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REDUCTION OF CONSTRAINTS:

Phase 2 Experimental Assessment for Sludge-Only Processing

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Executive Summary

The homogeneity constraint is currently used by the Defense Waste Processing Facility (DWPF) to discriminate compositions that are likely to result in glasses containing glass-in-glass amorphous phase separation from compositions that are likely to be homogeneous. The durability of glasses containing amorphous phase separation can be unpredictable so a phase separation discriminator was developed and implemented as part of the Product Composition Control System (PCCS) to avoid processing unacceptable phase separated glasses in the DWPF. However, implementation of the homogeneity constraint (i.e., the amorphous phase separation discriminator) has resulted in an overly restrictive operating region for the DWPF (i.e., it has limited processing in regions that would have resulted in acceptable glasses being produced). Therefore, studies were initiated to determine if the homogeneity constraint could be eliminated or replaced by other compositional constraints that would prevent the processing of unpredictable glasses while still allowing processing flexibility for DWPF during sludge-only processing. At the same time, the alternative constraint must not compromise product quality.

Results from the initial Reduction of Constraints (RC) paper study and the Phase 1 assessment of the typical sludge types and the next two sludge batches (i.e., sludge batch 3 and sludge batch 4) provided supporting evidence that the homogeneity constraint could be replaced by an Al_2O_3 and sum of alkali constraints without sacrificing glass acceptability or the ability to predict glass durability in the DWPF. The objective of this phase of the RC experimental study, Phase 2, was to further challenge the homogeneity constraint over a bounding glass compositional region for sludge-only processing. The constraint was challenged while monitoring the durability responses for both quenched (q) and centerline canister cooled (ccc) glasses within this composition region. In keeping with precedents set in other DWPF studies, replacing the homogeneity constraint with the Al_2O_3 and/or sum of alkali criterion over the composition region of interest could be technically defended if sufficient evidence establishes the fact that even unpredictable glasses are acceptable based on a predefined durability performance acceptance criterion. For Phase 2, unconditional elimination of the homogeneity constraint would also be possible if all glasses within the bounding glass composition region were predictable with PCCS and/or had acceptable durability regardless of the homogeneity classification. In this report and as was done in Phase 1 of the assessment, working definitions of predictable and acceptable with respect to durability have been established and utilized.

For Phase 2, forty glass compositions were selected for testing from three distinct regions. Sixteen of the compositions were selected from the outer-most bounding region, fifteen were selected from a more constrained inner layer of this bounding region, and the remaining nine compositions were selected from the Phase 1 study and represented compositions for sludge batches 3 and 4. Thirty-six of the forty compositions failed the homogeneity constraint; thus, ample opportunity was provided to challenge the homogeneity constraint. In this study, seventy-six of the eighty RC glasses (when considering both quenched and centerline canister cooled versions of the forty target compositions) were either predictable and/or acceptable with respect to durability regardless of homogeneity classification. All glasses tested representing sludge batch 3 and sludge batch 4 combined with Frit 320 (i.e., nine of the forty compositions or eighteen of the eighty glasses when heat treatment is considered) were predictable and acceptable with respect to durability. This included one glass, RC-97, that was a target replicate of a glass from the Phase 1 testing that had inconsistent results. The fifteen, or thirty when both heat treatments are considered, glasses representing the inner layer of the bounding compositional region were all also all predictable and/or acceptable with respect to durability. In fact, only four of these fifteen were not both predictable and acceptable. Three of the compositions were below the 95% confidence predictability band for durability for the measured composition representation for both heat treatments, but were predictable and acceptable for all other compositional representations. The other composition, RC-80, was a glass that was misbatched and contained no Al_2O_3, therefore, it was out of the bounding region for this task. Its durability was not acceptable but it was predictable for all representations. Finally, the remaining glasses were from the outer

layer of the bounding glass compositional region. A total of thirty-two glasses were tested from this region when both heat treatments are considered, and all but four were either predictable and/or acceptable. Glasses RC-70q, RC-70ccc, RC-71ccc, and RC-72q did not meet the predictable and/or acceptable definitions. All of the targeted compositions for these glasses were predicted to be inhomogeneous by the homogeneity constraint. However, when the glasses were assessed against the suggested Al_2O_3 and/or sum of alkali criteria, RC-72q did not meet the existing limit for alkali with an Al_2O_3 concentration of $\geq$3%. The other glasses did meet the Al_2O_3 and sum of alkali criteria. Although the homogeneity constraint would have prevented these compositions from being processed, it would have also prevented the processing of ten other compositions from the outer layer that were acceptable but were predicted to be inhomogeneous. Through the use of the Al_2O_3 and sum of alkali criteria and the data driven approach used in this study, previous RC studies, and the DWPF variability studies, the intent of the homogeneity constraint has been met by identifying unacceptable processing regions. In other words, the studies have shown that, by performing glass testing in proposed regions, the adequacy of the existing models can be evaluated and actual durability performance can be measured. The studies give the indication as to glass acceptability and they also meet the intent of applying the homogeneity constraint (i.e., assuring that DWPF glasses will be predictable and acceptable from a durability perspective). With this in mind, the homogeneity constraint could be replaced by the Al_2O_3 and sum of alkali constraints as long as the intent of the homogeneity constraint was met in the variability studies before DWPF accepts sludge batches. Therefore, the DWPF has been and should continue to be prohibited from processing unacceptable glass compositions through the on-going performance of variability studies and non-traditional feed impact studies for DWPF.

When the compositions of glasses RC-70q, RC-70ccc, and RC-71ccc are considered, both the Al_2O_3 and Fe_2O_3 concentrations are at the minimum limits in the bounding glass compositional region. This combination represents a region that has not been extensively studied for DWPF glass processing because most high level waste sludge contains significant quantities of Al_2O_3 or Fe_2O_3 or appreciable quantities of both. Since the region has not been extensively studied, the existing DWPF control models, especially for durability, may not directly apply. In order for this region to be better understood, additional studies are recommended as part of the continued DWPF durability model assessment. In fact, some glasses of this outer region have already been fabricated as part of the latest durability assessment task.

Based on the results of this assessment and the conclusions from other SRTC assessments, SRTC recommends the replacement of the homogeneity constraint (in its entirety with the associated low/high frit constraints) with the continued use of the Al_2O_3 and/or sum of alkali criteria and the continued performance of variability studies for each sludge batch or glass studies for proposed DWPF feed changes to meet the intent of the homogeneity constraint.

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Acronyms

ADS	Analytical Development Section
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	preliminary glass dissolution estimator based on free energy of hydration (in kcal/mol)
DWPF	Defense Waste Processing Facility
EA	Environmental Assessment
EDS	Energy Dispersive Spectroscopy
EPAR	Expected Property Acceptability Region
HLW	high-level waste
ICP	Inductively Coupled Plasma
IDMS	Integrated DWPF Melter System
LM	lithium-metaborate
MAR	Measurement Acceptability Region
PAR	Property Acceptability Region
PCCS	Product Composition Control System
PCT	Product Consistency Test
PCT-A	Product Consistency Test – Method A
PF	peroxide fusion
PNNL	Pacific Northwest National Laboratory
RC	reduction of constraints
SB	sludge batch
SEM	Scanning Electron Microscopy
SME	Slurry Mix Evaporator
SRS	Savannah River Site
SRTC	Savannah River Technology Center
SRTC-ML	Savannah River Technology Center – Mobile Laboratory
Tg	glass transition temperature
T_L	liquidus temperature
THERMO™	Thermodynamic Hydration Energy Reaction Model
TTR	technical task request
U_{std}	uranium standard
$\eta_{1150°C}$	melt viscosity at 1150°C
XRD	X-ray Diffraction

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1.0 Introduction

The Defense Waste Processing Facility (DWPF) is currently immobilizing high level radioactive wastes in borosilicate glass using a "sludge-only" flowsheet. The glass that is produced is poured into stainless steel canisters that will eventually be disposed of in a permanent, geological repository.

DWPF uses the Product Composition Control System (PCCS) to determine the acceptability of each batch of Slurry Mix Evaporator (SME) feed before processing in the melter. Acceptability is determined by the PCCS by imposing several constraints on the SME content composition. The PCCS constraints relate process or product properties, which take into account modeling, sampling, and analytical uncertainties. The uncertainties are accounted for in two steps. The first is the uncertainty due to the property models, which when accounted for provides the Property Acceptability Region (PAR). The second, and more restrictive, is the uncertainty due to sampling and analytical (grouped under the heading of measurement). This uncertainty is accounted for, when necessary, in addition to the property uncertainty, and the resulting region defines the Measurement Acceptability Region (MAR). The baseline document guiding the use of these data and models as they were applied to this study was "SME Acceptability Determination for DWPF Process Control" by Brown and Postles [1].

Several PCCS constraints support the prediction of the glass durability for a given SME batch, and the Savannah River Technology Center (SRTC) is reviewing these constraints [2]. The purpose of this review is two fold: 1) to revisit these constraints in light of the additional knowledge gained since the beginning of radioactive operations at DWPF and 2) to identify any supplemental studies needed to complement this knowledge so that redundant or overly conservative constraints can be relaxed and/or replaced by simpler constraints.

The specific PCCS constraint, which was evaluated for this study, was the homogeneity constraint. The homogeneity constraint was implemented to discriminate between glasses containing amorphous phase separation and homogeneous glasses. The basis for the constraint is to minimize the potential to produce amorphous phase separated glasses in the DWPF. The Product Consistency Test (PCT), ASTM C1285, response of glasses containing amorphous phase separation has been shown to be unpredictable [(3) and (4)]. Hence, a discriminator to avoid unpredictable behavior was developed so that the durability model could be limited to homogeneous glasses or glasses containing isotropic crystals such as spinel. The homogeneity constraint was derived from a discriminate analysis of 110 glasses (88 homogeneous and 22 phase-separated) in sludge versus frit-composition space [(3), (4), and (5)] and is a linear discriminate function of terms representing sludge and frit where higher concentrations of sludge components appear to lessen the chances for formation of amorphous phase separation.

In actual DWPF operation, implementation of this constraint has been overly conservative and has restricted the allowable glass composition processing envelope. In the sludge batch 1b (SB1b) variability study, application of the homogeneity constraint at the MAR limit eliminated much of the DWPF potential operability window [(6) and (7)]. Consequently and as part of the SB1b study, an evaluation of an existing property-composition database was performed and two new options for PCCS were created:

Criterion (1)

- use the alumina constraint as currently implemented in PCCS ($Al_2O_3 \geq 3$ wt%) **and** add a sum of alkali[(a)] constraint with an upper limit of 19.3 wt% ($\Sigma M_2O < 19.3$ wt%),

or

(a) Alkalis included in this sum are Na_2O, Li_2O, Cs_2O, and K_2O. However, for sludge-only processing, neither Cs_2O nor K_2O is introduced at significant concentrations, so the sum of alkali is based solely on Na_2O and Li_2O.

Criterion (2)
- adjust the lower limit on the alumina constraint to 4 wt% ($Al_2O_3 \geq 4.0$ wt%).

These options allowed DWPF to relax the homogeneity constraint from a measured acceptance criterion (i.e., the MAR) to a property acceptance criterion (i.e., the PAR) for SB1b.

The Al_2O_3 and sum of alkali constraints were based on the fact that Al_2O_3 is known to suppress the formation of amorphous phase separation in borosilicate glasses [(3), (4), (8), and (9)] and that sufficient quantities of Al_2O_3 have a positive impact on durability (usually independent of any homogeneity classification). On the other hand, relatively high quantities of alkali metal oxides may result in a reduction in borosilicate glass durability [(3) and (8)]. Nevertheless, durable simulated waste glasses have been produced with alkali concentrations exceeding 20 wt% [(10) – (15)]. In addition, criterion (1) constrains the glass composition in a durability region where the strong bases to weak acids are balanced in the leachate [3]. When criteria (1) and (2) were developed, they were created over the compositional envelopes previously tested, and it may be necessary to impose an upper alkali constraint for criterion (2) in certain glass-composition spaces.

At the time, Edwards and Brown evaluated the criteria against the existing composition-property database (> 1300 data points) [(a)] to gain a better understanding of the relationship between the alumina and the sum of alkali and the leaching behavior [6]. The majority of the data in the database was based on glasses that had been quenched from the melt temperature, although some of the data was collected from canisters filled from melter runs such as the Integrated DWPF Melter System (IDMS).

All but six glasses were classified as acceptable for processing independent of the homogeneity classification when either of the proposed criteria (1 or 2) was applied to the extensive database. Acceptability was based on glasses having a log NL [B] < 1.0, which was used to assure a boron release below the Environmental Assessment (EA) glass boron release with consideration of uncertainties [16]. As noted by Edwards and Brown, these six glasses were outside the feasible composition range for glasses expected to be produced during the processing of SB1b and contained either low concentrations of Fe_2O_3 (< 2.5 wt%) or high concentrations of B_2O_3 (> 19.6 wt%) [6]. Insufficient tetrahedral Fe_2O_3 has been hypothesized by Jantzen and Brown to lead to the inability to stabilize the glass network against phase separation [4]. High B_2O_3 0concentrations, on the other hand, can promote amorphous phase separation [(3), (8), and (17)]. All other glasses with Al_2O_3 exceeding 3 wt% and the ΣM_2O less than 19.3 wt% (Criterion 1) provided PCT results of log NL [B] < 1.0 [6]. The data also indicated that if the lower limit for Al_2O_3 were increased to 4.0 wt% (Criterion 2), there was not a need to add an upper sum of alkali constraint (over the glasses evaluated) to avoid glasses that had PCT results of log NL [B] > 1.0 or that leach as poorly as EA.

PCCS constraints have not been established for the B_2O_3 and Fe_2O_3 concentrations, since DWPF will not likely reach the limits given above. For the low Fe_2O_3 concentration of 2.5 wt%, the high level waste that will be processed in the DWPF contains significant quantities of iron and current blending strategies do not result in a glass with a level of Fe_2O_3 near this lower limit [18]. With respect to the high B_2O_3 concentrations, use of existing frits (i.e., Frit 200, 202, and 302) coupled with reasonable waste loadings (i.e., 25 to 50 wt%) make the probability of exceeding a glass B_2O_3 concentration of 19.6 wt% impractical.

The technical basis developed by Edwards and Brown for relaxing the homogeneity constraint to the PAR coupled with implementing one of the proposed equivalent criteria provided an increased composition operational window for SB1b operations [6] and was also applied for SB2 [(19), (20), and (21)].

(a) Over 3900 triplicate analyses (whose logarithms were averaged for each glass sample tested) formed the extensive database.

Given the effectiveness of applying the supporting criteria for SB1b and SB2 and the potential overly conservative application of the homogeneity discriminator for projected "sludge-only" glasses, an investigation into the possibility to replace this constraint in favor of the Al_2O_3 and/or sum of alkali criteria was initiated in FY2001 [(2) and (22)]. In Phase 1 of the RC study, the High Level Waste System Plan [23] and process knowledge were used to define the compositions of the five individual (or bounding) waste types and the projected blends for sludge batch 3 (SB3) and sludge batch 4 (SB4). A paper study utilizing these sludge compositions with Frits 165, 200, and 320 at various waste loadings generated a pool of glasses for testing the applicability of the existing PCCS durability related constraints [18]. Glass compositions within this region were assessed (at the PAR) using the current PCCS models [1], including both the existing and newly developed T_L models [24]. A more detailed discussion of the development of the sludge compositional envelopes and the assessment with respect to homogeneity is provided by Peeler et al. [18]. The assessments in the paper study provided strong evidence that the homogeneity constraint could be replaced (or the constraint not challenged) if DWPF were to transition from Frit 200 to either Frit 165 or Frit 320 and were to implement the new T_L model. Implementing the new T_L model allowed for higher WLs to be targeted, which lowered the dependence on the homogeneity constraint (consistent with historical observations).

After the initial paper study assessment, a Phase 1 experimental program was initiated and 34 compositions were fabricated to evaluate the homogeneity constraint [25]. Select centroid-based glasses (i.e., those that were feasible and met processing constraints) of these processing regions were batched, melted, and subjected to durability testing. The centroid-based glasses rarely challenged homogeneity, but six glasses were selected (covering the three frits of interest) that were predicted to be inhomogeneous. Therefore, the homogeneity constraint could be challenged in this study by monitoring the durability responses for both quenched and centerline-canistered cooled (ccc) glasses within this composition region. More specifically, the durability responses in the Phase 1 study were monitored in terms of predictability and/or acceptability independent of the homogeneity classification. To replace the homogeneity constraint, one must assure that the application of the Al_2O_3 and/or sum of alkali criteria produce glasses that are predictable and/or acceptable irrespective of their homogeneity classification. The results of Phase 1 supported replacement of the homogeneity constraint over the composition region tested. However, the applicability was limited since the glasses were centroid-based, did not account for expected sludge variation during processing, and were frit distinct compositions [25].

Phase 2, which is the subject of this report, was originally intended to test the outer sludge layer compositional regions selected in Phase 1. However, the focus of the compositional region shifted to account for possible compositional changes that may be made to improve melt rate and/or waste loading and to account for potential tank blending scheme changes. A bounding glass compositional region that took into account possible sludge compositional ranges and that would allow for future frit optimization was used instead to select glass compositions for testing. This region was intended to provide a technically defensible approach for eliminating or relaxing the homogeneity constraint for sludge-only processing for existing or newly developed frits. This bounding glass compositional region allows for testing of the constraints over a wider compositional space than identified in the Phase 1 studies and provides the possibility to eliminate processing regions which would not be acceptable or feasible for DWPF. Although upper and lower oxide bounds were defined based on sludge and frit input information, some of the compositions produced at the outer bounds may represent combinations of components that are not feasible with the existing feeds planned for the DWPF. Also, even though property models were used to reduce the risks of producing unacceptable glasses or to eliminate compositional spaces not allowed by PCCS, the existing property models would also not eliminate these infeasible combinations. In defining the bounds, additional measures could have possibly been applied to eliminate these combinations; however, it was felt that the most benefit would be obtained by allowing for as broad a region as possible to accommodate for future DWPF missions. In addition, definition of this compositional region should also provide glass processing regions of interest for future DWPF R&D

studies related to increasing melt rate, waste throughput, and/or waste loading. The upper and lower bounds on the major glass components defining the region were based on individual tank compositions and known borosilicate glass limitations. A total of forty compositions were selected, prepared, and assessed for Phase 2. The results are presented in this report.

The “phased” approach being utilized is solely data driven. That is, if it can be shown that glasses (covering the composition region of interest) are either predictable and/or acceptable, then the homogeneity constraint can be eliminated. However, the data may also show that the replacement of the constraint with the Al_2O_3 and/or sum of alkali criterion or by some other means to meet the intent of the constraint is necessary to cover the bounding glass compositional region. The “phased” approach does not consider a re-evaluation of the homogeneity constraint itself or alternative means of more adequately representing the terms of the constraint – although this may be a technically viable approach.

2.0 Objective Statement

The overall objective of Phase 2 of the study was to fabricate and test forty glass compositions to challenge the homogeneity constraint and determine whether it could be completely eliminated or replaced with supplemental constraints **for projected sludge-only processing**. The supplemental constraints that have been used were described and are restated here:

Criterion (1)

- use the alumina constraint as currently implemented in PCCS ($Al_2O_3 \geq 3$ wt%) **and** add a sum of alkali[(a)] constraint with an upper limit of 19.3 wt% ($\Sigma M_2O < 19.3$ wt%),

or

Criterion (2)

- adjust the lower limit on the alumina constraint to 4 wt% ($Al_2O_3 \geq 4.0$ wt%).

As mentioned above, the homogeneity constraint is currently used to identify compositions that are likely to result in glasses containing amorphous phase separation since the durability of phase-separated glasses can be unpredictable. Glasses in this study will not be evaluated for amorphous or glass-in-glass phase separation. However, the intent of the study is to provide evidence (via technical data) to establish the acceptability of these glasses based on predefined acceptance criteria over the composition region of interest, even if the glasses are unpredictable and are thought to contain amorphous phase separation.

This phase of the work has been prepared to address technical issues discussed in Technical Task Request (TTR) HLW/DWPF/TTR-01-0002 [2]. The activities were performed in accordance with the Task and Technical Quality Assurance (QA) Plan [26] and supplement the work of Peeler et al. [(18) and (25)].

(a) Alkali included in this sum are Na_2O, Li_2O, Cs_2O, and K_2O. However, for sludge-only processing, neither Cs_2O nor K_2O are introduced at significant concentrations, so the sum of alkali is based solely on Na_2O and Li_2O.

3.0 Definitions and Assumptions

In this section, a few critical terms are defined and the technical basis for the application of the free energy of hydration (ΔG_p) model to crystallized glasses is discussed. The definitions discussed below should be considered as "working definitions" that specifically applied to Phase 1 of this work and to this report. They are not intended to be formal definitions for implementation out of context of the RC studies.

3.1 Predictability

In this report, predictability is based on the 95% two-sided confidence interval for an individual PCT response as generated by the THERMO™ ΔG_p model [4]. This definition is consistent with that used in recent variability studies [(20) and (21)]. A comparison is made of the actual leaching performance as determined by the PCT and the prediction limits for an individual glass generated by the THERMO™ model. The durability of a glass is considered predictable if its PCT response is within the 95% confidence interval.

3.2 Acceptability

In this report, the term "acceptable" (in reference to a PCT response) is defined as glasses whose log NL [B] is less than 1.0 (or NL [B] < 10 g/L). This is consistent with the limit used to set the sum of alkali and Al_2O_3 criteria for relaxing the homogeneity constraint from the MAR to the PAR for SB1b [6]. This definition is considered to be conservative relative to the accepted values for the EA glass with consideration of uncertainties [16]. This limit is also considered conservative with respect to the requirements in the DWPF Waste Acceptance Product Specifications that state: "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 ensure that the mean PCT results for each waste type are at least two standard deviations below the mean results of the EA glass" [27]. Table 1 shows the normalized releases for boron, lithium, and sodium as reported by Jantzen et al. [16].

Table 1. Leachate Concentrations of the EA Glass as Reported by Jantzen et al. [16]

	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

3.3 Applying ΔG_P to Inhomogeneous Glasses

Although the ΔG_P model was developed to be applied to homogeneous glasses [(3) and (28)], it was applied to the glasses in this study irrespective of glass homogeneity to get an indication of predictability. This approach has technical merit when the secondary phases that form have minimal impact on the overall durability performance. Since any new phase that precipitates in a glass has the potential to affect the glass matrix, the rate of glass dissolution in water and, thus, chemical durability may be impacted [(10), (29), and (30)]. Jantzen and Bickford [29] indicated that grain boundary dissolution (due the presence of crystals with grain boundaries) was a major contributor to durability (or lack thereof) in crystallized glasses. They further indicated that grain boundary dissolution was more of an effect with species that were non-isotropic (such as acmite) than isotropic species (such as spinel) given the isotropic nature of glass or the residual glass matrix.

This concept may be more easily visualized by the equation below, where the durability response (as measured by PCT) is a function of the homogeneous glass (or residual glass matrix), the release or dissolution from the crystal(s) formed, the effect of stresses resulting from grain boundary interfaces with the residual glass matrix, and the effects of amorphous phase separation.

Eq. (1) Σ durability response = f(homogeneous) + f(crystal) + f(grain boundary) + f(amorphous phase separation)

If crystalline and/or amorphous phase separation does not occur, the durability response given in equation (1) is solely a function of the homogeneous glass matrix for which the ΔG_P model was specifically developed. This latter statement assumes the application of the homogeneity constraint or the replacement (Al_2O_3 and/or sum of alkali) constraints reduce the risk of developing amorphous phase separation so the potential impacts of that term are negligible. As previously discussed, the formation of spinel (isotropic structure) in a glass matrix typically has minimal impact on the durability response. This suggests that the impacts of components dissolving from the crystals or accelerated dissolution due to grain boundary stresses are minimal. Insight into the behavior of the crystals and their associated grain boundaries is provided by performing heat treatment on DWPF glasses during testing. Durability testing results that show no impact due to heat treatment suggest that the glass' durability response is only a function of the homogeneous glass matrix. This being the case (and assuming application of the homogeneity constraint or its replacement criteria), the durability response should approximate that of the homogeneous glass.

This is consistent with previous observations [(29) and (30)] and the results reported in the Waste Qualification Report (WQR) [28] that spinels have little to no impact on the durability response as defined by the PCT. It should be noted that there are some conditions in which this may not hold – even for spinel formation. For example, a glass that contains a very low concentration of Fe_2O_3 might precipitate spinel crystals that would deplete the glass matrix of Fe_2O_3. The residual glass matrix durability might then be impacted by the presence of the spinels in the glass.

In those cases where non-isotropic crystals form in the glass matrix, the terms f(crystal) and f(grain boundary) may not be minimal, and, therefore, the durability response is a more complex issue. In fact, results presented in the WQR indicated that glass produced during waste qualification runs (in Canister S00001 from the WP-14 campaign) contained 17-vol% acmite. The PCT results of this material were "almost twice as much as the surrounding bulk glass but still less than 1/10 the EA glass limit" [28]. In this case, application of the ΔG_P model with respect to predictability may not be justified given its development basis.

In this report, the ΔG_P model will be applied to all glasses to test the hypothesis or assumption discussed above. Namely, durability will be assessed on all glasses produced to determine the effect of spinel or other crystals on glass performance. It should be noted that previous studies [(20) and (21)] have also applied the ΔG_P model to both quenched and ccc glasses for the same reasons.

4.0 Selection of 40 Glass Compositions for Experimental Evaluation

A detailed discussion of the strategy for selecting glass compositions for the RC Phase 2 study was outlined by Herman et al. [31]. In general, compositional bounds for the major oxides in the waste or frit associated with DWPF sludge-only processing were defined based on the latest HLW System Plan blending projections [23]. The twelve major components considered were Al_2O_3, B_2O_3, CaO, Fe_2O_3, Li_2O, MgO, MnO, Na_2O, NiO, SiO_2, TiO_2, and U_3O_8, while the minor sludge components were covered in a group of “Others”. The “Others” for Phase 2 are similar to those used in Phase 1 of this study [25] and in the SB2 expanded variability study [21]. However, the “Others” in Phase 2 do not contain TiO_2 or ThO_2. TiO_2 was considered as one of the majors in Phase 2 in an effort to try to test a larger operating window for TiO_2 given future DWPF processing scenarios that include additions of the product from low-curie salt processing [23]. In the case of ThO_2, this oxide is present as a small fraction of the “Others” (i.e., 1.75 wt%) and its inclusion would result in more glasses being radioactive. By removing it, a small fraction of the glasses (i.e., those not containing uranium either) were non-radioactive which led to reduced cost and helped to minimize the radioactive waste generated without compromising the study. The study did not try to bound processing of non-traditional DWPF components that may be added to the sludge (e.g., Pu/Gd precipitates) or found in the tanks (e.g., sodium oxalate). However, the non-traditional components like the Pu/Gd precipitate would add extremely small concentrations and thus should not have a significant impact on predicted or measured properties. As to the tank contents, the oxalate in SB3 was not considered, but the sodium associated with it would be bounded by the upper limit proposed for Na_2O or restricted by PCCS predictions for durability.

The upper and lower bounds for the twelve major oxides and “Others” used to define the glass compositional region are provided in Table 2. This table defines the overall glass compositional region expected to bound projected sludge-only processing. Although considered a bounding region, distinct compositional regions may be defined that will be of no interest to DWPF from a processing or product performance perspective. More specifically, durability issues may arise if the upper limits for both Na_2O and Li_2O (i.e., glass modifiers) are combined with the lower bounds for Al_2O_3, Fe_2O_3, and SiO_2 (i.e., glass formers). Therefore, the current PCCS glass property/composition models and other constraints were imposed to limit the compositional region of interest to a smaller subregion in which current models apply. The models did restrict the compositional region, and the more restrictive bounds are reflected in the actual oxide range tested column of Table 2. Although models were used to limit the bounding compositional region, their use provides a method of imposing more realistic and feasible ranges for the compositional region of interest (given the existing models and their associated uncertainties). Any new models would have to be implemented in a way that would show their validity over the composition region of interest.

Although the regions are realistic from a model perspective, additional constraints were not used to limit possible combinations of components that may be unrealistic from a frit/sludge perspective. More specifically, constraints were not imposed to restrict the frit component (e.g., Li_2O) and a sludge component (e.g., Fe_2O_3) from being at their highest or lowest concentrations simultaneously. These extremes would not be possible from strictly a waste loading perspective. Therefore, although models were used to restrict the bounding compositional space, the use of the resulting subregion lower and upper limits may still yield component combinations that are infeasible from a DWPF processing perspective. However, as was discussed above, it was felt that the insight provided by these combinations might prove useful in future DWPF processing scenarios and would provide a more bounding region for elimination/replacement of the homogeneity constraint. To further minimize the effects of the infeasible region or combinations, a two “layer” approach was used with the “inner” layer providing a more feasible processing region. This strategy is discussed further in the following paragraphs.

Table 2. Upper and Lower Bounds for the Major Oxides and "Others" (Mass Fractions)

Oxide	Selected		Actual	
	Lower	Upper	Lower	Upper
Al_2O_3	0.0300	0.1500	0.0300	0.1481
B_2O_3	0.0500	0.1200	0.0500	0.1200
CaO	0.0050	0.0400	0.0050	0.0400
Fe_2O_3	0.0500	0.1800	0.0500	0.1681
Li_2O	0.0300	0.0700	0.0300	0.0700
MgO	0.0000	0.0400	0.0000	0.0400
MnO	0.0050	0.0800	0.0050	0.0800
Na_2O	0.0750	0.2500	0.0750	0.1995
NiO	0.0000	0.0500	0.0000	0.0500
SiO_2	0.4000	0.6500	0.4000	0.6500
TiO_2	0.000	0.0175	0.0000	0.0175
U_3O_8	0.000	0.0800	0.0000	0.0800
Others	0.000	0.0200	0.0000	0.0200

In general, models were applied at the PAR making the subregion more bounding than a subregion developed by use of the MAR. In defining this more feasible subregion, the homogeneity constraint was not imposed, and, thus, glasses were yielded to challenge this constraint. The primary property of concern and the only one that was measured in this study was glass durability as defined by the PCT [32]. However, as mentioned above, other processing constraints were imposed over the region to help to define a more feasible DWPF processing region. The properties assessed included durability response in terms of ΔG_P, viscosity at 1150°C ($\eta_{1150°C}$), T_L (using both the current and newly developed models), homogeneity, and Al_2O_3 and alkali concentrations. Acceptable predicted properties for this assessment were based on satisfying the respective values shown in Table 3. Due to the fact that the PAR limit for the new T_L model is compositionally dependent and changes from glass to glass [24], the PAR limit was conservatively set at 1010ºC to allow for a quick assessment. Since the new T_L is also not a linear function, it could not be easily implemented to assess the T_L over the bounding region. Therefore, a linear T_L model was derived from the prediction data and it was implemented to constrain the region. However, its limit was set at the Expected PAR (EPAR) limit, 1050°C, to provide a more bounding region. The viscosity was also constrained at its EPAR limit to help expand the glass region explored by this testing (i.e., region would not be overly restrictive). Although durability was constrained at the PAR, the assessments were made without the contribution of the "Others" components. In some cases, addition of the "Others" component resulted in the glasses not meeting the durability PAR since some of the "Others" had a negative ΔG_i contribution to the ΔG_P calculation. Glasses in the region were also assessed against the existing Al_2O_3 ($Al_2O_3 \geq 3.0\%$) and sum of alkali (sum of alkali <19.3%) criteria, but selection was not restricted by the criteria so the limits could be tested/validated.

Table 3. Summary of Constraints

Constraint	Units	Limit(s)	Impact On Glass Region
Homogeneity	Wt%	> 210.92034	Used to restrict region to glasses that fail Homogeneity PAR
Durability (ΔG_P)	Kcal/mol	-12.7178	Used to restrict region to glasses that satisfy durability PAR
Liquidus Temperature (T_L) – Original Model	°C	≤ 1024.9°C	Since model is being phased out, it is not used to restrict region only to assess selected glasses
Viscosity at 1150°C ($\eta_{1150°C}$)	Poise	$21.5308 \le \eta_{1150°C} \ge 105.4437$	PAR limits used to restrict region
Viscosity at 1150°C ($\eta_{1150°C}$)	Poise	$20 \le \eta_{1150°C} \ge 110$	EPAR limits used to provide the least restriction on the region
Liquidus Temperature (T_L) – New Model	°C	≤ 1010°C	Since model is nonlinear, a "linear" version of the T_L model was used to select the glasses within the region (≤1050°C), but glasses were assessed against the PAR limit (≤1010°C).

Obviously, the ranges of the oxides in Table 2 cover a wide compositional region, and some of the glasses in this region would not be feasible for DWPF processing. While the extreme combinations (the extreme vertices or EVs) of this region still allowed glasses that were not very likely to be produced by DWPF, the region was deemed to be bounding for sludge-only processing. If the homogeneity constraint could be shown to be unnecessary (after application of an Al_2O_3 and/or sum of alkali constraint) for all glasses selected from this bounding region, there would be a strong indication of the potential for the elimination or replacement of the homogeneity constraint (in its entirety) by the Al_2O_3 and/or sum of alkali constraint. However, the risk is that one or more of the selected glasses from this bounding region, when tested, would suggest that important information is being conveyed by the application of the homogeneity constraint (at least over this bounding region). Thus, for example, results may indicate that the homogeneity constraint can not be unconditionally eliminated without specific studies to address durability predictions in a particular region or that the application of the homogeneity constraint at the PAR limit must be continued along with the Al_2O_3 and/or sum of alkali constraint. A large set of glass compositions was generated from the extremes of this bounding region (i.e., outer layer), and fifteen compositions were subsequently selected as part of Phase 2 testing. The centroid of the extreme bounding region was also selected for testing.

The next fifteen compositions were selected from the large number of glass compositions generated in the interior, inner layer or less extreme, glass composition region. The inner layer was defined to provide an opportunity to more fully cover the interior of the bounding region of Table 2. Glass compositions selected from this region should be more representative for DWPF processing than those selected from the bounding region. The interior region moved in 20% of the range from the lower and the upper limits for each of the oxides of interest in the study, and these inner limits are shown in Table 4.

Table 4. Oxide Ranges for Inner Layer Glass Region (in Mass Fraction)

Oxide	Lower	Upper
Al_2O_3	0.054	0.126
B_2O_3	0.064	0.106
CaO	0.012	0.033
Fe_2O_3	0.076	0.154
Li_2O	0.038	0.062
MgO	0.008	0.032
MnO	0.02	0.065
Na_2O	0.11	0.215
NiO	0.01	0.04
SiO_2	0.45	0.6
TiO_2	0.0035	0.014
U_3O_8	0.016	0.064
Others	0.004	0.016

Besides the glass compositions selected by means of the bounding approach, nine compositions were also chosen from the set of results generated by the RC Phase 1 study [(18) and (25)]. Eight compositions were selected from the region generated during the Phase 1 testing that represented glass compositions made from SB3 and SB4 with Frit 320 [18]. The SB3 and SB4 compositions provide the opportunity to challenge homogeneity on compositions "more representative" of possible DWPF sludge/frit combinations. Finally, one composition (RC-30) from the Phase 1 testing was also included in Phase 2. In Phase 1, RC-30 had a PCT response that was predictable for two of the three compositional views with the measured bias-corrected response being unpredictable [25]. Although of minimal concern, this glass composition was included in this study due to the unpredictability of this glass coupled with the fact that there was a significant difference between the quenched and centerline canister cooled version in terms of PCT response. The nine compositions selected from the Phase 1 study had used different "Others", which contained TiO_2 and ThO_2. Thus, the TiO_2 for these glasses is accounted for in the "Others" and is not considered a major component as was done in Phase 2 of the study.

The forty selected compositions are given in Table 5. The last column of Table 5 lists the "Others" to be used in batching, with "New" referring to "Others" from this phase of the study and "Old" referring to the "Others" from Phase 1 of the study. In keeping with the naming scheme utilized in [25], the identifiers for these selected compositions have a prefix of "RC" and begin with the number 58 since the numbers 1 through 57 were used previously [25]. The property predictions for the forty target compositions are provided in Table 6, which also contains a summary column detailing the status of each glass composition relative to the limits outlined in Table 3. Consider RC-73 as an example; the "Property Par Status" indicates "Durable; Visc; T_L; Not Homog; New T_L; Al_2O_3; alkali". This nomenclature indicates that this particular target glass composition is predicted to satisfy the PAR limits for durability, viscosity, the old liquidus temperature model (T_L), the new liquidus temperature model (New T_L), the Al_2O_3 lower limit, and sum of alkali. However, this composition is predicted to be inhomogeneous (as noted by "Not Homog"), so it is a good candidate for this study. Thirty-six of the forty compositions failed the homogeneity constraint; thus, ample opportunity was provided to challenge the homogeneity constraint.

Experimental evaluation of the fabricated glasses will add to the existing foundation to determine whether the homogeneity constraint can be replaced (or relaxed) for projected sludge-only processing in favor of the Al_2O_3 and sum of alkali criterion. Experimental assessment will parallel those used in previous studies [(6) and (19)] to assess the homogeneity constraint. More specifically, durability of both quenched and ccc glasses will be evaluated via the PCT-Method A (PCT-A) [(32) and (33)].

