54	1.29
Batch 1	BCHSP321	3	2	1	2.59	2.59	2.07
U std	USTSP321	3	2	2	1.96	2.78	1.30
RC85	U24SP12	3	2	3	4.70	2.00	2.75
RC60	U38SP12	3	2	4	4.63	1.55	2.99
RC82	U14SP12	3	2	5	2.84	1.99	2.75
RC73	U25SP12	3	2	6	2.78	3.25	1.70
RC67	U06SP12	3	2	7	1.62	3.59	1.39
RC78	U40SP12	3	2	8	2.93	2.01	1.71
RC87	U07SP12	3	2	9	2.89	3.06	1.68
RC97	U19SP12	3	2	10	1.71	2.04	2.05
Batch 1	BCHSP322	3	2	11	2.57	2.50	2.04
U std	USTSP322	3	2	12	1.98	2.83	1.30
RC68	U46SP12	3	2	13	1.71	1.64	1.40
RC88	U03SP12	3	2	14	1.76	1.90	2.75
RC84	U44SP12	3	2	15	2.98	2.07	1.76
RC86	U42SP12	3	2	16	5.29	2.06	1.76
RC76	U27SP12	3	2	17	2.85	1.97	1.68
RC59	U02SP12	3	2	18	1.68	3.76	3.11
RC89	U29SP12	3	2	19	2.01	1.92	2.77
RC80	U12SP12	3	2	20	0.124	2.21	1.88
Batch 1	BCHSP323	3	2	21	2.61	2.56	2.07
U std	USTSP323	3	2	22	1.88	2.69	1.24
Batch 1	BCHSP411	4	1	1	2.68	2.58	2.17
U std	USTSP411	4	1	2	2.03	2.72	1.32
RC59	U02SP21	4	1	3	1.69	3.62	3.17
RC82	U14SP21	4	1	4	2.92	2.00	2.83
RC67	U06SP21	4	1	5	1.68	3.63	1.44
RC78	U40SP21	4	1	6	2.84	1.95	1.70
RC86	U42SP21	4	1	7	4.91	1.94	1.68
RC84	U44SP21	4	1	8	2.78	1.94	1.67
RC85	U24SP21	4	1	9	4.41	1.88	2.66
RC88	U03SP21	4	1	10	1.69	1.82	2.69
Batch 1	BCHSP412	4	1	11	2.51	2.44	2.05
U std	USTSP412	4	1	12	2.01	2.75	1.29
RC76	U27SP21	4	1	13	2.88	1.99	1.75
RC73	U25SP21	4	1	14	2.93	3.35	1.77
RC89	U29SP21	4	1	15	2.03	1.92	2.83
RC97	U19SP21	4	1	16	1.81	2.10	2.20
RC60	U38SP21	4	1	17	4.90	1.59	3.19
RC80	U12SP21	4	1	18	0.127	2.13	1.82
RC68	U46SP21	4	1	19	1.66	1.56	1.39
RC87	U07SP21	4	1	20	2.90	3.05	1.71
Batch 1	BCHSP413	4	1	21	2.63	2.56	2.12
U std	USTSP413	4	1	22	2.07	2.79	1.33
Batch 1	BCHSP421	4	2	1	2.49	2.48	2.04
U std	USTSP421	4	2	2	1.93	2.61	1.28
RC88	U03SP22	4	2	3	1.68	1.80	2.66
RC87	U07SP22	4	2	4	2.82	2.92	1.69
RC89	U29SP22	4	2	5	1.92	1.80	2.68
RC84	U44SP22	4	2	6	2.76	1.89	1.68
RC67	U06SP22	4	2	7	1.65	3.49	1.43

Table C.4: Measured Elemental Concentrations (wt%) for the ND Glasses Prepared Using Peroxide Fusion ***(continued)***

Glass ID	SRTC -ML ID	Block	Sub-Block	Analytical Sequence	Al	B	Li
RC80	U12SP22	4	2	8	0.166	2.06	1.81
RC68	U46SP22	4	2	9	1.64	1.49	1.38
RC85	U24SP22	4	2	10	4.54	1.87	2.74
Batch 1	BCHSP422	4	2	11	2.51	2.38	2.04
U std	USTSP422	4	2	12	2.01	2.66	1.31
RC78	U40SP22	4	2	13	2.80	1.91	1.69
RC86	U42SP22	4	2	14	4.85	1.89	1.68
RC73	U25SP22	4	2	15	2.80	3.18	1.72
RC60	U38SP22	4	2	16	4.55	1.51	2.99
RC82	U14SP22	4	2	17	2.81	1.89	2.71
RC59	U02SP22	4	2	18	1.63	3.49	3.03
RC97	U19SP22	4	2	19	1.71	1.96	2.08
RC76	U27SP22	4	2	20	2.77	1.88	1.70
Batch 1	BCHSP423	4	2	21	2.50	2.37	2.03
U std	USTSP423	4	2	22	1.95	2.58	1.28
Batch 1	BCHSP511	5	1	1	2.56	2.52	2.08
U std	USTSP511	5	1	2	2.05	2.71	1.33
ND27	U18SP11	5	1	3	1.77	3.27	1.87
ND24	U41SP11	5	1	4	3.06	1.98	2.94
ND30	U09SP11	5	1	5	3.14	2.48	2.23
ND04	U17SP11	5	1	6	1.73	3.67	3.24
ND23	U16SP11	5	1	7	2.94	1.93	1.76
ND09	U30SP11	5	1	8	4.94	1.52	1.43
ND31	U37SP11	5	1	9	1.78	1.96	2.96
ND02	U22SP11	5	1	10	1.76	3.61	1.47
Batch 1	BCHSP512	5	1	11	2.62	2.41	2.11
U std	USTSP512	5	1	12	2.19	2.79	1.41
ND21	U31SP11	5	1	13	3.10	3.32	2.75
ND29	U20SP11	5	1	14	1.77	1.99	1.86
ND11	U13SP11	5	1	15	2.44	1.51	3.12
ND18	U34SP11	5	1	16	1.68	1.54	1.41
ND22	U50SP11	5	1	17	3.09	3.16	1.82
ND16	U08SP11	5	1	18	5.93	1.55	3.27
ND28	U36SP11	5	1	19	1.72	3.20	2.89
ND25	U48SP11	5	1	20	5.37	1.89	1.73
ND26	U35SP11	5	1	21	1.66	1.85	1.72
Batch 1	BCHSP513	5	1	22	2.59	2.40	2.10
U std	USTSP513	5	1	23	2.49	2.30	2.02
Batch 1	BCHSP521	5	2	1	2.60	2.53	2.08
U std	USTSP521	5	2	2	1.98	2.63	1.25
ND21	U31SP12	5	2	3	2.93	3.21	2.62
ND29	U20SP12	5	2	4	1.55	1.82	1.67
ND31	U37SP12	5	2	5	1.69	1.92	2.90
ND22	U50SP12	5	2	6	2.91	3.05	1.69
ND24	U41SP12	5	2	7	2.93	1.87	2.83
ND27	U18SP12	5	2	8	1.70	3.25	1.81
ND09	U30SP12	5	2	9	5.01	1.50	1.37
ND11	U13SP12	5	2	10	2.46	1.48	3.19
Batch 1	BCHSP522	5	2	11	2.63	2.42	2.10
U std	USTSP522	5	2	12	2.08	2.75	1.31
ND23	U16SP12	5	2	13	2.99	1.94	1.75
ND28	U36SP12	5	2	14	1.70	3.29	2.95
ND26	U35SP12	5	2	15	1.71	1.93	1.79
ND02	U22SP12	5	2	16	1.74	3.75	1.44
ND25	U48SP12	5	2	17	5.65	1.93	1.74

Table C.4: Measured Elemental Concentrations (wt%) for the ND Glasses Prepared Using Peroxide Fusion *(continued)*

Glass ID	SRTC -ML ID	Block	Sub-Block	Analytical Sequence	Al	B	Li
ND04	U17SP12	5	2	18	1.62	3.61	3.17
ND30	U09SP12	5	2	19	2.95	2.40	2.08
ND18	U34SP12	5	2	20	1.71	1.57	1.42
ND16	U08SP12	5	2	21	5.89	1.50	3.22
Batch 1	BCHSP523	5	2	22	2.62	2.41	2.10
U std	USTSP523	5	2	23	2.07	2.70	1.30
Batch 1	BCHSP611	6	1	1	2.58	2.20	2.11
U std	USTSP611	6	1	2	1.84	2.74	1.16
ND28	U36SP21	6	1	3	1.46	3.27	2.55
ND04	U17SP21	6	1	4	1.50	3.75	2.94
ND24	U41SP21	6	1	5	2.68	1.99	2.59
ND11	U13SP21	6	1	6	2.18	1.53	2.86
ND02	U22SP21	6	1	7	1.62	3.72	1.34
ND29	U20SP21	6	1	8	1.58	1.97	1.68
ND16	U08SP21	6	1	9	5.71	1.56	3.13
ND30	U09SP21	6	1	10	2.96	2.46	2.11
Batch 1	BCHSP612	6	1	11	2.55	2.47	2.03
U std	USTSP612	6	1	12	2.00	2.76	1.26
ND18	U34SP21	6	1	13	1.57	1.56	1.32
ND26	U35SP21	6	1	14	1.57	1.92	1.64
ND27	U18SP21	6	1	15	1.60	3.21	1.69
ND23	U16SP21	6	1	16	2.78	1.91	1.62
ND09	U30SP21	6	1	17	4.77	1.53	1.32
ND21	U31SP21	6	1	18	2.79	3.14	2.48
ND31	U37SP 21	6	1	19	1.66	1.98	2.80
ND25	U48SP21	6	1	20	5.52	1.94	1.70
ND22	U50SP21	6	1	21	2.96	3.24	1.73
Batch 1	BCHSP613	6	1	22	2.57	2.50	2.05
U std	USTSP613	6	1	23	2.01	2.72	1.26
Batch 1	BCHSP621	6	2	1	2.53	2.51	2.06
U std	USTSP621	6	2	2	2.01	2.68	1.31
ND31	U37SP22	6	2	3	1.84	2.14	3.03
ND11	U13SP22	6	2	4	2.36	1.51	3.04
ND02	U22SP22	6	2	5	1.69	3.59	1.40
ND29	U20SP22	6	2	6	1.69	1.97	1.77
ND04	U17SP22	6	2	7	1.68	3.65	3.12
ND27	U18SP22	6	2	8	1.67	3.19	1.76
ND28	U36SP22	6	2	9	1.67	3.22	2.78
ND18	U34SP22	6	2	10	1.69	1.60	1.43
Batch 1	BCHSP622	6	2	11	2.58	2.44	2.09
U std	USTSP622	6	2	12	2.11	2.76	1.37
ND21	U31SP22	6	2	13	2.93	3.28	2.65
ND22	U50SP22	6	2	14	3.09	3.30	1.87
ND23	U16SP22	6	2	15	2.93	2.01	1.77
ND24	U41SP22	6	2	16	2.98	1.97	2.86
ND16	U08SP22	6	2	17	5.80	1.59	3.24
ND09	U30SP22	6	2	18	4.75	1.54	1.41
ND30	U09SP22	6	2	19	3.07	2.48	2.21
ND26	U35SP22	6	2	20	1.62	1.90	1.69
ND25	U48SP22	6	2	21	5.32	1.95	1.74
Batch 1	BCHSP623	6	2	22	2.61	2.47	2.11
U std	USTSP623	6	2	23	2.28	2.59	1.66

Table C.5: Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by Glass Number
(Batch 1: 0 – non-rad group and 100 – rad group; 101-U std)

Glass #	Glass ID	Oxide	Measured (wt%)	Measured Bias-Corrected (wt%)	Targeted (wt%)	Diff of Measured	Diff of Meas BC	% Diff of Measured	% Diff of Meas BC
0	Batch 1	Al2O3 (wt%)	4.9610	4.8770	4.8770	0.0840	0.0000	1.7%	0.0%
0	Batch 1	B2O3 (wt%)	8.0855	7.7770	7.7770	0.3085	0.0000	4.0%	0.0%
0	Batch 1	CaO (wt%)	1.2875	1.2200	1.2200	0.0675	0.0000	5.5%	0.0%
0	Batch 1	Cr2O3 (wt%)	0.1047	0.1070	0.1070	-0.0023	0.0000	-2.1%	0.0%
0	Batch 1	Fe2O3 (wt%)	13.1802	12.8390	12.8390	0.3412	0.0000	2.7%	0.0%
0	Batch 1	Li2O (wt%)	4.4948	4.4290	4.4290	0.0658	0.0000	1.5%	0.0%
0	Batch 1	MgO (wt%)	1.4941	1.4190	1.4190	0.0751	0.0000	5.3%	0.0%
0	Batch 1	MnO (wt%)	1.7022	1.7260	1.7260	-0.0238	0.0000	-1.4%	0.0%
0	Batch 1	Na2O (wt%)	9.7116	9.0030	9.0030	0.7086	0.0000	7.9%	0.0%
0	Batch 1	NiO (wt%)	0.7516	0.7510	0.7510	0.0006	0.0000	0.1%	0.0%
0	Batch 1	P2O5 (wt%)	0.2291	0.2291	0.0000	0.2291	0.2291		
0	Batch 1	SiO2 (wt%)	50.8084	50.2200	50.2200	0.5884	0.0000	1.2%	0.0%
0	Batch 1	TiO2 (wt%)	0.6811	0.6811	0.6770	0.0041	0.0041	0.6%	0.6%
0	Batch 1	ZrO2 (wt%)	0.0805	0.0805	0.0980	-0.0175	-0.0175	-17.8%	-17.8%
0	Batch 1	Sum of Oxides (wt%)	97.5724	95.3587	95.1430	2.4294	0.2157	2.6%	0.2%
100	Batch 1	Al2O3 (wt%)	4.8345	4.8770	4.8770	-0.0425	0.0000	-0.9%	0.0%
100	Batch 1	B2O3 (wt%)	7.8888	7.7770	7.7770	0.1118	0.0000	1.4%	0.0%
100	Batch 1	CaO (wt%)	1.2829	1.2200	1.2200	0.0629	0.0000	5.2%	0.0%
100	Batch 1	Cr2O3 (wt%)	0.1105	0.1070	0.1070	0.0035	0.0000	3.3%	0.0%
100	Batch 1	Fe2O3 (wt%)	12.7009	12.8390	12.8390	-0.1381	0.0000	-1.1%	0.0%
100	Batch 1	Li2O (wt%)	4.4571	4.4290	4.4290	0.0281	0.0000	0.6%	0.0%
100	Batch 1	MgO (wt%)	1.4569	1.4190	1.4190	0.0379	0.0000	2.7%	0.0%
100	Batch 1	MnO (wt%)	1.6340	1.7260	1.7260	-0.0920	0.0000	-5.3%	0.0%
100	Batch 1	Na2O (wt%)	9.6598	9.0030	9.0030	0.6568	0.0000	7.3%	0.0%
100	Batch 1	NiO (wt%)	0.7260	0.7510	0.7510	-0.0250	0.0000	-3.3%	0.0%
100	Batch 1	P2O5 (wt%)	0.0458	0.0458	0.0000	0.0458	0.0458		
100	Batch 1	SiO2 (wt%)	48.6321	50.2200	50.2200	-1.5879	0.0000	-3.2%	0.0%
100	Batch 1	ThO2 (wt%)	0.0058	0.0058	0.0000	0.0058	0.0058		
100	Batch 1	TiO2 (wt%)	0.6746	0.6770	0.6770	-0.0024	0.0000	-0.4%	0.0%
100	Batch 1	U3O8 (wt%)	0.0590	0.0621	0.0000	0.0590	0.0621		
100	Batch 1	ZrO2 (wt%)	0.0741	0.0741	0.0980	-0.0239	-0.0239	-24.4%	-24.4%
100	Batch 1	Sum of Oxides (wt%)	94.2427	95.2328	95.1430	-0.9003	0.0898	-0.9%	0.1%
1	ND01	Al2O3 (wt%)	3.2736	3.2046	3.0000	0.2736	0.2046	9.1%	6.8%
1	ND01	B2O3 (wt%)	5.1116	4.9081	5.0000	0.1116	-0.0919	2.2%	-1.8%
1	ND01	CaO (wt%)	4.2151	3.9758	4.0000	0.2151	-0.0242	5.4%	-0.6%
1	ND01	Cr2O3 (wt%)	0.0146	0.0150	0.0000	0.0146	0.0150		
1	ND01	Fe2O3 (wt%)	5.2899	5.1365	5.0000	0.2899	0.1365	5.8%	2.7%
1	ND01	Li2O (wt%)	3.1540	3.0971	3.0000	0.1540	0.0971	5.1%	3.2%
1	ND01	MgO (wt%)	0.0332	0.0313	0.0000	0.0332	0.0313		
1	ND01	MnO (wt%)	8.1216	8.1220	8.0000	0.1216	0.1220	1.5%	1.5%
1	ND01	Na2O (wt%)	24.0281	22.0685	23.6100	0.4181	-1.5415	1.8%	-6.5%
1	ND01	NiO (wt%)	0.0636	0.0634	0.0000	0.0636	0.0634		
1	ND01	P2O5 (wt%)	0.2291	0.2291	0.0000	0.2291	0.2291		
1	ND01	SiO2 (wt%)	48.4551	47.7268	48.3900	0.0651	-0.6632	0.1%	-1.4%
1	ND01	TiO2 (wt%)	0.0584	0.0584	0.0000	0.0584	0.0584		
1	ND01	ZrO2 (wt%)	0.0213	0.0213	0.0000	0.0213	0.0213		
1	ND01	Sum of Oxides (wt%)	102.0692	98.6579	100.0000	2.0692	-1.3421	2.1%	-1.3%
2	ND02	Al2O3 (wt%)	3.2169	3.2096	3.0000	0.2169	0.2096	7.2%	7.0%
2	ND02	B2O3 (wt%)	11.8090	11.6927	12.0000	-0.1910	-0.3073	-1.6%	-2.6%
2	ND02	CaO (wt%)	0.5226	0.4915	0.5000	0.0226	-0.0085	4.5%	-1.7%
2	ND02	Cr2O3 (wt%)	0.0107	0.0102	0.0000	0.0107	0.0102		
2	ND02	Fe2O3 (wt%)	4.7173	4.8120	5.0000	-0.2827	-0.1880	-5.7%	-3.8%
2	ND02	Li2O (wt%)	3.0410	3.0000	3.0000	0.0410	0.0000	1.4%	0.0%
2	ND02	MgO (wt%)	0.0083	0.0081	0.0000	0.0083	0.0081		
2	ND02	MnO (wt%)	8.3248	8.7586	8.0000	0.3248	0.7586	4.1%	9.5%
2	ND02	Na2O (wt %)	16.7988	15.7260	16.4500	0.3488	-0.7240	2.1%	-4.4%

Table C.5: Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by Glass Number
(Batch 1: 0 – non-rad group and 100 – rad group; 101-U std)

Glass #	Glass ID	Oxide	Measured (wt%)	Measured Bias-Corrected (wt%)	Targeted (wt%)	Diff of Measured	Diff of Meas BC	% Diff of Measured	% Diff of Meas BC
2	ND02	NiO (wt%)	0.0064	0.0066	0.0000	0.0064	0.0066		
2	ND02	P2O5 (wt%)	0.0458	0.0458	0.0000	0.0458	0.0458		
2	ND02	SiO2 (wt%)	41.2880	42.8591	42.3000	-1.0120	0.5591	-2.4%	1.3%
2	ND02	ThO2 (wt%)	0.2117	0.2117	0.0000	0.2117	0.2117		
2	ND02	TiO2 (wt%)	1.6798	1.6857	1.7500	-0.0702	-0.0643	-4.0%	-3.7%
2	ND02	U3O8 (wt%)	7.9006	8.2094	8.0000	-0.0994	0.2094	-1.2%	2.6%
2	ND02	ZrO2 (wt%)	0.0068	0.0068	0.0000	0.0068	0.0068		
2	ND02	Sum of Oxides (wt%)	99.5884	100.7335	100.0000	-0.4116	0.7335	-0.4%	0.7%
3	ND03	Al2O3 (wt%)	3.3066	3.2373	3.0000	0.3066	0.2373	10.2%	7.9%
3	ND03	B2O3 (wt%)	4.9667	4.7689	5.0000	-0.0333	-0.2311	-0.7%	-4.6%
3	ND03	CaO (wt%)	0.5338	0.5034	0.5000	0.0338	0.0034	6.8%	0.7%
3	ND03	Cr2O3 (wt%)	0.2748	0.2814	0.2638	0.0110	0.0176	4.2%	6.7%
3	ND03	Fe2O3 (wt%)	5.0397	4.8936	5.0000	0.0397	-0.1064	0.8%	-2.1%
3	ND03	Li2O (wt%)	7.0131	6.8866	7.0000	0.0131	-0.1134	0.2%	-1.6%
3	ND03	MgO (wt%)	3.6851	3.4739	4.0000	-0.3149	-0.5261	-7.9%	-13.2%
3	ND03	MnO (wt%)	8.2798	8.2803	8.0000	0.2798	0.2803	3.5%	3.5%
3	ND03	Na2O (wt%)	15.8390	14.5478	15.3300	0.5090	-0.7822	3.3%	-5.1%
3	ND03	NiO (wt%)	0.0636	0.0634	0.0000	0.0636	0.0634		
3	ND03	P2O5 (wt%)	0.9607	0.9607	0.9984	-0.0377	-0.0377	-3.8%	-3.8%
3	ND03	SiO2 (wt%)	48.4017	47.6739	48.4200	-0.0183	-0.7461	0.0%	-1.5%
3	ND03	TiO2 (wt%)	1.7556	1.7556	1.7500	0.0056	0.0056	0.3%	0.3%
3	ND03	ZrO2 (wt%)	0.0574	0.0574	0.0960	-0.0386	-0.0386	-40.2%	-40.2%
3	ND03	Sum of Oxides (wt%)	100.1775	97.3841	99.3582	0.8193	-1.9741	0.8%	-2.0%
4	ND04	Al2O3 (wt%)	3.0846	3.0778	3.0000	0.0846	0.0778	2.8%	2.6%
4	ND04	B2O3 (wt%)	11.8170	11.7011	12.0000	-0.1830	-0.2989	-1.5%	-2.5%
4	ND04	CaO (wt%)	0.5314	0.4982	0.5000	0.0314	-0.0018	6.3%	-0.4%
4	ND04	Cr2O3 (wt%)	0.2600	0.2502	0.2638	-0.0038	-0.0136	-1.4%	-5.2%
4	ND04	Fe2O3 (wt%)	4.7337	4.8116	5.0000	-0.2663	-0.1884	-5.3%	-3.8%
4	ND04	Li2O (wt%)	6.7117	6.6211	7.0000	-0.2883	-0.3789	-4.1%	-5.4%
4	ND04	MgO (wt%)	3.7780	3.6860	4.0000	-0.2220	-0.3140	-5.5%	-7.8%
4	ND04	MnO (wt%)	0.5304	0.5563	0.5000	0.0304	0.0563	6.1%	11.3%
4	ND04	Na2O (wt%)	10.9892	10.2345	10.3700	0.6192	-0.1355	6.0%	-1.3%
4	ND04	NiO (wt%)	0.0166	0.0174	0.0000	0.0166	0.0174		
4	ND04	P2O5 (wt%)	0.9804	0.9804	0.9984	-0.0180	-0.0180	-1.8%	-1.8%
4	ND04	SiO2 (wt%)	46.5143	48.0182	47.6300	-1.1157	0.3882	-2.3%	0.8%
4	ND04	ThO2 (wt%)	0.2127	0.2127	0.0000	0.2127	0.2127		
4	ND04	TiO2 (wt%)	0.0083	0.0084	0.0000	0.0083	0.0084		
4	ND04	U3O8 (wt%)	7.9011	8.2088	8.0000	-0.0989	0.2088	-1.2%	2.6%
4	ND04	ZrO2 (wt%)	0.0793	0.0793	0.0960	-0.0167	-0.0167	-17.4%	-17.4%
4	ND04	Sum of Oxides (wt%)	98.1488	98.9620	99.3582	-1.2094	-0.3962	-1.2%	-0.4%
5	ND05	Al2O3 (wt%)	13.8500	13.5583	13.4800	0.3700	0.0783	2.7%	0.6%
5	ND05	B2O3 (wt%)	5.0311	4.8320	5.0000	0.0311	-0.1680	0.6%	-3.4%
5	ND05	CaO (wt%)	4.2746	4.0319	4.0000	0.2746	0.0319	6.9%	0.8%
5	ND05	Cr2O3 (wt%)	0.2821	0.2888	0.2638	0.0183	0.0250	6.9%	9.5%
5	ND05	Fe2O3 (wt%)	5.1290	4.9804	5.0000	0.1290	-0.0196	2.6%	-0.4%
5	ND05	Li2O (wt%)	7.0077	6.8814	7.0000	0.0077	-0.1186	0.1%	-1.7%
5	ND05	MgO (wt%)	0.0332	0.0313	0.0000	0.0332	0.0313		
5	ND05	MnO (wt%)	8.3508	8.3514	8.0000	0.3508	0.3514	4.4%	4.4%
5	ND05	Na2O (wt%)	13.6822	12.5668	12.7400	0.9422	-0.1732	7.4%	-1.4%
5	ND05	NiO (wt%)	0.0636	0.0634	0.0000	0.0636	0.0634		
5	ND05	P2O5 (wt%)	0.9922	0.9922	0.9984	-0.0062	-0.0062	-0.6%	-0.6%
5	ND05	SiO2 (wt%)	43.3743	42.7224	42.7800	0.5943	-0.0576	1.4%	-0.1%
5	ND05	TiO2 (wt%)	0.0584	0.0584	0.0000	0.0584	0.0584		
5	ND05	ZrO2 (wt%)	0.0702	0.0702	0.0960	-0.0258	-0.0258	-26.8%	-26.8%
5	ND05	Sum of Oxides (wt%)	102.1994	99.4289	99.3582	2.8412	0.0707	2.9%	0.1%
6	ND06	Al2O3 (wt%)	3.4105	3.3385	3.0100	0.4005	0.3285	13.3%	10.9%

Table C.5: Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by Glass Number
(Batch 1: 0 – non-rad group and 100 – rad group; 101-U std)

				Measured					
			Measured	Bias-Corrected	Targeted	Diff of	Diff of	% Diff of	% Diff of
Glass #	Glass ID	Oxide	(wt%)	(wt%)	(wt%)	Measured	Meas BC	Measured	Meas BC
6	ND06	B2O3 (wt%)	4.8862	4.6919	5.0000	-0.1138	-0.3081	-2.3%	-6.2%
6	ND06	CaO (wt%)	0.5006	0.4721	0.5000	0.0006	-0.0279	0.1%	-5.6%
6	ND06	Cr2O3 (wt%)	0.0822	0.0842	0.0000	0.0822	0.0842		
6	ND06	Fe2O3 (wt%)	4.9897	4.8450	5.0000	-0.0103	-0.1550	-0.2%	-3.1%
6	ND06	Li2O (wt%)	7.1046	6.9765	7.0000	0.1046	-0.0235	1.5%	-0.3%
6	ND06	MgO (wt%)	0.0332	0.0313	0.0000	0.0332	0.0313		
6	ND06	MnO (wt%)	0.5049	0.5049	0.5000	0.0049	0.0049	1.0%	1.0%
6	ND06	Na2O (wt%)	14.5247	13.3403	13.9900	0.5347	-0.6497	3.8%	-4.6%
6	ND06	NiO (wt%)	0.0636	0.0634	0.0000	0.0636	0.0634		
6	ND06	P2O5 (wt%)	0.2291	0.2291	0.0000	0.2291	0.2291		
6	ND06	SiO2 (wt%)	61.2909	60.3695	65.0000	-3.7091	-4.6305	-5.7%	-7.1%
6	ND06	TiO2 (wt%)	0.0584	0.0584	0.0000	0.0584	0.0584		
6	ND06	ZrO2 (wt%)	0.0068	0.0068	0.0000	0.0068	0.0068		
6	ND06	Sum of Oxides (wt%)	97.6853	95.0118	100.0000	-2.3147	-4.9882	-2.3%	-5.0%
7	ND07	Al2O3 (wt%)	3.2263	3.1583	3.0000	0.2263	0.1583	7.5%	5.3%
7	ND07	B2O3 (wt%)	4.8942	4.7003	5.0000	-0.1058	-0.2997	-2.1%	-6.0%
7	ND07	CaO (wt%)	4.4320	4.1801	4.0000	0.4320	0.1801	10.8%	4.5%
7	ND07	Cr2O3 (wt%)	0.0146	0.0150	0.0000	0.0146	0.0150		
7	ND07	Fe2O3 (wt%)	5.1005	4.9526	5.0000	0.1005	-0.0474	2.0%	-0.9%
7	ND07	Li2O (wt%)	2.9871	2.9333	3.0000	-0.0129	-0.0667	-0.4%	-2.2%
7	ND07	MgO (wt%)	0.0332	0.0313	0.0000	0.0332	0.0313		
7	ND07	MnO (wt%)	0.5233	0.5233	0.5000	0.0233	0.0233	4.7%	4.7%
7	ND07	Na2O (wt%)	17.6588	16.2188	16.8300	0.8288	-0.6112	4.9%	-3.6%
7	ND07	NiO (wt%)	0.0636	0.0634	0.0000	0.0636	0.0634		
7	ND07	P2O5 (wt%)	0.2291	0.2291	0.0000	0.2291	0.2291		
7	ND07	SiO2 (wt%)	60.8631	59.9479	60.9200	-0.0569	-0.9721	-0.1%	-1.6%
7	ND07	TiO2 (wt%)	1.7681	1.7681	1.7500	0.0181	0.0181	1.0%	1.0%
7	ND07	ZrO2 (wt%)	0.0068	0.0068	0.0000	0.0068	0.0068		
7	ND07	Sum of Oxides (wt%)	101.8007	98.7281	100.0000	1.8007	-1.2719	1.8%	-1.3%
8	ND08	Al2O3 (wt%)	11.4929	11.2505	11.1900	0.3029	0.0605	2.7%	0.5%
8	ND08	B2O3 (wt%)	11.6158	11.1554	12.0000	-0.3842	-0.8446	-3.2%	-7.0%
8	ND08	CaO (wt%)	0.5111	0.4820	0.5000	0.0111	-0.0180	2.2%	-3.6%
8	ND08	Cr2O3 (wt%)	0.0146	0.0150	0.0000	0.0146	0.0150		
8	ND08	Fe2O3 (wt%)	5.1219	4.9734	5.0000	0.1219	-0.0266	2.4%	-0.5%
8	ND08	Li2O (wt%)	3.0248	2.9703	3.0000	0.0248	-0.0297	0.8%	-1.0%
8	ND08	MgO (wt%)	3.7059	3.4934	4.0000	-0.2941	-0.5066	-7.4%	-12.7%
8	ND08	MnO (wt%)	8.3347	8.3351	8.0000	0.3347	0.3351	4.2%	4.2%
8	ND08	Na2O (wt%)	15.0639	13.8353	14.4600	0.6039	-0.6247	4.2%	-4.3%
8	ND08	NiO (wt%)	0.0636	0.0634	0.0000	0.0636	0.0634		
8	ND08	P2O5 (wt%)	0.2291	0.2291	0.0000	0.2291	0.2291		
8	ND08	SiO2 (wt%)	42.3581	41.7213	41.8500	0.5081	-0.1287	1.2%	-0.3%
8	ND08	TiO2 (wt%)	0.0584	0.0584	0.0000	0.0584	0.0584		
8	ND08	ZrO2 (wt%)	0.0068	0.0068	0.0000	0.0068	0.0068		
8	ND08	Sum of Oxides (wt%)	101.6016	98.5894	100.0000	1.6016	-1.4106	1.6%	-1.4%
9	ND09	Al2O3 (wt%)	9.1971	9.1764	9.1500	0.0471	0.0264	0.5%	0.3%
9	ND09	B2O3 (wt%)	4.9023	4.8535	5.0000	-0.0977	-0.1465	-2.0%	-2.9%
9	ND09	CaO (wt%)	0.6008	0.5651	0.5000	0.1008	0.0651	20.2%	13.0%
9	ND09	Cr2O3 (wt%)	0.2530	0.2425	0.2638	-0.0108	-0.0213	-4.1%	-8.1%
9	ND09	Fe2O3 (wt%)	4.6320	4.7244	5.0000	-0.3680	-0.2756	-7.4%	-5.5%
9	ND09	Li2O (wt%)	2.9764	2.9364	3.0000	-0.0236	-0.0636	-0.8%	-2.1%
9	ND09	MgO (wt%)	0.0083	0.0081	0.0000	0.0083	0.0081		
9	ND09	MnO (wt%)	0.6895	0.7254	0.5000	0.1895	0.2254	37.9%	45.1%
9	ND09	Na2O (wt%)	19.3152	18.0786	19.0600	0.2552	-0.9814	1.3%	-5.1%
9	ND09	NiO (wt%)	0.0992	0.1034	0.0000	0.0992	0.1034		
9	ND09	P2O5 (wt%)	0.9584	0.9584	0.9984	-0.0400	-0.0400	-4.0%	-4.0%
9	ND09	SiO2 (wt%)	44.9387	46.6455	46.0400	-1.1013	0.6055	-2.4%	1.3%

Table C.5: Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by Glass Number
(Batch 1: 0 – non-rad group and 100 – rad group; 101-U std)

Glass #	Glass ID	Oxide	Measured (wt%)	Measured Bias-Corrected (wt%)	Targeted (wt%)	Diff of Measured	Diff of Meas BC	% Diff of Measured	% Diff of Meas BC
9	ND09	ThO2 (wt%)	0.2101	0.2101	0.0000	0.2101	0.2101		
9	ND09	TiO2 (wt%)	1.6672	1.6730	1.7500	-0.0828	-0.0770	-4.7%	-4.4%
9	ND09	U3O8 (wt%)	7.7707	8.0748	8.0000	-0.2293	0.0748	-2.9%	0.9%
9	ND09	ZrO2 (wt%)	0.0688	0.0688	0.0960	-0.0272	-0.0272	-28.3%	-28.3%
9	ND09	Sum of Oxides (wt%)	98.2877	99.0444	99.3582	-1.0705	-0.3138	-1.1%	-0.3%
10	ND10	Al2O3 (wt%)	5.0591	4.9528	3.0000	2.0591	1.9528	68.6%	65.1%
10	ND10	B2O3 (wt%)	11.7687	11.3029	12.0000	-0.2313	-0.6971	-1.9%	-5.8%
10	ND10	CaO (wt%)	4.4110	4.1605	4.0000	0.4110	0.1605	10.3%	4.0%
10	ND10	Cr2O3 (wt%)	0.0146	0.0150	0.0000	0.0146	0.0150		
10	ND10	Fe2O3 (wt%)	14.9547	14.5211	14.7400	0.2147	-0.2189	1.5%	-1.5%
10	ND10	Li2O (wt%)	3.0087	2.9544	3.0000	0.0087	-0.0456	0.3%	-1.5%
10	ND10	MgO (wt%)	3.7349	3.5208	4.0000	-0.2651	-0.4792	-6.6%	-12.0%
10	ND10	MnO (wt%)	0.5581	0.5581	0.5000	0.0581	0.0581	11.6%	11.6%
10	ND10	Na2O (wt%)	14.9628	13.7430	14.1800	0.7828	-0.4370	5.5%	-3.1%
10	ND10	NiO (wt%)	0.0636	0.0634	0.0000	0.0636	0.0634		
10	ND10	P2O5 (wt%)	0.2291	0.2291	0.0000	0.2291	0.2291		
10	ND10	SiO2 (wt%)	45.0323	44.3552	44.5800	0.4523	-0.2248	1.0%	-0.5%
10	ND10	TiO2 (wt%)	0.0584	0.0584	0.0000	0.0584	0.0584		
10	ND10	ZrO2 (wt%)	0.0068	0.0068	0.0000	0.0068	0.0068		
10	ND10	Sum of Oxides (wt%)	103.8628	100.4416	100.0000	3.8628	0.4416	3.9%	0.4%
11	ND11	Al2O3 (wt%)	4.4592	4.4486	3.0000	1.4592	1.4486	48.6%	48.3%
11	ND11	B2O3 (wt%)	4.8540	4.8061	5.0000	-0.1460	-0.1939	-2.9%	-3.9%
11	ND11	CaO (wt%)	4.0497	3.8203	4.0000	0.0497	-0.1797	1.2%	-4.5%
11	ND11	Cr2O3 (wt%)	0.0103	0.0098	0.0000	0.0103	0.0098		
11	ND11	Fe2O3 (wt%)	9.2245	9.4432	10.5400	-1.3155	-1.0968	-12.5%	-10.4%
11	ND11	Li2O (wt%)	6.5717	6.4829	7.0000	-0.4283	-0.5171	-6.1%	-7.4%
11	ND11	MgO (wt%)	3.0531	2.9725	4.0000	-0.9469	-1.0275	-23.7%	-25.7%
11	ND11	MnO (wt%)	6.7529	7.1268	8.0000	-1.2471	-0.8732	-15.6%	-10.9%
11	ND11	Na2O (wt%)	9.7789	9.1989	8.0400	1.7389	1.1589	21.6%	14.4%
11	ND11	NiO (wt%)	0.6801	0.7055	0.0000	0.6801	0.7055		
11	ND11	P2O5 (wt%)	0.0458	0.0458	0.0000	0.0458	0.0458		
11	ND11	SiO2 (wt%)	39.7830	41.5219	40.6800	-0.8970	0.8419	-2.2%	2.1%
11	ND11	ThO2 (wt%)	0.2106	0.2106	0.0000	0.2106	0.2106		
11	ND11	TiO2 (wt%)	1.3819	1.3843	1.7500	-0.3681	-0.3657	-21.0%	-20.9%
11	ND11	U3O8 (wt%)	7.9463	8.2584	8.0000	-0.0537	0.2584	-0.7%	3.2%
11	ND11	ZrO2 (wt%)	0.0068	0.0068	0.0000	0.0068	0.0068		
11	ND11	Sum of Oxides (wt%)	98.8087	100.4425	100.0100	-1.2013	0.4325	-1.2%	0.4%
12	ND12	Al2O3 (wt%)	3.2263	3.1865	3.0000	0.2263	0.1865	7.5%	6.2%
12	ND12	B2O3 (wt%)	4.9103	4.7888	5.0000	-0.0897	-0.2112	-1.8%	-4.2%
12	ND12	CaO (wt%)	4.2711	4.0650	4.0000	0.2711	0.0650	6.8%	1.6%
12	ND12	Cr2O3 (wt%)	0.2795	0.2889	0.2638	0.0157	0.0251	6.0%	9.5%
12	ND12	Fe2O3 (wt%)	17.7998	17.3997	17.8000	-0.0002	-0.4003	0.0%	-2.2%
12	ND12	Li2O (wt%)	2.9602	2.9539	3.0000	-0.0398	-0.0461	-1.3%	-1.5%
12	ND12	MgO (wt%)	0.0332	0.0315	0.0000	0.0332	0.0315		
12	ND12	MnO (wt%)	0.5565	0.5718	0.5000	0.0565	0.0718	11.3%	14.4%
12	ND12	Na2O (wt%)	17.4566	16.1407	17.0100	0.4466	-0.8693	2.6%	-5.1%
12	ND12	NiO (wt%)	0.0636	0.0632	0.0000	0.0636	0.0632		
12	ND12	P2O5 (wt%)	1.0357	1.0357	0.9984	0.0373	0.0373	3.7%	3.7%
12	ND12	SiO2 (wt%)	45.8345	45.5267	45.9400	-0.1055	-0.4133	-0.2%	-0.9%
12	ND12	TiO2 (wt%)	1.7764	1.7764	1.7500	0.0264	0.0264	1.5%	1.5%
12	ND12	ZrO2 (wt%)	0.0827	0.0827	0.0960	-0.0133	-0.0133	-13.8%	-13.8%
12	ND12	Sum of Oxides (wt%)	100.2865	97.9115	99.3582	0.9283	-1.4467	0.9%	-1.5%
13	ND13	Al2O3 (wt%)	3.1933	3.1540	3.0000	0.1933	0.1540	6.4%	5.1%
13	ND13	B2O3 (wt%)	4.9908	4.8673	5.0000	-0.0092	-0.1327	-0.2%	-2.7%
13	ND13	CaO (wt%)	0.5233	0.4980	0.5000	0.0233	-0.0020	4.7%	-0.4%
13	ND13	Cr2O3 (wt%)	0.2708	0.2798	0.2638	0.0070	0.0160	2.6%	6.1%

Table C.5: Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by Glass Number
(Batch 1: 0 – non-rad group and 100 – rad group; 101-U std)

Glass #	Glass ID	Oxide	Measured (wt%)	Measured Bias-Corrected (wt%)	Targeted (wt%)	Diff of Measured	Diff of Meas BC	% Diff of Measured	% Diff of Meas BC
13	ND13	Fe2O3 (wt%)	5.1862	5.0697	5.0000	0.1862	0.0697	3.7%	1.4%
13	ND13	Li2O (wt%)	2.9656	2.9593	3.0000	-0.0344	-0.0407	-1.1%	-1.4%
13	ND13	MgO (wt%)	3.4033	3.2314	3.7600	-0.3567	-0.5286	-9.5%	-14.1%
13	ND13	MnO (wt%)	0.5229	0.5373	0.5000	0.0229	0.0373	4.6%	7.5%
13	ND13	Na2O (wt%)	24.1629	22.3417	23.7000	0.4629	-1.3583	2.0%	-5.7%
13	ND13	NiO (wt%)	5.0391	5.0053	5.0000	0.0391	0.0053	0.8%	0.1%
13	ND13	P2O5 (wt%)	1.0391	1.0391	0.9984	0.0407	0.0407	4.1%	4.1%
13	ND13	SiO2 (wt%)	48.0808	47.7592	48.5300	-0.4492	-0.7708	-0.9%	-1.6%
13	ND13	TiO2 (wt%)	0.0584	0.0584	0.0000	0.0584	0.0584		
13	ND13	ZrO2 (wt%)	0.0821	0.0821	0.0960	-0.0139	-0.0139	-14.5%	-14.5%
13	ND13	Sum of Oxides (wt%)	99.5186	96.8826	99.3482	0.1704	-2.4656	0.2%	-2.5%
14	ND14	Al2O3 (wt%)	5.4087	5.3419	4.9300	0.4787	0.4119	9.7%	8.4%
14	ND14	B2O3 (wt%)	5.2404	5.1107	5.0000	0.2404	0.1107	4.8%	2.2%
14	ND14	CaO (wt%)	4.4879	4.2713	4.0000	0.4879	0.2713	12.2%	6.8%
14	ND14	Cr2O3 (wt%)	0.0146	0.0151	0.0000	0.0146	0.0151		
14	ND14	Fe2O3 (wt%)	5.3685	5.2481	5.0000	0.3685	0.2481	7.4%	5.0%
14	ND14	Li2O (wt%)	3.1540	3.1471	3.0000	0.1540	0.1471	5.1%	4.9%
14	ND14	MgO (wt%)	3.8882	3.6922	4.0000	-0.1118	-0.3078	-2.8%	-7.7%
14	ND14	MnO (wt%)	0.5565	0.5718	0.5000	0.0565	0.0718	11.3%	14.4%
14	ND14	Na2O (wt%)	24.0955	22.2793	22.2500	1.8455	0.0293	8.3%	0.1%
14	ND14	NiO (wt%)	0.0636	0.0632	5.0000	-4.9364	-4.9368	-98.7%	-98.7%
14	ND14	P2O5 (wt%)	0.2291	0.2291	0.0000	0.2291	0.2291		
14	ND14	SiO2 (wt%)	46.9576	46.6433	44.5700	2.3876	2.0733	5.4%	4.7%
14	ND14	TiO2 (wt%)	1.8932	1.8932	1.7500	0.1432	0.1432	8.2%	8.2%
14	ND14	ZrO2 (wt%)	0.0068	0.0068	0.0000	0.0068	0.0068		
14	ND14	Sum of Oxides (wt%)	101.3647	98.5130	100.0000	1.3647	-1.4870	1.4%	-1.5%
15	ND15	Al2O3 (wt%)	3.2499	3.2098	3.0000	0.2499	0.2098	8.3%	7.0%
15	ND15	B2O3 (wt%)	11.6319	11.3438	12.0000	-0.3681	-0.6562	-3.1%	-5.5%
15	ND15	CaO (wt%)	4.2641	4.0582	4.0000	0.2641	0.0582	6.6%	1.5%
15	ND15	Cr2O3 (wt%)	0.2814	0.2908	0.2638	0.0176	0.0270	6.7%	10.2%
15	ND15	Fe2O3 (wt%)	5.0576	4.9440	5.0000	0.0576	-0.0560	1.2%	-1.1%
15	ND15	Li2O (wt%)	7.0077	6.9926	7.0000	0.0077	-0.0074	0.1%	-0.1%
15	ND15	MgO (wt%)	0.0332	0.0315	0.0000	0.0332	0.0315		
15	ND15	MnO (wt%)	8.2443	8.4709	8.0000	0.2443	0.4709	3.1%	5.9%
15	ND15	Na2O (wt%)	7.9195	7.3229	7.6100	0.3095	-0.2871	4.1%	-3.8%
15	ND15	NiO (wt%)	4.7305	4.6988	4.7400	-0.0095	-0.0412	-0.2%	-0.9%
15	ND15	P2O5 (wt%)	1.0277	1.0277	0.9984	0.0293	0.0293	2.9%	2.9%
15	ND15	SiO2 (wt%)	44.3905	44.0932	44.9100	-0.5195	-0.8168	-1.2%	-1.8%
15	ND15	TiO2 (wt%)	1.7514	1.7514	1.7500	0.0014	0.0014	0.1%	0.1%
15	ND15	ZrO2 (wt%)	0.0871	0.0871	0.0960	-0.0089	-0.0089	-9.2%	-9.2%
15	ND15	Sum of Oxides (wt%)	99.6767	98.3226	99.3682	0.3085	-1.0456	0.3%	-1.1%
16	ND16	Al2O3 (wt%)	11.0205	10.9965	10.8900	0.1305	0.1065	1.2%	1.0%
16	ND16	B2O3 (wt%)	4.9908	4.9411	5.0000	-0.0092	-0.0589	-0.2%	-1.2%
16	ND16	CaO (wt%)	3.8768	3.6355	4.0000	-0.1232	-0.3645	-3.1%	-9.1%
16	ND16	Cr2O3 (wt%)	0.0093	0.0090	0.0000	0.0093	0.0090		
16	ND16	Fe2O3 (wt%)	4.6331	4.7091	5.0000	-0.3669	-0.2909	-7.3%	-5.8%
16	ND16	Li2O (wt%)	6.9216	6.8290	7.0000	-0.0784	-0.1710	-1.1%	-2.4%
16	ND16	MgO (wt%)	0.0083	0.0081	0.0000	0.0083	0.0081		
16	ND16	MnO (wt%)	0.5155	0.5407	0.5000	0.0155	0.0407	3.1%	8.1%
16	ND16	Na2O (wt%)	14.7370	13.7248	14.2600	0.4770	-0.5352	3.3%	-3.8%
16	ND16	NiO (wt%)	3.4438	3.6088	4.3100	-0.8662	-0.7012	-20.1%	-16.3%
16	ND16	P2O5 (wt%)	0.0369	0.0369	0.0000	0.0369	0.0369		
16	ND16	SiO2 (wt%)	40.4419	41.7515	41.0400	-0.5981	0.7115	-1.5%	1.7%
16	ND16	ThO2 (wt%)	0.2107	0.2107	0.0000	0.2107	0.2107		
16	ND16	TiO2 (wt%)	0.0083	0.0084	0.0000	0.0083	0.0084		
16	ND16	U3O8 (wt%)	7.8537	8.1598	8.0000	-0.1463	0.1598	-1.8%	2.0%

Table C.5: Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by Glass Number
(Batch 1: 0 – non-rad group and 100 – rad group; 101-U std)

Glass #	Glass ID	Oxide	Measured (wt%)	Measured Bias-Corrected (wt%)	Targeted (wt%)	Diff of Measured	Diff of Meas BC	% Diff of Measured	% Diff of Meas BC
16	ND16	ZrO2 (wt%)	0.0068	0.0068	0.0000	0.0068	0.0068		
16	ND16	Sum of Oxides (wt%)	98.7149	99.1766	100.0000	-1.2851	-0.8234	-1.3%	-0.8%
17	ND17	Al2O3 (wt%)	3.2310	3.1913	3.0000	0.2310	0.1913	7.7%	6.4%
17	ND17	B2O3 (wt%)	4.8701	4.7495	5.0000	-0.1299	-0.2505	-2.6%	-5.0%
17	ND17	CaO (wt%)	0.5181	0.4930	0.5000	0.0181	-0.0070	3.6%	-1.4%
17	ND17	Cr2O3 (wt%)	0.0146	0.0151	0.0000	0.0146	0.0151		
17	ND17	Fe2O3 (wt%)	5.0790	4.9649	5.0000	0.0790	-0.0351	1.6%	-0.7%
17	ND17	Li2O (wt%)	2.9764	2.9702	3.0000	-0.0236	-0.0298	-0.8%	-1.0%
17	ND17	MgO (wt%)	3.6561	3.4715	4.0000	-0.3439	-0.5285	-8.6%	-13.2%
17	ND17	MnO (wt%)	8.3250	8.5527	8.0000	0.3250	0.5527	4.1%	6.9%
17	ND17	Na2O (wt%)	13.9855	12.9313	13.3500	0.6355	-0.4187	4.8%	-3.1%
17	ND17	NiO (wt%)	4.8705	4.8378	4.8900	-0.0195	-0.0522	-0.4%	-1.1%
17	ND17	P2O5 (wt%)	0.2291	0.2291	0.0000	0.2291	0.2291		
17	ND17	SiO2 (wt%)	51.1293	50.7859	51.5100	-0.3807	-0.7241	-0.7%	-1.4%
17	ND17	TiO2 (wt%)	1.7764	1.7764	1.7500	0.0264	0.0264	1.5%	1.5%
17	ND17	ZrO2 (wt%)	0.0068	0.0068	0.0000	0.0068	0.0068		
17	ND17	Sum of Oxides (wt%)	100.6679	98.9756	100.0000	0.6679	-1.0244	0.7%	-1.0%
18	ND18	Al2O3 (wt%)	3.1413	3.1342	3.0000	0.1413	0.1342	4.7%	4.5%
18	ND18	B2O3 (wt%)	5.0472	4.9964	5.0000	0.0472	-0.0036	0.9%	-0.1%
18	ND18	CaO (wt%)	3.8803	3.6498	4.0000	-0.1197	-0.3502	-3.0%	-8.8%
18	ND18	Cr2O3 (wt%)	0.2175	0.2084	0.2638	-0.0463	-0.0554	-17.6%	-21.0%
18	ND18	Fe2O3 (wt%)	4.1294	4.2121	5.0000	-0.8706	-0.7879	-17.4%	-15.8%
18	ND18	Li2O (wt%)	3.0033	2.9629	3.0000	0.0033	-0.0371	0.1%	-1.2%
18	ND18	MgO (wt%)	0.0297	0.0289	0.0000	0.0297	0.0289		
18	ND18	MnO (wt%)	8.0102	8.4275	8.0000	0.0102	0.4275	0.1%	5.3%
18	ND18	Na2O (wt%)	12.5286	11.7259	11.9300	0.5986	-0.2041	5.0%	-1.7%
18	ND18	NiO (wt%)	4.2253	4.4054	4.8800	-0.6547	-0.4746	-13.4%	-9.7%
18	ND18	P2O5 (wt%)	0.9381	0.9381	0.9984	-0.0603	-0.0603	-6.0%	-6.0%
18	ND18	SiO2 (wt%)	44.0541	45.7282	45.1900	-1.1359	0.5382	-2.5%	1.2%
18	ND18	ThO2 (wt%)	0.2117	0.2117	0.0000	0.2117	0.2117		
18	ND18	TiO2 (wt%)	0.0080	0.0081	0.0000	0.0080	0.0081		
18	ND18	U3O8 (wt%)	7.7804	8.0850	8.0000	-0.2196	0.0850	-2.7%	1.1%
18	ND18	ZrO2 (wt%)	0.0775	0.0775	0.0960	-0.0185	-0.0185	-19.2%	-19.2%
18	ND18	Sum of Oxides (wt%)	97.2824	98.8002	99.3582	-2.0758	-0.5580	-2.1%	-0.6%
19	ND19	Al2O3 (wt%)	3.7979	3.7498	3.0000	0.7979	0.7498	26.6%	25.0%
19	ND19	B2O3 (wt%)	5.6429	5.5031	5.0000	0.6429	0.5031	12.9%	10.1%
19	ND19	CaO (wt%)	0.6118	0.5823	0.5000	0.1118	0.0823	22.4%	16.5%
19	ND19	Cr2O3 (wt%)	0.0146	0.0151	0.0000	0.0146	0.0151		
19	ND19	Fe2O3 (wt%)	5.8796	5.7475	18.0000	-12.1204	-12.2525	-67.3%	-68.1%
19	ND19	Li2O (wt%)	4.6449	4.6346	4.1200	0.5249	0.5146	12.7%	12.5%
19	ND19	MgO (wt%)	0.0332	0.0315	0.0000	0.0332	0.0315		
19	ND19	MnO (wt%)	9.4710	9.7306	8.0000	1.4710	1.7306	18.4%	21.6%
19	ND19	Na2O (wt%)	15.8053	14.6135	13.4400	2.3653	1.1735	17.6%	8.7%
19	ND19	NiO (wt%)	4.2979	4.2690	3.7600	0.5379	0.5090	14.3%	13.5%
19	ND19	P2O5 (wt%)	0.2291	0.2291	0.0000	0.2291	0.2291		
19	ND19	SiO2 (wt%)	50.2736	49.9365	44.1800	6.0936	5.7565	13.8%	13.0%
19	ND19	TiO2 (wt%)	0.0584	0.0584	0.0000	0.0584	0.0584		
19	ND19	ZrO2 (wt%)	0.0068	0.0068	0.0000	0.0068	0.0068		
19	ND19	Sum of Oxides (wt%)	100.7668	99.1078	100.0000	0.7668	-0.8922	0.8%	-0.9%
20	ND20	Al2O3 (wt%)	10.4773	10.3490	11.4500	-0.9727	-1.1010	-8.5%	-9.6%
20	ND20	B2O3 (wt%)	8.3315	8.1251	9.5500	-1.2185	-1.4249	-12.8%	-14.9%
20	ND20	CaO (wt%)	0.4687	0.4461	0.5000	-0.0313	-0.0539	-6.3%	-10.8%
20	ND20	Cr2O3 (wt%)	0.0146	0.0151	0.0000	0.0146	0.0151		
20	ND20	Fe2O3 (wt%)	15.7875	15.4329	5.0000	10.7875	10.4329	215.7%	208.7%
20	ND20	Li2O (wt%)	6.3026	6.2893	7.0000	-0.6974	-0.7107	-10.0%	-10.2%
20	ND20	MgO (wt%)	0.0332	0.0315	0.0000	0.0332	0.0315		

Table C.5: Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by Glass Number
(Batch 1: 0 – non-rad group and 100 – rad group; 101-U std)

Glass #	Glass ID	Oxide	Measured (wt%)	Measured Bias-Corrected (wt%)	Targeted (wt%)	Diff of Measured	Diff of Meas BC	% Diff of Measured	% Diff of Meas BC
20	ND20	MnO (wt%)	0.5333	0.5479	0.5000	0.0333	0.0479	6.7%	9.6%
20	ND20	Na2O (wt%)	14.3562	13.2738	15.6400	-1.2838	-2.3662	-8.2%	-15.1%
20	ND20	NiO (wt%)	3.7348	3.7097	4.4000	-0.6652	-0.6903	-15.1%	-15.7%
20	ND20	P2O5 (wt%)	0.2291	0.2291	0.0000	0.2291	0.2291		
20	ND20	SiO2 (wt%)	39.3631	39.0994	44.2100	-4.8469	-5.1106	-11.0%	-11.6%
20	ND20	TiO2 (wt%)	1.5800	1.5800	1.7500	-0.1700	-0.1700	-9.7%	-9.7%
20	ND20	ZrO2 (wt%)	0.0068	0.0068	0.0000	0.0068	0.0068		
20	ND20	Sum of Oxides (wt%)	101.2186	99.1358	100.0000	1.2186	-0.8642	1.2%	-0.9%
21	ND21	Al2O3 (wt%)	5.5504	5.5382	5.4000	0.1504	0.1382	2.8%	2.6%
21	ND21	B2O3 (wt%)	10.4244	10.3185	10.6000	-0.1756	-0.2815	-1.7%	-2.7%
21	ND21	CaO (wt%)	1.6380	1.5361	1.2000	0.4380	0.3361	36.5%	28.0%
21	ND21	Cr2O3 (wt%)	0.0710	0.0683	0.0528	0.0182	0.0155	34.5%	29.4%
21	ND21	Fe2O3 (wt%)	7.2059	7.3243	7.6000	-0.3941	-0.2757	-5.2%	-3.6%
21	ND21	Li2O (wt%)	5.6514	5.5751	6.2000	-0.5486	-0.6249	-8.8%	-10.1%
21	ND21	MgO (wt%)	1.2448	1.2145	0.8000	0.4448	0.4145	55.6%	51.8%
21	ND21	MnO (wt%)	1.9577	2.0533	2.0000	-0.0423	0.0533	-2.1%	2.7%
21	ND21	Na2O (wt%)	14.1011	13.1326	13.2300	0.8711	-0.0974	6.6%	-0.7%
21	ND21	NiO (wt%)	3.2379	3.3931	4.0000	-0.7621	-0.6069	-19.1%	-15.2%
21	ND21	P2O5 (wt%)	0.2505	0.2505	0.1997	0.0508	0.0508	25.4%	25.4%
21	ND21	SiO2 (wt%)	45.4489	46.9184	46.6200	-1.1711	0.2984	-2.5%	0.6%
21	ND21	ThO2 (wt%)	0.0400	0.0400	0.0000	0.0400	0.0400		
21	ND21	TiO2 (wt%)	0.3400	0.3418	0.3500	-0.0100	-0.0082	-2.8%	-2.3%
21	ND21	U3O8 (wt%)	1.5853	1.6470	1.6000	-0.0147	0.0470	-0.9%	2.9%
21	ND21	ZrO2 (wt%)	0.0142	0.0142	0.0192	-0.0050	-0.0050	-26.1%	-26.1%
21	ND21	Sum of Oxides (wt%)	98.7616	99.3658	99.8717	-1.1101	-0.5059	-1.1%	-0.5%
22	ND22	Al2O3 (wt%)	5.6921	5.6807	5.4000	0.2921	0.2807	5.4%	5.2%
22	ND22	B2O3 (wt%)	10.2634	10.1614	10.6000	-0.3366	-0.4386	-3.2%	-4.1%
22	ND22	CaO (wt%)	3.1870	2.9892	3.3000	-0.1130	-0.3108	-3.4%	-9.4%
22	ND22	Cr2O3 (wt%)	0.1941	0.1868	0.2110	-0.0169	-0.0242	-8.0%	-11.5%
22	ND22	Fe2O3 (wt%)	7.0856	7.2020	7.6000	-0.5144	-0.3980	-6.8%	-5.2%
22	ND22	Li2O (wt%)	3.8268	3.7757	3.8000	0.0268	-0.0243	0.7%	-0.6%
22	ND22	MgO (wt%)	2.9729	2.9005	3.2000	-0.2271	-0.2995	-7.1%	-9.4%
22	ND22	MnO (wt%)	1.9641	2.0600	2.0000	-0.0359	0.0600	-1.8%	3.0%
22	ND22	Na2O (wt%)	14.2538	13.2747	13.8300	0.4238	-0.5553	3.1%	-4.0%
22	ND22	NiO (wt%)	1.0388	1.0886	1.0000	0.0388	0.0886	3.9%	8.9%
22	ND22	P2O5 (wt%)	0.7283	0.7283	0.7987	-0.0704	-0.0704	-8.8%	-8.8%
22	ND22	SiO2 (wt%)	44.3899	45.8258	45.7200	-1.3301	0.1058	-2.9%	0.2%
22	ND22	ThO2 (wt%)	0.0421	0.0421	0.0000	0.0421	0.0421		
22	ND22	TiO2 (wt%)	0.3488	0.3506	0.3500	-0.0012	0.0006	-0.3%	0.2%
22	ND22	U3O8 (wt%)	1.5959	1.6583	1.6000	-0.0041	0.0583	-0.3%	3.6%
22	ND22	ZrO2 (wt%)	0.0425	0.0425	0.0768	-0.0343	-0.0343	-44.6%	-44.6%
22	ND22	Sum of Oxides (wt%)	97.6262	97.9673	99.4865	-1.8603	-1.5192	-1.9%	-1.5%
23	ND23	Al2O3 (wt%)	5.4984	5.4860	5.4000	0.0984	0.0860	1.8%	1.6%
23	ND23	B2O3 (wt%)	6.2708	6.2070	6.4000	-0.1292	-0.1930	-2.0%	-3.0%
23	ND23	CaO (wt%)	1.2629	1.1842	1.2000	0.0629	-0.0158	5.2%	-1.3%
23	ND23	Cr2O3 (wt%)	0.2102	0.2023	0.2110	-0.0008	-0.0087	-0.4%	-4.1%
23	ND23	Fe2O3 (wt%)	13.7537	13.9794	14.5500	-0.7963	-0.5706	-5.5%	-3.9%
23	ND23	Li2O (wt%)	3.7138	3.6637	3.8000	-0.0862	-0.1363	-2.3%	-3.6%
23	ND23	MgO (wt%)	0.8176	0.7977	0.8000	0.0176	-0.0023	2.2%	-0.3%
23	ND23	MnO (wt%)	1.9744	2.0708	2.0000	-0.0256	0.0708	-1.3%	3.5%
23	ND23	Na2O (wt%)	16.9049	15.7438	16.3000	0.6049	-0.5562	3.7%	-3.4%
23	ND23	NiO (wt%)	0.8989	0.9420	1.0000	-0.1011	-0.0580	-10.1%	-5.8%
23	ND23	P2O5 (wt%)	0.7693	0.7693	0.7987	-0.0294	-0.0294	-3.7%	-3.7%
23	ND23	SiO2 (wt%)	44.2691	45.7012	45.0000	-0.7309	0.7012	-1.6%	1.6%
23	ND23	ThO2 (wt%)	0.0439	0.0439	0.0000	0.0439	0.0439		
23	ND23	TiO2 (wt%)	0.3553	0.3571	0.3500	0.0053	0.0071	1.5%	2.0%

Table C.5: Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by Glass Number
(Batch 1: 0 – non-rad group and 100 – rad group; 101-U std)

Glass #	Glass ID	Oxide	Measured (wt%)	Measured Bias-Corrected (wt%)	Targeted (wt%)	Diff of Measured	Diff of Meas BC	% Diff of Measured	% Diff of Meas BC
23	ND23	U3O8 (wt%)	1.5965	1.6588	1.6000	-0.0035	0.0588	-0.2%	3.7%
23	ND23	ZrO2 (wt%)	0.0630	0.0630	0.0768	-0.0138	-0.0138	-18.0%	-18.0%
23	ND23	Sum of Oxides (wt%)	98.4027	98.8703	99.4865	-1.0838	-0.6162	-1.1%	-0.6%
24	ND24	Al2O3 (wt%)	5.5032	5.4908	5.4000	0.1032	0.0908	1.9%	1.7%
24	ND24	B2O3 (wt%)	6.2869	6.2250	6.4000	-0.1131	-0.1750	-1.8%	-2.7%
24	ND24	CaO (wt%)	1.2562	1.1816	1.2000	0.0562	-0.0184	4.7%	-1.5%
24	ND24	Cr2O3 (wt%)	0.0608	0.0583	0.0528	0.0080	0.0055	15.2%	10.4%
24	ND24	Fe2O3 (wt%)	9.0990	9.2819	9.5500	-0.4510	-0.2681	-4.7%	-2.8%
24	ND24	Li2O (wt%)	6.0389	5.9570	6.2000	-0.1611	-0.2430	-2.6%	-3.9%
24	ND24	MgO (wt%)	3.0759	2.9980	3.2000	-0.1241	-0.2020	-3.9%	-6.3%
24	ND24	MnO (wt%)	2.0006	2.1048	2.0000	0.0006	0.1048	0.0%	5.2%
24	ND24	Na2O (wt%)	13.6013	12.7304	12.9000	0.7013	-0.1696	5.4%	-1.3%
24	ND24	NiO (wt%)	0.9478	0.9881	1.0000	-0.0522	-0.0119	-5.2%	-1.2%
24	ND24	P2O5 (wt%)	0.1902	0.1902	0.1997	-0.0095	-0.0095	-4.8%	-4.8%
24	ND24	SiO2 (wt%)	43.8599	45.5257	45.0000	-1.1401	0.5257	-2.5%	1.2%
24	ND24	ThO2 (wt%)	0.1716	0.1716	0.0000	0.1716	0.1716		
24	ND24	TiO2 (wt%)	0.3469	0.3481	0.3500	-0.0031	-0.0019	-0.9%	-0.5%
24	ND24	U3O8 (wt%)	6.3824	6.6323	6.4000	-0.0176	0.2323	-0.3%	3.6%
24	ND24	ZrO2 (wt%)	0.0079	0.0079	0.0192	-0.0113	-0.0113	-59.1%	-59.1%
24	ND24	Sum of Oxides (wt%)	98.8294	99.8916	99.8717	-1.0423	0.0199	-1.0%	0.0%
25	ND25	Al2O3 (wt%)	10.3261	10.3034	10.2500	0.0761	0.0534	0.7%	0.5%
25	ND25	B2O3 (wt%)	6.2064	6.1445	6.4000	-0.1936	-0.2555	-3.0%	-4.0%
25	ND25	CaO (wt%)	1.2422	1.1717	1.2000	0.0422	-0.0283	3.5%	-2.4%
25	ND25	Cr2O3 (wt%)	0.0616	0.0588	0.0528	0.0088	0.0060	16.7%	11.3%
25	ND25	Fe2O3 (wt%)	6.9040	7.0676	7.6000	-0.6960	-0.5324	-9.2%	-7.0%
25	ND25	Li2O (wt%)	3.7191	3.6695	3.8000	-0.0809	-0.1305	-2.1%	-3.4%
25	ND25	MgO (wt%)	3.0754	2.9943	3.2000	-0.1246	-0.2057	-3.9%	-6.4%
25	ND25	MnO (wt%)	1.9355	2.0426	2.0000	-0.0645	0.0426	-3.2%	2.1%
25	ND25	Na2O (wt%)	17.1678	16.1524	17.2000	-0.0322	-1.0476	-0.2%	-6.1%
25	ND25	NiO (wt%)	0.9279	0.9625	1.0000	-0.0721	-0.0375	-7.2%	-3.7%
25	ND25	P2O5 (wt%)	0.1964	0.1964	0.1997	-0.0033	-0.0033	-1.6%	-1.6%
25	ND25	SiO2 (wt%)	43.1433	45.0277	45.0000	-1.8567	0.0277	-4.1%	0.1%
25	ND25	ThO2 (wt%)	0.0410	0.0410	0.0000	0.0410	0.0410		
25	ND25	TiO2 (wt%)	0.3499	0.3505	0.3500	-0.0001	0.0005	0.0%	0.1%
25	ND25	U3O8 (wt%)	1.5654	1.6269	1.6000	-0.0346	0.0269	-2.2%	1.7%
25	ND25	ZrO2 (wt%)	0.0068	0.0068	0.0192	-0.0124	-0.0124	-64.8%	-64.8%
25	ND25	Sum of Oxides (wt%)	96.8688	97.8168	99.8717	-3.0029	-2.0549	-3.0%	-2.1%
26	ND26	Al2O3 (wt%)	3.0988	3.0916	3.0000	0.0988	0.0916	3.3%	3.1%
26	ND26	B2O3 (wt%)	6.1178	6.0571	6.4000	-0.2822	-0.3429	-4.4%	-5.4%
26	ND26	CaO (wt%)	1.2746	1.2024	1.2000	0.0746	0.0024	6.2%	0.2%
26	ND26	Cr2O3 (wt%)	0.0600	0.0573	0.0528	0.0072	0.0045	13.7%	8.5%
26	ND26	Fe2O3 (wt%)	7.3304	7.5042	7.6000	-0.2696	-0.0958	-3.5%	-1.3%
26	ND26	Li2O (wt%)	3.6815	3.6320	3.8000	-0.1185	-0.1680	-3.1%	-4.4%
26	ND26	MgO (wt%)	0.7950	0.7740	0.8000	-0.0050	-0.0260	-0.6%	-3.3%
26	ND26	MnO (wt%)	6.6564	7.0250	6.5000	0.1564	0.5250	2.4%	8.1%
26	ND26	Na2O (wt%)	17.6598	16.6123	17.5500	0.1098	-0.9377	0.6%	-5.3%
26	ND26	NiO (wt%)	0.9595	0.9953	1.0000	-0.0405	-0.0047	-4.1%	-0.5%
26	ND26	P2O5 (wt%)	0.2010	0.2010	0.1997	0.0013	0.0013	0.7%	0.7%
26	ND26	SiO2 (wt%)	43.2978	45.1904	45.0000	-1.7022	0.1904	-3.8%	0.4%
26	ND26	ThO2 (wt%)	0.1714	0.1714	0.0000	0.1714	0.1714		
26	ND26	TiO2 (wt%)	0.3505	0.3512	0.3500	0.0005	0.0012	0.2%	0.3%
26	ND26	U3O8 (wt%)	6.3518	6.6014	6.4000	-0.0482	0.2014	-0.8%	3.1%
26	ND26	ZrO2 (wt%)	0.0068	0.0068	0.0192	-0.0124	-0.0124	-64.8%	-64.8%
26	ND26	Sum of Oxides (wt%)	98.0131	99.4733	99.8717	-1.8586	-0.3984	-1.9%	-0.4%
27	ND27	Al2O3 (wt%)	3.1838	3.1767	3.0000	0.1838	0.1767	6.1%	5.9%
27	ND27	B2O3 (wt%)	10.4003	10.2966	10.6000	-0.1997	-0.3034	-1.9%	-2.9%

Table C.5: Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by Glass Number
(Batch 1: 0 – non-rad group and 100 – rad group; 101-U std)

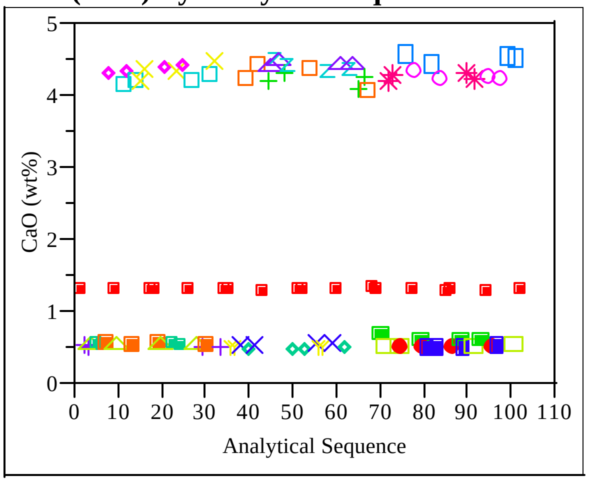
Glass #	Glass ID	Oxide	Measured (wt%)	Measured Bias-Corrected (wt%)	Targeted (wt%)	Diff of Measured	Diff of Meas BC	% Diff of Measured	% Diff of Meas BC
27	ND27	CaO (wt%)	3.3457	3.1562	3.3000	0.0457	-0.1438	1.4%	-4.4%
27	ND27	Cr2O3 (wt%)	0.2094	0.1998	0.2110	-0.0016	-0.0112	-0.8%	-5.3%
27	ND27	Fe2O3 (wt%)	7.2595	7.4315	7.6000	-0.3405	-0.1685	-4.5%	-2.2%
27	ND27	Li2O (wt%)	3.8375	3.7857	3.8000	0.0375	-0.0143	1.0%	-0.4%
27	ND27	MgO (wt%)	0.8551	0.8326	0.8000	0.0551	0.0326	6.9%	4.1%
27	ND27	MnO (wt%)	1.9743	2.0836	2.0000	-0.0257	0.0836	-1.3%	4.2%
27	ND27	Na2O (wt%)	16.2158	15.2552	15.9400	0.2758	-0.6848	1.7%	-4.3%
27	ND27	NiO (wt%)	3.7202	3.8590	4.0000	-0.2798	-0.1410	-7.0%	-3.5%
27	ND27	P2O5 (wt%)	0.7716	0.7716	0.7987	-0.0271	-0.0271	-3.4%	-3.4%
27	ND27	SiO2 (wt%)	44.5504	46.4971	45.4100	-0.8596	1.0871	-1.9%	2.4%
27	ND27	ThO2 (wt%)	0.0437	0.0437	0.0000	0.0437	0.0437		
27	ND27	TiO2 (wt%)	0.3821	0.3828	0.3500	0.0321	0.0328	9.2%	9.4%
27	ND27	U3O8 (wt%)	1.6167	1.6803	1.6000	0.0167	0.0803	1.0%	5.0%
27	ND27	ZrO2 (wt%)	0.0633	0.0633	0.0768	-0.0135	-0.0135	-17.5%	-17.5%
27	ND27	Sum of Oxides (wt%)	98.4294	99.5157	99.4865	-1.0571	0.0292	-1.1%	0.0%
28	ND28	Al2O3 (wt%)	3.0941	3.0866	3.0000	0.0941	0.0866	3.1%	2.9%
28	ND28	B2O3 (wt%)	10.4486	10.3450	10.6000	-0.1514	-0.2550	-1.4%	-2.4%
28	ND28	CaO (wt%)	3.3740	3.1738	3.3000	0.0740	-0.1262	2.2%	-3.8%
28	ND28	Cr2O3 (wt%)	0.0674	0.0646	0.0528	0.0146	0.0118	27.7%	22.4%
28	ND28	Fe2O3 (wt%)	7.3951	7.5434	7.6000	-0.2049	-0.0566	-2.7%	-0.7%
28	ND28	Li2O (wt%)	6.0120	5.9302	6.2000	-0.1880	-0.2698	-3.0%	-4.4%
28	ND28	MgO (wt%)	0.7680	0.7485	0.8000	-0.0320	-0.0515	-4.0%	-6.4%
28	ND28	MnO (wt%)	2.0028	2.1071	2.0000	0.0028	0.1071	0.1%	5.4%
28	ND28	Na2O (wt%)	14.1530	13.2469	13.2300	0.9230	0.0169	7.0%	0.1%
28	ND28	NiO (wt%)	0.9282	0.9678	1.0000	-0.0718	-0.0322	-7.2%	-3.2%
28	ND28	P2O5 (wt%)	0.2132	0.2132	0.1997	0.0135	0.0135	6.7%	6.7%
28	ND28	SiO2 (wt%)	48.1423	49.9737	48.8700	-0.7277	1.1037	-1.5%	2.3%
28	ND28	ThO2 (wt%)	0.0405	0.0405	0.0000	0.0405	0.0405		
28	ND28	TiO2 (wt%)	1.3663	1.3710	1.4000	-0.0337	-0.0290	-2.4%	-2.1%
28	ND28	U3O8 (wt%)	1.6014	1.6641	1.6000	0.0014	0.0641	0.1%	4.0%
28	ND28	ZrO2 (wt%)	0.0126	0.0126	0.0192	-0.0066	-0.0066	-34.6%	-34.6%
28	ND28	Sum of Oxides (wt%)	99.6194	100.4889	99.8717	-0.2523	0.6172	-0.3%	0.6%
29	ND29	Al2O3 (wt%)	3.1130	3.1067	3.0000	0.1130	0.1067	3.8%	3.6%
29	ND29	B2O3 (wt%)	6.2386	6.1770	6.4000	-0.1614	-0.2230	-2.5%	-3.5%
29	ND29	CaO (wt%)	1.2771	1.2047	1.2000	0.0771	0.0047	6.4%	0.4%
29	ND29	Cr2O3 (wt%)	0.2056	0.1962	0.2110	-0.0054	-0.0148	-2.6%	-7.0%
29	ND29	Fe2O3 (wt%)	14.6083	14.9547	14.9900	-0.3817	-0.0353	-2.5%	-0.2%
29	ND29	Li2O (wt%)	3.7568	3.7064	3.8000	-0.0432	-0.0936	-1.1%	-2.5%
29	ND29	MgO (wt%)	0.8207	0.7990	0.8000	0.0207	-0.0010	2.6%	-0.1%
29	ND29	MnO (wt%)	1.9567	2.0650	2.0000	-0.0433	0.0650	-2.2%	3.3%
29	ND29	Na2O (wt%)	15.9182	14.9756	15.6900	0.2282	-0.7144	1.5%	-4.6%
29	ND29	NiO (wt%)	0.9289	0.9636	1.0000	-0.0711	-0.0364	-7.1%	-3.6%
29	ND29	P2O5 (wt%)	0.7376	0.7376	0.7987	-0.0611	-0.0611	-7.7%	-7.7%
29	ND29	SiO2 (wt%)	44.9285	46.8924	46.5200	-1.5915	0.3724	-3.4%	0.8%
29	ND29	ThO2 (wt%)	0.0446	0.0446	0.0000	0.0446	0.0446		
29	ND29	TiO2 (wt%)	1.4104	1.4128	1.4000	0.0104	0.0128	0.7%	0.9%
29	ND29	U3O8 (wt%)	1.5889	1.6514	1.6000	-0.0111	0.0514	-0.7%	3.2%
29	ND29	ZrO2 (wt%)	0.0268	0.0268	0.0768	-0.0500	-0.0500	-65.0%	-65.0%
29	ND29	Sum of Oxides (wt%)	97.5606	98.9146	99.4865	-1.9259	-0.5719	-1.9%	-0.6%
30	ND30	Al2O3 (wt%)	5.7252	5.7134	3.0000	2.7252	2.7134	90.8%	90.4%
30	ND30	B2O3 (wt%)	7.9049	7.8261	6.4000	1.5049	1.4261	23.5%	22.3%
30	ND30	CaO (wt%)	2.4347	2.2967	1.2000	1.2347	1.0967	102.9%	91.4%
30	ND30	Cr2O3 (wt%)	0.1153	0.1100	0.0528	0.0625	0.0572	118.3%	108.4%
30	ND30	Fe2O3 (wt%)	6.5322	6.6865	7.6000	-1.0678	-0.9135	-14.1%	-12.0%
30	ND30	Li2O (wt%)	4.6449	4.5828	6.2000	-1.5551	-1.6172	-25.1%	-26.1%
30	ND30	MgO (wt%)	1.8182	1.7703	3.2000	-1.3818	-1.4297	-43.2%	-44.7%

Table C.5: Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by Glass Number
(Batch 1: 0 – non-rad group and 100 – rad group; 101-U std)

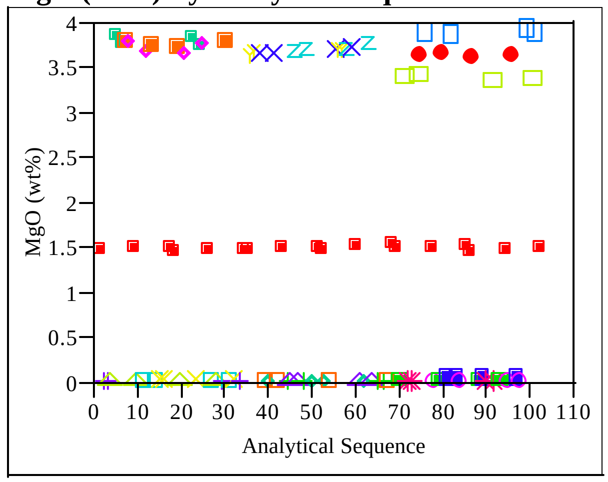
				Measured					
			Measured	Bias-Corrected	Targeted	Diff of	Diff of	% Diff of	% Diff of
Glass #	Glass ID	Oxide	(wt%)	(wt%)	(wt%)	Measured	Meas BC	Measured	Meas BC
30	ND30	MnO (wt%)	4.9390	5.2123	2.0000	2.9390	3.2123	146.9%	160.6%
30	ND30	Na2O (wt%)	14.5153	13.6505	13.2500	1.2653	0.4005	9.5%	3.0%
30	ND30	NiO (wt%)	2.1360	2.2157	3.9700	-1.8340	-1.7543	-46.2%	-44.2%
30	ND30	P2O5 (wt%)	0.4170	0.4170	0.1997	0.2173	0.2173	108.8%	108.8%
30	ND30	SiO2 (wt%)	41.8838	43.7098	46.0300	-4.1462	-2.3202	-9.0%	-5.0%
30	ND30	ThO2 (wt%)	0.1055	0.1055	0.0000	0.1055	0.1055		
30	ND30	TiO2 (wt%)	0.8247	0.8261	0.3500	0.4747	0.4761	135.6%	136.0%
30	ND30	U3O8 (wt%)	3.8958	4.0489	6.4000	-2.5042	-2.3511	-39.1%	-36.7%
30	ND30	ZrO2 (wt%)	0.0304	0.0304	0.0192	0.0112	0.0112	58.5%	58.5%
30	ND30	Sum of Oxides (wt%)	97.9227	99.2020	99.8717	-1.9490	-0.6697	-2.0%	-0.7%
31	ND31	Al2O3 (wt%)	3.2925	3.2858	5.6900	-2.3975	-2.4042	-42.1%	-42.3%
31	ND31	B2O3 (wt%)	6.4398	6.3742	8.1100	-1.6702	-1.7358	-20.6%	-21.4%
31	ND31	CaO (wt%)	1.2670	1.1881	2.3200	-1.0530	-1.1319	-45.4%	-48.8%
31	ND31	Cr2O3 (wt%)	0.0680	0.0654	0.1216	-0.0536	-0.0562	-44.1%	-46.2%
31	ND31	Fe2O3 (wt%)	6.7077	6.8179	6.9800	-0.2723	-0.1621	-3.9%	-2.3%
31	ND31	Li2O (wt%)	6.2919	6.2075	4.8100	1.4819	1.3975	30.8%	29.1%
31	ND31	MgO (wt%)	3.1247	3.0486	1.8400	1.2847	1.2086	69.8%	65.7%
31	ND31	MnO (wt%)	1.9415	2.0363	4.8200	-2.8785	-2.7837	-59.7%	-57.8%
31	ND31	Na2O (wt%)	13.8925	12.9383	14.1300	-0.2375	-1.1917	-1.7%	-8.4%
31	ND31	NiO (wt%)	3.7206	3.8988	2.3300	1.3906	1.5688	59.7%	67.3%
31	ND31	P2O5 (wt%)	0.2086	0.2086	0.4601	-0.2515	-0.2515	-54.7%	-54.7%
31	ND31	SiO2 (wt%)	45.0590	46.5161	43.2400	1.8190	3.2761	4.2%	7.6%
31	ND31	ThO2 (wt%)	0.1742	0.1742	0.0000	0.1742	0.1742		
31	ND31	TiO2 (wt%)	0.3532	0.3550	0.8300	-0.4768	-0.4750	-57.4%	-57.2%
31	ND31	U3O8 (wt%)	6.3041	6.5497	3.9800	2.3241	2.5697	58.4%	64.6%
31	ND31	ZrO2 (wt%)	0.0068	0.0068	0.0442	-0.0374	-0.0374	-84.7%	-84.7%
31	ND31	Sum of Oxides (wt%)	98.8520	99.6713	99.7059	-0.8539	-0.0346	-0.9%	0.0%
101	Ustd	Al2O3 (wt%)	3.7942	3.8271	4.1000	-0.3058	-0.2729	-7.5%	-6.7%
101	Ustd	B2O3 (wt%)	8.6571	8.5359	9.2090	-0.5519	-0.6731	-6.0%	-7.3%
101	Ustd	CaO (wt%)	1.3634	1.2972	1.3010	0.0624	-0.0038	4.8%	-0.3%
101	Ustd	Cr2O3 (wt%)	0.2316	0.2243	0.0000	0.2316	0.2243		
101	Ustd	Fe2O3 (wt%)	12.7789	12.9181	13.1960	-0.4171	-0.2779	-3.2%	-2.1%
101	Ustd	Li2O (wt%)	2.8729	2.8542	3.0570	-0.1841	-0.2028	-6.0%	-6.6%
101	Ustd	MgO (wt%)	1.1629	1.1327	1.2100	-0.0471	-0.0773	-3.9%	-6.4%
101	Ustd	MnO (wt%)	2.7100	2.8627	2.8920	-0.1820	-0.0293	-6.3%	-1.0%
101	Ustd	Na2O (wt%)	12.0765	11.2561	11.7950	0.2815	-0.5389	2.4%	-4.6%
101	Ustd	NiO (wt%)	0.9762	1.0098	1.1200	-0.1438	-0.1102	-12.8%	-9.8%
101	Ustd	P2O5 (wt%)	0.0458	0.0458	0.0000	0.0458	0.0458		
101	Ustd	SiO2 (wt%)	45.4173	46.9038	45.3530	0.0643	1.5508	0.1%	3.4%
101	Ustd	ThO2 (wt%)	0.0596	0.0596	0.0000	0.0596	0.0596		
101	Ustd	TiO2 (wt%)	0.9240	0.9273	1.0490	-0.1250	-0.1217	-11.9%	-11.6%
101	Ustd	U3O8 (wt%)	2.2860	2.4060	2.4060	-0.1200	0.0000	-5.0%	0.0%
101	Ustd	ZrO2 (wt%)	0.0068	0.0068	0.0000	0.0068	0.0068		
101	Ustd	Sum of Oxides (wt%)	95.3633	96.2674	96.6880	-1.3247	-0.4206	-1.4%	-0.4%

Exhibit C.1: SRTC-ML Measurements for Samples of Glasses in the Non-Radioactive Group Prepared Using the LM Method

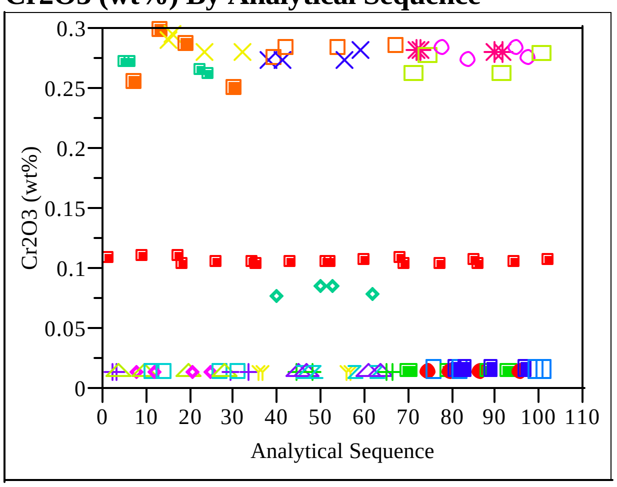
CaO (wt%) By Analytical Sequence



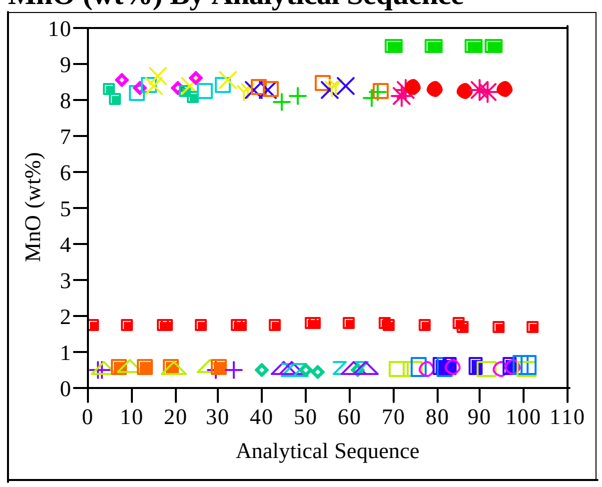
MgO (wt%) By Analytical Sequence



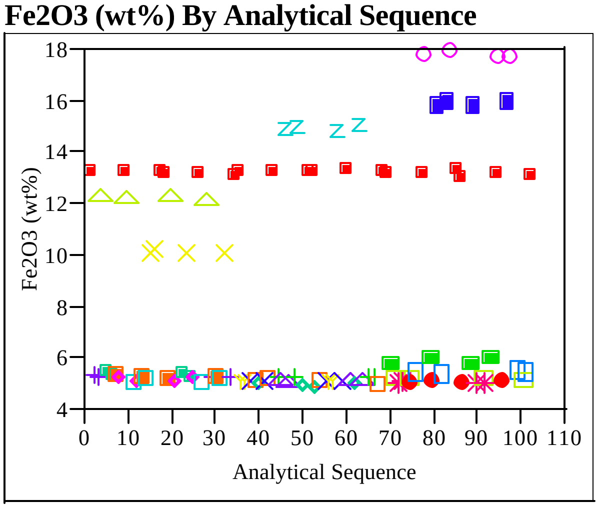
Cr2O3 (wt%) By Analytical Sequence



MnO (wt%) By Analytical Sequence



Fe2O3 (wt%) By Analytical Sequence



Na2O (wt%) By Analytical Sequence

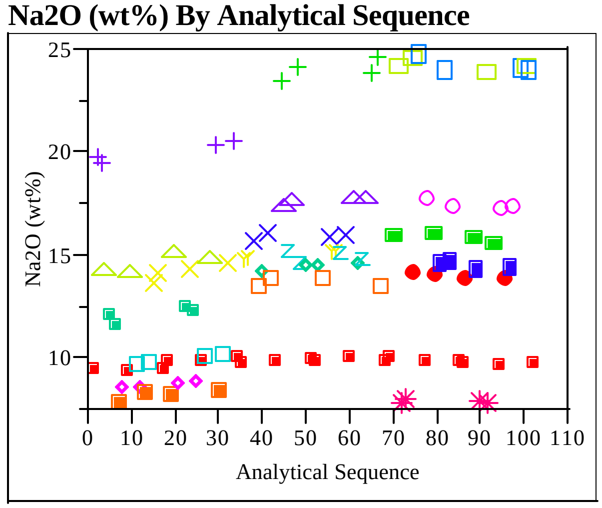
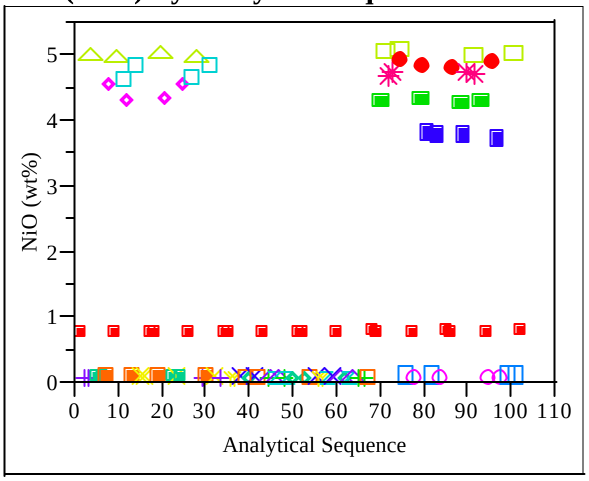
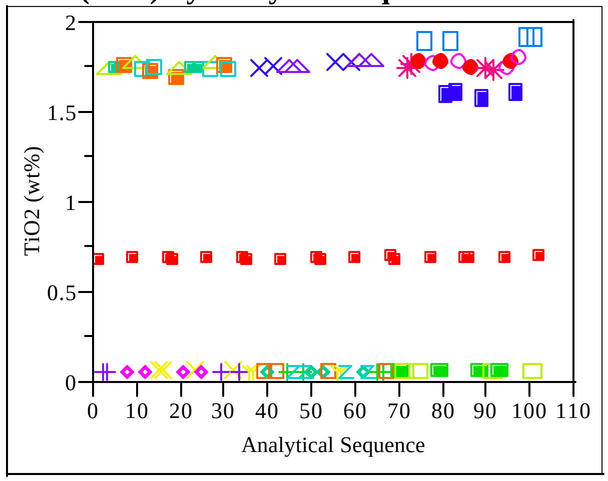


Exhibit C.1: SRTC-ML Measurements for Samples of Glasses in the Non-Radioactive Group Prepared Using the LM Method *(continued)*

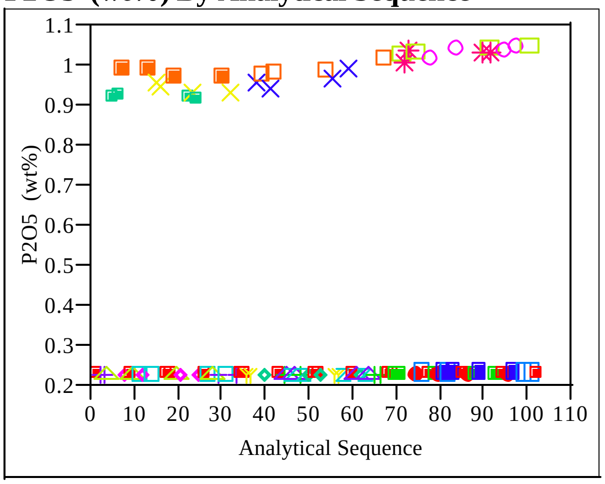
NiO (wt%) By Analytical Sequence



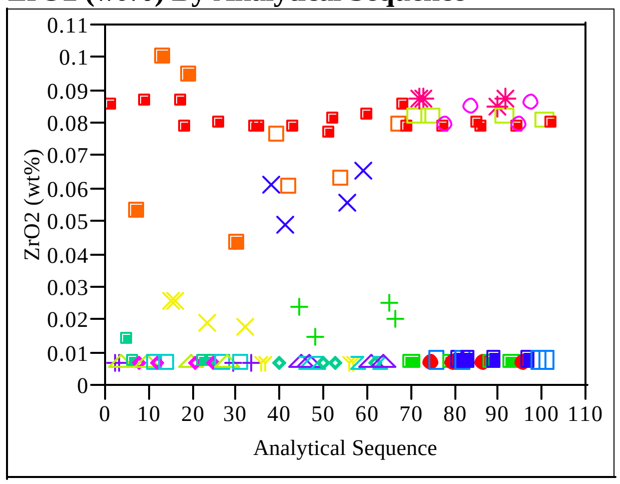
TiO2 (wt%) By Analytical Sequence



P2O5 (wt%) By Analytical Sequence



ZrO2 (wt%) By Analytical Sequence



SiO2 (wt%) By Analytical Sequence

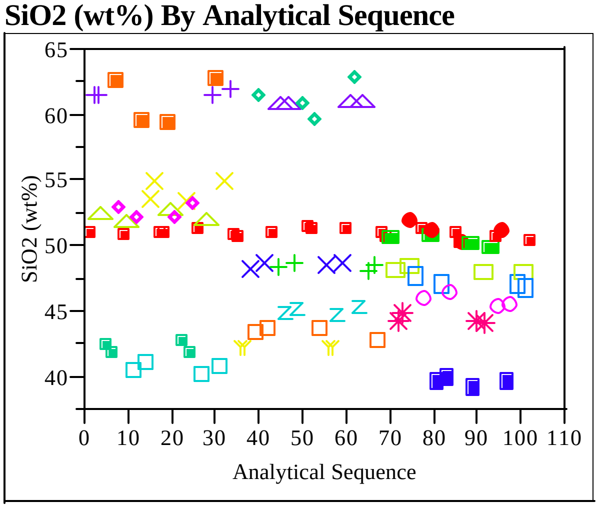
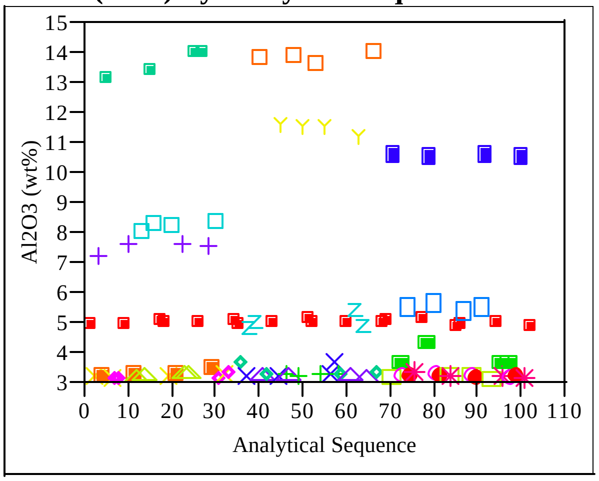
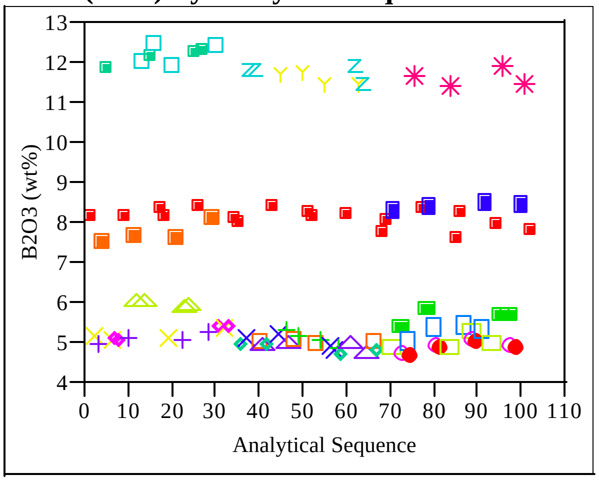


Exhibit C.2: SRTC-ML Measurements for Samples of Glasses in the Non-Radioactive Group Prepared Using the PF Method

Al2O3 (wt%) By Analytical Sequence



B2O3 (wt%) By Analytical Sequence



Li2O (wt%) By Analytical Sequence

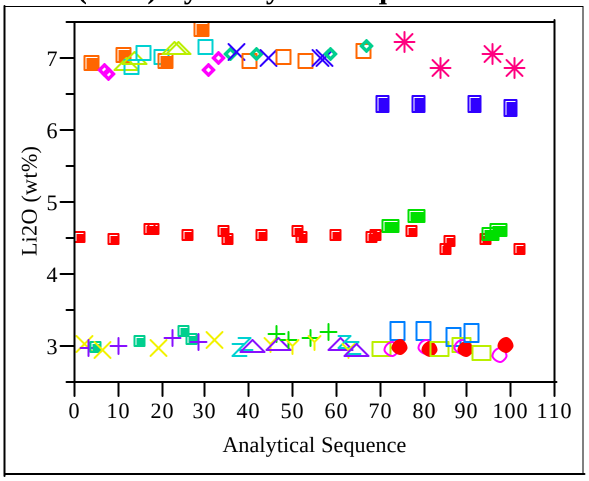
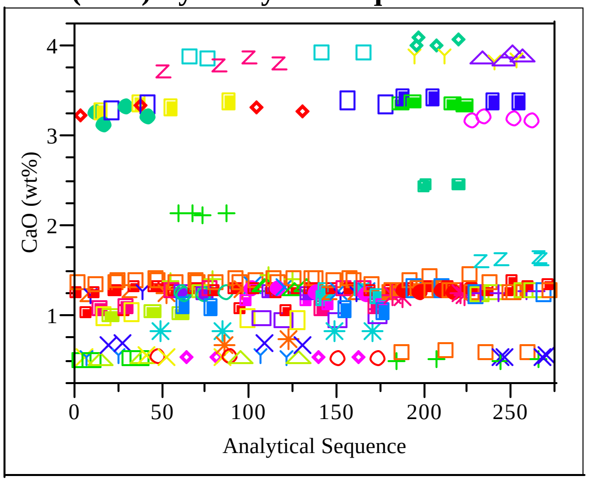
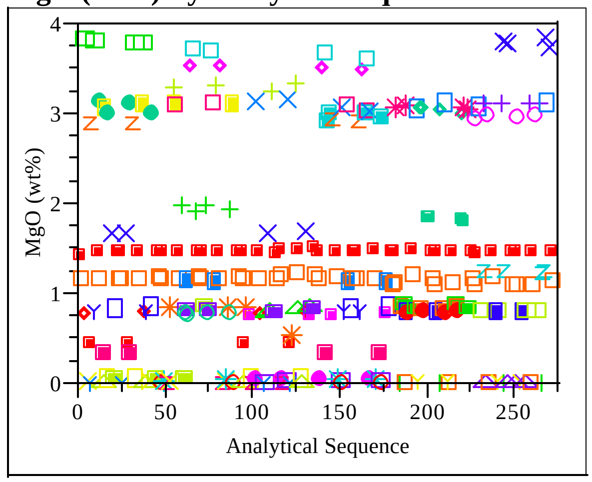


Exhibit C.3: SRTC-ML Measurements for Samples of Glasses in the Radioactive Group Prepared Using the LM Method

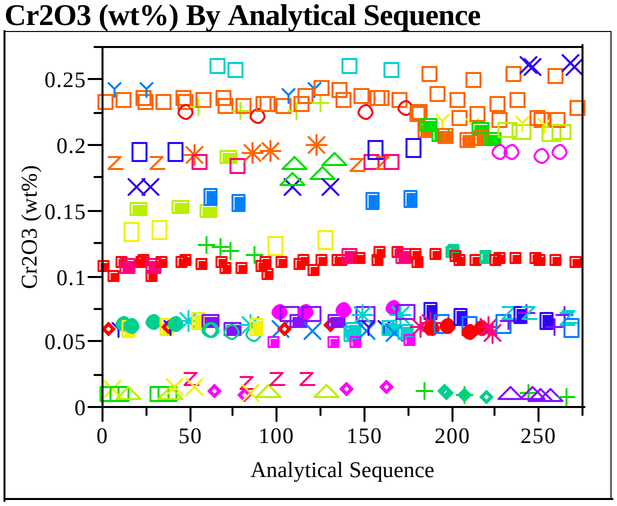
CaO (wt%) By Analytical Sequence



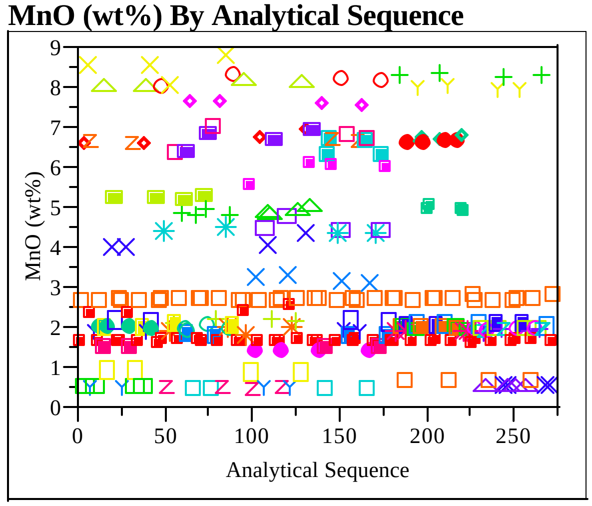
MgO (wt%) By Analytical Sequence



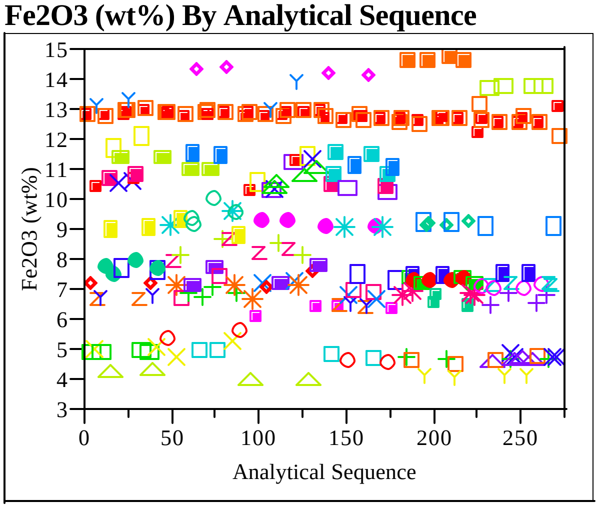
Cr2O3 (wt%) By Analytical Sequence



MnO (wt%) By Analytical Sequence



Fe2O3 (wt%) By Analytical Sequence



Na2O (wt%) By Analytical Sequence

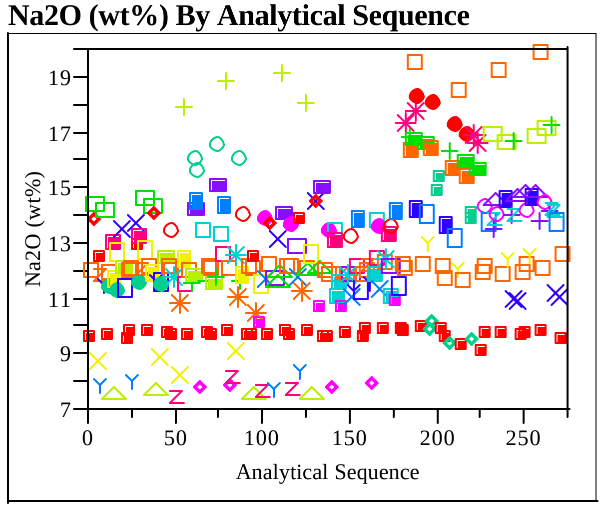
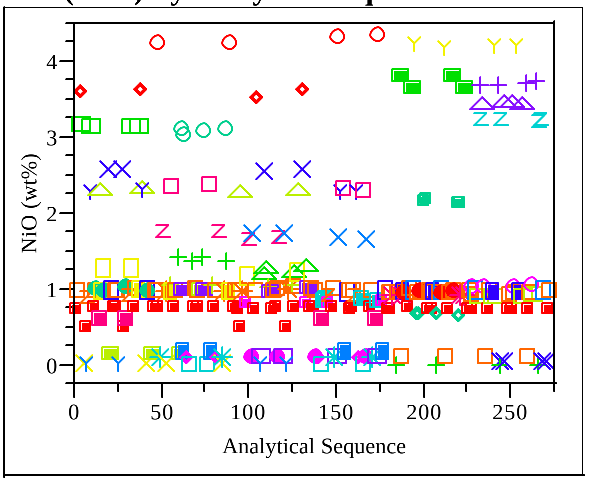
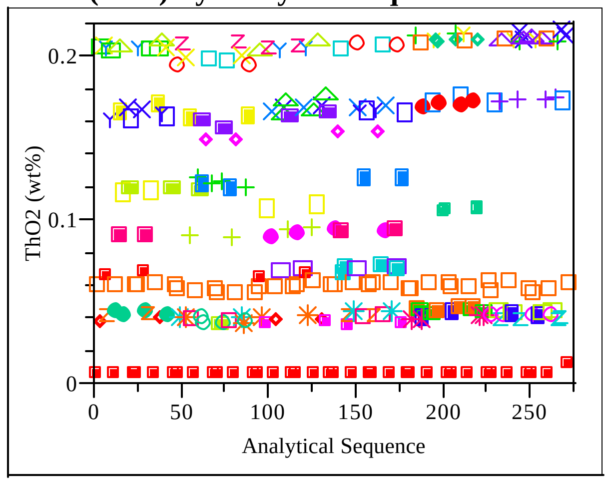


Exhibit C.3: SRTC-ML Measurements for Samples of Glasses in the Radioactive Group Prepared Using the LM Method *(continued)*

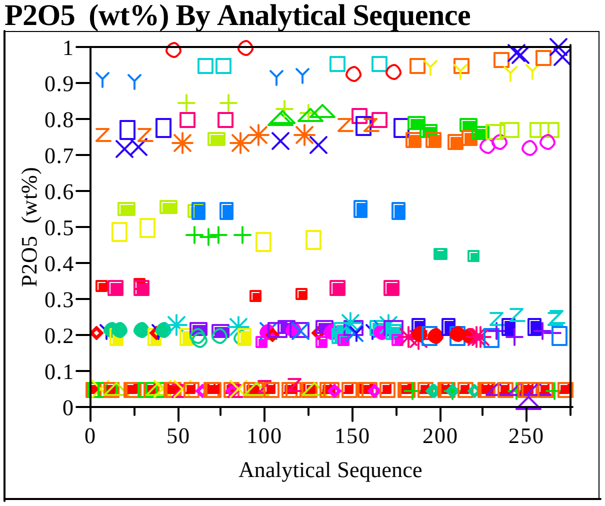
NiO (wt%) By Analytical Sequence



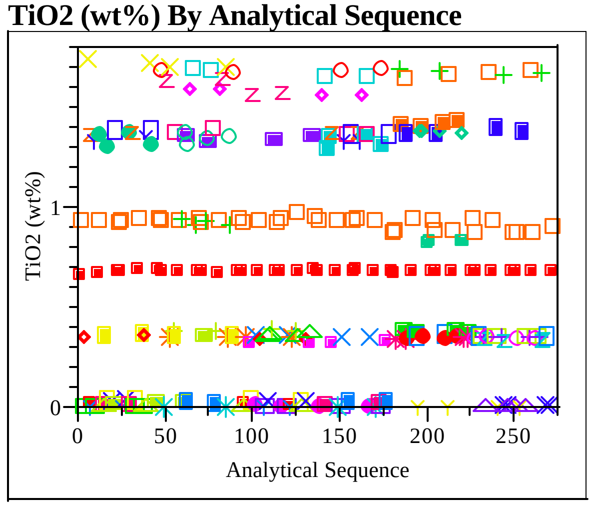
ThO2 (wt%) By Analytical Sequence



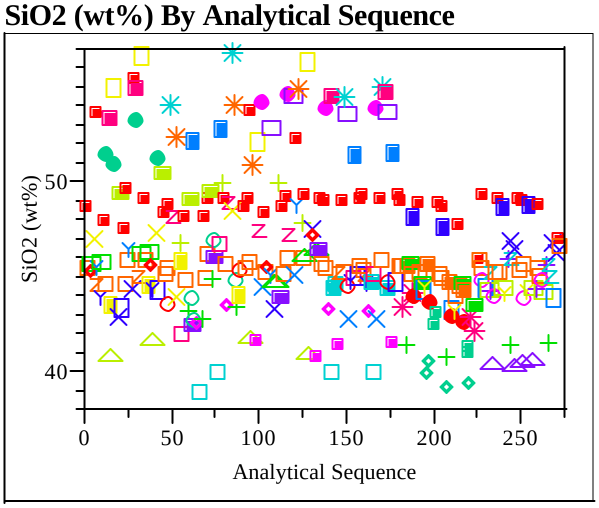
P2O5 (wt%) By Analytical Sequence



TiO2 (wt%) By Analytical Sequence



SiO2 (wt%) By Analytical Sequence



U3O8 (wt%) By Analytical Sequence

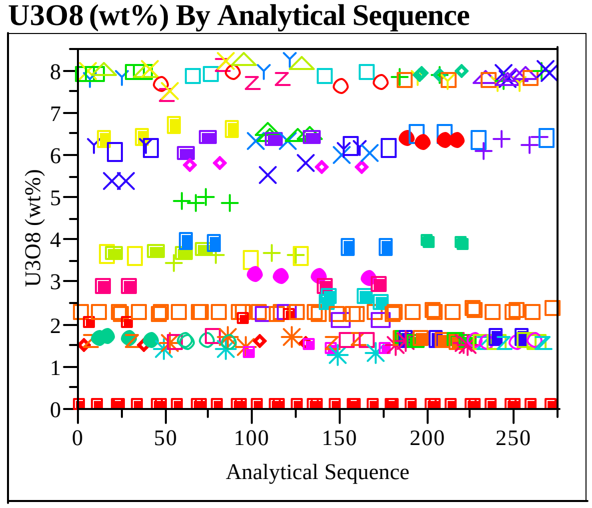


Exhibit C.3: SRTC-ML Measurements for Samples of Glasses in the Radioactive Group Prepared Using the LM Method *(continued)*

ZrO2 (wt%) By Analytical Sequence

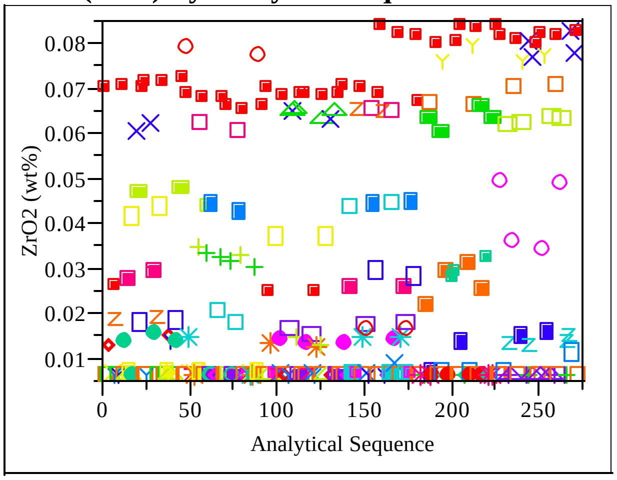
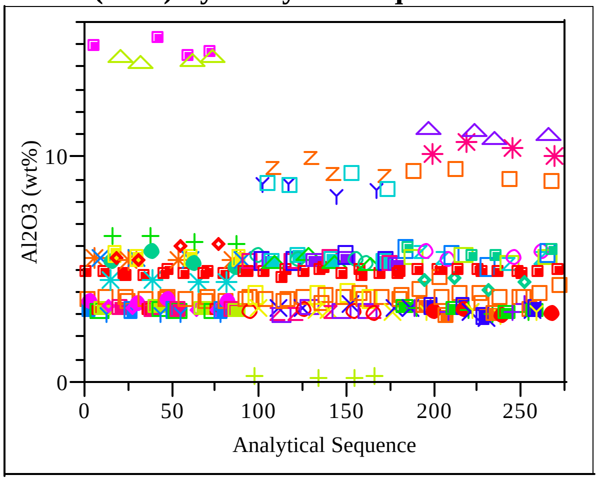
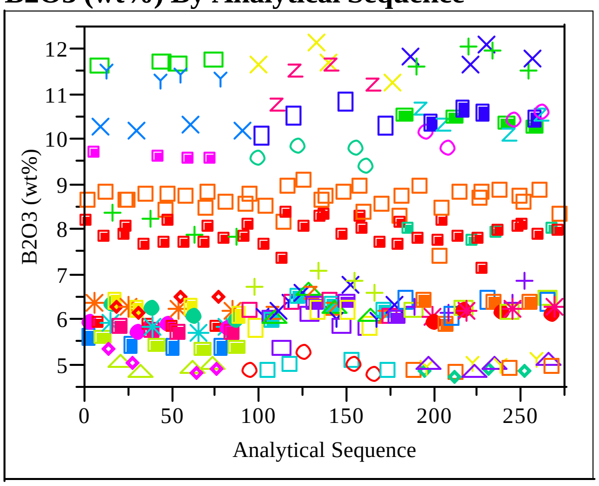