Table 5. Target Compositions for Phase 2 Test Glasses (Mass Fraction)

ID	Selection Basis	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	Others Type
RC58	OL EV	0.0300	0.0751	0.0050	0.0500	0.0700	0.0400	0.0050	0.0750	0.0000	0.6124	0.0175	0.0000	0.0200	New
RC59	OL EV	0.0300	0.1200	0.0050	0.0500	0.0700	0.0000	0.0800	0.0843	0.0000	0.4632	0.0175	0.0800	0.0000	New
RC60	OL EV	0.0915	0.0500	0.0400	0.0500	0.0700	0.0400	0.0050	0.1310	0.0000	0.4050	0.0175	0.0800	0.0200	New
RC61	OL EV	0.0300	0.0500	0.0050	0.1681	0.0300	0.0400	0.0800	0.0750	0.0000	0.4450	0.0175	0.0594	0.0000	New
RC62	OL EV	0.1443	0.0500	0.0050	0.0500	0.0700	0.0000	0.0800	0.0750	0.0272	0.4185	0.0000	0.0800	0.0000	New
RC63	OL EV	0.1308	0.1200	0.0050	0.0500	0.0300	0.0400	0.0758	0.1109	0.0000	0.4000	0.0175	0.0000	0.0200	New
RC64	OL EV	0.0300	0.1200	0.0050	0.1317	0.0700	0.0000	0.0050	0.0750	0.0000	0.4633	0.0000	0.0800	0.0200	New
RC65	OL EV	0.0720	0.0500	0.0050	0.0500	0.0300	0.0000	0.0050	0.1914	0.0000	0.5966	0.0000	0.0000	0.0000	New
RC66	OL EV	0.0300	0.0500	0.0400	0.0947	0.0300	0.0000	0.0800	0.1320	0.0000	0.5233	0.0000	0.0000	0.0200	New
RC67	OL EV	0.0300	0.1200	0.0400	0.0872	0.0300	0.0000	0.0050	0.0750	0.0197	0.4956	0.0175	0.0800	0.0000	New
RC68	OL EV	0.0300	0.0500	0.0050	0.0500	0.0300	0.0000	0.0800	0.1337	0.0499	0.4539	0.0175	0.0800	0.0200	New
RC69	OL EV	0.0800	0.1200	0.0400	0.0500	0.0700	0.0000	0.0800	0.0938	0.0487	0.4000	0.0175	0.0000	0.0000	New
RC70	OL EV	0.0300	0.1200	0.0050	0.0500	0.0300	0.0400	0.0050	0.1407	0.0335	0.4658	0.0000	0.0800	0.0000	New
RC71	OL EV	0.0300	0.0500	0.0400	0.0500	0.0700	0.0400	0.0800	0.0817	0.0436	0.5147	0.0000	0.0000	0.0000	New
RC72	OL EV	0.0300	0.0588	0.0050	0.1182	0.0700	0.0000	0.0050	0.1389	0.0486	0.5081	0.0175	0.0000	0.0000	New
RC73	IL EV	0.0540	0.1060	0.0330	0.0760	0.0380	0.0080	0.0210	0.1100	0.0100	0.4500	0.0140	0.0640	0.0160	New
RC74	IL EV	0.0540	0.0640	0.0120	0.0760	0.0490	0.0080	0.0200	0.1100	0.0100	0.5615	0.0035	0.0160	0.0160	New
RC75	IL EV	0.0540	0.0640	0.0330	0.0760	0.0417	0.0320	0.0200	0.1100	0.0100	0.5253	0.0140	0.0160	0.0040	New
RC76	IL EV	0.0540	0.0640	0.0120	0.0760	0.0380	0.0080	0.0650	0.1387	0.0100	0.4523	0.0140	0.0640	0.0040	New
RC77	IL EV	0.0540	0.0640	0.0330	0.0910	0.0620	0.0320	0.0200	0.1125	0.0100	0.4500	0.0035	0.0640	0.0040	New
RC78	IL EV	0.0540	0.0640	0.0120	0.1195	0.0380	0.0320	0.0650	0.1100	0.0100	0.4500	0.0140	0.0275	0.0040	New
RC79	IL EV	0.0788	0.1060	0.0120	0.0760	0.0620	0.0080	0.0637	0.1100	0.0100	0.4500	0.0035	0.0160	0.0040	New
RC80	IL EV	0.0825	0.0640	0.0120	0.0760	0.0380	0.0320	0.0200	0.1628	0.0100	0.4500	0.0035	0.0332	0.0160	New
RC81	IL EV	0.0540	0.1060	0.0120	0.0760	0.0380	0.0320	0.0322	0.1100	0.0184	0.4500	0.0035	0.0640	0.0040	New
RC82	IL EV	0.0540	0.0640	0.0120	0.0760	0.0620	0.0320	0.0650	0.1130	0.0257	0.4500	0.0140	0.0163	0.0160	New
RC83	IL EV	0.0540	0.0640	0.0330	0.0777	0.0380	0.0080	0.0650	0.1330	0.0400	0.4638	0.0035	0.0160	0.0040	New
RC84	IL EV	0.0540	0.0640	0.0120	0.1195	0.0380	0.0080	0.0471	0.1100	0.0139	0.4500	0.0035	0.0640	0.0160	New
RC85	IL EV	0.0906	0.0640	0.0121	0.0760	0.0620	0.0080	0.0200	0.1100	0.0253	0.4500	0.0140	0.0640	0.0040	New
RC86	IL EV	0.0970	0.0640	0.0120	0.0760	0.0382	0.0303	0.0650	0.1115	0.0100	0.4500	0.0140	0.0160	0.0160	New
RC87	IL EV	0.0540	0.1000	0.0120	0.0967	0.0380	0.0080	0.0200	0.1542	0.0331	0.4500	0.0140	0.0160	0.0040	New
RC88	SB3 OL at 25% WL	0.0306	0.0601	0.0090	0.1069	0.0603	0.0005	0.0437	0.1153	0.0011	0.5462	N/A	0.0219	0.0046	Old
RC89	SB3 OL at 25% WL	0.0354	0.0601	0.0090	0.1069	0.0607	0.0005	0.0081	0.1153	0.0132	0.5462	N/A	0.0351	0.0096	Old
RC90	SB4 OL at 25% WL	0.0442	0.0601	0.0080	0.0952	0.0603	0.0007	0.0427	0.1153	0.0012	0.5537	N/A	0.0140	0.0046	Old
RC91	SB4 OL at 25% WL	0.0346	0.0601	0.0124	0.0952	0.0603	0.0007	0.0148	0.1305	0.0012	0.5537	N/A	0.0320	0.0046	Old
RC92	SB4 OL at 30% WL	0.0314	0.0562	0.0096	0.1143	0.0568	0.0008	0.0513	0.1143	0.0014	0.5140	N/A	0.0384	0.0115	Old
RC93	SB4 OL at 30% WL	0.0303	0.0562	0.0096	0.1143	0.0568	0.0109	0.0178	0.1325	0.0014	0.5204	N/A	0.0384	0.0115	Old
RC94	SB3 Ring at 25% WL	0.0310	0.0601	0.0102	0.1080	0.0605	0.0034	0.0151	0.1235	0.0061	0.5458	N/A	0.0290	0.0073	Old
RC95	SB4 Ring at 25% WL	0.0303	0.0601	0.0096	0.1078	0.0605	0.0043	0.0235	0.1205	0.0049	0.5514	N/A	0.0204	0.0066	Old
RC96	OL centroid	0.0654	0.0843	0.0206	0.0749	0.0505	0.0200	0.0482	0.1098	0.0152	0.4426	0.0093	0.0495	0.0097	New
RC97	RC-30	0.0312	0.0651	0.0061	0.1204	0.0462	0.0166	0.0397	0.1294	0.0294	0.4453	N/A	0.0541	0.0164	Old

Table 6. Property Predictions for Phase 2 Test Glasses (Based on Targeted Compositions)

ID	Property PAR Status	Al_2O_3 (mass fraction)	Alkalis (mass fraction)	Viscosity (Poise)	Homogeneity wt %	ΔG_p (kcal/mol)	Old T_L (°C)	New T_L (°C)
RC58	Durable; Not Visc; T_L; Not Homog; New T_L; Al_2O_3; alkali	0.0300	0.1450	109.92	181.50	-8.2089	868.4	890.8
RC59	Durable; Visc; T_L; Not Homog; New T_L; Al_2O_3; alkali	0.0300	0.1543	28.46	166.27	-12.7156	891.2	562.1
RC60	Not Durable; Visc; T_L; Not Homog; New T_L; Al_2O_3; Not alkali	0.0915	0.2010	22.52	207.69	-12.8415	935.4	913.9
RC61	Durable; Visc; Not T_L; Not Homog; Not New T_L; Al_2O_3; alkali	0.0300	0.1050	79.15	210.92	-7.2889	1110.7	1029.5
RC62	Durable; Not Visc; T_L; Homog; New T_L; Al_2O_3; alkali	0.1443	0.1450	109.88	210.94	-7.2879	970.1	1009.9
RC63	Durable; Not Visc; T_L; Not Homog; Not New T_L; Al_2O_3; alkali	0.1308	0.1409	109.91	210.91	-8.8827	970.2	1030.0
RC64	Durable; Not Visc; Not T_L; Homog; New T_L; Al_2O_3; alkali	0.0300	0.1450	20.46	210.93	-9.0716	1033.9	939.1
RC65	Durable; Not Visc; T_L; Homog; New T_L; Al_2O_3; alkali	0.0720	0.2214	105.86	210.92	-12.7143	877.8	599.2
RC66	Not Durable; Visc; T_L; Not Homog; New T_L; Al_2O_3; alkali	0.0300	0.1620	87.69	210.92	-12.8388	948.7	722.8
RC67	Durable; Not Visc; T_L; Not Homog; Not New T_L; Al_2O_3; alkali	0.0300	0.1050	109.87	204.33	-6.4074	945.3	1023.8
RC68	Not Durable; Visc; T_L; Not Homog; Not New T_L; Al_2O_3; alkali	0.0300	0.1637	69.38	155.06	-12.8438	893.2	1029.5
RC69	Durable; Not Visc; T_L; Not Homog; Not New T_L; Al_2O_3; Not alkali	0.0800	0.1638	20.97	205.66	-12.7145	930.6	1056.4
RC70	Durable; Visc; T_L; Not Homog; Not New T_L; Al_2O_3; alkali	0.0300	0.1707	43.08	169.31	-12.7158	890.7	1065.7
RC71	Durable; Visc; T_L; Not Homog; New T_L; Al_2O_3; alkali	0.0300	0.1517	67.95	182.64	-12.7134	881.7	998.8
RC72	Durable; Not Visc; T_L; Not Homog; Not New T_L; Al_2O_3; Not alkali	0.0300	0.2089	19.98	210.92	-12.7143	990.5	1043.2
RC73	Durable; Visc; T_L; Not Homog; New T_L; Al_2O_3; alkali	0.0540	0.1480	55.04	204.95	-10.005	952.8	971.1
RC74	Durable; Not Visc; T_L; Not Homog; New T_L; Al_2O_3; alkali	0.0540	0.1590	105.64	206.0	-9.0400	918.8	918.9
RC75	Durable; Not Visc; T_L; Not Homog; New T_L; Al_2O_3; alkali	0.0540	0.1517	105.64	210.88	-9.3085	928.0	969.4
RC76	Not Durable; Visc; T_L; Not Homog; New T_L; Al_2O_3; alkali	0.0540	0.1767	48.16	191.32	-12.7411	951.9	802.7
RC77	Durable; Visc; T_L; Not Homog; New T_L; Al_2O_3; alkali	0.0540	0.1745	30.22	210.91	-11.8780	982.1	952.1
RC78	Durable; Visc; Not T_L; Not Homog; Not New T_L; Al_2O_3; alkali	0.0540	0.1480	56.58	210.92	-10.1897	1038.1	1013.1
RC79	Durable; Visc; T_L; Not Homog; New T_L; Al_2O_3; alkali	0.0788	0.1720	32.44	210.92	-11.9784	967.5	848.6
RC80	Not Durable; Visc; T_L; Not Homog; New T_L; Al_2O_3; Not alkali	0.0825	0.2008	42.64	210.91	-12.8124	969.9	968.5
RC81	Durable; Visc; T_L; Not Homog; Not New T_L; Al_2O_3; alkali	0.0540	0.1480	55.04	193.09	-10.3965	952.8	1055.3
RC82	Not Durable; Visc; T_L; Not Homog; Not New T_L; Al_2O_3; alkali	0.0540	0.1750	32.76	190.68	-12.8121	952.8	1034.7
RC83	Not Durable; Visc; T_L; Not Homog; Not New T_L; Al_2O_3; alkali	0.0540	0.1710	56.83	205.08	-12.7396	950.8	1036.4
RC84	Durable; Visc; Not T_L; Not Homog; Not New T_L; Al_2O_3; alkali	0.0540	0.1480	56.58	210.92	-9.5728	1038.1	1055.7
RC85	Durable; Visc; T_L; Homog; Not New T_L; Al_2O_3; alkali	0.0906	0.1720	48.10	210.92	-9.3222	975.5	1040.2
RC86	Durable; Not Visc; T_L; Not Homog; Not New T_L; Al_2O_3; alkali	0.0970	0.1497	105.79	210.91	-9.1576	980.3	1054.3
RC87	Not Durable; Visc; T_L; Not Homog; Not New T_L; Al_2O_3; alkali	0.0540	0.1922	25.88	210.92	-12.7373	993.4	1037.5
RC88	Durable; Visc; T_L; Not Homog; New T_L; Al_2O_3; alkali	0.0306	0.1756	49.99	208.13	-11.6644	960.2	717.8
RC89	Durable; Visc; T_L; Not Homog; New T_L; Al_2O_3; alkali	0.0354	0.1760	51.36	210.90	-10.3542	962.3	882.4
RC90	Durable; Visc; T_L; Not Homog; New T_L; Al_2O_3; alkali	0.0442	0.1756	61.56	209.85	-11.1416	946.2	731.4
RC91	Durable; Visc; T_L; Not Homog; New T_L; Al_2O_3; alkali	0.0346	0.1908	47.46	209.34	-11.9931	942.5	703.7
RC92	Durable; Visc; T_L; Not Homog; New T_L; Al_2O_3; alkali	0.0314	0.1712	44.07	206.60	-11.7326	982.8	770.5
RC93	Durable; Visc; T_L; Not Homog; New T_L; Al_2O_3; alkali	0.0303	0.1894	35.99	209.89	-12.3010	979.8	800.2
RC94	Durable; Visc; T_L; Not Homog; New T_L; Al_2O_3; alkali	0.0310	0.1841	44.64	210.89	-11.4925	962.0	794.4
RC95	Durable; Visc; T_L; Not Homog; New T_L; Al_2O_3; alkali	0.0303	0.1810	48.03	210.54	-11.4797	959.8	780.5
RC96	Durable; Visc; T_L; Not Homog; New T_L; Al_2O_3; alkali	0.0654	0.1603	45.36	201.06	-11.1476	960.1	978.6
RC97	Durable; Visc; T_L; Not Homog; Not New T_L; Al_2O_3; alkali	0.0312	0.1756	24.84	199.07	-12.5352	1024.3	1069.7

5.0 Experimental

The experimental procedures used to fabricate and the analytical techniques used to physically and chemically characterize the RC glass compositions are described in this section.

5.1 Glass Fabrication

The forty compositions to be prepared for Phase 2 of the RC study were identified in Table 5, while the minor components or "Others" are identified in Table 7. Both the "New" and "Old" others are shown in Table 7. Approximately 150-g of each batch were prepared from the proper proportions of reagent-grade metal oxides, carbonates, H_3BO_3, and salts using SRTC technical procedure ITS-0001, "Glass Batching" [34]. Actual weights of the batch materials were recorded on the batch sheets, and the batch sheets can be found in lab notebooks WSRC-NB-2002-00067 and WSRC-NB-2002-00119. After batching, the glasses were melted using procedure ITS-0003, "Glass Melting" [34]. Raw materials were melted using 250-mL crucibles of 95% platinum/5% gold. The crucibles were heated in a high temperature furnace at a rate of ~8°C/minute until the target melt temperature, 1150°C, was reached. After an isothermal hold at 1150°C for 1 hour, the crucible was removed and the glass was poured onto a clean stainless steel plate and allowed to air cool. Visual observations on the resulting pour patty and residual crucible glass were documented on the batch melting sheets, which were also pasted in WSRC-NB-2002-00067 and WSRC-NB-2002-00119.

Table 7. Oxide Ranges for Sludge "Others" (in Mass Fractions)

Oxide	"Old Others"	"New Others"
B_2O_3	0.0132	*
BaO	0.0174	0.0196
CdO	0.0679	0.0768
CoO	0.0094	0.0106
Cr_2O_3	0.1175	0.1319
CuO	0.0280	0.0316
La_2O_3	0.0203	0.0229
Li_2O	0.0655	*
ThO_2	0.0175	N/A
RuO_2	0.0288	0.0325
MoO_3	0.0033	0.0038
P_2O_5	0.4460	0.4992
PbO	0.0461	0.0520
SnO_2	0.0100	0.0113
SrO	0.0102	0.0115
TiO_2	0.0133	*
V_2O_5	0.0134	0.0151
ZnO	0.0294	0.0332
ZrO_2	0.0426	0.0480
SUM	1.0000	1.00.00

*These components are represented in the major oxides and were not included in the others.

After cooling, the pour patty and residual crucible glass were ground, and the crushed glass was subsequently transferred to its original crucible for a second melt at 1150°C. After another isothermal hold for 1 hour at temperature, the crucible was removed and the glass was quenched by pouring onto a clean stainless steel plate. Visual observations on the resulting pour patty and residual crucible glass were again documented. Any unreacted materials or observations of note were also recorded on the melting data sheets. Typically, 140 grams of glass were poured from the crucible while ~10 grams remained along the crucible walls. Samples of the pour patty were used to support property measurements and the subsequent heat treatment. Glasses were identified and stored in containers labeled using the unique RC nomenclature defined in Table 5.

To better understand the effects of slow cooling on the product, approximately 25 grams of each glass was heat-treated to simulate cooling along the centerline of a DWPF-type canister [35]. This cooling regime is commonly referred to as the centerline canister cooling (ccc) curve. This terminology will be utilized in this report to differentiate the samples produced using the slow cooling regime from those that were quenched.

5.2 Property Measurements

5.2.1 Chemical Composition Analysis

A representative sample from each RC glass pour patty was submitted to the SRTC Mobile Laboratory (SRTC-ML) for chemical analysis to confirm that the "as-fabricated" glasses corresponded to the defined target compositions. Appendix C provides the analytical plans by Edwards that accompanied these samples. Two plans were written with one for the radioactive glasses and one for the non-radioactive glasses. The 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 dissolution techniques PF and LM. The cation concentrations of interest were measured on the dissolutions using Inductively Coupled Plasma – Atomic Emission Spectroscopy (ICP – AES). Both analytical plans were developed to provide the opportunity to evaluate potential sources of error in the measurements. Glass standards were intermittently run to assess the performance of the ICP-AES over the course of the analyses and for potential bias-correction needs.

5.2.2 Crystallization

Although visual observations for crystallization were performed and documented as part of the glass fabrication, representative samples for some of the quenched and ccc glasses were submitted to the SRTC Analytical Development Section (ADS) for X-ray Diffraction (XRD) analysis. Samples were selected based on PCT response or visual observation of crystallinity. The detection limit for this analysis was approximately 1.0-vol%. Therefore, crystals present at $\geq$1.0-vol% would be detected and the diffractometer would also allow a qualitative determination of the crystalline species. Otherwise, a characteristic high background devoid of crystalline spectral lines indicates that the glass product was amorphous.

Scanning Electron Microscope (SEM) with Energy Dispersive Spectroscopy (EDS) analysis was also used on select RC glasses to confirm and/or enhance visual and XRD results and to further characterize features or microstructures.

5.2.3 Product Consistency Test – Method A

The Product Consistency Test (PCT) was performed on each fabricated glass, both quenched and ccc, to assess chemical durability using technical procedure GTOP-3-025, "Nuclear Waste Glass Product Consistency Test (PCT) Method" [33]. Method A, PCT-A, of the procedure was performed. This required the PCT being conducted in triplicate for each glass sample (both quenched and ccc versions). Along with the RC glasses, the EA glass [16], the Approved Reference Material (ARM-1) glass, and blanks from each sample cleaning batch were included in each PCT-A conducted. Samples were ground to 100-200 mesh, washed, and dried according to procedure. Type I ASTM water was used as the leachate, and a leachate volume to sample mass ratio of 15 ml to 1.5 grams of glass was utilized. Approximately 22 ml stainless steel vessels were used as the leaching vessels. The sealed vessels were placed in an oven at 90 ± 2°C for 7 days ±2%. After the vessels were removed from the oven and the resulting solutions cooled, the leachates were sampled and filtered. The leachate samples were labeled and analyzed according to analytical plans provided by Edwards. The SRTC-ML was issued three plans, which are given as Appendix D. Since there were radioactive and non-radioactive glasses and a large number of vessels and limited space in a single PCT oven, three groups of tests were initiated. The quenched and ccc versions of each glass were tested in the same set/group to minimize the chance for variability. The plans provided an opportunity to assess the consistency (repeatability) of the PCT-A and analytical procedures in the effort to evaluate chemical durability of the RC glasses. Normalized release rates were calculated based on targeted, measured and measured bias-corrected compositions using the average of the logs of the leachate concentrations.

6.0 Results and Discussion

This section provides a detailed discussion of the chemical composition measurements, an assessment of crystallization via XRD and/or SEM/EDS, and an analysis of the PCT-A results.

6.1 A Statistical Review of the Chemical Composition Measurements

In this section, the measured versus targeted compositions of the forty RC glasses (RC58 through RC97) are presented and compared. The targeted compositions for these glasses are provided in Table 5 and Table A.1 of Appendix A. Chemical composition measurements for these glasses were conducted by the SRTC-ML following the two analytical plans provided in Appendix C. The first analytical plan covered the non-radioactive glasses from this task and from the task outlined in WSRC-RP-2002-00269 [36]. The second analytical plan covered the radioactive glasses from both of these studies. As mentioned above, two dissolution methods were utilized in each plan: samples prepared by LM dissolution were used to measure elemental concentrations of 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), while samples prepared by PF dissolution were used to measure elemental concentrations of aluminum (Al), boron (B), and lithium (Li). The LM dissolution was also used to measure thorium (Th) and uranium (U) in the radioactive glasses. 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 given that they are anticipated to be near or below the ICP-AES detection limits. 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. The instrumentation was re-calibrated between the duplicate analyses.

Tables A.2 and A.3 provide the elemental concentration measurements derived from the samples prepared using LM for the non-radioactive and radioactive glasses, respectively, and Tables A.4 and A.5 provide the measurements derived from the samples prepared using PF for the two groups of glasses. Measurements for standards (Waste Compliance Plan glass 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 RC 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 these measurements and the targeted compositions for these glasses.

6.1.1 Measurements in Analytical Sequence

Exhibit A.1 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 glasses (study glasses and standards) included in the analytical plan. Similar plots for samples prepared from the non-radioactive glasses using the PF method are provided in Exhibit A.2. Exhibits A.3 and A.4 provide parallel plots for the radioactive glasses. These plots include all of the measurement data from Tables A.2 through A.5.

A review of these plots indicates no significant patterns or trends in the analytical process over the course of these measurements, and no obvious outliers are apparent in these chemical composition measurements.

6.1.2 Batch 1 and Uranium Standard Results

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

Exhibit A.5 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 of an analysis of variance (ANOVA) investigation looking for statistically significant differences among the block means for each of the standards are also included. 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-AES calibration effect at the 5% significance level, which suggests that bias correction may be advantageous. The reference values for the oxide concentrations of the standard are given in the headers of the measurements in the exhibit.

Exhibit A.6 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-AES analytical/calibration blocks for these data, which suggest that bias correction may not be necessary.

Exhibit A.7 provides a parallel 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-AES calibration effect 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-AES calibration effect at the 5% significance level.

Exhibit A.8 completes this look at the data by providing a set of analyses of the measurements derived from samples of the radioactive glasses prepared via the PF method. The results from these statistical tests indicate a significant ICP-AES calibration effect at the 5% significance level for the Al measurements for both Batch 1 and the U_{std}.

The combined results suggest that it may be helpful to bias correct the oxide measurements of the RC glasses for the effect of the ICP-AES calibration on each of the analytical blocks. The basis for this bias correction is presented as part of Exhibits A.5 and A.8 – the average measurement for Batch 1 for each ICP-AES block for Al, Ca, Cr, Fe, Mg, Mn, Na, Ni, P, Si, Ti, and Zr and the average measurement for the U_{std} for each ICP-AES 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 the uranium values. For the other oxides, the Batch 1 results were used to conduct the bias correction as long as the reference value for the oxide concentration in the Batch 1 glass was greater than or equal to 0.1 wt%. Thus, applying this approach and based upon the information in the exhibits, the Batch 1 results were used to bias correct the Al_2O_3, CaO, Cr_2O_3, Fe_2O_3, MgO, MnO, Na_2O, NiO, SiO_2, and TiO_2 measurements. No bias correction was conducted for P_2O_5, ThO_2, or ZrO_2.

The bias correction was conducted as given in Equation (2) and as follows. For each oxide, let $\bar{a}_{ij}$ be the average measurement for the ith oxide at analytical block j for Batch 1 (or U_{std} for uranium), and let t_i be the reference value for the ith oxide for Batch 1 (or for U_{std} if uranium). (The averages and reference values are provided in Exhibits A.5 through A.8.) Let $\bar{c}_{ijk}$ be the average measurement for the ith oxide at analytical block j for the kth glass.

Eq. (2)

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

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).

6.1.3 Composition Measurements by Glass Number

Exhibits A.9 through A.12 provide plots of the oxide concentration measurements by Glass ID # (including both the Batch 1 glass, labeled as glass number 0 for the non-radioactive group and 100 for the radioactive group, and U_{std} glass, labeled as glass number 101) for the measured and bias-corrected (bc) values for the LM and PF preparation methods for the two groups of glasses. Different symbols and colors are used to represent the different glasses. These plots show the individual measurements across the duplicates of each preparation method and the two ICP-AES calibrations for each glass. 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 RC glasses are provided in the sections that follow.

6.1.4 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 the glass. These determinations were conducted for the measured and bias-corrected data. A sum of oxides was also computed for each glass based upon both the measured and bias-corrected values. Exhibit A.13 provides a plot 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 A.13 are offered: the measured (and measured bc) Al_2O_3 values for glasses RC-79 and RC-80 differ substantially from their respective targets. The measured value for RC-79 exceeds its target by an amount that is approximately equal to the targeted Al_2O_3 for RC-80. Also note the pattern of behavior between the measured versus targeted values for the other oxides for these two glasses. The measured values for the other oxides for RC-79 are consistently below their targets while the measured values for RC-80 exceed their targets. This information prompted a review of the applicable batch sheets, which indicated that the quantity of Al_2O_3 for RC-80 had mistakenly been added to RC-79, which would result in the off target Al_2O_3 concentrations and subsequent alteration in the other components. The "as-batched" compositions of RC-79 and RC-80 were re-calculated based on this finding and the "as-batched" compositions (i.e., the revised target compositions) and the initial targeted compositions are given in Table 8 and Table A.6 in Appendix A. No other significant problem is seen in the plots in Exhibit A.13.

Table 8. "As-Batched" Composition of RC-79 and RC-80 Based on Batch Sheet Information Compared to the Initial Targeted Composition (wt% Oxides)

Glass ID	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
RC-79 "As-batched"	14.90	9.79	1.11	7.02	5.73	0.74	5.89	10.16	0.92	41.57	0.33	1.48	0.37
RC-79 Targeted	7.88	10.60	1.20	7.60	6.20	0.80	6.37	11.00	1.00	45.00	0.35	1.60	0.40
RC-80 "As-batched"	0.00	6.97	1.31	8.28	4.14	3.49	2.18	17.74	1.09	49.04	0.39	3.62	1.74
RC-80 Targeted	8.25	6.40	1.20	7.60	3.80	3.20	2.00	16.28	1.00	45.00	0.35	3.32	1.60

It should be noted that based on the "as-batched" composition, RC-79 is predicted to satisfy all property predictions (at the PAR) with the exception of homogeneity. Glass RC-80, on the other hand, would not have been selected because it failed the Al_2O_3 constraint and the lower bound for Al_2O_3 for the bounding glass compositional region (i.e., this glass is outside the region of interest). However, since the glass also failed the homogeneity constraint, it was not eliminated since it provided another data point for challenging the constraint.

Table A.7 provides a summary of the average compositions as well as the targeted compositions and some associated differences and relative differences. In this table, the revised targeted compositions are used for RC-79 and RC-80. Notice that the targeted sums of oxides for the RC glasses do not sum to 100% due to the "Others" component of the RC glasses and an incomplete coverage of the oxides in the Batch 1 (glasses # 0 and #100) and U_{std} (glass # 101) glasses. All of the sums of oxides (both measured and bias-corrected) fall within the interval of 95 to 105 wt% for the RC glasses, which provides a mass balance of the cations measured by SRTC-ML procedures against the major anion in a vitrified product which is oxygen. This also provides an indication that the dissolutions were successful in terms of fully dissolving all components and that the chemical composition analyses were adequate.

Entries in Table A.7 also 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%, which was the statistical significance level used in this study. Overall, these comparisons between the measured and targeted compositions suggest that there were no significant problems in the batching or fabrication of the Phase 2 study glasses other than those already discussed for RC-79 and RC-80.

Recall that glass RC-97 was intended to be a repeat of RC-30 from an earlier phase of the RC task [25]. Table A.8 provides information of the chemical compositions of these two glasses. The information for RC-30 was taken from WSRC-TR-2002-00120 [25]. The values in this table suggest that the goal of repeating RC-30 (from a compositional standpoint) as part of this study was met. The comparison of the durabilities for RC-97 and RC-30 is discussed in the following sections.

6.2 Crystallization

Representative samples of thirteen of the RC glasses were submitted for XRD with almost all of these glasses coming from the outer layer bounding region. As stated in Section 5.2.2, glasses were selected based on PCT response or visual observation of crystallinity. Both the quenched and ccc glasses were submitted. Once again, XRD was performed to assess the presence of crystals at a given detection limit not glass-in-glass phase separation. The development and detection of amorphous phase separation were not considered as metrics in this task. Although, the other twenty-seven glasses were not submitted for XRD, they visually appeared to be single-phased and were assumed to be homogeneous (or crystal-free) for the purposes of applying the ΔG_p durability model. As discussed in later sections, PCT responses were also indicative of the glasses not containing crystals or at least not having crystals that impacted durability (see Equation (1)). Representative XRD patterns are shown in this section. A few of the glass samples were also submitted for SEM analyses to confirm the XRD analyses and the chemical nature of the crystalline species. Table 9 summarizes the XRD and SEM/EDS results of the glasses that were submitted for analyses. For the SEM results, a "(q)" after the result denotes the quenched glass, while a "(ccc)" after the result denotes the ccc version of the glass.

Table 9. Summary of XRD and SEM Analysis of the RC Phase 2 Glasses

Glass	XRD q	XRD ccc	SEM/EDS
RC-58	Amorphous	Amorphous	RuO_2 particles (q)
RC-59	Amorphous	Amorphous	N/A
RC-61	Magnetite	Acmite, Magnetite	Fe, Mn-based crystals and some crystals with Si (q), very crystallized looking with crystals containing Mn, Fe, Si, and U (ccc)
RC-62	Trevorite	Trevorite, $CaSO_4$	N/A
RC-64	Amorphous	Trevorite	N/A
RC-67	Amorphous	Amorphous	N/A
RC-68	Trevorite	Krinovite	N/A
RC-70	Amorphous	Amorphous	Amorphous (q), Amorphous (ccc)
RC-71	Amorphous	Acmite, Li_2SiO_3	N/A
RC-72	Amorphous	Li_2SiO_3, Ni_6MnO_8	Small amount of crystals with Fe, Ni, and Si (q)
RC-80	Amorphous	Amorphous	N/A
RC-84	Amorphous	Trevorite	N/A
RC-97	Amorphous	Trevorite, Krinovite	N/A

Note: magnetite (Fe_3O_4), trevorite ($NiFe_2O_4$), acmite ($NaFeSi_2O_6$), and krinovite ($NaMg_2CrSi_3O_{10}$) were reported by XRD analysis.

Ten of the thirteen quenched glasses were found to be amorphous by XRD, while only five of the thirteen heat-treated, ccc, glasses were found to be amorphous. Spinel crystals (magnetite and trevorite) were found in the three quenched glasses. Crystals of spinel (magnetite, trevorite, and Ni_6MnO_8), acmite, and lithium metasilicate were found in select ccc glasses. An XRD pattern for RC-58q is shown in Figure 1. The XRD pattern shows the characteristic high background devoid of crystalline spectral lines indicative of an amorphous, non-crystalline product. As discussed above, the X-ray diffractometer used in this study has a detection limit of approximately 1.0 vol%, therefore, undissolved solids and/or crystallization present below this limit would remain undetected by the XRD unit (e.g., the undissolved RuO_2 particles identified by SEM/EDS). XRD patterns for RC-58ccc, RC-59q, RC-59ccc, RC-64q, RC-67q, RC-67ccc, RC-70q, RC-70ccc, RC-71q, RC-72q, RC-80q, RC-80ccc, RC-84q, and RC-97q indicate amorphous (or crystal-free) products.

Crystals of spinel were detected in several RC glasses. The spinel types that were identified include trevorite ($NiFe_2O_4$), magnetite (Fe_3O_4), and Ni_6MnO_8. These types of crystals have routinely been found in DWPF glasses. Spinel was detected in RC-61q, RC-61ccc, RC-62q, RC-62ccc, RC-64ccc, RC-68q, RC-72ccc, RC-84ccc, and RC-97ccc. Figure 2 depicts the XRD pattern for glass RC64-ccc with trevorite.

Acmite and Li_2SiO_3 were identified in several of the ccc heat-treated glasses. Krinovite, which is an acmite type structure, was also found in two of the ccc glasses. Figure 3 shows the XRD pattern for RC-71ccc, which contained acmite and Li_2SiO_3. Both acmite and Li_2SiO_3 have been found in previous DWPF glass studies and were shown to have a negative impact on durability [(29) and (30)]. The impact of the presence of these types of crystals on durability predictions and acceptability will be considered in the later PCT discussion sections. $CaSO_4$ was identified in RC-62ccc; however this type of crystal has not been typically found in DWPF glasses and only matched one peak in the spectrum. For the major oxides, no chemicals were added in the sulfate form. Thus, the sulfate would have come from the impurities and thus its identification in the glass is suspect.

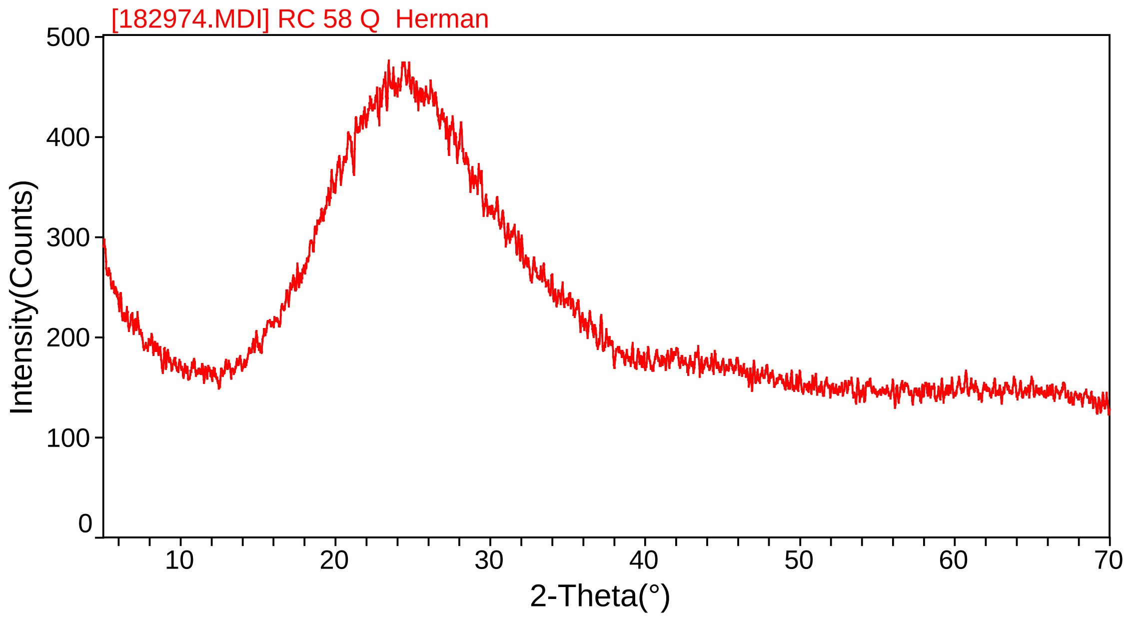

Figure 1. Amorphous Pattern for RC-58q

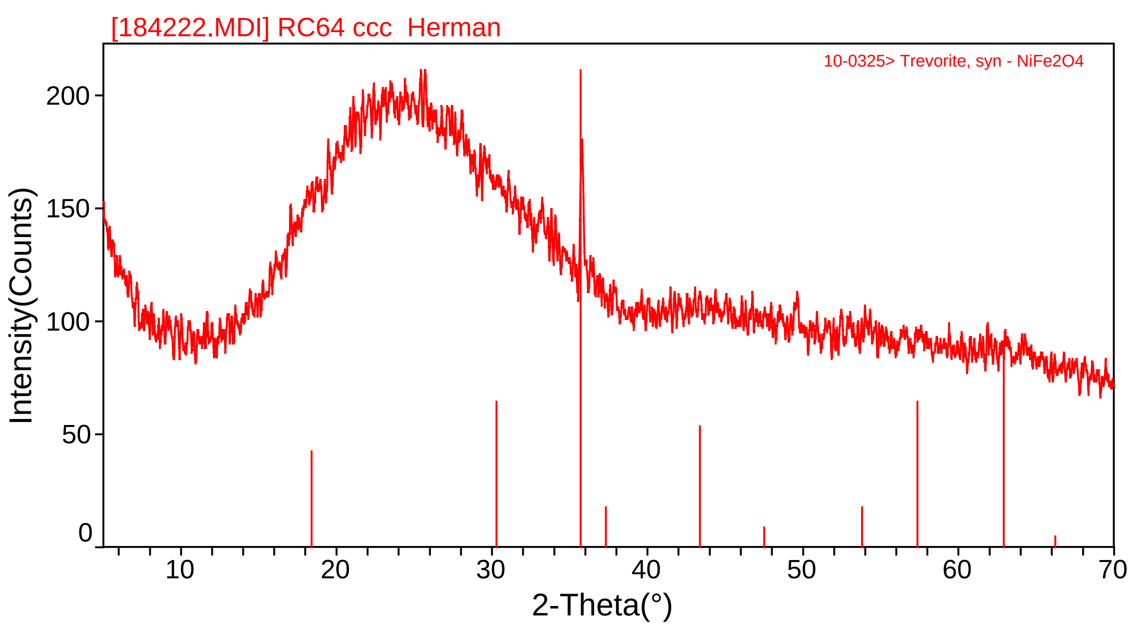

Figure 2. Trevorite Pattern for RC-64ccc

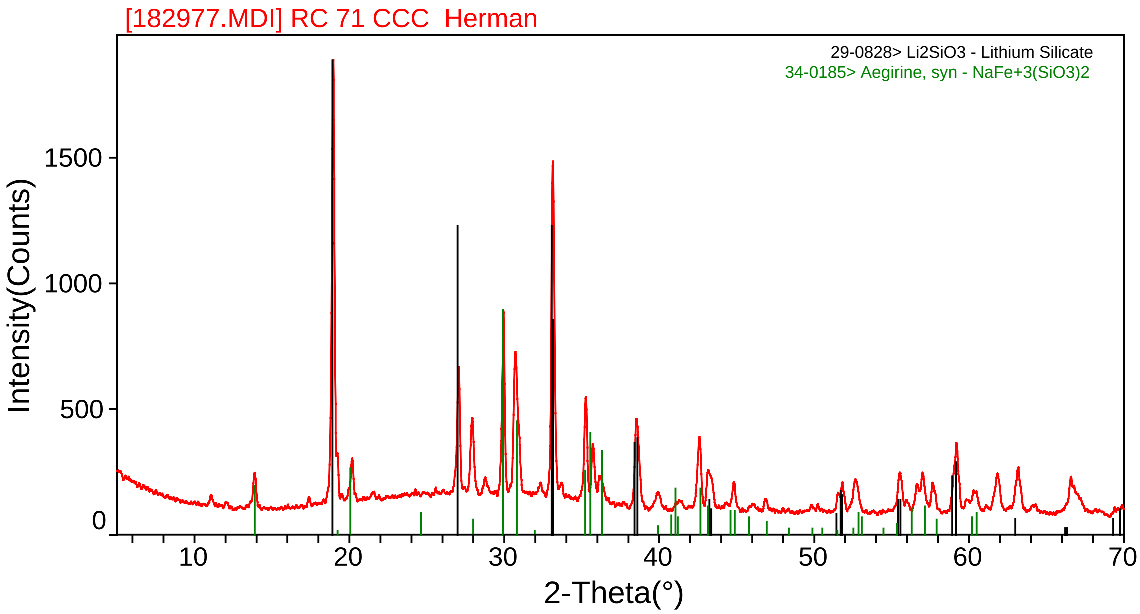

Figure 3. Acmite and Lithium Metasilicate Pattern for RC-71ccc

SEM was performed on a total of six RC glasses. Analysis of glass RC-58q identified particles of RuO_2. They were mostly clustered in one region of the glass sample. RuO_2 has been shown to be a nucleating agent in past glass studies for DWPF [37]. For glass RC-61q, SEM confirmed the presence of spinel type crystals and other crystals containing Mn, Fe, and Si (possibly acmite). A typical SEM micrograph (500x-magnification) of this glass is given as Figure 4. The EDS scan of the crystals shown in Figure 4 is given as Figure 5. The EDS indicates a high concentration of Fe and Mn, which are indicative of spinel-type crystals. For glass RC-61ccc, SEM of the glass indicated crystals were present. Isolated pockets of the crystals were randomly distributed across the surface of the glass. Most of these crystals contained Mn and Fe, but Si and U but may also have been present. Although XRD indicated the presence of acmite, acmite crystals were not specifically identified in the SEM/EDS.