Exhibit C.4: SRTC-ML Measurements for Samples of Glasses in the Non-Radioactive Group Prepared Using the PF Method

Al2O3 (wt%) By Analytical Sequence



B2O3 (wt%) By Analytical Sequence



Li2O (wt%) By Analytical Sequence

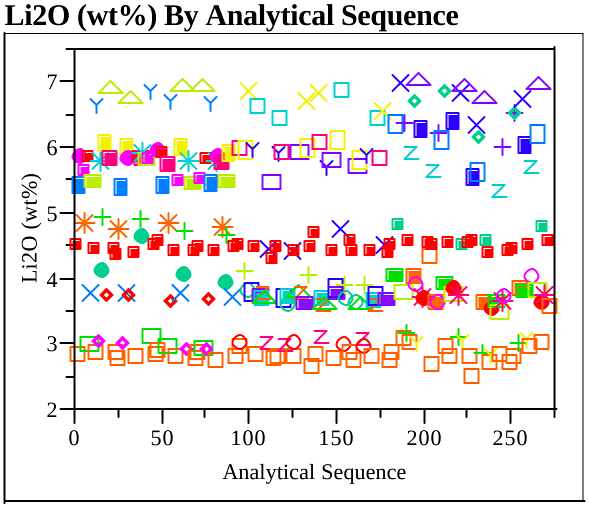
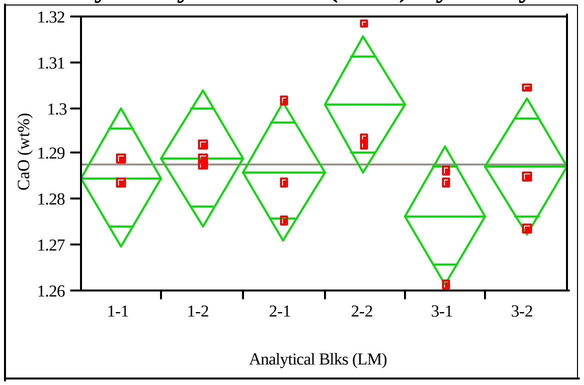


Exhibit C.5: SRTC-ML Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the LM Method for the Non-Radioactive Group

Batch 1 – CaO reference value 1.22 wt%
Oneway Analysis of CaO (wt%) By Analytical Blks (LM)



Oneway Anova
Summary of Fit

Rsquare	0.34992
Adj Rsquare	0.079053
Root Mean Square Error	0.01195
Mean of Response	1.287497
Observations (or Sum Wgts)	18

Analysis of Variance

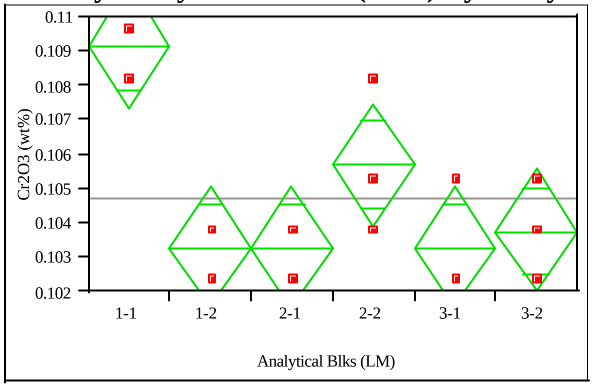
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Blks (LM)	5	0.00092243	0.000184	1.2919	0.3300
Error	12	0.00171369	0.000143		
C. Total	17	0.00263612			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	1.28493	0.00690	1.2699	1.3000
1-2	3	1.28913	0.00690	1.2741	1.3042
2-1	3	1.28633	0.00690	1.2713	1.3014
2-2	3	1.30079	0.00690	1.2858	1.3158
3-1	3	1.27654	0.00690	1.2615	1.2916
3-2	3	1.28726	0.00690	1.2722	1.3023

Std Error uses a pooled estimate of error variance

Batch 1 – Cr2O3 reference value 0.107 wt%
Oneway Analysis of Cr2O3 (wt%) By Analytical Blks (LM)



Oneway Anova
Summary of Fit

Rsquare	0.773333
Adj Rsquare	0.678889
Root Mean Square Error	0.00142
Mean of Response	0.104748
Observations (or Sum Wgts)	18

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Blks (LM)	5	0.00008260	0.000017	8.1882	0.0014
Error	12	0.00002421	0.000002		
C. Total	17	0.00010681			

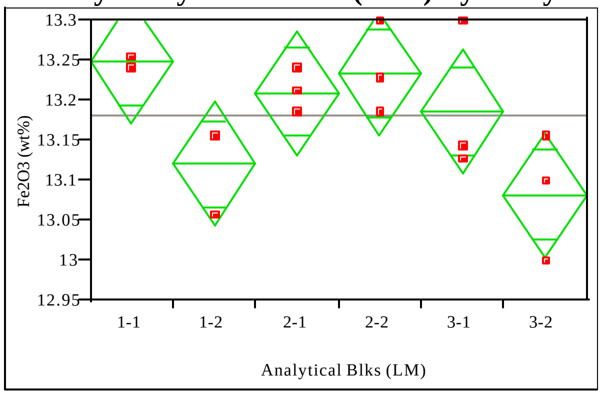
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	0.109133	0.00082	0.10735	0.11092
1-2	3	0.103286	0.00082	0.10150	0.10507
2-1	3	0.103286	0.00082	0.10150	0.10507
2-2	3	0.105722	0.00082	0.10394	0.10751
3-1	3	0.103286	0.00082	0.10150	0.10507
3-2	3	0.103774	0.00082	0.10199	0.10556

Std Error uses a pooled estimate of error variance

Exhibit C.5: SRTC-ML Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the LM Method for the Non-Radioactive Group *(continued)*

Batch 1 – Fe2O3 reference value 12.839 wt%
Oneway Analysis of Fe2O3 (wt%) By Analytical Blks (LM)



Oneway Anova
Summary of Fit

Rsquare	0.588355
Adj Rsquare	0.416836
Root Mean Square Error	0.061862
Mean of Response	13.18025
Observations (or Sum Wgts)	18

Analysis of Variance

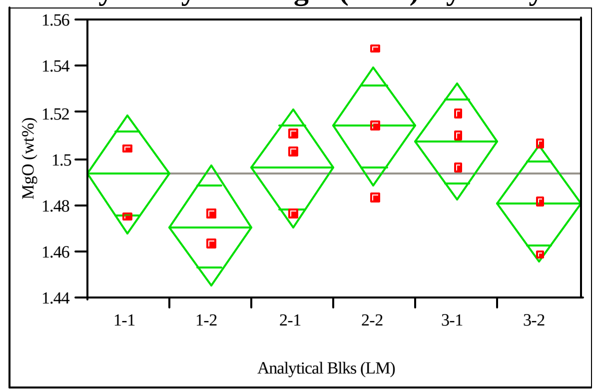
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Blks (LM)	5	0.06563646	0.013127	3.4303	0.0372
Error	12	0.04592281	0.003827		
C. Total	17	0.11155927			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	13.2486	0.03572	13.171	13.326
1-2	3	13.1199	0.03572	13.042	13.198
2-1	3	13.2104	0.03572	13.133	13.288
2-2	3	13.2343	0.03572	13.156	13.312
3-1	3	13.1866	0.03572	13.109	13.264
3-2	3	13.0818	0.03572	13.004	13.160

Std Error uses a pooled estimate of error variance

Batch 1 – MgO reference value 1.419 wt%
Oneway Analysis of MgO (wt%) By Analytical Blks (LM)



Oneway Anova
Summary of Fit

Rsquare	0.441563
Adj Rsquare	0.208881
Root Mean Square Error	0.020179
Mean of Response	1.494139
Observations (or Sum Wgts)	18

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Blks (LM)	5	0.00386374	0.000773	1.8977	0.1685
Error	12	0.00488641	0.000407		
C. Total	17	0.00875015			

Means for Oneway Anova

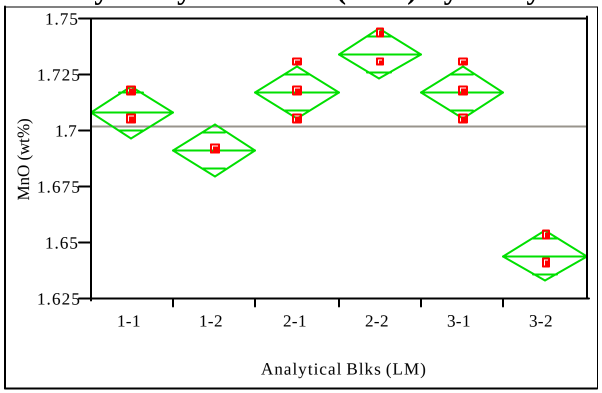
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	1.49395	0.01165	1.4686	1.5193
1-2	3	1.47129	0.01165	1.4459	1.4967
2-1	3	1.49616	0.01165	1.4708	1.5215
2-2	3	1.51440	0.01165	1.4890	1.5398
3-1	3	1.50777	0.01165	1.4824	1.5331
3-2	3	1.48127	0.01165	1.4559	1.5067

Std Error uses a pooled estimate of error variance

Exhibit C.5: SRTC-ML Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the LM Method for the Non-Radioactive Group *(continued)*

Batch 1 – MnO reference value 1.726 wt%

Oneway Analysis of MnO (wt%) By Analytical Blks (LM)



Oneway Anova

Summary of Fit

Rsquare	0.937824
Adj Rsquare	0.911917
Root Mean Square Error	0.00913
Mean of Response	1.702232
Observations (or Sum Wgts)	18

Analysis of Variance

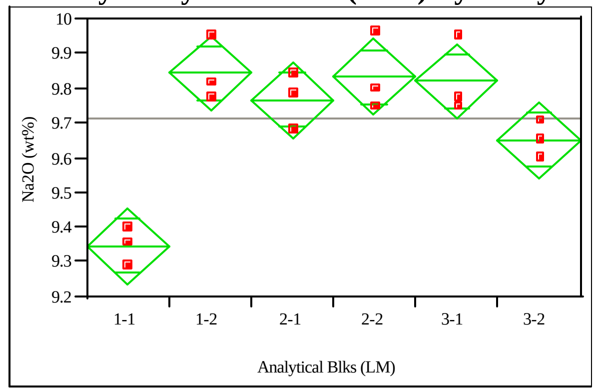
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Blks (LM)	5	0.01508814	0.003018	36.2000	<.0001
Error	12	0.00100032	0.000083		
C. Total	17	0.01608846			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	1.70869	0.00527	1.6972	1.7202
1-2	3	1.69147	0.00527	1.6800	1.7030
2-1	3	1.71730	0.00527	1.7058	1.7288
2-2	3	1.73451	0.00527	1.7230	1.7460
3-1	3	1.71730	0.00527	1.7058	1.7288
3-2	3	1.64413	0.00527	1.6326	1.6556

Batch 1 – Na2O reference value 9.003 wt%

Oneway Analysis of Na2O (wt%) By Analytical Blks (LM)



Oneway Anova

Summary of Fit

Rsquare	0.859107
Adj Rsquare	0.800401
Root Mean Square Error	0.087303
Mean of Response	9.711591
Observations (or Sum Wgts)	18

Analysis of Variance

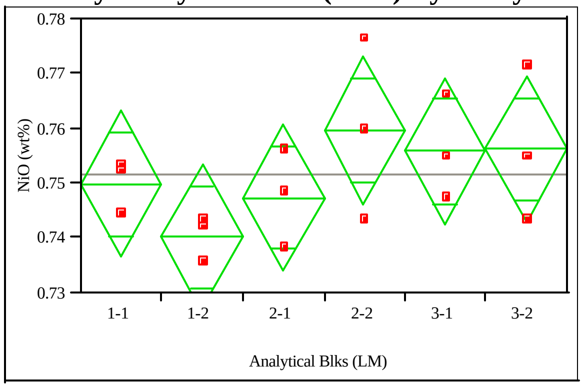
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Blks (LM)	5	0.55768941	0.111538	14.6342	<.0001
Error	12	0.09146090	0.007622		
C. Total	17	0.64915031			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	9.34613	0.05040	9.2363	9.4560
1-2	3	9.84489	0.05040	9.7351	9.9547
2-1	3	9.76851	0.05040	9.6587	9.8783
2-2	3	9.83591	0.05040	9.7261	9.9457
3-1	3	9.82243	0.05040	9.7126	9.9322
3-2	3	9.65168	0.05040	9.5419	9.7615

Exhibit C.5: SRTC-ML Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the LM Method for the Non-Radioactive Group *(continued)*

Batch 1 – NiO reference value 0.751 wt%
Oneway Analysis of NiO (wt%) By Analytical Blks (LM)



Oneway Anova
Summary of Fit

Rsquare	0.360236
Adj Rsquare	0.093667
Root Mean Square Error	0.010676
Mean of Response	0.751553
Observations (or Sum Wgts)	18

Analysis of Variance

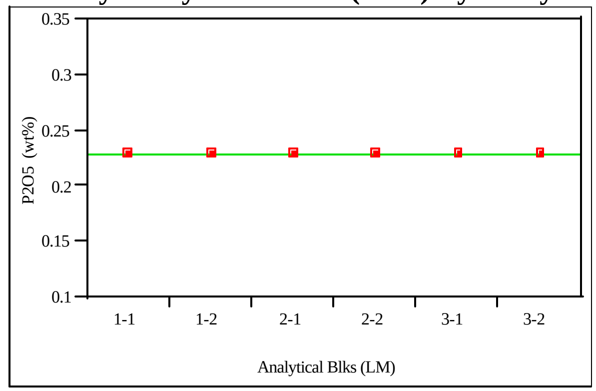
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Blks (LM)	5	0.00077014	0.000154	1.3514	0.3086
Error	12	0.00136773	0.000114		
C. Total	17	0.00213787			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	0.749927	0.00616	0.73650	0.76336
1-2	3	0.740171	0.00616	0.72674	0.75360
2-1	3	0.747382	0.00616	0.73395	0.76081
2-2	3	0.759682	0.00616	0.74625	0.77311
3-1	3	0.755865	0.00616	0.74244	0.76929
3-2	3	0.756289	0.00616	0.74286	0.76972

Std Error uses a pooled estimate of error variance

Batch 1 – P2O5 reference value ~0 wt%
Oneway Analysis of P2O5 (wt%) By Analytical Blks (LM)



Oneway Anova
Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	0.22914
Observations (or Sum Wgts)	18

Analysis of Variance

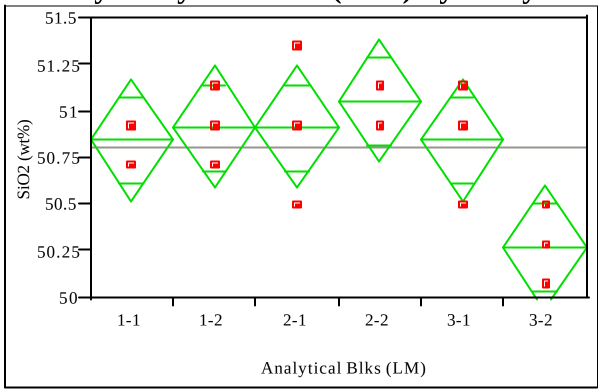
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Blks (LM)	5	0	0	.	.
Error	12	0	0		
C. Total	17	0			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	0.229140	0	0.22914	0.22914
1-2	3	0.229140	0	0.22914	0.22914
2-1	3	0.229140	0	0.22914	0.22914
2-2	3	0.229140	0	0.22914	0.22914
3-1	3	0.229140	0	0.22914	0.22914
3-2	3	0.229140	0	0.22914	0.22914

Exhibit C.5: SRTC-ML Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the LM Method for the Non-Radioactive Group *(continued)*

Batch 1 – SiO2 reference value 50.22 wt %
Oneway Analysis of SiO2 (wt%) By Analytical Blks (LM)



Oneway Anova
Summary of Fit

Rsquare	0.576471
Adj Rsquare	0.4
Root Mean Square Error	0.26201
Mean of Response	50.80837
Observations (or Sum Wgts)	18

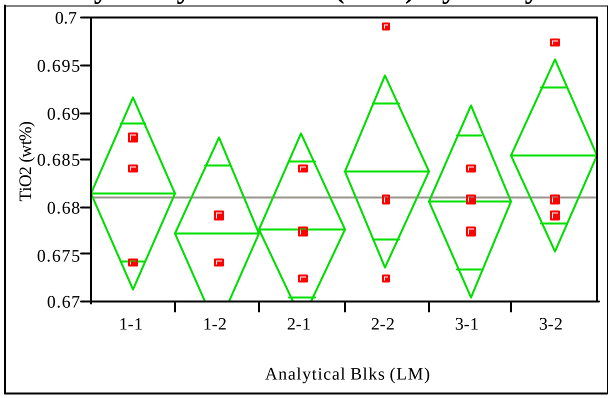
Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Blks (LM)	5	1.1212681	0.224254	3.2667	0.0431
Error	12	0.8237888	0.068649		
C. Total	17	1.9450569			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	50.8440	0.15127	50.514	51.174
1-2	3	50.9153	0.15127	50.586	51.245
2-1	3	50.9153	0.15127	50.586	51.245
2-2	3	51.0580	0.15127	50.728	51.388
3-1	3	50.8440	0.15127	50.514	51.174
3-2	3	50.2736	0.15127	49.944	50.603

Batch 1 – TiO2 reference value 0.677 wt%
Oneway Analysis of TiO2 (wt%) By Analytical Blks (LM)



Oneway Anova
Summary of Fit

Rsquare	0.172549
Adj Rsquare	-0.17222
Root Mean Square Error	0.008076
Mean of Response	0.6811
Observations (or Sum Wgts)	18

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Blks (LM)	5	0.00016322	0.000033	0.5005	0.7704
Error	12	0.00078273	0.000065		
C. Total	17	0.00094596			

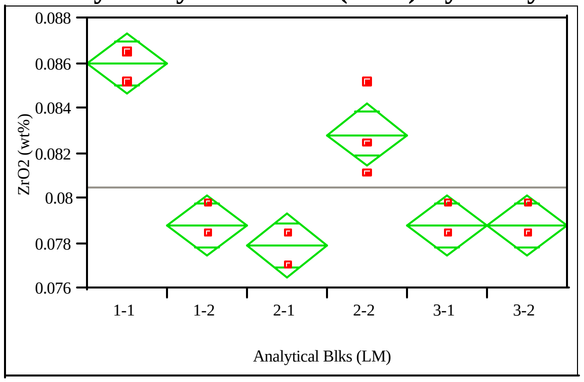
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	0.681656	0.00466	0.67150	0.69182
1-2	3	0.677208	0.00466	0.66705	0.68737
2-1	3	0.677764	0.00466	0.66760	0.68792
2-2	3	0.683880	0.00466	0.67372	0.69404
3-1	3	0.680544	0.00466	0.67038	0.69070
3-2	3	0.685548	0.00466	0.67539	0.69571

Std Error uses a pooled estimate of error variance

Exhibit C.5: SRTC-ML Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the LM Method for the Non-Radioactive Group *(continued)*

Batch 1 – ZrO2 reference value 0.098 wt%
Oneway Analysis of ZrO2 (wt%) By Analytical Blks (LM)



Oneway Anova
Summary of Fit

Rsquare	0.913305
Adj Rsquare	0.877182
Root Mean Square Error	0.001103
Mean of Response	0.080523
Observations (or Sum Wgts)	18

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Blks (LM)	5	0.00015378	0.000031	25.2833	<.0001
Error	12	0.00001460	0.000001		
C. Total	17	0.00016838			

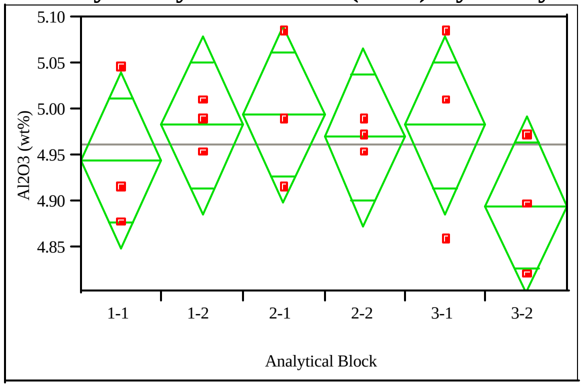
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	0.086001	0.00064	0.08461	0.08739
1-2	3	0.078797	0.00064	0.07741	0.08018
2-1	3	0.077896	0.00064	0.07651	0.07928
2-2	3	0.082849	0.00064	0.08146	0.08424
3-1	3	0.078797	0.00064	0.07741	0.08018
3-2	3	0.078797	0.00064	0.07741	0.08018

Std Error uses a pooled estimate of error variance

Exhibit C.6: SRTC-ML Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the PF Method for the Non-Radioactive Group

Batch 1 – Al2O3 reference value 4.8777 wt%
Oneway Analysis of Al2O3 (wt%) By Analytical Block



Oneway Anova
Summary of Fit

Rsquare	0.225303
Adj Rsquare	-0.09749
Root Mean Square Error	0.076881
Mean of Response	4.960987
Observations (or Sum Wgts)	18

Analysis of Variance

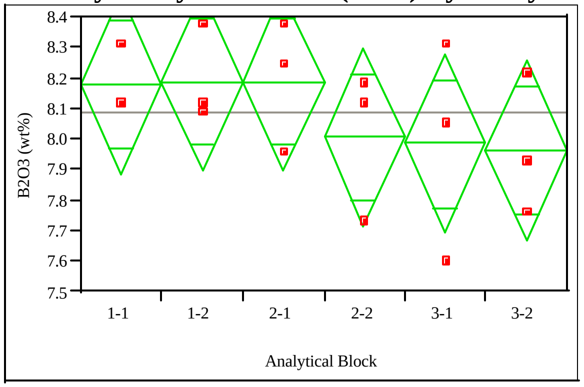
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Block	5	0.02062788	0.004126	0.6980	0.6353
Error	12	0.07092818	0.005911		
C. Total	17	0.09155606			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	4.94419	0.04439	4.8475	5.0409
1-2	3	4.98198	0.04439	4.8853	5.0787
2-1	3	4.99458	0.04439	4.8979	5.0913
2-2	3	4.96938	0.04439	4.8727	5.0661
3-1	3	4.98198	0.04439	4.8853	5.0787
3-2	3	4.89380	0.04439	4.7971	4.9905

Std Error uses a pooled estimate of error variance

Batch 1 – B2O3 reference value 7.777 wt%
Oneway Analysis of B2O3 (wt%) By Analytical Block



Oneway Anova
Summary of Fit

Rsquare	0.220898
Adj Rsquare	-0.10373
Root Mean Square Error	0.232314
Mean of Response	8.085527
Observations (or Sum Wgts)	18

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Block	5	0.18362448	0.036725	0.6805	0.6468
Error	12	0.64763916	0.053970		
C. Total	17	0.83126364			

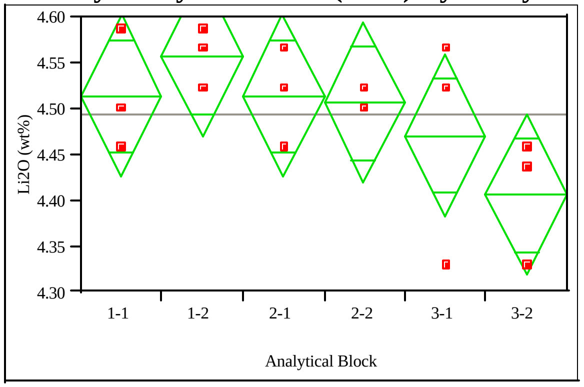
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	8.17855	0.13413	7.8863	8.4708
1-2	3	8.18928	0.13413	7.8970	8.4815
2-1	3	8.18928	0.13413	7.8970	8.4815
2-2	3	8.00682	0.13413	7.7146	8.2991
3-1	3	7.98535	0.13413	7.6931	8.2776
3-2	3	7.96389	0.13413	7.6716	8.2561

Std Error uses a pooled estimate of error variance

Exhibit C.6: SRTC-ML Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the PF Method for the Non-Radioactive Group *(continued)*

Batch 1 – Li2O reference value 4.429 wt%
Oneway Analysis of Li2O (wt%) By Analytical Block



Oneway Anova
Summary of Fit

Rsquare	0.403158
Adj Rsquare	0.154474
Root Mean Square Error	0.069762
Mean of Response	4.494777
Observations (or Sum Wgts)	18

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Block	5	0.03944882	0.007890	1.6212	0.2281
Error	12	0.05840073	0.004867		
C. Total	17	0.09784954			

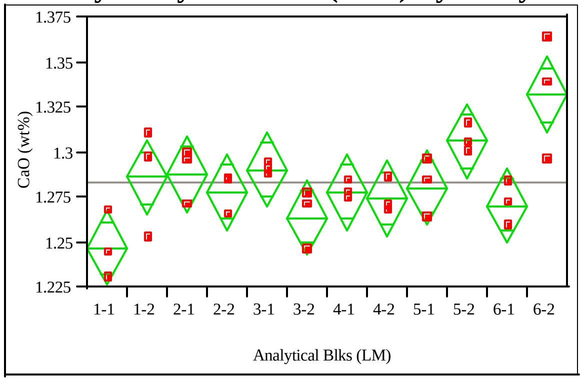
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	4.51391	0.04028	4.4262	4.6017
1-2	3	4.55697	0.04028	4.4692	4.6447
2-1	3	4.51391	0.04028	4.4262	4.6017
2-2	3	4.50674	0.04028	4.4190	4.5945
3-1	3	4.47086	0.04028	4.3831	4.5586
3-2	3	4.40627	0.04028	4.3185	4.4940

Std Error uses a pooled estimate of error variance

Exhibit C.7: SRTC-ML Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the LM Method for the Radioactive Group

Batch 1 – CaO reference value 1.22 wt%
Oneway Analysis of CaO (wt%) By Analytical Blks (LM)



Oneway Anova

Summary of Fit

Rsquare	0.672258
Adj Rsquare	0.522043
Root Mean Square Error	0.017424
Mean of Response	1.282929
Observations (or Sum Wgts)	36

Analysis of Variance

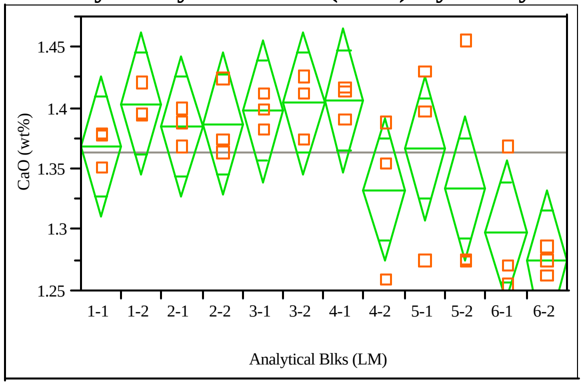
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Blks (LM)	11	0.01494531	0.001359	4.4753	0.0010
Error	24	0.00728619	0.000304		
C. Total	35	0.02223150			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	1.24684	0.01006	1.2261	1.2676
1-2	3	1.28595	0.01006	1.2652	1.3067
2-1	3	1.28794	0.01006	1.2672	1.3087
2-2	3	1.27786	0.01006	1.2571	1.2986
3-1	3	1.29039	0.01006	1.2696	1.3112
3-2	3	1.26397	0.01006	1.2432	1.2847
4-1	3	1.27820	0.01006	1.2574	1.2990
4-2	3	1.27427	0.01006	1.2535	1.2950
5-1	3	1.28063	0.01006	1.2599	1.3014
5-2	3	1.30620	0.01006	1.2854	1.3270
6-1	3	1.27083	0.01006	1.2501	1.2916
6-2	3	1.33206	0.01006	1.3113	1.3528

Std Error uses a pooled estimate of error variance

U std – CaO reference value 1.301 wt%
Oneway Analysis of CaO (wt%) By Analytical Blks (LM)



Oneway Anova

Summary of Fit

Rsquare	0.525541
Adj Rsquare	0.308081
Root Mean Square Error	0.049105
Mean of Response	1.363419
Observations (or Sum Wgts)	36

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Blks (LM)	11	0.06410245	0.005827	2.4167	0.0343
Error	24	0.05787177	0.002411		
C. Total	35	0.12197422			

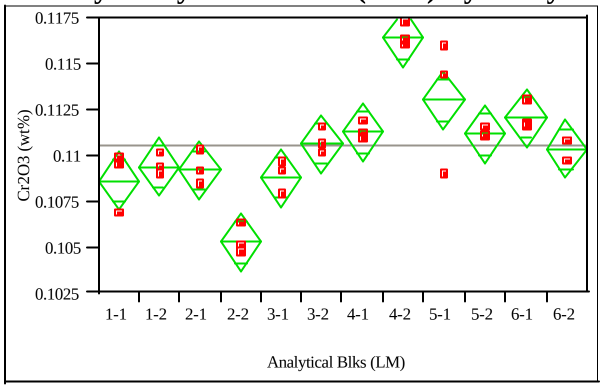
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	1.36892	0.02835	1.3104	1.4274
1-2	3	1.40371	0.02835	1.3452	1.4622
2-1	3	1.38519	0.02835	1.3267	1.4437
2-2	3	1.38731	0.02835	1.3288	1.4458
3-1	3	1.39763	0.02835	1.3391	1.4561
3-2	3	1.40388	0.02835	1.3454	1.4624
4-1	3	1.40696	0.02835	1.3484	1.4655
4-2	3	1.33373	0.02835	1.2752	1.3922
5-1	3	1.36699	0.02835	1.3085	1.4255
5-2	3	1.33445	0.02835	1.2759	1.3930
6-1	3	1.29812	0.02835	1.2396	1.3566
6-2	3	1.27415	0.02835	1.2156	1.3327

Std Error uses a pooled estimate of error variance

Exhibit C.7: SRTC-ML Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the LM Method for the Radioactive Group (continued)

Batch 1 – Cr2O3 reference 0.107 wt%
Oneway Analysis of Cr2O3 (wt%) By Analytical Blks (LM)



Oneway Anova

Summary of Fit

Rsquare	0.852978
Adj Rsquare	0.785593
Root Mean Square Error	0.001325
Mean of Response	0.110527
Observations (or Sum Wgts)	36

Analysis of Variance

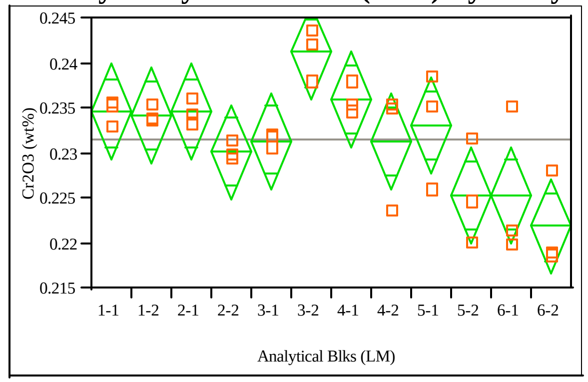
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Blks (LM)	11	0.00024449	0.000022	12.6583	<.0001
Error	24	0.00004214	0.000002		
C. Total	35	0.00028663			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	0.108653	0.00077	0.10707	0.11023
1-2	3	0.109402	0.00077	0.10782	0.11098
2-1	3	0.109210	0.00077	0.10763	0.11079
2-2	3	0.105282	0.00077	0.10370	0.10686
3-1	3	0.108803	0.00077	0.10722	0.11038
3-2	3	0.110652	0.00077	0.10907	0.11223
4-1	3	0.111274	0.00077	0.10970	0.11285
4-2	3	0.116433	0.00077	0.11485	0.11801
5-1	3	0.113026	0.00077	0.11145	0.11460
5-2	3	0.111183	0.00077	0.10960	0.11276
6-1	3	0.112059	0.00077	0.11048	0.11364
6-2	3	0.110348	0.00077	0.10877	0.11193

Std Error uses a pooled estimate of error variance

U std – Cr2O3 reference value ~0 wt%
Oneway Analysis of Cr2O3 (wt%) By Analytical Blks (LM)



Oneway Anova

Summary of Fit

Rsquare	0.66263
Adj Rsquare	0.508002
Root Mean Square Error	0.004459
Mean of Response	0.231595
Observations (or Sum Wgts)	36

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Blks (LM)	11	0.00093710	0.000085	4.2853	0.0014
Error	24	0.00047711	0.000020		
C. Total	35	0.00141421			

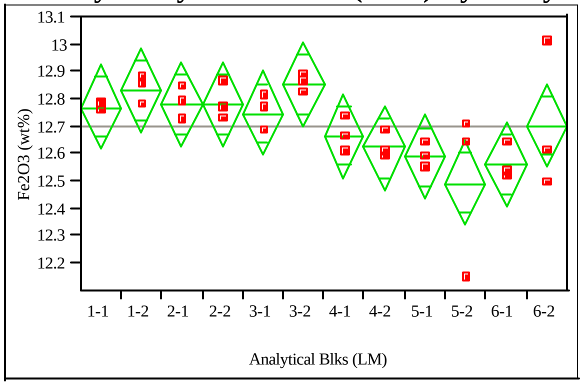
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	0.234548	0.00257	0.22923	0.23986
1-2	3	0.234236	0.00257	0.22892	0.23955
2-1	3	0.234538	0.00257	0.22923	0.23985
2-2	3	0.230173	0.00257	0.22486	0.23549
3-1	3	0.231430	0.00257	0.22612	0.23674
3-2	3	0.241203	0.00257	0.23589	0.24652
4-1	3	0.235961	0.00257	0.23065	0.24127
4-2	3	0.231357	0.00257	0.22604	0.23667
5-1	3	0.233091	0.00257	0.22778	0.23840
5-2	3	0.225354	0.00257	0.22004	0.23067
6-1	3	0.225413	0.00257	0.22010	0.23073
6-2	3	0.221842	0.00257	0.21653	0.22715

Std Error uses a pooled estimate of error variance

Exhibit C.7: SRTC-ML Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the LM Method for the Radioactive Group *(continued)*

Batch 1 – Fe2O3 reference value 12.839 wt%
Oneway Analysis of Fe2O3 (wt%) By Analytical Blks (LM)



Oneway Anova

Summary of Fit

Rsquare	0.522323
Adj Rsquare	0.303387
Root Mean Square Error	0.128452
Mean of Response	12.70085
Observations (or Sum Wgts)	36

Analysis of Variance

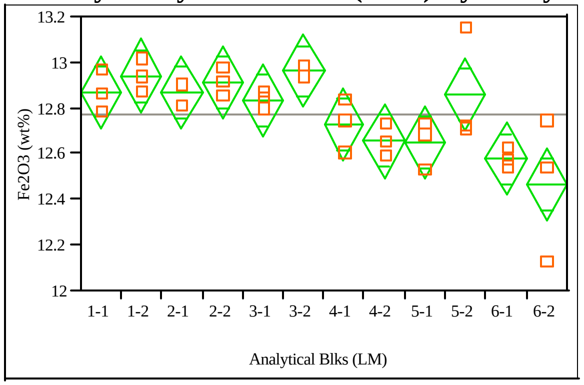
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Blks (LM)	11	0.43300728	0.039364	2.3857	0.0363
Error	24	0.39599635	0.016500		
C. Total	35	0.82900363			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	12.7706	0.07416	12.617	12.924
1-2	3	12.8343	0.07416	12.681	12.987
2-1	3	12.7827	0.07416	12.630	12.936
2-2	3	12.7829	0.07416	12.630	12.936
3-1	3	12.7498	0.07416	12.597	12.903
3-2	3	12.8544	0.07416	12.701	13.007
4-1	3	12.6645	0.07416	12.511	12.818
4-2	3	12.6233	0.07416	12.470	12.776
5-1	3	12.5904	0.07416	12.437	12.743
5-2	3	12.4934	0.07416	12.340	12.646
6-1	3	12.5605	0.07416	12.407	12.714
6-2	3	12.7035	0.07416	12.550	12.857

Std Error uses a pooled estimate of error variance

U std – Fe2O3 reference value 13.196 wt%
Oneway Analysis of Fe2O3 (wt%) By Analytical Blks (LM)



Oneway Anova

Summary of Fit

Rsquare	0.662123
Adj Rsquare	0.507263
Root Mean Square Error	0.133793
Mean of Response	12.77888
Observations (or Sum Wgts)	36

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Blks (LM)	11	0.8418957	0.076536	4.2756	0.0014
Error	24	0.4296130	0.017901		
C. Total	35	1.2715087			

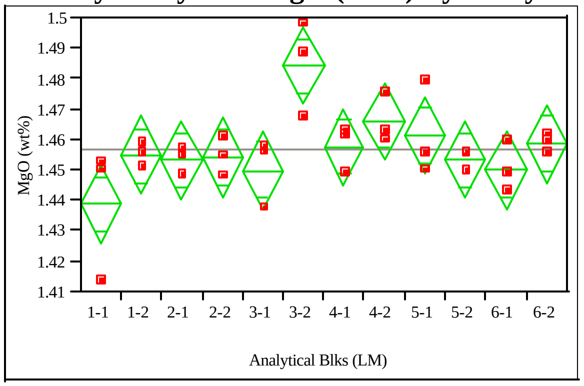
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	12.8733	0.07725	12.714	13.033
1-2	3	12.9411	0.07725	12.782	13.100
2-1	3	12.8724	0.07725	12.713	13.032
2-2	3	12.9163	0.07725	12.757	13.076
3-1	3	12.8356	0.07725	12.676	12.995
3-2	3	12.9667	0.07725	12.807	13.126
4-1	3	12.7278	0.07725	12.568	12.887
4-2	3	12.6562	0.07725	12.497	12.816
5-1	3	12.6482	0.07725	12.489	12.808
5-2	3	12.8632	0.07725	12.704	13.023
6-1	3	12.5795	0.07725	12.420	12.739
6-2	3	12.4663	0.07725	12.307	12.626

Std Error uses a pooled estimate of error variance

Exhibit C.7: SRTC-ML Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the LM Method for the Radioactive Group *(continued)*

Batch 1 – MgO reference value 1.419 wt %
Oneway Analysis of MgO (wt%) By Analytical Blks (LM)



Oneway Anova

Summary of Fit

Rsquare	0.59159
Adj Rsquare	0.404402
Root Mean Square Error	0.010711
Mean of Response	1.456903
Observations (or Sum Wgts)	36

Analysis of Variance

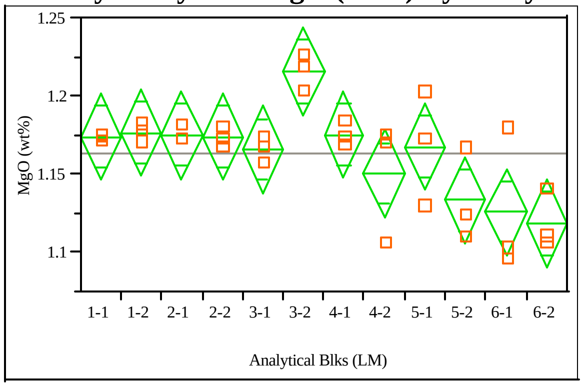
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Blks (LM)	11	0.00398800	0.000363	3.1604	0.0089
Error	24	0.00275316	0.000115		
C. Total	35	0.00674116			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	1.43862	0.00618	1.4259	1.4514
1-2	3	1.45497	0.00618	1.4422	1.4677
2-1	3	1.45322	0.00618	1.4405	1.4660
2-2	3	1.45425	0.00618	1.4415	1.4670
3-1	3	1.45000	0.00618	1.4372	1.4628
3-2	3	1.48441	0.00618	1.4716	1.4972
4-1	3	1.45759	0.00618	1.4448	1.4703
4-2	3	1.46610	0.00618	1.4533	1.4789
5-1	3	1.46149	0.00618	1.4487	1.4743
5-2	3	1.45336	0.00618	1.4406	1.4661
6-1	3	1.45020	0.00618	1.4374	1.4630
6-2	3	1.45863	0.00618	1.4459	1.4714

Std Error uses a pooled estimate of error variance

U std – MgO reference value 1.21 wt%
Oneway Analysis of MgO (wt%) By Analytical Blks (LM)



Oneway Anova

Summary of Fit

Rsquare	0.645856
Adj Rsquare	0.48354
Root Mean Square Error	0.023403
Mean of Response	1.162949
Observations (or Sum Wgts)	36

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Blks (LM)	11	0.02397160	0.002179	3.9790	0.0023
Error	24	0.01314440	0.000548		
C. Total	35	0.03711600			

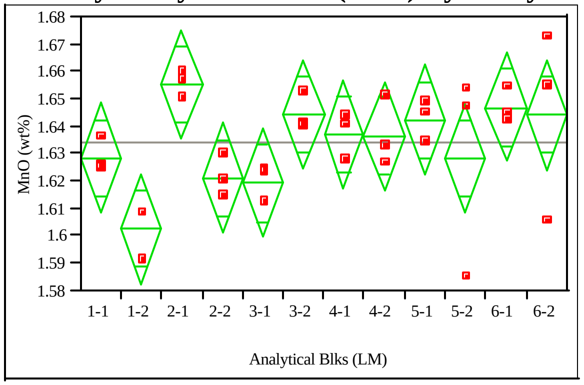
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	1.17410	0.01351	1.1462	1.2020
1-2	3	1.17707	0.01351	1.1492	1.2050
2-1	3	1.17556	0.01351	1.1477	1.2034
2-2	3	1.17391	0.01351	1.1460	1.2018
3-1	3	1.16605	0.01351	1.1382	1.1939
3-2	3	1.21624	0.01351	1.1884	1.2441
4-1	3	1.17583	0.01351	1.1479	1.2037
4-2	3	1.15017	0.01351	1.1223	1.1781
5-1	3	1.16821	0.01351	1.1403	1.1961
5-2	3	1.13337	0.01351	1.1055	1.1613
6-1	3	1.12586	0.01351	1.0980	1.1537
6-2	3	1.11901	0.01351	1.0911	1.1469

Std Error uses a pooled estimate of error variance

Exhibit C.7: SRTC-ML Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the LM Method for the Radioactive Group *(continued)*

Batch 1 – MnO reference value 1.726 wt%
Oneway Analysis of MnO (wt%) By Analytical Blks (LM)



Oneway Anova
Summary of Fit

Rsquare	0.515708
Adj Rsquare	0.29374
Root Mean Square Error	0.016648
Mean of Response	1.633992
Observations (or Sum Wgts)	36

Analysis of Variance

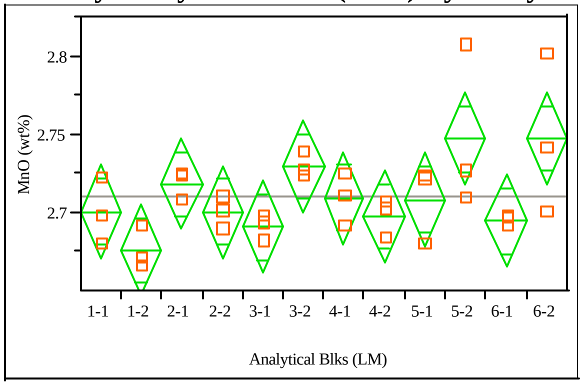
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Blks (LM)	11	0.00708362	0.000644	2.3233	0.0408
Error	24	0.00665211	0.000277		
C. Total	35	0.01373572			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	1.62863	0.00961	1.6088	1.6485
1-2	3	1.60242	0.00961	1.5826	1.6223
2-1	3	1.65553	0.00961	1.6357	1.6754
2-2	3	1.62136	0.00961	1.6015	1.6412
3-1	3	1.61955	0.00961	1.5997	1.6394
3-2	3	1.64434	0.00961	1.6245	1.6642
4-1	3	1.63711	0.00961	1.6173	1.6570
4-2	3	1.63664	0.00961	1.6168	1.6565
5-1	3	1.64254	0.00961	1.6227	1.6624
5-2	3	1.62846	0.00961	1.6086	1.6483
6-1	3	1.64710	0.00961	1.6273	1.6669
6-2	3	1.64421	0.00961	1.6244	1.6641

Std Error uses a pooled estimate of error variance

U std – MnO reference value 2.892 wt%
Oneway Analysis of MnO (wt%) By Analytical Blks (LM)



Oneway Anova
Summary of Fit

Rsquare	0.524085
Adj Rsquare	0.305957
Root Mean Square Error	0.024716
Mean of Response	2.710035
Observations (or Sum Wgts)	36

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Blks (LM)	11	0.01614535	0.001468	2.4026	0.0352
Error	24	0.01466141	0.000611		
C. Total	35	0.03080676			

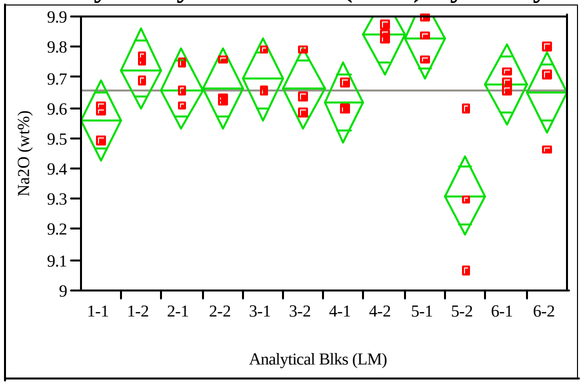
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	2.70029	0.01427	2.6708	2.7297
1-2	3	2.67584	0.01427	2.6464	2.7053
2-1	3	2.71854	0.01427	2.6891	2.7480
2-2	3	2.70024	0.01427	2.6708	2.7297
3-1	3	2.69116	0.01427	2.6617	2.7206
3-2	3	2.72964	0.01427	2.7002	2.7591
4-1	3	2.70894	0.01427	2.6795	2.7384
4-2	3	2.69745	0.01427	2.6680	2.7269
5-1	3	2.70829	0.01427	2.6788	2.7377
5-2	3	2.74746	0.01427	2.7180	2.7769
6-1	3	2.69491	0.01427	2.6655	2.7244
6-2	3	2.74767	0.01427	2.7182	2.7771

Std Error uses a pooled estimate of error variance

Exhibit C.7: SRTC-ML Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the LM Method for the Radioactive Group *(continued)*

Batch 1 – Na2O reference value 9.003 wt%
Oneway Analysis of Na2O (wt%) By Analytical Blks (LM)



Oneway Anova

Summary of Fit

Rsquare	0.672717
Adj Rsquare	0.522713
Root Mean Square Error	0.110569
Mean of Response	9.659802
Observations (or Sum Wgts)	36

Analysis of Variance

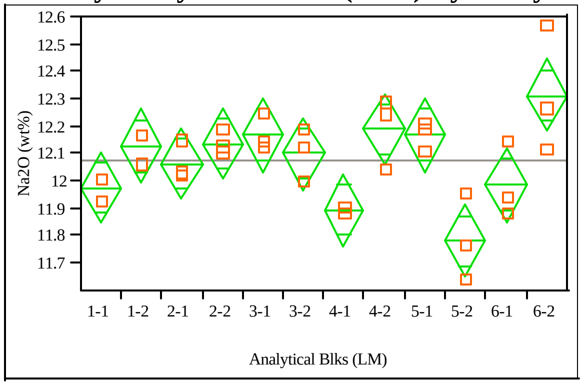
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Blks (LM)	11	0.60309770	0.054827	4.4846	0.0010
Error	24	0.29341233	0.012226		
C. Total	35	0.89651003			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	9.55831	0.06384	9.4266	9.6901
1-2	3	9.72964	0.06384	9.5979	9.8614
2-1	3	9.66489	0.06384	9.5331	9.7966
2-2	3	9.66619	0.06384	9.5344	9.7979
3-1	3	9.69661	0.06384	9.5649	9.8284
3-2	3	9.66565	0.06384	9.5339	9.7974
4-1	3	9.61825	0.06384	9.4865	9.7500
4-2	3	9.84408	0.06384	9.7123	9.9758
5-1	3	9.82688	0.06384	9.6951	9.9586
5-2	3	9.31297	0.06384	9.1812	9.4447
6-1	3	9.68125	0.06384	9.5495	9.8130
6-2	3	9.65289	0.06384	9.5211	9.7846

Std Error uses a pooled estimate of error variance

U std – Na2O reference value 11.795 wt%
Oneway Analysis of Na2O (wt%) By Analytical Blks (LM)



Oneway Anova

Summary of Fit

Rsquare	0.704684
Adj Rsquare	0.569331
Root Mean Square Error	0.110299
Mean of Response	12.07649
Observations (or Sum Wgts)	36

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Blks (LM)	11	0.69672707	0.063339	5.2063	0.0004
Error	24	0.29198113	0.012166		
C. Total	35	0.98870819			

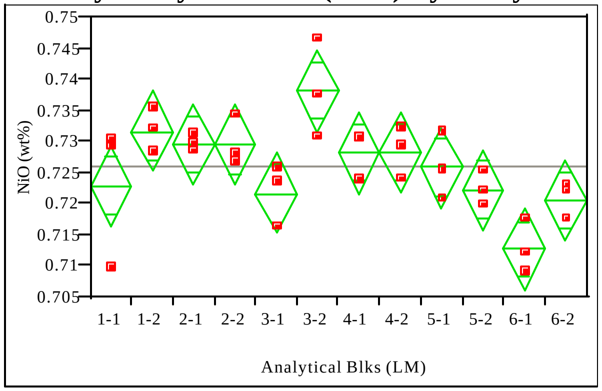
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	11.9764	0.06368	11.845	12.108
1-2	3	12.1304	0.06368	11.999	12.262
2-1	3	12.0653	0.06368	11.934	12.197
2-2	3	12.1374	0.06368	12.006	12.269
3-1	3	12.1694	0.06368	12.038	12.301
3-2	3	12.1014	0.06368	11.970	12.233
4-1	3	11.8956	0.06368	11.764	12.027
4-2	3	12.1899	0.06368	12.058	12.321
5-1	3	12.1689	0.06368	12.038	12.300
5-2	3	11.7820	0.06368	11.651	11.913
6-1	3	11.9857	0.06368	11.854	12.117
6-2	3	12.3155	0.06368	12.184	12.447

Std Error uses a pooled estimate of error variance

Exhibit C.7: SRTC-ML Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the LM Method for the Radioactive Group *(continued)*

Batch 1 – NiO reference value 0.751 wt%
Oneway Analysis of NiO (wt%) By Analytical Blks (LM)



Oneway Anova

Summary of Fit

Rsquare	0.66453
Adj Rsquare	0.510773
Root Mean Square Error	0.005417
Mean of Response	0.725968
Observations (or Sum Wgts)	36

Analysis of Variance

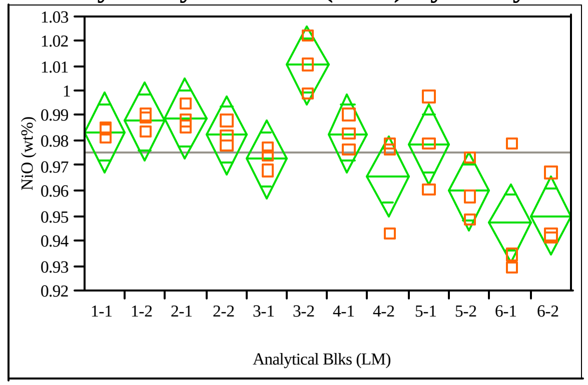
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Blks (LM)	11	0.00139497	0.000127	4.3220	0.0013
Error	24	0.00070421	0.000029		
C. Total	35	0.00209918			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	0.722945	0.00313	0.71649	0.72940
1-2	3	0.731747	0.00313	0.72529	0.73820
2-1	3	0.729618	0.00313	0.72316	0.73607
2-2	3	0.729545	0.00313	0.72309	0.73600
3-1	3	0.721745	0.00313	0.71529	0.72820
3-2	3	0.738190	0.00313	0.73174	0.74464
4-1	3	0.728175	0.00313	0.72172	0.73463
4-2	3	0.728328	0.00313	0.72187	0.73478
5-1	3	0.725758	0.00313	0.71930	0.73221
5-2	3	0.722203	0.00313	0.71575	0.72866
6-1	3	0.712681	0.00313	0.70623	0.71914
6-2	3	0.720685	0.00313	0.71423	0.72714

Std Error uses a pooled estimate of error variance

U std – NiO reference value 1.12 wt%
Oneway Analysis of NiO (wt%) By Analytical Blks (LM)



Oneway Anova

Summary of Fit

Rsquare	0.714434
Adj Rsquare	0.58355
Root Mean Square Error	0.013317
Mean of Response	0.976152
Observations (or Sum Wgts)	36

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Blks (LM)	11	0.01064861	0.000968	5.4585	0.0003
Error	24	0.00425635	0.000177		
C. Total	35	0.01490497			

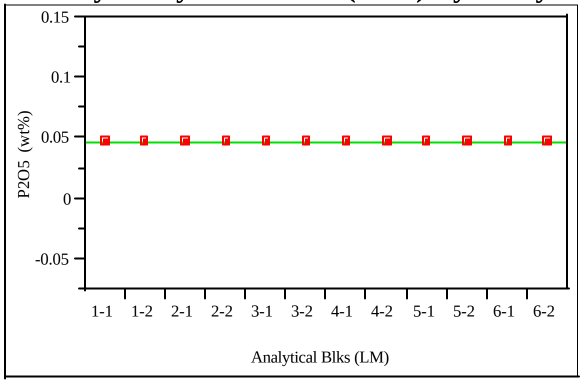
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	0.98364	0.00769	0.96777	0.9995
1-2	3	0.98802	0.00769	0.97215	1.0039
2-1	3	0.98950	0.00769	0.97363	1.0054
2-2	3	0.98277	0.00769	0.96690	0.9986
3-1	3	0.97290	0.00769	0.95703	0.9888
3-2	3	1.01070	0.00769	0.99484	1.0266
4-1	3	0.98348	0.00769	0.96761	0.9993
4-2	3	0.96615	0.00769	0.95028	0.9820
5-1	3	0.97917	0.00769	0.96330	0.9950
5-2	3	0.95982	0.00769	0.94395	0.9757
6-1	3	0.94734	0.00769	0.93147	0.9632
6-2	3	0.95033	0.00769	0.93446	0.9662

Std Error uses a pooled estimate of error variance

Exhibit C.7: SRTC-ML Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the LM Method for the Radioactive Group *(continued)*

Batch 1 – P2O5 reference value ~0 wt%
Oneway Analysis of P2O5 (wt%) By Analytical Blks (LM)



Oneway Anova

Summary of Fit

Rsquare	1
Adj Rsquare	1
Root Mean Square Error	0
Mean of Response	0.045828
Observations (or Sum Wgts)	36

Analysis of Variance

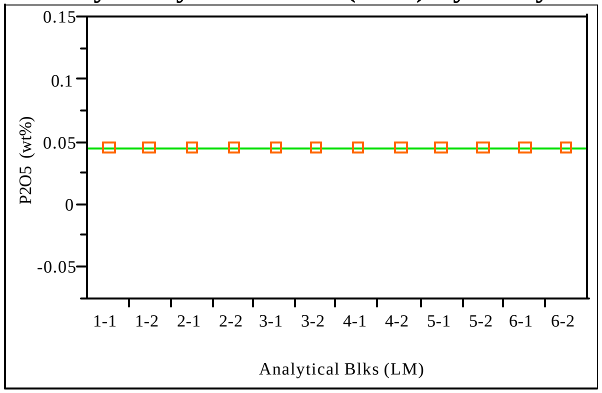
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Blks (LM)	11	6.9333e-33	6.303e-34	.	.
Error	24	0	0		
C. Total	35	6.9333e-33			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	0.045828	0	0.04583	0.04583
1-2	3	0.045828	0	0.04583	0.04583
2-1	3	0.045828	0	0.04583	0.04583
2-2	3	0.045828	0	0.04583	0.04583
3-1	3	0.045828	0	0.04583	0.04583
3-2	3	0.045828	0	0.04583	0.04583
4-1	3	0.045828	0	0.04583	0.04583
4-2	3	0.045828	0	0.04583	0.04583
5-1	3	0.045828	0	0.04583	0.04583
5-2	3	0.045828	0	0.04583	0.04583
6-1	3	0.045828	0	0.04583	0.04583
6-2	3	0.045828	0	0.04583	0.04583

Std Error uses a pooled estimate of error variance

U std – P2O5 reference value ~0 wt%
Oneway Analysis of P2O5 (wt%) By Analytical Blks (LM)



Oneway Anova

Summary of Fit

Rsquare	1
Adj Rsquare	1
Root Mean Square Error	0
Mean of Response	0.045828
Observations (or Sum Wgts)	36

Analysis of Variance

Source	DF	Sum o f Squares	Mean Square	F Ratio	Prob > F
Analytical Blks (LM)	11	6.9333e-33	6.303e-34	.	.
Error	24	0	0		
C. Total	35	6.9333e-33			