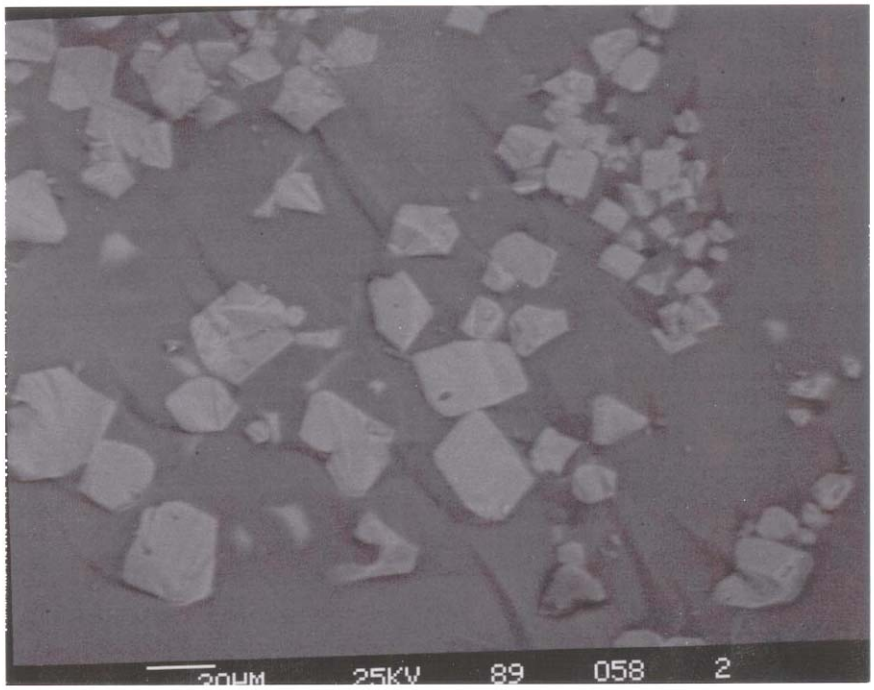

Figure 4. SEM of RC-61q at 500x

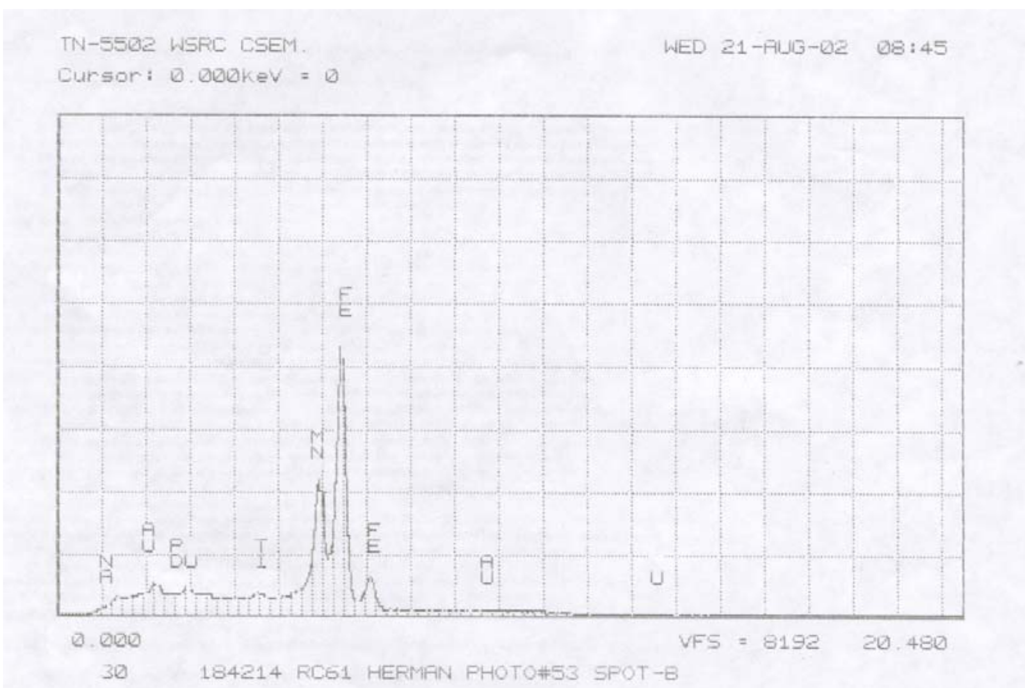

Figure 5. EDS of RC-61q

SEM/EDS analyses of glasses RC-70q and RC-70ccc did not detect any crystalline phases. SEM/EDS of glass RC-72q indicated the presence of small amounts of Fe and Ni based crystals. While XRD analyses suggested that glass RC-72q was amorphous, this discrepancy can likely be attributed to the detection limit of the XRD unit of ~ 1 vol%. Typically, the Fe and Ni based crystals form spinel and do not have an impact on durability. This will be assessed in the durability section to be discussed later.

XRD of RC-97q indicated that it was amorphous, while XRD of RC-97ccc indicated the presence of magnetite and krinovite. Both of these XRD results were consistent with the results for RC-30 from the Phase 1 study. However, krinovite, which is an acmite type crystal, was not found in the Phase 1 study, but this may have been due to a small quantity being present. Krinovite is a chromium rich phase, and RC-97 did have a larger amount (~1.5x) of Cr_2O_3 detected in the glass than did RC –30. This slight difference may also explain the detection of Krinovite in the RC-97 glass.

6.3 Durability as Measured by the PCT-A

6.3.1 A Statistical Review of the PCT-A Measurements

The RC glasses were subjected to the PCT-A as an assessment of their durabilities. Durability is the critical product quality metric for DWPF glass variability studies and, as stated earlier, is the main property of interest in these RC studies. Both quenched and ccc versions of each of these glasses were subjected to the PCT-A in triplicate. The PCTs were conducted in three groups following the methods described in Section 5.2.3. The three groups of PCTs were the non-radioactive glasses (including the non-radioactive glasses from the PCT assessment study [36]), and two sets of the radioactive glasses. Analytical plans for the three groups of PCTs, presented in Appendix D, were provided to the SRTC-ML to support the measurement of the compositions of the solutions resulting from these PCTs. Samples of a multi-element, standard solution were also included in all of these analytical plans (as a check on the accuracy of the ICP-AES used for these measurements). In this and following sections, the measurements generated by the SRTC-ML for these PCTs are presented and reviewed.

Table B.1 provides the elemental leachate concentration measurements determined by the SRTC-ML for the solution samples generated by the PCTs. The PCT-A results for the centerline, canister-cooled glasses are indicated by a "ccc" suffix. One of the quality control checkpoints for the PCT procedure is the ratio of the volume of leachate to the mass of sample. Two rows of Table B.1 are shaded to indicate that their solutions fell outside the volume of solution to mass of sample guidelines (ratio must be 10±0.5 ml of solution/g of sample [(32) and (33)]).[a] Two successful solutions out of the three conducted for a glass are required to generate a representative PCT result for that glass [(32) and (33)]. This criterion was satisfied for both the quenched and ccc versions for all the RC glasses. In the discussions that follow, the two shaded rows of Table B.1 are excluded from all analyses. Any measurement in Table B.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 to these data were performed.

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-AES measurement process, the measurements for each glass are reviewed, the quenched versus centerline-cooled results are compared, the PCT values are normalized using the compositions (targeted, measured, and bias-corrected) presented in Table A.7, and the normalized PCT values are compared to durability predictions for these compositions generated from the current DWPF models [1].

[a] One of the triplicates from RC70ccc and RC97q failed to meet this criteria.

6.3.2 Measurements in Analytical Sequence

Exhibits B.1 through B.3 provide plots of the leachate concentrations (ppm) in analytical sequence as generated by the SRTC-ML including all of the standards for the three groups (one non-radioactive and two radioactive) of PCTs. Different colors are used for each glass with a plus being used to represent results from quenched glasses while a solid circle represents ccc results. No problems are seen in these plots.

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

Exhibits B.4 through B.6 provide an analysis of the SRTC-ML measurements of the samples of the multi-element solution standard by ICP-AES analytical (or calibration) block for each set of PCTs. An ANOVA investigating for statistically significant differences among the block averages for these samples for each element of interest is included in these exhibits. The 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, a statistically significant (at the 5% level) difference among the Li and Na average measurements over these blocks for group 1 of the radioactive glasses, and a statistically significant (at the 5% level) difference among the Li average measurements over these blocks for group 2 of the radioactive glasses. However, no bias correction of the PCT-A results for the study glasses was conducted. This approach was taken since the triplicate PCTs for a single study glass were placed in different ICP-AES blocks. Averaging the ppm values for each set of triplicates (or duplicates in the case of the two glasses where one replicate did not meet the PCT criteria) helps to minimize the impact of the ICP-AES effects.

Table 10 summarizes the multi-element solution standard average measurements and the reference values for the four primary elements of interest. The results indicate consistent and accurate measurements from the SRTC-ML processes used to conduct these analyses.

6.3.4 Measurements by Glass Number

Exhibits B.7 through B.9 provide plots by PCT group of the leachate concentrations for each type of submitted sample: the standards, quenched RC glasses, and ccc RC glasses. These plots allow for the assessment of the repeatability of the measurements, which suggests no obvious outliers among these data.

6.3.5 Quenched versus Centerline-Cooled Results

As with most high-level waste (HLW) glasses, the RC glasses contain some components that can precipitate from glass during cooling. As the glass is poured into a canister, crystallization can take place within the temperature interval between the liquidus temperature (T_L) and glass-transition temperature (T_g). A portion of the glass cast into canisters is quenched on the canister walls, and another portion of glass, near the canister centerline, cools more slowly. Thus, the temperature history of the ccc glass is most favorable for crystalline phases to form.

As discussed in Section 3.3, the formation of a new phase may chemically and mechanically affect the glass matrix in which it is embedded. As also discussed in Section 3.3, these changes may impact the rate of glass dissolution in water and thus change its chemical durability [(10), (29), and (30)]. The effect of ccc on the PCT of HLW glasses was determined for more than 100 glass compositions [(9) and (10)] and for the DWPF projected glass compositions [35]. Riley et al. [38] and Plodinec et al. [(39) and (40)] also indicated that the residual glass composition was the major factor that controlled the PCT response of HLW glasses with durable crystalline phases. Other chemical or mechanical factors, such as concentration gradients and mechanical stresses, played a secondary role.

Table 10. 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	51.0
	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	6.3%	-2.9%	6.4%	0.6%
Rad Group 1	1	21.6	9.5	83.7	49.5
	2	21.0	9.7	86.5	50.2
	3	22.5	9.7	82.9	49.7
	4	20.9	9.8	88.1	49.6
	5	22.4	9.7	86.2	50.1
	6	21.4	9.9	87.5	50.1
	7	20.4	9.9	86.7	50.2
	8	21.5	10.0	86.6	50.5
	9	20.9	9.8	86.4	50.2
	Grand Average	21.4	9.8	86.1	50.0
	Reference Value	20	10	81	50
	% difference	7.0%	-2.3%	6.2%	0.0%
Rad Group 2	1	20.4	9.5	83.2	49.9
	2	20.6	9.6	87.2	49.8
	3	20.8	9.7	86.3	50.4
	4	21.2	9.7	86.7	50.5
	5	22.8	9.7	85.5	49.7
	6	20.9	9.9	87.3	50.5
	7	20.8	9.7	85.0	50.2
	8	20.9	9.8	86.2	50.3
	9	21.0	9.8	86.2	50.7
	Grand Average	21.1	9.7	86.0	50.2
	Reference Value	20	10	81	50
	% difference	5.3%	-2.8%	6.1%	0.4%

Exhibits B.10 (in ppm) and B.11 (in log ppm) provide a closer look at the quenched versus centerline-cooled results for the RC glasses, including a statistical comparison of the average differences due to heat treatment for each element of interest. These paired-t statistical tests indicate no statistically significant (at the 5% level) differences, on average, between the PCT values for the two heat treatments for any element of interest (i.e., B, Li, Na, and Si).

An additional look at the log [B (ppm)] values is provided in Figure 6, a plot of the ccc versus quenched results for the RC glasses. These results were derived using all of the PCT values (i.e., all three groups). Although no statistical difference (on average) is seen between the quenched and ccc average log [B(ppm)] results for these glasses, some of the individual glasses show statistically significant differences between their quenched and ccc results. These glasses are labeled in Figure 6.

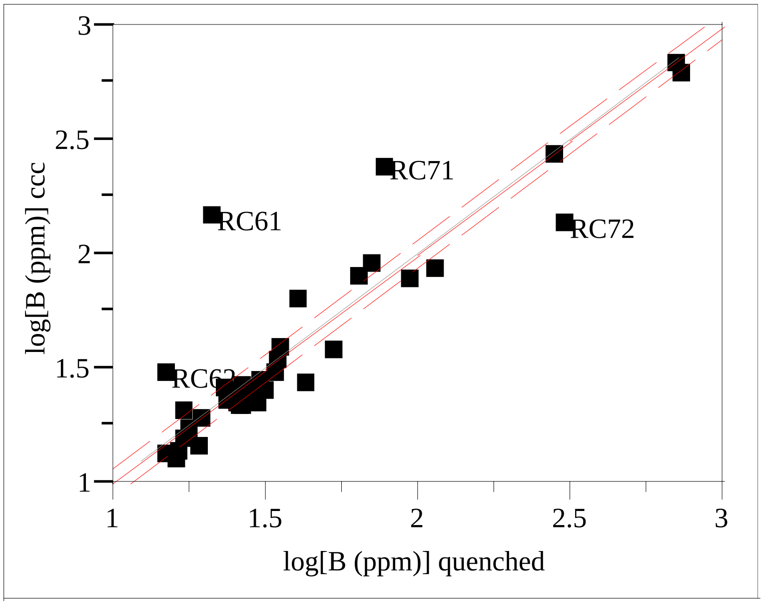

Figure 6. log [B (ppm)] for Quenched vs ccc Glasses

For those glasses which are shown well above the 45° (1:1 correlation) line (i.e., RC-61, RC-62, and RC-71), the quenched version is more durable (lower log B release) than its ccc counterpart. For example, the averaged log [B (ppm)] for RC-61q and RC-61ccc are 1.317 and 2.164, respectively. The lower durability of the ccc version may be a result of the formation of acmite (as identified by XRD and summarized in Table 9). Only one glass is shown below the 45° line in Figure 6, RC-72. The ccc version of RC-72 is more durable (lower B release) than its quenched counterpart. The average log [B (ppm)] values for RC-72q and RC-72ccc are 2.479 and 2.131, respectively. As shown in Table 9, the formation of lithium metasilicate and/or spinel in the ccc version of RC-72 could have played a role in this difference.

For those glasses lying on (or close to) the 45° line, there is little difference between the log [B (ppm)] releases of the quenched and ccc versions. Therefore, other glasses that were determined to have crystals as presented in Table 9 (i.e., RC-64, RC-68, RC-84, and RC-97) appeared to contain either very small amounts of crystals or crystals that did not impact durability since minimal difference was seen between the different heat treatments. In addition, the glasses that were not analyzed by XRD also were not found to have any differences between heat treatments, and therefore did not likely contain any or significant quantities of durability impacting crystals. It should be noted that RC-97 did not appear to have a significant difference between the quenched and ccc results in this study; whereas, the RC-30 glass did [25]. Only a slight difference was seen in this study, which is expected given that the quenched glass was amorphous and the ccc version contained spinel and krinovite.

As described above, insight into the measured PCT-A difference between the quenched and ccc versions of a specific glass can be gained by considering the potential effects of crystallization on durability. As previously mentioned, the effects of crystallization on durability (as measured by the PCT-A response) are highly dependent upon several factors including the type and extent of crystallization and the resulting residual glass composition (see Equation 1 above).

With respect to the three RC glasses shown above the 45° line in Figure 6, all but one of the ccc glasses (RC-62) formed acmite (see Table 9) as defined by XRD analysis. It is hypothesized that the significant difference in the PCT response between the quenched and ccc version of these glasses is attributed to an accelerated grain boundary dissolution discussed above [29] and/or alteration of the residual glass matrix due to the formation of acmite. That is, the formation of acmite in select ccc samples is expected to have led to the deleterious effect on the PCT response. This latter statement assumes that the formation of spinel has minimal or no impact on durability as described by Jantzen and Bickford [29] and Cicero, et al. [30]. The ccc version of RC-71 also contained Li_2SiO_3, which has been shown in some studies to have a deleterious effect on PCT response [(29) and (30)]. The RC-62 glasses both contained trevorite, which has typically not been shown to affect durability; however the ccc glass did have poorer durability. This glass contained a very low concentration of Fe_2O_3, and the residual glass composition could have been depleted by the formation of trevorite crystals, which would have resulted in overall poorer durability for the glass (i.e., approaching the 2.5 wt% Fe_2O_3 limit as observed by Brown and Edwards [5] assuming the volume percent crystallization is extensive). XRD also identified the presence of $CaSO_4$ based on a match with one of the peaks. Although the presence of this crystal is suspect, it is possible that a different crystal may be present that might impact durability or that larger amounts of trevorite in the ccc glass may have impacted the durability. A comparison of the two XRD patterns indicates that the intensity of the trevorite peaks is larger for the ccc glass.

The ccc version of one RC glass (RC-72) was more durable than its quenched counterpart (see Figure 6 – below the 45° line). As shown in Table 9, spinel and Li_2SiO_3 crystals formed in the ccc glass, while the quenched glass was amorphous by XRD. SEM/EDS of the quenched glass did indicate the possibility of small amounts of spinel type crystals. In the case of RC-72, it appears that the formation of the crystals may actually have enhanced the durability response potentially as a result of altering the residual glass matrix or causing a secondary effect. This enhanced durability response is consistent with previous work by Kim et. al. [10] and supports the theory that Li_2SiO_3 crystals impact on durability may more directly be tied to the residual glass matrix composition versus just the presence of the crystals.

It should be mentioned that there are RC glasses (RC-64ccc, RC-84ccc, and RC-97ccc) that formed spinel crystals in which their presence or formation had no measurable effect on durability relative to their quenched counterparts. This latter observation is consistent with previous results where the presence of spinels had little to no effect on the measured PCT response of the glass compared to a non-devitrified counterpart glass [(28), (29), and (30)].

6.3.6 Normalized PCT-A Results

PCT leachate concentrations are typically normalized using the cation composition (expressed as a weight fraction) in the glass to obtain a grams-per-liter (g/L) leachate concentration. The normalization of the PCT values is usually conducted using the measured compositions of the glasses. This is the preferred calculation process for the PCT values [(32) and (33)]. 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 B.1 of Appendix B),
2. Average the common logarithms over the triplicates for each element of interest, and then

Normalize Using the 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 Normalize Using the 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 Normalize Using the 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.

In step 2, only those PCT values satisfying all PCT-A criteria were used to derive the normalized PCT-A for the glass (i.e. the two shaded rows of Table B.1 were excluded from the normalization process).

Exhibit B.12 provides scatter plots for these results and offers an opportunity to investigate the consistency in the leaching across the elements for the glasses of this study. All heat treatments (quenched and ccc versions) of the glasses and all compositional views (targeted, measured, and measured bias-corrected compositions) are represented in this set of plots. Consistency in the leaching across the elements (e.g., congruent dissolution) is typically demonstrated by a high degree of linear correlation among the values for pairs of these elements [3]. A high degree of correlation is seen for these data for all pairs of the elements. The smallest correlation (~94%) is between B and Si. Table 11 summarizes the normalized PCTs for the glasses of this study.

Six of the eighty RC glasses (including both quenched and ccc glasses) were not acceptable based on the working definition being used in this report. Glasses RC-70q, RC-70ccc, RC-71ccc, RC-72q, RC-80q, and RC-80ccc failed the log NL [B] < 1 limit. Five of the six also had higher releases than the normalized release for EA [16], with RC-71ccc having a release less than the measured EA glass release of log NL [B] < 1.222. This glass would, however, not have been at least two standard deviations below the results for the EA glass. Two of the six glasses, RC-80q and RC-80ccc, were predicted by THERMO™ to fail the durability criteria and, thus, their unacceptable releases were expected. Once again, RC-80 was a misbatched glass and contained no Al_2O_3; therefore, its poor durability was anticipated. Based on XRD data, RC-70q, RC-70ccc, and RC-72q were amorphous, while RC-71ccc was found to contain acmite and Li_2SiO_3 that have been shown to impact durability [(29) and (30)]. Glass RC-72q contained a high amount of alkali components (i.e., target was 20.89%), which may have led to its poorer durability. Based on the analyses performed, no obvious explanation for the poor durability shown by glass RC-70 exists. This glass may in fact contain amorphous phase separation, but, as stated earlier, detection of or analyses for amorphous phase separation was not part of this task.

All of the other glasses were acceptable in terms of their PCT-A response relative to EA or based on the definition of acceptability being used in this report regardless of thermal history (or more importantly with respect to the objectives of this task – homogeneity classification). Some of these same glasses (i.e., RC-60, RC-66, RC-68, RC-76, RC-82, RC-83, and RC-87) were predicted to fail the durability PAR (see Table 6), but were all determined to be acceptable based on PCT-A performance. Addressing the disconnect between predictability and acceptability is the subject of a separate SRTC task described in WSRC-RP-2002-00269 by A.D. Cozzi [36].

Table 11. Normalized PCT-A Values by Glass ID/Compositional View/Heat Treatment

Glass ID	Composition	Results from Quenched Glasses								Results from ccc Glasses							
		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		-0.160	-0.193	-0.235	-0.519	0.692	0.641	0.583	0.303	--	--	--	--	--	--	--	--
ARM		-0.299	-0.251	-0.288	-0.581	0.502	0.561	0.515	0.262	--	--	--	--	--	--	--	--
ARM		-0.254	-0.208	-0.245	-0.546	0.558	0.619	0.568	0.285	--	--	--	--	--	--	--	--
EA	see [16]	1.157	0.900	1.023	0.530	14.356	7.935	10.533	3.389	--	--	--	--	--	--	--	--
EA	see [16]	1.238	0.955	1.131	0.574	17.305	9.011	13.505	3.746	--	--	--	--	--	--	--	--
EA	see [16]	1.153	0.878	1.033	0.513	14.239	7.546	10.796	3.258	--	--	--	--	--	--	--	--
RC58	Measured	0.590	0.500	0.444	0.180	3.89	3.17	2.78	1.51	0.502	0.410	0.336	0.109	3.18	2.57	2.17	1.29
RC58	Measured bc	0.613	0.511	0.472	0.186	4.10	3.24	2.96	1.53	0.525	0.420	0.363	0.115	3.35	2.63	2.31	1.30
RC58	Targeted	0.601	0.504	0.479	0.178	3.99	3.19	3.01	1.51	0.513	0.413	0.371	0.107	3.26	2.59	2.35	1.28
RC59	measured	0.885	0.814	0.652	0.306	7.68	6.52	4.49	2.02	0.869	0.802	0.653	0.306	7.40	6.33	4.49	2.02
RC59	Measured bc	0.895	0.816	0.682	0.291	7.84	6.54	4.81	1.95	0.879	0.803	0.683	0.292	7.56	6.36	4.82	1.96
RC59	Targeted	0.873	0.797	0.665	0.308	7.46	6.26	4.63	2.03	0.857	0.784	0.666	0.309	7.19	6.08	4.63	2.04
RC60	Measured	0.197	0.153	0.201	-0.115	1.57	1.42	1.59	0.77	0.206	0.277	0.235	-0.037	1.61	1.89	1.72	0.92
RC60	Measured bc	0.206	0.155	0.233	-0.127	1.61	1.43	1.71	0.75	0.216	0.279	0.267	-0.049	1.64	1.90	1.85	0.89
RC60	Targeted	0.193	0.127	0.215	-0.123	1.56	1.34	1.64	0.75	0.203	0.251	0.249	-0.046	1.59	1.78	1.77	0.90
RC61	Measured	0.123	0.053	-0.027	-0.213	1.33	1.13	0.94	0.61	0.969	0.549	0.569	-0.206	9.32	3.54	3.71	0.62
RC61	Measured bc	0.128	0.054	0.006	-0.225	1.34	1.13	1.01	0.60	0.974	0.550	0.601	-0.218	9.42	3.55	3.99	0.61
RC61	Targeted	0.126	0.051	-0.005	-0.226	1.34	1.12	0.99	0.59	0.973	0.546	0.590	-0.219	9.39	3.52	3.89	0.60
RC62	Measured	-0.015	-0.018	-0.186	-0.187	0.97	0.96	0.65	0.65	0.287	0.317	-0.055	-0.004	1.93	2.08	0.88	0.99
RC62	Measured bc	-0.011	-0.017	-0.155	-0.201	0.98	0.96	0.70	0.63	0.291	0.318	-0.024	-0.017	1.96	2.08	0.95	0.96
RC62	Targeted	-0.019	-0.025	-0.180	-0.194	0.96	0.94	0.66	0.64	0.283	0.310	-0.049	-0.010	1.92	2.04	0.89	0.98
RC63	Measured	-0.078	-0.153	-0.222	-0.499	0.84	0.70	0.60	0.32	-0.180	-0.255	-0.315	-0.534	0.66	0.56	0.48	0.29
RC63	Measured bc	-0.056	-0.143	-0.194	-0.493	0.88	0.72	0.64	0.32	-0.158	-0.244	-0.287	-0.528	0.70	0.57	0.52	0.30
RC63	Targeted	-0.073	-0.144	-0.186	-0.477	0.84	0.72	0.65	0.33	-0.176	-0.245	-0.279	-0.512	0.67	0.57	0.53	0.31
RC64	Measured	0.504	0.436	0.167	0.033	3.19	2.73	1.47	1.08	0.380	0.341	0.108	-0.022	2.40	2.19	1.28	0.95
RC64	Measured bc	0.509	0.437	0.198	0.020	3.23	2.73	1.58	1.05	0.385	0.342	0.139	-0.036	2.43	2.20	1.38	0.92
RC64	Targeted	0.483	0.420	0.196	0.035	3.04	2.63	1.57	1.08	0.359	0.325	0.138	-0.020	2.28	2.11	1.37	0.95
RC65	Measured	0.004	-0.044	0.193	-0.255	1.01	0.90	1.56	0.56	-0.102	-0.063	0.118	-0.288	0.79	0.87	1.31	0.52
RC65	Measured bc	0.026	-0.034	0.221	-0.249	1.06	0.92	1.66	0.56	-0.080	-0.053	0.146	-0.282	0.83	0.89	1.40	0.52
RC65	Targeted	0.013	-0.037	0.214	-0.240	1.03	0.92	1.64	0.57	-0.093	-0.056	0.139	-0.273	0.81	0.88	1.38	0.53
RC66	Measured	0.427	0.402	0.356	0.009	2.67	2.52	2.27	1.02	0.227	0.200	0.157	-0.145	1.69	1.58	1.44	0.72
RC66	Measured bc	0.449	0.412	0.383	0.015	2.81	2.58	2.42	1.04	0.249	0.210	0.185	-0.139	1.78	1.62	1.53	0.73
RC66	Targeted	0.439	0.401	0.385	0.024	2.75	2.52	2.43	1.06	0.240	0.199	0.186	-0.130	1.74	1.58	1.54	0.74

Table 11. Normalized PCT-A Values by Glass ID/Compositional View/Heat Treatment *(continued)*

		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)
RC67	Measured	-0.089	-0.040	-0.215	-0.353	0.82	0.91	0.61	0.44	-0.146	-0.088	-0.251	-0.410	0.71	0.82	0.56	0.39
RC67	Measured bc	-0.079	-0.039	-0.184	-0.366	0.83	0.91	0.66	0.43	-0.136	-0.086	-0.220	-0.423	0.73	0.82	0.60	0.38
RC67	Targeted	-0.114	-0.034	-0.198	-0.368	0.77	0.93	0.63	0.43	-0.171	-0.081	-0.234	-0.424	0.67	0.83	0.58	0.38
RC68	Measured	0.410	0.312	0.349	0.068	2.57	2.05	2.23	1.17	0.600	0.536	0.461	0.193	3.99	3.43	2.89	1.56
RC68	Measured bc	0.419	0.314	0.381	0.056	2.63	2.06	2.41	1.14	0.610	0.537	0.493	0.181	4.07	3.45	3.11	1.52
RC68	Targeted	0.409	0.313	0.356	0.060	2.57	2.05	2.27	1.15	0.600	0.536	0.468	0.185	3.98	3.44	2.94	1.53
RC69	Measured	0.221	0.211	0.189	-0.202	1.66	1.63	1.55	0.63	0.315	0.329	0.218	-0.145	2.07	2.14	1.65	0.72
RC69	Measured bc	0.243	0.221	0.217	-0.196	1.75	1.66	1.65	0.64	0.337	0.340	0.245	-0.140	2.17	2.19	1.76	0.73
RC69	Targeted	0.229	0.213	0.214	-0.195	1.69	1.63	1.64	0.64	0.323	0.331	0.243	-0.138	2.10	2.14	1.75	0.73
RC70	Measured	1.298	1.133	1.082	0.417	19.88	13.59	12.08	2.61	1.227	1.070	1.011	0.380	16.85	11.76	10.27	2.40
RC70	Measured bc	1.303	1.134	1.112	0.402	20.09	13.61	12.94	2.52	1.231	1.071	1.041	0.365	17.03	11.78	11.00	2.32
RC70	Targeted	1.287	1.132	1.091	0.411	19.37	13.56	12.34	2.58	1.215	1.069	1.021	0.374	16.42	11.73	10.49	2.37
RC71	Measured	0.671	0.624	0.617	0.135	4.69	4.20	4.14	1.37	1.155	0.609	0.986	0.310	14.29	4.07	9.68	2.04
RC71	Measured bc	0.694	0.634	0.645	0.141	4.94	4.30	4.41	1.38	1.177	0.620	1.014	0.315	15.04	4.17	10.32	2.07
RC71	Targeted	0.694	0.616	0.646	0.145	4.94	4.13	4.43	1.40	1.177	0.602	1.015	0.320	15.05	4.00	10.35	2.09
RC72	Measured	1.212	0.938	1.072	0.683	16.29	8.66	11.82	4.82	0.864	0.674	0.765	0.469	7.31	4.72	5.82	2.94
RC72	Measured bc	1.234	0.948	1.100	0.688	17.14	8.87	12.59	4.88	0.886	0.684	0.793	0.474	7.69	4.83	6.20	2.98
RC72	Targeted	1.218	0.940	1.094	0.695	16.50	8.71	12.41	4.95	0.870	0.676	0.786	0.480	7.41	4.74	6.12	3.02
RC73	Measured	-0.071	-0.085	-0.154	-0.378	0.85	0.82	0.70	0.42	-0.155	-0.137	-0.216	-0.410	0.70	0.73	0.61	0.39
RC73	Measured bc	-0.061	-0.083	-0.122	-0.391	0.87	0.83	0.76	0.41	-0.146	-0.135	-0.184	-0.423	0.71	0.73	0.65	0.38
RC73	Targeted	-0.080	-0.092	-0.140	-0.385	0.83	0.81	0.72	0.41	-0.164	-0.144	-0.203	-0.418	0.69	0.72	0.63	0.38
RC74	Measured	-0.075	-0.109	-0.175	-0.299	0.84	0.78	0.67	0.50	-0.158	-0.142	-0.233	-0.329	0.69	0.72	0.58	0.47
RC74	Measured bc	-0.071	-0.109	-0.144	-0.312	0.85	0.78	0.72	0.49	-0.154	-0.141	-0.202	-0.342	0.70	0.72	0.63	0.45
RC74	Targeted	-0.084	-0.117	-0.177	-0.323	0.82	0.76	0.67	0.47	-0.167	-0.150	-0.235	-0.353	0.68	0.71	0.58	0.44
RC75	Measured	-0.054	-0.092	-0.113	-0.360	0.88	0.81	0.77	0.44	0.025	-0.143	-0.184	-0.367	1.06	0.72	0.66	0.43
RC75	Measured bc	-0.049	-0.091	-0.083	-0.375	0.89	0.81	0.83	0.42	0.030	-0.142	-0.154	-0.382	1.07	0.72	0.70	0.41
RC75	Targeted	-0.070	-0.089	-0.095	-0.366	0.85	0.81	0.80	0.43	0.009	-0.140	-0.166	-0.374	1.02	0.72	0.68	0.42
RC76	Measured	0.079	0.016	0.023	-0.174	1.20	1.04	1.06	0.67	0.126	0.017	0.007	-0.180	1.34	1.04	1.02	0.66
RC76	Measured bc	0.088	0.018	0.055	-0.187	1.23	1.04	1.13	0.65	0.135	0.019	0.038	-0.193	1.36	1.04	1.09	0.64
RC76	Targeted	0.066	0.004	0.044	-0.180	1.16	1.01	1.11	0.66	0.112	0.004	0.028	-0.185	1.29	1.01	1.07	0.65
RC77	Measured	0.266	0.197	0.263	-0.035	1.84	1.57	1.83	0.92	0.294	0.248	0.205	-0.055	1.97	1.77	1.60	0.88
RC77	Measured bc	0.271	0.198	0.293	-0.050	1.86	1.58	1.96	0.89	0.299	0.248	0.236	-0.070	1.99	1.77	1.72	0.85
RC77	Targeted	0.251	0.179	0.286	-0.042	1.78	1.51	1.93	0.91	0.280	0.229	0.229	-0.062	1.90	1.70	1.69	0.87
RC78	Measured	0.189	0.101	0.093	-0.198	1.55	1.26	1.24	0.63	0.057	0.007	-0.052	-0.268	1.14	1.02	0.89	0.54
RC78	Measured bc	0.199	0.102	0.127	-0.208	1.58	1.27	1.34	0.62	0.066	0.008	-0.018	-0.278	1.17	1.02	0.96	0.53
RC78	Targeted	0.176	0.084	0.106	-0.204	1.50	1.21	1.28	0.63	0.044	-0.010	-0.039	-0.274	1.11	0.98	0.91	0.53

Table 11. Normalized PCT-A Values by Glass ID/Compositional View/Heat Treatment *(continued)*

		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)
RC79	Measured	-0.057	-0.102	-0.195	-0.340	0.88	0.79	0.64	0.46	-0.151	-0.142	-0.236	-0.341	0.71	0.72	0.58	0.46
RC79	Measured bc	-0.053	-0.102	-0.163	-0.351	0.89	0.79	0.69	0.45	-0.146	-0.141	-0.203	-0.352	0.71	0.72	0.63	0.44
RC79	Targeted	-0.066	-0.112	-0.179	-0.343	0.86	0.77	0.66	0.45	-0.160	-0.152	-0.220	-0.345	0.69	0.71	0.60	0.45
RC80	Measured	1.515	1.143	1.350	0.911	32.70	13.89	22.37	8.14	1.495	1.118	1.324	0.887	31.27	13.13	21.09	7.71
RC80	Measured bc	1.524	1.144	1.381	0.898	33.42	13.94	24.04	7.90	1.505	1.120	1.355	0.874	31.95	13.18	22.66	7.49
RC80	Targeted	1.507	1.127	1.368	0.908	32.11	13.40	23.35	8.08	1.487	1.103	1.343	0.884	30.70	12.67	22.01	7.66
RC81	Measured	0.036	-0.016	-0.050	-0.272	1.09	0.96	0.89	0.53	0.031	-0.019	-0.046	-0.301	1.07	0.96	0.90	0.50
RC81	Measured bc	0.041	-0.015	-0.017	-0.283	1.10	0.97	0.96	0.52	0.036	-0.018	-0.013	-0.312	1.09	0.96	0.97	0.49
RC81	Targeted	0.021	-0.023	-0.034	-0.285	1.05	0.95	0.92	0.52	0.015	-0.026	-0.030	-0.314	1.04	0.94	0.93	0.49
RC82	Measured	0.427	0.336	0.340	0.034	2.68	2.17	2.19	1.08	0.285	0.257	0.204	-0.008	1.93	1.81	1.60	0.98
RC82	Measured bc	0.437	0.338	0.372	0.022	2.73	2.18	2.36	1.05	0.295	0.259	0.236	-0.020	1.97	1.81	1.72	0.95
RC82	Targeted	0.420	0.319	0.373	0.031	2.63	2.08	2.36	1.07	0.278	0.240	0.237	-0.011	1.89	1.74	1.72	0.97
RC83	Measured	0.104	0.073	0.095	-0.204	1.27	1.18	1.24	0.63	0.041	0.039	0.024	-0.256	1.10	1.10	1.06	0.55
RC83	Measured bc	0.109	0.074	0.126	-0.217	1.28	1.19	1.34	0.61	0.045	0.040	0.054	-0.270	1.11	1.10	1.13	0.54
RC83	Targeted	0.102	0.063	0.119	-0.208	1.26	1.16	1.32	0.62	0.039	0.029	0.048	-0.261	1.09	1.07	1.12	0.55
RC84	Measured	-0.008	-0.047	-0.127	-0.315	0.98	0.90	0.75	0.48	-0.143	-0.103	-0.180	-0.339	0.72	0.79	0.66	0.46
RC84	Measured bc	0.001	-0.046	-0.095	-0.326	1.00	0.90	0.80	0.47	-0.134	-0.101	-0.148	-0.351	0.73	0.79	0.71	0.45
RC84	Targeted	-0.018	-0.062	-0.092	-0.310	0.96	0.87	0.81	0.49	-0.153	-0.118	-0.146	-0.334	0.70	0.76	0.72	0.46
RC85	Measured	-0.050	-0.034	-0.090	-0.263	0.89	0.92	0.81	0.55	-0.098	0.013	-0.106	-0.234	0.80	1.03	0.78	0.58
RC85	Measured bc	-0.041	-0.033	-0.058	-0.276	0.91	0.93	0.88	0.53	-0.089	0.015	-0.074	-0.247	0.82	1.03	0.84	0.57
RC85	Targeted	-0.067	-0.057	-0.069	-0.269	0.86	0.88	0.85	0.54	-0.115	-0.010	-0.085	-0.239	0.77	0.98	0.82	0.58
RC86	Measured	-0.116	-0.132	-0.191	-0.413	0.77	0.74	0.64	0.39	-0.175	-0.160	-0.219	-0.423	0.67	0.69	0.60	0.38
RC86	Measured bc	-0.106	-0.130	-0.160	-0.426	0.78	0.74	0.69	0.38	-0.166	-0.158	-0.187	-0.436	0.68	0.69	0.65	0.37
RC86	Targeted	-0.124	-0.145	-0.158	-0.413	0.75	0.72	0.70	0.39	-0.183	-0.174	-0.185	-0.423	0.66	0.67	0.65	0.38
RC87	Measured	0.056	-0.040	0.032	-0.259	1.14	0.91	1.08	0.55	-0.004	-0.062	-0.022	-0.283	0.99	0.87	0.95	0.52
RC87	Measured bc	0.065	-0.039	0.063	-0.274	1.16	0.91	1.16	0.53	0.005	-0.061	0.009	-0.297	1.01	0.87	1.02	0.50
RC87	Targeted	0.041	-0.053	0.051	-0.264	1.10	0.89	1.12	0.55	-0.018	-0.075	-0.003	-0.287	0.96	0.84	0.99	0.52
RC88	Measured	0.224	0.194	0.143	-0.046	1.67	1.56	1.39	0.90	0.186	0.171	0.048	-0.064	1.54	1.48	1.12	0.86
RC88	Measured bc	0.233	0.196	0.176	-0.057	1.71	1.57	1.50	0.88	0.196	0.172	0.081	-0.075	1.57	1.49	1.20	0.84
RC88	Targeted	0.207	0.172	0.167	-0.053	1.61	1.48	1.47	0.88	0.170	0.148	0.072	-0.072	1.48	1.41	1.18	0.85
RC89	Measured	0.022	0.046	-0.002	-0.152	1.05	1.11	1.00	0.70	-0.002	0.048	-0.028	-0.164	1.00	1.12	0.94	0.69
RC89	Measured bc	0.032	0.048	0.029	-0.166	1.08	1.12	1.07	0.68	0.008	0.050	0.003	-0.177	1.02	1.12	1.01	0.67
RC89	Targeted	0.020	0.036	0.027	-0.150	1.05	1.09	1.06	0.71	-0.004	0.039	0.000	-0.162	0.99	1.09	1.00	0.69
RC90	Measured	-0.011	0.024	-0.038	-0.187	0.98	1.06	0.92	0.65	-0.026	0.007	-0.071	-0.215	0.94	1.02	0.85	0.61
RC90	Measured bc	-0.006	0.025	-0.005	-0.199	0.99	1.06	0.99	0.63	-0.021	0.008	-0.039	-0.227	0.95	1.02	0.91	0.59
RC90	Targeted	-0.023	0.009	-0.014	-0.189	0.95	1.02	0.97	0.65	-0.038	-0.008	-0.048	-0.217	0.92	0.98	0.90	0.61