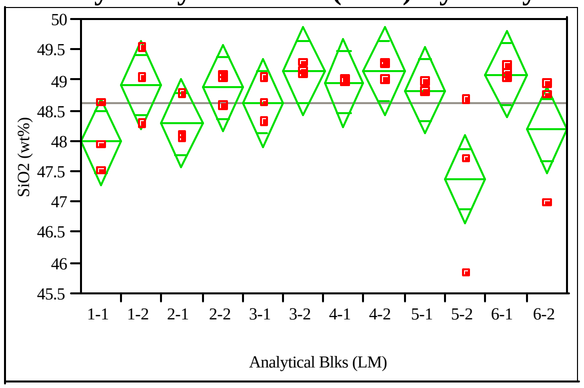
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	0.045828	0	0.04583	0.04583
1-2	3	0.045828	0	0.04583	0.04583
2-1	3	0.045828	0	0.04583	0.04583
2-2	3	0.045828	0	0.04583	0.04583
3-1	3	0.045828	0	0.04583	0.04583
3-2	3	0.045828	0	0.04583	0.04583
4-1	3	0.045828	0	0.04583	0.04583
4-2	3	0.045828	0	0.04583	0.04583
5-1	3	0.045828	0	0.04583	0.04583
5-2	3	0.045828	0	0.04583	0.04583
6-1	3	0.045828	0	0.04583	0.04583
6-2	3	0.045828	0	0.04583	0.04583

Std Error uses a pooled estimate of error variance

Exhibit C.7: SRTC-ML Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the LM Method for the Radioactive Group *(continued)*

Batch 1 – SiO2 reference value 50.22 wt%
Oneway Analysis of SiO2 (wt%) By Analytical Blks (LM)



Oneway Anova

Summary of Fit

Rsquare	0.531795
Adj Rsquare	0.317202
Root Mean Square Error	0.604995
Mean of Response	48.63211
Observations (or Sum Wgts)	36

Analysis of Variance

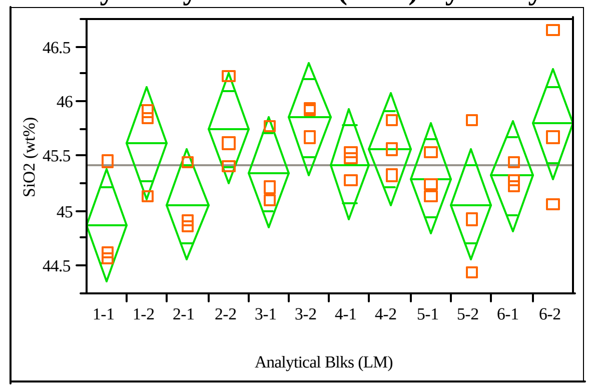
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Blks (LM)	11	9.977528	0.907048	2.4781	0.0306
Error	24	8.784441	0.366018		
C. Total	35	18.761970			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	48.0030	0.34929	47.282	48.724
1-2	3	48.9358	0.34929	48.215	49.657
2-1	3	48.3011	0.34929	47.580	49.022
2-2	3	48.8766	0.34929	48.156	49.597
3-1	3	48.6406	0.34929	47.920	49.361
3-2	3	49.1583	0.34929	48.437	49.879
4-1	3	48.9672	0.34929	48.246	49.688
4-2	3	49.1647	0.34929	48.444	49.886
5-1	3	48.8488	0.34929	48.128	49.570
5-2	3	47.3891	0.34929	46.668	48.110
6-1	3	49.0991	0.34929	48.378	49.820
6-2	3	48.2013	0.34929	47.480	48.922

Std Error uses a pooled estimate of error variance

U std – SiO2 reference value 45.353 wt%
Oneway Analysis of SiO2 (wt%) By Analytical Blks (LM)



Oneway Anova

Summary of Fit

Rsquare	0.429904
Adj Rsquare	0.168609
Root Mean Square Error	0.421928
Mean of Response	45.41734
Observations (or Sum Wgts)	36

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Blks (LM)	11	3.2218929	0.292899	1.6453	0.1487
Error	24	4.2725623	0.178023		
C. Total	35	7.4944553			

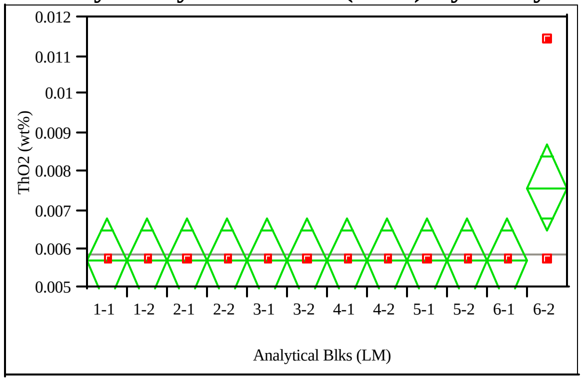
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	44.8768	0.24360	44.374	45.380
1-2	3	45.6249	0.24360	45.122	46.128
2-1	3	45.0693	0.24360	44.567	45.572
2-2	3	45.7539	0.24360	45.251	46.257
3-1	3	45.3574	0.24360	44.855	45.860
3-2	3	45.8481	0.24360	45.345	46.351
4-1	3	45.4302	0.24360	44.927	45.933
4-2	3	45.5678	0.24360	45.065	46.071
5-1	3	45.3004	0.24360	44.798	45.803
5-2	3	45.0622	0.24360	44.559	45.565
6-1	3	45.3211	0.24360	44.818	45.824
6-2	3	45.7960	0.24360	45.293	46.299

Std Error uses a pooled estimate of error variance

Exhibit C.7: SRTC-ML Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the LM Method for the Radioactive Group (continued)

Batch 1 – ThO2 reference value ~0 wt%
Oneway Analysis of ThO2 (wt%) By Analytical Blks (LM)



Oneway Anova

Summary of Fit

Rsquare	0.314286
Adj Rsquare	0
Root Mean Square Error	0.000948
Mean of Response	0.005848
Observations (or Sum Wgts)	36

Analysis of Variance

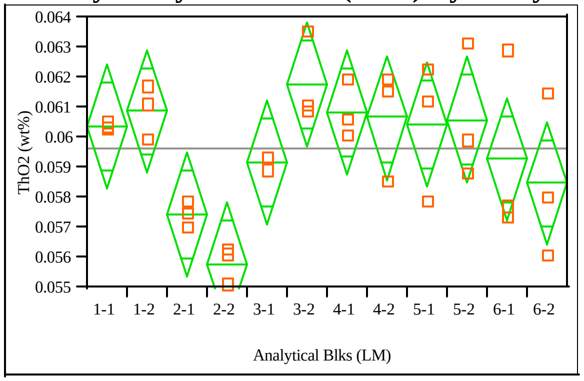
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Blks (LM)	11	0.00000989	8.9918e-7	1.0000	0.4744
Error	24	0.00002158	8.9918e-7		
C. Total	35	0.00003147			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	0.005689	0.00055	0.00456	0.00682
1-2	3	0.005689	0.00055	0.00456	0.00682
2-1	3	0.005689	0.00055	0.00456	0.00682
2-2	3	0.005689	0.00055	0.00456	0.00682
3-1	3	0.005689	0.00055	0.00456	0.00682
3-2	3	0.005689	0.00055	0.00456	0.00682
4-1	3	0.005689	0.00055	0.00456	0.00682
4-2	3	0.005689	0.00055	0.00456	0.00682
5-1	3	0.005689	0.00055	0.00456	0.00682
5-2	3	0.005689	0.00055	0.00456	0.00682
6-1	3	0.005689	0.00055	0.00456	0.00682
6-2	3	0.007586	0.00055	0.00646	0.00872

Std Error uses a pooled estimate of error variance

U std – ThO2 reference value ~0 wt%
Oneway Analysis of ThO2 (wt%) By Analytical Blks (LM)



Oneway Anova

Summary of Fit

Rsquare	0.574565
Adj Rsquare	0.379574
Root Mean Square Error	0.001728
Mean of Response	0.059641
Observations (or Sum Wgts)	36

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Blks (LM)	11	0.00009674	0.0000088	2.9466	0.0130
Error	24	0.00007163	0.000003		
C. Total	35	0.00016838			

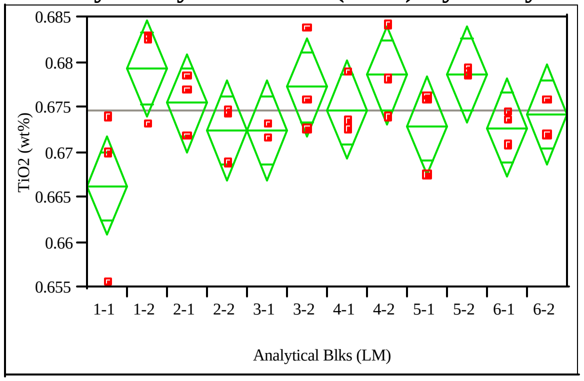
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	0.060367	0.00100	0.05831	0.06243
1-2	3	0.060891	0.00100	0.05883	0.06295
2-1	3	0.057415	0.00100	0.05536	0.05947
2-2	3	0.055781	0.00100	0.05372	0.05784
3-1	3	0.059167	0.00100	0.05711	0.06123
3-2	3	0.061791	0.00100	0.05973	0.06385
4-1	3	0.060839	0.00100	0.05878	0.06290
4-2	3	0.060653	0.00100	0.05859	0.06271
5-1	3	0.060421	0.00100	0.05836	0.06248
5-2	3	0.060600	0.00100	0.05854	0.06266
6-1	3	0.059285	0.00100	0.05723	0.06134
6-2	3	0.058482	0.00100	0.05642	0.06054

Std Error uses a pooled estimate of error variance

Exhibit C.7: SRTC-ML Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the LM Method for the Radioactive Group *(continued)*

Batch 1 – TiO2 reference value 0.677 wt%
Oneway Analysis of TiO2 (wt%) By Analytical Blks (LM)



Oneway Anova

Summary of Fit

Rsquare	0.466722
Adj Rsquare	0.222302
Root Mean Square Error	0.004578
Mean of Response	0.674602
Observations (or Sum Wgts)	36

Analysis of Variance

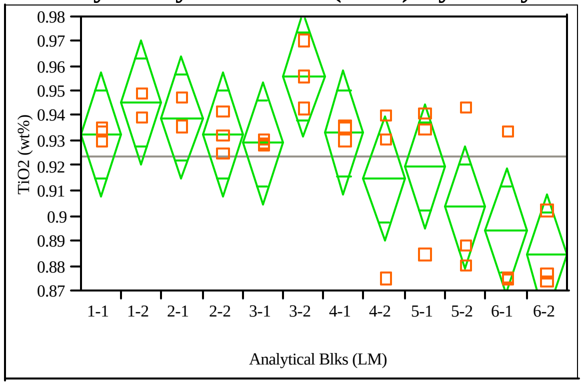
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Blks (LM)	11	0.00044025	0.000040	1.9095	0.0898
Error	24	0.00050303	0.000021		
C. Total	35	0.00094329			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	0.666299	0.00264	0.66084	0.67175
1-2	3	0.679337	0.00264	0.67388	0.68479
2-1	3	0.675534	0.00264	0.67008	0.68099
2-2	3	0.672393	0.00264	0.66694	0.67785
3-1	3	0.672432	0.00264	0.66698	0.67789
3-2	3	0.677186	0.00264	0.67173	0.68264
4-1	3	0.674828	0.00264	0.66937	0.68028
4-2	3	0.678542	0.00264	0.67309	0.68400
5-1	3	0.672960	0.00264	0.66750	0.67842
5-2	3	0.678665	0.00264	0.67321	0.68412
6-1	3	0.672766	0.00264	0.66731	0.67822
6-2	3	0.674278	0.00264	0.66882	0.67973

Std Error uses a pooled estimate of error variance

U std – TiO2 reference value 1.049 wt%
Oneway Analysis of TiO2 (wt%) By Analytical Blks (LM)



Oneway Anova

Summary of Fit

Rsquare	0.592999
Adj Rsquare	0.406457
Root Mean Square Error	0.020774
Mean of Response	0.924016
Observations (or Sum Wgts)	36

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Blks (LM)	11	0.01509059	0.001372	3.1789	0.0086
Error	24	0.01035732	0.000432		
C. Total	35	0.02544790			

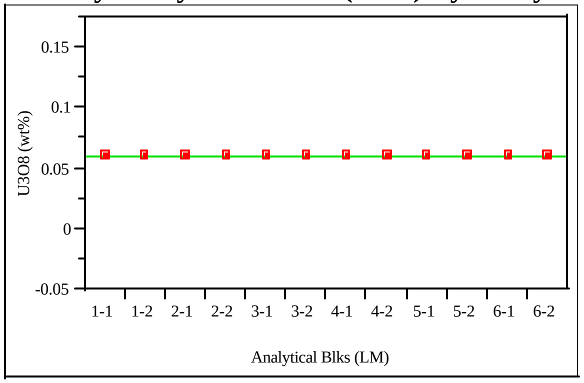
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	0.932823	0.01199	0.90807	0.95758
1-2	3	0.945834	0.01199	0.92108	0.97059
2-1	3	0.939568	0.01199	0.91481	0.96432
2-2	3	0.932907	0.01199	0.90815	0.95766
3-1	3	0.929332	0.01199	0.90458	0.95409
3-2	3	0.956531	0.01199	0.93178	0.98129
4-1	3	0.933769	0.01199	0.90901	0.95852
4-2	3	0.915254	0.01199	0.89050	0.94001
5-1	3	0.919935	0.01199	0.89518	0.94469
5-2	3	0.903745	0.01199	0.87899	0.92850
6-1	3	0.894393	0.01199	0.86964	0.91915
6-2	3	0.884101	0.01199	0.85935	0.90886

Std Error uses a pooled estimate of error variance

Exhibit C.7: SRTC-ML Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the LM Method for the Radioactive Group *(continued)*

Batch 1 – U3O8 reference value ~0 wt%
Oneway Analysis of U3O8 (wt%) By Analytical Blks (LM)



Oneway Anova

Summary of Fit

Rsquare	1
Adj Rsquare	1
Root Mean Square Error	0
Mean of Response	0.05896
Observations (or Sum Wgts)	36

Analysis of Variance

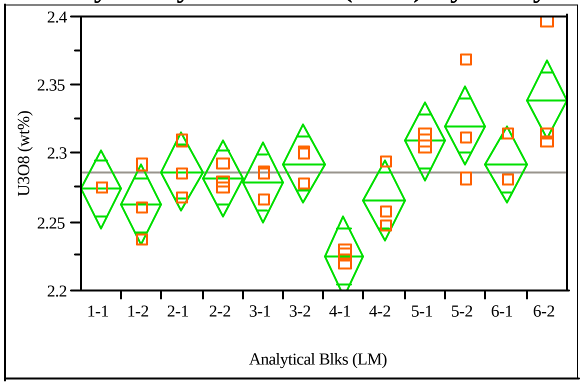
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Blks (LM)	11	1.56e-32	1.418e-33	.	.
Error	24	0	0		
C. Total	35	1.56e-32			

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
5-1	3	0.058960	0	0.05896	0.05896
5-2	3	0.058960	0	0.05896	0.05896
6-1	3	0.058960	0	0.05896	0.05896
6-2	3	0.058960	0	0.05896	0.05896

Std Error uses a pooled estimate of error variance

U std – U3O8 reference value 2.406 wt%
Oneway Analysis of U3O8 (wt%) By Analytical Blks (LM)



Oneway Anova

Summary of Fit

Rsquare	0.675903
Adj Rsquare	0.527358
Root Mean Square Error	0.023966
Mean of Response	2.285997
Observations (or Sum Wgts)	36

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Blks (LM)	11	0.02874794	0.002613	4.5502	0.0009
Error	24	0.01378473	0.000574		
C. Total	35	0.04253267			

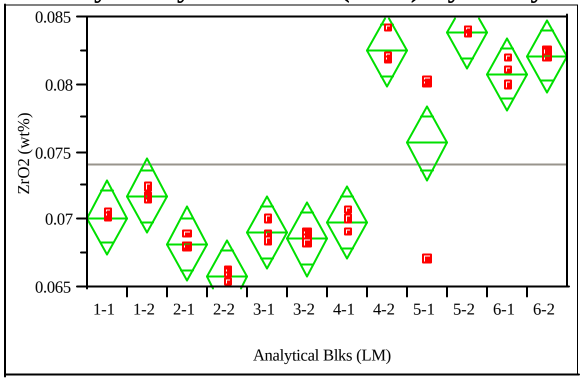
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	2.27464	0.01384	2.2461	2.3032
1-2	3	2.26269	0.01384	2.2341	2.2912
2-1	3	2.28722	0.01384	2.2587	2.3158
2-2	3	2.28250	0.01384	2.2539	2.3111
3-1	3	2.27939	0.01384	2.2508	2.3080
3-2	3	2.29280	0.01384	2.2642	2.3214
4-1	3	2.22495	0.01384	2.1964	2.2535
4-2	3	2.26591	0.01384	2.2374	2.2945
5-1	3	2.30958	0.01384	2.2810	2.3381
5-2	3	2.32055	0.01384	2.2920	2.3491
6-1	3	2.29197	0.01384	2.2634	2.3205
6-2	3	2.33977	0.01384	2.3112	2.3683

Std Error uses a pooled estimate of error variance

Exhibit C.7: SRTC-ML Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the LM Method for the Radioactive Group *(continued)*

Batch 1 – ZrO2 reference value 0.098 wt%
Oneway Analysis of ZrO2 (wt%) By Analytical Blks (LM)



Oneway Anova

Summary of Fit

Rsquare	0.920568
Adj Rsquare	0.884162
Root Mean Square Error	0.002271
Mean of Response	0.074051
Observations (or Sum Wgts)	36

Analysis of Variance

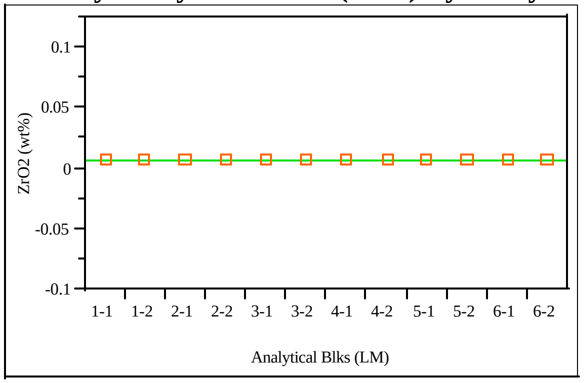
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Blks (LM)	11	0.00143390	0.000130	25.2860	<.0001
Error	24	0.00012372	0.000005		
C. Total	35	0.00155762			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	0.070209	0.00131	0.06750	0.07291
1-2	3	0.071775	0.00131	0.06907	0.07448
2-1	3	0.068213	0.00131	0.06551	0.07092
2-2	3	0.065814	0.00131	0.06311	0.06852
3-1	3	0.069061	0.00131	0.06636	0.07177
3-2	3	0.068590	0.00131	0.06588	0.07130
4-1	3	0.069825	0.00131	0.06712	0.07253
4-2	3	0.082573	0.00131	0.07987	0.08528
5-1	3	0.075685	0.00131	0.07298	0.07839
5-2	3	0.083862	0.00131	0.08116	0.08657
6-1	3	0.080841	0.00131	0.07814	0.08355
6-2	3	0.082166	0.00131	0.07946	0.08487

Std Error uses a pooled estimate of error variance

U std – ZrO2 reference value ~0 wt%
Oneway Analysis of ZrO2 (wt%) By Analytical Blks (LM)



Oneway Anova

Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	0.006754
Observations (or Sum Wgts)	36

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Blks (LM)	11	0	0	.	.
Error	24	0	0		
C. Total	35	0			

Means for Oneway Anova

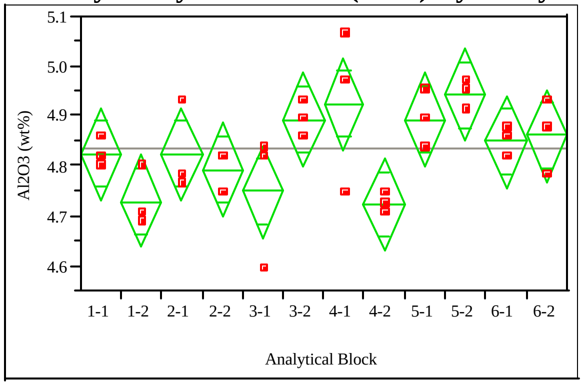
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	0.006754	0	0.00675	0.00675
1-2	3	0.006754	0	0.00675	0.00675
2-1	3	0.006754	0	0.00675	0.00675
2-2	3	0.006754	0	0.00675	0.00675
3-1	3	0.006754	0	0.00675	0.00675
3-2	3	0.006754	0	0.00675	0.00675
4-1	3	0.006754	0	0.00675	0.00675
4-2	3	0.006754	0	0.00675	0.00675
5-1	3	0.006754	0	0.00675	0.00675
5-2	3	0.006754	0	0.00675	0.00675
6-1	3	0.006754	0	0.00675	0.00675
6-2	3	0.006754	0	0.00675	0.00675

Std Error uses a pooled estimate of error variance

Exhibit C.8: SRTC-ML Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the PF Method for the Radioactive Group

Batch 1 – Al2O3 reference value 4.877 wt%

Oneway Analysis of Al2O3 (wt%) By Analytical Block



Oneway Anova

Summary of Fit

Rsquare	0.553293
Adj Rsquare	0.348553
Root Mean Square Error	0.078287
Mean of Response	4.834496
Observations (or Sum Wgts)	36

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Block	11	0.18218981	0.016563	2.7024	0.0202
Error	24	0.14709266	0.006129		
C. Total	35	0.32928247			

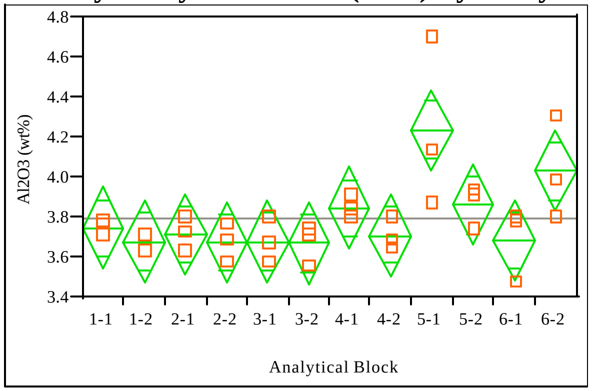
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	4.82452	0.04520	4.7312	4.9178
1-2	3	4.73005	0.04520	4.6368	4.8233
2-1	3	4.82452	0.04520	4.7312	4.9178
2-2	3	4.79303	0.04520	4.6997	4.8863
3-1	3	4.74894	0.04520	4.6557	4.8422
3-2	3	4.89380	0.04520	4.8005	4.9871
4-1	3	4.92530	0.04520	4.8320	5.0186
4-2	3	4.72375	0.04520	4.6305	4.8170
5-1	3	4.89381	0.04520	4.8005	4.9871
5-2	3	4.94419	0.04520	4.8509	5.0375
6-1	3	4.84972	0.04520	4.7564	4.9430
6-2	3	4.86231	0.04520	4.7690	4.9556

Std Error uses a pooled estimate of error variance

U std – Al2O3 reference value 4.1 wt%

Oneway Analysis of Al2O3 (wt%) By Analytical Block



Oneway Anova

Summary of Fit

Rsquare	0.60306
Adj Rsquare	0.421129
Root Mean Square Error	0.168943
Mean of Response	3.794221
Observations (or Sum Wgts)	36

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Block	11	1.0407064	0.094610	3.3148	0.0068
Error	24	0.6850043	0.028542		
C. Total	35	1.7257107			

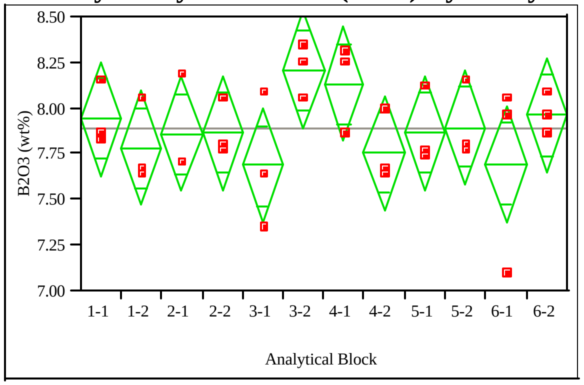
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	3.74751	0.09754	3.5462	3.9488
1-2	3	3.67823	0.09754	3.4769	3.8795
2-1	3	3.71602	0.09754	3.5147	3.9173
2-2	3	3.67193	0.09754	3.4706	3.8732
3-1	3	3.67823	0.09754	3.4769	3.8795
3-2	3	3.66563	0.09754	3.4643	3.8669
4-1	3	3.84828	0.09754	3.6470	4.0496
4-2	3	3.70972	0.09754	3.5084	3.9110
5-1	3	4.23878	0.09754	4.0375	4.4401
5-2	3	3.86088	0.09754	3.6596	4.0622
6-1	3	3.68452	0.09754	3.4832	3.8858
6-2	3	4.03093	0.09754	3.8296	4.2322

Std Error uses a pooled estimate of error variance

Exhibit C.8: SRTC-ML Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the PF Method for the Radioactive Group *(continued)*

Batch 1 – B2O3 reference value 7.777wt%
Oneway Analysis of B2O3 (wt%) By Analytical Block



Oneway Anova

Summary of Fit

Rsquare	0.336354
Adj Rsquare	0.032182
Root Mean Square Error	0.263833
Mean of Response	7.888755
Observations (or Sum Wgts)	36

Analysis of Variance

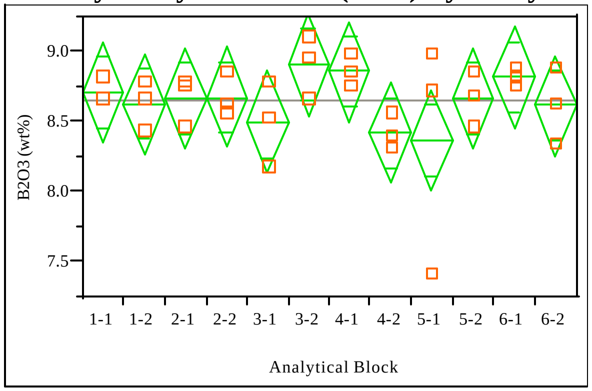
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Block	11	0.8467001	0.076973	1.1058	0.3983
Error	24	1.6705911	0.069608		
C. Total	35	2.5172912			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	7.94242	0.15232	7.6280	8.2568
1-2	3	7.78142	0.15232	7.4670	8.0958
2-1	3	7.85656	0.15232	7.5422	8.1709
2-2	3	7.86729	0.15232	7.5529	8.1817
3-1	3	7.68483	0.15232	7.3704	7.9992
3-2	3	8.21075	0.15232	7.8964	8.5251
4-1	3	8.13561	0.15232	7.8212	8.4500
4-2	3	7.75996	0.15232	7.4456	8.0743
5-1	3	7.86729	0.15232	7.5529	8.1817
5-2	3	7.89949	0.15232	7.5851	8.2139
6-1	3	7.69556	0.15232	7.3812	8.0099
6-2	3	7.96389	0.15232	7.6495	8.2783

Std Error uses a pooled estimate of error variance

U std – B2O3 reference value 9.209 wt%
Oneway Analysis of B2O3 (wt%) By Analytical Block



Oneway Anova

Summary of Fit

Rsquare	0.289628
Adj Rsquare	-0.03596
Root Mean Square Error	0.303433
Mean of Response	8.657059
Observations (or Sum Wgts)	36

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Block	11	0.9009292	0.081903	0.8896	0.5627
Error	24	2.2097144	0.092071		
C. Total	35	3.1106436			

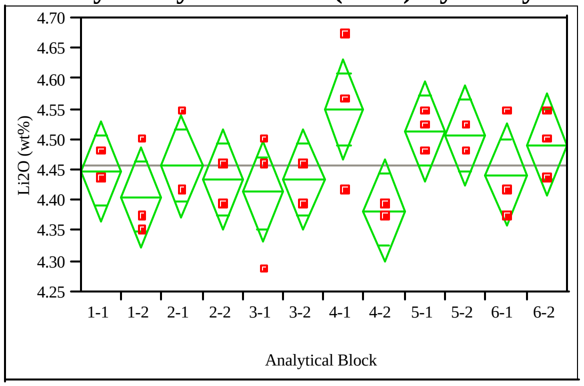
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	8.71520	0.17519	8.3536	9.0768
1-2	3	8.62933	0.17519	8.2678	8.9909
2-1	3	8.67226	0.17519	8.3107	9.0338
2-2	3	8.68300	0.17519	8.3214	9.0446
3-1	3	8.50054	0.17519	8.1390	8.8621
3-2	3	8.90839	0.17519	8.5468	9.2700
4-1	3	8.86546	0.17519	8.5039	9.2270
4-2	3	8.42540	0.17519	8.0638	8.7870
5-1	3	8.37174	0.17519	8.0102	8.7333
5-2	3	8.67226	0.17519	8.3107	9.0338
6-1	3	8.82253	0.17519	8.4610	9.1841
6-2	3	8.61860	0.17519	8.2570	8.9802

Std Error uses a pooled estimate of error variance

Exhibit C.8: SRTC-ML Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the PF Method for the Radioactive Group *(continued)*

Batch 1 – Li2O reference value 4.429 wt %
Oneway Analysis of Li2O (wt%) By Analytical Block



Oneway Anova

Summary of Fit

Rsquare	0.405792
Adj Rsquare	0.133447
Root Mean Square Error	0.06967
Mean of Response	4.457101
Observations (or Sum Wgts)	36

Analysis of Variance

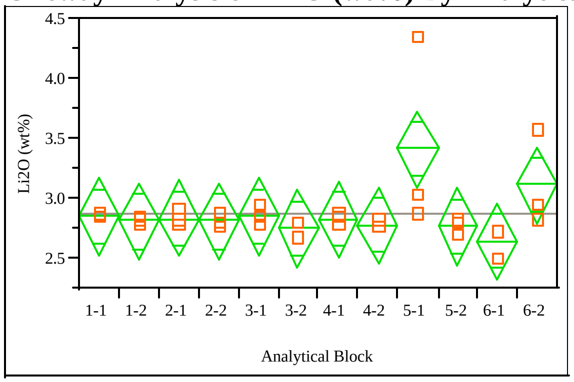
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Block	11	0.07955425	0.007232	1.4900	0.1994
Error	24	0.11649246	0.004854		
C. Total	35	0.19604671			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	4.44933	0.04022	4.3663	4.5323
1-2	3	4.40627	0.04022	4.3233	4.4893
2-1	3	4.45650	0.04022	4.3735	4.5395
2-2	3	4.43497	0.04022	4.3520	4.5180
3-1	3	4.41344	0.04022	4.3304	4.4965
3-2	3	4.43497	0.04022	4.3520	4.5180
4-1	3	4.54980	0.04022	4.4668	4.6328
4-2	3	4.38474	0.04022	4.3017	4.4678
5-1	3	4.51391	0.04022	4.4309	4.5969
5-2	3	4.50674	0.04022	4.4237	4.5898
6-1	3	4.44215	0.04022	4.3591	4.5252
6-2	3	4.49238	0.04022	4.4094	4.5754

Std Error uses a pooled estimate of error variance

U std – Li2Oreference value 3.057 wt%
Oneway Analysis of Li2O (wt%) By Analytical Block



Oneway Anova

Summary of Fit

Rsquare	0.438093
Adj Rsquare	0.180552
Root Mean Square Error	0.269136
Mean of Response	2.872925
Observations (or Sum Wgts)	36

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Block	11	1.3553707	0.123216	1.7011	0.1337
Error	24	1.7384259	0.072434		
C. Total	35	3.0937966			

Means for Oneway Anova

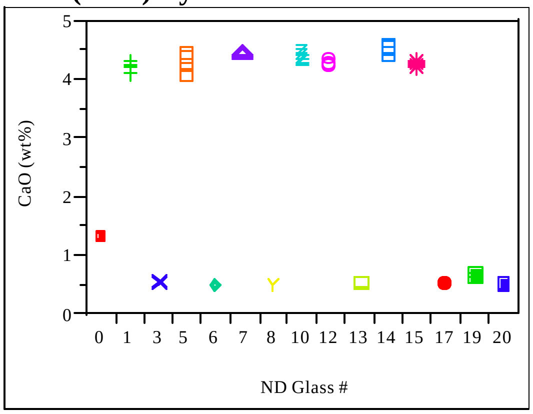
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	2.85618	0.15539	2.5355	3.1769
1-2	3	2.81312	0.15539	2.4924	3.1338
2-1	3	2.83465	0.15539	2.5140	3.1554
2-2	3	2.81312	0.15539	2.4924	3.1338
3-1	3	2.85618	0.15539	2.5355	3.1769
3-2	3	2.75571	0.15539	2.4350	3.0764
4-1	3	2.82748	0.15539	2.5068	3.1482
4-2	3	2.77724	0.15539	2.4565	3.0979
5-1	3	3.41593	0.15539	3.0952	3.7366
5-2	3	2.77006	0.15539	2.4494	3.0908
6-1	3	2.64089	0.15539	2.3202	2.9616
6-2	3	3.11453	0.15539	2.7938	3.4352

Std Error uses a pooled estimate of error variance

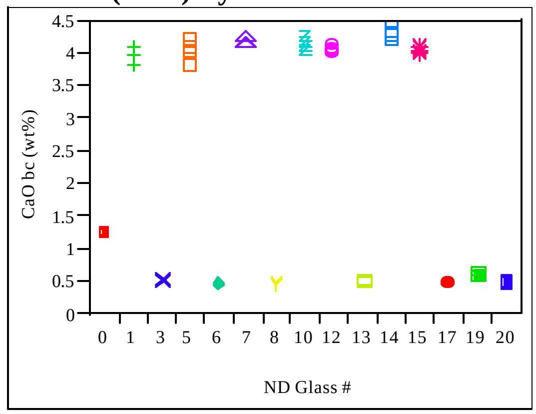
Exhibit C.9: SRTC-ML Measurements by Glass Number for Samples Prepared Using the LM Method for the Non-Radioactive Group

(0 – Batch 1)

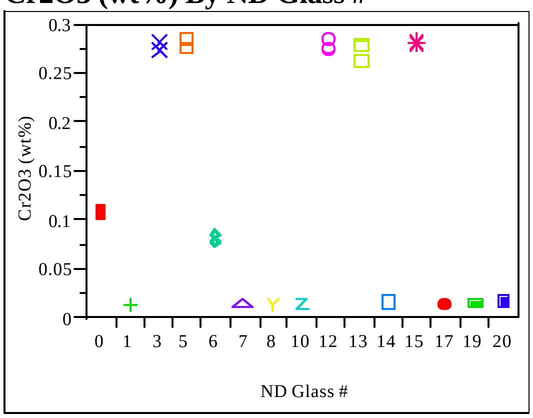
CaO (wt%) By ND Glass #



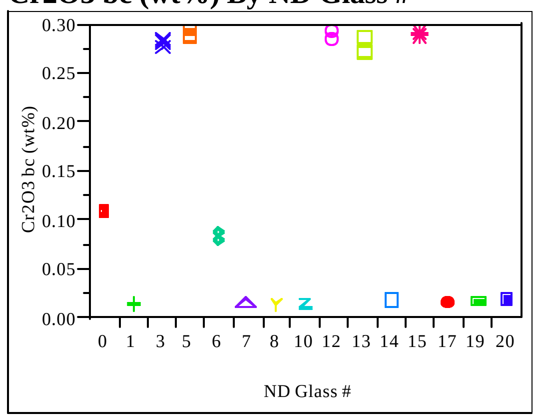
CaO bc (wt%) By ND Glass #



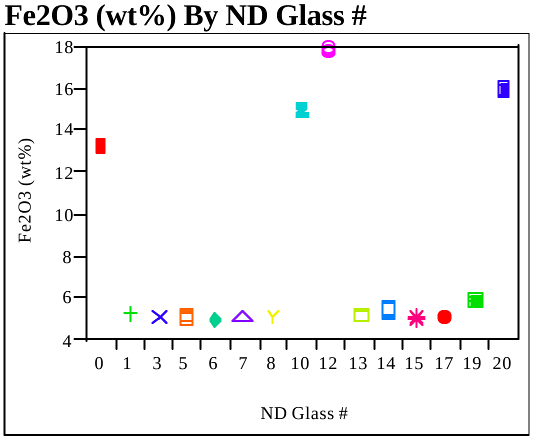
Cr2O3 (wt%) By ND Glass #



Cr2O3 bc (wt%) By ND Glass #



Fe2O3 (wt%) By ND Glass #



Fe2O3 bc (wt%) By ND Glass #

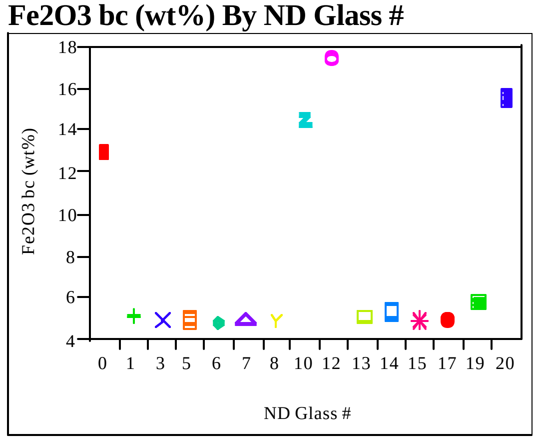
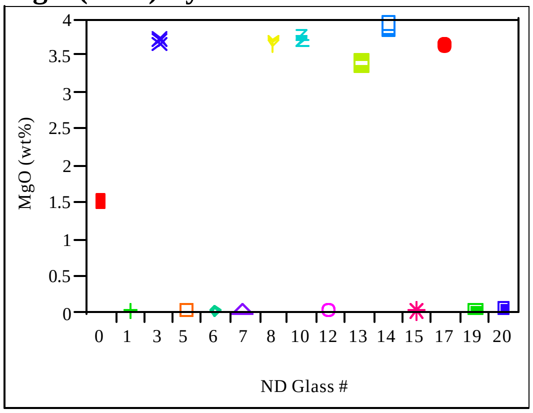


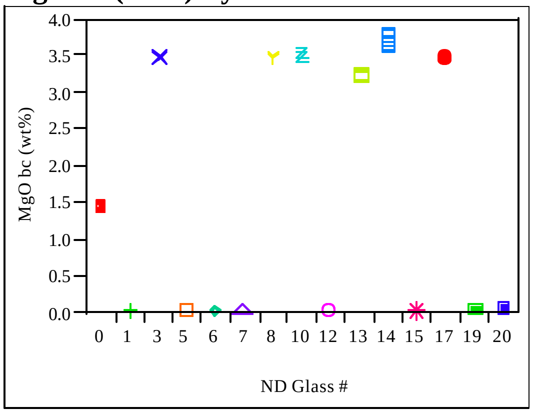
Exhibit C.9: SRTC-ML Measurements by Glass Number for Samples Prepared Using the LM Method for the Non-Radioactive Group *(continued)*

(0 – Batch 1)

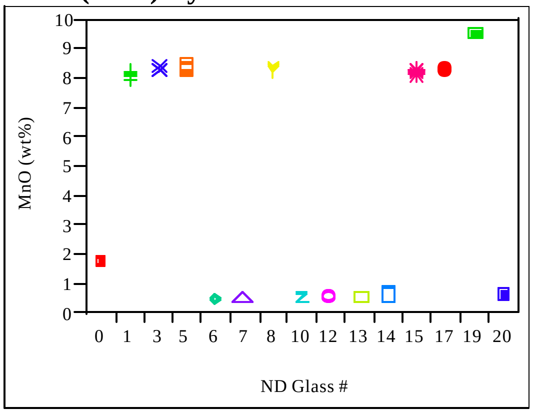
MgO (wt%) By ND Glass #



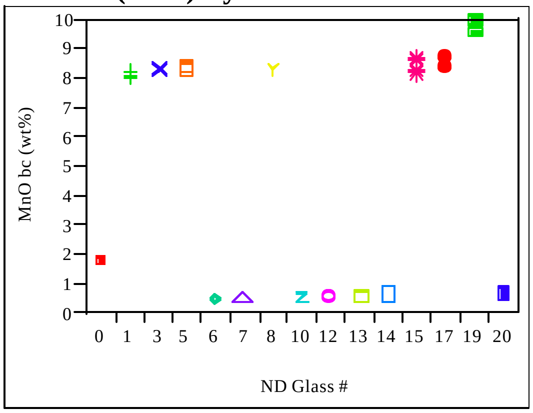
MgO bc (wt%) By ND Glass #



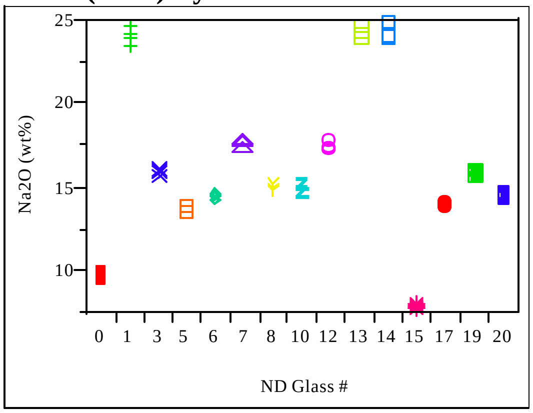
MnO (wt%) By ND Glass #



MnO bc (wt%) By ND Glass #



Na2O (wt%) By ND Glass #



Na2O bc (wt%) By ND Glass #

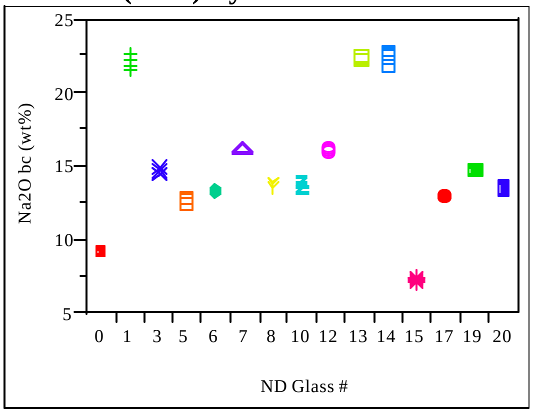
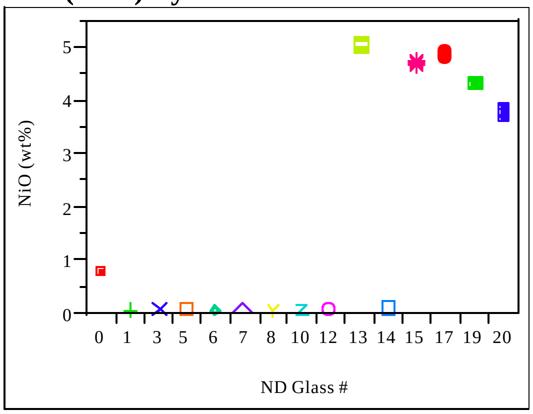


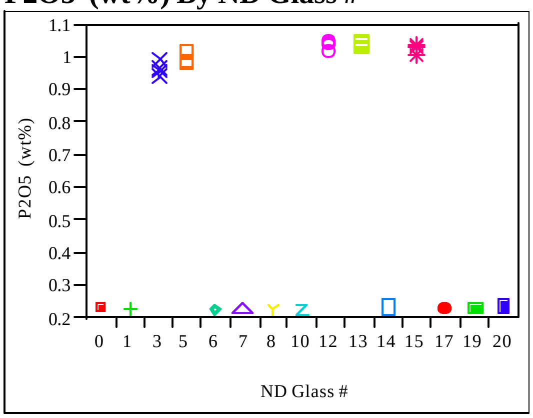
Exhibit C.9: SRTC-ML Measurements by Glass Number for Samples Prepared Using the LM Method for the Non-Radioactive Group *(continued)*

(0 – Batch 1)

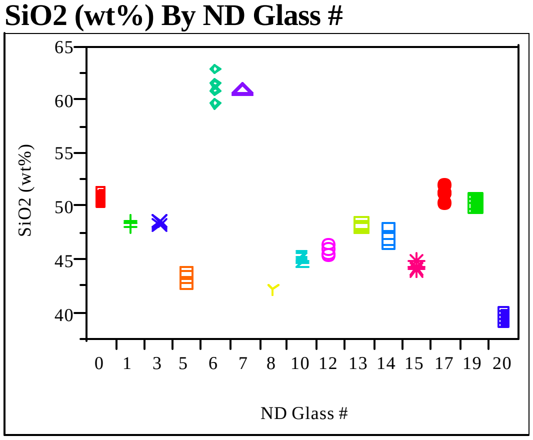
NiO (wt%) By ND Glass #



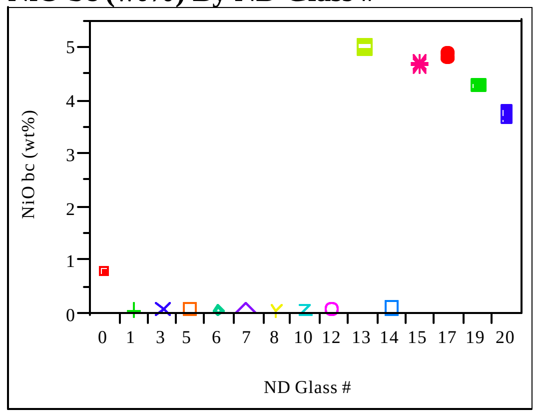
P2O5 (wt%) By ND Glass #



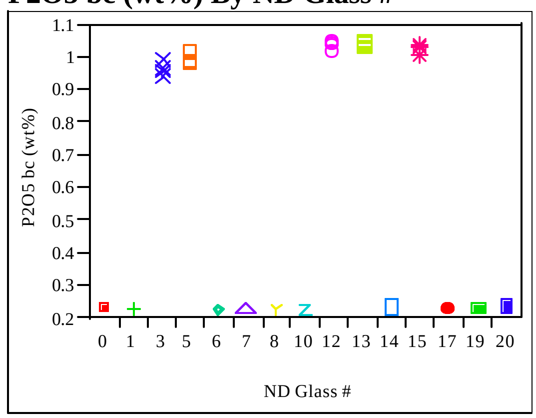
SiO2 (wt%) By ND Glass #



NiO bc (wt%) By ND Glass #



P2O5 bc (wt%) By ND Glass #



SiO2 bc (wt%) By ND Glass #

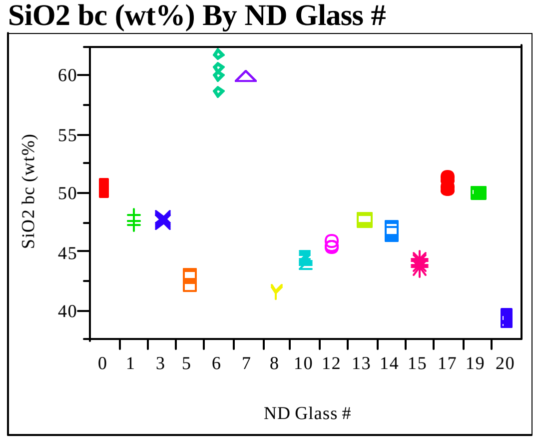
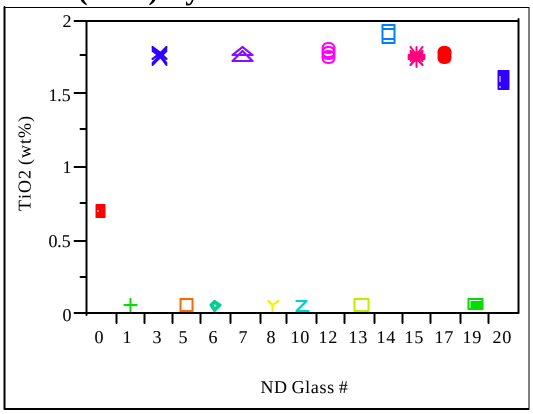


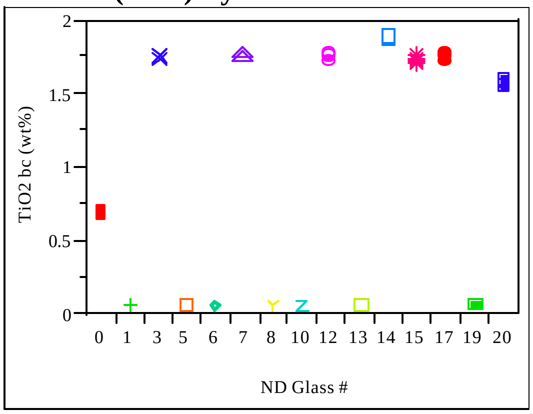
Exhibit C.9: SRTC-ML Measurements by Glass Number for Samples Prepared Using the LM Method for the Non-Radioactive Group *(continued)*

(0 – Batch 1)

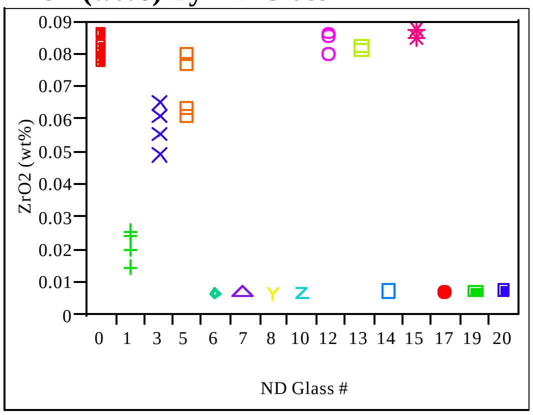
TiO2 (wt%) By ND Glass #



TiO2 bc (wt%) By ND Glass #



ZrO2 (wt%) By ND Glass #



ZrO2 bc (wt%) By ND Glass #

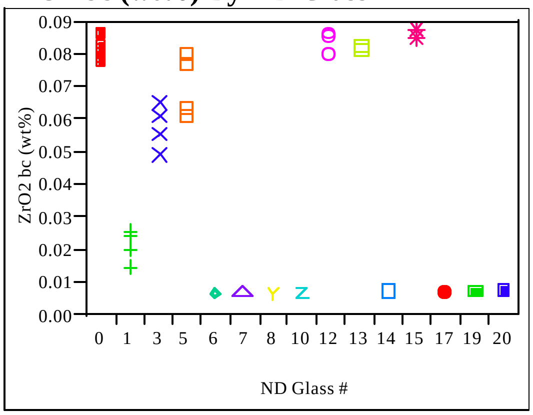
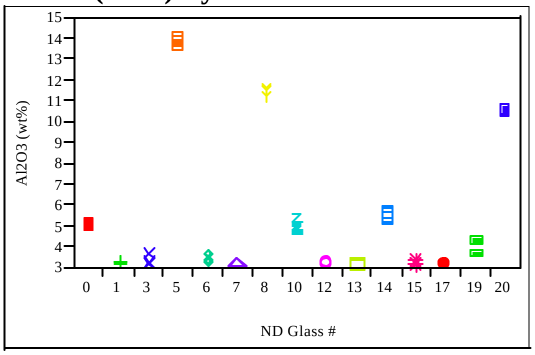


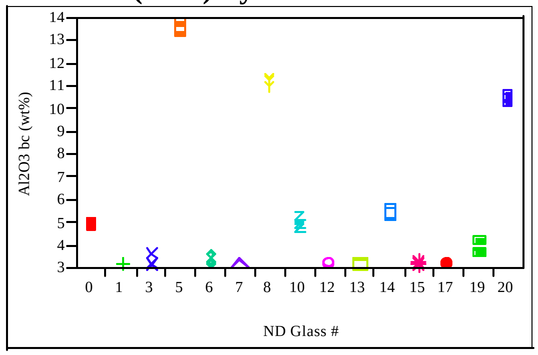
Exhibit C.10: SRTC-ML Measurements by Glass Number for Samples Prepared Using the PF Method for the Non-Radioactive Group

(0 – Batch 1)

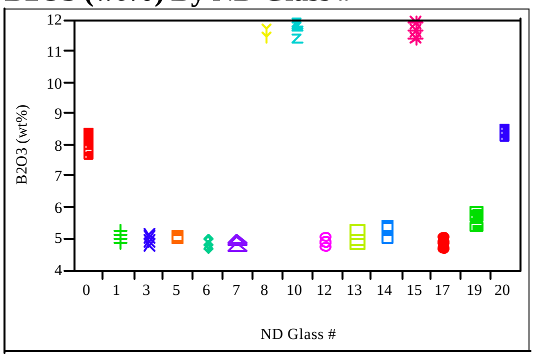
Al2O3 (wt%) By ND Glass #



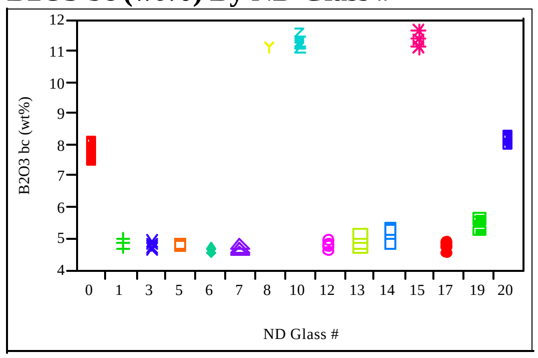
Al2O3 bc (wt%) By ND Glass #



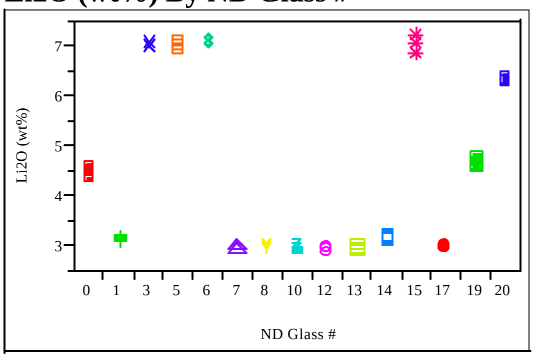
B2O3 (wt%) By ND Glass #



B2O3 bc (wt%) By ND Glass #



Li2O (wt%) By ND Glass #



Li2O bc (wt%) By ND Glass #

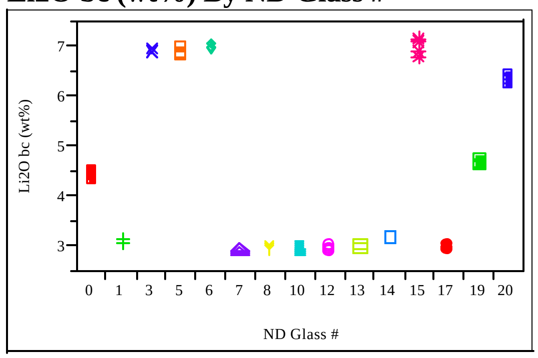
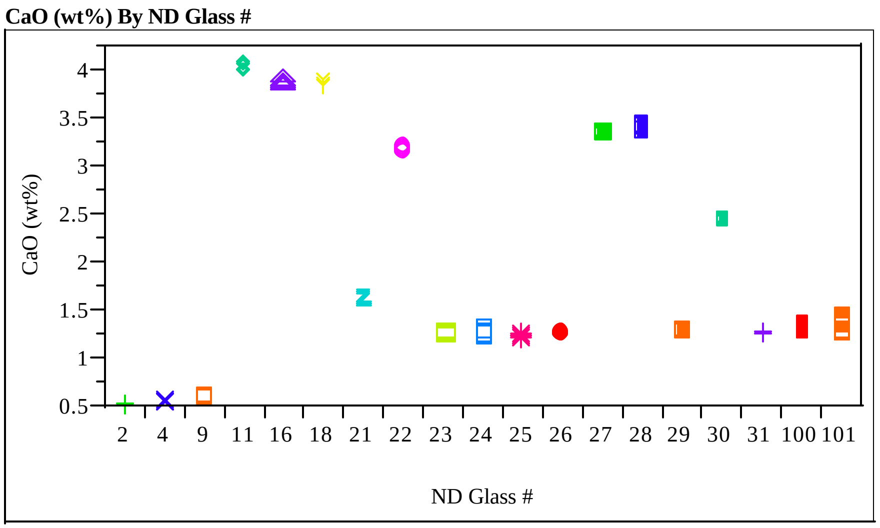
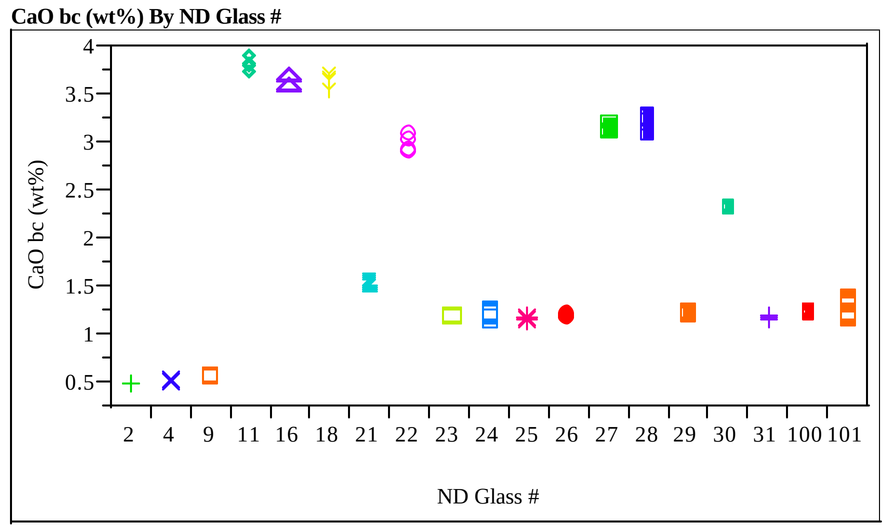
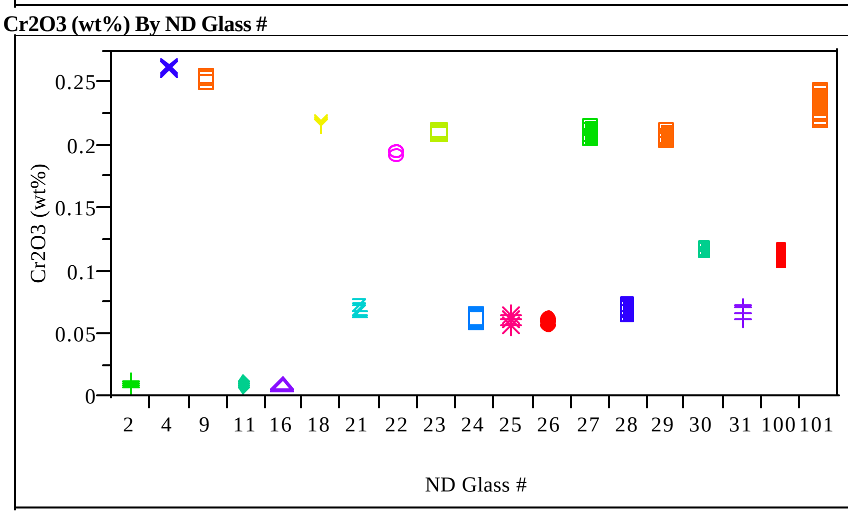