Table 11. Normalized PCT-A Values by Glass ID/Compositional View/Heat Treatment *(continued)*

		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)
RC91	Measured	0.159	0.140	0.270	-0.056	1.44	1.38	1.86	0.88	0.069	0.092	0.086	-0.110	1.17	1.24	1.22	0.78
RC91	Measured bc	0.164	0.141	0.302	-0.067	1.46	1.38	2.01	0.86	0.074	0.093	0.119	-0.121	1.19	1.24	1.32	0.76
RC91	Targeted	0.146	0.129	0.289	-0.066	1.40	1.35	1.95	0.86	0.057	0.081	0.106	-0.119	1.14	1.21	1.28	0.76
RC92	Measured	0.145	0.130	0.058	-0.089	1.40	1.35	1.14	0.81	0.127	0.119	0.035	-0.110	1.34	1.32	1.08	0.78
RC92	Measured bc	0.150	0.130	0.088	-0.104	1.41	1.35	1.23	0.79	0.132	0.120	0.065	-0.125	1.35	1.32	1.16	0.75
RC92	Targeted	0.129	0.119	0.078	-0.105	1.35	1.32	1.20	0.79	0.111	0.108	0.055	-0.126	1.29	1.28	1.14	0.75
RC93	Measured	0.213	0.171	0.163	-0.036	1.63	1.48	1.46	0.92	0.161	0.136	0.077	-0.090	1.45	1.37	1.19	0.81
RC93	Measured bc	0.218	0.171	0.195	-0.048	1.65	1.48	1.57	0.89	0.165	0.136	0.110	-0.102	1.46	1.37	1.29	0.79
RC93	Targeted	0.194	0.147	0.191	-0.038	1.56	1.40	1.55	0.92	0.141	0.112	0.105	-0.092	1.38	1.29	1.27	0.81
RC94	Measured	0.170	0.141	0.119	-0.068	1.48	1.38	1.32	0.85	0.165	0.113	0.074	-0.107	1.46	1.30	1.19	0.78
RC94	Measured bc	0.174	0.142	0.151	-0.081	1.49	1.39	1.42	0.83	0.170	0.114	0.106	-0.120	1.48	1.30	1.28	0.76
RC94	Targeted	0.148	0.120	0.145	-0.070	1.41	1.32	1.40	0.85	0.144	0.092	0.100	-0.109	1.39	1.24	1.26	0.78
RC95	Measured	0.217	0.174	0.122	-0.039	1.65	1.49	1.33	0.91	0.163	0.146	0.210	-0.071	1.45	1.40	1.62	0.85
RC95	Measured bc	0.222	0.174	0.153	-0.053	1.67	1.49	1.42	0.89	0.167	0.146	0.241	-0.085	1.47	1.40	1.74	0.82
RC95	Targeted	0.205	0.159	0.152	-0.051	1.60	1.44	1.42	0.89	0.151	0.131	0.239	-0.083	1.41	1.35	1.74	0.83
RC96	Measured	0.015	0.003	-0.044	-0.278	1.04	1.01	0.90	0.53	-0.013	-0.016	-0.070	-0.291	0.97	0.96	0.85	0.51
RC96	Measured bc	0.020	0.004	-0.014	-0.293	1.05	1.01	0.97	0.51	-0.008	-0.016	-0.039	-0.305	0.98	0.96	0.91	0.50
RC96	Targeted	-0.002	-0.017	-0.017	-0.285	1.00	0.96	0.96	0.52	-0.031	-0.037	-0.043	-0.297	0.93	0.92	0.91	0.50
RC97	Measured	0.545	0.428	0.087	0.146	3.51	2.68	1.22	1.40	0.652	0.584	0.377	0.297	4.49	3.83	2.38	1.98
RC97	Measured bc	0.555	0.430	0.118	0.133	3.59	2.69	1.31	1.36	0.662	0.585	0.407	0.284	4.59	3.85	2.56	1.92
RC97	Targeted	0.541	0.418	0.111	0.146	3.48	2.62	1.29	1.40	0.648	0.574	0.401	0.296	4.45	3.75	2.52	1.98

6.3.7 Predicted versus Measured PCTs

As seen in Table 11, when the extremes of the glass composition envelope that was used to bound future sludge-only processing at DWPF are experimentally explored some of the resulting durabilities approach those of EA, while others actually exceed the EA durability. Exhibit B.13 provides a closer look at these results based upon the glass chemical compositions (targeted, measured, and measured bias corrected) and the heat treatment (ccc and quenched). The exhibit provides plots of predictions from the DWPF durability models that relate the logarithm of the normalized PCT-A (for each element of interest) to a linear function of a free energy of hydration term (ΔG_p, kcal/100g glass) derived from the glass composition [3]. Prediction limits (at a 95% confidence) for an individual PCT-A result are also plotted along with the linear fit. The EA and ARM results are also indicated on these plots. Quenched results are plotted as open circles, ccc results as pluses, and ARM and EA as small squares. Different colors are used to represent the different glasses in these plots. For each PCT-A response of interest, plots are provided that include all of the compositional views of the glasses on a single plot and then each compositional view (targeted, measured, and measured bc) on a separate plot.

The durability for a glass is deemed “predictable” in this report if its normalized PCT-A response falls with the confidence intervals provided in these plots. Note that while many of the RC glasses reveal predictable PCTs, some do not. To provide a closer look at each glass, the predicted versus measured B release is plotted for each glass in Exhibit B.14.

Note that the plot for RC-97 reveals an acceptable and predictable durability for this glass. This result reinforces the results seen for the targeted and measured views of RC-30 in the previous study [25].

6.4 Challenges to the Homogeneity Discriminator

The homogeneity constraint is currently used to discriminate compositions that are likely to result in phase-separated glasses from compositions that are likely to be homogeneous. In this context, phase separation refers to the development of amorphous or glass-in-glass phase separation. The technical basis for developing and implementing the phase-separation discriminator into PCCS was the fact that durability of glasses containing amorphous phase separation has been found to be unpredictable for some DWPF type glasses. If sufficient evidence can establish the fact that the glasses of this study are acceptable based on a predefined acceptance criterion over the composition region of interest even if they are unpredictable, then eliminating or replacing the homogeneity constraint with composition parameters that are equivalent, yet less restrictive, may be possible. More specifically, to unconditionally eliminate or replace the homogeneity constraint, glasses within the composition region of interest should be predictable and/or acceptable regardless of the homogeneity classification.

Table 12 summarizes various physical properties of the RC glasses. The columns in Table 12 indicate the glass ID; selection basis; homogeneity classification/prediction; the Al_2O_3, sum of alkali and Fe_2O_3 concentration in glass; the XRD results of both quenched and ccc glasses, if applicable; results of the SEM analysis, if applicable; and the PCT-A results for both quenched and ccc glasses.

Table 12. Classification of RC Glasses (Based on Targeted Composition) with Related Physical Properties of Interest

ID	Selection Basis	Homogeneity Prediction	Al_2O_3 (mass fraction)	∑alkali (mass fraction)	Fe_2O_3 (mas fraction)	XRD q	XRD ccc	SEM	PCT-A q	PCT-A ccc
RC58	OL EV	No	0.0300	0.145	0.0500	A	A	RuO_2 (q)	NP (all)	NP (all)
RC59	OL EV	No	0.0300	0.1543	0.0500	A	A	NM	NP (mbc)	NP (mbc)
RC60	OL EV	No	0.0915	0.2010	0.0500	NM	NM	Fe, Mn, Si, (q), Mn, Fe, Si, U (ccc)	-	-
RC61	OL EV	No	0.0300	0.1050	0.1681	Magnetite	Acmite, Magnetite	NM	NP (all)	NP (all)
RC62	OL EV	Yes	0.1443	0.1450	0.0500	Trevorite	Trevorite, CaSO4	NM	NP (all)	NP (all)
RC63	OL EV	No	0.1308	0.1409	0.0500	NM	NM	NM	-	-
RC64	OL EV	Yes	0.0300	0.1450	0.1317	A	Trevorite	NM	NP (all)	NP (all)
RC65	OL EV	Yes	0.0720	0.2214	0.0500	NM	NM	NM	NP (t)	NP (t, m)
RC66	OL EV	No	0.0300	0.1620	0.0947	NM	NM	NM	-	-
RC67	OL EV	No	0.0300	0.1050	0.0872	A	A	NM	NP (all)	NP (all)
RC68	OL EV	No	0.0300	0.1637	0.0500	Trevorite	Krinovite	NM	-	-
RC69	OL EV	No	0.0800	0.1638	0.0500	NM	NM	NM	-	-
RC70	OL EV	No	0.0300	0.1707	0.0500	A	A	Clean (q and ccc)	NP (all), >1	NP (all), >1
RC71	OL EV	No	0.0300	0.1517	0.0500	A	Acmite, Li_2SiO_3	NM	-	NP (all), >1
RC72	OL EV	No	0.0300	0.2089	0.1182	A	Li_2SiO_3, Ni_6MnO_8	Fe, Ni (q)	NP (all), >1	NP (t, mbc)
RC73	IL EV	No	0.0540	0.1480	0.0760	NM	NM	NM	-	-
RC74	IL EV	No	0.0540	0.1590	0.0760	NM	NM	NM	-	-
RC75	IL EV	No	0.0540	0.1517	0.0760	NM	NM	NM	-	-
RC76	IL EV	No	0.0540	0.1767	0.0760	NM	NM	NM	NP (m)	NP (m)
RC77	IL EV	No	0.0540	0.1745	0.0910	NM	NM	NM	-	-
RC78	IL EV	No	0.0540	0.1480	0.1195	NM	NM	NM	-	-
RC79	IL EV	No	0.0788	0.1720	0.0760	NM	NM	NM	-	-
RC80	IL EV	No	0.0825	0.2008	0.0760	A	A	NM	-, >1	-, >1
RC81	IL EV	No	0.0540	0.1480	0.0760	NM	NM	NM	-	-
RC82	IL EV	No	0.0540	0.1750	0.0760	NM	NM	NM	-	-
RC83	IL EV	No	0.0540	0.1710	0.0777	NM	NM	NM	NP (m)	NP (m)
RC84	IL EV	No	0.0540	0.1480	0.1195	A	Trevorite	NM	-	-
RC85	IL EV	Yes	0.0906	0.1720	0.0760	NM	NM	NM	-	-
RC86	IL EV	No	0.0970	0.1497	0.0760	NM	NM	NM	-	-
RC87	IL EV	No	0.0540	0.1922	0.0967	NM	NM	NM	NP (m)	NP (m, t)
RC88	SB3 OL at 25% WL	No	0.0306	0.1756	0.1069	NM	NM	NM	-	-
RC89	SB3 OL at 25% WL	No	0.0354	0.1760	0.1069	NM	NM	NM	-	-
RC90	SB4 OL at 25% WL	No	0.0442	0.1756	0.0952	NM	NM	NM	-	-
RC91	SB4 OL at 25% WL	No	0.0346	0.1908	0.0952	NM	NM	NM	-	-
RC92	SB4 OL at 30% WL	No	0.0314	0.1712	0.1143	NM	NM	NM	-	-
RC93	SB4 OL at 30% WL	No	0.0303	0.1894	0.1143	NM	NM	NM	-	-
RC94	SB3 Ring at 25% WL	No	0.0310	0.1841	0.1080	NM	NM	NM	-	-
RC95	SB4 Ring at 25% WL	No	0.0303	0.1810	0.1078	NM	NM	NM	-	-
RC96	OL centroid	No	0.0654	0.1603	0.0749	NM	NM	NM	-	-
RC97	RC-30	No	0.0312	0.1756	0.1204	A	Trevorite, Krinovite	NM	-	-

The homogeneity column indicates either a "Yes" or "No" meaning that the glass is either predicted to be homogeneous or inhomogeneous, respectively, based on the homogeneity discriminator. The columns showing the XRD results either use an "A" to represent an amorphous glass (i.e., absent of crystallization at a given detection limit), the type of crystal(s) reported by SRTC-ADS is provided, or an "NM" is shown to indicate that the glass was not measured. The SEM column is presented either by the elements detected by EDS or by an "NM" indicating that the glass was not measured.

As discussed in Section 3.3, although the ΔG_P model was developed to be applied to a homogeneous glass [(3) and (28)], application to inhomogeneous glasses does have potential (and technical merit) given the impact of the developing secondary phase(s) is minimal to the overall performance, see Equation (1). In this report, the ΔG_P model was applied to both quenched and ccc glasses (to assess the predictability) – regardless of the presence or absence of crystallization and/or amorphous phase separation – to test this hypothesis or assumption. It should be noted that previous studies [(20) and (21)] have also applied the ΔG_P model to both quenched and ccc glasses with success (given the formation of spinels and minimization of the last two terms in Equation (1)). It should be noted that the formation of non-isotropic crystals (such as acmite) may have a significant impact on the crystallization and grain boundary terms resulting in the classification of "unpredictable" (see Section 6.3.5).

Therefore, the PCT-A columns in Table 12 are expressed in terms of predictable ("-") and unpredictable ("NP"), respectively. If "NP" is shown in the PCT-A column the compositional basis for which the PCT-A is unpredictable is shown in parenthesis. For example, "(all)" indicates that the PCT-A is unpredictable based on all (targeted, measured, and measured-bias corrected) compositional views. The use of "(mbc)", "(m)" and "(t") represents measured bias-corrected, measured, and targeted compositional views, respectively. Also included in the PCT-A columns is an indication as to the acceptability of the glass based on the actual PCT-A measured B response. A ">1" indicates that the log NL [B] release (g/L) was greater than or equal to 1 ("unacceptable"). If the response was less than 1 ("acceptable"), no entry was made in the respective cell.

With respect to the primary task objective, thirty-six of the forty targeted compositions actually challenged the homogeneity constraint according to the prediction based on targeted compositions. Predictions of homogeneity using both measured and measured bias-corrected values provided similar results. Of the eighty glasses (when both heat treatments are considered), fifty-three of the glasses were both predictable and acceptable. Twenty-one of the eighty glasses had acceptable durabilities but were not predictable. A few of these glasses had cases where only one compositional view was just under the predictability bounds. As mentioned above, RC-80 was not acceptable, but it was predictable for both heat treatments. Finally, four of the eighty glasses were neither predictable nor acceptable. Discussions of the challenges to the homogeneity discriminator are discussed by the selection basis (i.e., SB3 and SB4, inner layer, outer layer) in the sections that follow.

6.4.1 Phase 1 Re-Test Glass

As mentioned earlier, RC-97 was selected for testing based on conflicting results from Phase 1 testing with RC-30. RC-30 was unpredictable only when considering the measured-bias corrected version of the quenched glass in the Phase 1 test [25]. However, in the current phase of testing, all views of RC-97 were considered predictable and acceptable. Therefore, it is believed that this glass should be considered predictable and acceptable. Note that RC-97 failed the homogeneity PAR. Thus the constraint was overly restrictive for the glass and the results support the elimination or replacement of the homogeneity constraint with the proposed alumina and sum of alkali criteria.

6.4.2 SB3 and SB4 Glasses

Eight of the compositions tested in this study or sixteen glasses when both heat treatments are considered represented glass compositions that might be fabricated if SB3 and SB4 are combined with Frit 320 (using sludge projections similar to those identified in the HLW System Plan [23]). All sixteen of these glasses were predicted to be inhomogeneous (i.e., they failed the homogeneity PAR) and turned out to be both predictable and acceptable. This supports findings of the RC paper study and the Phase 1 studies with these sludge batches and Frit 320 [(18) and (25)]. Thus, support for elimination or replacement of the homogeneity constraint with the proposed criteria is further provided by these SB3 and SB4 based glasses.

6.4.3 Inner Layer Glasses

Selection of the interior region/layer was discussed in Section 4.0 and in WSRC-RP-2002-00236 [31]. Fifteen compositions from this region were tested. Of the thirty glasses (when both heat treatments are considered), eight did not meet the predictable and acceptable criteria. These glasses included both heat treatments for RC-76, RC-80, RC-83, and RC-87. RC-76 and RC-83 were only non-predictable for the measured compositional view. The points were just below the predictability line (i.e., ΔG_p model was overly conservative - see Exhibit B.14). RC-87 was unpredictable for the measured and target compositional views. These representations also fell just below the predictability line (see Exhibit B.14). All of these glasses had log NL [B] releases that were much less than 1 g/L. Similar behavior was seen for glass RC-30 in the Phase 1 study [25]. This is the reason it was retested as part of this study and, as stated above, all compositional representations for glass RC-97 (i.e., the re-batched RC-30) were predictable in this study.

Finally, RC-80 was the glass that was misbatched and did not contain any Al_2O_3 so technically it was not within the bounding glass compositional region. However it was included as part of the evaluation. This glass was predicted to be non-durable and the PCT results verified this prediction (for both the quenched and ccc versions). Therefore, this glass would not have been selected for processing in DWPF during the SME acceptability assessment.

All of the glasses in the inner layer, except RC-85, were predicted to be inhomogeneous. The actual measured durability of all of the glasses (except the misbatched RC-80) were acceptable and, with the exception of the six cases discussed above, all glasses were predictable. Therefore, since the basis of this study is that a glass has to be predictable and/or acceptable, all of the glasses from the inner layer would meet the predictable and/or acceptable definition. Thus, the glasses tested in the inner layer region would allow for the elimination or replacement of the homogeneity constraint. For the case of the inner layer glasses, applying the homogeneity constraint even at the PAR limit would have unnecessarily restricted processing. Therefore, the data from the inner layer provides support for elimination or replacement of the homogeneity constraint with the alumina and sum of alkali criteria to provide a more flexible operating region for DWPF. The intent of the constraint was demonstrated on this region through the data analysis showing all glasses were either predictable and/or acceptable.

6.4.4 Outer Layer Glasses

As discussed in Section 4.0, the extreme/outer layer of the glass bounding region was generated from the composition extremes of the bounding region. Since the region represents the extremes in the individual oxide bounds, it may also represent some glass compositions that would not possibly be seen in the DWPF. More specifically, constraints were not imposed to restrict a frit component (e.g., Li_2O) and a sludge component (e.g., Fe_2O_3) from being at their higher or lowest concentrations simultaneously. These extremes would not be possible from strictly a waste loading perspective. However, the region was deemed to be bounding for sludge-only processing, and if the homogeneity constraint could be shown to be unnecessary over this bounding region, then this would be a strong indication that it could be unconditionally eliminated or replaced. Fifteen compositions were selected from this region, along with the centroid bringing the total to thirty-two glasses when the centroid and both heat treatments are considered. Nineteen of the thirty-two glasses in the outer layer were not predictable; however, only four of the thirty-two also did not meet the durability acceptability criteria defined for this report (i.e., log NL [B] <1 g/L). The glasses that failed to be both predictable and acceptable were RC-70q, RC-70ccc, RC-71ccc, and RC-72q. Based on the target compositions, all were predicted to be inhomogeneous. When compared to the Al_2O_3 and sum of alkali criteria, all three had Al_2O_3 concentrations above 3.0 wt%, while RC-72q failed the sum of alkali constraint (> 19.3%). Neither the quenched or ccc version of the RC-72 was predictable (except for the measured ccc composition). However, only the quenched version of the glass did not meet durability acceptability criteria with a log NL [B] release of slightly greater than 1.2. Thus glass RC-72 provides support for continued use of the 3% Al_2O_3 and 19.3% constraints – more specifically this glass would not have been processed in DWPF given the application of these constraints as a replacement to the homogeneity constraint.

For RC-70q and RC-70ccc, both glasses were determined to be amorphous by XRD, but the log normalized boron releases were greater than 1.2 for all of the replicates of both heat treatments. Therefore, the crystallization history of the glasses does not support the poor durability - compositionally these glasses promote a low durability product irrespective of the development of crystallization. This glass could in fact contain amorphous phase separation, but detection or analyses for this type of phase separation was not an objective of this study.

For RC-71ccc, the glass was determined to contain acmite and lithium metasilicate that have both been shown to negatively impact durability [(29) and (30)]. The log NL [B] releases were just below 1.2 for all compositional representations of the ccc glass, while the quenched glasses had a log normalized release less than 0.7. Given the presence of the crystals in this glass, it is not surprising that the glass was not predictable since THERMO™ was not developed to evaluate crystalline glasses [3] (see Equation 1). As previously noted, both RC-70 and RC-71 were predicted to be inhomogeneous and hence represent glasses in which the discriminator would have protected DWPF from processing. While these glasses provide merit for retaining the homogeneity constraint as currently implemented the ten other compositions or twenty glasses with both heat treatments considered provide evidence that the homogeneity constraint unnecessarily restricts DWPF processing. These ten compositions were predicted to be inhomogeneous but were predictable and/or acceptable when subjected to the PCT. However, studies like this one, the variability studies, and other studies performed to support the reduction of constraints have shown that by performing glass testing in proposed regions, the adequacy of the existing models can be evaluated and actual durability performance can be measured. The studies give the indication as to glass acceptability and they also meet the intent of applying the homogeneity constraint (i.e., assuring that DWPF glasses will be predictable and acceptable). With this in mind, the homogeneity constraint could be replaced by the Al_2O_3 and sum of alkali constraints as long as the intent of the homogeneity constraint was met in the variability studies before DWPF accepts sludge batches.

An additional assessment of the three unacceptable glasses was made to try to ascertain why the predictability/acceptability criteria or the proposed alternative criteria (alumina and sum of alkali) may have failed. The targeted glass compositions were reviewed to see if compositionally there are indicators of why these glasses yield such low durability products and are not predictable. For these glasses, the main sludge components, Al_2O_3 and Fe_2O_3, are at the minimum targeted levels in the bounding region. At these minimum levels, Al_2O_3 and Fe_2O_3 would represent only a small fraction of the sludge components in the glass. Since these oxides are the two principal components in Savannah River Site sludge, the glass compositions represent regions, which were not feasible or studied in DWPF testing and thus would not be adequately covered by the existing durability discriminator. Moreover, it is highly unlikely that such a low combination would occur during actual processing.

7.0 Summary

The homogeneity constraint is currently used to discriminate compositions that are likely to result in glasses containing amorphous phase separation from compositions that are likely to be homogeneous. The technical basis for developing and implementing the phase-separation discriminator into PCCS was the fact that the durability of phase-separated glasses has been found to be unpredictable and unacceptable for some DWPF type glasses during pilot-scale testing in the IDMS. If sufficient evidence can establish the fact that although these glasses may be unpredictable, they are acceptable based on a predefined acceptance criteria over the composition region of interest, then replacing the homogeneity constraint with less restrictive constraints can be technically defended. More specifically, to replace the homogeneity constraint, glasses within the composition region of interest should be predictable and/or acceptable regardless of the homogeneity classification given the application of either the Al_2O_3 and/or sum of alkali criteria or performance data indicating the predictability and/or acceptability.

The objective of this experimental study was to challenge the homogeneity constraint for sludge-only processing by monitoring the durability responses for both quenched and ccc glasses within a bounding glass compositional region. More specifically, the durability responses were monitored independent of the homogeneity classification but in terms of predictability and/or acceptability.

In this report, experimental data from the forty Phase 2 glasses were presented and discussed. The primary areas of interest included:

(1) assessments to assure targeted compositions were indeed met,
(2) assessments with respect to crystallization via XRD and/or SEM/EDS analysis, and
(3) assessments of the PCT-A response as a function of quenched and ccc heat treatments.

These data, coupled with historical DWPF data, were then used to draw conclusions regarding the potential limitations of the homogeneity constraint. The following is a summary of the major conclusions for each of the major areas of interest:

Compositional Assessment:

The chemical composition measurements for the RC glasses were conducted by the SRTC-ML following analytical plans (see Appendix C). The analytical plans were developed in such a way as to provide the opportunity to evaluate potential sources of error. Based on this assessment, it was concluded that the targeted compositions were indeed met. Batching errors did occur for RC-79 and RC-80. However, the two glasses were still used in the assessment given that they still challenged homogeneity. Based on the actual "as-batched" composition, RC-79 was predicted to satisfy all property predictions (at the PAR) with the exception of homogeneity, while RC-80 was predicted to fail durability, homogeneity, and the Al_2O_3 and alkali limit. RC-97, that was made to represent the RC-30 composition from the Phase 1 study, successfully repeated the glass composition from the earlier study.

Crystallization Assessment:

Representative samples of select quenched and ccc glasses were submitted for XRD and/or SEM/EDS analysis. Spinel crystals were found in a couple of the quenched RC glasses that were submitted, while the remaining glasses submitted were amorphous based on XRD analysis. After the glasses were heat treated according to the ccc schedule, the ccc glasses did show some degree of crystallization as detected by XRD and/or SEM/EDS analysis. Crystalline phases detected by XRD and/or SEM/EDS analysis included acmite, spinel, and Li_2SiO_3. These are typical of phases found in previous SRTC studies for DWPF.

Challenges to the Homogeneity Constraint:

With respect to the primary task objective (i.e., challenging the homogeneity constraint), thirty-six of the forty compositions challenged the homogeneity constraint. The two criteria being used to assess these glasses are predictability and acceptability. As defined in Section 3.0, predictability is based on the 95% two-sided confidence interval for an individual PCT-A response as generated by the THERMO™ ΔG_p model. A comparison is made of the actual leaching performance as determined by the PCT-A and the prediction limits for an individual glass generated by the THERMO™ model. The durability of a glass is considered predictable if its PCT response is within the 95% confidence interval. Although the ΔG_P model was developed to be applied to homogeneous glasses [(3) and (28)], application to inhomogeneous glasses does have potential (and technical merit) given the impact of developing secondary phase(s) is minimal to the overall performance. As discussed earlier and as shown in Equation 1, durability response is a function of the homogeneous glass, the release or dissolution from the crystal(s) formed, the effect of stresses resulting from grain boundary interfaces with the residual glass matrix, and the effects of amorphous phase separation.

Eq. (1) Σ durability response = f(homogeneous) + f(crystal) + f(grain boundary) + f(amorphous phase separation)

If crystalline and/or amorphous phase separation does not occur, the durability response is solely a function of the homogeneous glass matrix for which the ΔG_P model was specifically developed. In this report, the ΔG_P model was applied to both quenched and ccc glasses (to assess the predictability) – regardless of the presence or absence of crystallization and/or amorphous phase separation – to test this hypothesis or assumption. It should be noted that previous studies [(20) and (21)] have also applied the ΔG_P model to both quenched and ccc glasses with success (given the formation of spinels). It should be noted that the formation of non-isotropic crystals (such as acmite) may have a significant impact on the crystallization and grain boundary terms resulting in the classification of "unpredictable".

The term "acceptable" (in reference to a PCT response) is defined as glasses whose log NL [B] is less than 1.0 (or NL [B] < 10 g/L). Both are working definitions defined and used throughout this report and are consistent with previous studies.

When coupling the PCT-A response with the PCT prediction (and assuming the ΔG_P model is applicable for all RC glasses), twenty-five of the eighty RC glasses (when both heat treatments are considered) were not predictable for at least one of the compositional views. Some of these glasses were better than the ΔG_P model prediction (i.e., ΔG_P prediction was overly conservative). A significant fraction of these twenty-five (i.e., nineteen) were found in the outer layer of the bounding glass compositional region. For the glasses from the outer layer region, not all compositional views were predictable. Of the forty glass compositions, thirteen were submitted for XRD analyses based on appearance and PCT response. Eight contained crystals in either the quenched or ccc version or in both. Only one of the eight glasses (RC-71ccc) was determined to contain crystals that typically impact durability.

In terms of acceptability, six of the eighty RC glasses did not meet the predefined limit of log NL [B] < 1.0 (or NL [B] < 10.0 g/L). Two of these glasses (RC-80q and RC-80ccc) were predicted to be non-durable.

When both the predictability and/or acceptability criteria are considered, only four glasses did not meet one or the other criteria. These glasses were RC-70q, RC-70ccc, RC-71ccc, and RC-72q. All were predicted to be inhomogeneous by the current homogeneity constraint. RC-72 exceeded the existing alkali constraint for Al_2O_3 concentrations $\geq$3 wt%, and thus supports the existing alumina and sum of alkali criteria. RC-70 and RC-71, on the other hand, both met the alumina and sum of alkali criteria and thus would not have been restricted from processing. However, the compositions represented by glasses RC-70 and RC-71 simultaneously contain minimum quantities of Al_2O_3 and Fe_2O_3 and represent compositions that have not been studied in previous DWPF studies. Although other glasses in this study were also at these lower levels, an explanation as to the predictability/acceptability of these glasses versus RC-70 and RC-71 was not found based on the analyses performed. As noted above, both RC-70 and RC-71 compositions were predicted to be inhomogeneous and hence represent glasses in which the discriminator would have protected DWPF from processing.

Taken as a whole, the data showed that the homogeneity constraint would have restricted processing of two compositions (i.e., RC-70 and RC-71) that were neither predictable nor acceptable. The sum of alkali and alumina criteria would have prevented processing of the other composition (RC-72) that was neither predictable nor acceptable. While these glasses provide merit for retaining the homogeneity constraint as currently implemented the thirty-three other compositions provide evidence that the homogeneity constraint unnecessarily restricts DWPF processing. The constraint would have unnecessarily limited the processing of the thirty-three compositions that were predicted to be inhomogeneous but were predictable and/or acceptable when subjected to the PCT-A. However, studies like this one, the variability studies, and other studies performed to support the reduction of constraints have shown that by performing glass testing in proposed regions, the adequacy of the existing models can be evaluated and actual durability performance can be measured. The studies give the indication as to glass acceptability and they also meet the intent of applying the homogeneity constraint (i.e., assuring that DWPF glasses will be predictable and acceptable). With this in mind, the homogeneity constraint could be replaced by the Al_2O_3 and sum of alkali constraints as long as the intent of the homogeneity constraint was met in the variability studies before DWPF accepts sludge batches.

The results also provide some evidence for a compositional region that has not been extensively studied or understood from a durability perspective. This region contained glasses with low Al_2O_3 (i.e., ~3 wt% Al_2O_3) and low Fe_2O_3 (i.e., ~5 wt% Fe_2O_3) concentrations. Glasses in this region were also studied as part of the durability assessment task [36]. Therefore, a better understanding of this region may be gained.

8.0 Path Forward

Based on the data driven approach provided in this report and by the paper study and Phase 1 experimental study for the Reduction of Constraints task, the following recommendations can be made:

- The homogeneity constraint can be replaced for sludge only processing as long as variability studies continue to be performed to qualify incoming sludge batches. The same methodology would also be applied to other streams to be added to DWPF.
- The DWPF should discontinue the use of the homogeneity constraint for sludge batch 2 and continue to use the alumina and sum of alkali criteria since the variability study results support the intent of the homogeneity constraint (i.e., all glasses over the region tested were either predictable and/or acceptable).

SRTC further recommends that, as part of the continued durability model assessment, the lower range of aluminum and iron oxide should continue to be investigated for applicability of the durability predictor (i.e., THERMO™).

9.0 References

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Appendix A:

Tables and Exhibits Supporting the Analysis of the Chemical Composition Measurements of the RC Glasses

Table A.1: Targeted Oxide Concentrations (as wt%'s) for the RC Glasses

ID	Al_2O_3	B_2O_3	CaO	Cr_2O_3	Fe_2O_3	Li_2O	MgO	MnO	Na_2O	NiO	P_2O_5	SiO_2	TiO_2	U_3O_8	ZrO_2	Others
RC58	3.000	7.510	0.500	0.264	5.000	7.000	4.000	0.500	7.500	0.000	0.998	61.240	1.750	0.000	0.096	0.642
RC59	3.000	12.000	0.500	0.000	5.000	7.000	0.000	8.000	8.433	0.000	0.000	46.320	1.750	8.000	0.000	0.000
RC60	9.149	5.000	4.000	0.264	5.000	7.000	4.000	0.500	13.100	0.000	0.998	40.500	1.750	8.000	0.096	0.643
RC61	3.000	5.000	0.500	0.000	16.810	3.000	4.000	8.000	7.500	0.000	0.000	44.500	1.750	5.939	0.000	0.001
RC62	14.430	5.000	0.500	0.000	5.000	7.000	0.000	8.000	7.500	2.720	0.000	41.850	0.000	8.000	0.000	0.000
RC63	13.080	12.000	0.500	0.264	5.000	3.000	4.000	7.580	11.090	0.000	0.998	40.000	1.750	0.000	0.096	0.642
RC64	3.000	12.000	0.500	0.264	13.170	7.000	0.000	0.500	7.500	0.000	0.998	46.330	0.000	8.000	0.096	0.642
RC65	7.200	5.000	0.500	0.000	5.000	3.000	0.000	0.500	19.140	0.000	0.000	59.660	0.000	0.000	0.000	0.000
RC66	3.000	5.000	4.000	0.264	9.470	3.000	0.000	8.000	13.200	0.000	0.998	52.330	0.000	0.000	0.096	0.642
RC67	3.000	12.000	4.000	0.000	8.719	3.000	0.000	0.500	7.500	1.967	0.000	49.560	1.750	8.000	0.000	0.004
RC68	3.000	5.000	0.500	0.264	5.000	3.000	0.000	8.000	13.370	4.985	0.998	45.390	1.750	8.000	0.096	0.647
RC69	8.000	12.000	4.000	0.000	5.000	7.000	0.000	8.000	9.380	4.870	0.000	40.000	1.750	0.000	0.000	0.000
RC70	3.000	12.000	0.500	0.000	5.000	3.000	4.000	0.500	14.070	3.350	0.000	46.580	0.000	8.000	0.000	0.000
RC71	3.000	5.000	4.000	0.000	5.000	7.000	4.000	8.000	8.170	4.360	0.000	51.470	0.000	0.000	0.000	0.000
RC72	3.000	5.880	0.500	0.000	11.820	7.000	0.000	0.500	13.890	4.860	0.000	50.810	1.750	0.000	0.000	0.000
RC73	5.400	10.600	3.300	0.211	7.600	3.800	0.800	2.100	11.000	1.000	0.799	45.000	1.400	6.400	0.077	0.513
RC74	5.400	6.400	1.200	0.211	7.600	4.904	0.800	2.000	11.000	1.000	0.799	56.150	0.350	1.600	0.077	0.509
RC75	5.400	6.400	3.300	0.053	7.600	4.168	3.200	2.000	11.000	1.000	0.200	52.530	1.400	1.600	0.019	0.130
RC76	5.400	6.400	1.200	0.053	7.600	3.800	0.800	6.500	13.870	1.000	0.200	45.230	1.400	6.400	0.019	0.128
RC77	5.400	6.400	3.300	0.053	9.097	6.200	3.200	2.000	11.250	1.000	0.200	45.000	0.350	6.400	0.019	0.131
RC78	5.400	6.400	1.200	0.053	11.950	3.800	3.200	6.500	11.000	1.000	0.200	45.000	1.400	2.750	0.019	0.128
RC79	7.876	10.600	1.200	0.053	7.600	6.200	0.800	6.374	11.000	1.000	0.200	45.000	0.350	1.600	0.019	0.128
RC80	8.250	6.400	1.200	0.211	7.600	3.800	3.200	2.000	16.280	1.000	0.799	45.000	0.350	3.317	0.077	0.516
RC81	5.400	10.600	1.200	0.053	7.600	3.800	3.200	3.215	11.000	1.835	0.200	45.000	0.350	6.400	0.019	0.128
RC82	5.400	6.400	1.200	0.211	7.600	6.200	3.200	6.500	11.300	2.570	0.799	45.000	1.400	1.630	0.077	0.513
RC83	5.400	6.400	3.300	0.053	7.770	3.800	0.800	6.500	13.300	4.000	0.200	46.380	0.350	1.600	0.019	0.128
RC84	5.400	6.400	1.200	0.211	11.950	3.800	0.800	4.710	11.000	1.390	0.799	45.000	0.350	6.400	0.077	0.513
RC85	9.060	6.400	1.210	0.053	7.600	6.200	0.800	2.000	11.000	2.530	0.200	45.000	1.400	6.400	0.019	0.128
RC86	9.700	6.400	1.200	0.211	7.600	3.820	3.030	6.500	11.150	1.000	0.799	45.000	1.400	1.600	0.077	0.513
RC87	5.400	10.000	1.200	0.053	9.670	3.800	0.800	2.000	15.420	3.310	0.200	45.000	1.400	1.600	0.019	0.128
RC88	3.060	6.010	0.900	0.054	10.690	6.030	0.050	4.370	11.530	0.110	0.205	54.620	0.061	2.190	0.020	0.100
RC89	3.540	6.010	0.900	0.113	10.690	6.070	0.050	0.810	11.530	1.320	0.428	54.620	0.128	3.510	0.041	0.240
RC90	4.420	6.010	0.800	0.054	9.520	6.030	0.070	4.270	11.530	0.120	0.205	55.370	0.061	1.400	0.020	0.120
RC91	3.460	6.010	1.240	0.054	9.520	6.030	0.070	1.480	13.050	0.120	0.205	55.370	0.061	3.200	0.020	0.110
RC92	3.140	5.620	0.960	0.135	11.430	5.680	0.080	5.130	11.430	0.140	0.513	51.400	0.153	3.840	0.049	0.300
RC93	3.030	5.620	0.960	0.135	11.430	5.680	1.090	1.780	13.250	0.140	0.513	52.040	0.153	3.840	0.049	0.290
RC94	3.100	6.010	1.020	0.086	10.800	6.050	0.340	1.510	12.350	0.610	0.326	54.580	0.097	2.900	0.031	0.190
RC95	3.030	6.010	0.960	0.078	10.780	6.050	0.430	2.350	12.050	0.490	0.294	55.140	0.088	2.040	0.028	0.182
RC96	6.540	8.430	2.060	0.128	7.490	5.050	2.000	4.820	10.980	1.520	0.484	44.260	0.930	4.950	0.047	0.311
RC97	3.120	6.510	0.610	0.193	12.040	4.620	1.660	3.970	12.940	2.940	0.731	44.530	0.218	5.410	0.070	0.438

Table A.2: Measured Elemental Concentrations (wt%) for the RC 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 A.2: Measured Elemental Concentrations (wt%) for the RC 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 A.2: Measured Elemental Concentrations (wt%) for the RC 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 A.2: Measured Elemental Concentrations (wt%) for the RC 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 A.3: Measured Elemental Concentrations (wt%) for the RC 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 A.3: Measured Elemental Concentrations (wt%) for the RC 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 A.3: Measured Elemental Concentrations (wt%) for the RC 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 A.3: Measured Elemental Concentrations (wt%) for the RC 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 A.3: Measured Elemental Concentrations (wt%) for the RC 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 A.3: Measured Elemental Concentrations (wt%) for the RC 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 A.3: Measured Elemental Concentrations (wt%) for the RC 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 A.3: Measured Elemental Concentrations (wt%) for the RC 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 A.3: Measured Elemental Concentrations (wt%) for the RC 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 A.4: Measured Elemental Concentrations (wt%) for the RC 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 A.4: Measured Elemental Concentrations (wt%) for the RC 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 A.4: Measured Elemental Concentrations (wt%) for the RC 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 A.5: Measured Elemental Concentrations (wt%) for the RC 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 A.5: Measured Elemental Concentrations (wt%) for the RC 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 A.5: Measured Elemental Concentrations (wt%) for the RC 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 A.5: Measured Elemental Concentrations (wt%) for the RC 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 A.5: Measured Elemental Concentrations (wt%) for the RC 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	U37SP21	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 A.6: As-Batched Oxide Concentrations (as wt%'s) for the RC79 and RC80 Glasses

ID	RC79	RC80
Al2O3	14.9	0
B2O3	9.79	6.97
CaO	1.11	1.31
Fe2O3	7.02	8.28
Li2O	5.73	4.14
MgO	0.74	3.49
MnO	5.89	2.18
Na2O	10.16	17.74
NiO	0.92	1.09
SiO2	41.57	49.04
TiO2	0.33	0.39
U3O8	1.48	3.62
Others	0.37	1.74

Table A7: Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by Glass Number (0 and 100 - Batch 1 and 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%
58	RC58	Al2O3 (wt%)	3.2641	3.2073	3.0000	0.2641	0.2073	8.8%	6.9%
58	RC58	B2O3 (wt%)	7.6956	7.3128	7.5100	0.1856	-0.1972	2.5%	-2.6%
58	RC58	CaO (wt%)	0.5254	0.4980	0.5000	0.0254	-0.0020	5.1%	-0.4%
58	RC58	Cr2O3 (wt%)	0.2722	0.2743	0.2638	0.0084	0.0105	3.2%	4.0%
58	RC58	Fe2O3 (wt%)	5.2041	5.0678	5.0000	0.2041	0.0678	4.1%	1.4%
58	RC58	Li2O (wt%)	7.0507	6.8850	7.0000	0.0507	-0.1150	0.7%	-1.6%
58	RC58	MgO (wt%)	3.7597	3.5985	4.0000	-0.2403	-0.4015	-6.0%	-10.0%
58	RC58	MnO (wt%)	0.5242	0.5322	0.5000	0.0242	0.0322	4.8%	6.4%
58	RC58	Na2O (wt%)	8.1251	7.6255	7.5000	0.6251	0.1255	8.3%	1.7%
58	RC58	NiO (wt%)	0.0636	0.0641	0.0000	0.0636	0.0641		
58	RC58	P2O5 (wt%)	0.9779	0.9779	0.9984	-0.0205	-0.0205	-2.1%	-2.1%
58	RC58	SiO2 (wt%)	60.9701	60.1796	61.2400	-0.2700	-1.0604	-0.4%	-1.7%
58	RC58	TiO2 (wt%)	1.7264	1.7264	1.7500	-0.0236	-0.0236	-1.3%	-1.3%
58	RC58	ZrO2 (wt%)	0.0726	0.0726	0.0960	-0.0234	-0.0234	-24.4%	-24.4%
58	RC58	Sum of Oxides (wt%)	100.2317	98.0221	99.3582	0.8735	-1.3361	0.9%	-1.3%
59	RC59	Al2O3 (wt%)	3.1791	3.2155	3.0000	0.1791	0.2155	6.0%	7.2%
59	RC59	B2O3 (wt%)	11.6560	11.4087	12.0000	-0.3440	-0.5913	-2.9%	-4.9%
59	RC59	CaO (wt%)	0.5277	0.5051	0.5000	0.0277	0.0051	5.5%	1.0%
59	RC59	Cr2O3 (wt%)	0.0130	0.0128	0.0000	0.0130	0.0128		
59	RC59	Fe2O3 (wt%)	4.9745	4.9925	5.0000	-0.0255	-0.0075	-0.5%	-0.1%
59	RC59	Li2O (wt%)	6.7224	6.6974	7.0000	-0.2776	-0.3026	-4.0%	-4.3%
59	RC59	MgO (wt%)	0.0083	0.0081	0.0000	0.0083	0.0081		
59	RC59	MnO (wt%)	8.4561	8.9745	8.0000	0.4561	0.9745	5.7%	12.2%
59	RC59	Na2O (wt%)	8.6974	8.1103	8.4300	0.2674	-0.3197	3.2%	-3.8%
59	RC59	NiO (wt%)	0.0064	0.0066	0.0000	0.0064	0.0066		
59	RC59	P2O5 (wt%)	0.0458	0.0458	0.0000	0.0458	0.0458		
59	RC59	SiO2 (wt%)	46.5993	48.2188	46.3200	0.2793	1.8988	0.6%	4.1%
59	RC59	ThO2 (wt%)	0.2021	0.2021	0.0000	0.2021	0.2021		
59	RC59	TiO2 (wt%)	1.7107	1.7200	1.7500	-0.0393	-0.0300	-2.2%	-1.7%
59	RC59	U3O8 (wt%)	7.9078	8.3574	8.0000	-0.0922	0.3574	-1.2%	4.5%
59	RC59	ZrO2 (wt%)	0.0068	0.0068	0.0000	0.0068	0.0068		
59	RC59	Sum of Oxides (wt%)	100.7135	102.4826	100.0000	0.7135	2.4826	0.7%	2.5%
60	RC60	Al2O3 (wt%)	8.8570	8.9560	9.1500	-0.2930	-0.1940	-3.2%	-2.1%
60	RC60	B2O3 (wt%)	4.9586	4.8536	5.0000	-0.0414	-0.1464	-0.8%	-2.9%
60	RC60	CaO (wt%)	3.9002	3.7187	4.0000	-0.0998	-0.2813	-2.5%	-7.0%
60	RC60	Cr2O3 (wt%)	0.2590	0.2510	0.2638	-0.0048	-0.0128	-1.8%	-4.9%
60	RC60	Fe2O3 (wt%)	4.8875	4.9354	5.0000	-0.1125	-0.0646	-2.3%	-1.3%
60	RC60	Li2O (wt%)	6.5933	6.5676	7.0000	-0.4067	-0.4324	-5.8%	-6.2%
60	RC60	MgO (wt%)	3.6773	3.5796	4.0000	-0.3227	-0.4204	-8.1%	-10.5%
60	RC60	MnO (wt%)	0.4881	0.5144	0.5000	-0.0119	0.0144	-2.4%	2.9%
60	RC60	Na2O (wt%)	13.5224	12.5525	13.1000	0.4224	-0.5475	3.2%	-4.2%
60	RC60	NiO (wt%)	0.0064	0.0066	0.0000	0.0064	0.0066		
60	RC60	P2O5 (wt%)	0.9487	0.9487	0.9984	-0.0497	-0.0497	-5.0%	-5.0%
60	RC60	SiO2 (wt%)	39.6899	40.8208	40.5000	-0.8101	0.3208	-2.0%	0.8%
60	RC60	ThO2 (wt%)	0.2018	0.2018	0.0000	0.2018	0.2018		
60	RC60	TiO2 (wt%)	1.6733	1.6775	1.7500	-0.0767	-0.0725	-4.4%	-4.1%
60	RC60	U3O8 (wt%)	7.8926	8.3842	8.0000	-0.1074	0.3842	-1.3%	4.8%
60	RC60	ZrO2 (wt%)	0.0319	0.0319	0.0960	-0.0641	-0.0641	-66.7%	-66.7%

Table A7: Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by Glass Number (0 and 100 - Batch 1 and 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
60	RC60	Sum of Oxides (wt%)	97.5879	98.0003	99.3582	-1.7703	-1.3579	-1.8%	-1.4%
61	RC61	Al2O3 (wt%)	3.3397	3.3984	3.0000	0.3397	0.3984	11.3%	13.3%
61	RC61	B2O3 (wt%)	5.0391	4.9842	5.0000	0.0391	-0.0158	0.8%	-0.3%
61	RC61	CaO (wt%)	0.5452	0.5198	0.5000	0.0452	0.0198	9.0%	4.0%
61	RC61	Cr2O3 (wt%)	0.0136	0.0131	0.0000	0.0136	0.0131		
61	RC61	Fe2O3 (wt%)	14.3078	14.4491	16.8100	-2.5022	-2.3609	-14.9%	-14.0%
61	RC61	Li2O (wt%)	2.9818	2.9767	3.0000	-0.0182	-0.0233	-0.6%	-0.8%
61	RC61	MgO (wt%)	3.5246	3.4309	4.0000	-0.4754	-0.5691	-11.9%	-14.2%
61	RC61	MnO (wt%)	7.6367	8.0491	8.0000	-0.3633	0.0491	-4.5%	0.6%
61	RC61	Na2O (wt%)	7.8808	7.3161	7.5000	0.3808	-0.1839	5.1%	-2.5%
61	RC61	NiO (wt%)	0.1112	0.1145	0.0000	0.1112	0.1145		
61	RC61	P2O5 (wt%)	0.0458	0.0458	0.0000	0.0458	0.0458		
61	RC61	SiO2 (wt%)	43.1465	44.3770	44.5000	-1.3535	-0.1230	-3.0%	-0.3%
61	RC61	ThO2 (wt%)	0.1522	0.1522	0.0000	0.1522	0.1522		
61	RC61	TiO2 (wt%)	1.5812	1.5852	1.7500	-0.1688	-0.1648	-9.6%	-9.4%
61	RC61	U3O8 (wt%)	5.7710	6.1301	5.9400	-0.1690	0.1901	-2.8%	3.2%
61	RC61	ZrO2 (wt%)	0.0068	0.0068	0.0000	0.0068	0.0068		
61	RC61	Sum of Oxides (wt%)	96.0840	97.5490	100.0000	-3.9160	-2.4510	-3.9%	-2.5%
62	RC62	Al2O3 (wt%)	14.3366	14.5881	14.4300	-0.0934	0.1581	-0.6%	1.1%
62	RC62	B2O3 (wt%)	4.9586	4.9048	5.0000	-0.0414	-0.0952	-0.8%	-1.9%
62	RC62	CaO (wt%)	0.5165	0.4954	0.5000	0.0165	-0.0046	3.3%	-0.9%
62	RC62	Cr2O3 (wt%)	0.0102	0.0100	0.0000	0.0102	0.0100		
62	RC62	Fe2O3 (wt%)	4.1110	4.1228	5.0000	-0.8890	-0.8772	-17.8%	-17.5%
62	RC62	Li2O (wt%)	6.8785	6.8663	7.0000	-0.1215	-0.1337	-1.7%	-1.9%
62	RC62	MgO (wt%)	0.0083	0.0081	0.0000	0.0083	0.0081		
62	RC62	MnO (wt%)	8.0850	8.5947	8.0000	0.0850	0.5947	1.1%	7.4%
62	RC62	Na2O (wt%)	7.5900	7.0720	7.5000	0.0900	-0.4280	1.2%	-5.7%
62	RC62	NiO (wt%)	2.2901	2.3604	2.7200	-0.4299	-0.3596	-15.8%	-13.2%
62	RC62	P2O5 (wt%)	0.0458	0.0458	0.0000	0.0458	0.0458		
62	RC62	SiO2 (wt%)	41.2714	42.5756	41.8500	-0.5786	0.7256	-1.4%	1.7%
62	RC62	ThO2 (wt%)	0.2074	0.2074	0.0000	0.2074	0.2074		
62	RC62	TiO2 (wt%)	0.0083	0.0084	0.0000	0.0083	0.0084		
62	RC62	U3O8 (wt%)	8.0782	8.5343	8.0000	0.0782	0.5343	1.0%	6.7%
62	RC62	ZrO2 (wt%)	0.0068	0.0068	0.0000	0.0068	0.0068		
62	RC62	Sum of Oxides (wt%)	98.4029	100.4009	100.0000	-1.5971	0.4009	-1.6%	0.4%
63	RC63	Al2O3 (wt%)	13.6044	13.3672	13.0800	0.5244	0.2872	4.0%	2.2%
63	RC63	B2O3 (wt%)	12.1229	11.5201	12.0000	0.1229	-0.4799	1.0%	-4.0%
63	RC63	CaO (wt%)	0.5327	0.5050	0.5000	0.0327	0.0050	6.5%	1.0%
63	RC63	Cr2O3 (wt%)	0.2667	0.2688	0.2638	0.0029	0.0050	1.1%	1.9%
63	RC63	Fe2O3 (wt%)	5.3292	5.1896	5.0000	0.3292	0.1896	6.6%	3.8%
63	RC63	Li2O (wt%)	3.0679	2.9957	3.0000	0.0679	-0.0043	2.3%	-0.1%
63	RC63	MgO (wt%)	3.8012	3.6382	4.0000	-0.1988	-0.3618	-5.0%	-9.0%
63	RC63	MnO (wt%)	8.1023	8.2261	7.5800	0.5223	0.6461	6.9%	8.5%
63	RC63	Na2O (wt%)	12.0376	11.2957	11.0900	0.9476	0.2057	8.5%	1.9%
63	RC63	NiO (wt%)	0.0636	0.0641	0.0000	0.0636	0.0641		
63	RC63	P2O5 (wt%)	0.9183	0.9183	0.9984	-0.0801	-0.0801	-8.0%	-8.0%
63	RC63	SiO2 (wt%)	42.0907	41.5450	40.0000	2.0907	1.5450	5.2%	3.9%
63	RC63	TiO2 (wt%)	1.7347	1.7347	1.7500	-0.0153	-0.0153	-0.9%	-0.9%
63	RC63	ZrO2 (wt%)	0.0084	0.0084	0.0960	-0.0876	-0.0876	-91.2%	-91.2%
63	RC63	Sum of Oxides (wt%)	103.6808	101.2770	99.3582	4.3226	1.9188	4.4%	1.9%
64	RC64	Al2O3 (wt%)	3.0515	3.1052	3.0000	0.0515	0.1052	1.7%	3.5%
64	RC64	B2O3 (wt%)	11.4226	11.2993	12.0000	-0.5774	-0.7007	-4.8%	-5.8%
64	RC64	CaO (wt%)	0.5604	0.5376	0.5000	0.0604	0.0376	12.1%	7.5%
64	RC64	Cr2O3 (wt%)	0.2427	0.2374	0.2638	-0.0211	-0.0264	-8.0%	-10.0%
64	RC64	Fe2O3 (wt%)	13.3951	13.4327	13.1700	0.2251	0.2627	1.7%	2.0%
64	RC64	Li2O (wt%)	6.7386	6.7272	7.0000	-0.2614	-0.2728	-3.7%	-3.9%
64	RC64	MgO (wt%)	0.0175	0.0170	0.0000	0.0175	0.0170		
64	RC64	MnO (wt%)	0.5365	0.5703	0.5000	0.0365	0.0703	7.3%	14.1%
64	RC64	Na2O (wt%)	8.0245	7.4769	7.5000	0.5245	-0.0231	7.0%	-0.3%
64	RC64	NiO (wt%)	0.0333	0.0343	0.0000	0.0333	0.0343		
64	RC64	P2O5 (wt%)	0.9153	0.9153	0.9984	-0.0831	-0.0831	-8.3%	-8.3%
64	RC64	SiO2 (wt%)	46.5282	47.9900	46.3300	0.1982	1.6600	0.4%	3.6%
64	RC64	ThO2 (wt%)	0.2057	0.2057	0.0000	0.2057	0.2057		

Table A7: Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by Glass Number (0 and 100 - Batch 1 and 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
64	RC64	TiO2 (wt%)	0.0083	0.0084	0.0000	0.0083	0.0084		
64	RC64	U3O8 (wt%)	7.9925	8.4432	8.0000	-0.0075	0.4432	-0.1%	5.5%
64	RC64	ZrO2 (wt%)	0.0068	0.0068	0.0960	-0.0892	-0.0892	-93.0%	-93.0%
64	RC64	Sum of Oxides (wt%)	99.6795	101.0074	99.3582	0.3213	1.6492	0.3%	1.7%
65	RC65	Al2O3 (wt%)	7.5108	7.3803	7.2000	0.3108	0.1803	4.3%	2.5%
65	RC65	B2O3 (wt%)	5.1035	4.8497	5.0000	0.1035	-0.1503	2.1%	-3.0%
65	RC65	CaO (wt%)	0.5205	0.4934	0.5000	0.0205	-0.0066	4.1%	-1.3%
65	RC65	Cr2O3 (wt%)	0.0146	0.0147	0.0000	0.0146	0.0147		
65	RC65	Fe2O3 (wt%)	5.3006	5.1618	5.0000	0.3006	0.1618	6.0%	3.2%
65	RC65	Li2O (wt%)	3.0517	2.9800	3.0000	0.0517	-0.0200	1.7%	-0.7%
65	RC65	MgO (wt%)	0.0332	0.0317	0.0000	0.0332	0.0317		
65	RC65	MnO (wt%)	0.5165	0.5244	0.5000	0.0165	0.0244	3.3%	4.9%
65	RC65	Na2O (wt%)	20.0852	18.8478	19.1400	0.9452	-0.2922	4.9%	-1.5%
65	RC65	NiO (wt%)	0.0636	0.0641	0.0000	0.0636	0.0641		
65	RC65	P2O5 (wt%)	0.2291	0.2291	0.0000	0.2291	0.2291		
65	RC65	SiO2 (wt%)	61.7188	60.9186	59.6600	2.0588	1.2586	3.5%	2.1%
65	RC65	TiO2 (wt%)	0.0584	0.0584	0.0000	0.0584	0.0584		
65	RC65	ZrO2 (wt%)	0.0068	0.0068	0.0000	0.0068	0.0068		
65	RC65	Sum of Oxides (wt%)	104.2133	101.5609	100.0000	4.2133	1.5609	4.2%	1.6%
66	RC66	Al2O3 (wt%)	3.1602	3.1053	3.0000	0.1602	0.1053	5.3%	3.5%
66	RC66	B2O3 (wt%)	5.1438	4.8880	5.0000	0.1438	-0.1120	2.9%	-2.2%
66	RC66	CaO (wt%)	4.3235	4.0983	4.0000	0.3235	0.0983	8.1%	2.5%
66	RC66	Cr2O3 (wt%)	0.2854	0.2875	0.2638	0.0216	0.0237	8.2%	9.0%
66	RC66	Fe2O3 (wt%)	10.0508	9.7876	9.4700	0.5808	0.3176	6.1%	3.4%
66	RC66	Li2O (wt%)	2.9925	2.9223	3.0000	-0.0075	-0.0777	-0.2%	-2.6%
66	RC66	MgO (wt%)	0.0332	0.0317	0.0000	0.0332	0.0317		
66	RC66	MnO (wt%)	8.4767	8.6061	8.0000	0.4767	0.6061	6.0%	7.6%
66	RC66	Na2O (wt%)	14.1203	13.2499	13.2000	0.9203	0.0499	7.0%	0.4%
66	RC66	NiO (wt%)	0.0636	0.0641	0.0000	0.0636	0.0641		
66	RC66	P2O5 (wt%)	0.9376	0.9376	0.9984	-0.0608	-0.0608	-6.1%	-6.1%
66	RC66	SiO2 (wt%)	54.0708	53.3698	52.3300	1.7408	1.0398	3.3%	2.0%
66	RC66	TiO2 (wt%)	0.0584	0.0584	0.0000	0.0584	0.0584		
66	RC66	ZrO2 (wt%)	0.0220	0.0220	0.0960	-0.0740	-0.0740	-77.1%	-77.1%
66	RC66	Sum of Oxides (wt%)	103.7388	101.4286	99.3582	4.3806	2.0704	4.4%	2.1%
67	RC67	Al2O3 (wt%)	3.0941	3.1293	3.0000	0.0941	0.1293	3.1%	4.3%
67	RC67	B2O3 (wt%)	11.3179	11.0750	12.0000	-0.6821	-0.9250	-5.7%	-7.7%
67	RC67	CaO (wt%)	3.8033	3.6251	4.0000	-0.1967	-0.3749	-4.9%	-9.4%
67	RC67	Cr2O3 (wt%)	0.0216	0.0213	0.0000	0.0216	0.0213		
67	RC67	Fe2O3 (wt%)	8.3238	8.3540	8.7200	-0.3962	-0.3660	-4.5%	-4.2%
67	RC67	Li2O (wt%)	3.0464	3.0352	3.0000	0.0464	0.0352	1.5%	1.2%
67	RC67	MgO (wt%)	0.0083	0.0081	0.0000	0.0083	0.0081		
67	RC67	MnO (wt%)	0.5107	0.5391	0.5000	0.0107	0.0391	2.1%	7.8%
67	RC67	Na2O (wt%)	7.7889	7.2492	7.5000	0.2889	-0.2508	3.9%	-3.3%
67	RC67	NiO (wt%)	1.7223	1.7724	1.9700	-0.2477	-0.1976	-12.6%	-10.0%
67	RC67	P2O5 (wt%)	0.0538	0.0538	0.0000	0.0538	0.0538		
67	RC67	SiO2 (wt%)	47.9615	49.4167	49.5600	-1.5985	-0.1433	-3.2%	-0.3%
67	RC67	ThO2 (wt%)	0.2078	0.2078	0.0000	0.2078	0.2078		
67	RC67	TiO2 (wt%)	1.6049	1.6111	1.7500	-0.1451	-0.1389	-8.3%	-7.9%
67	RC67	U3O8 (wt%)	7.7845	8.1952	8.0000	-0.2155	0.1952	-2.7%	2.4%
67	RC67	ZrO2 (wt%)	0.0068	0.0068	0.0000	0.0068	0.0068		
67	RC67	Sum of Oxides (wt%)	97.2564	98.3001	100.0000	-2.7436	-1.6999	-2.7%	-1.7%
68	RC68	Al2O3 (wt%)	3.1649	3.2011	3.0000	0.1649	0.2011	5.5%	6.7%
68	RC68	B2O3 (wt%)	4.9908	4.8830	5.0000	-0.0092	-0.1170	-0.2%	-2.3%
68	RC68	CaO (wt%)	0.5418	0.5166	0.5000	0.0418	0.0166	8.4%	3.3%
68	RC68	Cr2O3 (wt%)	0.2255	0.2184	0.2638	-0.0383	-0.0454	-14.5%	-17.2%
68	RC68	Fe2O3 (wt%)	5.0440	5.0915	5.0000	0.0440	0.0915	0.9%	1.8%
68	RC68	Li2O (wt%)	3.0033	2.9926	3.0000	0.0033	-0.0074	0.1%	-0.2%
68	RC68	MgO (wt%)	0.0083	0.0081	0.0000	0.0083	0.0081		
68	RC68	MnO (wt%)	8.1877	8.6306	8.0000	0.1877	0.6306	2.3%	7.9%
68	RC68	Na2O (wt%)	13.5931	12.6189	13.3700	0.2231	-0.7511	1.7%	-5.6%
68	RC68	NiO (wt%)	4.2988	4.4291	4.9900	-0.6912	-0.5609	-13.9%	-11.2%
68	RC68	P2O5 (wt%)	0.9607	0.9607	0.9984	-0.0377	-0.0377	-3.8%	-3.8%
68	RC68	SiO2 (wt%)	44.5162	45.7845	45.3900	-0.8738	0.3945	-1.9%	0.9%

Table A7: Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by Glass Number (0 and 100 - Batch 1 and 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
68	RC68	ThO2 (wt%)	0.2014	0.2014	0.0000	0.2014	0.2014		
68	RC68	TiO2 (wt%)	1.6854	1.6896	1.7500	-0.0646	-0.0604	-3.7%	-3.5%
68	RC68	U3O8 (wt%)	7.7345	8.2157	8.0000	-0.2655	0.2157	-3.3%	2.7%
68	RC68	ZrO2 (wt%)	0.0476	0.0476	0.0960	-0.0484	-0.0484	-50.4%	-50.4%
68	RC68	Sum of Oxides (wt%)	98.2041	99.4895	99.3582	-1.1541	0.1313	-1.2%	0.1%
69	RC69	Al2O3 (wt%)	8.2429	8.0999	8.0000	0.2429	0.0999	3.0%	1.2%
69	RC69	B2O3 (wt%)	12.2115	11.6043	12.0000	0.2115	-0.3957	1.8%	-3.3%
69	RC69	CaO (wt%)	4.2081	3.9889	4.0000	0.2081	-0.0111	5.2%	-0.3%
69	RC69	Cr2O3 (wt%)	0.0146	0.0147	0.0000	0.0146	0.0147		
69	RC69	Fe2O3 (wt%)	5.1362	5.0017	5.0000	0.1362	0.0017	2.7%	0.0%
69	RC69	Li2O (wt%)	7.0238	6.8589	7.0000	0.0238	-0.1411	0.3%	-2.0%
69	RC69	MgO (wt%)	0.0332	0.0317	0.0000	0.0332	0.0317		
69	RC69	MnO (wt%)	8.3056	8.4325	8.0000	0.3056	0.4325	3.8%	5.4%
69	RC69	Na2O (wt%)	9.9381	9.3261	9.3800	0.5581	-0.0539	6.0%	-0.6%
69	RC69	NiO (wt%)	4.7369	4.7749	4.8700	-0.1331	-0.0951	-2.7%	-2.0%
69	RC69	P2O5 (wt%)	0.2291	0.2291	0.0000	0.2291	0.2291		
69	RC69	SiO2 (wt%)	40.6467	40.1198	40.0000	0.6467	0.1198	1.6%	0.3%
69	RC69	TiO2 (wt%)	1.7389	1.7389	1.7500	-0.0111	-0.0111	-0.6%	-0.6%
69	RC69	ZrO2 (wt%)	0.0068	0.0068	0.0000	0.0068	0.0068		
69	RC69	Sum of Oxides (wt%)	102.4725	100.2283	100.0000	2.4725	0.2283	2.5%	0.2%
70	RC70	Al2O3 (wt%)	3.1460	3.2016	3.0000	0.1460	0.2016	4.9%	6.7%
70	RC70	B2O3 (wt%)	11.6963	11.5708	12.0000	-0.3037	-0.4292	-2.5%	-3.6%
70	RC70	CaO (wt%)	0.5179	0.4989	0.5000	0.0179	-0.0011	3.6%	-0.2%
70	RC70	Cr2O3 (wt%)	0.0104	0.0102	0.0000	0.0104	0.0102		
70	RC70	Fe2O3 (wt%)	4.9167	4.9308	5.0000	-0.0833	-0.0692	-1.7%	-1.4%
70	RC70	Li2O (wt%)	2.9925	2.9876	3.0000	-0.0075	-0.0124	-0.2%	-0.4%
70	RC70	MgO (wt%)	3.8063	3.7333	4.0000	-0.1937	-0.2667	-4.8%	-6.7%
70	RC70	MnO (wt%)	0.5158	0.5512	0.5000	0.0158	0.0512	3.2%	10.2%
70	RC70	Na2O (wt%)	14.3778	13.4224	14.0700	0.3078	-0.6476	2.2%	-4.6%
70	RC70	NiO (wt%)	3.1439	3.2463	3.3500	-0.2061	-0.1037	-6.2%	-3.1%
70	RC70	P2O5 (wt%)	0.0458	0.0458	0.0000	0.0458	0.0458		
70	RC70	SiO2 (wt%)	45.9340	47.5949	46.5800	-0.6460	1.0149	-1.4%	2.2%
70	RC70	ThO2 (wt%)	0.2050	0.2050	0.0000	0.2050	0.2050		
70	RC70	TiO2 (wt%)	0.0081	0.0081	0.0000	0.0081	0.0081		
70	RC70	U3O8 (wt%)	7.9201	8.3996	8.0000	-0.0799	0.3996	-1.0%	5.0%
70	RC70	ZrO2 (wt%)	0.0068	0.0068	0.0000	0.0068	0.0068		
70	RC70	Sum of Oxides (wt%)	99.2433	100.4132	100.0000	-0.7567	0.4132	-0.8%	0.4%
71	RC71	Al2O3 (wt%)	3.2169	3.1609	3.0000	0.2169	0.1609	7.2%	5.4%
71	RC71	B2O3 (wt%)	5.2645	5.0027	5.0000	0.2645	0.0027	5.3%	0.1%
71	RC71	CaO (wt%)	4.3725	4.1447	4.0000	0.3725	0.1447	9.3%	3.6%
71	RC71	Cr2O3 (wt%)	0.0146	0.0147	0.0000	0.0146	0.0147		
71	RC71	Fe2O3 (wt%)	5.2041	5.0678	5.0000	0.2041	0.0678	4.1%	1.4%
71	RC71	Li2O (wt%)	6.8785	6.7170	7.0000	-0.1215	-0.2830	-1.7%	-4.0%
71	RC71	MgO (wt%)	3.7473	3.5867	4.0000	-0.2527	-0.4133	-6.3%	-10.3%
71	RC71	MnO (wt%)	8.4896	8.6194	8.0000	0.4896	0.6194	6.1%	7.7%
71	RC71	Na2O (wt%)	8.7317	8.1947	8.1700	0.5617	0.0247	6.9%	0.3%
71	RC71	NiO (wt%)	4.4474	4.4831	4.3600	0.0874	0.1231	2.0%	2.8%
71	RC71	P2O5 (wt%)	0.2291	0.2291	0.0000	0.2291	0.2291		
71	RC71	SiO2 (wt%)	52.6803	51.9973	51.4700	1.2103	0.5273	2.4%	1.0%
71	RC71	TiO2 (wt%)	0.0584	0.0584	0.0000	0.0584	0.0584		
71	RC71	ZrO2 (wt%)	0.0068	0.0068	0.0000	0.0068	0.0068		
71	RC71	Sum of Oxides (wt%)	103.3417	101.2831	100.0000	3.3417	1.2831	3.3%	1.3%
72	RC72	Al2O3 (wt%)	3.2263	3.1702	3.0000	0.2263	0.1702	7.5%	5.7%
72	RC72	B2O3 (wt%)	5.9568	5.6607	5.8800	0.0768	-0.2193	1.3%	-3.7%
72	RC72	CaO (wt%)	0.5380	0.5100	0.5000	0.0380	0.0100	7.6%	2.0%
72	RC72	Cr2O3 (wt%)	0.0146	0.0147	0.0000	0.0146	0.0147		
72	RC72	Fe2O3 (wt%)	12.2132	11.8936	11.8200	0.3932	0.0736	3.3%	0.6%
72	RC72	Li2O (wt%)	7.0346	6.8692	7.0000	0.0346	-0.1308	0.5%	-1.9%
72	RC72	MgO (wt%)	0.0332	0.0317	0.0000	0.0332	0.0317		
72	RC72	MnO (wt%)	0.5562	0.5647	0.5000	0.0562	0.0647	11.2%	12.9%
72	RC72	Na2O (wt%)	14.5921	13.6913	13.8900	0.7021	-0.1987	5.1%	-1.4%
72	RC72	NiO (wt%)	4.9850	5.0251	4.8600	0.1250	0.1651	2.6%	3.4%
72	RC72	P2O5 (wt%)	0.2291	0.2291	0.0000	0.2291	0.2291		

Table A7: Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by Glass Number (0 and 100 - Batch 1 and 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
72	RC72	SiO2 (wt%)	52.1989	51.5221	50.8100	1.3889	0.7121	2.7%	1.4%
72	RC72	TiO2 (wt%)	1.7514	1.7514	1.7500	0.0014	0.0014	0.1%	0.1%
72	RC72	ZrO2 (wt%)	0.0068	0.0068	0.0000	0.0068	0.0068		
72	RC72	Sum of Oxides (wt%)	103.3362	100.9406	100.0100	3.3262	0.9306	3.3%	0.9%
73	RC73	Al2O3 (wt%)	5.3426	5.4031	5.4000	-0.0574	0.0031	-1.1%	0.1%
73	RC73	B2O3 (wt%)	10.3842	10.1629	10.6000	-0.2158	-0.4371	-2.0%	-4.1%
73	RC73	CaO (wt%)	3.3256	3.1914	3.3000	0.0256	-0.1086	0.8%	-3.3%
73	RC73	Cr2O3 (wt%)	0.1944	0.1867	0.2110	-0.0167	-0.0243	-7.9%	-11.5%
73	RC73	Fe2O3 (wt%)	7.4689	7.5364	7.6000	-0.1311	-0.0636	-1.7%	-0.8%
73	RC73	Li2O (wt%)	3.7353	3.7214	3.8000	-0.0647	-0.0786	-1.7%	-2.1%
73	RC73	MgO (wt%)	0.8217	0.8018	0.8000	0.0217	0.0018	2.7%	0.2%
73	RC73	MnO (wt%)	2.1038	2.2329	2.1000	0.0038	0.1329	0.2%	6.3%
73	RC73	Na2O (wt%)	11.3443	10.5433	11.0000	0.3443	-0.4567	3.1%	-4.2%
73	RC73	NiO (wt%)	0.9455	0.9757	1.0000	-0.0545	-0.0243	-5.4%	-2.4%
73	RC73	P2O5 (wt%)	0.7711	0.7711	0.7987	-0.0276	-0.0276	-3.5%	-3.5%
73	RC73	SiO2 (wt%)	44.2268	45.5421	45.0000	-0.7732	0.5421	-1.7%	1.2%
73	RC73	ThO2 (wt%)	0.1631	0.1631	0.0000	0.1631	0.1631		
73	RC73	TiO2 (wt%)	1.3641	1.3687	1.4000	-0.0359	-0.0313	-2.6%	-2.2%
73	RC73	U3O8 (wt%)	6.1001	6.5035	6.4000	-0.2999	0.1035	-4.7%	1.6%
73	RC73	ZrO2 (wt%)	0.0232	0.0232	0.0768	-0.0536	-0.0536	-69.8%	-69.8%
73	RC73	Sum of Oxides (wt%)	98.3147	99.1272	99.4866	-1.1718	-0.3593	-1.2%	-0.4%
74	RC74	Al2O3 (wt%)	5.4748	5.5710	5.4000	0.0748	0.1710	1.4%	3.2%
74	RC74	B2O3 (wt%)	6.2788	6.2111	6.4000	-0.1212	-0.1889	-1.9%	-3.0%
74	RC74	CaO (wt%)	0.9971	0.9486	1.2000	-0.2029	-0.2514	-16.9%	-21.0%
74	RC74	Cr2O3 (wt%)	0.1961	0.1934	0.2110	-0.0150	-0.0176	-7.1%	-8.3%
74	RC74	Fe2O3 (wt%)	7.0447	7.0701	7.6000	-0.5553	-0.5299	-7.3%	-7.0%
74	RC74	Li2O (wt%)	4.8171	4.8087	4.9000	-0.0829	-0.0913	-1.7%	-1.9%
74	RC74	MgO (wt%)	0.7797	0.7589	0.8000	-0.0203	-0.0411	-2.5%	-5.1%
74	RC74	MnO (wt%)	1.9463	2.0543	2.0000	-0.0537	0.0543	-2.7%	2.7%
74	RC74	Na2O (wt%)	10.9444	10.1864	11.0000	-0.0556	-0.8136	-0.5%	-7.4%
74	RC74	NiO (wt%)	0.9852	1.0139	1.0000	-0.0148	0.0139	-1.5%	1.4%
74	RC74	P2O5 (wt%)	0.7465	0.7465	0.7987	-0.0523	-0.0523	-6.5%	-6.5%
74	RC74	SiO2 (wt%)	53.1284	54.7318	56.1500	-3.0216	-1.4182	-5.4%	-2.5%
74	RC74	ThO2 (wt%)	0.0405	0.0405	0.0000	0.0405	0.0405		
74	RC74	TiO2 (wt%)	0.3546	0.3560	0.3500	0.0046	0.0060	1.3%	1.7%
74	RC74	U3O8 (wt%)	1.6401	1.7264	1.6000	0.0401	0.1264	2.5%	7.9%
74	RC74	ZrO2 (wt%)	0.0101	0.0101	0.0768	-0.0667	-0.0667	-86.9%	-86.9%
74	RC74	Sum of Oxides (wt%)	95.3845	96.4275	99.4866	-4.1020	-3.0591	-4.1%	-3.1%
75	RC75	Al2O3 (wt%)	5.3898	5.4863	5.4000	-0.0102	0.0863	-0.2%	1.6%
75	RC75	B2O3 (wt%)	6.1661	6.0996	6.4000	-0.2339	-0.3004	-3.7%	-4.7%
75	RC75	CaO (wt%)	3.2332	3.1149	3.3000	-0.0668	-0.1851	-2.0%	-5.6%
75	RC75	Cr2O3 (wt%)	0.0637	0.0626	0.0528	0.0110	0.0098	20.8%	18.6%
75	RC75	Fe2O3 (wt%)	7.7290	7.7509	7.6000	0.1290	0.1509	1.7%	2.0%
75	RC75	Li2O (wt%)	4.1928	4.1865	4.1700	0.0228	0.0165	0.5%	0.4%
75	RC75	MgO (wt%)	3.0730	3.0141	3.2000	-0.1270	-0.1859	-4.0%	-5.8%
75	RC75	MnO (wt%)	2.0096	2.1470	2.0000	0.0096	0.1470	0.5%	7.4%
75	RC75	Na2O (wt%)	11.4647	10.7028	11.0000	0.4647	-0.2972	4.2%	-2.7%
75	RC75	NiO (wt%)	0.9938	1.0261	1.0000	-0.0062	0.0261	-0.6%	2.6%
75	RC75	P2O5 (wt%)	0.2134	0.2134	0.1997	0.0137	0.0137	6.9%	6.9%
75	RC75	SiO2 (wt%)	51.7277	53.5958	52.5300	-0.8023	1.0658	-1.5%	2.0%
75	RC75	ThO2 (wt%)	0.0432	0.0432	0.0000	0.0432	0.0432		
75	RC75	TiO2 (wt%)	1.3381	1.3465	1.4000	-0.0619	-0.0535	-4.4%	-3.8%
75	RC75	U3O8 (wt%)	1.6702	1.7712	1.6000	0.0702	0.1712	4.4%	10.7%
75	RC75	ZrO2 (wt%)	0.0126	0.0126	0.0192	-0.0066	-0.0066	-34.3%	-34.3%
75	RC75	Sum of Oxides (wt%)	99.3209	100.5734	99.8716	-0.5507	0.7017	-0.6%	0.7%
76	RC76	Al2O3 (wt%)	5.3567	5.4174	5.4000	-0.0433	0.0174	-0.8%	0.3%
76	RC76	B2O3 (wt%)	6.2064	6.0734	6.4000	-0.1936	-0.3266	-3.0%	-5.1%
76	RC76	CaO (wt%)	1.2509	1.1923	1.2000	0.0509	-0.0077	4.2%	-0.6%
76	RC76	Cr2O3 (wt%)	0.0634	0.0625	0.0528	0.0106	0.0097	20.1%	18.5%
76	RC76	Fe2O3 (wt%)	7.4237	7.4502	7.6000	-0.1763	-0.1498	-2.3%	-2.0%
76	RC76	Li2O (wt%)	3.6922	3.6785	3.8000	-0.1078	-0.1215	-2.8%	-3.2%
76	RC76	MgO (wt%)	0.8078	0.7849	0.8000	0.0078	-0.0151	1.0%	-1.9%
76	RC76	MnO (wt%)	6.6915	7.0645	6.5000	0.1915	0.5645	2.9%	8.7%