Exhibit C.11: SRTC-ML Measurements by Glass Number for Samples Prepared Using the LM Method for the Radioactive Group

(100 – Batch 1; 101 – U std)







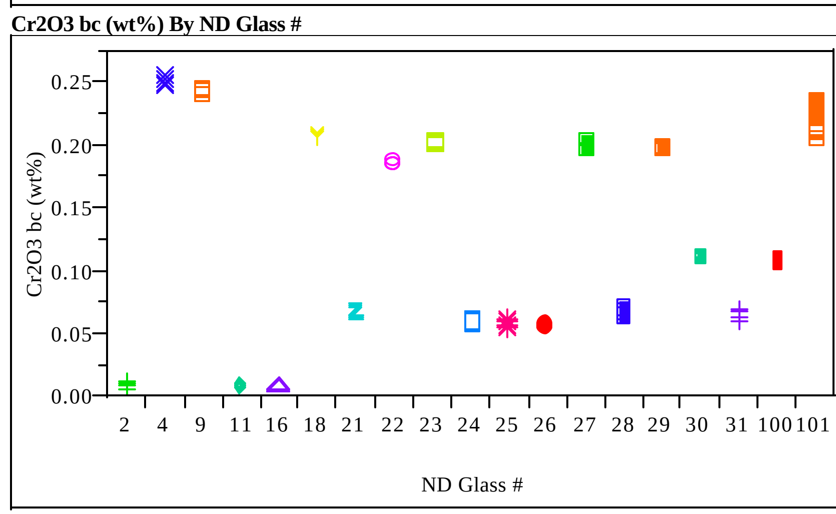
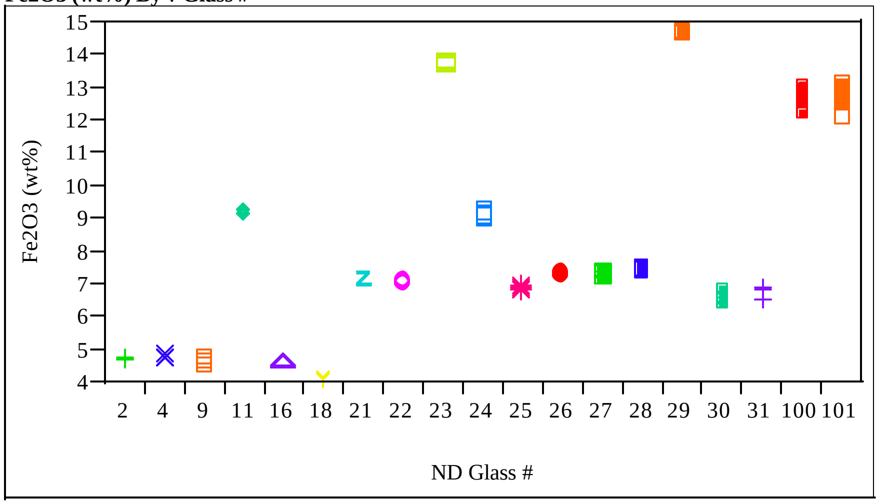


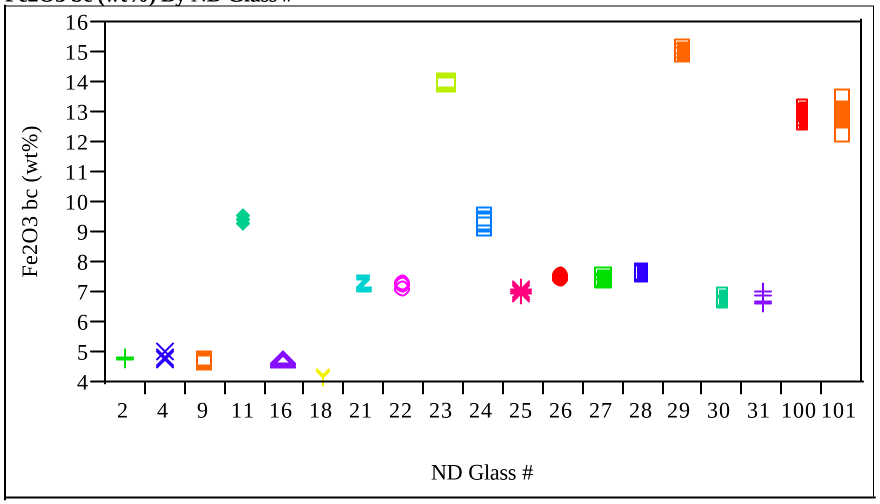
Exhibit C.11: SRTC-ML Measurements by Glass Number for Samples Prepared Using the LM Method for the Radioactive Group *(continued)*

(100 – Batch 1; 101 – U std)

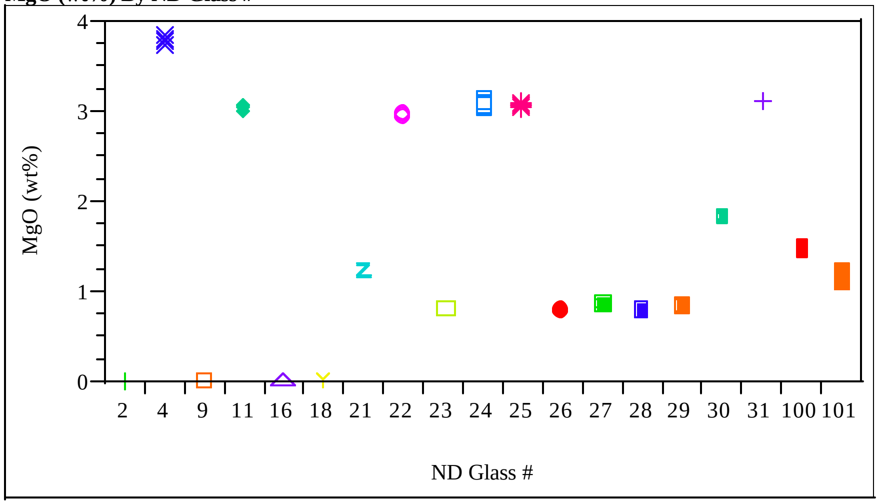
Fe2O3 (wt%) By v Glass #



Fe2O3 bc (wt%) By ND Glass #



MgO (wt%) By ND Glass #



MgO bc (wt%) By ND Glass #

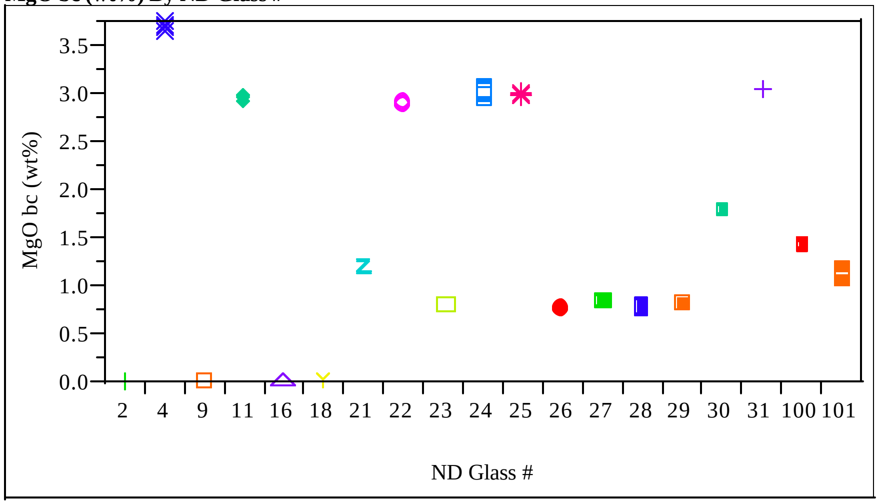
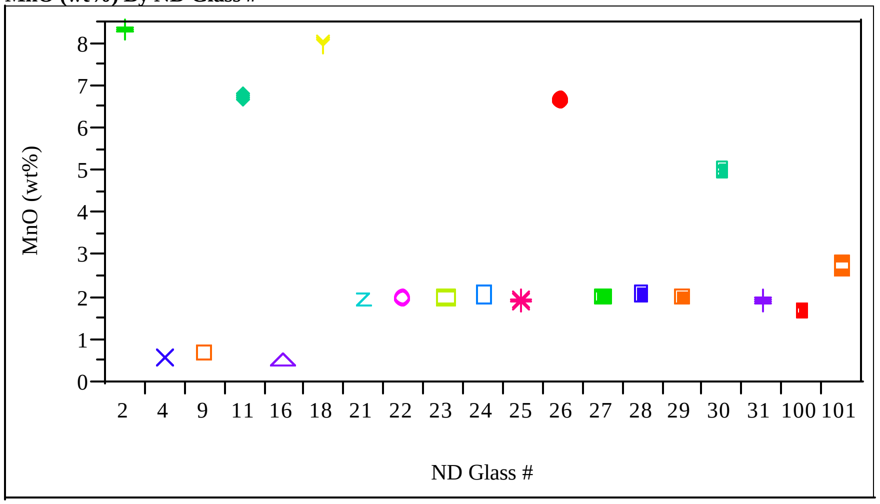


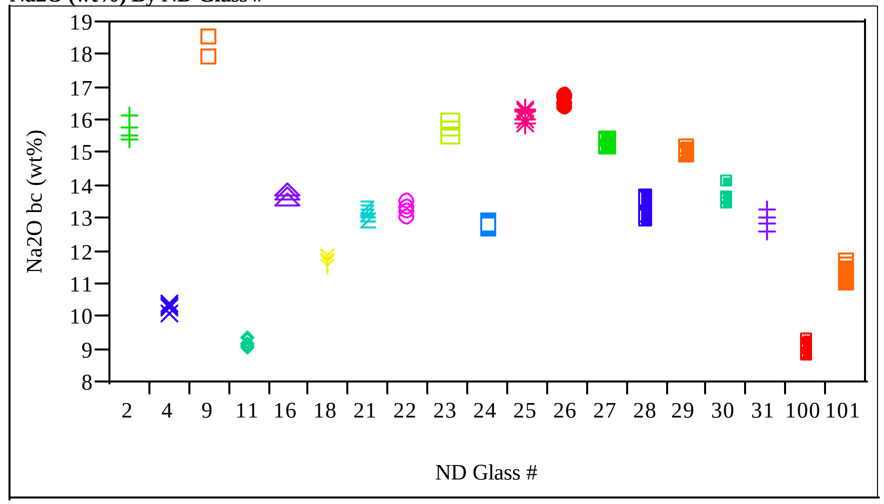
Exhibit C.11: SRTC-ML Measurements by Glass Number for Samples Prepared Using the LM Method for the Radioactive Group *(continued)*

(100 – Batch 1; 101 – U std)

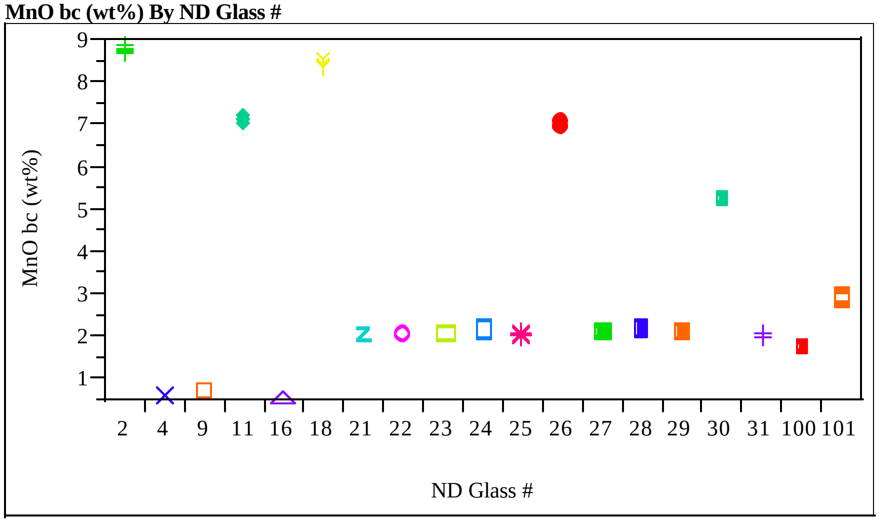
MnO (wt%) By ND Glass #



Na2O (wt%) By ND Glass #



MnO bc (wt%) By ND Glass #



Na2O bc (wt%) By ND Glass #

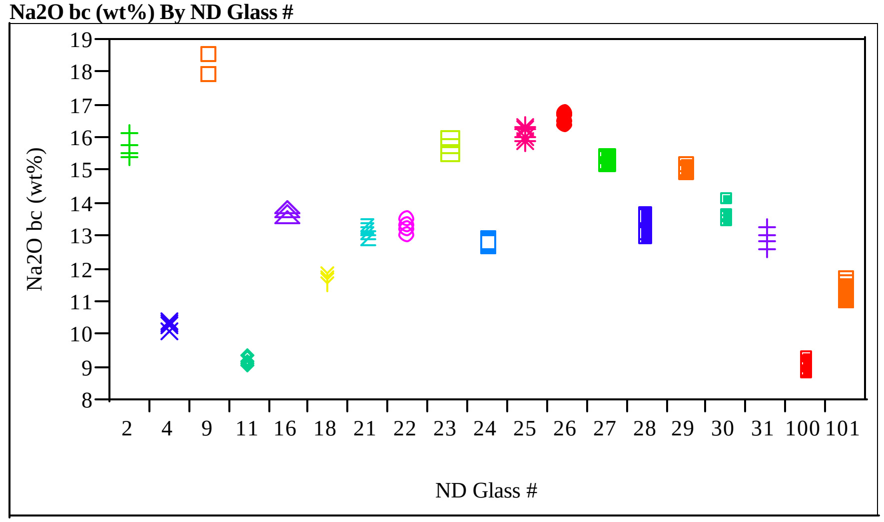
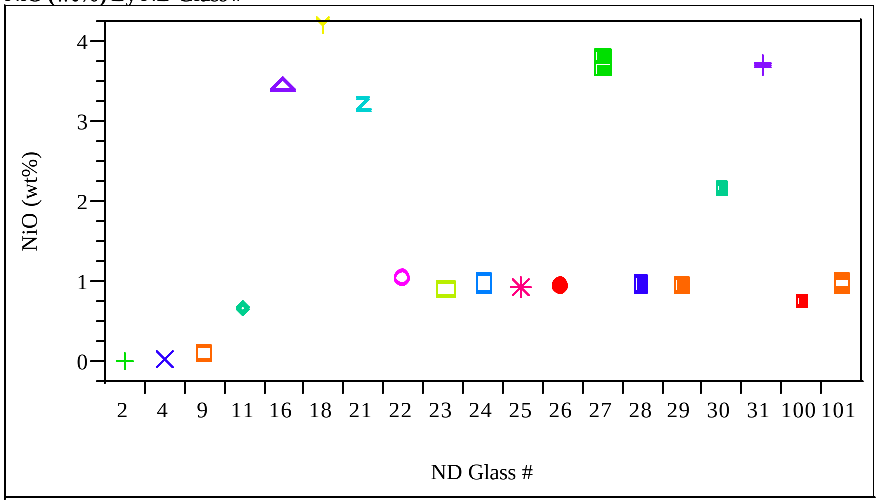


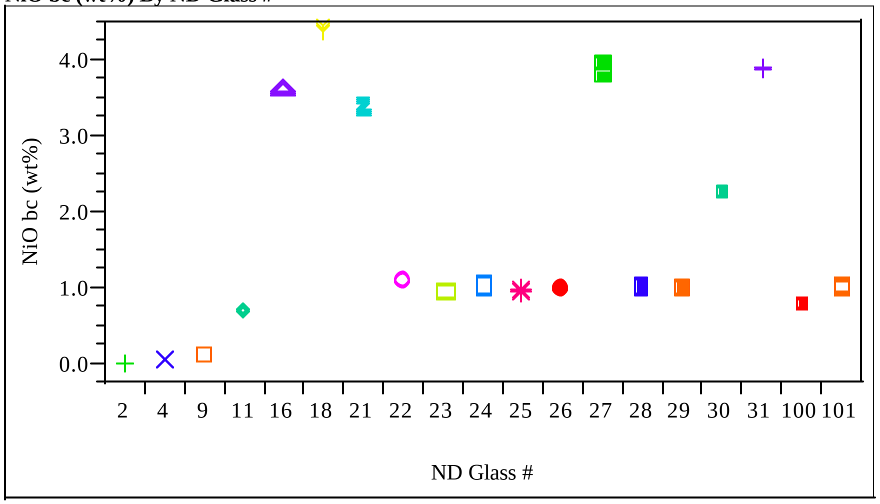
Exhibit C.11: SRTC-ML Measurements by Glass Number for Samples Prepared Using the LM Method for the Radioactive Group *(continued)*

(100 – Batch 1; 101 – U std)

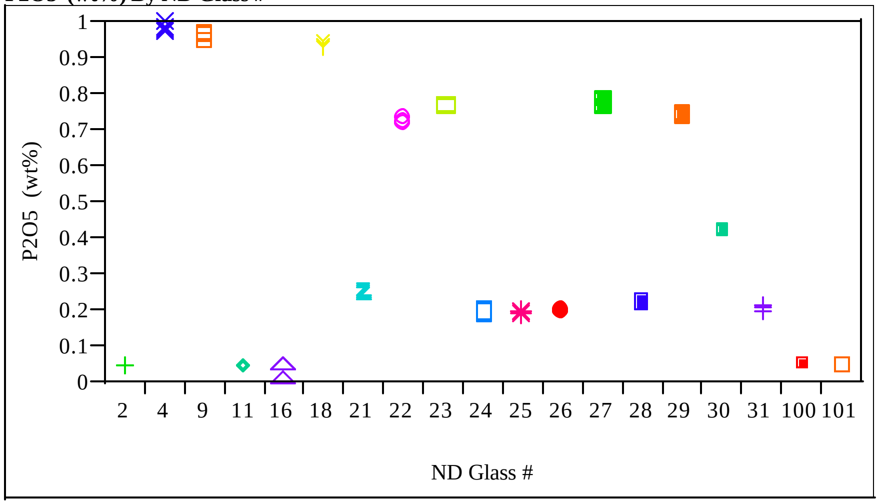
NiO (wt%) By ND Glass #



NiO bc (wt%) By ND Glass #



P2O5 (wt%) By ND Glass #



P2O5 bc (wt%) By ND Glass #

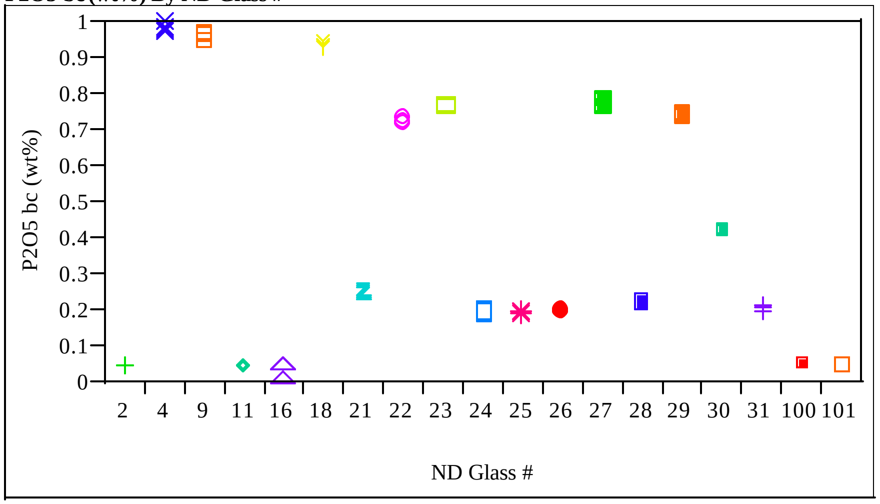
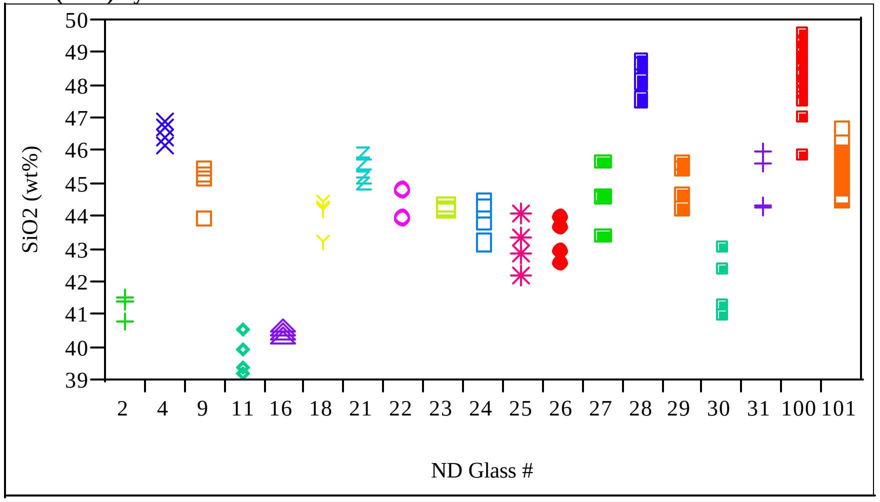


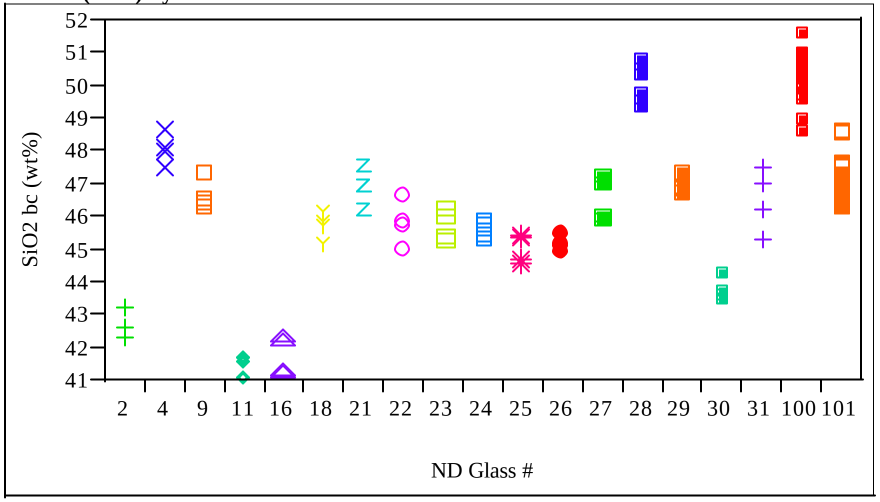
Exhibit C.11: SRTC-ML Measurements by Glass Number for Samples Prepared Using the LM Method for the Radioactive Group *(continued)*

(100 – Batch 1; 101 – U std)

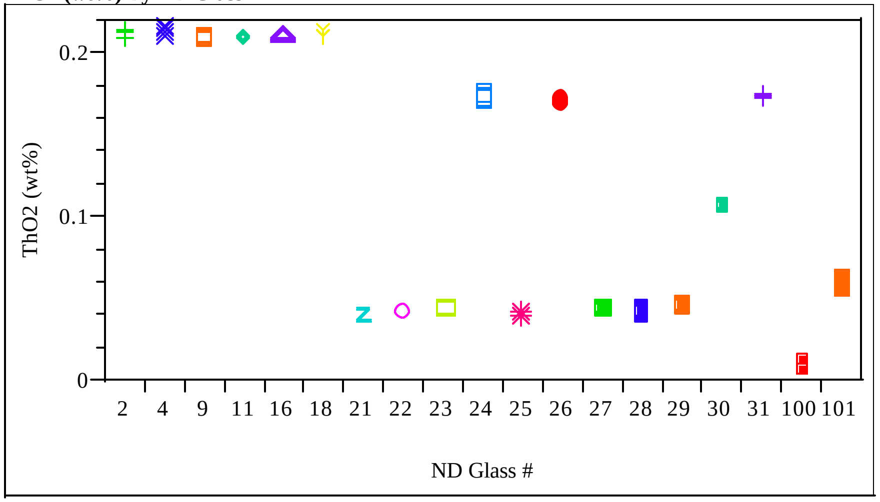
SiO2 (wt%) By ND Glass #



SiO2 bc (wt%) By ND Glass #



ThO2 (wt%) By ND Glass #



ThO2 bc (wt%) By ND Glass #

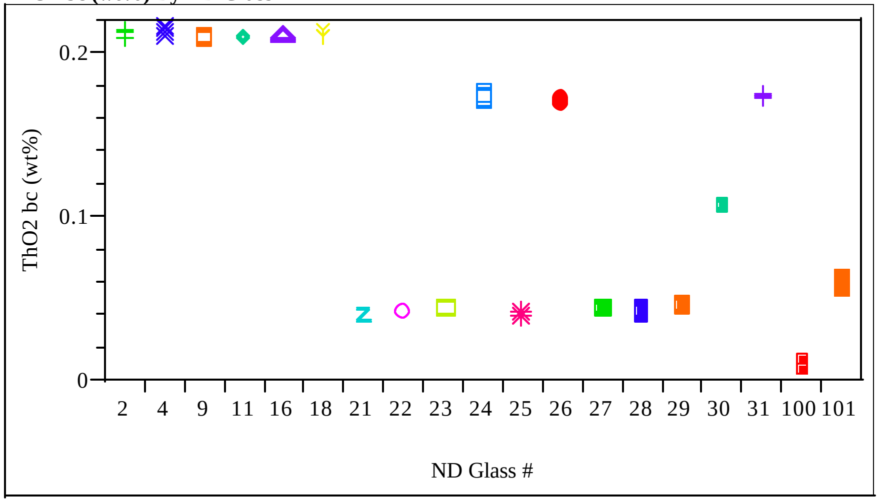
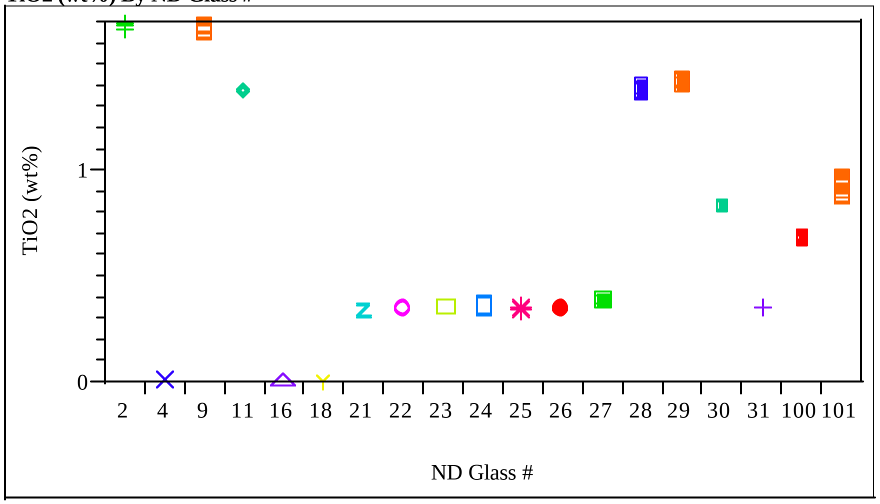


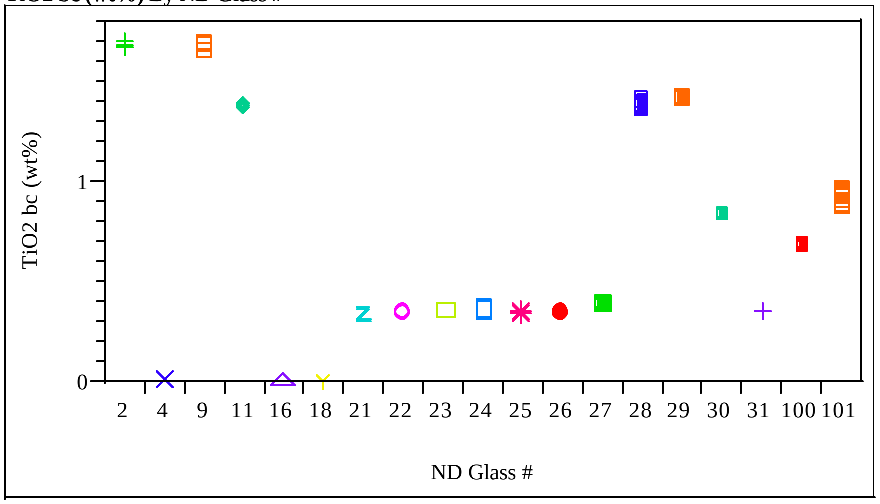
Exhibit C.11: SRTC-ML Measurements by Glass Number for Samples Prepared Using the LM Method for the Radioactive Group *(continued)*

(100 – Batch 1; 101 – U std)

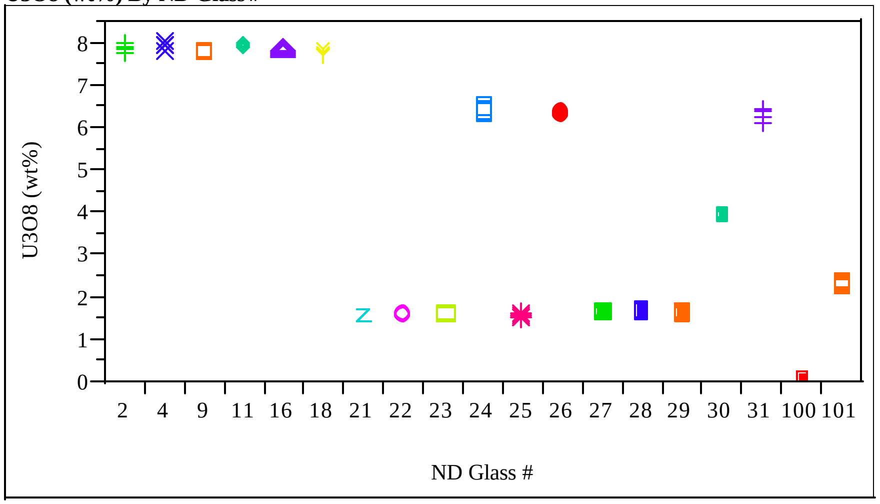
TiO2 (wt%) By ND Glass #



TiO2 bc (wt%) By ND Glass #



U3O8 (wt%) By ND Glass #



U3O8 bc (wt%) By ND Glass #

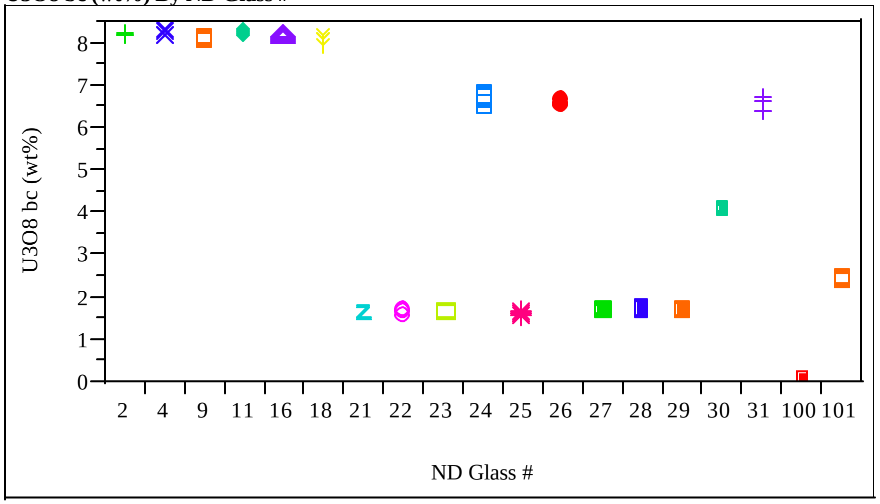
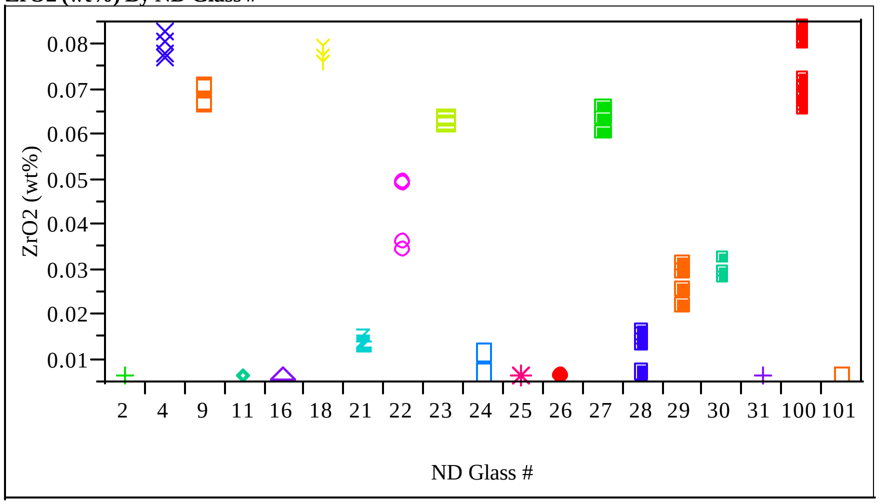


Exhibit C.11: SRTC-ML Measurements by Glass Number for Samples Prepared Using the LM Method for the Radioactive Group *(continued)*

(100 – Batch 1; 101 – U std)

ZrO2 (wt%) By ND Glass #



ZrO2 bc (wt%) By ND Glass #

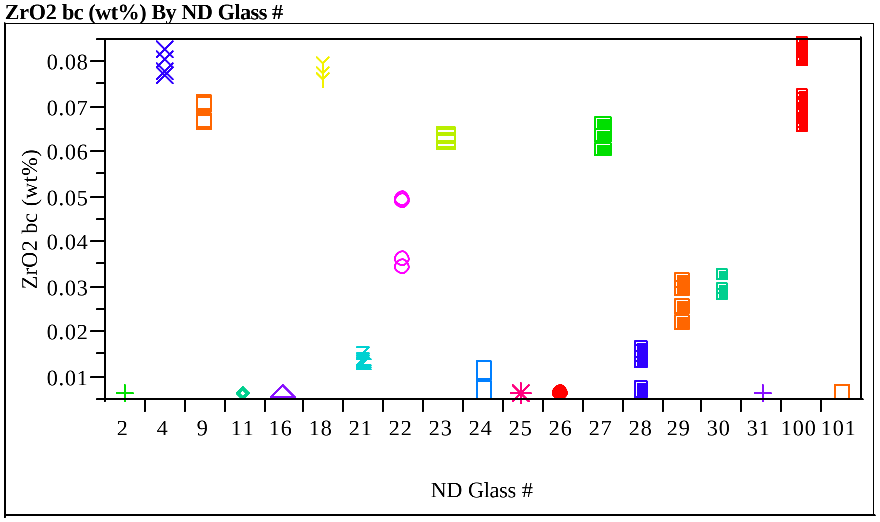
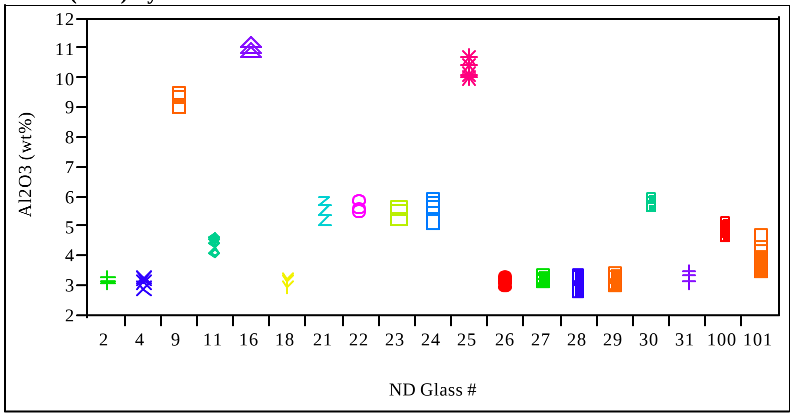


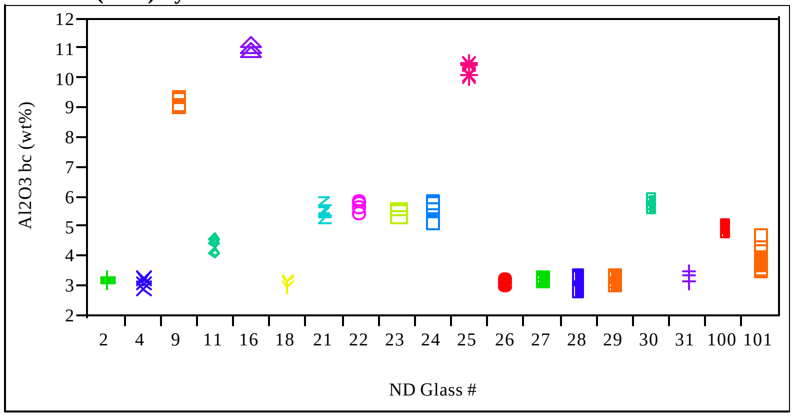
Exhibit C.12: SRTC-ML Measurements by Glass Number for Samples Prepared Using the PF Method for the Radioactive Group

(100 – Batch 1; 101 – U std)

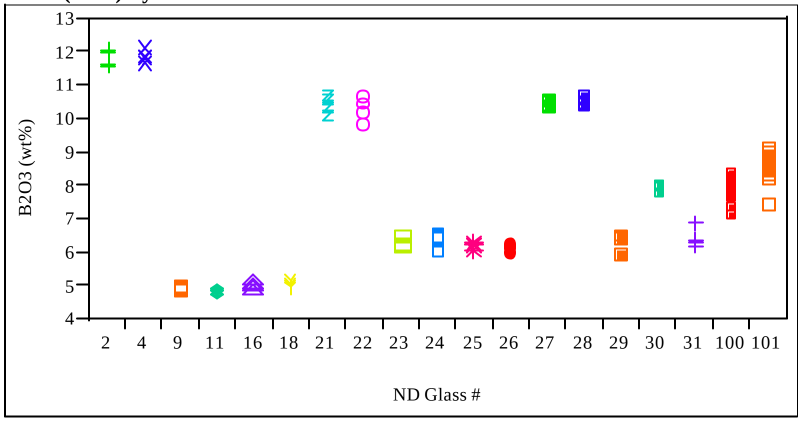
Al2O3 (wt%) By ND Glass #



Al2O3 bc (wt%) By ND Glass #



B2O3 (wt%) By ND Glass #



B2O3 bc (wt%) By ND Glass #

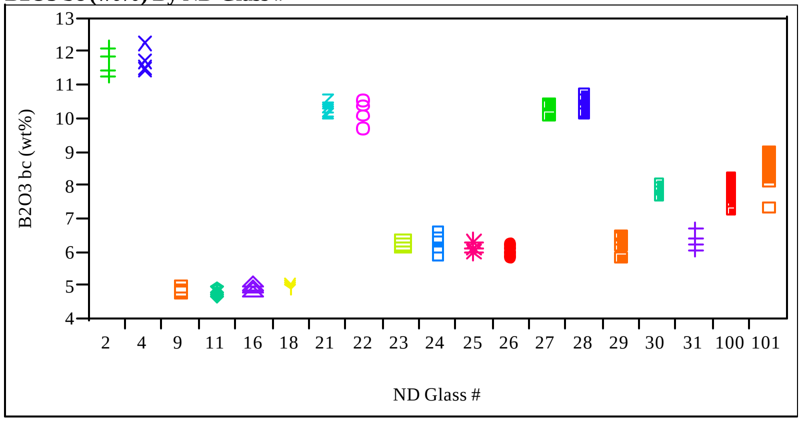
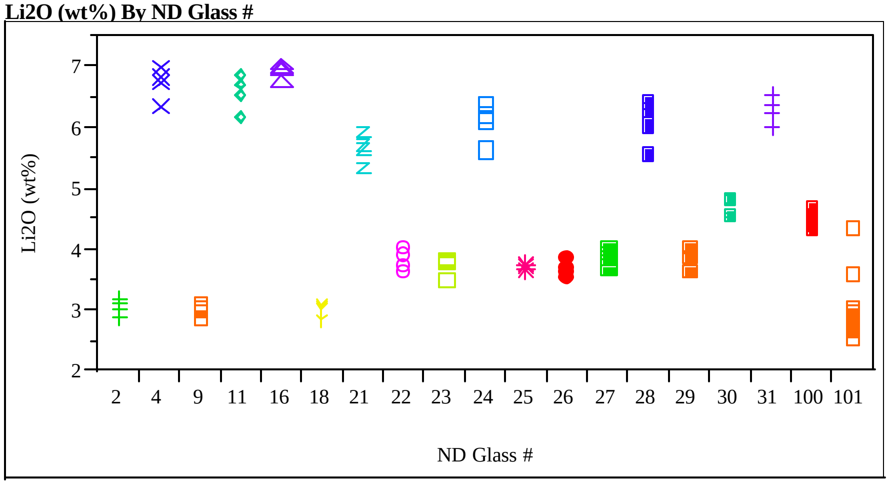


Exhibit C.12: SRTC-ML Measurements by Glass Number for Samples Prepared Using the PF Method for the Radioactive Group *(continued)*

(100 – Batch 1; 101 – U std)

Li2O (wt%) By ND Glass #



Li2O bc (wt%) By ND Glass #

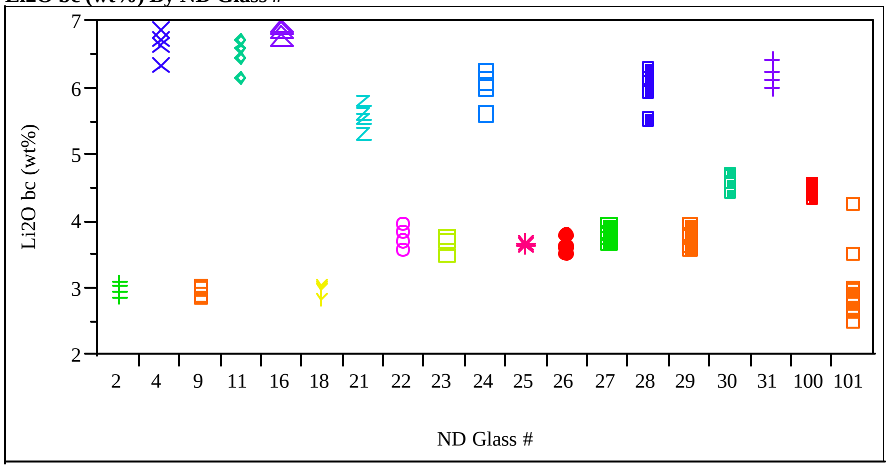
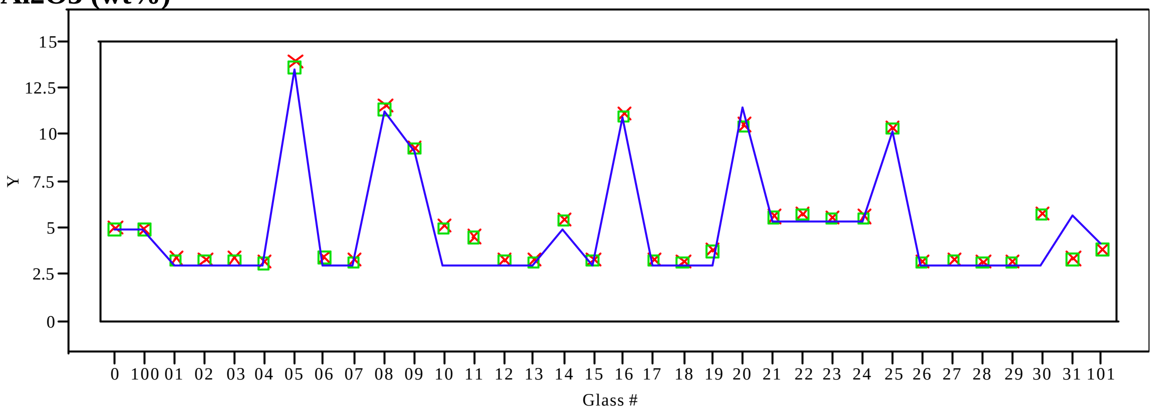


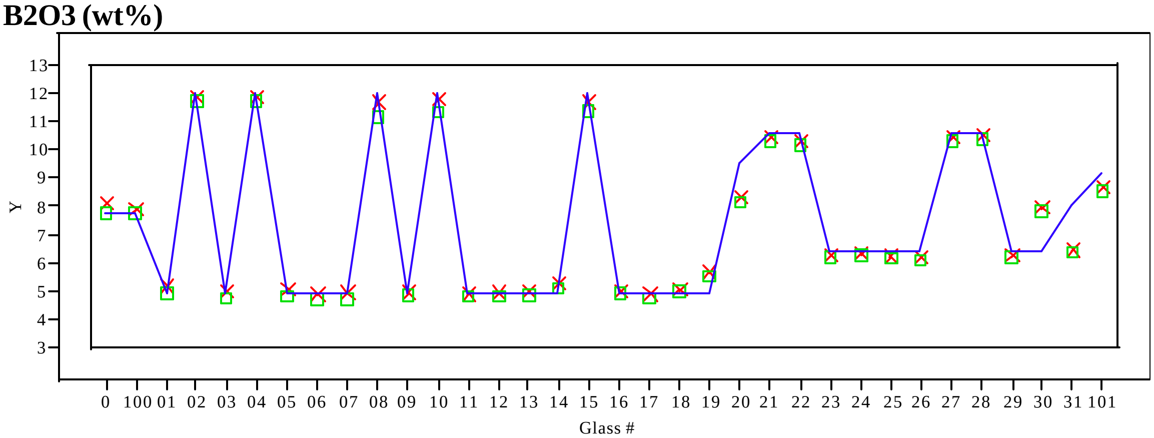
Exhibit C.13: Average Measured and Bias -Corrected (bc) Versus Targeted Compositions by ND Glass #by Oxide

(0 – Batch 1 non-rad group; 100 – Batch 1 rad group; and 101 – U std)

Al2O3 (wt%)



B2O3 (wt%)



CaO (wt%)

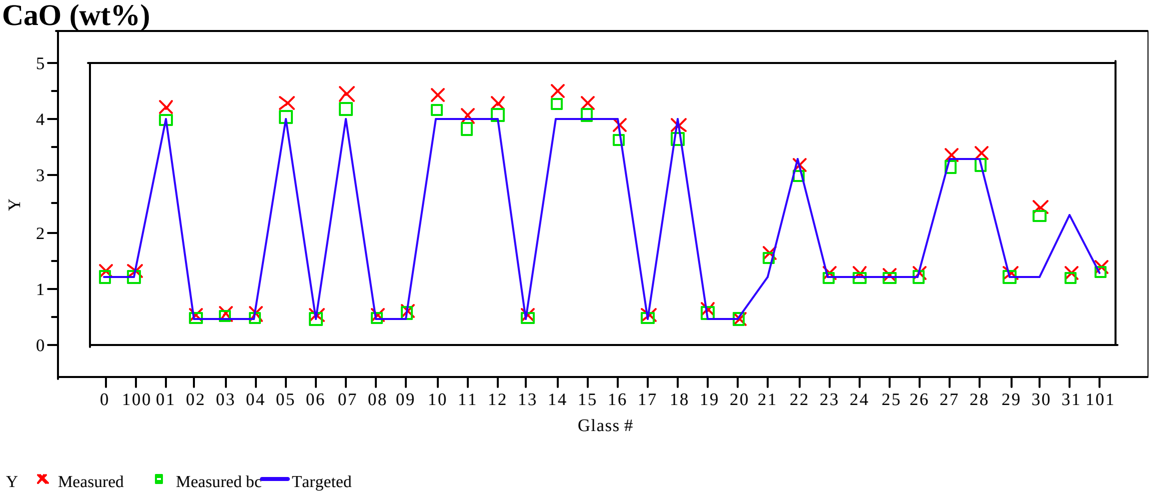
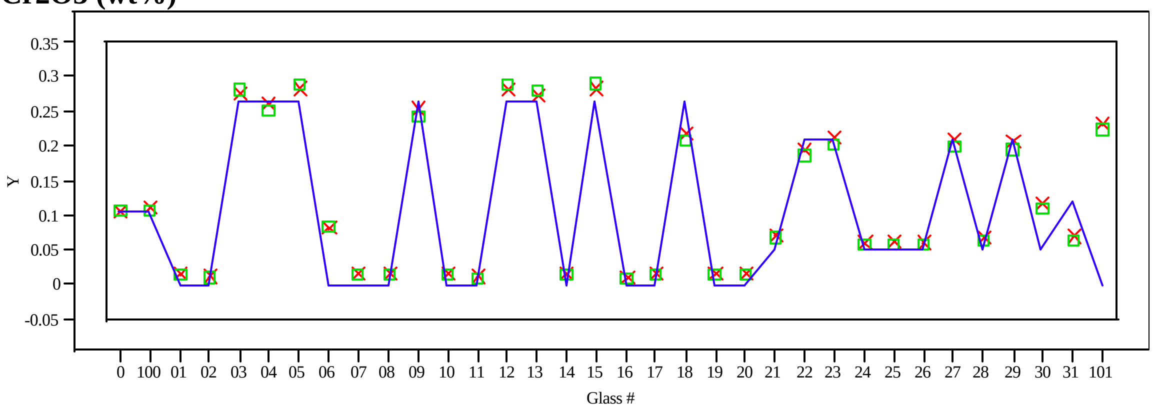


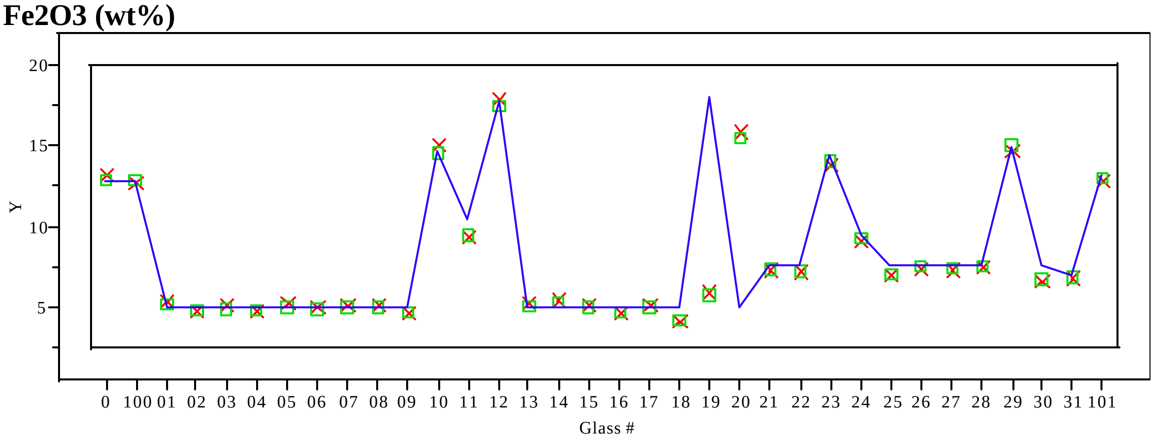
Exhibit C.13: Average Measured and Bias -Corrected (bc) Versus Targeted Compositions by ND Glass #by Oxide *(continued)*

(0 – Batch 1 non-rad group; 100 – Batch 1 rad group; and 101 – U std)

Cr2O3 (wt%)



Fe2O3 (wt%)



Li2O (wt%)

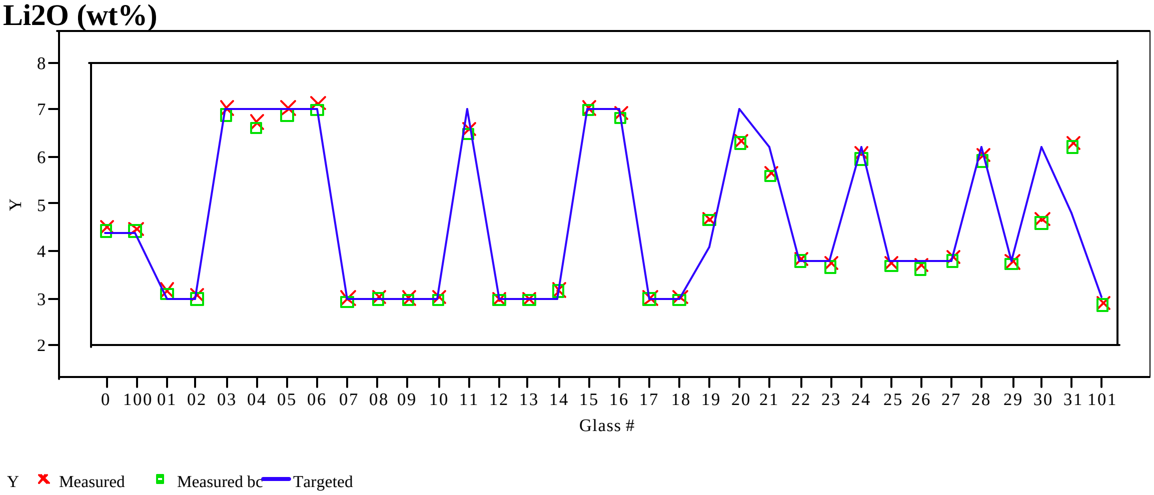
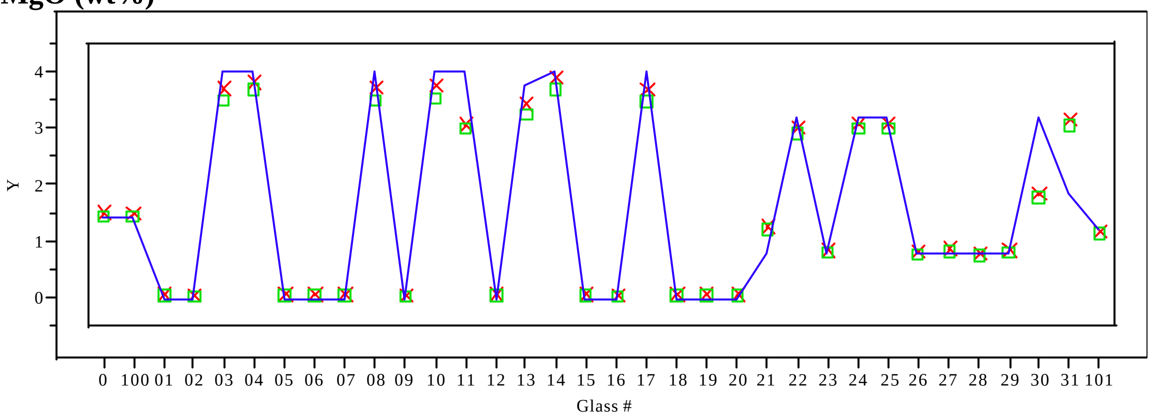