Table A7: Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by Glass Number (0 and 100 - Batch 1 and 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
76	RC76	Na2O (wt%)	14.5473	13.5396	13.8700	0.6773	-0.3304	4.9%	-2.4%
76	RC76	NiO (wt%)	0.9721	1.0003	1.0000	-0.0279	0.0003	-2.8%	0.0%
76	RC76	P2O5 (wt%)	0.2157	0.2157	0.1997	0.0160	0.0160	8.0%	8.0%
76	RC76	SiO2 (wt%)	44.6488	45.9922	45.2300	-0.5812	0.7622	-1.3%	1.7%
76	RC76	ThO2 (wt%)	0.1616	0.1616	0.0000	0.1616	0.1616		
76	RC76	TiO2 (wt%)	1.3410	1.3462	1.4000	-0.0590	-0.0538	-4.2%	-3.8%
76	RC76	U3O8 (wt%)	6.3054	6.6380	6.4000	-0.0946	0.2380	-1.5%	3.7%
76	RC76	ZrO2 (wt%)	0.0068	0.0068	0.0192	-0.0124	-0.0124	-64.8%	-64.8%
76	RC76	Sum of Oxides (wt%)	99.6913	100.6240	99.8716	-0.1804	0.7524	-0.2%	0.8%
77	RC77	Al2O3 (wt%)	5.4134	5.5084	5.4000	0.0134	0.1084	0.2%	2.0%
77	RC77	B2O3 (wt%)	6.1903	6.1233	6.4000	-0.2097	-0.2767	-3.3%	-4.3%
77	RC77	CaO (wt%)	3.3028	3.1613	3.3000	0.0028	-0.1387	0.1%	-4.2%
77	RC77	Cr2O3 (wt%)	0.0596	0.0590	0.0528	0.0069	0.0063	13.0%	11.8%
77	RC77	Fe2O3 (wt%)	8.9516	8.9841	9.1000	-0.1484	-0.1159	-1.6%	-1.3%
77	RC77	Li2O (wt%)	5.9474	5.9370	6.2000	-0.2526	-0.2630	-4.1%	-4.2%
77	RC77	MgO (wt%)	3.0652	2.9991	3.2000	-0.1348	-0.2009	-4.2%	-6.3%
77	RC77	MnO (wt%)	1.9489	2.0673	2.0000	-0.0511	0.0673	-2.6%	3.4%
77	RC77	Na2O (wt%)	11.8683	11.0670	11.2500	0.6183	-0.1830	5.5%	-1.6%
77	RC77	NiO (wt%)	0.9326	0.9614	1.0000	-0.0674	-0.0386	-6.7%	-3.9%
77	RC77	P2O5 (wt%)	0.1880	0.1880	0.1997	-0.0117	-0.0117	-5.8%	-5.8%
77	RC77	SiO2 (wt%)	44.3033	45.8493	45.0000	-0.6967	0.8493	-1.5%	1.9%
77	RC77	ThO2 (wt%)	0.1639	0.1639	0.0000	0.1639	0.1639		
77	RC77	TiO2 (wt%)	0.3501	0.3519	0.3500	0.0001	0.0019	0.0%	0.6%
77	RC77	U3O8 (wt%)	6.4601	6.8265	6.4000	0.0601	0.4265	0.9%	6.7%
77	RC77	ZrO2 (wt%)	0.0068	0.0068	0.0192	-0.0124	-0.0124	-64.8%	-64.8%
77	RC77	Sum of Oxides (wt%)	99.1522	100.2542	99.8716	-0.7195	0.3825	-0.7%	0.4%
78	RC78	Al2O3 (wt%)	5.3804	5.4413	5.4000	-0.0196	0.0413	-0.4%	0.8%
78	RC78	B2O3 (wt%)	6.2144	6.0810	6.4000	-0.1856	-0.3190	-2.9%	-5.0%
78	RC78	CaO (wt%)	1.2220	1.1682	1.2000	0.0220	-0.0318	1.8%	-2.7%
78	RC78	Cr2O3 (wt%)	0.0561	0.0527	0.0528	0.0033	0.0000	6.3%	0.0%
78	RC78	Fe2O3 (wt%)	11.1101	11.2815	11.9500	-0.8399	-0.6685	-7.0%	-5.6%
78	RC78	Li2O (wt%)	3.6599	3.6468	3.8000	-0.1401	-0.1532	-3.7%	-4.0%
78	RC78	MgO (wt%)	2.9619	2.8750	3.2000	-0.2381	-0.3250	-7.4%	-10.2%
78	RC78	MnO (wt%)	6.4559	6.8074	6.5000	-0.0441	0.3074	-0.7%	4.7%
78	RC78	Na2O (wt%)	11.3437	10.4954	11.0000	0.3437	-0.5046	3.1%	-4.6%
78	RC78	NiO (wt%)	0.8359	0.8620	1.0000	-0.1641	-0.1380	-16.4%	-13.8%
78	RC78	P2O5 (wt%)	0.2039	0.2039	0.1997	0.0042	0.0042	2.1%	2.1%
78	RC78	SiO2 (wt%)	44.4092	45.4538	45.0000	-0.5908	0.4538	-1.3%	1.0%
78	RC78	ThO2 (wt%)	0.0693	0.0693	0.0000	0.0693	0.0693		
78	RC78	TiO2 (wt%)	1.3220	1.3226	1.4000	-0.0780	-0.0774	-5.6%	-5.5%
78	RC78	U3O8 (wt%)	2.5517	2.7343	2.7500	-0.1983	-0.0157	-7.2%	-0.6%
78	RC78	ZrO2 (wt%)	0.0068	0.0068	0.0192	-0.0124	-0.0124	-64.8%	-64.8%
78	RC78	Sum of Oxides (wt%)	97.8030	98.5020	99.8716	-2.0686	-1.3696	-2.1%	-1.4%
79	RC79	Al2O3 (wt%)	14.7901	15.0521	14.9000	-0.1099	0.1521	-0.7%	1.0%
79	RC79	B2O3 (wt%)	9.5873	9.4840	9.7900	-0.2027	-0.3060	-2.1%	-3.1%
79	RC79	CaO (wt%)	1.1358	1.0854	1.1100	0.0258	-0.0246	2.3%	-2.2%
79	RC79	Cr2O3 (wt%)	0.0489	0.0468	0.0490	-0.0001	-0.0022	-0.2%	-4.5%
79	RC79	Fe2O3 (wt%)	6.2716	6.3292	7.0200	-0.7484	-0.6908	-10.7%	-9.8%
79	RC79	Li2O (wt%)	5.6029	5.5937	5.7300	-0.1271	-0.1363	-2.2%	-2.4%
79	RC79	MgO (wt%)	0.7463	0.7231	0.7400	0.0063	-0.0169	0.8%	-2.3%
79	RC79	MnO (wt%)	5.8928	6.2220	5.8900	0.0028	0.3320	0.0%	5.6%
79	RC79	Na2O (wt%)	10.5446	9.7807	10.1600	0.3846	-0.3793	3.8%	-3.7%
79	RC79	NiO (wt%)	0.7983	0.8222	0.9200	-0.1217	-0.0978	-13.2%	-10.6%
79	RC79	P2O5 (wt%)	0.1772	0.1772	0.1847	-0.0075	-0.0075	-4.1%	-4.1%
79	RC79	SiO2 (wt%)	41.2334	42.2766	41.5700	-0.3366	0.7066	-0.8%	1.7%
79	RC79	ThO2 (wt%)	0.0361	0.0361	0.0000	0.0361	0.0361		
79	RC79	TiO2 (wt%)	0.3190	0.3196	0.3300	-0.0110	-0.0104	-3.3%	-3.2%
79	RC79	U3O8 (wt%)	1.3951	1.4814	1.4800	-0.0849	0.0014	-5.7%	0.1%
79	RC79	ZrO2 (wt%)	0.0068	0.0068	0.0178	-0.0110	-0.0110	-62.1%	-62.1%
79	RC79	Sum of Oxides (wt%)	98.5859	99.4369	99.8915	-1.3056	-0.4546	-1.3%	-0.5%
80	RC80	Al2O3 (wt%)	0.2820	0.2861	0.0000	0.2820	0.2861		
80	RC80	B2O3 (wt%)	6.8423	6.6966	6.9700	-0.1277	-0.2734	-1.8%	-3.9%
80	RC80	CaO (wt%)	1.4260	1.3591	1.3100	0.1160	0.0491	8.9%	3.7%

Table A7: Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by Glass Number (0 and 100 - Batch 1 and 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
80	RC80	Cr2O3 (wt%)	0.2290	0.2259	0.2300	-0.0010	-0.0041	-0.4%	-1.8%
80	RC80	Fe2O3 (wt%)	8.4065	8.4376	8.2800	0.1265	0.1576	1.5%	1.9%
80	RC80	Li2O (wt%)	3.9936	3.9797	4.1400	-0.1464	-0.1603	-3.5%	-3.9%
80	RC80	MgO (wt%)	3.3111	3.2172	3.4900	-0.1789	-0.2728	-5.1%	-7.8%
80	RC80	MnO (wt%)	2.1794	2.3010	2.1800	-0.0006	0.1210	0.0%	5.6%
80	RC80	Na2O (wt%)	18.5148	17.2313	17.7400	0.7748	-0.5087	4.4%	-2.9%
80	RC80	NiO (wt%)	1.0496	1.0801	1.0900	-0.0404	-0.0099	-3.7%	-0.9%
80	RC80	P2O5 (wt%)	0.8352	0.8352	0.8690	-0.0338	-0.0338	-3.9%	-3.9%
80	RC80	SiO2 (wt%)	48.6835	50.1568	49.0400	-0.3565	1.1168	-0.7%	2.3%
80	RC80	ThO2 (wt%)	0.0928	0.0928	0.0000	0.0928	0.0928		
80	RC80	TiO2 (wt%)	0.3909	0.3925	0.3900	0.0009	0.0025	0.2%	0.6%
80	RC80	U3O8 (wt%)	3.6128	3.8034	3.6200	-0.0072	0.1834	-0.2%	5.1%
80	RC80	ZrO2 (wt%)	0.0242	0.0242	0.0835	-0.0593	-0.0593	-71.1%	-71.1%
80	RC80	Sum of Oxides (wt%)	99.8737	100.1195	99.4325	0.4412	0.6870	0.4%	0.7%
81	RC81	Al2O3 (wt%)	5.4229	5.5182	5.4000	0.0229	0.1182	0.4%	2.2%
81	RC81	B2O3 (wt%)	10.2232	10.1131	10.6000	-0.3768	-0.4869	-3.6%	-4.6%
81	RC81	CaO (wt%)	1.2818	1.2249	1.2000	0.0818	0.0249	6.8%	2.1%
81	RC81	Cr2O3 (wt%)	0.0575	0.0551	0.0528	0.0047	0.0023	8.9%	4.4%
81	RC81	Fe2O3 (wt%)	6.9558	7.0178	7.6000	-0.6442	-0.5822	-8.5%	-7.7%
81	RC81	Li2O (wt%)	3.7407	3.7342	3.8000	-0.0593	-0.0658	-1.6%	-1.7%
81	RC81	MgO (wt%)	3.0871	2.9912	3.2000	-0.1129	-0.2088	-3.5%	-6.5%
81	RC81	MnO (wt%)	3.1788	3.3571	3.2200	-0.0412	0.1371	-1.3%	4.3%
81	RC81	Na2O (wt%)	11.4046	10.5790	11.0000	0.4046	-0.4210	3.7%	-3.8%
81	RC81	NiO (wt%)	1.6819	1.7324	1.8400	-0.1581	-0.1076	-8.6%	-5.8%
81	RC81	P2O5 (wt%)	0.2085	0.2085	0.1997	0.0088	0.0088	4.4%	4.4%
81	RC81	SiO2 (wt%)	43.6909	44.7963	45.0000	-1.3091	-0.2037	-2.9%	-0.5%
81	RC81	ThO2 (wt%)	0.1675	0.1675	0.0000	0.1675	0.1675		
81	RC81	TiO2 (wt%)	0.3518	0.3525	0.3500	0.0018	0.0025	0.5%	0.7%
81	RC81	U3O8 (wt%)	6.1592	6.5397	6.4000	-0.2408	0.1397	-3.8%	2.2%
81	RC81	ZrO2 (wt%)	0.0072	0.0072	0.0192	-0.0120	-0.0120	-62.3%	-62.3%
81	RC81	Sum of Oxides (wt%)	97.6194	98.3948	99.8816	-2.2623	-1.4868	-2.3%	-1.5%
82	RC82	Al2O3 (wt%)	5.3992	5.4606	5.4000	-0.0008	0.0606	0.0%	1.1%
82	RC82	B2O3 (wt%)	6.2869	6.1532	6.4000	-0.1131	-0.2468	-1.8%	-3.9%
82	RC82	CaO (wt%)	1.3028	1.2422	1.2000	0.1028	0.0422	8.6%	3.5%
82	RC82	Cr2O3 (wt%)	0.1865	0.1807	0.2110	-0.0246	-0.0303	-11.6%	-14.4%
82	RC82	Fe2O3 (wt%)	7.0112	7.0804	7.6000	-0.5888	-0.5196	-7.7%	-6.8%
82	RC82	Li2O (wt%)	5.9582	5.9357	6.2000	-0.2418	-0.2643	-3.9%	-4.3%
82	RC82	MgO (wt%)	3.0904	3.0083	3.2000	-0.1096	-0.1917	-3.4%	-6.0%
82	RC82	MnO (wt%)	6.7385	7.1042	6.5000	0.2385	0.6042	3.7%	9.3%
82	RC82	Na2O (wt%)	12.1799	11.3064	11.3000	0.8799	0.0064	7.8%	0.1%
82	RC82	NiO (wt%)	2.3357	2.4064	2.5700	-0.2343	-0.1636	-9.1%	-6.4%
82	RC82	P2O5 (wt%)	0.8017	0.8017	0.7987	0.0029	0.0029	0.4%	0.4%
82	RC82	SiO2 (wt%)	44.6697	45.9366	45.0000	-0.3303	0.9366	-0.7%	2.1%
82	RC82	ThO2 (wt%)	0.0405	0.0405	0.0000	0.0405	0.0405		
82	RC82	TiO2 (wt%)	1.3739	1.3774	1.4000	-0.0261	-0.0226	-1.9%	-1.6%
82	RC82	U3O8 (wt%)	1.6428	1.7451	1.6300	0.0128	0.1151	0.8%	7.1%
82	RC82	ZrO2 (wt%)	0.0636	0.0636	0.0768	-0.0132	-0.0132	-17.2%	-17.2%
82	RC82	Sum of Oxides (wt%)	99.0813	99.8429	99.4866	-0.4052	0.3563	-0.4%	0.4%
83	RC83	Al2O3 (wt%)	5.8338	5.9353	5.4000	0.4338	0.5353	8.0%	9.9%
83	RC83	B2O3 (wt%)	6.3674	6.2986	6.4000	-0.0326	-0.1014	-0.5%	-1.6%
83	RC83	CaO (wt%)	3.3002	3.1659	3.3000	0.0002	-0.1341	0.0%	-4.1%
83	RC83	Cr2O3 (wt%)	0.0610	0.0597	0.0528	0.0082	0.0069	15.6%	13.1%
83	RC83	Fe2O3 (wt%)	7.2920	7.3124	7.7700	-0.4780	-0.4576	-6.2%	-5.9%
83	RC83	Li2O (wt%)	3.7084	3.7020	3.8000	-0.0916	-0.0980	-2.4%	-2.6%
83	RC83	MgO (wt%)	0.7984	0.7776	0.8000	-0.0016	-0.0224	-0.2%	-2.8%
83	RC83	MnO (wt%)	6.7561	7.1813	6.5000	0.2561	0.6813	3.9%	10.5%
83	RC83	Na2O (wt%)	14.0684	13.1084	13.3000	0.7684	-0.1916	5.8%	-1.4%
83	RC83	NiO (wt%)	3.6073	3.7179	4.0000	-0.3927	-0.2821	-9.8%	-7.1%
83	RC83	P2O5 (wt%)	0.2073	0.2073	0.1997	0.0076	0.0076	3.8%	3.8%
83	RC83	SiO2 (wt%)	45.9468	47.3947	46.3800	-0.4332	1.0147	-0.9%	2.2%
83	RC83	ThO2 (wt%)	0.0397	0.0397	0.0000	0.0397	0.0397		
83	RC83	TiO2 (wt%)	0.3522	0.3539	0.3500	0.0022	0.0039	0.6%	1.1%
83	RC83	U3O8 (wt%)	1.5797	1.6688	1.6000	-0.0203	0.0688	-1.3%	4.3%

Table A7: Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by Glass Number (0 and 100 - Batch 1 and 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
83	RC83	ZrO2 (wt%)	0.0106	0.0106	0.0192	-0.0086	-0.0086	-45.0%	-45.0%
83	RC83	Sum of Oxides (wt%)	99.9292	100.9340	99.8716	0.0575	1.0624	0.1%	1.1%
84	RC84	Al2O3 (wt%)	5.3520	5.4124	5.4000	-0.0480	0.0124	-0.9%	0.2%
84	RC84	B2O3 (wt%)	6.2547	6.1192	6.4000	-0.1453	-0.2808	-2.3%	-4.4%
84	RC84	CaO (wt%)	1.3155	1.2567	1.2000	0.1155	0.0567	9.6%	4.7%
84	RC84	Cr2O3 (wt%)	0.1812	0.1767	0.2110	-0.0298	-0.0343	-14.1%	-16.3%
84	RC84	Fe2O3 (wt%)	10.6700	10.7001	11.9500	-1.2800	-1.2499	-10.7%	-10.5%
84	RC84	Li2O (wt%)	3.6707	3.6579	3.8000	-0.1293	-0.1421	-3.4%	-3.7%
84	RC84	MgO (wt%)	0.8212	0.7942	0.8000	0.0212	-0.0058	2.6%	-0.7%
84	RC84	MnO (wt%)	4.9266	5.2104	4.7100	0.2166	0.5004	4.6%	10.6%
84	RC84	Na2O (wt%)	11.9039	11.0703	11.0000	0.9039	0.0703	8.2%	0.6%
84	RC84	NiO (wt%)	1.2425	1.2783	1.3900	-0.1475	-0.1117	-10.6%	-8.0%
84	RC84	P2O5 (wt%)	0.8077	0.8077	0.7987	0.0090	0.0090	1.1%	1.1%
84	RC84	SiO2 (wt%)	45.4746	46.6999	45.0000	0.4746	1.6999	1.1%	3.8%
84	RC84	ThO2 (wt%)	0.1703	0.1703	0.0000	0.1703	0.1703		
84	RC84	TiO2 (wt%)	0.3616	0.3628	0.3500	0.0116	0.0128	3.3%	3.7%
84	RC84	U3O8 (wt%)	6.4879	6.8283	6.4000	0.0879	0.4283	1.4%	6.7%
84	RC84	ZrO2 (wt%)	0.0649	0.0649	0.0768	-0.0119	-0.0119	-15.5%	-15.5%
84	RC84	Sum of Oxides (wt%)	99.7052	100.6099	99.4866	0.2186	1.1233	0.2%	1.1%
85	RC85	Al2O3 (wt%)	8.6492	8.7501	9.0600	-0.4108	-0.3099	-4.5%	-3.4%
85	RC85	B2O3 (wt%)	6.1581	6.0280	6.4000	-0.2419	-0.3720	-3.8%	-5.8%
85	RC85	CaO (wt%)	1.2582	1.2075	1.2100	0.0482	-0.0025	4.0%	-0.2%
85	RC85	Cr2O3 (wt%)	0.0614	0.0590	0.0528	0.0086	0.0062	16.3%	11.8%
85	RC85	Fe2O3 (wt%)	6.6737	6.7338	7.6000	-0.9263	-0.8662	-12.2%	-11.4%
85	RC85	Li2O (wt%)	5.8828	5.8630	6.2000	-0.3172	-0.3370	-5.1%	-5.4%
85	RC85	MgO (wt%)	0.8071	0.7876	0.8000	0.0071	-0.0124	0.9%	-1.6%
85	RC85	MnO (wt%)	1.9415	2.0608	2.0000	-0.0585	0.0608	-2.9%	3.0%
85	RC85	Na2O (wt%)	11.5386	10.7239	11.0000	0.5386	-0.2761	4.9%	-2.5%
85	RC85	NiO (wt%)	2.3056	2.3791	2.5300	-0.2244	-0.1509	-8.9%	-6.0%
85	RC85	P2O5 (wt%)	0.2132	0.2132	0.1997	0.0135	0.0135	6.8%	6.8%
85	RC85	SiO2 (wt%)	44.4675	45.7927	45.0000	-0.5325	0.7927	-1.2%	1.8%
85	RC85	ThO2 (wt%)	0.1653	0.1653	0.0000	0.1653	0.1653		
85	RC85	TiO2 (wt%)	1.3420	1.3465	1.4000	-0.0580	-0.0535	-4.1%	-3.8%
85	RC85	U3O8 (wt%)	6.2164	6.6268	6.4000	-0.1836	0.2268	-2.9%	3.5%
85	RC85	ZrO2 (wt%)	0.0086	0.0086	0.0192	-0.0106	-0.0106	-55.1%	-55.1%
85	RC85	Sum of Oxides (wt%)	97.6892	98.7457	99.8716	-2.1824	-1.1259	-2.2%	-1.1%
86	RC86	Al2O3 (wt%)	9.5042	9.6118	9.7000	-0.1958	-0.0882	-2.0%	-0.9%
86	RC86	B2O3 (wt%)	6.2788	6.1441	6.4000	-0.1212	-0.2559	-1.9%	-4.0%
86	RC86	CaO (wt%)	1.2612	1.2104	1.2000	0.0612	0.0104	5.1%	0.9%
86	RC86	Cr2O3 (wt%)	0.1868	0.1795	0.2110	-0.0242	-0.0315	-11.5%	-14.9%
86	RC86	Fe2O3 (wt%)	6.5960	6.6556	7.6000	-1.0040	-0.9444	-13.2%	-12.4%
86	RC86	Li2O (wt%)	3.7030	3.6902	3.8200	-0.1170	-0.1298	-3.1%	-3.4%
86	RC86	MgO (wt%)	2.9222	2.8513	3.0300	-0.1078	-0.1787	-3.6%	-5.9%
86	RC86	MnO (wt%)	6.6755	7.0855	6.5000	0.1755	0.5855	2.7%	9.0%
86	RC86	Na2O (wt%)	12.0429	11.1920	11.1500	0.8929	0.0420	8.0%	0.4%
86	RC86	NiO (wt%)	0.9135	0.9426	1.0000	-0.0865	-0.0574	-8.7%	-5.7%
86	RC86	P2O5 (wt%)	0.7733	0.7733	0.7987	-0.0254	-0.0254	-3.2%	-3.2%
86	RC86	SiO2 (wt%)	44.9665	46.3077	45.0000	-0.0335	1.3077	-0.1%	2.9%
86	RC86	ThO2 (wt%)	0.0423	0.0423	0.0000	0.0423	0.0423		
86	RC86	TiO2 (wt%)	1.3729	1.3776	1.4000	-0.0271	-0.0224	-1.9%	-1.6%
86	RC86	U3O8 (wt%)	1.6295	1.7369	1.6000	0.0295	0.1369	1.8%	8.6%
86	RC86	ZrO2 (wt%)	0.0423	0.0423	0.0768	-0.0345	-0.0345	-45.0%	-45.0%
86	RC86	Sum of Oxides (wt%)	98.9109	99.8430	99.4866	-0.5757	0.3564	-0.6%	0.4%
87	RC87	Al2O3 (wt%)	5.4701	5.5330	5.4000	0.0701	0.1330	1.3%	2.5%
87	RC87	B2O3 (wt%)	9.6677	9.4633	10.0000	-0.3323	-0.5367	-3.3%	-5.4%
87	RC87	CaO (wt%)	1.2504	1.1891	1.2000	0.0504	-0.0109	4.2%	-0.9%
87	RC87	Cr2O3 (wt%)	0.0575	0.0573	0.0528	0.0047	0.0046	9.0%	8.7%
87	RC87	Fe2O3 (wt%)	9.5420	9.5839	9.6700	-0.1280	-0.0861	-1.3%	-0.9%
87	RC87	Li2O (wt%)	3.6922	3.6791	3.8000	-0.1078	-0.1209	-2.8%	-3.2%
87	RC87	MgO (wt%)	0.7802	0.7615	0.8000	-0.0198	-0.0385	-2.5%	-4.8%
87	RC87	MnO (wt%)	1.9807	2.0872	2.0000	-0.0193	0.0872	-1.0%	4.4%
87	RC87	Na2O (wt%)	16.1059	15.0019	15.4200	0.6859	-0.4181	4.4%	-2.7%
87	RC87	NiO (wt%)	3.0845	3.1750	3.3100	-0.2255	-0.1350	-6.8%	-4.1%

Table A7: Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by Glass Number (0 and 100 - Batch 1 and 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
87	RC87	P2O5 (wt%)	0.1940	0.1940	0.1997	-0.0057	-0.0057	-2.8%	-2.8%
87	RC87	SiO2 (wt%)	44.5600	46.0497	45.0000	-0.4400	1.0497	-1.0%	2.3%
87	RC87	ThO2 (wt%)	0.0383	0.0383	0.0000	0.0383	0.0383		
87	RC87	TiO2 (wt%)	1.3471	1.3532	1.4000	-0.0529	-0.0468	-3.8%	-3.3%
87	RC87	U3O8 (wt%)	1.6118	1.6973	1.6000	0.0118	0.0973	0.7%	6.1%
87	RC87	ZrO2 (wt%)	0.0068	0.0068	0.0192	-0.0124	-0.0124	-64.8%	-64.8%
87	RC87	Sum of Oxides (wt%)	99.3891	99.8707	99.8716	-0.4825	-0.0009	-0.5%	0.0%
88	RC88	Al2O3 (wt%)	3.1744	3.2097	3.0600	0.1144	0.1497	3.7%	4.9%
88	RC88	B2O3 (wt%)	5.7878	5.6617	6.0100	-0.2222	-0.3483	-3.7%	-5.8%
88	RC88	CaO (wt%)	0.9639	0.9211	0.9000	0.0639	0.0211	7.1%	2.3%
88	RC88	Cr2O3 (wt%)	0.0715	0.0684	0.0541	0.0174	0.0144	32.2%	26.6%
88	RC88	Fe2O3 (wt%)	10.5372	10.6314	10.6900	-0.1528	-0.0586	-1.4%	-0.5%
88	RC88	Li2O (wt%)	5.7267	5.7056	6.0300	-0.3033	-0.3244	-5.0%	-5.4%
88	RC88	MgO (wt%)	0.0232	0.0224	0.0500	-0.0268	-0.0276	-53.6%	-55.1%
88	RC88	MnO (wt%)	4.5269	4.7803	4.3700	0.1569	0.4103	3.6%	9.4%
88	RC88	Na2O (wt%)	12.1776	11.2963	11.5300	0.6476	-0.2337	5.6%	-2.0%
88	RC88	NiO (wt%)	0.1128	0.1162	0.1100	0.0028	0.0062	2.6%	5.6%
88	RC88	P2O5 (wt%)	0.2173	0.2173	0.2052	0.0122	0.0122	5.9%	5.9%
88	RC88	SiO2 (wt%)	53.6542	55.0082	54.6200	-0.9658	0.3882	-1.8%	0.7%
88	RC88	ThO2 (wt%)	0.0698	0.0698	0.0081	0.0617	0.0617	767.0%	767.0%
88	RC88	TiO2 (wt%)	0.0083	0.0083	0.0612	-0.0529	-0.0529	-86.5%	-86.5%
88	RC88	U3O8 (wt%)	2.1820	2.3165	2.1900	-0.0080	0.1265	-0.4%	5.8%
88	RC88	ZrO2 (wt%)	0.0170	0.0170	0.0196	-0.0026	-0.0026	-13.4%	-13.4%
88	RC88	Sum of Oxides (wt%)	99.2505	100.0500	99.9080	-0.6576	0.1420	-0.7%	0.1%
89	RC89	Al2O3 (wt%)	3.7507	3.7926	3.5400	0.2107	0.2526	6.0%	7.1%
89	RC89	B2O3 (wt%)	5.9810	5.8517	6.0100	-0.0290	-0.1583	-0.5%	-2.6%
89	RC89	CaO (wt%)	0.9694	0.9300	0.9000	0.0694	0.0300	7.7%	3.3%
89	RC89	Cr2O3 (wt%)	0.1282	0.1255	0.1128	0.0154	0.0127	13.7%	11.2%
89	RC89	Fe2O3 (wt%)	11.4026	11.4343	10.6900	0.7126	0.7443	6.7%	7.0%
89	RC89	Li2O (wt%)	5.9366	5.9140	6.0700	-0.1334	-0.1560	-2.2%	-2.6%
89	RC89	MgO (wt%)	0.0315	0.0307	0.0500	-0.0185	-0.0193	-37.0%	-38.6%
89	RC89	MnO (wt%)	0.8438	0.8972	0.8100	0.0338	0.0872	4.2%	10.8%
89	RC89	Na2O (wt%)	12.3025	11.4640	11.5300	0.7725	-0.0660	6.7%	-0.6%
89	RC89	NiO (wt%)	1.2019	1.2389	1.3200	-0.1181	-0.0811	-8.9%	-6.1%
89	RC89	P2O5 (wt%)	0.4700	0.4700	0.4282	0.0418	0.0418	9.8%	9.8%
89	RC89	SiO2 (wt%)	54.8698	56.5990	54.6200	0.2498	1.9790	0.5%	3.6%
89	RC89	ThO2 (wt%)	0.1115	0.1115	0.0168	0.0947	0.0947	563.6%	563.6%
89	RC89	TiO2 (wt%)	0.0226	0.0227	0.1277	-0.1051	-0.1050	-82.3%	-82.3%
89	RC89	U3O8 (wt%)	3.5551	3.7560	3.5100	0.0451	0.2460	1.3%	7.0%
89	RC89	ZrO2 (wt%)	0.0395	0.0395	0.0409	-0.0014	-0.0014	-3.4%	-3.4%
89	RC89	Sum of Oxides (wt%)	101.6165	102.6772	99.7763	1.8402	2.9009	1.8%	2.9%
90	RC90	Al2O3 (wt%)	4.5395	4.6196	4.4200	0.1195	0.1996	2.7%	4.5%
90	RC90	B2O3 (wt%)	5.8441	5.7811	6.0100	-0.1659	-0.2289	-2.8%	-3.8%
90	RC90	CaO (wt%)	0.8383	0.7993	0.8000	0.0383	-0.0007	4.8%	-0.1%
90	RC90	Cr2O3 (wt%)	0.0678	0.0657	0.0541	0.0138	0.0116	25.5%	21.5%
90	RC90	Fe2O3 (wt%)	9.2558	9.3468	9.5200	-0.2642	-0.1732	-2.8%	-1.8%
90	RC90	Li2O (wt%)	5.8290	5.8191	6.0300	-0.2010	-0.2109	-3.3%	-3.5%
90	RC90	MgO (wt%)	0.0462	0.0449	0.0700	-0.0238	-0.0251	-34.1%	-35.8%
90	RC90	MnO (wt%)	4.4181	4.6569	4.2700	0.1481	0.3869	3.5%	9.1%
90	RC90	Na2O (wt%)	12.1833	11.3093	11.5300	0.6533	-0.2207	5.7%	-1.9%
90	RC90	NiO (wt%)	0.1129	0.1163	0.1200	-0.0071	-0.0037	-5.9%	-3.1%
90	RC90	P2O5 (wt%)	0.2296	0.2296	0.2052	0.0244	0.0244	11.9%	11.9%
90	RC90	SiO2 (wt%)	55.1121	56.6839	55.3700	-0.2579	1.3139	-0.5%	2.4%
90	RC90	ThO2 (wt%)	0.0428	0.0428	0.0081	0.0348	0.0348	432.0%	432.0%
90	RC90	TiO2 (wt%)	0.0083	0.0083	0.0612	-0.0529	-0.0529	-86.5%	-86.4%
90	RC90	U3O8 (wt%)	1.3781	1.4633	1.4000	-0.0219	0.0633	-1.6%	4.5%
90	RC90	ZrO2 (wt%)	0.0129	0.0129	0.0196	-0.0067	-0.0067	-34.4%	-34.4%
90	RC90	Sum of Oxides (wt%)	99.9188	100.9998	99.8880	0.0308	1.1117	0.0%	1.1%
91	RC91	Al2O3 (wt%)	3.6042	3.6673	3.4600	0.1442	0.2073	4.2%	6.0%
91	RC91	B2O3 (wt%)	5.8361	5.7729	6.0100	-0.1739	-0.2371	-2.9%	-3.9%
91	RC91	CaO (wt%)	1.2800	1.2232	1.2400	0.0400	-0.0168	3.2%	-1.4%
91	RC91	Cr2O3 (wt%)	0.0737	0.0705	0.0541	0.0196	0.0165	36.3%	30.5%
91	RC91	Fe2O3 (wt%)	9.2062	9.2899	9.5200	-0.3138	-0.2301	-3.3%	-2.4%

Table A7: Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by Glass Number (0 and 100 - Batch 1 and 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
91	RC91	Li2O (wt%)	5.8774	5.8671	6.0300	-0.1526	-0.1629	-2.5%	-2.7%
91	RC91	MgO (wt%)	0.0581	0.0563	0.0700	-0.0119	-0.0137	-17.0%	-19.6%
91	RC91	MnO (wt%)	1.4347	1.5151	1.4800	-0.0453	0.0351	-3.1%	2.4%
91	RC91	Na2O (wt%)	13.6613	12.6725	13.0500	0.6113	-0.3775	4.7%	-2.9%
91	RC91	NiO (wt%)	0.1162	0.1197	0.1200	-0.0038	-0.0003	-3.2%	-0.3%
91	RC91	P2O5 (wt%)	0.2101	0.2101	0.2052	0.0049	0.0049	2.4%	2.4%
91	RC91	SiO2 (wt%)	54.1574	55.5265	55.3700	-1.2126	0.1565	-2.2%	0.3%
91	RC91	ThO2 (wt%)	0.0924	0.0924	0.0081	0.0843	0.0843	1047.4%	1047.4%
91	RC91	TiO2 (wt%)	0.0101	0.0102	0.0612	-0.0510	-0.0510	-83.4%	-83.4%
91	RC91	U3O8 (wt%)	3.1421	3.3368	3.2000	-0.0579	0.1368	-1.8%	4.3%
91	RC91	ZrO2 (wt%)	0.0142	0.0142	0.0196	-0.0054	-0.0054	-27.8%	-27.8%
91	RC91	Sum of Oxides (wt%)	98.7741	99.4444	99.8980	-1.1240	-0.4536	-1.1%	-0.5%
92	RC92	Al2O3 (wt%)	3.2452	3.3027	3.1400	0.1052	0.1627	3.4%	5.2%
92	RC92	B2O3 (wt%)	5.4175	5.3588	5.6200	-0.2025	-0.2612	-3.6%	-4.6%
92	RC92	CaO (wt%)	1.0797	1.0333	0.9600	0.1197	0.0733	12.5%	7.6%
92	RC92	Cr2O3 (wt%)	0.1604	0.1590	0.1351	0.0252	0.0239	18.7%	17.7%
92	RC92	Fe2O3 (wt%)	11.1533	11.1937	11.4300	-0.2767	-0.2363	-2.4%	-2.1%
92	RC92	Li2O (wt%)	5.5437	5.5347	5.6800	-0.1363	-0.1453	-2.4%	-2.6%
92	RC92	MgO (wt%)	0.2548	0.2487	0.0800	0.1748	0.1687	218.5%	210.9%
92	RC92	MnO (wt%)	5.2345	5.5542	5.1300	0.1045	0.4242	2.0%	8.3%
92	RC92	Na2O (wt%)	11.9775	11.1690	11.4300	0.5475	-0.2610	4.8%	-2.3%
92	RC92	NiO (wt%)	0.3461	0.3565	0.1400	0.2061	0.2165	147.2%	154.6%
92	RC92	P2O5 (wt%)	0.5949	0.5949	0.5129	0.0820	0.0820	16.0%	16.0%
92	RC92	SiO2 (wt%)	49.5547	51.2818	51.4000	-1.8453	-0.1182	-3.6%	-0.2%
92	RC92	ThO2 (wt%)	0.0982	0.0982	0.0201	0.0780	0.0780	387.8%	387.8%
92	RC92	TiO2 (wt%)	0.1048	0.1054	0.1530	-0.0482	-0.0475	-31.5%	-31.1%
92	RC92	U3O8 (wt%)	3.7088	3.9193	3.8400	-0.1312	0.0793	-3.4%	2.1%
92	RC92	ZrO2 (wt%)	0.0365	0.0365	0.0490	-0.0125	-0.0125	-25.5%	-25.5%
92	RC92	Sum of Oxides (wt%)	98.5104	99.9467	99.7201	-1.2097	0.2266	-1.2%	0.2%
93	RC93	Al2O3 (wt%)	3.1082	3.1627	3.0300	0.0782	0.1327	2.6%	4.4%
93	RC93	B2O3 (wt%)	5.3772	5.3189	5.6200	-0.2428	-0.3011	-4.3%	-5.4%
93	RC93	CaO (wt%)	1.0456	0.9968	0.9600	0.0856	0.0368	8.9%	3.8%
93	RC93	Cr2O3 (wt%)	0.1554	0.1506	0.1351	0.0203	0.0155	15.0%	11.5%
93	RC93	Fe2O3 (wt%)	11.1953	11.3051	11.4300	-0.2347	-0.1249	-2.1%	-1.1%
93	RC93	Li2O (wt%)	5.3769	5.3675	5.6800	-0.3031	-0.3125	-5.3%	-5.5%
93	RC93	MgO (wt%)	1.1068	1.0773	1.0900	0.0168	-0.0127	1.5%	-1.2%
93	RC93	MnO (wt%)	1.7473	1.8416	1.7800	-0.0327	0.0616	-1.8%	3.5%
93	RC93	Na2O (wt%)	14.1348	13.1222	13.2500	0.8848	-0.1278	6.7%	-1.0%
93	RC93	NiO (wt%)	0.1381	0.1423	0.1400	-0.0019	0.0023	-1.3%	1.7%
93	RC93	P2O5 (wt%)	0.5375	0.5375	0.5129	0.0246	0.0246	4.8%	4.8%
93	RC93	SiO2 (wt%)	51.7759	53.2563	52.0400	-0.2641	1.2163	-0.5%	2.3%
93	RC93	ThO2 (wt%)	0.1216	0.1216	0.0201	0.1015	0.1015	504.3%	504.3%
93	RC93	TiO2 (wt%)	0.0154	0.0154	0.1530	-0.1375	-0.1375	-89.9%	-89.9%
93	RC93	U3O8 (wt%)	3.8044	4.0410	3.8400	-0.0356	0.2010	-0.9%	5.2%
93	RC93	ZrO2 (wt%)	0.0435	0.0435	0.0490	-0.0055	-0.0055	-11.1%	-11.1%
93	RC93	Sum of Oxides (wt%)	99.6840	100.5005	99.7301	-0.0461	0.7704	0.0%	0.8%
94	RC94	Al2O3 (wt%)	3.1885	3.2446	3.1000	0.0885	0.1446	2.9%	4.7%
94	RC94	B2O3 (wt%)	5.7234	5.6616	6.0100	-0.2866	-0.3484	-4.8%	-5.8%
94	RC94	CaO (wt%)	1.0742	1.0310	1.0200	0.0542	0.0110	5.3%	1.1%
94	RC94	Cr2O3 (wt%)	0.1101	0.1057	0.0858	0.0243	0.0200	28.4%	23.3%
94	RC94	Fe2O3 (wt%)	10.5584	10.6539	10.8000	-0.2416	-0.1461	-2.2%	-1.4%
94	RC94	Li2O (wt%)	5.7590	5.7491	6.0500	-0.2910	-0.3009	-4.8%	-5.0%
94	RC94	MgO (wt%)	0.3321	0.3240	0.3400	-0.0079	-0.0160	-2.3%	-4.7%
94	RC94	MnO (wt%)	1.4927	1.5843	1.5100	-0.0173	0.0743	-1.1%	4.9%
94	RC94	Na2O (wt%)	13.1064	12.1805	12.3500	0.7564	-0.1695	6.1%	-1.4%
94	RC94	NiO (wt%)	0.5894	0.6082	0.6100	-0.0206	-0.0018	-3.4%	-0.3%
94	RC94	P2O5 (wt%)	0.3242	0.3242	0.3256	-0.0014	-0.0014	-0.4%	-0.4%
94	RC94	SiO2 (wt%)	54.3002	55.9167	54.5800	-0.2798	1.3367	-0.5%	2.4%
94	RC94	ThO2 (wt%)	0.0913	0.0913	0.0128	0.0786	0.0786	614.9%	614.9%
94	RC94	TiO2 (wt%)	0.0090	0.0090	0.0971	-0.0881	-0.0881	-90.7%	-90.7%
94	RC94	U3O8 (wt%)	2.8760	3.0660	2.9000	-0.0240	0.1660	-0.8%	5.7%
94	RC94	ZrO2 (wt%)	0.0271	0.0271	0.0311	-0.0040	-0.0040	-13.0%	-13.0%
94	RC94	Sum of Oxides (wt%)	99.5620	100.5773	99.8223	-0.2603	0.7550	-0.3%	0.8%

Table A7: Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by Glass Number (0 and 100 - Batch 1 and 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
95	RC95	Al2O3 (wt%)	3.1744	3.2300	3.0300	0.1444	0.2000	4.8%	6.6%
95	RC95	B2O3 (wt%)	5.8441	5.7812	6.0100	-0.1659	-0.2288	-2.8%	-3.8%
95	RC95	CaO (wt%)	1.0407	0.9983	0.9600	0.0807	0.0383	8.4%	4.0%
95	RC95	Cr2O3 (wt%)	0.0996	0.0974	0.0776	0.0221	0.0199	28.5%	25.7%
95	RC95	Fe2O3 (wt%)	10.6188	10.6482	10.7800	-0.1612	-0.1318	-1.5%	-1.2%
95	RC95	Li2O (wt%)	5.8451	5.8349	6.0500	-0.2049	-0.2151	-3.4%	-3.6%
95	RC95	MgO (wt%)	0.4336	0.4223	0.4300	0.0036	-0.0077	0.8%	-1.8%
95	RC95	MnO (wt%)	2.3816	2.5311	2.3500	0.0316	0.1811	1.3%	7.7%
95	RC95	Na2O (wt%)	12.8942	12.0138	12.0500	0.8442	-0.0362	7.0%	-0.3%
95	RC95	NiO (wt%)	0.4750	0.4896	0.4900	-0.0150	-0.0004	-3.1%	-0.1%
95	RC95	P2O5 (wt%)	0.3192	0.3192	0.2944	0.0248	0.0248	8.4%	8.4%
95	RC95	SiO2 (wt%)	53.6916	55.3904	55.1400	-1.4484	0.2504	-2.6%	0.5%
95	RC95	ThO2 (wt%)	0.0661	0.0661	0.0116	0.0545	0.0545	472.2%	472.2%
95	RC95	TiO2 (wt%)	0.0147	0.0148	0.0878	-0.0731	-0.0730	-83.3%	-83.2%
95	RC95	U3O8 (wt%)	2.0856	2.2031	2.0400	0.0456	0.1631	2.2%	8.0%
95	RC95	ZrO2 (wt%)	0.0262	0.0262	0.0281	-0.0019	-0.0019	-6.9%	-6.9%
95	RC95	Sum of Oxides (wt%)	99.0106	100.0667	99.8294	-0.8188	0.2374	-0.8%	0.2%
96	RC96	Al2O3 (wt%)	6.3912	6.5040	6.5400	-0.1488	-0.0360	-2.3%	-0.5%
96	RC96	B2O3 (wt%)	8.0980	8.0108	8.4300	-0.3320	-0.4192	-3.9%	-5.0%
96	RC96	CaO (wt%)	2.1411	2.0361	2.0600	0.0811	-0.0239	3.9%	-1.2%
96	RC96	Cr2O3 (wt%)	0.1210	0.1207	0.1279	-0.0069	-0.0072	-5.4%	-5.6%
96	RC96	Fe2O3 (wt%)	6.9212	6.9516	7.4900	-0.5688	-0.5384	-7.6%	-7.2%
96	RC96	Li2O (wt%)	4.8225	4.8143	5.0500	-0.2275	-0.2357	-4.5%	-4.7%
96	RC96	MgO (wt%)	1.9660	1.9190	2.0000	-0.0340	-0.0810	-1.7%	-4.0%
96	RC96	MnO (wt%)	4.8853	5.1472	4.8200	0.0653	0.3272	1.4%	6.8%
96	RC96	Na2O (wt%)	11.6816	10.8809	10.9800	0.7016	-0.0991	6.4%	-0.9%
96	RC96	NiO (wt%)	1.3935	1.4344	1.5200	-0.1265	-0.0856	-8.3%	-5.6%
96	RC96	P2O5 (wt%)	0.4790	0.4790	0.4842	-0.0052	-0.0052	-1.1%	-1.1%
96	RC96	SiO2 (wt%)	43.5877	45.0488	44.2600	-0.6723	0.7888	-1.5%	1.8%
96	RC96	ThO2 (wt%)	0.1233	0.1233	0.0000	0.1233	0.1233		
96	RC96	TiO2 (wt%)	0.9284	0.9326	0.9300	-0.0016	0.0026	-0.2%	0.3%
96	RC96	U3O8 (wt%)	4.9274	5.1886	4.9500	-0.0226	0.2386	-0.5%	4.8%
96	RC96	ZrO2 (wt%)	0.0322	0.0322	0.0466	-0.0143	-0.0143	-30.8%	-30.8%
96	RC96	Sum of Oxides (wt%)	98.4994	99.6236	99.6887	-1.1893	-0.0651	-1.2%	-0.1%
97	RC97	Al2O3 (wt%)	3.2736	3.3103	3.1200	0.1536	0.1903	4.9%	6.1%
97	RC97	B2O3 (wt%)	6.4478	6.3085	6.5100	-0.0622	-0.2015	-1.0%	-3.1%
97	RC97	CaO (wt%)	0.6656	0.6385	0.6100	0.0556	0.0285	9.1%	4.7%
97	RC97	Cr2O3 (wt%)	0.1674	0.1637	0.1927	-0.0253	-0.0290	-13.2%	-15.0%
97	RC97	Fe2O3 (wt%)	10.6657	10.6954	12.0400	-1.3743	-1.3446	-11.4%	-11.2%
97	RC97	Li2O (wt%)	4.5157	4.4980	4.6200	-0.1043	-0.1220	-2.3%	-2.6%
97	RC97	MgO (wt%)	1.6620	1.6187	1.6600	0.0020	-0.0413	0.1%	-2.5%
97	RC97	MnO (wt%)	4.0681	4.3235	3.9700	0.0981	0.3535	2.5%	8.9%
97	RC97	Na2O (wt%)	13.6886	12.7547	12.9400	0.7486	-0.1853	5.8%	-1.4%
97	RC97	NiO (wt%)	2.5569	2.6354	2.9400	-0.3831	-0.3046	-13.0%	-10.4%
97	RC97	P2O5 (wt%)	0.7232	0.7232	0.7314	-0.0082	-0.0082	-1.1%	-1.1%
97	RC97	SiO2 (wt%)	44.4568	45.8489	44.5300	-0.0732	1.3189	-0.2%	3.0%
97	RC97	ThO2 (wt%)	0.1681	0.1681	0.0287	0.1394	0.1394	485.8%	485.8%
97	RC97	TiO2 (wt%)	0.0276	0.0277	0.2181	-0.1905	-0.1904	-87.3%	-87.3%
97	RC97	U3O8 (wt%)	5.4955	5.8052	5.4100	0.0855	0.3952	1.6%	7.3%
97	RC97	ZrO2 (wt%)	0.0626	0.0626	0.0699	-0.0072	-0.0072	-10.3%	-10.3%
97	RC97	Sum of Oxides (wt%)	98.6452	99.5825	99.5908	-0.9456	-0.0083	-0.9%	0.0%
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%

Table A7: Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by Glass Number (0 and 100 - Batch 1 and 101 – U std)

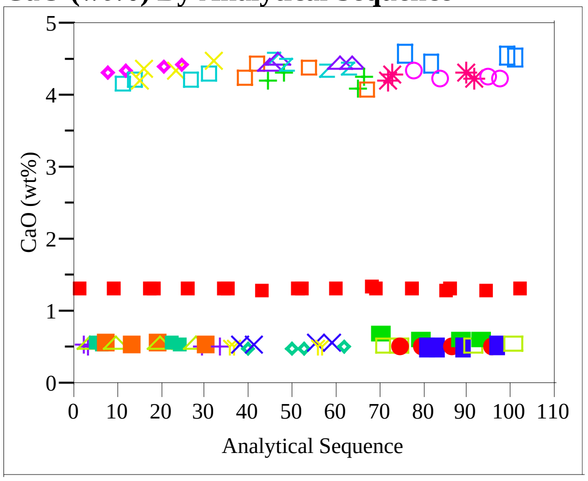
Glass #	Glass ID	Oxide	Measured (wt%)	Measured Bias-Corrected (wt%)	Targeted (wt%)	Diff of Measured	Diff of Meas BC	% Diff of Measured	% Diff of Meas BC
100	Batch 1	ThO2 (wt%)	0.0058	0.0058	0.0000	0.0058	0.0058		
100	Batch 1	TiO2 (wt%)	0.6746	0.6770	0.6770	-0.0024	0.0000	-0.4%	0.0%
100	Batch 1	U3O8 (wt%)	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%
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%

Table A.8 RC97 vs RC30 Chemical Composition Measurements

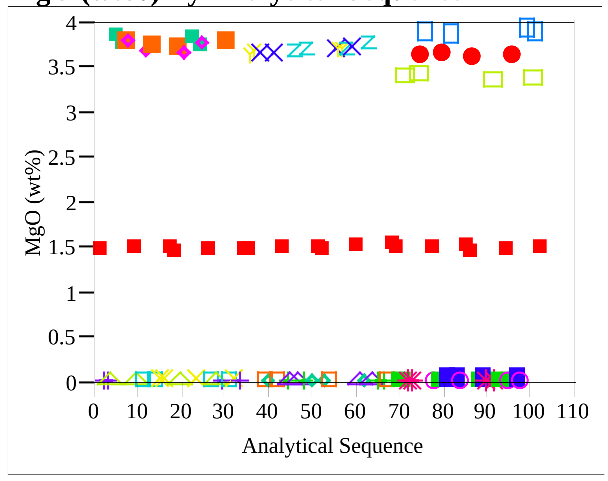
Glass #		Measured (wt%)	Measured Bias-Corrected (wt%)	Targeted (wt%)	Diff of Measured	Diff of Meas BC	% Diff of Measured	% Diff of Meas BC
30	Al2O3 (wt%)	3.2594	3.2456	3.1150	0.0138	0.1306	4.6%	4.2%
30	B2O3 (wt%)	6.3352	6.2925	6.5140	0.0426	-0.2215	-2.7%	-3.4%
30	CaO (wt%)	0.6723	0.6069	0.6130	0.0654	-0.0061	9.7%	-1.0%
30	Cr2O3 (wt%)	0.1060	0.1028	0.1260	0.0031	-0.0232	-15.9%	-18.4%
30	Fe2O3 (wt%)	11.3339	11.3324	12.0400	0.0015	-0.7076	-5.9%	-5.9%
30	Li2O (wt%)	4.5265	4.6401	4.6200	-0.1136	0.0201	-2.0%	-1.6%
30	MgO (wt%)	1.6469	1.5546	1.6630	0.0923	-0.1084	-1.0%	-6.5%
30	MnO (wt%)	3.8930	3.7921	3.9730	0.1009	-0.1809	-2.0%	-4.6%
30	Na2O (wt%)	13.2407	12.6235	12.9390	0.6172	-0.3155	2.3%	-2.4%
30	NiO (wt%)	2.7982	2.7797	2.9380	0.0185	-0.1583	-4.8%	-5.4%
30	P2O5 (wt%)	0.3844	0.3844	0.4782	0.0000	-0.0938	-19.6%	-19.6%
30	SiO2 (wt%)	45.8345	45.3040	44.5340	0.5305	0.7700	2.9%	1.7%
30	TiO2 (wt%)	0.0117	0.0111	0.0143	0.0006	-0.0032	-18.3%	-22.3%
30	U3O8 (wt%)	5.4656	5.7562	5.4138	-0.2906	0.3424	1.0%	6.3%
30	ZrO2 (wt%)	0.6838	0.6838	0.6957	0.0000	-0.0119	-1.7%	-1.7%
30	Sum of Oxides (wt%)	100.1921	99.1098	99.6770	1.0823	-0.5672	0.5%	-0.7%
97	Al2O3 (wt%)	3.2736	3.3103	3.1200	0.1536	0.1903	4.9%	6.1%
97	B2O3 (wt%)	6.4478	6.3085	6.5100	-0.0622	-0.2015	-1.0%	-3.1%
97	CaO (wt%)	0.6656	0.6385	0.6100	0.0556	0.0285	9.1%	4.7%
97	Cr2O3 (wt%)	0.1674	0.1637	0.1927	-0.0253	-0.0290	-13.2%	-15.0%
97	Fe2O3 (wt%)	10.6657	10.6954	12.0400	-1.3743	-1.3446	-11.4%	-11.2%
97	Li2O (wt%)	4.5157	4.4980	4.6200	-0.1043	-0.1220	-2.3%	-2.6%
97	MgO (wt%)	1.6620	1.6187	1.6600	0.0020	-0.0413	0.1%	-2.5%
97	MnO (wt%)	4.0681	4.3235	3.9700	0.0981	0.3535	2.5%	8.9%
97	Na2O (wt%)	13.6886	12.7547	12.9400	0.7486	-0.1853	5.8%	-1.4%
97	NiO (wt%)	2.5569	2.6354	2.9400	-0.3831	-0.3046	-13.0%	-10.4%
97	P2O5 (wt%)	0.7232	0.7232	0.7314	-0.0082	-0.0082	-1.1%	-1.1%
97	SiO2 (wt%)	44.4568	45.8489	44.5300	-0.0732	1.3189	-0.2%	3.0%
97	ThO2 (wt%)	0.1681	0.1681	0.0287	0.1394	0.1394	485.8%	485.8%
97	TiO2 (wt%)	0.0276	0.0277	0.2181	-0.1905	-0.1904	-87.3%	-87.3%
97	U3O8 (wt%)	5.4955	5.8052	5.4100	0.0855	0.3952	1.6%	7.3%
97	ZrO2 (wt%)	0.0626	0.0626	0.0699	-0.0072	-0.0072	-10.3%	-10.3%
97	Sum of Oxides (wt%)	98.6452	99.5825	99.5908	-0.9456	-0.0083	-0.9%	0.0%

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

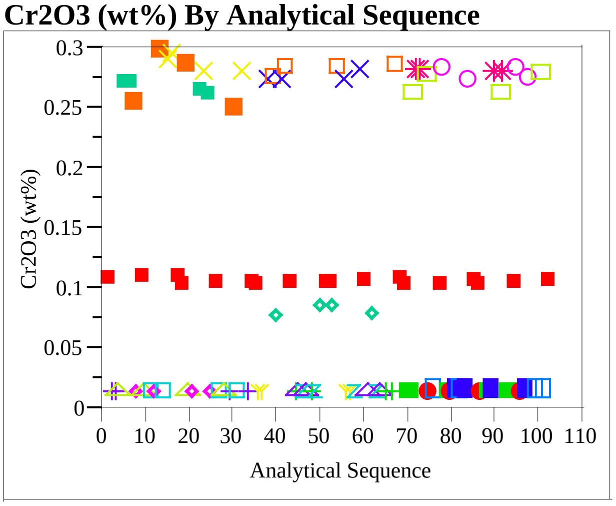
CaO (wt%) By Analytical Sequence



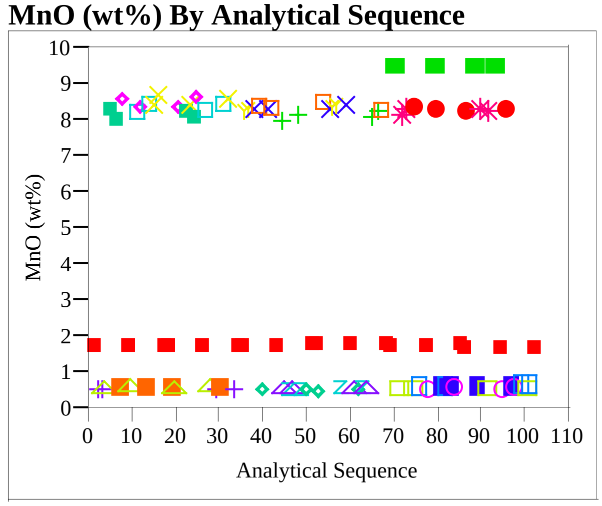
MgO (wt%) By Analytical Sequence



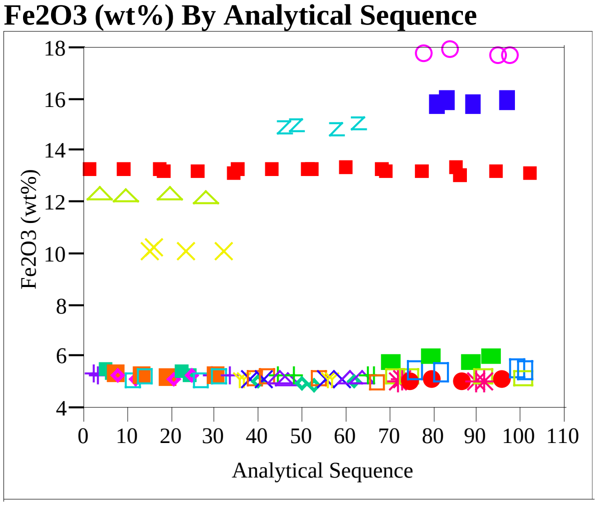
Cr2O3 (wt%) By Analytical Sequence



MnO (wt%) By Analytical Sequence



Fe2O3 (wt%) By Analytical Sequence



Na2O (wt%) By Analytical Sequence

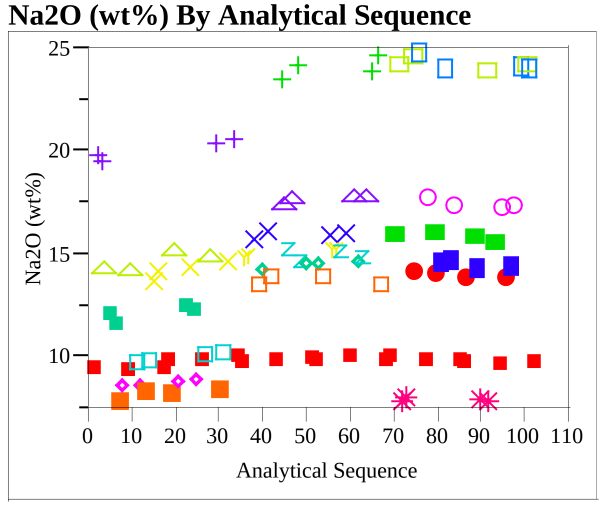
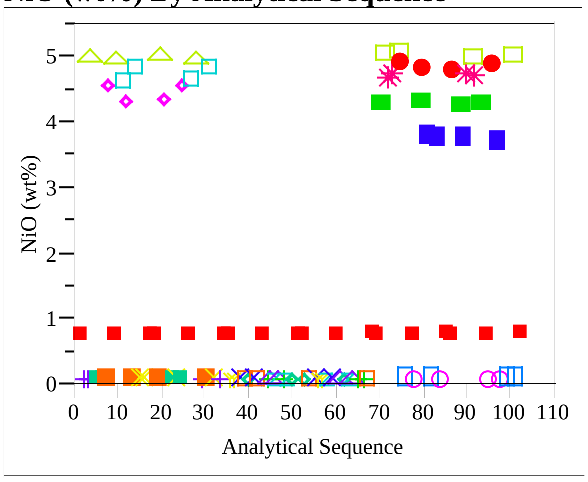
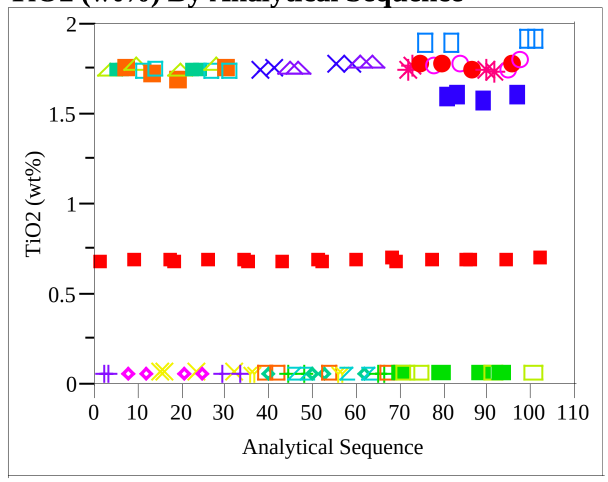


Exhibit A.1: SRTC-ML Measurements for Samples of Glasses in the Non-Radioactive Group Prepared Using the LM Method *(continued)*

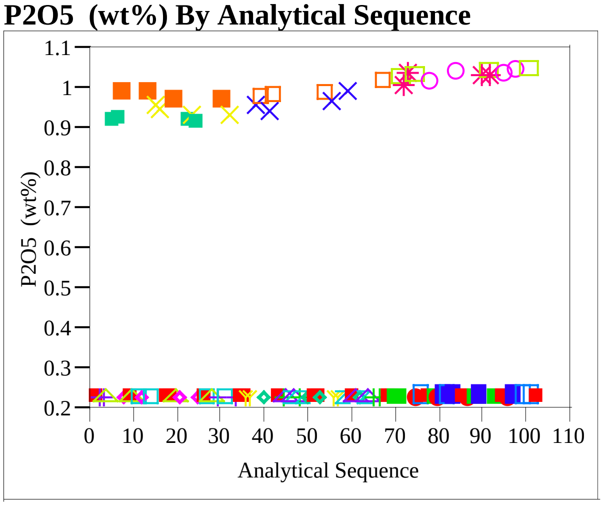
NiO (wt%) By Analytical Sequence



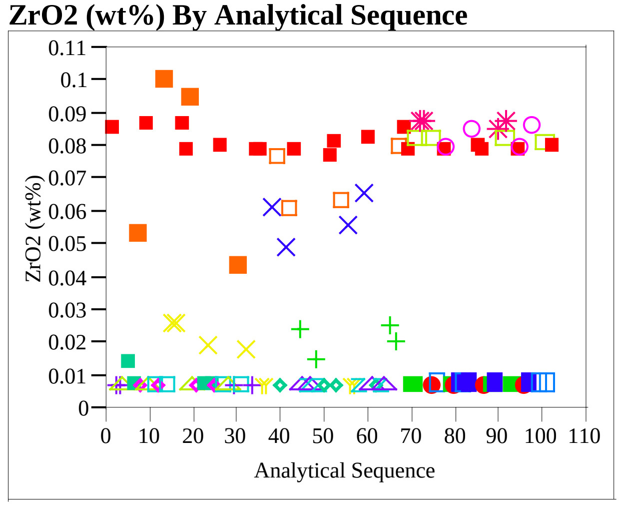
TiO2 (wt%) By Analytical Sequence



P2O5 (wt%) By Analytical Sequence



ZrO2 (wt%) By Analytical Sequence



SiO2 (wt%) By Analytical Sequence

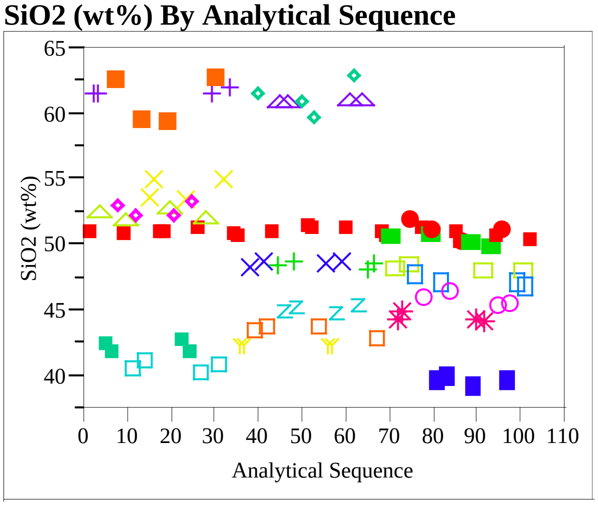
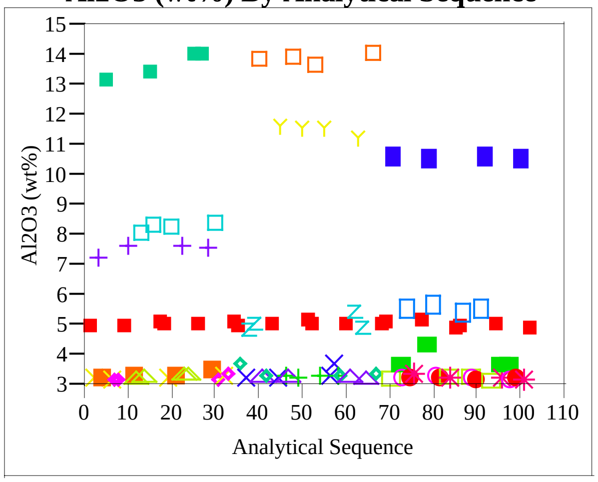
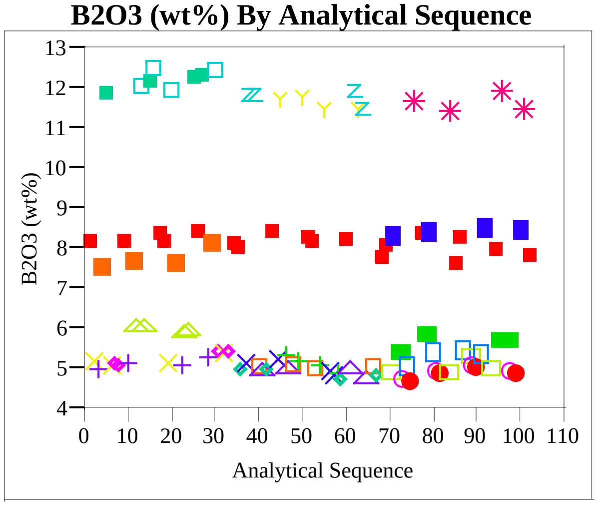


Exhibit A.2: SRTC-ML Measurements for Samples of Glasses in the Non-Radioactive Group Prepared Using the PF Method

Al2O3 (wt%) By Analytical Sequence



B2O3 (wt%) By Analytical Sequence



Li2O (wt%) By Analytical Sequence

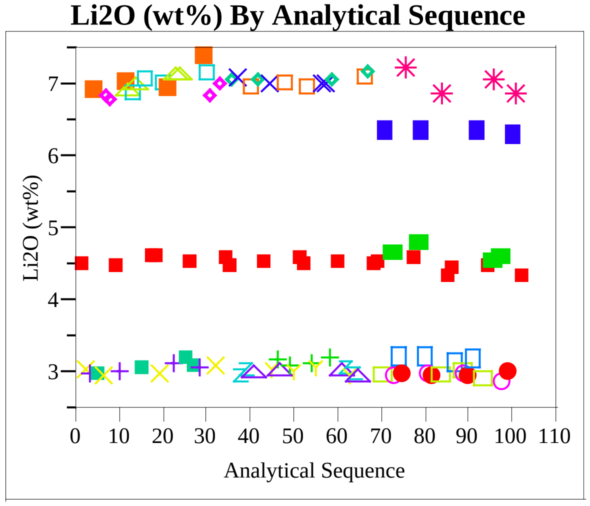
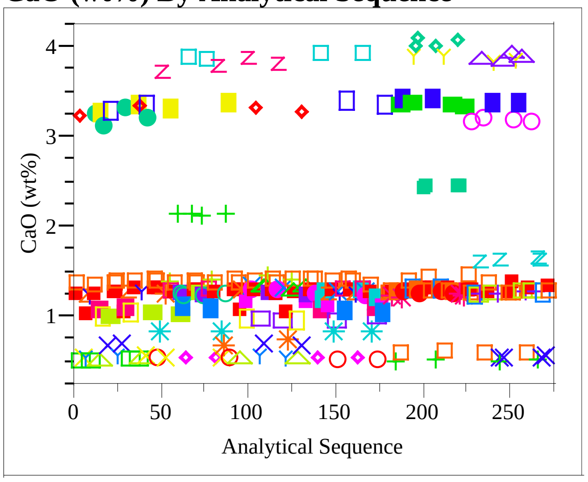
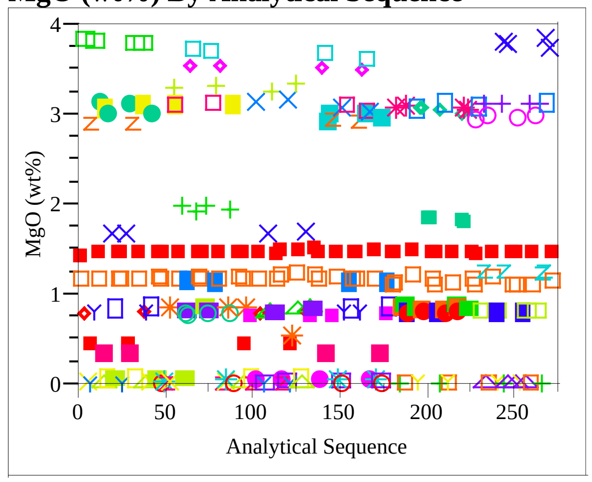


Exhibit A.3: SRTC-ML Measurements for Samples of Glasses in the Radioactive Group Prepared Using the LM Method

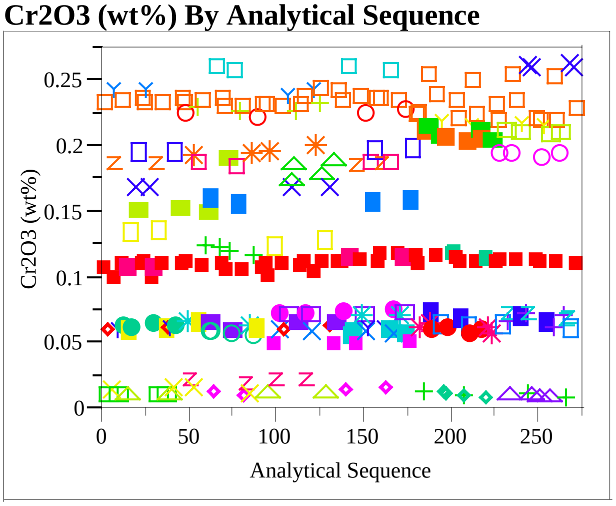
CaO (wt%) By Analytical Sequence



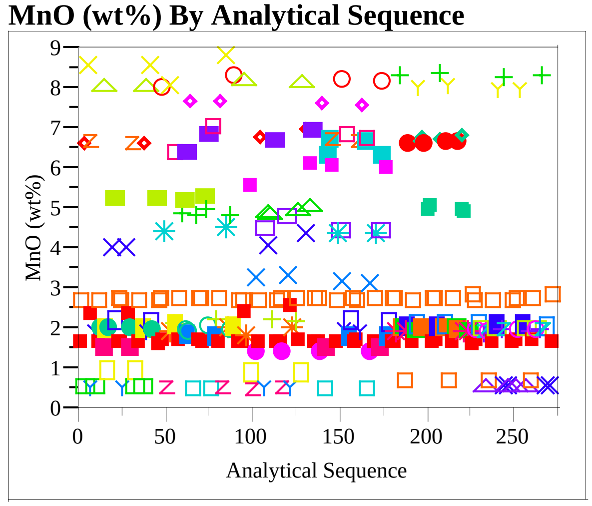
MgO (wt%) By Analytical Sequence



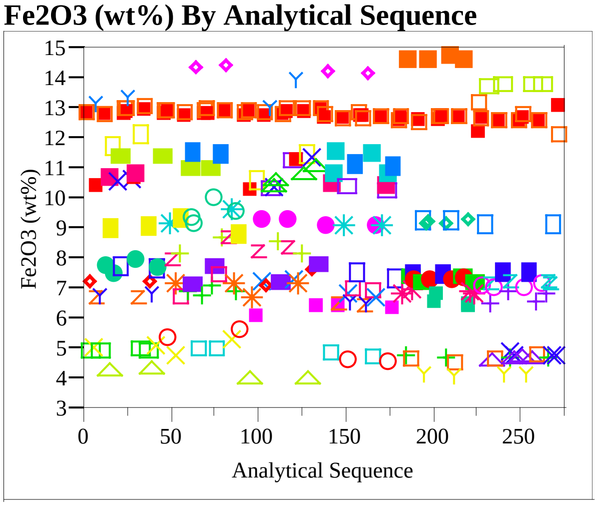
Cr2O3 (wt%) By Analytical Sequence



MnO (wt%) By Analytical Sequence



Fe2O3 (wt%) By Analytical Sequence



Na2O (wt%) By Analytical Sequence

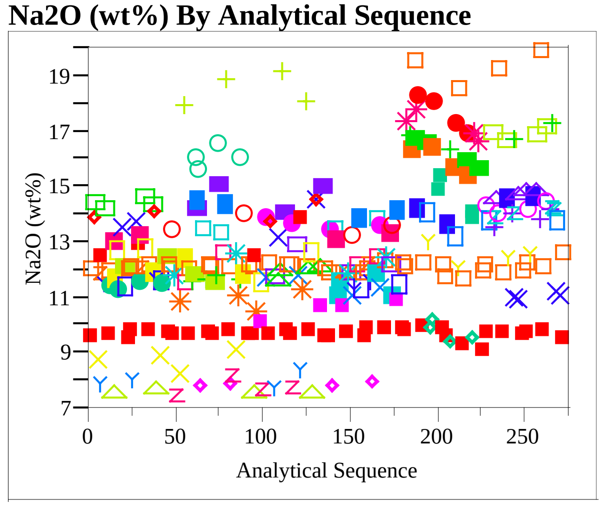
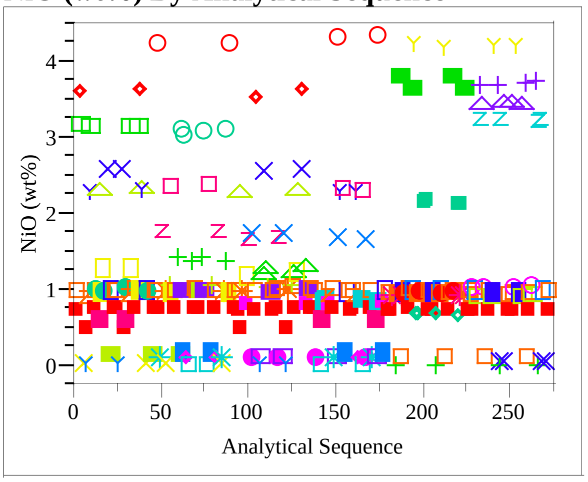
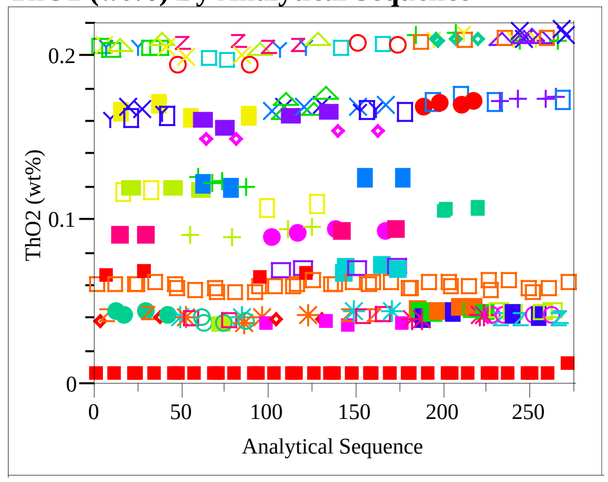


Exhibit A.3: SRTC-ML Measurements for Samples of Glasses in the Radioactive Group Prepared Using the LM Method *(continued)*