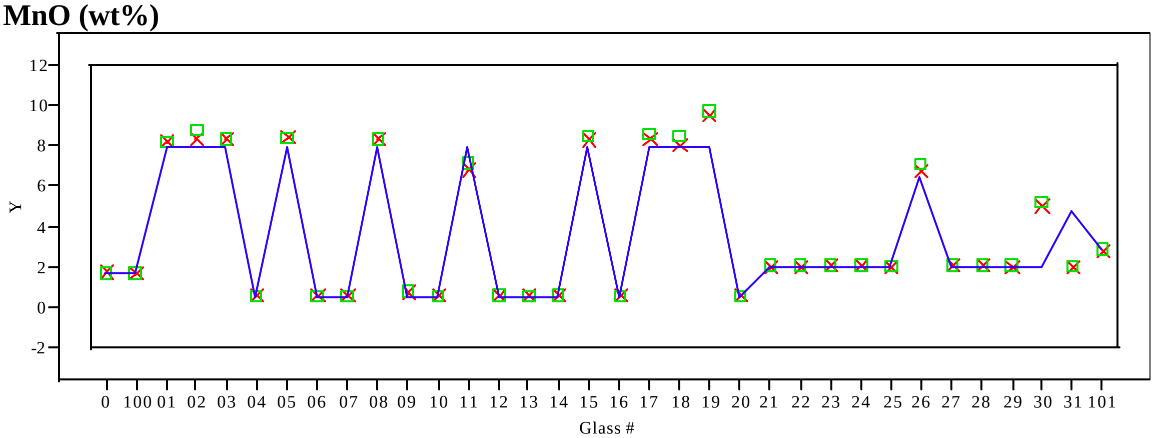
Exhibit C.13: Average Measured and Bias -Corrected (bc) Versus Targeted Compositions by ND Glass #by Oxide *(continued)*

(0 – Batch 1 non-rad group; 100 – Batch 1 rad group; and 101 – U std)

MgO (wt%)



MnO (wt%)



Na2O (wt%)

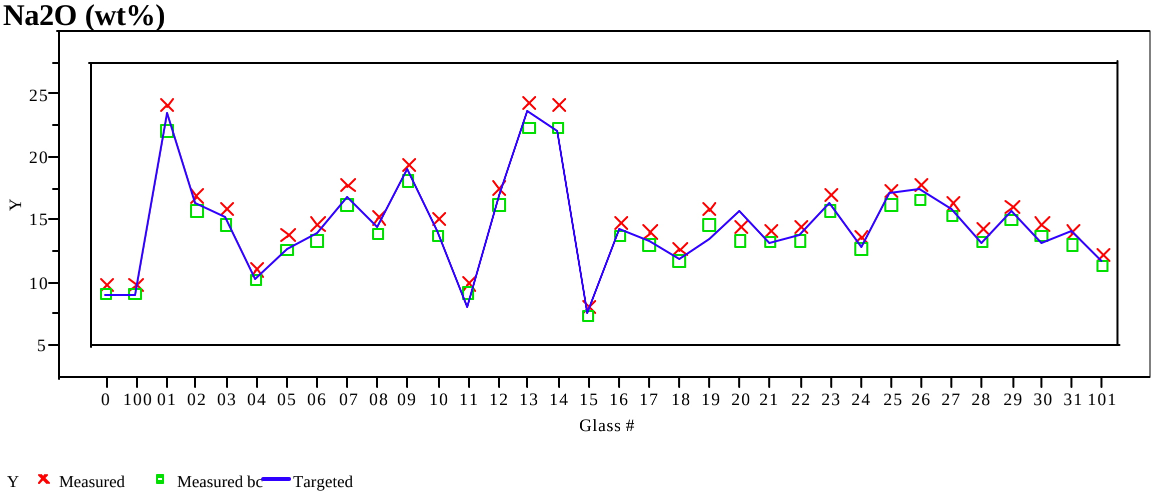
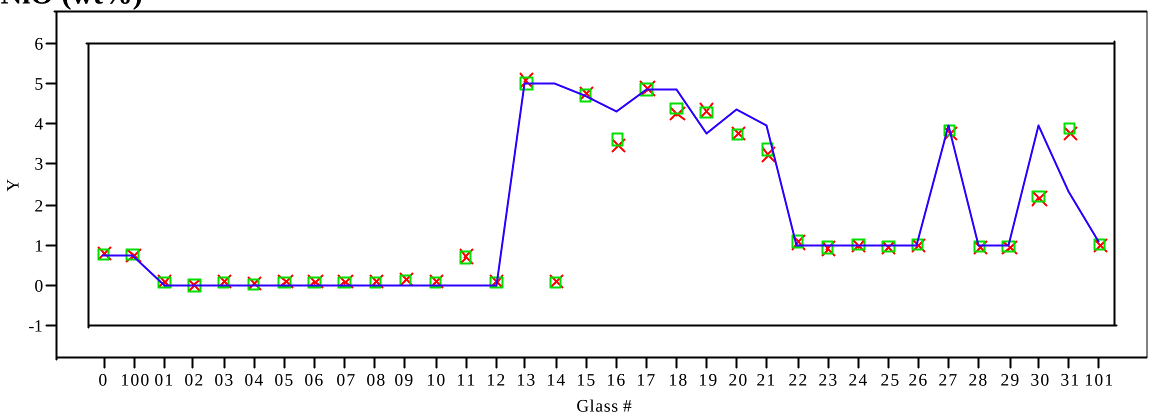


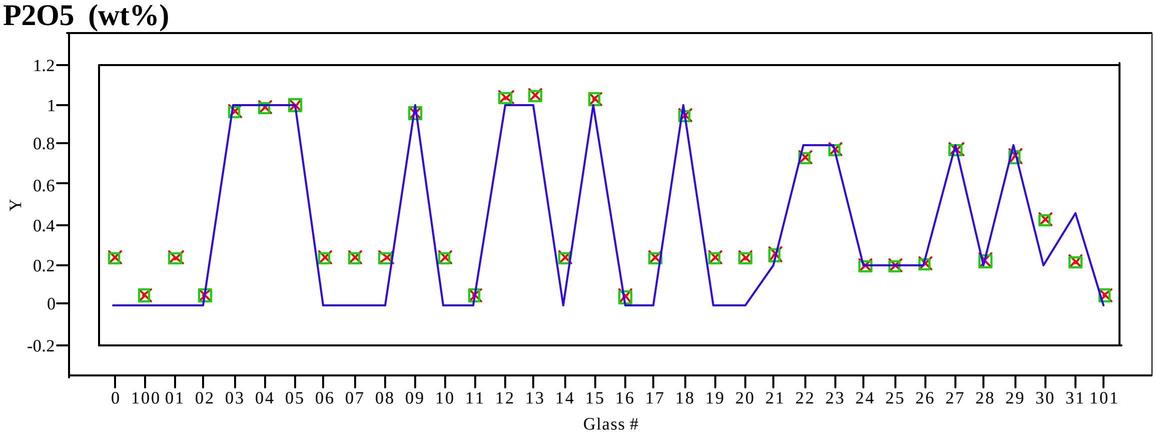
Exhibit C.13: Average Measured and Bias -Corrected (bc) Versus Targeted Compositions by ND Glass #by Oxide *(continued)*

(0 – Batch 1 non-rad group; 100 – Batch 1 rad group; and 101 – U std)

NiO (wt%)



P2O5 (wt%)



SiO2 (wt%)

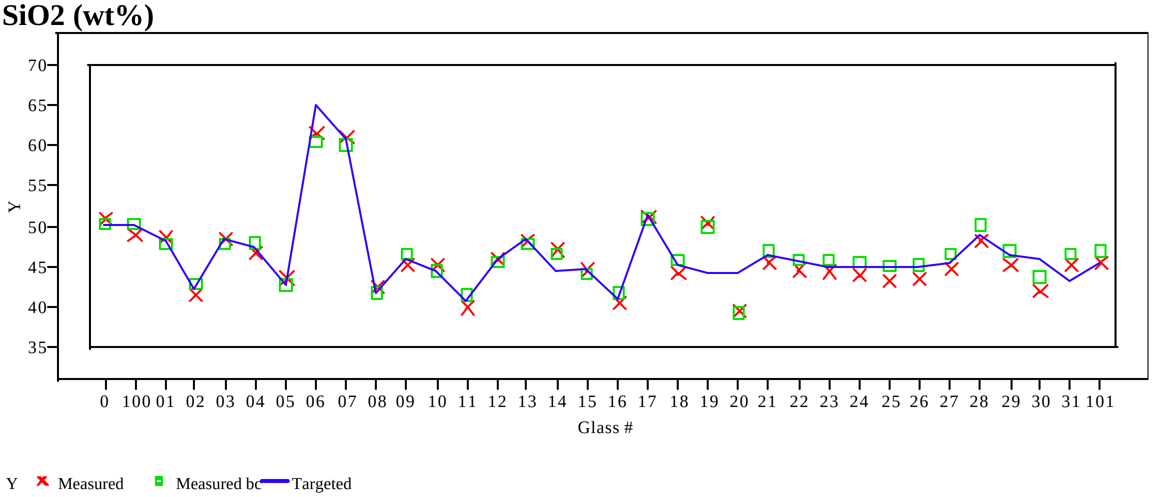
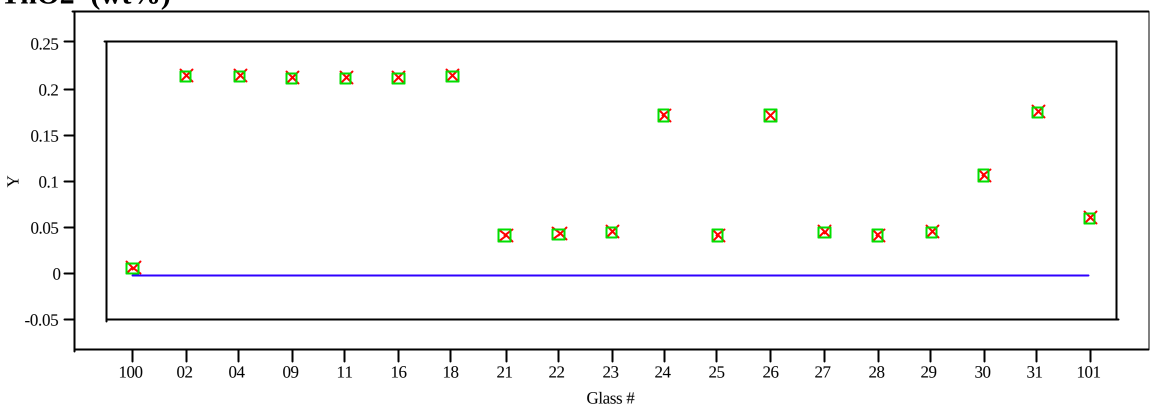


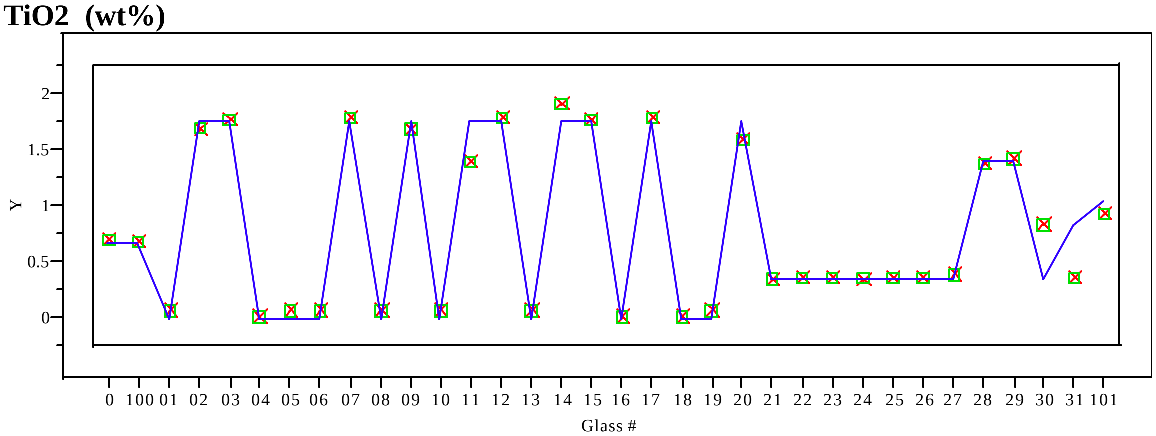
Exhibit C.13: Average Measured and Bias -Corrected (bc) Versus Targeted Compositions by ND Glass #by Oxide *(continued)*

(0 – Batch 1 non-rad group; 100 – Batch 1 rad group; and 101 – U std)

ThO2 (wt%)



TiO2 (wt%)



U3O8 (wt%)

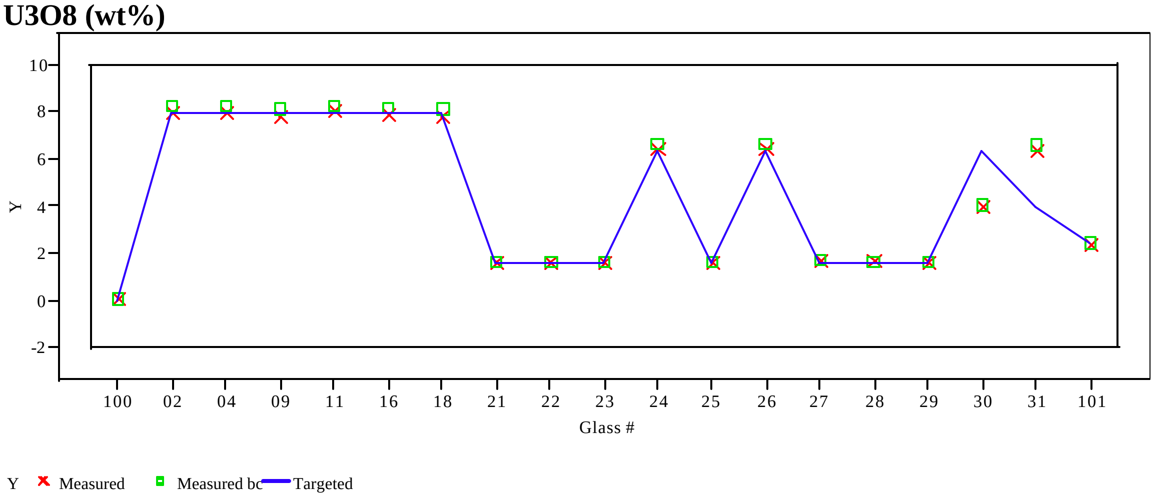
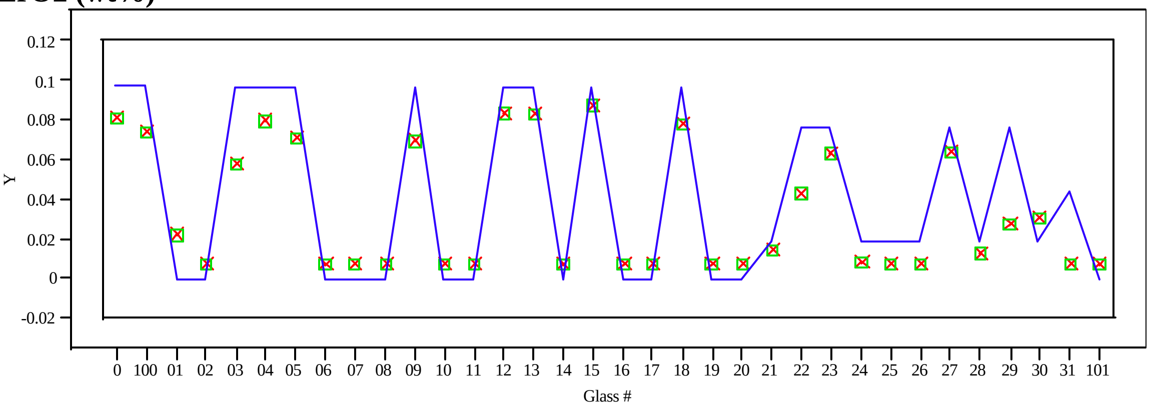


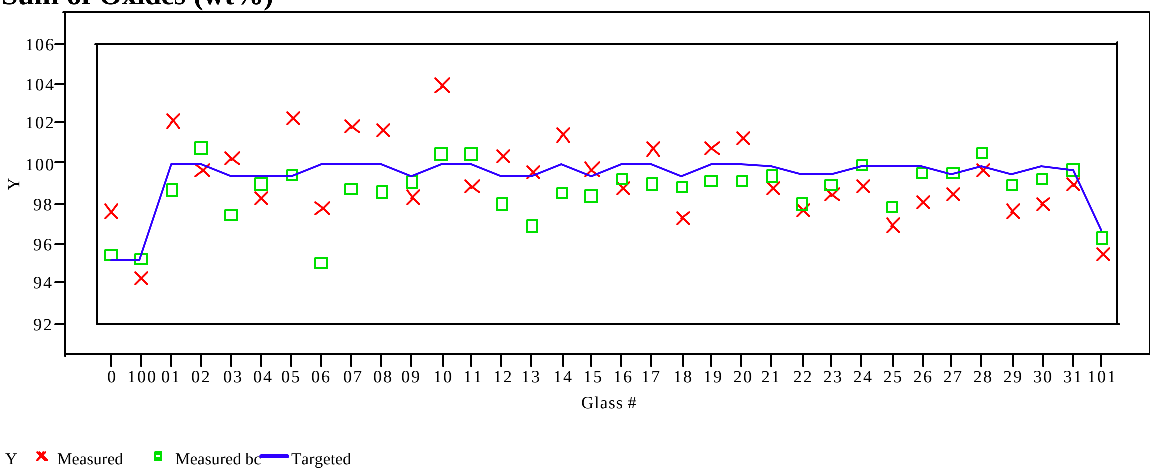
Exhibit C.13: Average Measured and Bias -Corrected (bc) Versus Targeted Compositions by ND Glass #by Oxide *(continued)*

(0 – Batch 1 non-rad group; 100 – Batch 1 rad group; and 101 – U std)

ZrO2 (wt%)



Sum of Oxides (wt%)



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Appendix D

Tables and Exhibits Supporting the Analysis of the PCT Results for the ND Glasses

Table D.1: SRTC-ML Measurements of the PCT Solutions for the ND and RC Glasses by Analytical Planning Group

Analytical Plan	Glass ID	SRTC-ML ID	Heat Treatment	Block	Seq #	Al	B	Ca	Fe	Li	Mg	Mn	Na	Ni	Si	U
SCS-00035	soln std	std-b1-1		1	1	3.83	21.1	<0.060	4.06	10.0	<0.010	<0.010	86.4	<0.100	49.5	
SCS-00035	ND10	c038	quenched	1	2	1.02	553	<0.060	<0.400	111	<0.010	<0.010	1240	<0.100	383	
SCS-00035	ND06ccc	c122	ccc	1	3	0.928	177	<0.060	<0.400	278	<0.010	<0.010	886	<0.100	1630	
SCS-00035	ND06	c067	quenched	1	4	2.10	313	<0.060	<0.400	462	<0.010	<0.010	1610	<0.100	2760	
SCS-00035	RC63	c002	quenched	1	5	20.9	31.3	<0.060	0.414	9.64	<0.010	<0.010	51.9	<0.100	59.6	
SCS-00035	EA	c043		1	6	1.24	591	<0.060	<0.400	171	<0.010	<0.010	1450	<0.100	820	
SCS-00035	ND01ccc	c006	ccc	1	7	5.19	108	<0.060	<0.400	79.2	<0.010	<0.010	1230	<0.100	755	
SCS-00035	ND19ccc	c131	ccc	1	8	1.52	257	<0.060	<0.400	172	<0.010	<0.010	1270	<0.100	1110	
SCS-00035	RC63ccc	c065	ccc	1	9	16.5	23.4	<0.060	0.227	6.64	<0.010	<0.010	36.8	<0.100	48.7	
SCS-00035	soln std	std-b1-2		1	10	3.84	21.2	<0.060	4.25	9.70	<0.010	<0.010	83.7	<0.100	50.4	
SCS-00035	ND19	c044	quenched	1	11	2.24	308	<0.060	<0.400	213	<0.010	<0.010	1530	<0.100	1280	
SCS-00035	ND01	c092	quenched	1	12	5.39	113	<0.060	<0.400	81.6	<0.010	<0.010	1380	<0.100	794	
SCS-00035	RC69	c024	quenched	1	13	14.0	60.2	<0.060	2.83	49.6	<0.010	3.97	110	1.53	119	
SCS-00035	ARM	c010		1	14	4.58	24.9	<0.060	<0.400	15.5	<0.010	<0.010	42.8	<0.100	66.8	
SCS-00035	ND10ccc	c074	ccc	1	15	1.03	500	<0.060	<0.400	105	<0.010	<0.010	1120	<0.100	354	
SCS-00035	ND14	c071	quenched	1	16	14.0	98.6	<0.060	<0.400	72.6	<0.010	<0.010	1190	<0.100	519	
SCS-00035	RC69ccc	c093	ccc	1	17	22.8	81.3	<0.060	1.87	70.0	<0.010	8.13	122	0.717	136	
SCS-00035	ND14ccc	c039	ccc	1	18	13.3	82.2	<0.060	<0.400	63.9	<0.010	<0.010	1010	<0.100	441	
SCS-00035	soln std	std-b1-3		1	19	3.89	21.2	<0.060	4.28	9.66	<0.010	<0.010	84.6	<0.100	50.3	
SCS-00035	soln std	std-b2-1		2	1	3.92	21.2	<0.060	3.89	9.83	<0.010	<0.010	85.1	<0.100	49.8	
SCS-00035	RC69	c118	quenched	2	2	15.5	63.1	<0.060	2.04	55.4	<0.010	3.83	119	1.46	121	
SCS-00035	ND06ccc	c021	ccc	2	3	1.11	182	<0.060	<0.400	296	<0.010	<0.010	964	<0.100	1700	
SCS-00035	ND10	c036	quenched	2	4	1.10	574	<0.060	<0.400	118	<0.010	<0.010	1320	<0.100	402	
SCS-00035	ND06	c026	quenched	2	5	1.89	286	<0.060	<0.400	436	<0.010	<0.010	1460	<0.100	2530	
SCS-00035	EA	c070		2	6	1.11	448	<0.060	<0.400	147	<0.010	<0.010	1200	<0.100	727	
SCS-00035	ND01ccc	c015	ccc	2	7	5.27	104	<0.060	<0.400	78.2	<0.010	<0.010	1290	<0.100	742	
SCS-00035	ND14	c007	quenched	2	8	14.2	94.2	<0.060	<0.400	72.3	<0.010	<0.010	1240	<0.100	519	
SCS-00035	RC63	c076	quenched	2	9	21.6	31.4	<0.060	<0.400	10.1	<0.010	<0.010	53.6	<0.100	62.8	
SCS-00035	soln std	std-b1-2		2	10	3.85	21.2	<0.060	3.90	9.83	<0.010	<0.010	88.0	<0.100	49.7	
SCS-00035	ND19	c056	quenched	2	11	2.10	320	<0.060	<0.400	218	<0.010	<0.010	1640	<0.100	1500	
SCS-00035	ND19ccc	c052	ccc	2	12	1.92	265	<0.060	<0.400	181	<0.010	<0.010	1360	<0.100	1160	
SCS-00035	ARM	c078		2	13	4.84	25.6	<0.060	<0.400	14.8	<0.010	<0.010	41.0	<0.100	65.0	
SCS-00035	RC63ccc	c116	ccc	2	14	21.2	26.5	<0.060	<0.400	8.61	<0.010	<0.010	46.4	<0.100	62.3	
SCS-00035	ND14ccc	c084	ccc	2	15	13.3	80.9	<0.060	<0.400	63.9	<0.010	<0.010	1060	<0.100	474	
SCS-00035	RC69ccc	c082	ccc	2	16	22.9	77.2	<0.060	1.95	69.2	<0.010	7.87	123	0.706	135	
SCS-00035	ND10ccc	c083	ccc	2	17	1.04	498	<0.060	<0.400	102	<0.010	<0.010	1150	<0.100	370	
SCS-00035	ND01	c001	quenched	2	18	7.76	407	<0.060	<0.400	216	<0.010	<0.010	3890	<0.100	2100	
SCS-00035	soln std	std-b2-3		2	19	3.88	21.6	<0.060	3.91	9.84	<0.010	<0.010	86.2	<0.100	50.7	
SCS-00035	soln std	std-b3-1		3	1	3.85	20.9	<0.060	4.01	9.66	<0.010	<0.010	87.3	<0.100	49.5	

Table D.1: SRTC-ML Measurements of the PCT Solutions for the ND and RC Glasses by Analytical Planning Group

Analytical Plan	Glass ID	SRTC-ML ID	Heat Treatment	Block	Seq #	Al	B	Ca	Fe	Li	Mg	Mn	Na	Ni	Si	U
SCS-00035	ND10ccc	c129	ccc	3	2	1.03	510	<0.060	<0.400	101	<0.010	<0.010	1150	<0.100	369	
SCS-00035	ND14ccc	c085	ccc	3	3	13.4	85.8	<0.060	<0.400	65	<0.010	<0.010	1050	<0.100	462	
SCS-00035	RC63	c029	quenched	3	4	22.1	31.7	<0.060	<0.400	10.3	<0.010	<0.010	55.2	<0.100	64.9	
SCS-00035	ND19	c114	quenched	3	5	2.01	317	<0.060	<0.400	216	<0.010	<0.010	1600	<0.100	1220	
SCS-00035	RC69	c072	quenched	3	6	15.3	66.2	<0.060	2.20	54.3	<0.010	4.12	113	1.46	118	
SCS-00035	ARM	c018		3	7	4.88	22.5	<0.060	<0.400	15.1	<0.010	<0.010	41.6	<0.100	65.7	
SCS-00035	RC69ccc	c077	ccc	3	8	22.9	76.7	<0.060	1.72	69.8	<0.010	8.40	120	0.747	137	
SCS-00035	RC63ccc	c134	ccc	3	9	21.2	24.8	<0.060	<0.400	8.72	<0.010	<0.010	47.4	<0.100	62.7	
SCS-00035	soln std	std-b3-2		3	10	3.99	21.1	<0.060	3.83	9.91	<0.010	<0.010	86.9	<0.100	50.2	
SCS-00035	ND06ccc	c079	ccc	3	11	0.877	177	<0.060	<0.400	291	<0.010	<0.010	960	<0.100	1730	
SCS-00035	ND06	c025	quenched	3	12	1.86	300	<0.060	<0.400	454	<0.010	<0.010	1510	<0.100	2680	
SCS-00035	ND01ccc	c027	ccc	3	13	5.27	103	<0.060	<0.400	79.7	<0.010	<0.010	1180	<0.100	756	
SCS-00035	ND19ccc	c108	ccc	3	14	1.98	235	<0.060	<0.400	173	<0.010	<0.010	1140	<0.100	1010	
SCS-00035	EA	c128		3	15	1.34	483	<0.060	<0.400	154	<0.010	<0.010	1300	<0.100	772	
SCS-00035	ND01	c033	quenched	3	16	5.84	114	<0.060	<0.400	88.1	<0.010	<0.010	1370	<0.100	816	
SCS-00035	ND14	c127	quenched	3	17	14.2	96.0	<0.060	<0.400	73.5	<0.010	<0.010	1160	<0.100	518	
SCS-00035	ND10	c023	quenched	3	18	1.24	557	<0.060	<0.400	114	<0.010	<0.010	1270	<0.100	394	
SCS-00035	soln std	std-b3-3		3	19	4.66	21.8	<0.060	3.82	10.0	<0.010	<0.010	86.4	<0.100	51.1	
SCS-00035	soln std	std-b4-1		4	1	3.66	20.0	<0.060	3.63	9.85	<0.010	<0.010	84.8	<0.100	49.8	
SCS-00035	ND20	c003	quenched	4	2	37.8	24.3	<0.060	38.8	25.77	<0.010	0.2497	127	4.4587	127	
SCS-00035	RC71ccc	c030	ccc	4	3	1.50	232	<0.060	<0.400	129	<0.010	<0.010	622	<0.100	495	
SCS-00035	ND07	c097	quenched	4	4	1.15	30.5	<0.060	<0.400	27.17	<0.010	<0.010	285	<0.100	304	
SCS-00035	blank	c045		4	5	<0.090	<0.150	<0.060	<0.400	<0.200	<0.010	<0.010	<0.100	<0.100	<0.790	
SCS-00035	ND15ccc	c102	ccc	4	6	0.335	497	<0.060	<0.400	331	<0.010	<0.010	584	<0.100	689	
SCS-00035	ND12ccc	c034	ccc	4	7	2.64	44.0	<0.060	1.34	32.6	<0.010	<0.010	295	<0.100	216	
SCS-00035	ND20ccc	c125	ccc	4	8	38.6	36.5	<0.060	28.2	41.8	<0.010	0.875	146	<0.100	143	
SCS-00035	ND03	c017	quenched	4	9	4.32	647	<0.060	<0.400	574	<0.010	<0.010	3450	<0.100	1610	
SCS-00035	soln std	std-b4-2		4	10	3.85	21.2	<0.060	3.68	9.88	<0.010	<0.010	84	<0.100	50.4	
SCS-00035	ND07ccc	c120	ccc	4	11	2.17	20.5	<0.060	0.466	21.9	<0.010	<0.010	222	<0.100	218	
SCS-00035	RC65ccc	c004	ccc	4	12	20.1	10.0	<0.060	17.5	12.1	<0.010	0.879	194	<0.100	146	
SCS-00035	RC71	c066	quenched	4	13	0.821	74.6	<0.060	<0.400	177	<0.010	<0.010	270	<0.100	336	
SCS-00035	RC65	c087	quenched	4	14	21.4	11.0	<0.060	17.8	12.5	<0.010	1.06	230	<0.100	161	
SCS-00035	ND15	c113	quenched	4	15	0.418	553	<0.060	<0.400	344	<0.010	<0.010	610	<0.100	592	
SCS-00035	ND03ccc	c088	ccc	4	16	4.17	708	<0.060	<0.400	560	<0.010	<0.010	3800	<0.100	1750	
SCS-00035	ND12	c031	quenched	4	17	2.21	78.4	<0.060	2.18	49.7	<0.010	<0.010	463	<0.100	315	
SCS-00035	soln std	std-b4-3		4	18	3.66	21.0	<0.060	3.79	9.90	<0.010	<0.010	84.4	<0.100	50.0	
SCS-00035	soln std	std-b5-1		5	1	3.87	20.6	<0.060	4.17	9.58	<0.010	<0.010	88.2	<0.100	49.9	
SCS-00035	ND03	c089	quenched	5	2	4.53	590	<0.060	<0.400	567	<0.010	<0.010	3480	<0.100	1550	
SCS-00035	ND07	c049	quenched	5	3	0.875	41.4	<0.060	<0.400	30.3	<0.010	<0.010	307	<0.100	338	

Table D.1: SRTC-ML Measurements of the PCT Solutions for the ND and RC Glasses by Analytical Planning Group

Analytical Plan	Glass ID	SRTC-ML ID	Heat Treatment	Block	Seq #	Al	B	Ca	Fe	Li	Mg	Mn	Na	Ni	Si	U
SCS-00035	blank	c101		5	4	<0.090	2.45	<0.060	<0.400	0.264	<0.010	<0.010	<0.100	<0.100	<0.790	
SCS-00035	ND07ccc	c096	ccc	5	5	2.64	20.7	<0.060	<0.400	22.9	<0.010	<0.010	224	<0.100	222	
SCS-00035	ND12ccc	c040	ccc	5	6	3.00	39.8	<0.060	2.22	33.5	<0.010	<0.010	312	<0.100	227	
SCS-00035	ND15ccc	c094	ccc	5	7	0.544	493	<0.060	<0.400	334	<0.010	<0.010	595	<0.100	695	
SCS-00035	RC65	c073	quenched	5	8	22.2	17.4	<0.060	18.4	13.1	<0.010	1.60	232	<0.100	161	
SCS-00035	ND20ccc	c062	ccc	5	9	39.1	36.9	<0.060	27.2	41.9	<0.010	1.27	148	<0.100	143	
SCS-00035	soln std	std-b5-2		5	10	3.89	21.2	<0.060	4.29	9.65	<0.010	<0.010	87.9	<0.100	50.4	
SCS-00035	RC71ccc	c121	ccc	5	11	1.59	238	<0.060	<0.400	133	<0.010	<0.010	636	<0.100	512	
SCS-00035	ND15	c081	quenched	5	12	0.671	534	<0.060	<0.400	346	<0.010	<0.010	608	<0.100	600	
SCS-00035	RC71	c095	quenched	5	13	0.980	80.8	<0.060	<0.400	118	<0.010	<0.010	270	<0.100	338	
SCS-00035	RC65ccc	c068	ccc	5	14	20.6	14.6	<0.060	16.9	12.7	<0.010	1.29	198	<0.100	154	
SCS-00035	ND03ccc	c041	ccc	5	15	4.23	641	<0.060	<0.400	563	<0.010	<0.010	3130	<0.100	1780	
SCS-00035	ND20	c060	quenched	5	16	40.0	36.3	<0.060	35.6	27.2	<0.010	<0.010	127	4.95	133	
SCS-00035	ND12	c100	quenched	5	17	2.53	63.2	<0.060	2.21	45.5	<0.010	<0.010	426	<0.100	294	
SCS-00035	soln std	std-b5-3		5	18	3.93	21.0	<0.060	4.26	9.74	<0.010	<0.010	88.8	<0.100	50.0	
SCS-00035	soln std	std-b6-1		6	1	3.78	21.5	<0.060	3.69	9.90	<0.010	<0.010	88.2	<0.100	50.1	
SCS-00035	ND15	c059 100x	quenched	6	2	0.614	551	<0.060	<0.400	340	<0.010	<0.010	605	<0.100	594	
SCS-00035	ND15ccc	c115	ccc	6	3	0.623	535	<0.060	<0.400	345	<0.010	<0.010	609	<0.100	711	
SCS-00035	RC65	c008	quenched	6	4	21.8	21.4	<0.060	17.6	12.8	<0.010	1.59	235	<0.100	159	
SCS-00035	ND20	c119	quenched	6	5	40.4	32.0	<0.060	39.0	28.0	<0.010	0.714	133	5.22	134	
SCS-00035	RC65ccc	c055	ccc	6	6	19.6	13.5	<0.060	15.9	12.0	<0.010	1.27	195	<0.100	146	
SCS-00035	RC71	c117	quenched	6	7	1.00	74.9	<0.060	<0.400	116	<0.010	<0.010	265	<0.100	335	
SCS-00035	RC71ccc	c013	ccc	6	8	1.67	231	<0.060	<0.400	128	<0.010	<0.010	624	<0.100	500	
SCS-00035	ND03ccc	c124	ccc	6	9	4.23	714	<0.060	<0.400	562	<0.010	<0.010	4030	<0.100	1800	
SCS-00035	soln std	std-b6-2		6	10	3.74	21.2	<0.060	3.67	9.44	<0.010	<0.010	86.4	<0.100	49.6	
SCS-00035	ND20ccc	c042	ccc	6	11	37.8	37.1	<0.060	26.8	40.2	<0.010	1.28	144	<0.100	142	
SCS-00035	ND12	c032	quenched	6	12	2.41	61.5	<0.060	2.08	46.2	<0.010	<0.010	426	<0.100	294	
SCS-00035	ND07ccc	c037	ccc	6	13	2.78	20.4	<0.060	<0.400	21.6	<0.010	<0.010	218	<0.100	214	
SCS-00035	ND12ccc	c109	ccc	6	14	3.00	37.6	<0.060	2.52	31.2	<0.010	<0.010	300	<0.100	221	
SCS-00035	ND07	c050	quenched	6	15	1.30	29.2	<0.060	<0.400	26.8	<0.010	<0.010	279	<0.100	295	
SCS-00035	ND03	c103	quenched	6	16	4.45	649	<0.060	<0.400	577	<0.010	<0.010	3720	<0.100	1660	
SCS-00035	soln std	std-b6-3		6	17	3.71	21.2	<0.060	3.75	9.40	<0.010	<0.010	85.6	<0.100	49.7	
SCS-00035	soln std	std-b7-1		7	1	3.86	19.5	<0.060	3.64	9.50	<0.010	<0.010	88.2	<0.100	49.8	
SCS-00035	RC58	c057	quenched	7	2	2.25	87.5	<0.060	5.63	103	3.79	0.010	162	<0.100	421	
SCS-00035	ND17ccc	c112	ccc	7	3	0.633	209	<0.060	<0.400	110	<0.010	<0.010	918	<0.100	818	
SCS-00035	RC58ccc	c090	ccc	7	4	1.57	72.9	<0.060	2.88	84.7	1.21	<0.010	128	<0.100	356	
SCS-00035	ND17	c016	quenched	7	5	1.68	203	<0.060	0.608	89.1	2.80	6.90	959	2.06	784	
SCS-00035	RC72	c105	quenched	7	6	2.53	303	<0.060	0.388	287	<0.010	<0.010	1310	<0.100	1180	
SCS-00035	ND08ccc	c035	ccc	7	7	18.2	91.3	<0.060	1.07	26.4	0.366	2.92	181	<0.100	89.8	

Table D.1: SRTC-ML Measurements of the PCT Solutions for the ND and RC Glasses by Analytical Planning Group

Analytical Plan	Glass ID	SRTC-ML ID	Heat Treatment	Block	Seq #	Al	B	Ca	Fe	Li	Mg	Mn	Na	Ni	Si	U
SCS-00035	RC72ccc	c106	ccc	7	8	2.61	117	<0.060	0.462	145	<0.010	<0.010	560	0.08	669	
SCS-00035	RC66	c132	quenched	7	9	0.856	43.1	<0.060	<0.400	35.7	<0.010	<0.010	239	<0.100	263	
SCS-00035	soln std	std-b7-2		7	10	4.03	20.3	<0.060	4.59	9.69	<0.010	<0.010	86.2	<0.100	50.0	
SCS-00035	RC66ccc	c019	ccc	7	11	1.57	23.0	<0.060	0.641	21.8	<0.010	0.386	149	<0.100	178	
SCS-00035	ND13ccc	c104	ccc	7	12	6.72	779	<0.060	<0.400	261	<0.010	<0.010	6090	<0.100	3200	
SCS-00035	ND13	c022	quenched	7	13	5.92	750	<0.060	<0.400	276	<0.010	<0.010	6040	<0.100	3120	
SCS-00035	ND05	c009	quenched	7	14	36.0	26.0	<0.060	<0.400	33.4	<0.010	<0.010	99.2	<0.100	104	
SCS-00035	ND08	c011	quenched	7	15	19.0	107	<0.060	1.33	31.6	0.899	4.68	222	<0.100	95.3	
SCS-00035	ND05ccc	c086	ccc	7	16	41.6	65.2	<0.060	<0.400	102	<0.010	<0.010	166	<0.100	191	
SCS-00035	soln std	std-b7-3		7	17	3.97	22.99	<0.060	3.58	9.60	<0.010	<0.010	85.8	<0.100	49.8	
SCS-00035	soln std	std-b8-1		8	1	4.12	20.3	<0.060	3.70	9.74	<0.010	<0.010	87.6	<0.100	51.0	
SCS-00035	RC72ccc	c061	ccc	8	2	2.29	159	<0.060	<0.400	164	<0.010	<0.010	716	<0.100	773	
SCS-00035	ND05	c080	quenched	8	3	36.6	15.2	<0.060	<0.400	34.2	<0.010	<0.010	102	<0.100	103	
SCS-00035	ND08ccc	c005	ccc	8	4	17.9	77.4	<0.060	1.24	24.0	0.654	3.48	170	<0.100	83.6	
SCS-00035	ND08	c130	quenched	8	5	19.1	111	<0.060	1.80	30.7	1.61	6.40	225	<0.100	94.0	
SCS-00035	RC66	c012	quenched	8	6	1.13	41.2	<0.060	<0.400	34.4	<0.010	<0.010	231	<0.100	253	
SCS-00035	ND05ccc	c110	ccc	8	7	40.3	59.0	<0.060	<0.400	102	<0.010	<0.010	163	<0.100	189	
SCS-00035	RC66ccc	c123	ccc	8	8	1.81	23.6	<0.060	0.665	21.5	<0.010	0.548	140	<0.100	173	
SCS-00035	ND17	c028	quenched	8	9	3.25	211	<0.060	1.72	93.4	6.18	13.7	951	4.1031	792	
SCS-00035	soln std	std-b8-2		8	10	4.09	20.9	<0.060	3.67	9.63	<0.010	<0.010	86.2	<0.100	51.0	
SCS-00035	ND13	c091	quenched	8	11	6.05	763	<0.060	<0.400	275	<0.010	<0.010	5520	<0.100	2950	
SCS-00035	ND13ccc	c126	ccc	8	12	7.01	781	<0.060	<0.400	257	<0.010	<0.010	5780	<0.100	3160	
SCS-00035	RC58ccc	c051	ccc	8	13	1.87	83.8	<0.060	3.20	83.0	1.48	<0.010	128	<0.100	367	
SCS-00035	RC58	c046	quenched	8	14	3.58	102	<0.060	10.1	104	8.61	0.997	176	<0.100	449	
SCS-00035	RC72	c048	quenched	8	15	2.68	325	<0.060	<0.400	295	<0.010	<0.010	1320	<0.100	1240	
SCS-00035	ND17ccc	c064	ccc	8	16	0.865	242.0	<0.060	<0.400	107	<0.010	<0.010	962	<0.100	890	
SCS-00035	blank	c135		8	17	0.183	<0.150	<0.060	<0.400	<0.200	<0.010	<0.010	<0.100	<0.100	<0.790	
SCS-00035	soln std	std-b8-3		8	18	4.08	23.8	<0.060	3.65	9.6	<0.010	<0.010	86.8	<0.100	51.0	
SCS-00035	soln std	std-b9-1		9	1	3.84	20.4	<0.060	3.67	9.49	<0.010	<0.010	81.8	<0.100	51.5	
SCS-00035	ND13	c111	quenched	9	2	5.73	741	<0.060	<0.400	272	<0.010	<0.010	5600	<0.100	2980	
SCS-00035	ND08	c058	quenched	9	3	19.9	117	<0.060	1.97	31.9	1.66	6.62	226	<0.100	97.6	
SCS-00035	ND05	c099	quenched	9	4	35.0	18.8	<0.060	<0.400	32.8	<0.010	<0.010	104	<0.100	104	
SCS-00035	RC66	c133	quenched	9	5	0.856	43.7	<0.060	<0.400	35.1	<0.010	<0.010	243	<0.100	259	
SCS-00035	RC58	c075	quenched	9	6	2.07	90.3	<0.060	5.30	104	3.50	<0.010	165	<0.100	425	
SCS-00035	ND17ccc	c047	ccc	9	7	0.474	230	<0.060	<0.400	106	<0.010	<0.010	976	<0.100	835	
SCS-00035	ND17	c063	quenched	9	8	1.45	217	<0.060	0.329	97.9	1.99	5.43	979	1.61	782	
SCS-00035	ND05ccc	c020	ccc	9	9	42.1	66.4	<0.060	<0.400	106	<0.010	<0.010	167	<0.100	191	
SCS-00035	soln std	std-b9-2		9	10	3.85	21.8	<0.060	3.66	9.49	<0.010	<0.010	88.3	<0.100	51.4	
SCS-00035	RC58ccc	c054	ccc	9	11	1.56	71.9	<0.060	3.27	84.6	1.50	<0.010	136	<0.100	376	

Table D.1: SRTC-ML Measurements of the PCT Solutions for the ND and RC Glasses by Analytical Planning Group

Analytical Plan	Glass ID	SRTC-ML ID	Heat Treatment	Block	Seq #	Al	B	Ca	Fe	Li	Mg	Mn	Na	Ni	Si	U
SCS-00035	RC72ccc	c069	ccc	9	12	2.42	133	<0.060	<0.400	154.0	<0.010	<0.010	624	<0.100	716	
SCS-00035	RC72	c053	quenched	9	13	2.50	278	<0.060	<0.400	268	<0.010	<0.010	1210	<0.100	1110	
SCS-00035	ND08ccc	c107	ccc	9	14	18.0	86.8	<0.060	1.00	24.9	0.382	2.90	177	<0.100	85.6	
SCS-00035	ND13ccc	c098	ccc	9	15	7.05	786	<0.060	<0.400	263	<0.010	<0.010	5730	<0.100	3200	
SCS-00035	RC66ccc	c014	ccc	9	16	1.42	36.1	<0.060	0.655	22.8	<0.010	0.375	163	<0.100	193	
SCS-00035	blank	c136		9	17	<0.090	<0.150	<0.060	<0.400	<0.200	<0.010	<0.010	<0.100	<0.100	<0.790	
SCS-00035	soln std	std-b9-3		9	18	3.89	23.6	<0.060	3.67	9.56	<0.010	<0.010	83.5	<0.100	51.9	
SCS-00041	soln std	STD-B1-1		1	1	3.77	20	<0.060	4.2	9.42	<0.040	<0.010	84.9	<0.100	50.5	<1.00
SCS-00041	ND25	F058	quenched	1	2	24.8	22	<0.060	3.49	14.5	0.106	0.534	131	0.265	96.8	4.62
SCS-00041	blank	F049		1	3	<0.090	0.487	<0.060	<0.040	<0.500	<0.040	<0.010	<0.100	<0.100	<0.790	<1.00
SCS-00041	ND28	F018	quenched	1	4	1.56	328	<0.060	0.077	215	<0.040	<0.010	808	<0.100	736	1.8
SCS-00041	ND21ccc	F004	ccc	1	5	8.26	60.2	<0.060	5.33	40	0.536	1.92	174	1.87	183	6.54
SCS-00041	ND25ccc	F045	ccc	1	6	21.5	28.2	<0.060	2.84	19.1	<0.040	0.355	177	0.166	132	5.54
SCS-00041	ND24	F094	quenched	1	7	13.93	49	<0.060	14.2	54.8	2.89	2.71	183	0.871	207	5.1
SCS-00041	ND16ccc	F079	ccc	1	8	31.8	21.7	<0.060	<0.040	55.4	<0.040	<0.010	193	<0.100	123	5.11
SCS-00041	soln std	STD-B1-2		1	9	3.66	21.1	<0.060	4.24	9.06	<0.040	<0.010	80.9	<0.100	49.9	<1.00
SCS-00041	ND21	F051	quenched	1	10	6.99	81.8	<0.060	4.63	53.4	0.031	1.32	235	1.47	228	6.78
SCS-00041	ND29ccc	F091	ccc	1	11	5.44	47	<0.060	17.8	33.2	0.577	2.43	262	0.852	258	5.2
SCS-00041	ND16	F062	quenched	1	12	27.7	15.7	<0.060	0.261	37.6	<0.040	<0.010	182	0.128	109	3.15
SCS-00041	ND28ccc	F013	ccc	1	13	1.52	213	<0.060	0.25	146	<0.040	<0.010	543	<0.100	552	1.95
SCS-00041	ND24ccc	F020	ccc	1	14	14.8	59.6	<0.060	16.9	68.5	3.47	3.09	227	0.93	264	5.76
SCS-00041	ND29	F073	quenched	1	15	4.2	55.9	<0.060	13.5	37	<0.040	1.31	297	0.401	284	4.72
SCS-00041	soln std	STD-B1-3		1	16	3.88	21.8	<0.060	4.31	9.22	<0.040	<0.010	82.1	<0.100	50.7	<1.00
SCS-00041	soln std	STD-B2-1		2	1	3.9	20.2	<0.060	4.15	10	<0.040	<0.010	84.8	0.259	50.8	<1.00
SCS-00041	ND25ccc	F003	ccc	2	2	22.1	29.5	<0.060	3.06	20.5	0.059	0.467	178	0.447	133	5.7
SCS-00041	ND24ccc	F054	ccc	2	3	15	59.4	<0.060	16.4	70.9	3.35	3.13	268	1.14	295	5.86
SCS-00041	ND16	F063	quenched	2	4	28.4	15.7	<0.060	0.252	39.3	<0.040	<0.010	182	0.341	109	3.47
SCS-00041	ND21ccc	F070	ccc	2	5	7.94	50.9	<0.060	3.09	36.3	<0.040	0.804	150	1.07	162	6.09
SCS-00041	ND16ccc	F056	ccc	2	6	30.4	21.1	<0.060	0.491	55.1	<0.040	<0.010	183	0.324	118	5.56
SCS-00041	ND24	F008	quenched	2	7	12.9	50.4	<0.060	10.4	57.2	1.67	1.86	221	0.82	248	4.84
SCS-00041	ND28ccc	F093	ccc	2	8	1.52	205	<0.060	0.206	143	<0.040	<0.010	543	0.307	537	2.18
SCS-00041	soln std	STD-B2-2		2	9	3.92	20.1	<0.060	4.15	10	<0.040	<0.010	84.9	0.267	51.5	<1.00
SCS-00041	ND28	F102	quenched	2	10	1.68	316	<0.060	0.11	219	<0.040	<0.010	823	0.283	766	2.12
SCS-00041	ND29ccc	F084	ccc	2	11	7.11	49.7	<0.060	29.8	34	1.57	4.6	253	1.59	265	5.89
SCS-00041	ND25	F108	quenched	2	12	24.5	22.4	<0.060	3.16	15	<0.040	0.509	161	0.441	122	4.66
SCS-00041	blank	F077		2	13	<0.090	0.791	<0.060	0.183	<0.500	<0.040	<0.010	<0.100	0.276	<0.790	<1.00
SCS-00041	ND29	F011	quenched	2	14	5.1	59.7	<0.060	18.7	40.6	0.495	2.72	303	1.11	290	5.26
SCS-00041	ND21	F087	quenched	2	15	8.97	82.5	<0.060	8.43	55.2	1.12	3.01	227	3.14	238	7.44
SCS-00041	soln std	STD-B2-3		2	16	3.89	20.2	<0.060	4.15	10	<0.040	<0.010	84.7	0.265	51.5	<1.00

Table D.1: SRTC-ML Measurements of the PCT Solutions for the ND and RC Glasses by Analytical Planning Group

Analytical Plan	Glass ID	SRTC-ML ID	Heat Treatment	Block	Seq #	Al	B	Ca	Fe	Li	Mg	Mn	Na	Ni	Si	U
SCS-00041	soln std	STD-B3-1		3	1	3.96	20	<0.060	3.97	10	<0.040	<0.010	87.1	<0.100	50.4	<1.00
SCS-00041	ND28	F029	quenched	3	2	1.7	325	<0.060	<0.040	209	<0.040	<0.010	821	<0.100	726	1.89
SCS-00041	ND21	F035	quenched	3	3	8.09	84.6	<0.060	5.97	55.8	0.263	1.88	227	2	222	7.24
SCS-00041	ND29ccc	F096	ccc	3	4	5.58	42.9	<0.060	12.8	31.3	<0.040	1.04	234	0.179	234	5.02
SCS-00041	ND21ccc	F041	ccc	3	5	8.23	53.8	<0.060	4.02	38.8	<0.040	1.25	158	1.32	176	6.18
SCS-00041	ND29	F015	quenched	3	6	4.87	48.5	<0.060	11	34.3	<0.040	<0.010	272	0.163	255	5.06
SCS-00041	ND24ccc	F007	ccc	3	7	15	57.9	<0.060	15.4	70.8	2.84	2.76	254	0.759	294	5.54
SCS-00041	ND25ccc	F107	ccc	3	8	22.2	27.7	<0.060	2.95	20.1	<0.040	0.312	170	0.141	140	5.33
SCS-00041	soln std	STD-B3-2		3	9	3.98	20	<0.060	4.02	10	<0.040	<0.010	86.6	<0.100	50.4	<1.00
SCS-00041	ND16	F024	quenched	3	10	28.6	16.7	<0.060	<0.040	39.9	<0.040	<0.010	165	<0.100	119	3.25
SCS-00041	ND25	F097	quenched	3	11	25.1	21	<0.060	3.14	15.2	<0.040	0.367	157	0.155	131	4.44
SCS-00041	ND16ccc	F040	ccc	3	12	30.5	20.4	<0.060	0.182	54.9	<0.040	<0.010	177	<0.100	131	5.4
SCS-00041	ND28ccc	F071	ccc	3	13	1.65	220	<0.060	<0.040	142	<0.040	<0.010	537	<0.100	575	1.96
SCS-00041	ND24	F025	quenched	3	14	13.2	51.4	<0.060	10.9	57.9	1.6	1.82	214	0.558	269	4.92
SCS-00041	soln std	STD-B3-3		3	15	3.93	20	<0.060	3.99	9.91	<0.040	<0.010	85.4	<0.100	50.3	<1.00
SCS-00041	soln std	STD-B4-1		4	1	3.95	20.3	<0.060	4.12	10.1	<0.040	<0.010	87.4	<0.100	50.7	<1.00
SCS-00041	ND18ccc	F009	ccc	4	2	4.29	63.9	<0.060	1.95	49.8	<0.040	11.7	221	0.189	234	8.79
SCS-00041	ND04ccc	F103	ccc	4	3	0.13	844	<0.060	<0.040	437	<0.040	<0.010	1120	<0.100	909	1.26
SCS-00041	ND30	F109	quenched	4	4	9.78	47.6	<0.060	1.53	31.5	<0.040	0.947	178	0.234	156	3.41
SCS-00041	ND04	F048	quenched	4	5	0.126	1230	<0.060	<0.040	594	<0.040	<0.010	1520	<0.100	1130	<1.00
SCS-00041	ND31ccc	F082	ccc	4	6	2.32	240	<0.060	<0.040	212	<0.040	<0.010	892	<0.100	760	3.4
SCS-00041	ND30ccc	F052	ccc	4	7	12.5	42.7	<0.060	5.52	29.6	0.345	3.88	155	0.744	150	4.44
SCS-00041	ND27	F069	quenched	4	8	1.23	503	<0.060	<0.040	181	<0.040	<0.010	1350	<0.100	816	<1.00
SCS-00041	soln std	STD-B4-2		4	9	3.96	20.5	<0.060	4.15	10.1	<0.040	<0.010	86.8	<0.100	50.4	<1.00
SCS-00041	ND18	F092	quenched	4	10	2.37	29.9	<0.060	0.314	22.5	<0.040	0.844	153	0.769	178	2.62
SCS-00041	ND02ccc	F039	ccc	4	11	1.19	330	<0.060	<0.040	97.7	<0.040	0.256	761	<0.100	407	7.65
SCS-00041	ND27ccc	F081	ccc	4	12	1.18	527	<0.060	<0.040	184	<0.040	<0.010	1400	<0.100	856	<1.00
SCS-00041	ND31	F031	quenched	4	13	3.18	423	<0.060	<0.040	354	<0.040	<0.010	1450	<0.100	1100	3.73
SCS-00041	ND02	F036	quenched	4	14	1.6	345	<0.060	0.272	97.9	<0.040	1.92	770	<0.100	405	8.99
SCS-00041	soln std	STD-B4-3		4	15	3.9	20.6	<0.060	4.09	10.1	<0.040	<0.010	87.5	<0.100	50.4	<1.00
SCS-00041	soln std	STD-B5-1		5	1	3.99	20.2	<0.060	4.13	10.1	<0.040	<0.010	86.2	<0.100	50.6	<1.00
SCS-00041	ND30	F022	quenched	5	2	10.2	41.6	<0.060	2.79	31.3	<0.040	1.84	176	0.404	161	3.62
SCS-00041	ND04	F006	quenched	5	3	0.245	1250	<0.060	<0.040	602	<0.040	<0.010	1550	<0.100	1140	<1.00
SCS-00041	ND27ccc	F105	ccc	5	4	1.32	567	<0.060	<0.040	200	<0.040	<0.010	1490	<0.100	927	<1.00
SCS-00041	ND31	F100	quenched	5	5	3.21	436	<0.060	<0.040	365	<0.040	<0.010	1490	<0.100	1110	3.85
SCS-00041	ND27	F044	quenched	5	6	1.3	448	<0.060	<0.040	159	<0.040	<0.010	1160	<0.100	722	1.07
SCS-00041	ND30ccc	F032	ccc	5	7	12.5	43.4	<0.060	6.09	29.1	0.541	4.3	154	0.758	153	4.69
SCS-00041	ND04ccc	F088	ccc	5	8	0.225	862	<0.060	<0.040	442	<0.040	<0.010	1120	<0.100	919	1.29
SCS-00041	soln std	STD-B5-2		5	9	4	20.5	<0.060	4.12	10	<0.040	<0.010	86.4	<0.100	49.9	<1.00

Table D.1: SRTC-ML Measurements of the PCT Solutions for the ND and RC Glasses by Analytical Planning Group

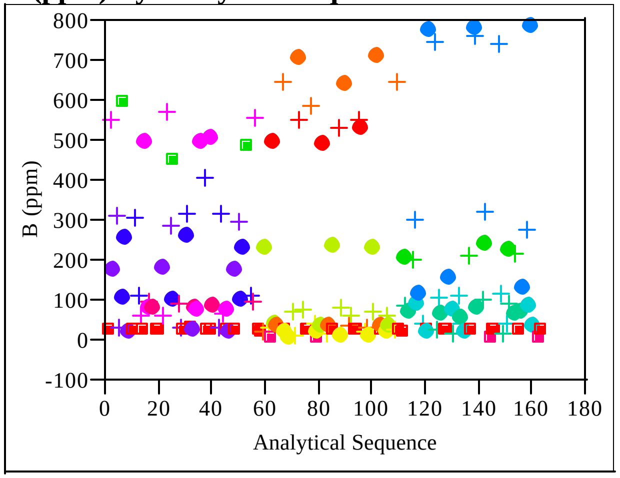
Analytical Plan	Glass ID	SRTC-ML ID	Heat Treatment	Block	Seq #	Al	B	Ca	Fe	Li	Mg	Mn	Na	Ni	Si	U
SCS-00041	ND18ccc	F060	ccc	5	10	4.45	65.9	<0.060	2.28	49.1	<0.040	12.3	283	0.212	307	9.38
SCS-00041	ND02ccc	F016	ccc	5	11	1.16	336	<0.060	<0.040	100	<0.040	<0.010	763	<0.100	410	7.51
SCS-00041	ND31ccc	F047	ccc	5	12	2.44	250	<0.060	<0.040	224	<0.040	<0.010	922	<0.100	790	3.43
SCS-00041	ND02	F014	quenched	5	13	1.52	264	<0.060	0.048	77.6	<0.040	0.466	595	<0.100	305	8.75
SCS-00041	ND18	F043	quenched	5	14	2.21	31.4	<0.060	0.102	22	<0.040	0.208	125	0.24	151	2.42
SCS-00041	soln std	STD-B5-3		5	15	3.93	20.4	<0.060	4.11	9.65	<0.040	<0.010	83.4	<0.100	48.7	<1.00
SCS-00041	soln std	STD-B6-1		6	1	3.67	20.1	<0.060	4.1	9.63	<0.040	<0.010	84.1	<0.100	49.4	<1.00
SCS-00041	ND02	F095	quenched	6	2	1.12	330	<0.060	<0.040	98.7	<0.040	<0.010	741	<0.100	389	7.15
SCS-00041	ND18	F110	quenched	6	3	2.11	28.7	<0.060	0.258	22.5	<0.040	0.559	155	0.621	188	2.39
SCS-00041	ND02ccc	F106	ccc	6	4	1.02	329	<0.060	<0.040	96.8	<0.040	<0.010	741	<0.100	401	7.35
SCS-00041	ND30ccc	F090	ccc	6	5	12.7	37.8	<0.060	6.43	29.3	0.72	4.59	161	0.922	158	4.49
SCS-00041	ND18ccc	F050	ccc	6	6	2.52	81	<0.060	0.537	61.8	<0.040	1.85	345	0.114	374	6.96
SCS-00041	ND04ccc	F068	ccc	6	7	<0.090	737	<0.060	<0.040	386	<0.040	<0.010	974	<0.100	795	<1.00
SCS-00041	ND27ccc	F083	ccc	6	8	1.07	545	<0.060	<0.040	194	<0.040	<0.010	1440	<0.100	870	<1.00
SCS-00041	soln std	STD-B6-2		6	9	3.71	20.2	<0.060	4.09	9.46	<0.040	<0.010	82.6	<0.100	47.7	<1.00
SCS-00041	ND30	F002	quenched	6	10	9.67	40.4	<0.060	1.66	31.6	<0.040	0.982	180	0.298	163	3.25
SCS-00041	ND04	F053	quenched	6	11	<0.090	1200	<0.060	<0.040	604	<0.040	<0.010	1540	<0.100	1120	<1.00
SCS-00041	ND27	F059	quenched	6	12	1.17	511	<0.060	<0.040	187	<0.040	<0.010	1360	<0.100	823	<1.00
SCS-00041	ND31ccc	F074	ccc	6	13	2.21	272	<0.060	<0.040	242	<0.040	<0.010	994	<0.100	828	3.3
SCS-00041	ND31	F104	quenched	6	14	2.79	395	<0.060	<0.040	342	<0.040	<0.010	1390	<0.100	1070	2.34
SCS-00041	soln std	STD-B6-3		6	15	3.69	20.5	<0.060	4.1	9.6	<0.040	<0.010	84.4	<0.100	48.1	<1.00
SCS-00041	soln std	STD-B7-1		7	1	3.75	20.6	<0.060	4.17	9.71	<0.040	<0.010	84.4	<0.100	49.4	<1.00
SCS-00041	ND09ccc	F076	ccc	7	2	28.4	10.3	<0.060	15.6	9.9	<0.040	1.68	180	<0.100	130	25.8
SCS-00041	EA	F086		7	3	1.04	673	<0.060	<0.040	195	<0.040	<0.010	1660	<0.100	918	<1.00
SCS-00041	ND23ccc	F012	ccc	7	4	13.5	29.2	<0.060	9.72	20.1	<0.040	0.678	177	0.12	156	6.09
SCS-00041	ND26ccc	F061	ccc	7	5	2.83	173	<0.060	<0.040	109	<0.040	<0.010	860	<0.100	644	5.14
SCS-00041	ND26	F057	quenched	7	6	2.89	249	<0.060	<0.040	149	<0.040	<0.010	1160	<0.100	870	5.88
SCS-00041	ND11ccc	F065	ccc	7	7	14.3	166	<0.060	1.24	158	<0.040	1.76	438	<0.100	358	7.31
SCS-00041	ARM	F099		7	8	4.69	21.8	<0.060	<0.040	15.4	<0.040	<0.010	42.6	<0.100	66.4	<1.00
SCS-00041	soln std	STD-B7-2		7	9	3.75	20.5	<0.060	4.16	9.64	<0.040	<0.010	84.4	<0.100	48.9	<1.00
SCS-00041	ND23	F001	quenched	7	10	13.1	26.1	<0.060	9.46	19	<0.040	0.6	181	0.166	157	6.31
SCS-00041	ND22	F101	quenched	7	11	5.16	31.1	<0.060	0.931	16.7	<0.040	<0.010	108	<0.100	105	1.34
SCS-00041	ND09	F038	quenched	7	12	29.5	10.5	<0.060	16.4	9.23	<0.040	1.97	206	<0.100	140	27.9
SCS-00041	ND22ccc	F017	ccc	7	13	11.9	126	<0.060	4.77	61.1	2.09	2.67	294	0.156	187	3.4
SCS-00041	ND11	F030	quenched	7	14	17	21.7	<0.060	4.82	51.9	0.054	1.98	115	0.196	147	4.32
SCS-00041	soln std	STD-B7-3		7	15	3.74	20.5	<0.060	4.16	9.76	<0.040	<0.010	85.9	<0.100	49.1	<1.00
SCS-00041	soln std	STD-B8-1		8	1	3.7	20.4	<0.060	4.19	9.89	<0.040	<0.010	85.2	<0.100	50.6	<1.00
SCS-00041	ND22	F010	quenched	8	2	5.2	33.7	<0.060	0.62	16.8	<0.040	<0.010	116	<0.100	101	2.34
SCS-00041	ND23ccc	F021	ccc	8	3	13.6	25.4	<0.060	9.77	20.1	<0.040	0.779	143	<0.100	125	6.38

Table D.1: SRTC-ML Measurements of the PCT Solutions for the ND and RC Glasses by Analytical Planning Group

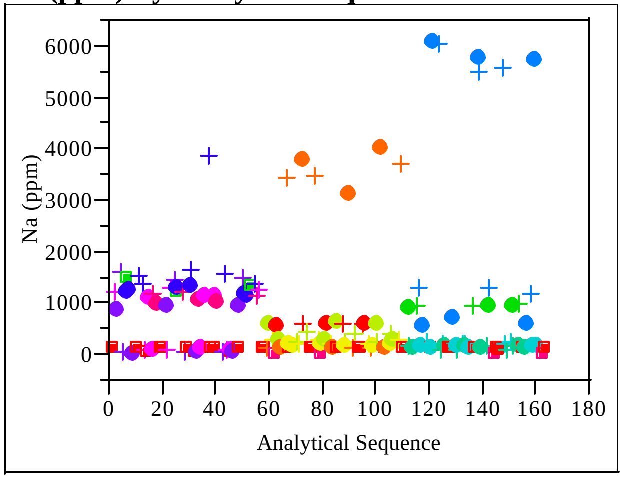
Analytical Plan	Glass ID	SRTC-ML ID	Heat Treatment	Block	Seq #	Al	B	Ca	Fe	Li	Mg	Mn	Na	Ni	Si	U
SCS-00041	ND26ccc	F072	ccc	8	4	2.89	196	<0.060	<0.040	118	<0.040	<0.010	963	<0.100	716	5.08
SCS-00041	ND09ccc	F055	ccc	8	5	28.3	11.9	<0.060	16	9.85	<0.040	1.9	184	<0.100	122	25.8
SCS-00041	ND23	F089	quenched	8	6	12.5	25.1	<0.060	8.55	18	<0.040	0.538	185	<0.100	148	6.24
SCS-00041	ND11ccc	F027	ccc	8	7	16.9	146	<0.060	2.15	140	0.204	2.99	374	<0.100	303	8.65
SCS-00041	ND26	F028	quenched	8	8	3.34	177	<0.060	<0.040	108	<0.040	<0.010	897	<0.100	637	7.07
SCS-00041	soln std	STD-B8-2		8	9	3.72	20.4	<0.060	4.2	9.6	<0.040	<0.010	83.5	<0.100	49.1	<1.00
SCS-00041	ND22ccc	F067	ccc	8	10	11.9	135	<0.060	4.61	60	1.64	2.42	314	<0.100	181	3.77
SCS-00041	ND11	F078	quenched	8	11	16.7	22.4	<0.060	2.9	48.2	<0.040	1.04	115	<0.100	126	3.97
SCS-00041	ND09	F033	quenched	8	12	29.1	12.4	<0.060	16.6	9.17	<0.040	2.09	220	<0.100	131	27.7
SCS-00041	ARM	F026		8	13	4.97	19.6	<0.060	<0.040	15	<0.040	<0.010	40.5	<0.100	64.9	<1.00
SCS-00041	EA	F075		8	14	1.17	701	<0.060	<0.040	203	<0.040	<0.010	1700	<0.100	916	<1.00
SCS-00041	soln std	STD-B8-3		8	15	3.69	20.5	<0.060	4.2	9.51	<0.040	<0.010	82.4	<0.100	48.7	<1.00
SCS-00041	soln std	STD-B9-1		9	1	3.8	20.6	<0.060	4.17	9.58	<0.040	<0.010	82.6	<0.100	49.2	<1.00
SCS-00041	ND11	F066	quenched	9	2	16.8	21.5	<0.060	2.64	47	<0.040	0.948	103	<0.100	127	3.77
SCS-00041	ARM	F042		9	3	4.88	20.6	<0.060	<0.040	15.1	<0.040	<0.010	40.8	<0.100	65.3	<1.00
SCS-00041	EA	F023		9	4	1.21	642	<0.060	<0.040	197	<0.040	<0.010	1670	<0.100	927	<1.00
SCS-00041	ND11ccc	F037	ccc	9	5	16.5	161	<0.060	1.92	148	0.237	2.61	409	<0.100	329	8.76
SCS-00041	ND23ccc	F005	ccc	9	6	13.6	28.5	<0.060	10	19.5	<0.040	0.839	162	0.157	150	6.29
SCS-00041	ND23	F046	quenched	9	7	13.1	28.3	<0.060	9.41	18.7	<0.040	0.713	188	0.199	156	6.57
SCS-00041	ND26	F080	quenched	9	8	3.46	183	<0.060	<0.040	112	<0.040	<0.010	928	<0.100	662	7.33
SCS-00041	soln std	STD-B9-2		9	9	3.75	20.3	<0.060	4.18	9.55	<0.040	<0.010	82.9	<0.100	48.7	<1.00
SCS-00041	ND26ccc	F098	ccc	9	10	3.04	223	<0.060	<0.040	135	<0.040	<0.010	1060	<0.100	816	5.75
SCS-00041	ND09ccc	F085	ccc	9	11	29	14.5	<0.060	16.5	10	<0.040	1.98	184	<0.100	131	27.2
SCS-00041	ND22	F019	quenched	9	12	5.46	34.8	<0.060	0.751	17.2	<0.040	<0.010	110	<0.100	102	2.52
SCS-00041	ND22ccc	F064	ccc	9	13	12	117	<0.060	4.71	60.4	1.87	2.57	273	0.17	167	3.85
SCS-00041	ND09	F034	quenched	9	14	30.8	14.7	<0.060	18	9.5	<0.040	2.36	212	0.102	138	29.6
SCS-00041	soln std	STD-B9-3		9	15	3.71	20.2	<0.060	4.17	9.51	<0.040	<0.010	81.6	<0.100	48.7	<1.00

Exhibit D.1: SRTC-ML PCT Measurements in Overall Analytical Sequence Including All RC and ND Glasses, EA, ARM, Blanks, and Samples of the Solution Standard for Non-Radioactive Glasses

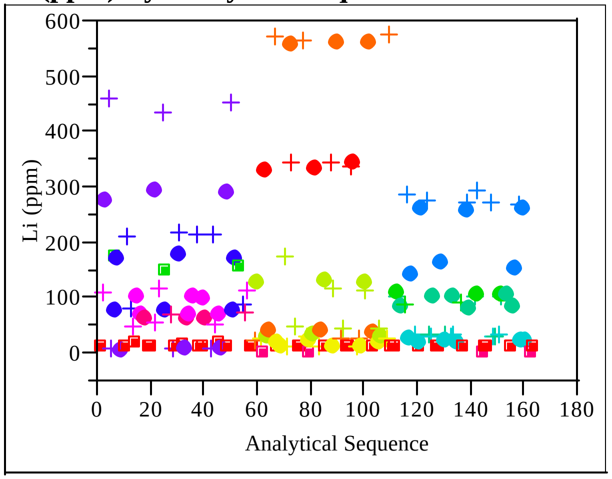
B (ppm) By Analytical Sequence



Na (ppm) By Analytical Sequence



Li (ppm) By Analytical Sequence



Si (ppm) By Analytical Sequence

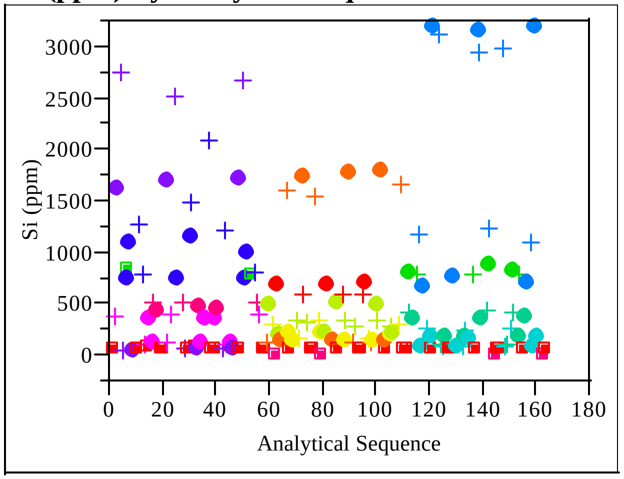
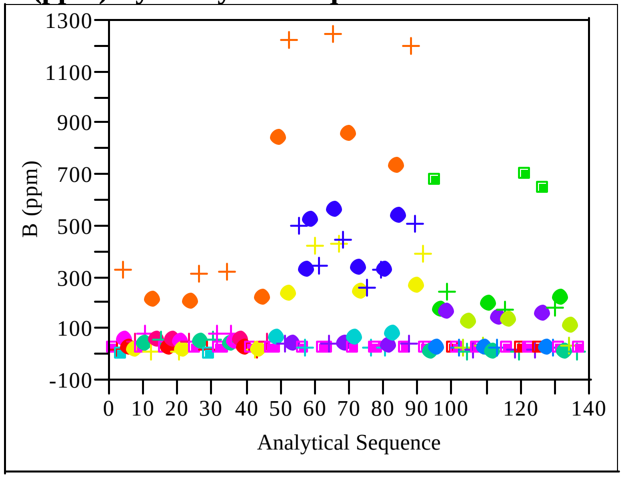
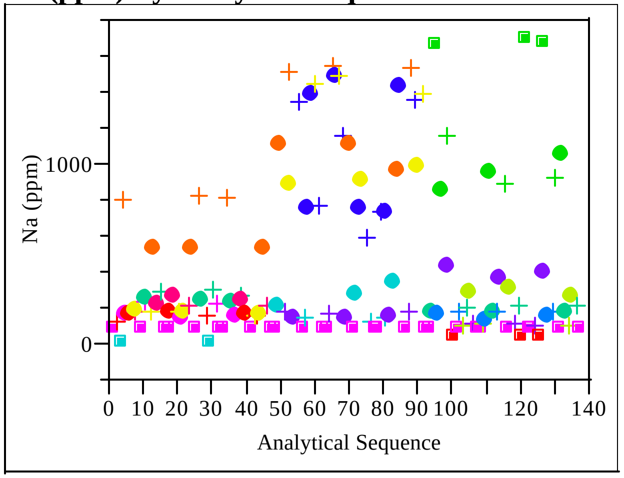


Exhibit D.2: SRTC-ML PCT Measurements in Overall Analytical Sequence Including All ND Glasses, EA, ARM, Blanks, and Samples of the Solution Standard for the Radioactive Glasses

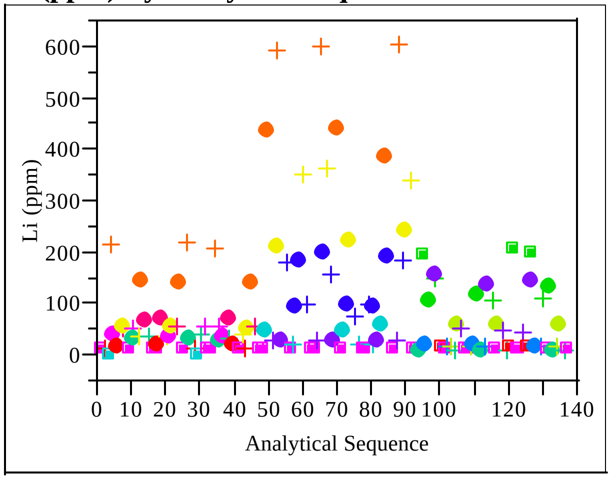
B (ppm) By Analytical Sequence



Na (ppm) By Analytical Sequence



Li (ppm) By Analytical Sequence



Si (ppm) By Analytical Sequence

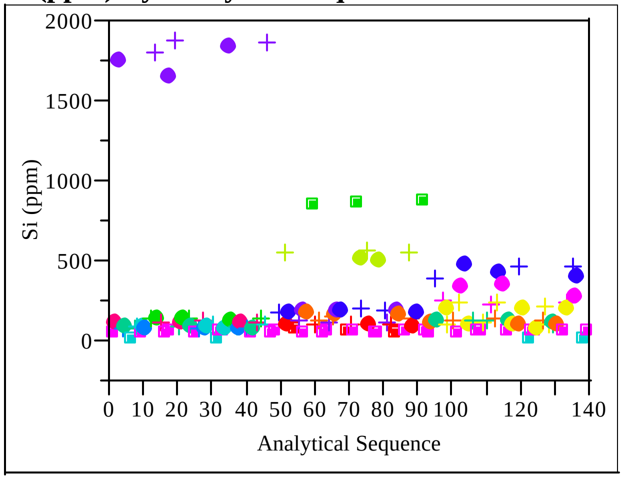
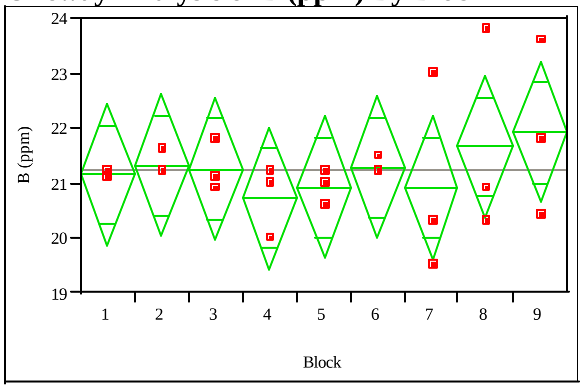


Exhibit D.3: Measurements of the Multi-Element Solution Standard by ICP Block for Non-Radioactive Group

Oneway Analysis of B (ppm) By Block



Oneway Anova

Summary of Fit

Rsquare	0.141724
Adj Rsquare	-0.23973
Root Mean Square Error	1.06646
Mean of Response	21.25148
Observations (or Sum Wgts)	27

Analysis of Variance

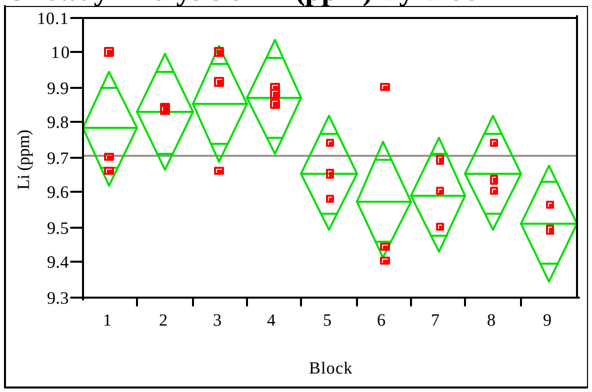
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	8	3.380474	0.42256	0.3715	0.9222
Error	18	20.472067	1.13734		
C. Total	26	23.852541			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	21.1667	0.61572	19.873	22.460
2	3	21.3333	0.61572	20.040	22.627
3	3	21.2667	0.61572	19.973	22.560
4	3	20.7333	0.61572	19.440	22.027
5	3	20.9333	0.61572	19.640	22.227
6	3	21.3000	0.61572	20.006	22.594
7	3	20.9300	0.61572	19.636	22.224
8	3	21.6667	0.61572	20.373	22.960
9	3	21.9333	0.61572	20.640	23.227

Std Error uses a pooled estimate of error variance

Oneway Analysis of Li (ppm) By Block



Oneway Anova

Summary of Fit

Rsquare	0.566117
Adj Rsquare	0.37328
Root Mean Square Error	0.135797
Mean of Response	9.706296
Observations (or Sum Wgts)	27

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	8	0.43309630	0.054137	2.9357	0.0275
Error	18	0.33193333	0.018441		
C. Total	26	0.76502963			

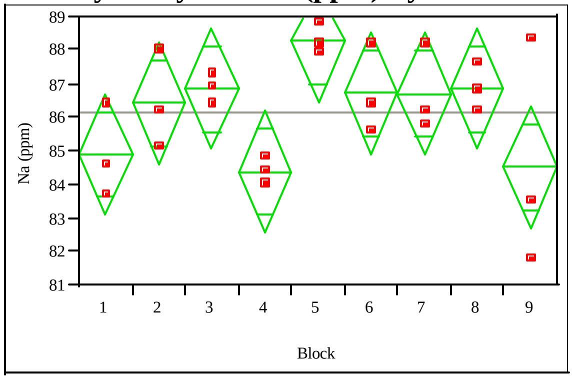
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	9.78667	0.07840	9.6219	9.951
2	3	9.83333	0.07840	9.6686	9.998
3	3	9.85667	0.07840	9.6919	10.021
4	3	9.87667	0.07840	9.7119	10.041
5	3	9.65667	0.07840	9.4919	9.821
6	3	9.58000	0.07840	9.4153	9.745
7	3	9.59667	0.07840	9.4319	9.761
8	3	9.65667	0.07840	9.4919	9.821
9	3	9.51333	0.07840	9.3486	9.678

Std Error uses a pooled estimate of error variance

Exhibit D.3: Measurements of the Multi-Element Solution Standard by ICP Block for Non-Radioactive Group *(continued)*

Oneway Analysis of Na (ppm) By Block



Oneway Anova

Summary of Fit

Rsquare	0.506878
Adj Rsquare	0.287712
Root Mean Square Error	1.486607
Mean of Response	86.1963
Observations (or Sum Wgts)	27

Analysis of Variance

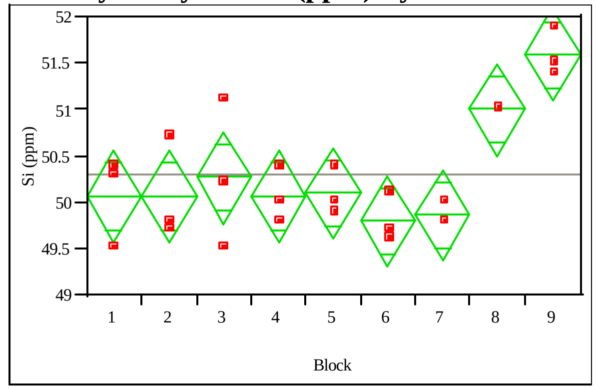
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	8	40.889630	5.11120	2.3128	0.0666
Error	18	39.780000	2.21000		
C. Total	26	80.669630			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	84.9000	0.85829	83.097	86.703
2	3	86.4333	0.85829	84.630	88.237
3	3	86.8667	0.85829	85.063	88.670
4	3	84.4000	0.85829	82.597	86.203
5	3	88.3000	0.85829	86.497	90.103
6	3	86.7333	0.85829	84.930	88.537
7	3	86.7333	0.85829	84.930	88.537
8	3	86.8667	0.85829	85.063	88.670
9	3	84.5333	0.85829	82.730	86.337

Std Error uses a pooled estimate of error variance

Oneway Analysis of Si (ppm) By Block



Oneway Anova

Summary of Fit

Rsquare	0.737379
Adj Rsquare	0.620658
Root Mean Square Error	0.409155
Mean of Response	50.31481
Observations (or Sum Wgts)	27

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	8	8.460741	1.05759	6.3175	0.0006
Error	18	3.013333	0.16741		
C. Total	26	11.474074			

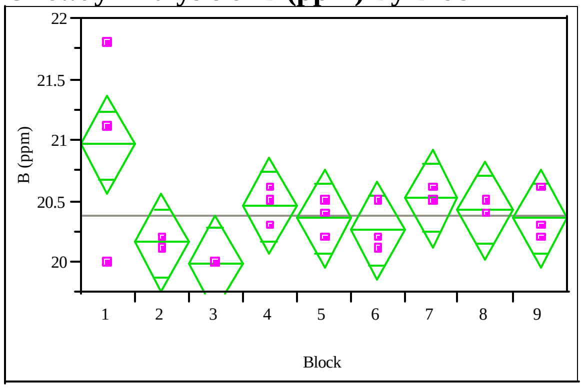
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	50.0667	0.23623	49.570	50.563
2	3	50.0667	0.23623	49.570	50.563
3	3	50.2667	0.23623	49.770	50.763
4	3	50.0667	0.23623	49.570	50.563
5	3	50.1000	0.23623	49.604	50.596
6	3	49.8000	0.23623	49.304	50.296
7	3	49.8667	0.23623	49.370	50.363
8	3	51.0000	0.23623	50.504	51.496
9	3	51.6000	0.23623	51.104	52.096

Std Error uses a pooled estimate of error variance

Exhibit D.4: Measurements of the Multi-Element Solution Standard by ICP Block for Radioactive Group

Oneway Analysis of B (ppm) By Block



Oneway Anova

Summary of Fit

Rsquare	0.473153
Adj Rsquare	0.238999
Root Mean Square Error	0.327731
Mean of Response	20.3963
Observations (or Sum Wgts)	27

Analysis of Variance

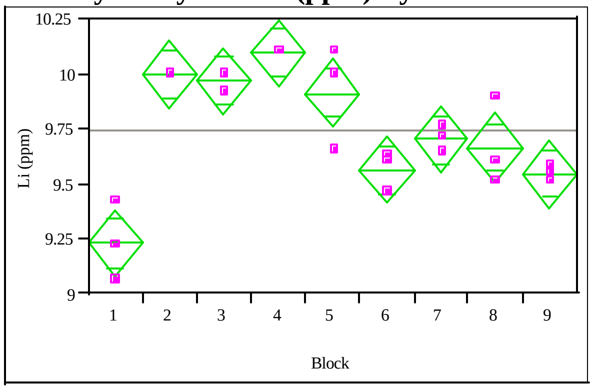
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	8	1.7362963	0.217037	2.0207	0.1026
Error	18	1.9333333	0.107407		
C. Total	26	3.6696296			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	20.9667	0.18922	20.569	21.364
2	3	20.1667	0.18922	19.769	20.564
3	3	20.0000	0.18922	19.602	20.398
4	3	20.4667	0.18922	20.069	20.864
5	3	20.3667	0.18922	19.969	20.764
6	3	20.2667	0.18922	19.869	20.664
7	3	20.5333	0.18922	20.136	20.931
8	3	20.4333	0.18922	20.036	20.831
9	3	20.3667	0.18922	19.969	20.764

Std Error uses a pooled estimate of error variance

Oneway Analysis of Li (ppm) By Block



Oneway Anova

Summary of Fit

Rsquare	0.864953
Adj Rsquare	0.804932
Root Mean Square Error	0.126315
Mean of Response	9.744444
Observations (or Sum Wgts)	27

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	8	1.8394667	0.229933	14.4109	<.0001
Error	18	0.2872000	0.015956		
C. Total	26	2.1266667			

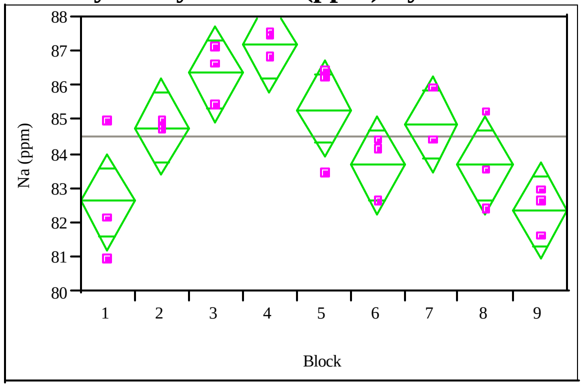
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	9.2333	0.07293	9.0801	9.387
2	3	10.0000	0.07293	9.8468	10.153
3	3	9.9700	0.07293	9.8168	10.123
4	3	10.1000	0.07293	9.9468	10.253
5	3	9.9167	0.07293	9.7635	10.070
6	3	9.5633	0.07293	9.4101	9.717
7	3	9.7033	0.07293	9.5501	9.857
8	3	9.6667	0.07293	9.5135	9.820
9	3	9.5467	0.07293	9.3935	9.700

Std Error uses a pooled estimate of error variance

Exhibit D.4: Measurements of the Multi-Element Solution Standard by ICP Block for Radioactive Group *(continued)*

Oneway Analysis of Na (ppm) By Block



Oneway Anova

Summary of Fit

Rsquare	0.724608
Adj Rsquare	0.602211
Root Mean Square Error	1.158383
Mean of Response	84.55926
Observations (or Sum Wgts)	27

Analysis of Variance

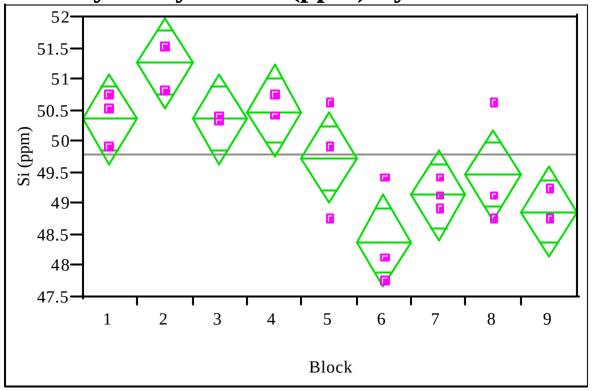
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	8	63.551852	7.94398	5.9202	0.0009
Error	18	24.153333	1.34185		
C. Total	26	87.705185			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	82.6333	0.66879	81.228	84.038
2	3	84.8000	0.66879	83.395	86.205
3	3	86.3667	0.66879	84.962	87.772
4	3	87.2333	0.66879	85.828	88.638
5	3	85.3333	0.66879	83.928	86.738
6	3	83.7000	0.66879	82.295	85.105
7	3	84.9000	0.66879	83.495	86.305
8	3	83.7000	0.66879	82.295	85.105
9	3	82.3667	0.66879	80.962	83.772

Std Error uses a pooled estimate of error variance

Oneway Analysis of Si (ppm) By Block



Oneway Anova

Summary of Fit

Rsquare	0.755852
Adj Rsquare	0.647342
Root Mean Square Error	0.599382
Mean of Response	49.78889
Observations (or Sum Wgts)	27

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	8	20.020000	2.50250	6.9657	0.0003
Error	18	6.466667	0.35926		
C. Total	26	26.486667			

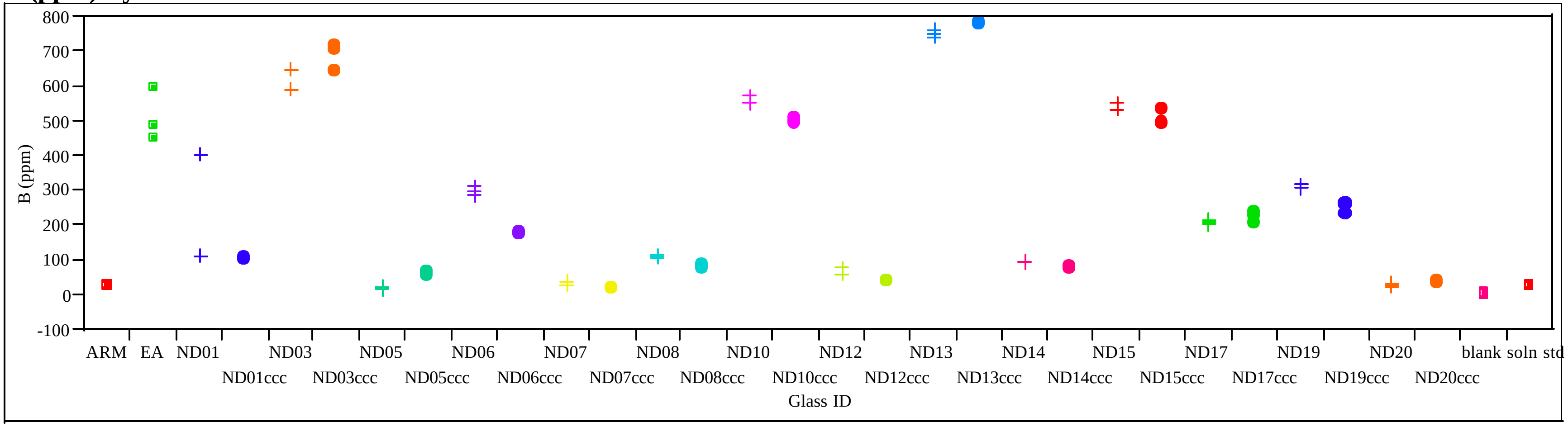
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	50.3667	0.34605	49.640	51.094
2	3	51.2667	0.34605	50.540	51.994
3	3	50.3667	0.34605	49.640	51.094
4	3	50.5000	0.34605	49.773	51.227
5	3	49.7333	0.34605	49.006	50.460
6	3	48.4000	0.34605	47.673	49.127
7	3	49.1333	0.34605	48.406	49.860
8	3	49.4667	0.34605	48.740	50.194
9	3	48.8667	0.34605	48.140	49.594

Std Error uses a pooled estimate of error variance

Exhibit D.5: SRTC-ML PCT Measurements by Glass ID or Standard for Non-Radioactive Group

B (ppm) By Glass ID



Li (ppm) By Glass ID

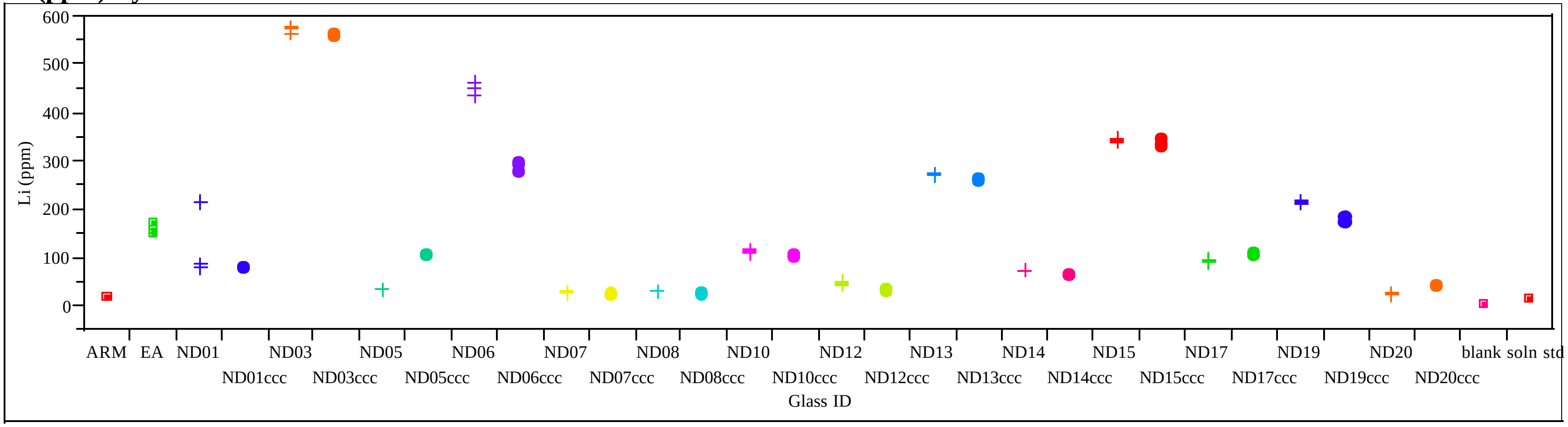
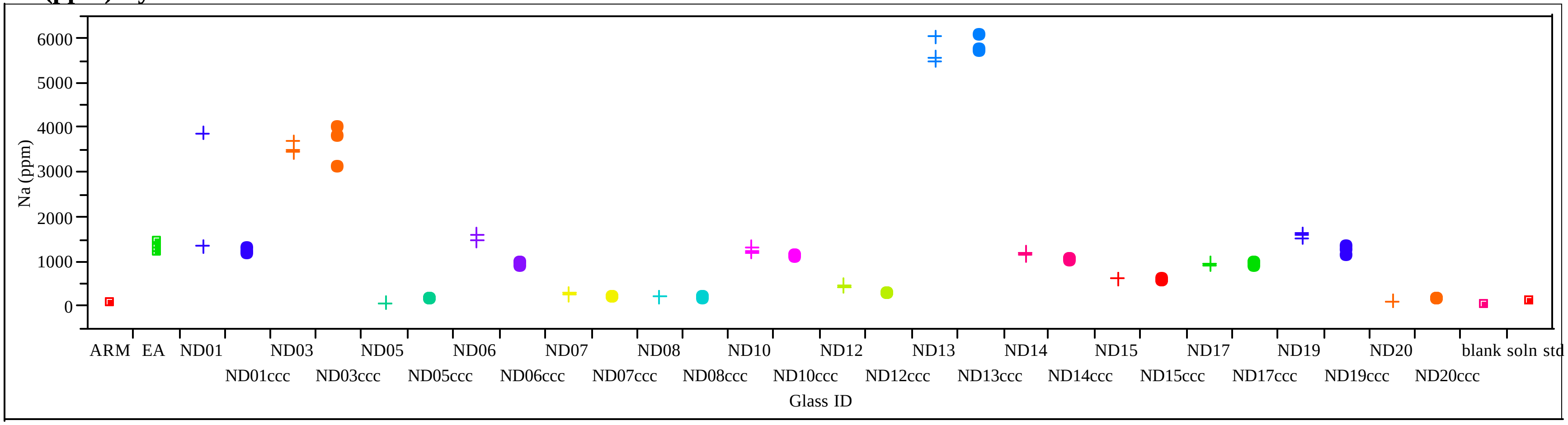


Exhibit D.5: SRTC-ML PCT Measurements by Glass ID or Standard for Non-Radioactive Group

Na (ppm) By Glass ID



Oneway Analysis of Si (ppm) By Glass ID

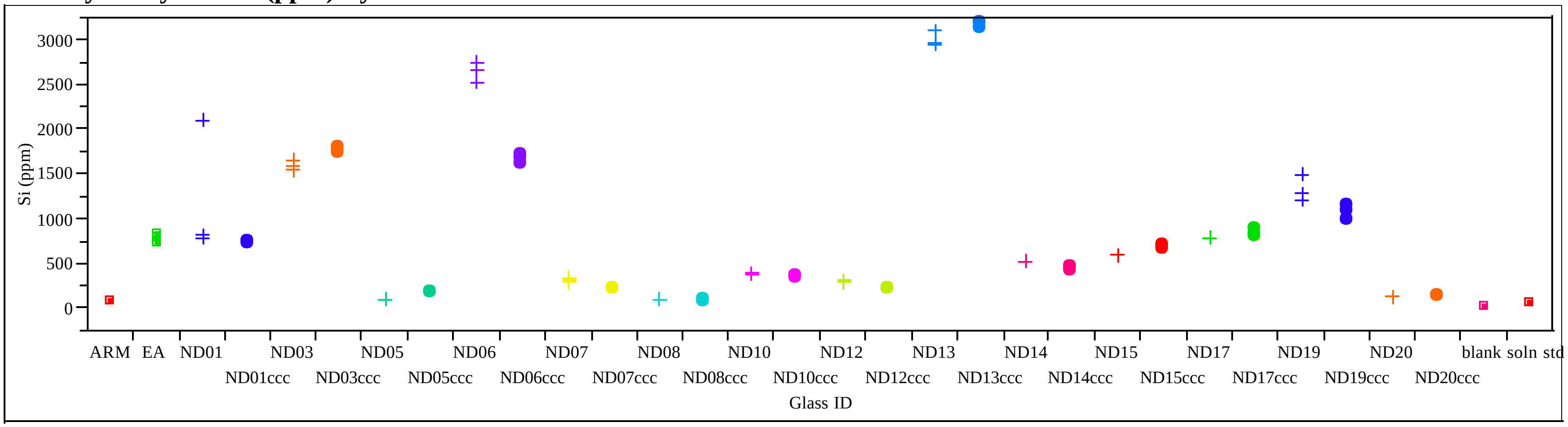
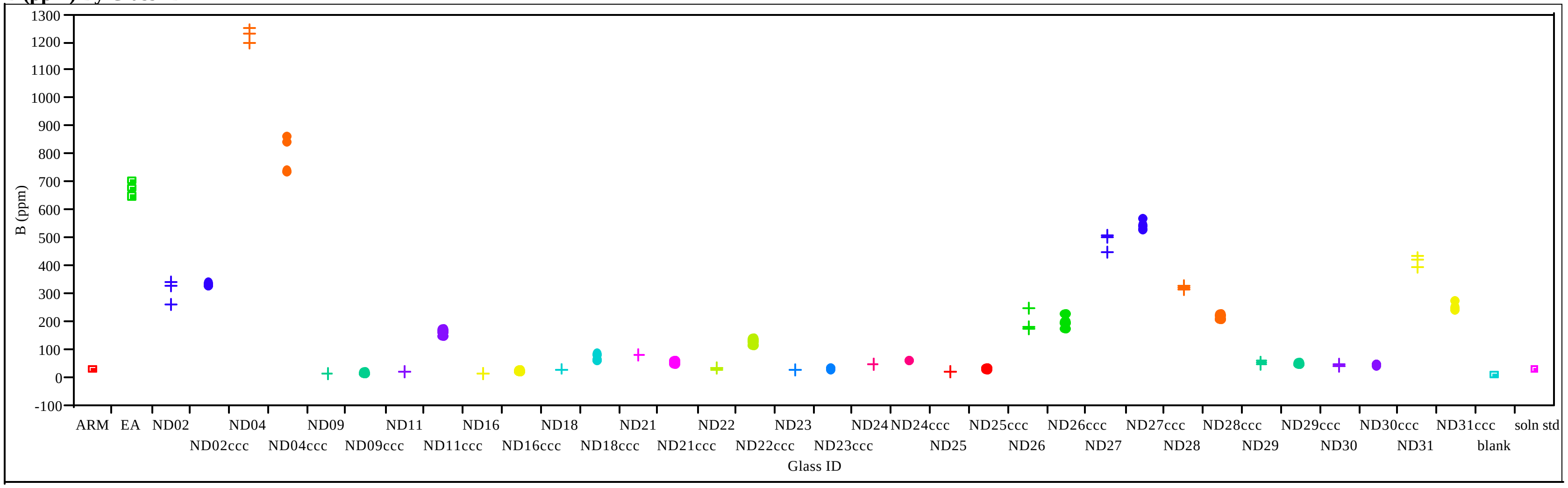


Exhibit D.6: SRTC-ML PCT Measurements by Glass ID or Standard for Radioactive Group

B (ppm) By Glass ID



Li (ppm) By Glass ID

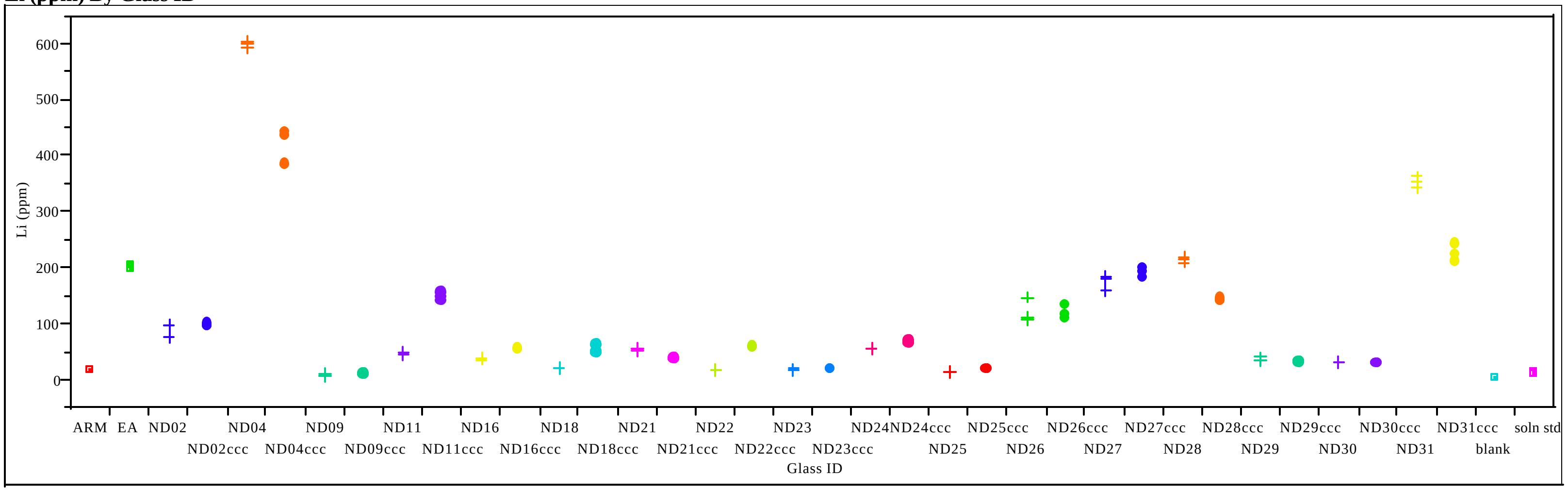
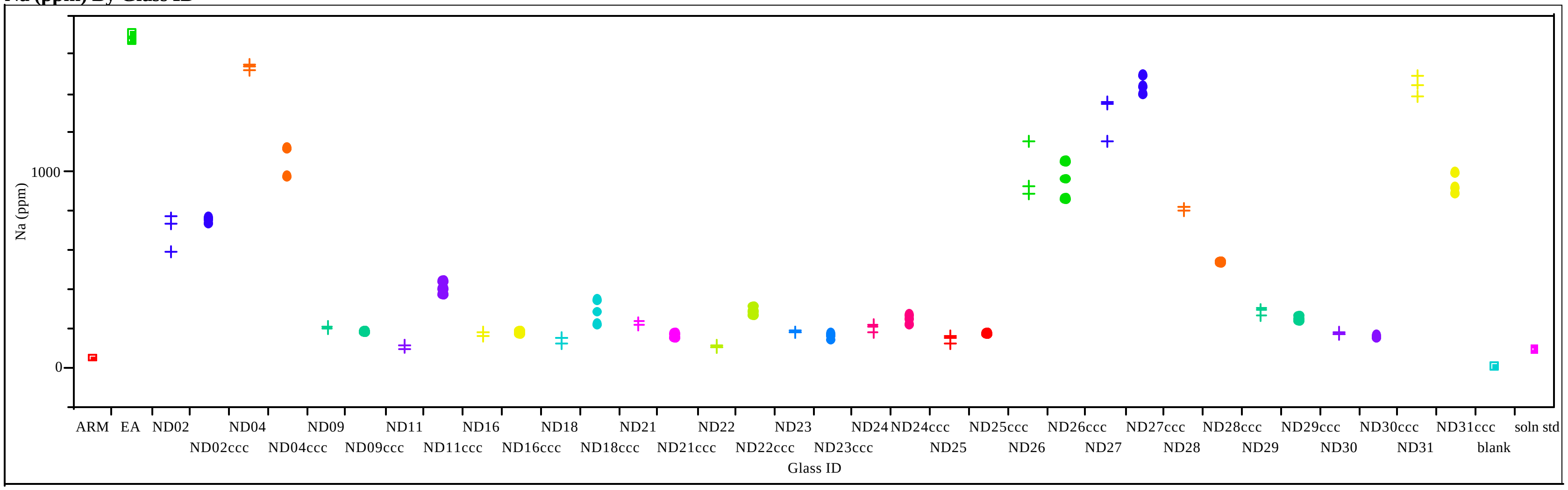


Exhibit D.6: SRTC-ML PCT Measurements by Glass ID or Standard for Radioactive Group 1

Na (ppm) By Glass ID



Si (ppm) By Glass ID

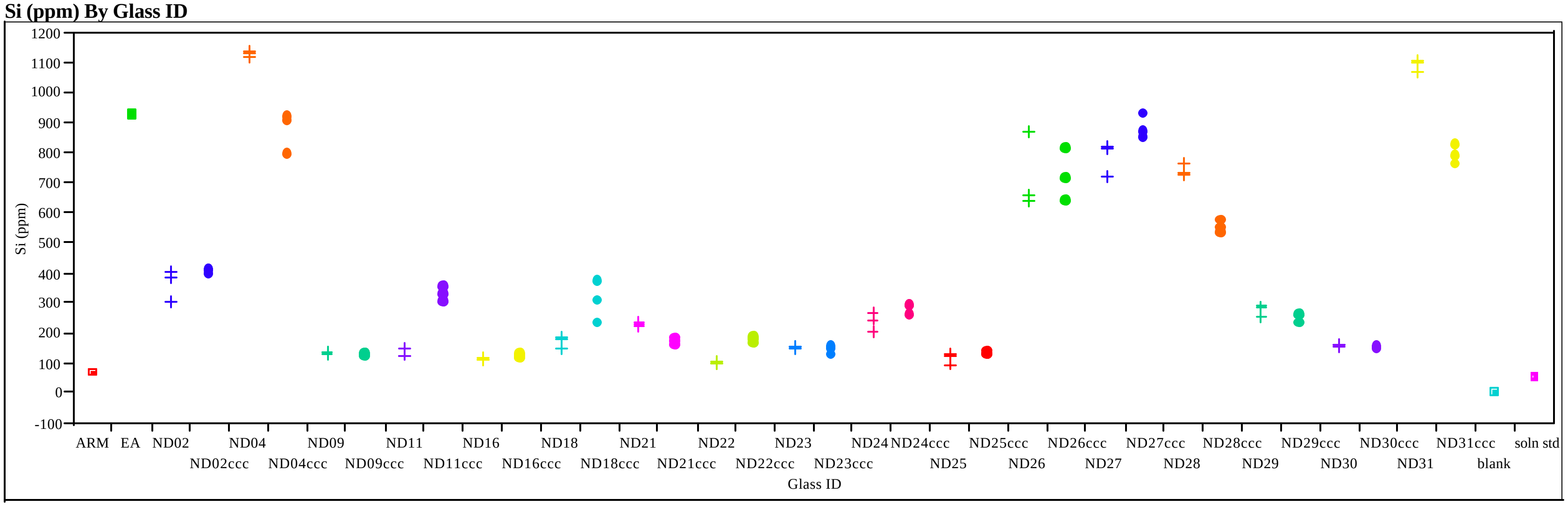
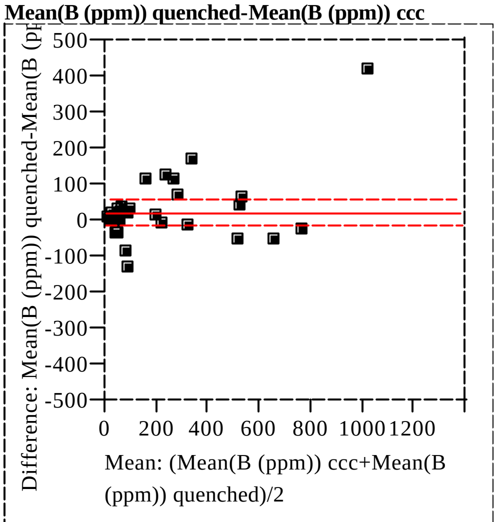


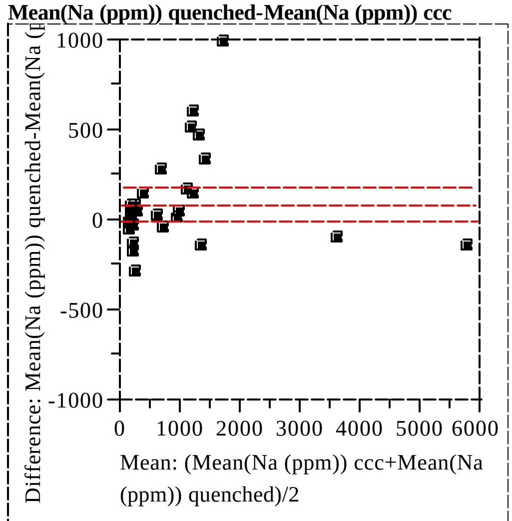
Exhibit D.7: Pairwise Comparisons between the PCTs (in ppm) for the Two Heat Treatments (Quenched and Centerline -Cooled)

Difference:
Mean(B (ppm)) quenched-Mean(B (ppm)) ccc



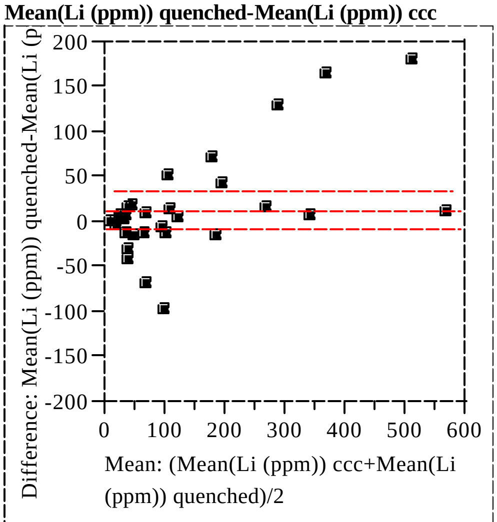
Mean(B (ppm)) quenched	233.804	t-Ratio	1.271895
Mean(B (ppm)) ccc	212.086	DF	30
Mean Difference	21.7183	Prob > |t|	0.2132
Std Error	17.0755	Prob > t	0.1066
Upper95%	56.5912	Prob < t	0.8934
Lower95%	-13.155		
N	31		
Correlation	0.94724		

Difference:
Mean(Na (ppm)) quenched-Mean(Na (ppm)) ccc



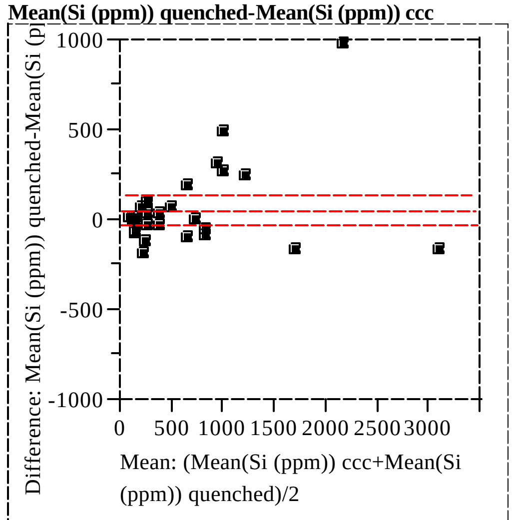
Mean(Na (ppm)) quenched	922.787	t-Ratio	1.877127
Mean(Na (ppm)) ccc	835.366	DF	30
Mean Difference	87.4215	Prob > |t|	0.0703
Std Error	46.572	Prob > t	0.0351
Upper95%	182.534	Prob < t	0.9649
Lower95%	-7.6912		
N	31		
Correlation	0.97573		

Difference:
Mean(Li (ppm)) quenched-Mean(Li (ppm)) ccc



Mean(Li (ppm)) quenched	140.037	t-Ratio	1.253814
Mean(Li (ppm)) ccc	127.138	DF	30
Mean Difference	12.8988	Prob > |t|	0.2196
Std Error	10.2877	Prob > t	0.1098
Upper95%	33.909	Prob < t	0.8902
Lower95%	-8.1114		
N	31		
Correlation	0.95089		

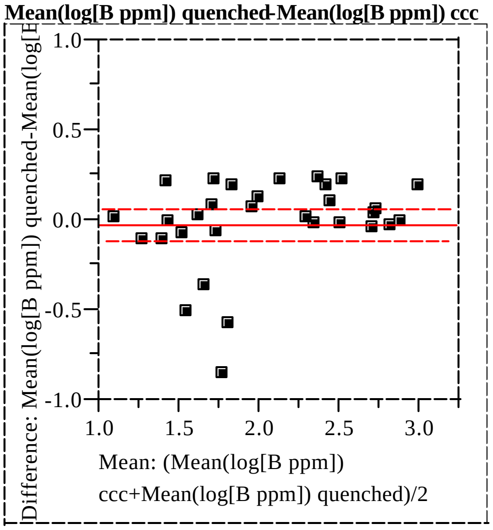
Difference:
Mean(Si (ppm)) quenched-Mean(Si (ppm)) ccc