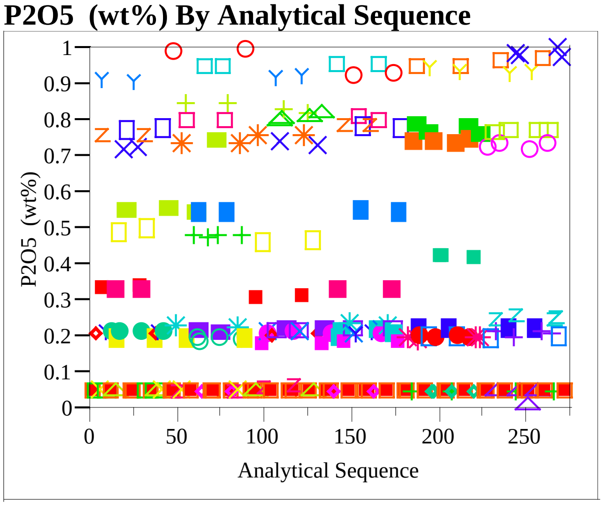
NiO (wt%) By Analytical Sequence



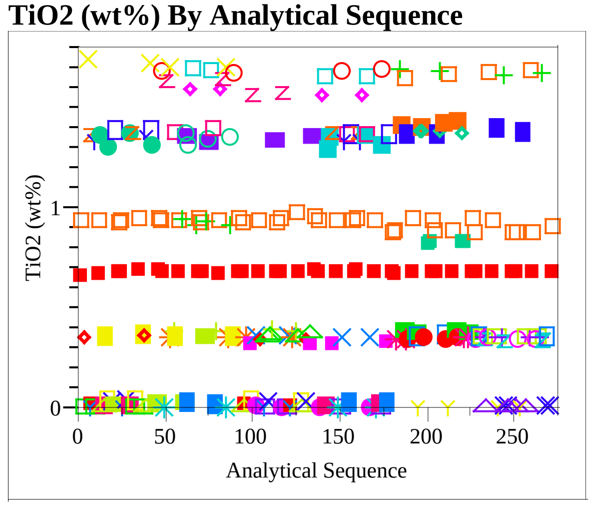
ThO2 (wt%) By Analytical Sequence



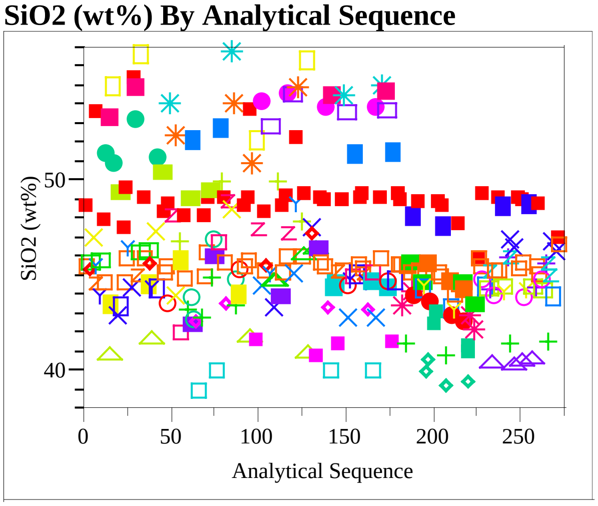
P2O5 (wt%) By Analytical Sequence



TiO2 (wt%) By Analytical Sequence



SiO2 (wt%) By Analytical Sequence



U3O8 (wt%) By Analytical Sequence

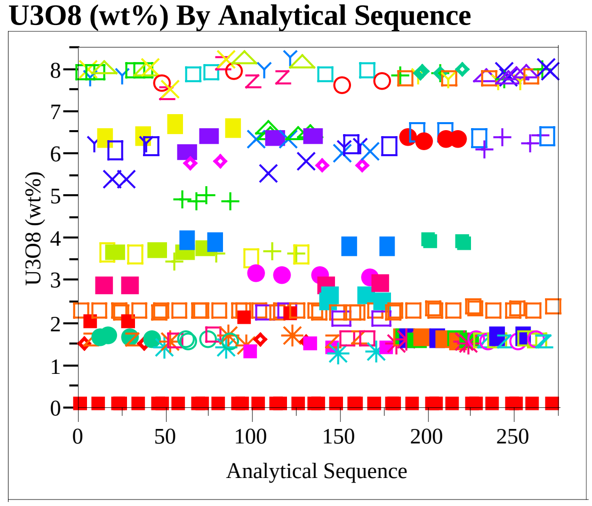


Exhibit A.3: SRTC-ML Measurements for Samples of Glasses in the Radioactive Group Prepared Using the LM Method *(continued)*

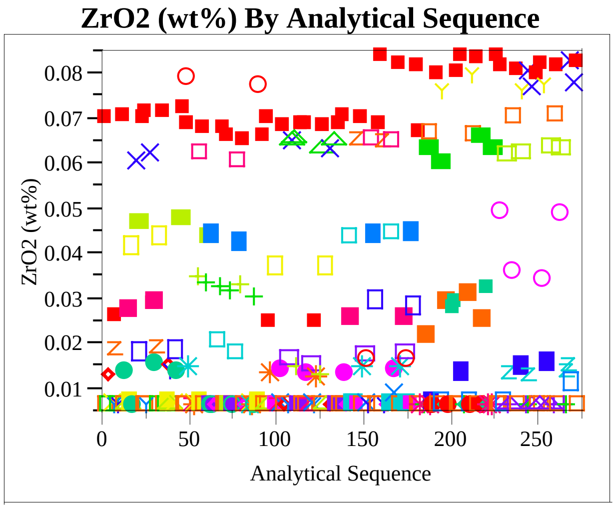
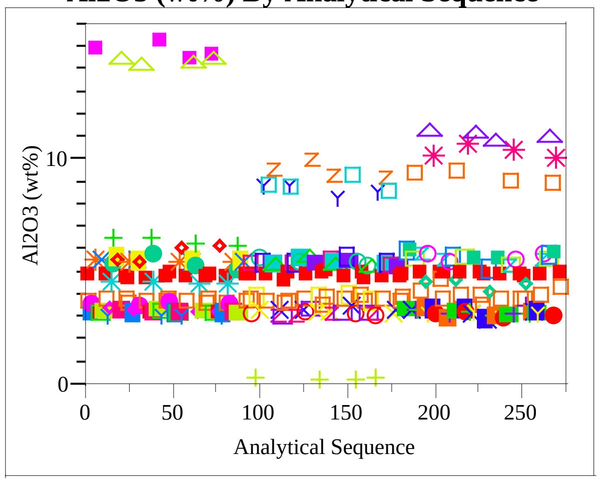
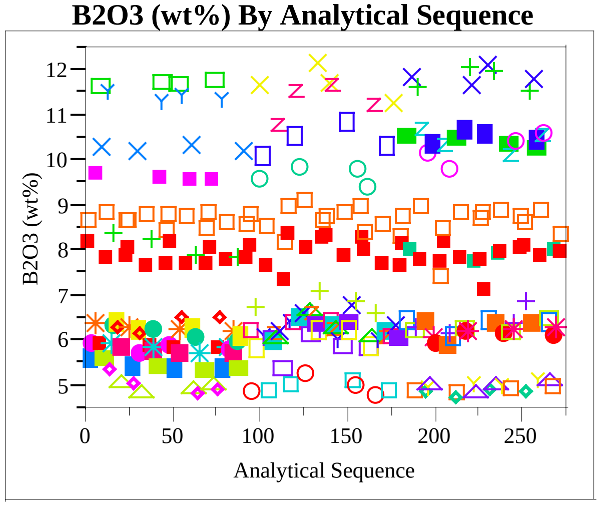


Exhibit A.4: SRTC-ML Measurements for Samples of Glasses in the Non-Radioactive Group Prepared Using the PF Method

Al2O3 (wt%) By Analytical Sequence



B2O3 (wt%) By Analytical Sequence



Li2O (wt%) By Analytical Sequence

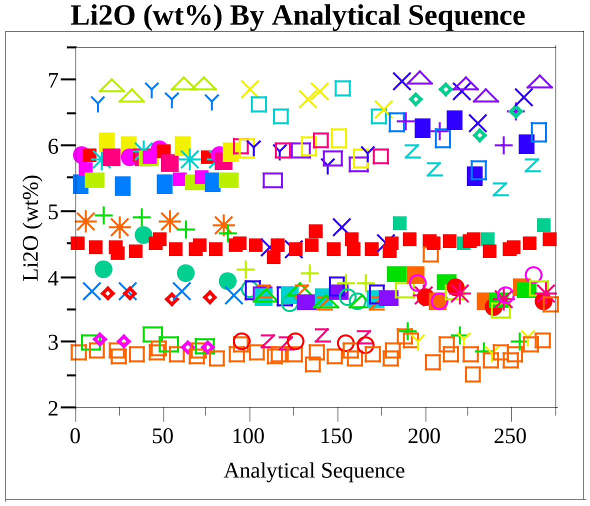
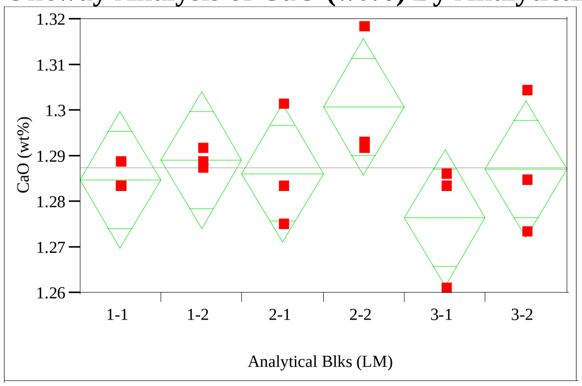


Exhibit A.5: SRTC-ML Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the LM Method for the Non-Radioactive Group

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			

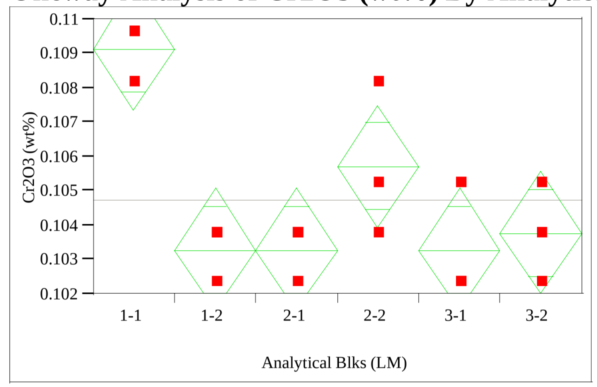
Means for Oneway Anova

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			

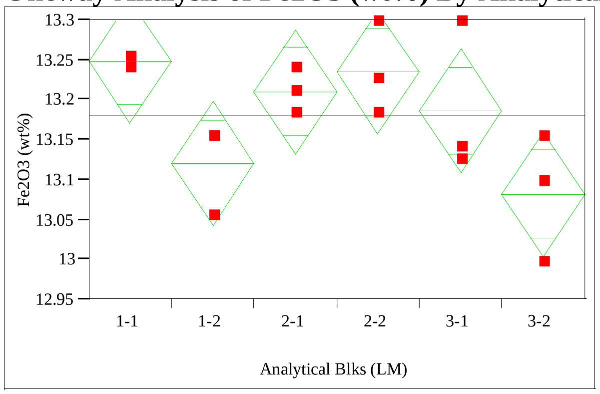
Means for Oneway Anova

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 A.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 – Fe_2O_3 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

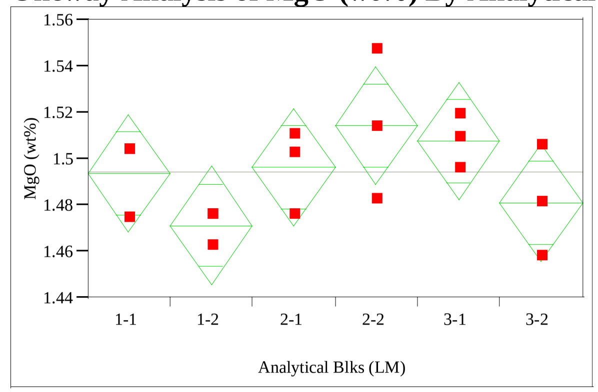
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Blks (LM)	5	0.06563646	0.013127	3.4303	0.0372
Error	12	0.04592281	0.003827		
C. Total	17	0.11155927			

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			

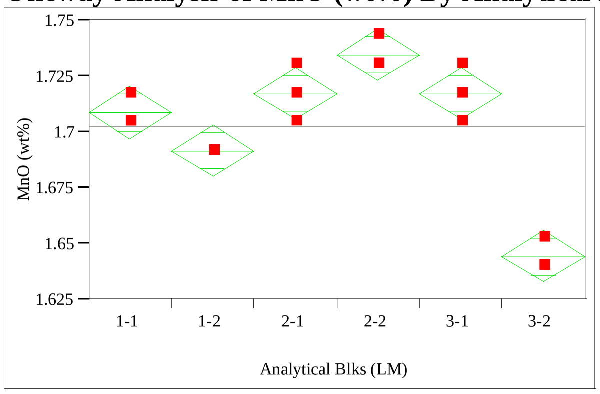
Means for Oneway Anova

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 A.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

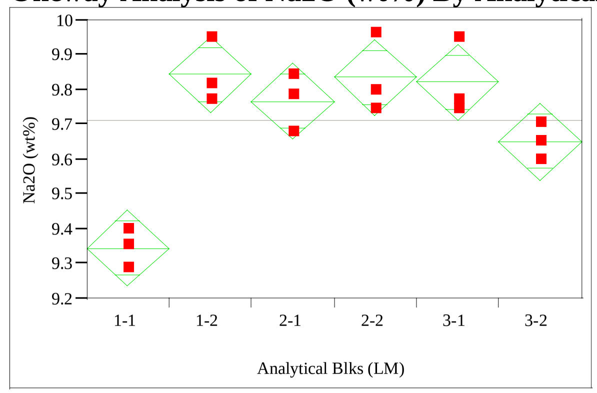
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Blks (LM)	5	0.01508814	0.003018	36.2000	<.0001
Error	12	0.00100032	0.000083		
C. Total	17	0.01608846			

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

Std Error uses a pooled estimate of error variance

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			

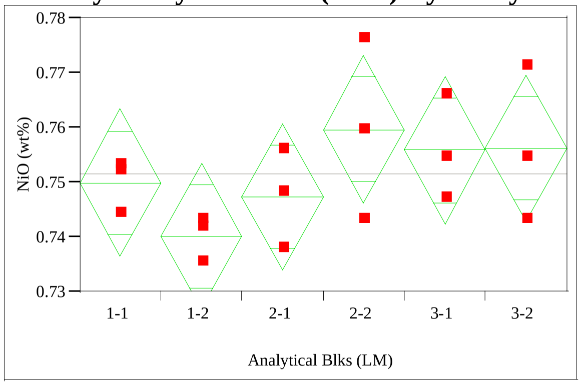
Means for Oneway Anova

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

Std Error uses a pooled estimate of error variance

Exhibit A.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

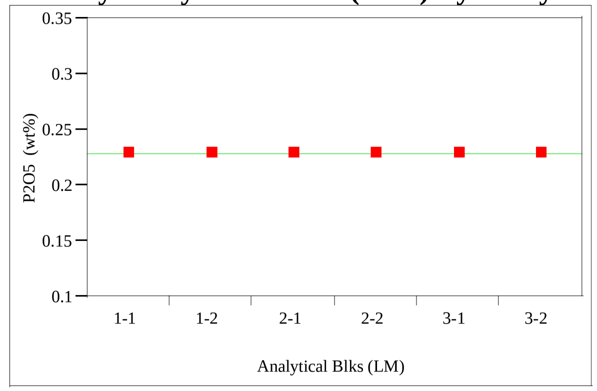
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Blks (LM)	5	0.00077014	0.000154	1.3514	0.3086
Error	12	0.00136773	0.000114		
C. Total	17	0.00213787			

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

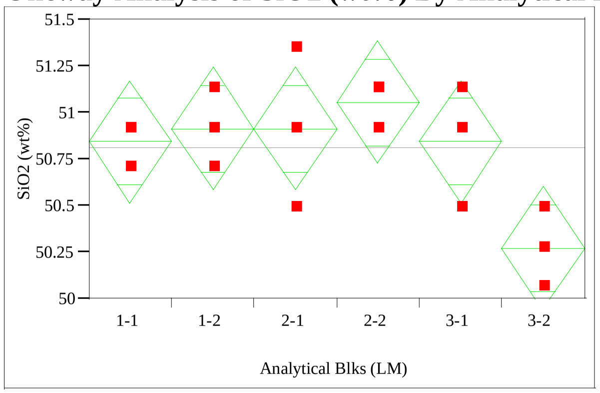
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	0.229140	0	0.22914	0.22914
1-2	3	0.229140	0	0.22914	0.22914
2-1	3	0.229140	0	0.22914	0.22914
2-2	3	0.229140	0	0.22914	0.22914
3-1	3	0.229140	0	0.22914	0.22914
3-2	3	0.229140	0	0.22914	0.22914

Std Error uses a pooled estimate of error variance

Exhibit A.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			

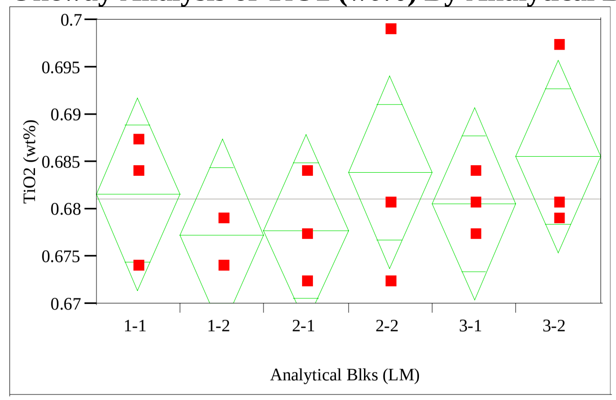
Means for Oneway Anova

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

Std Error uses a pooled estimate of error variance

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			

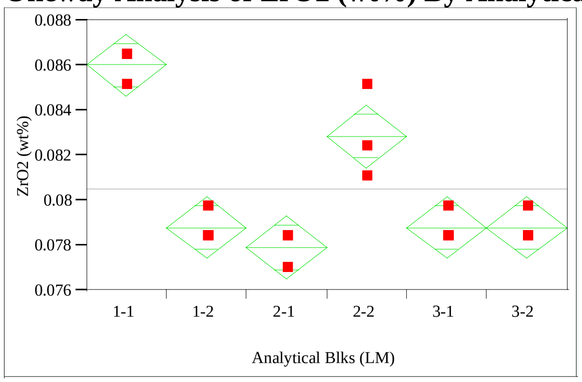
Means for Oneway Anova

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 A.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

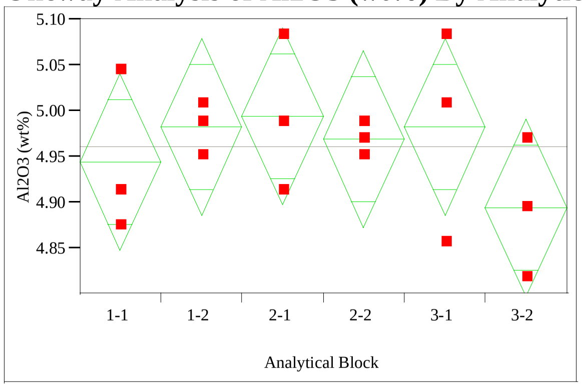
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	0.086001	0.00064	0.08461	0.08739
1-2	3	0.078797	0.00064	0.07741	0.08018
2-1	3	0.077896	0.00064	0.07651	0.07928
2-2	3	0.082849	0.00064	0.08146	0.08424
3-1	3	0.078797	0.00064	0.07741	0.08018
3-2	3	0.078797	0.00064	0.07741	0.08018

Std Error uses a pooled estimate of error variance

Exhibit A.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			

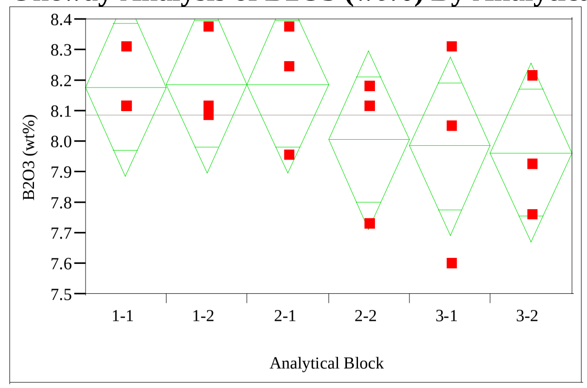
Means for Oneway Anova

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

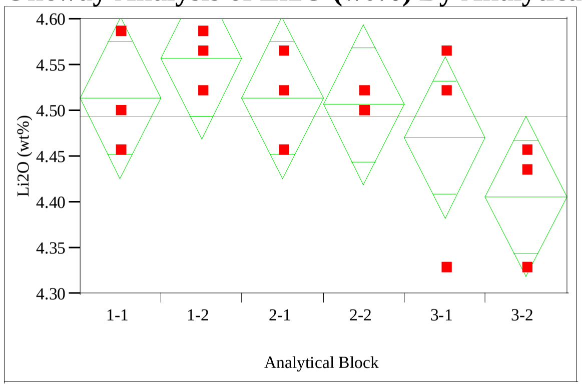
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	8.17855	0.13413	7.8863	8.4708
1-2	3	8.18928	0.13413	7.8970	8.4815
2-1	3	8.18928	0.13413	7.8970	8.4815
2-2	3	8.00682	0.13413	7.7146	8.2991
3-1	3	7.98535	0.13413	7.6931	8.2776
3-2	3	7.96389	0.13413	7.6716	8.2561

Std Error uses a pooled estimate of error variance

Exhibit A.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			

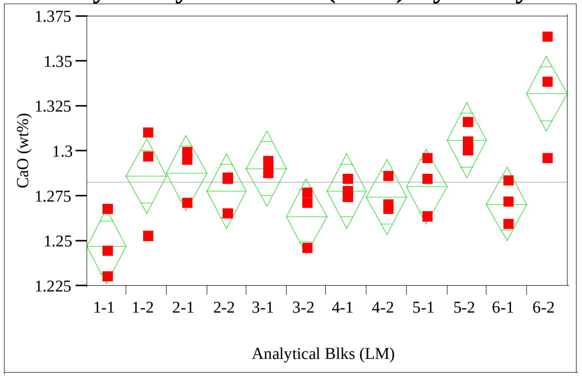
Means for Oneway Anova

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 A.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

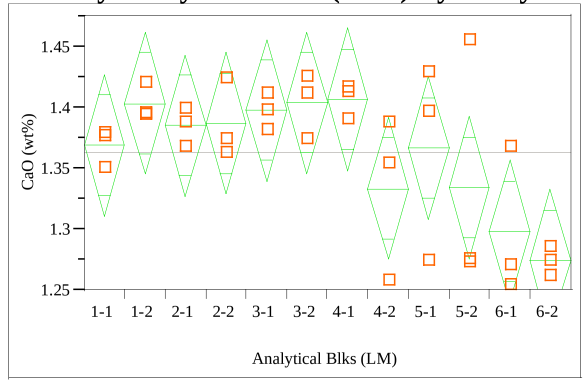
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Blks (LM)	11	0.01494531	0.001359	4.4753	0.0010
Error	24	0.00728619	0.000304		
C. Total	35	0.02223150			

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			

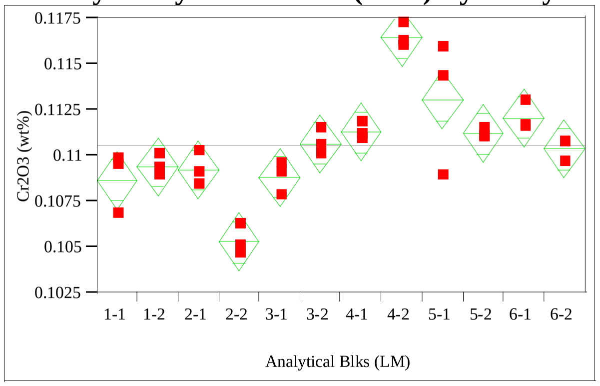
Means for Oneway Anova

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 A.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

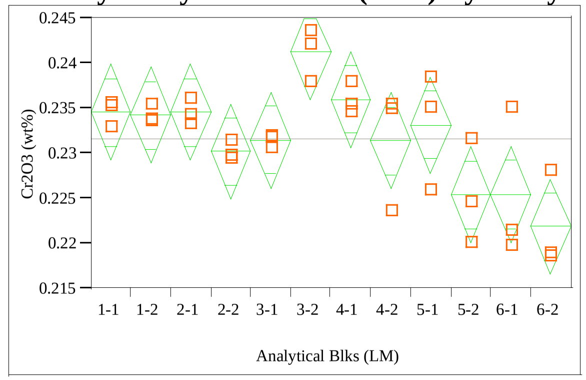
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Blks (LM)	11	0.00024449	0.000022	12.6583	<.0001
Error	24	0.00004214	0.000002		
C. Total	35	0.00028663			

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

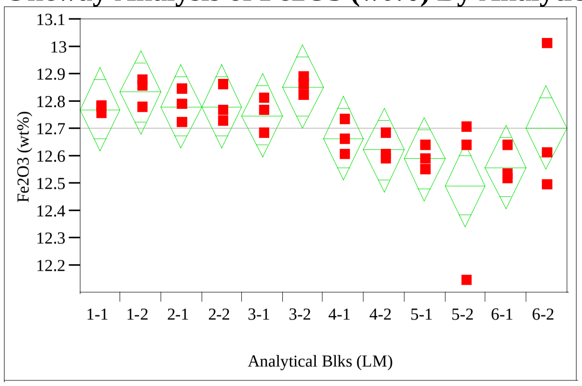
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	0.234548	0.00257	0.22923	0.23986
1-2	3	0.234236	0.00257	0.22892	0.23955
2-1	3	0.234538	0.00257	0.22923	0.23985
2-2	3	0.230173	0.00257	0.22486	0.23549
3-1	3	0.231430	0.00257	0.22612	0.23674
3-2	3	0.241203	0.00257	0.23589	0.24652
4-1	3	0.235961	0.00257	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 A.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			

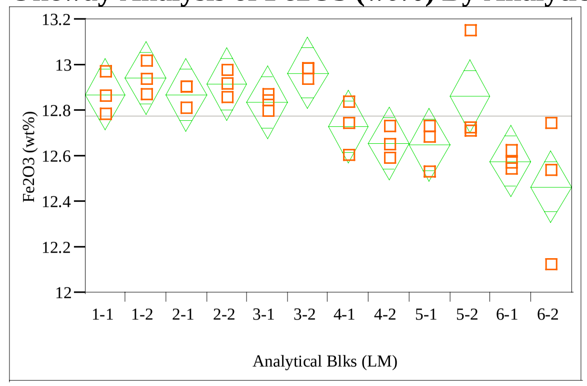
Means for Oneway Anova

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			

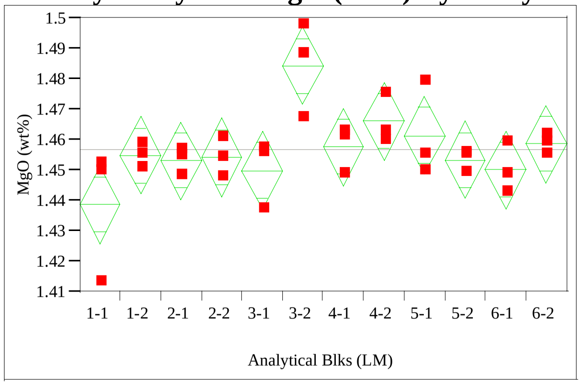
Means for Oneway Anova

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 A.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

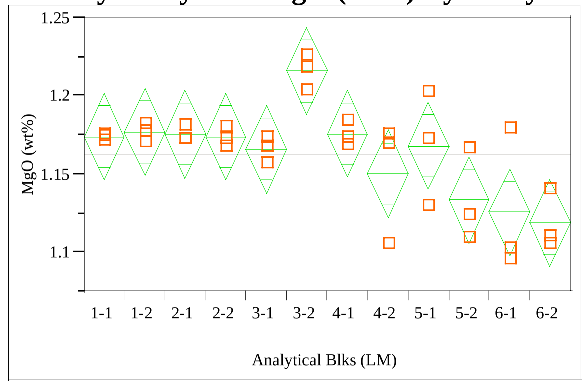
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Blks (LM)	11	0.00398800	0.000363	3.1604	0.0089
Error	24	0.00275316	0.000115		
C. Total	35	0.00674116			

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			

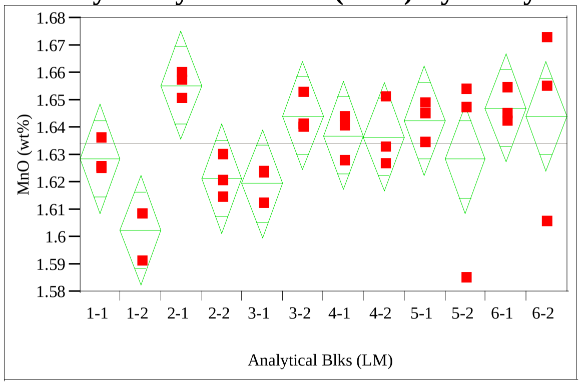
Means for Oneway Anova

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 A.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

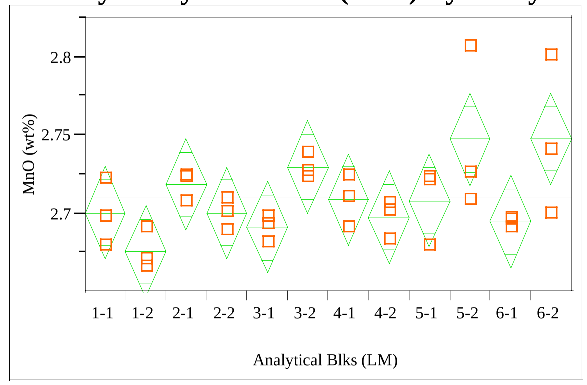
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Blks (LM)	11	0.00708362	0.000644	2.3233	0.0408
Error	24	0.00665211	0.000277		
C. Total	35	0.01373572			

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			

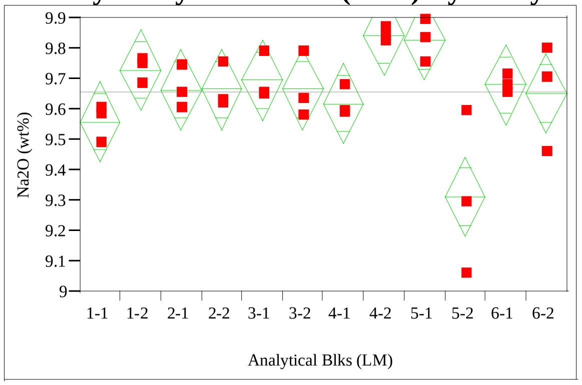
Means for Oneway Anova

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 A.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

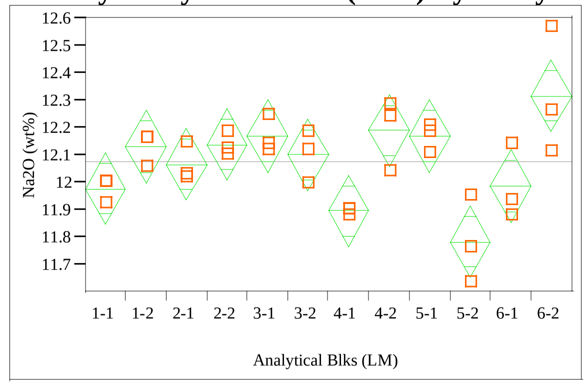
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Blks (LM)	11	0.60309770	0.054827	4.4846	0.0010
Error	24	0.29341233	0.012226		
C. Total	35	0.89651003			

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			

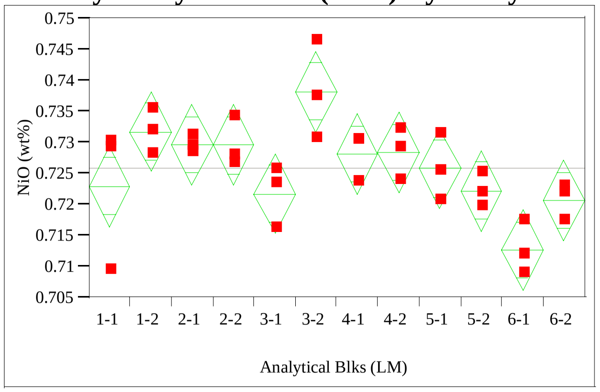
Means for Oneway Anova

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 A.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

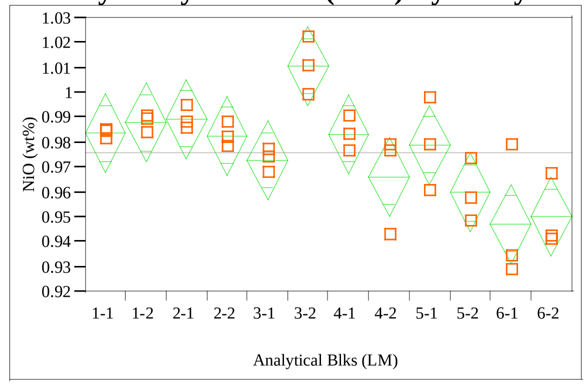
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Blks (LM)	11	0.00139497	0.000127	4.3220	0.0013
Error	24	0.00070421	0.000029		
C. Total	35	0.00209918			

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			

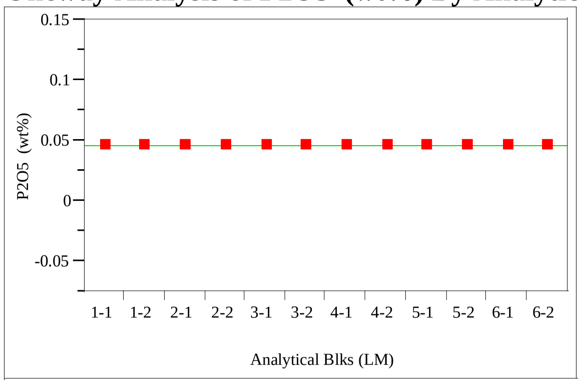
Means for Oneway Anova

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 A.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

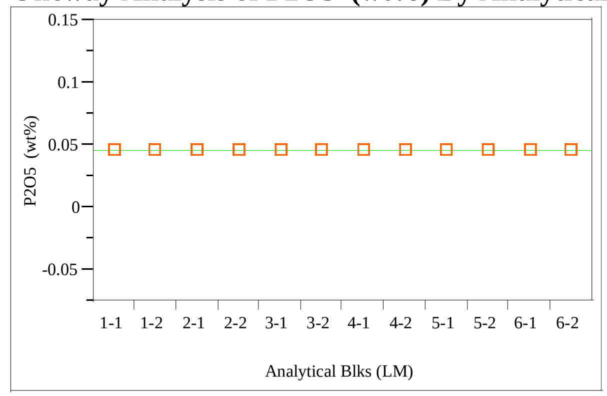
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Blks (LM)	11	6.9333e-33	6.303e-34	.	.
Error	24	0	0		
C. Total	35	6.9333e-33			

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 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			

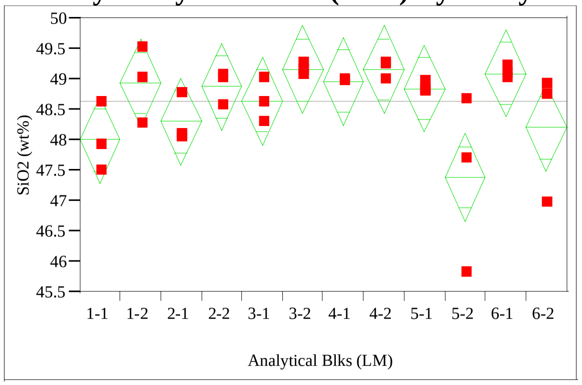
Means for Oneway Anova

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

Exhibit A.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

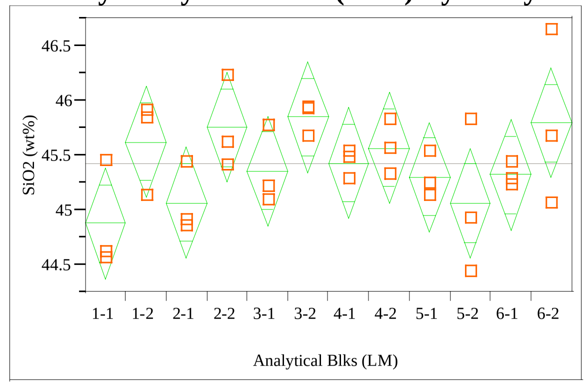
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Blks (LM)	11	9.977528	0.907048	2.4781	0.0306
Error	24	8.784441	0.366018		
C. Total	35	18.761970			

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			

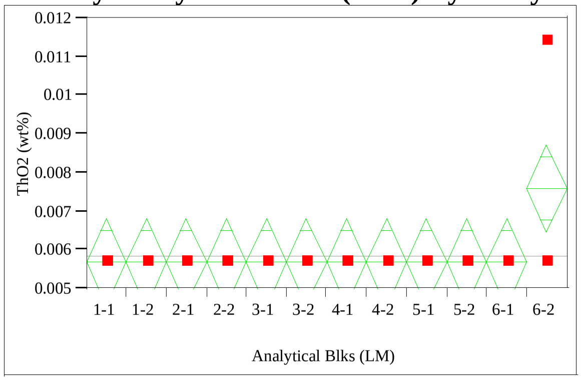
Means for Oneway Anova

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 A.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

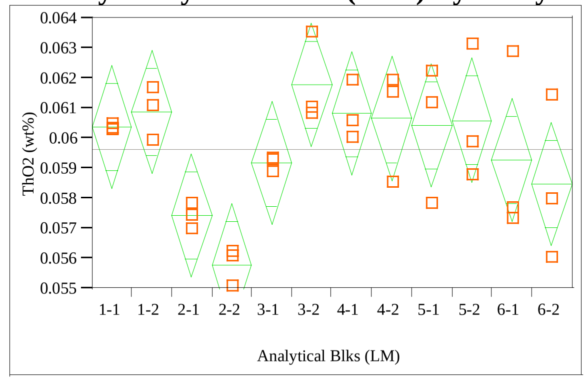
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Blks (LM)	11	0.00000989	8.9918e-7	1.0000	0.4744
Error	24	0.00002158	8.9918e-7		
C. Total	35	0.00003147			

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			

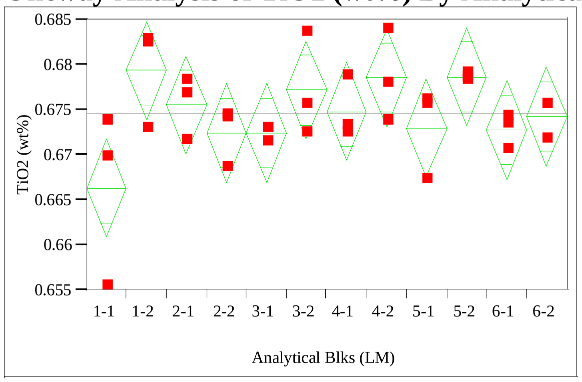
Means for Oneway Anova

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 A.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

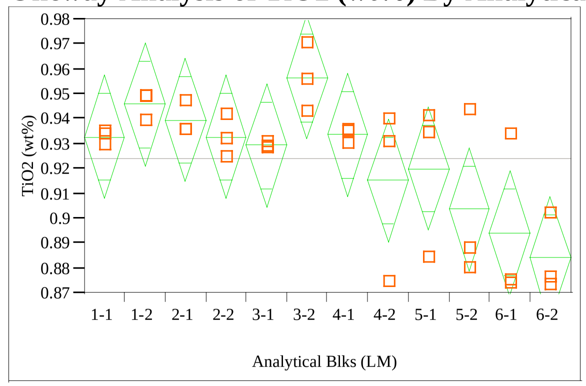
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Blks (LM)	11	0.00044025	0.000040	1.9095	0.0898
Error	24	0.00050303	0.000021		
C. Total	35	0.00094329			

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			

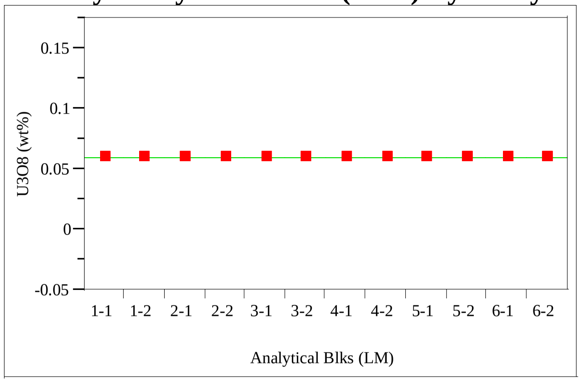
Means for Oneway Anova

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 A.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