Mean(Si (ppm)) quenched	637.534	t-Ratio	1.272773
Mean(Si (ppm)) ccc	586.043	DF	30
Mean Difference	51.4914	Prob > |t|	0.2129
Std Error	40.4561	Prob > t	0.1064
Upper95%	134.114	Prob < t	0.8936
Lower95%	-31.131		
N	31		
Correlation	0.95186		

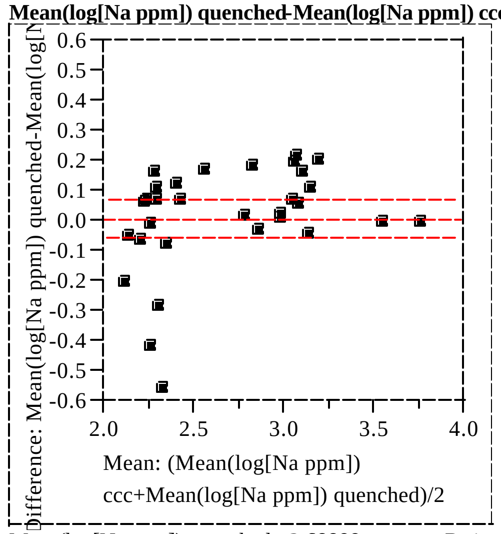
Exhibit D.8: Pairwise Comparisons between the PCTs (in log ppm) for the Two Heat Treatments (Quenched and Centerline -Cooled)

Difference:
Mean(log[B ppm]) quenched-Mean(log[B ppm]) ccc



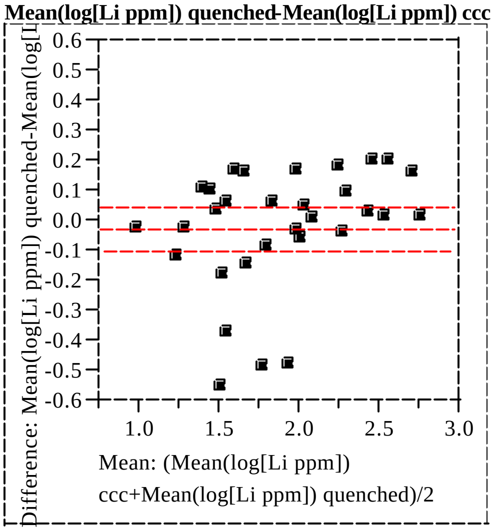
Mean(log[B ppm]) quenched	2.03035	t-Ratio	-0.56841
Mean(log[B ppm]) ccc	2.0558	DF	30
Mean Difference	-0.0255	Prob > |t|	0.5740
Std Error	0.04478	Prob > t	0.7130
Upper95%	0.066	Prob < t	0.2870
Lower95%	-0.1169		
N	31		
Correlation	0.90471		

Difference:
Mean(log[Na ppm]) quenched-Mean(log[Na ppm]) ccc



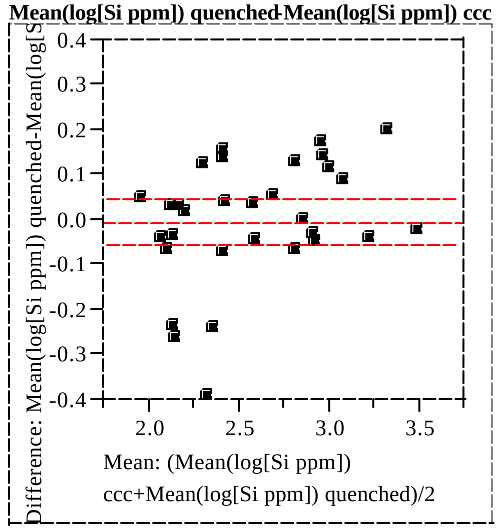
Mean(log[Na ppm]) quenched	2.68899	t-Ratio	0.153475
Mean(log[Na ppm]) ccc	2.68415	DF	30
Mean Difference	0.00484	Prob > |t|	0.8791
Std Error	0.03154	Prob > t	0.4395
Upper95%	0.06925	Prob < t	0.5605
Lower95%	-0.0596		
N	31		
Correlation	0.93669		

Difference:
Mean(log[Li ppm]) quenched-Mean(log[Li ppm]) ccc



Mean(log[Li ppm]) quenched	1.87158	t-Ratio	-0.82529
Mean(log[Li ppm]) ccc	1.90157	DF	30
Mean Difference	-0.03	Prob > |t|	0.4157
Std Error	0.03634	Prob > t	0.7921
Upper95%	0.04422	Prob < t	0.2079
Lower95%	-0.1042		
N	31		
Correlation	0.9159		

Difference:
Mean(log[Si ppm]) quenched-Mean(log[Si ppm]) ccc



Mean(log[Si ppm]) quenched	2.57436	t-Ratio	-0.18839
Mean(log[Si ppm]) ccc	2.57896	DF	30
Mean Difference	-0.0046	Prob > |t|	0.8518
Std Error	0.02443	Prob > t	0.5741
Upper95%	0.04529	Prob < t	0.4259
Lower95%	-0.0545		
N	31		
Correlation	0.95445		

Exhibit D.9: Correlations and Scatter Plots of Normalized PCTs Over All Compositional Views/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	0.9869	0.9823	0.9440
log NL[Li(g/L)]	0.9869	1.0000	0.9751	0.9433
log NL[Na (g/L)]	0.9823	0.9751	1.0000	0.9618
log NL[Si (g/L)]	0.9440	0.9433	0.9618	1.0000

Scatterplot Matrix

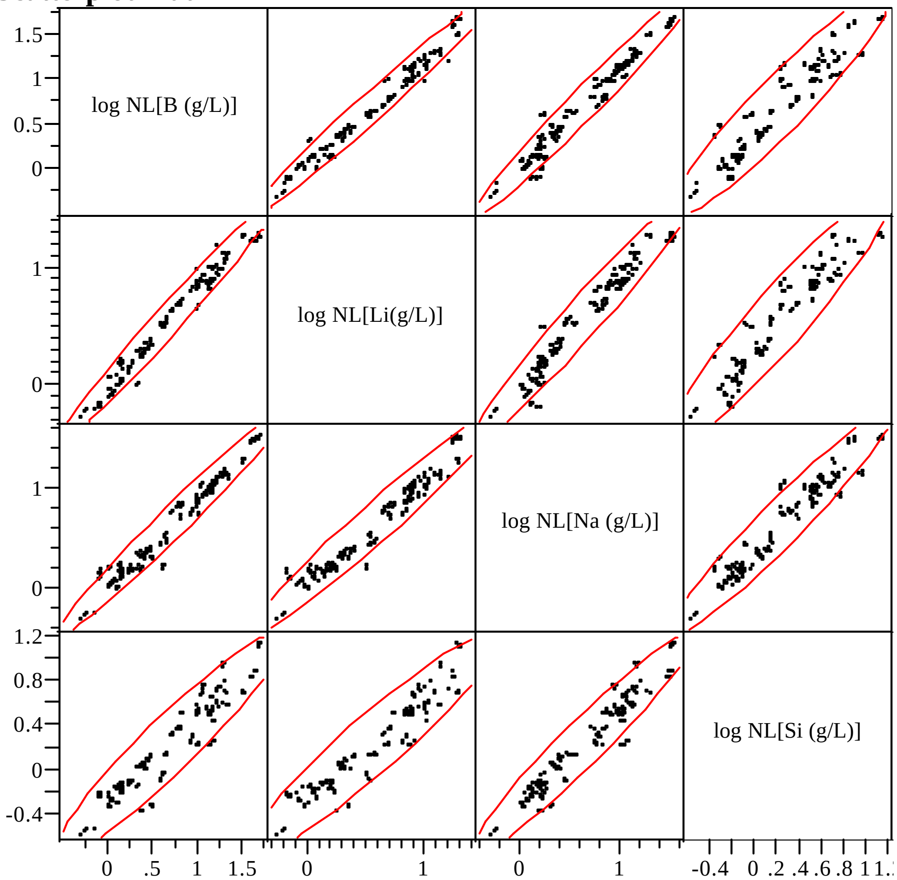
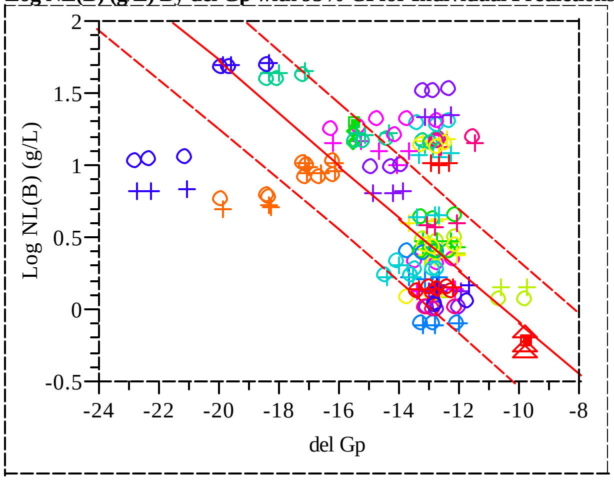


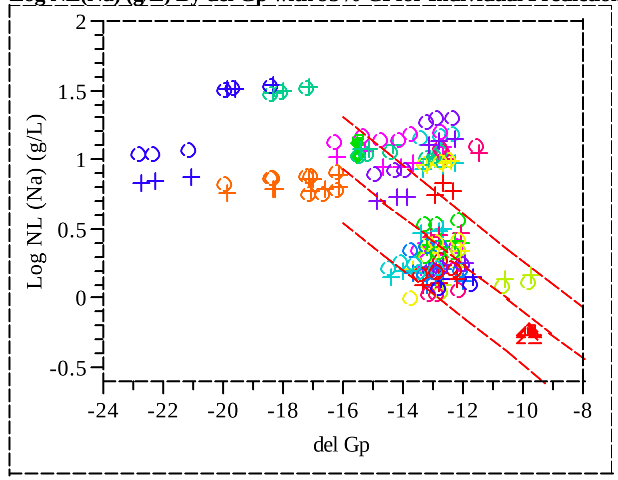
Exhibit D.10: del Gp (ΔG_p) Predictions versus Common Logarithm Normalized Leachate (log NL[.]) for B, Li, Na, and Si by Compositional View/Heat Treatment

All Data

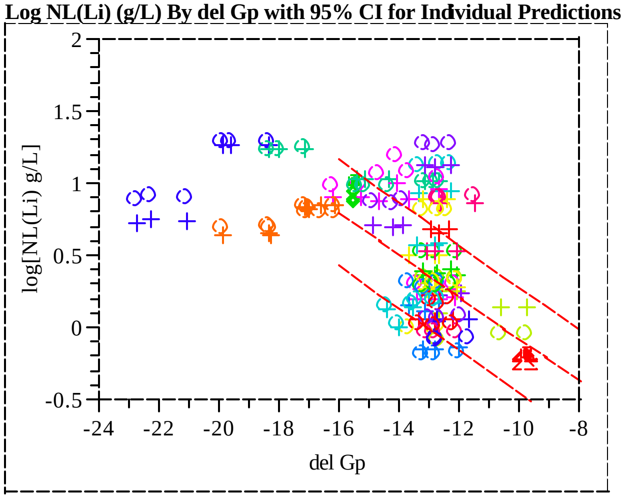
Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions



Log NL(Na) (g/L) By del Gp with 95% CI for Individual Predictions



Log NL(Li) (g/L) By del Gp with 95% CI for Indvidual Predictions



Log NL(Si) (g/L) By del Gp with 95% CI for Individual Predictions

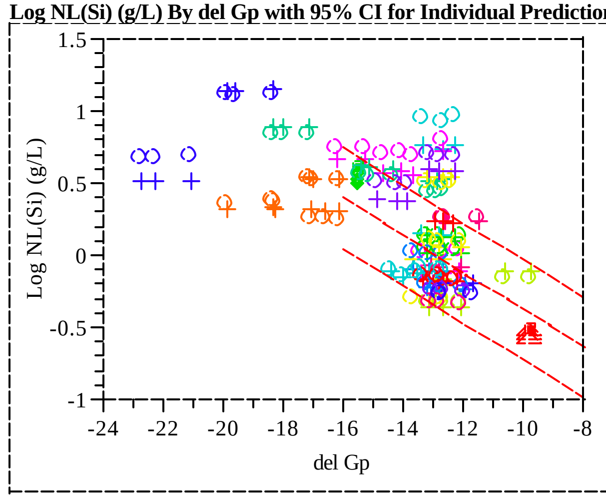
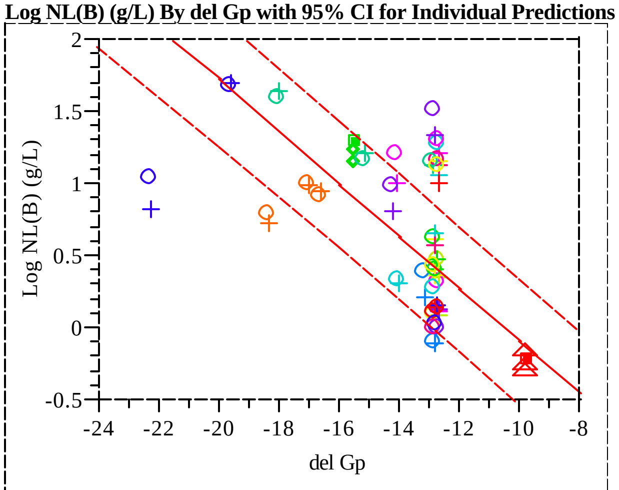


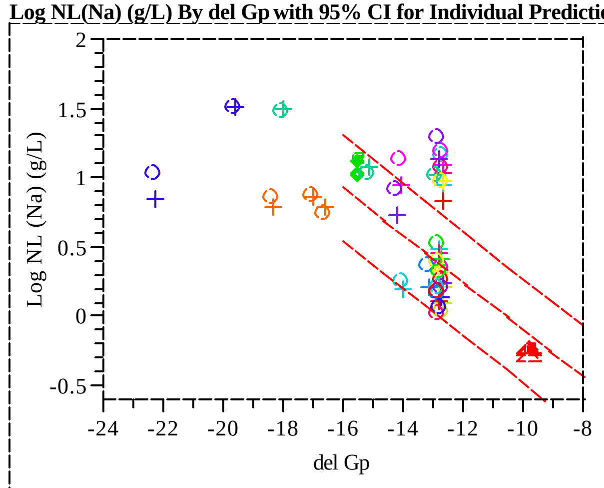
Exhibit D.10: del Gp (ΔG_p) Predictions versus Common Logarithm Normalized Leachate (log NL[.]) for B, Li, Na, and Si by Compositional View/Heat Treatment *(continued)*

Targeted Compositions

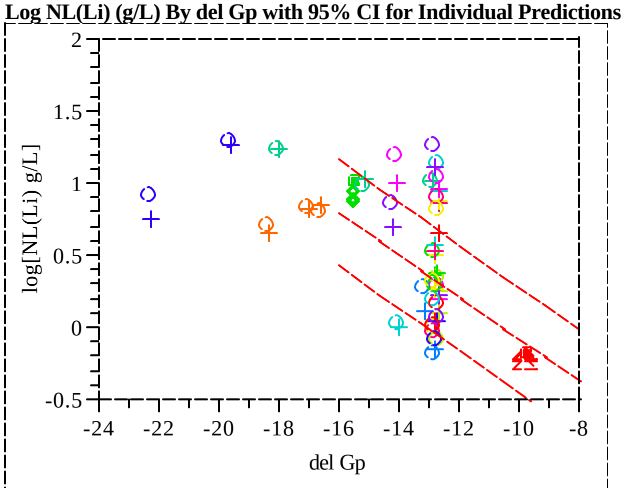
Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions



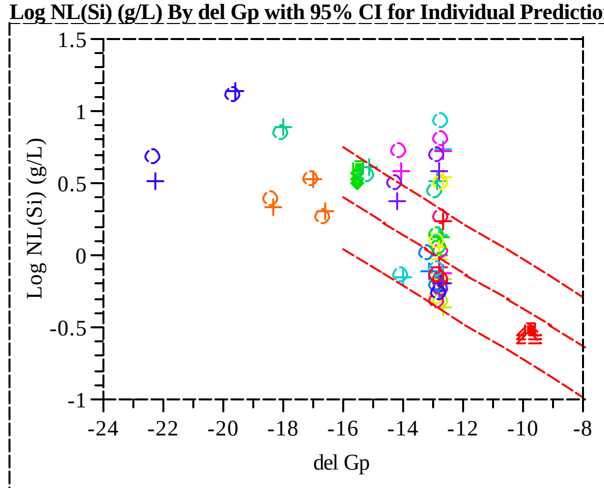
Log NL(Na) (g/L) By del Gp with 95% CI for Individual Predictions



Log NL(Li) (g/L) By del Gp with 95% CI for Individual Predictions

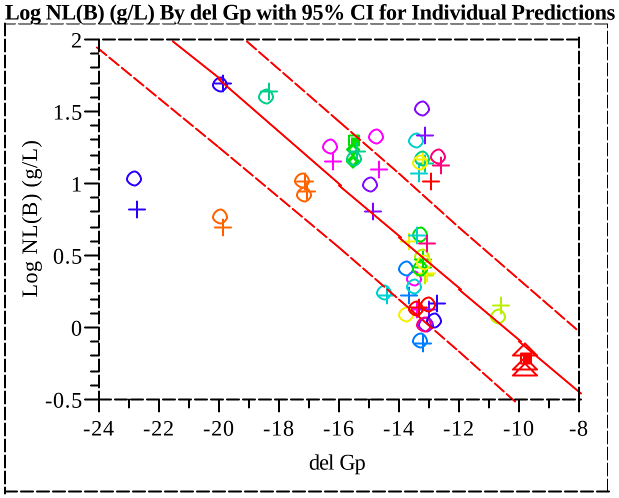


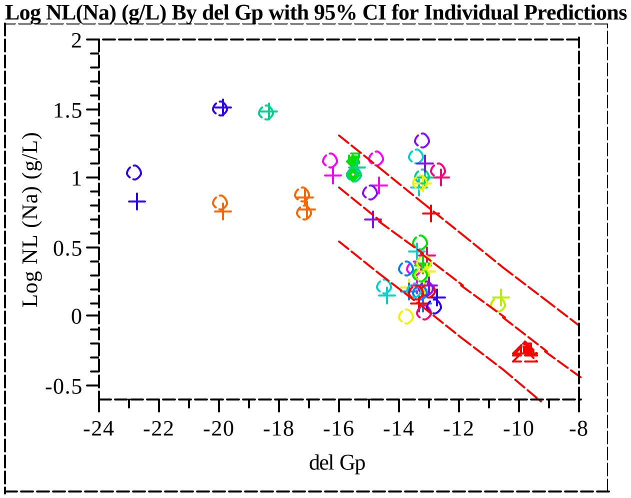
Log NL(Si) (g/L) By del Gp with 95% CI for Individual Predictions

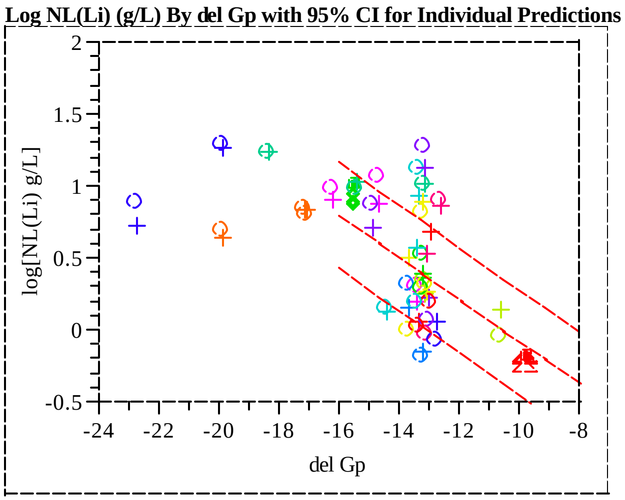


ExhibitD.10: del Gp (ΔG$_p$) Predictions versus Common Logarithm Normalized Leachate (log NL[ ]) for B, Li, Na, and Si by Compositional View/Heat Treatment *(continued)*

Measured Compositions







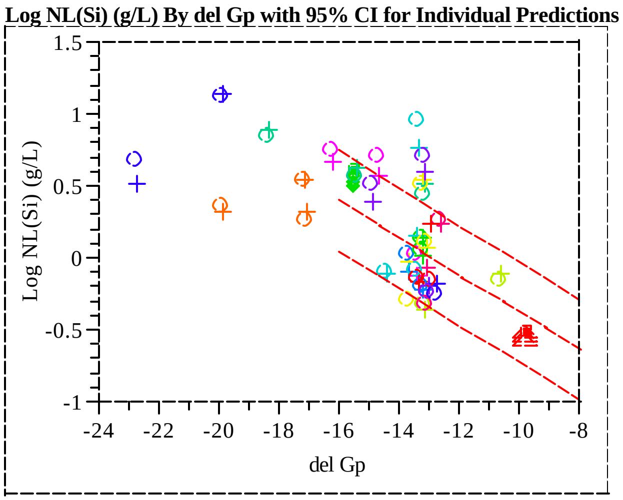
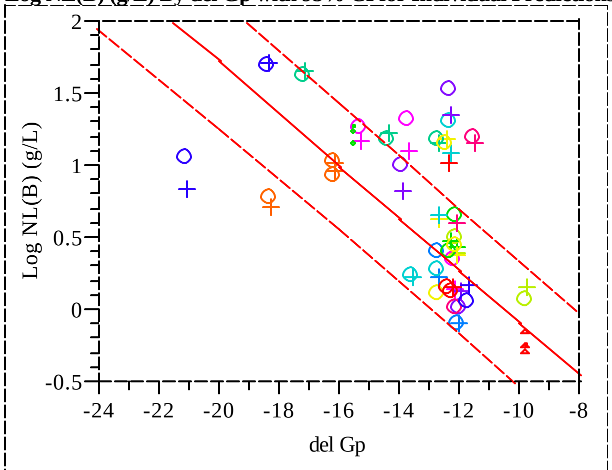


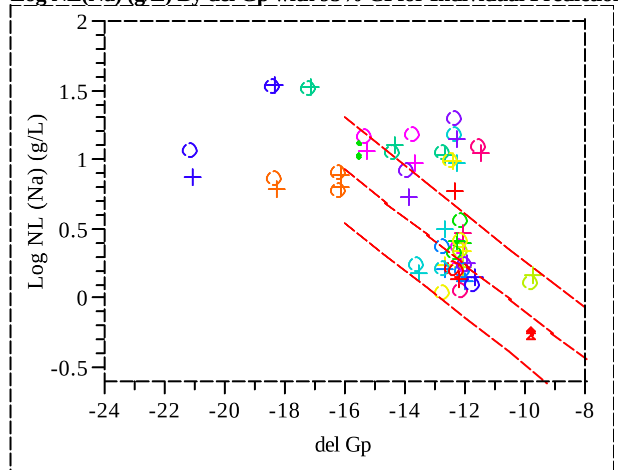
Exhibit D.10: del Gp (ΔG_p) Predictions versus Common Logarithm Normalized Leachate (log NL[ ]) for B, Li, Na, and Si by Compositional View/Heat Treatment *(continued)*

Measured bc Compositions

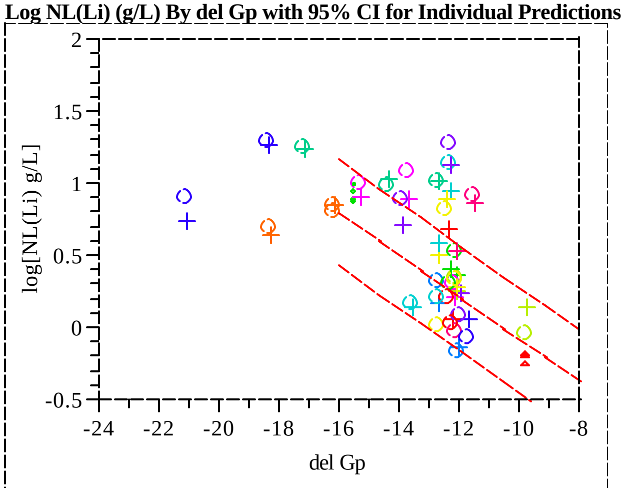
Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions



Log NL(Na) (g/L) By del Gp with 95% CI for Individual Predictions



Log NL(Li) (g/L) By del Gp with 95% CI for Individual Predictions



Log NL(Si) (g/L) By del Gp with 95% CI for Individual Predictions

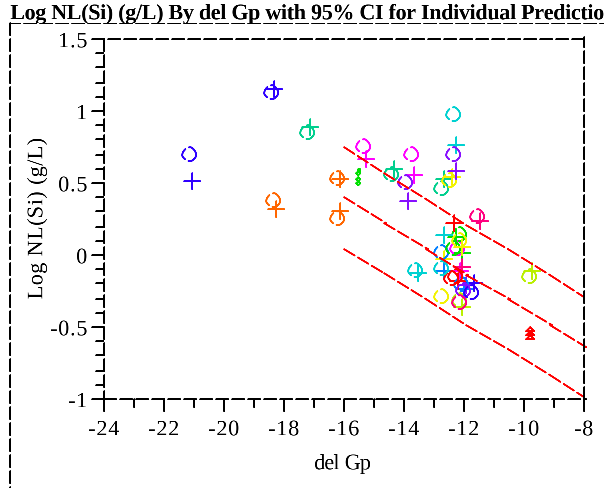
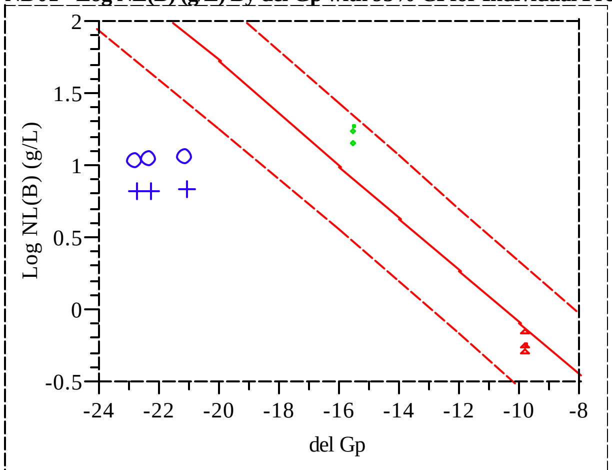
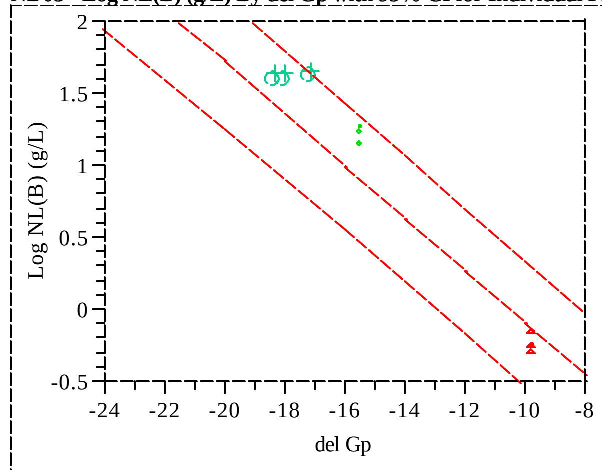


Exhibit D.11: del Gp (ΔG_p) Predictions versus Common Logarithm Normalized Leachate for B, (log NLB [ ]), by Glass ID - AllCompositional Views/Heat Treatments with EA and ARM

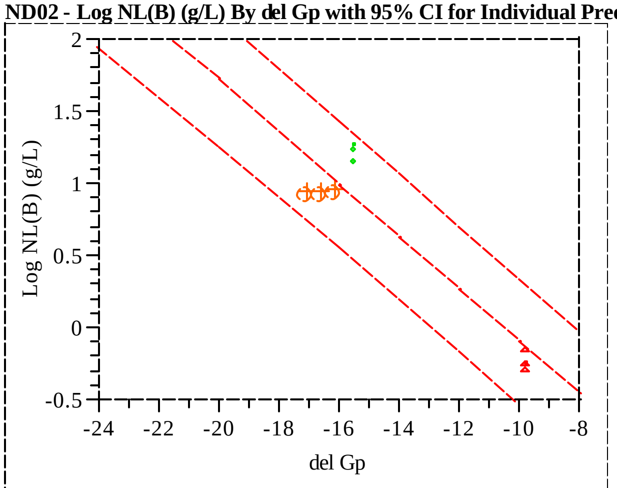
ND01 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions



ND03 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions



ND02 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions



ND04 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions

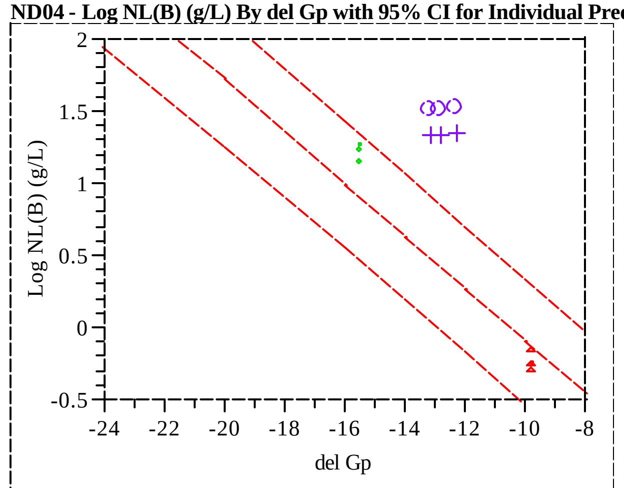
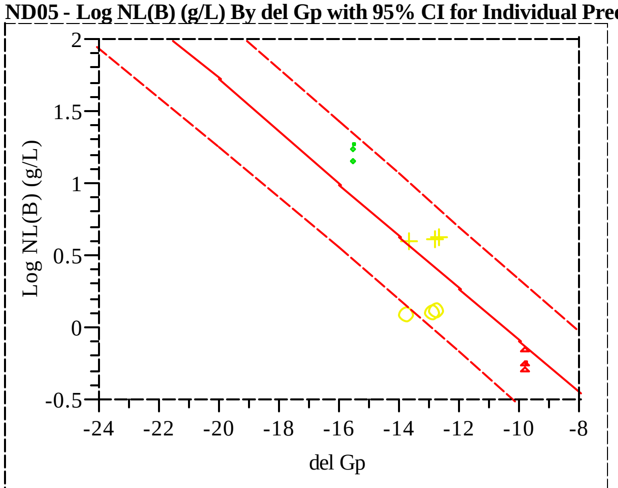
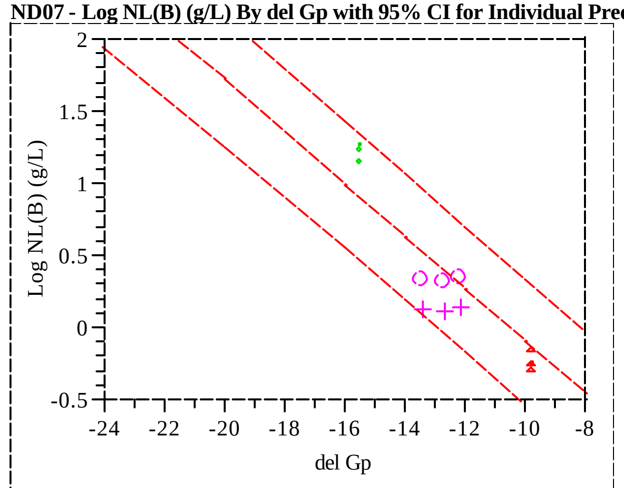


Exhibit D.11: del Gp (ΔG_p) Predictions versus Common Logarithm Normalized Leachate for B, (log NLB [ ]), by Glass ID - AllCompositional Views/Heat Treatments with EA and ARM *(continued)*

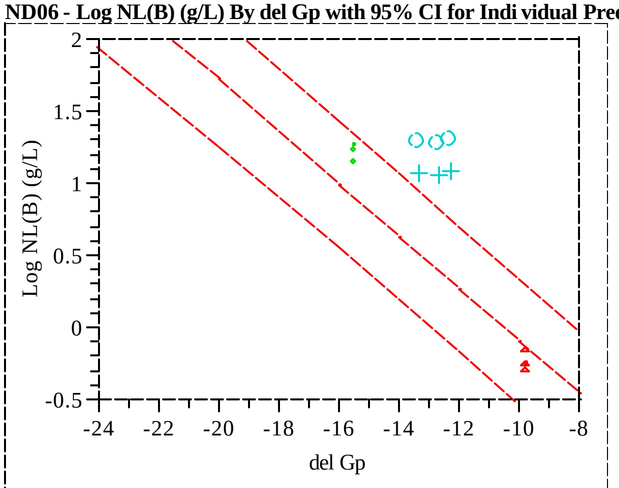
ND05 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions



ND07 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions



ND06 - Log NL(B) (g/L) By del Gp with 95% CI for Indi vidual Predictions



ND08 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions

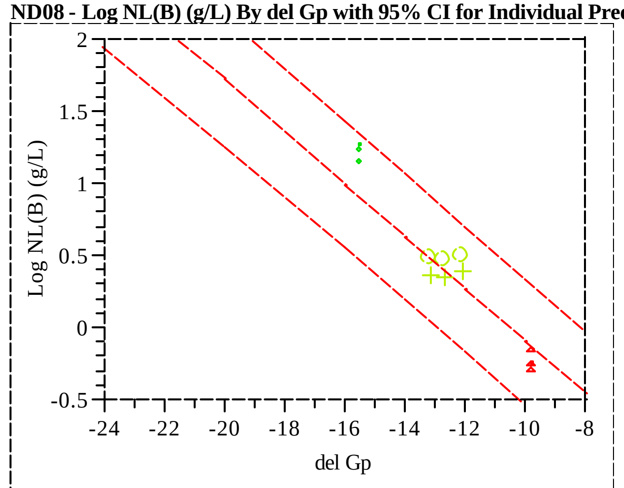
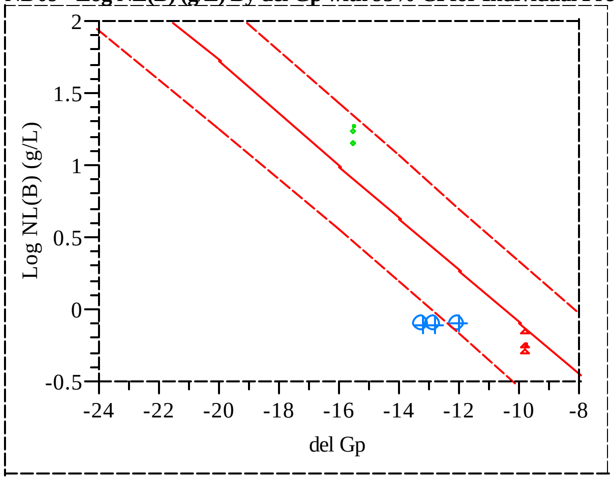
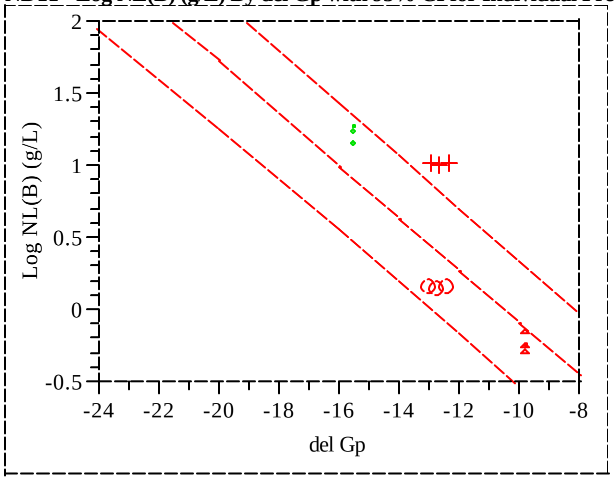


Exhibit D.11: del Gp (ΔG$_p$) Predictions versus Common Logarithm Normalized Leachate for B, (log NLB [ ]), by Glass ID - AllCompositional Views/Heat Treatments with EA and ARM *(continued)*

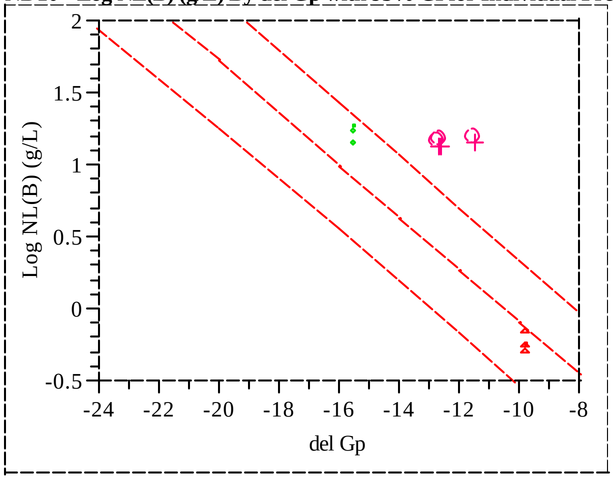
ND09 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions



ND11 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions



ND10 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions



ND12 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions

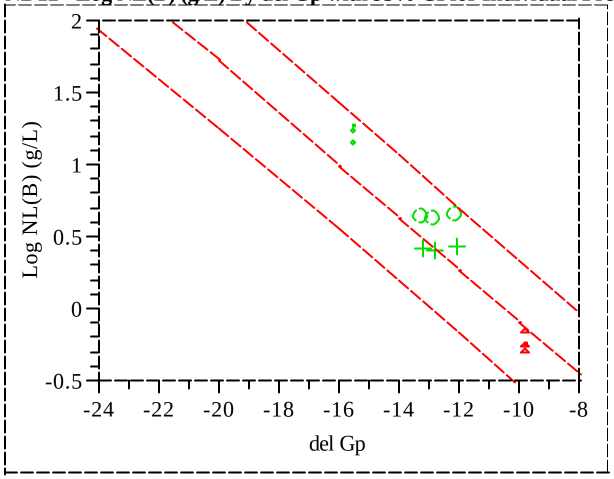
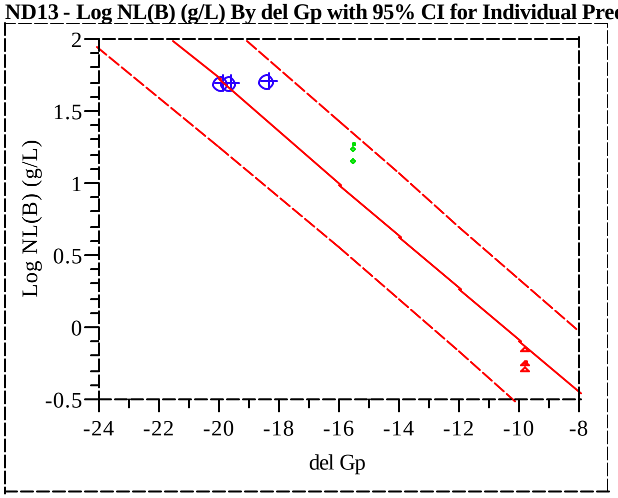
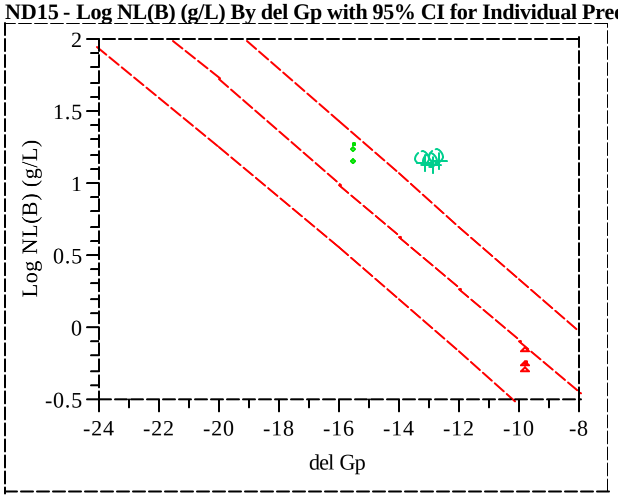


Exhibit D.11: del Gp (ΔG$_p$) Predictions versus Common Logarithm Normalized Leachate for B, (log NLB [ ]), by Glass ID - All Compositional Views/Heat Treatments with EA and ARM *(continued)*

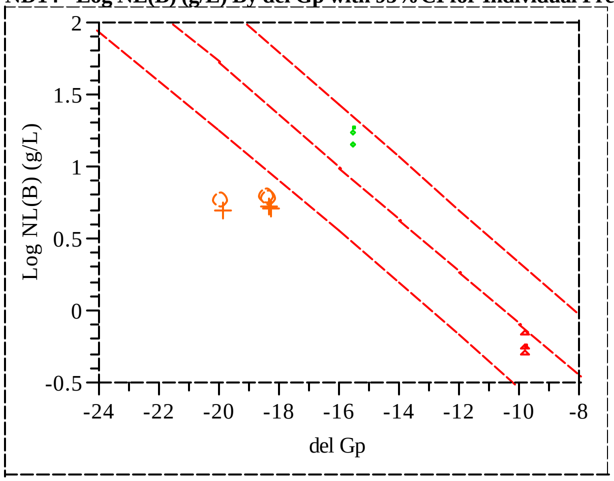
ND13 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions



ND15 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions



ND14 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions



ND16 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions

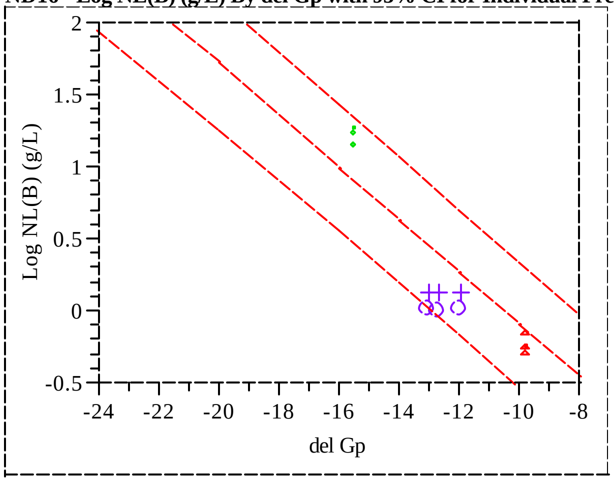
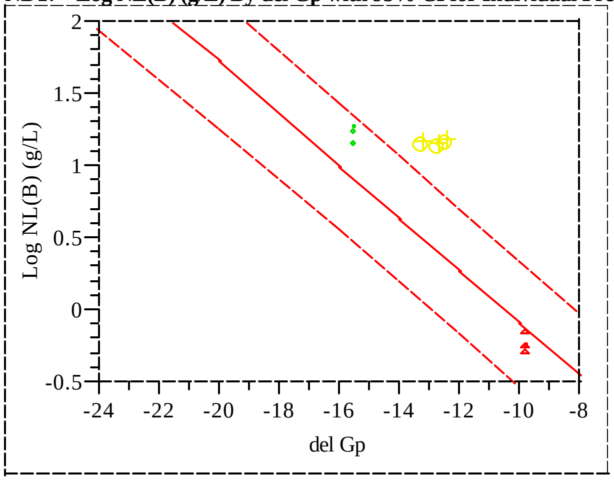
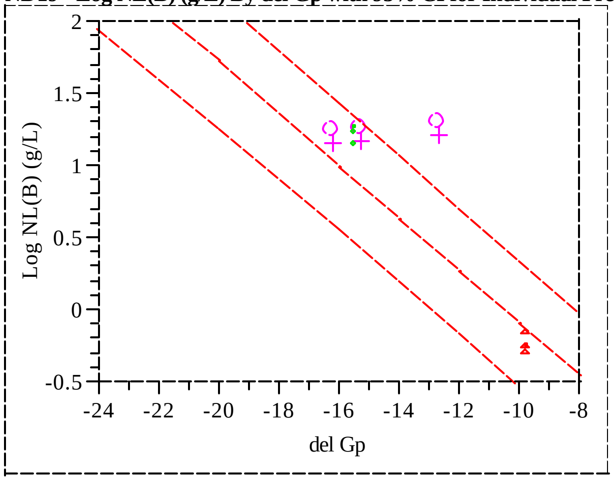


Exhibit D.11: del Gp (ΔG_p) Predictions versus **Common Logarithm Normalized Leachate for B, (log NLB [ ]), by Glass ID - AllCompositional Views/Heat Treatments with EA and ARM** *(continued)*

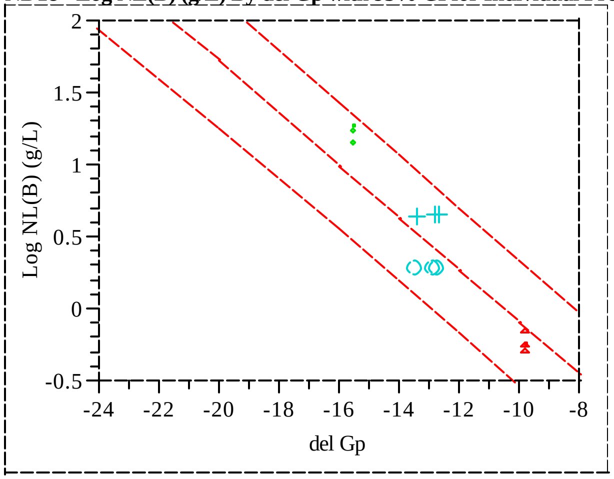
ND17 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions



ND19 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions



ND18 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions



ND20 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions

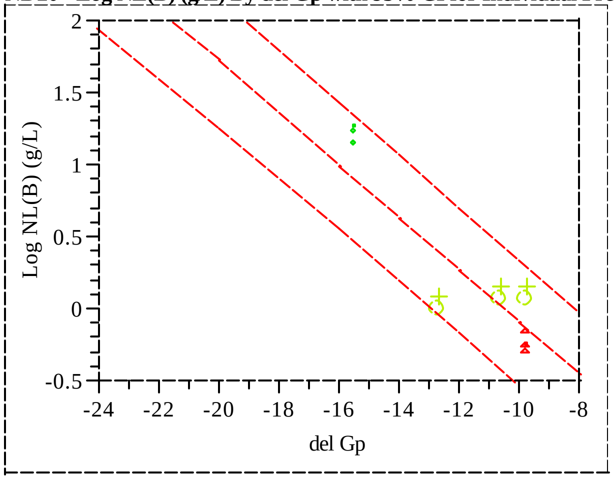
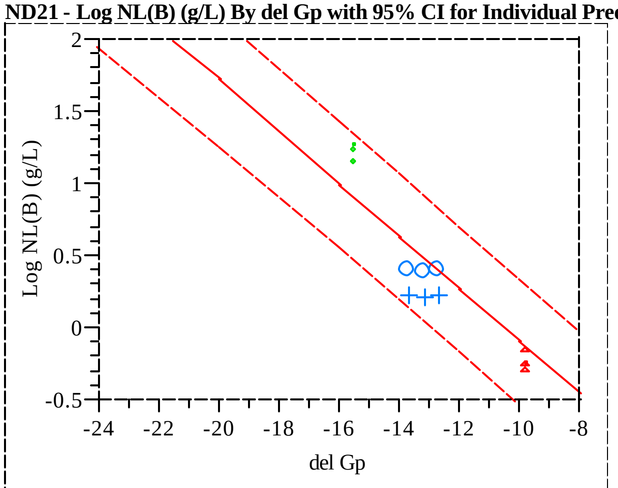
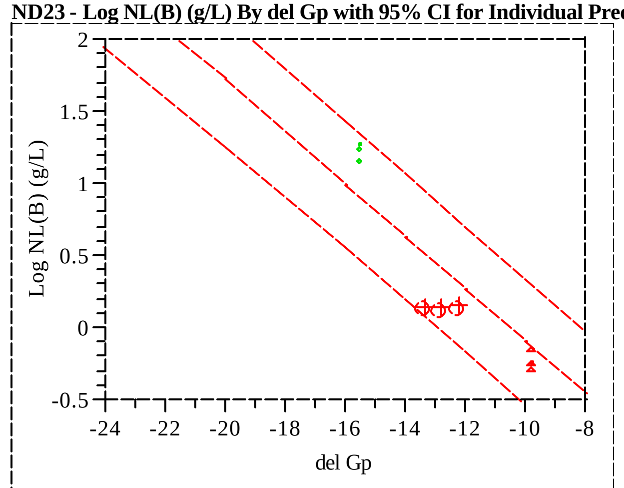


Exhibit D.11: del Gp (ΔG_p) Predictions versus Common Logarithm Normalized Leachate for B, (log NLB [ ]), by Glass ID - AllCompositional Views/Heat Treatments with EA and ARM *(continued)*

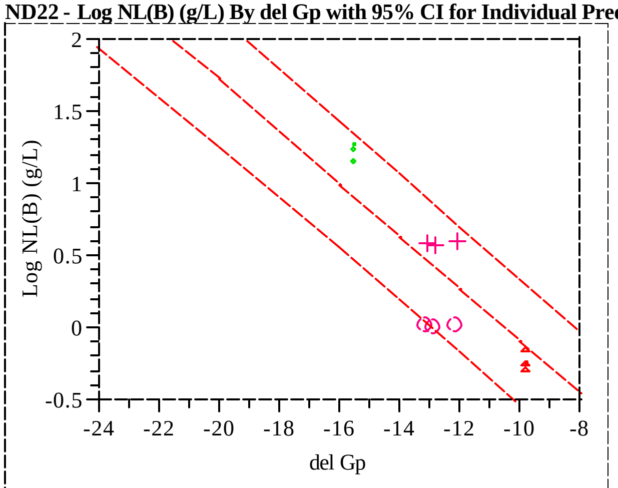
ND21 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions



ND23 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions



ND22 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions



ND24 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions

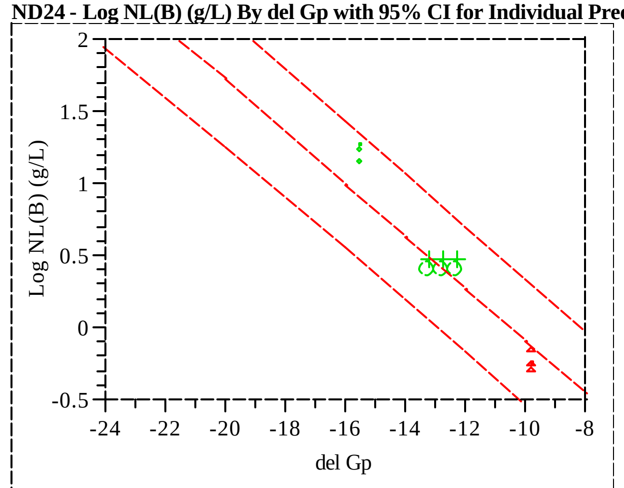
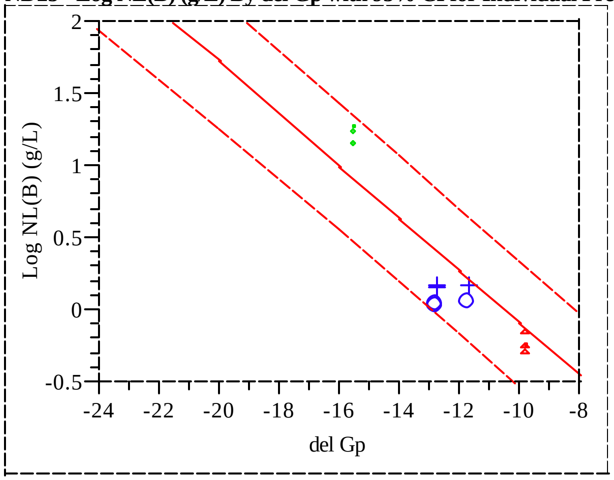
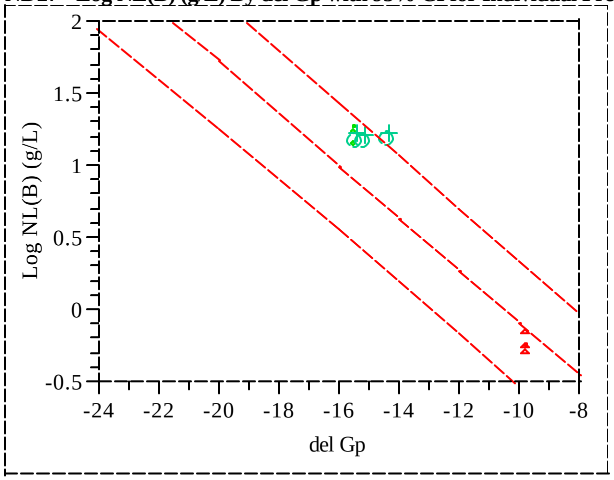


Exhibit D.11: del Gp (ΔG$_p$) Predictions versus Common Logarithm Normalized Leachate for B, (log NLB [ ]), by Glass ID - AllCompositional Views/Heat Treatments with EA and ARM *(continued)*

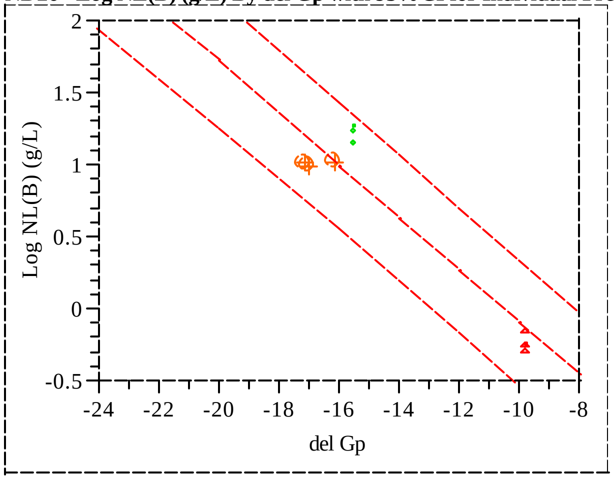
ND25 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions



ND27 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions



ND26 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions



ND28 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions

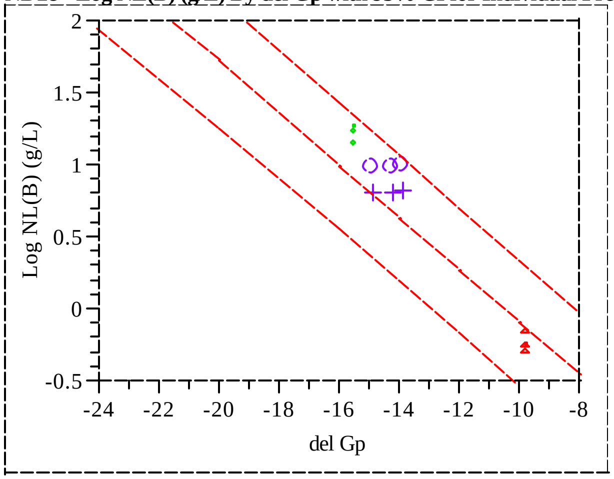
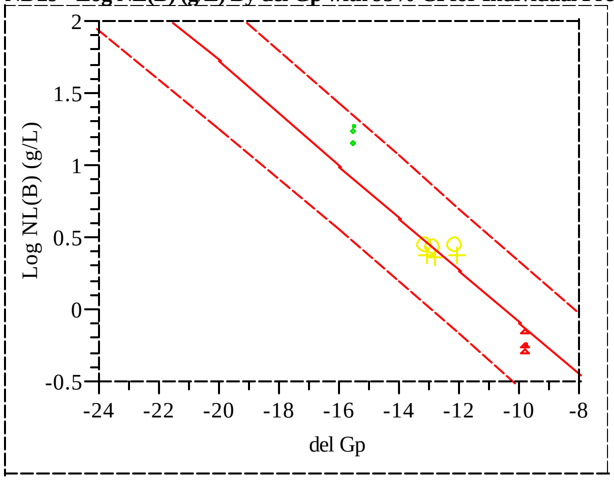
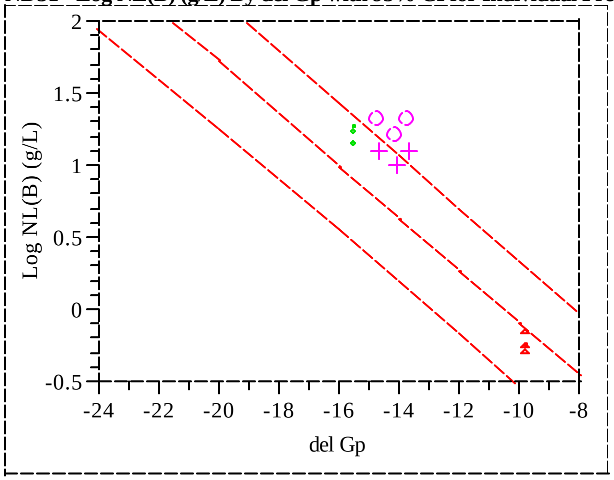


Exhibit D.11: del Gp (ΔG_p) Predictions versus Common Logarithm Normalized Leachate for B, (log NLB [ ]), by Glass ID - AllCompositional Views/Heat Treatments with EA and ARM *(continued)*

ND29 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions



ND31 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions



ND30 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions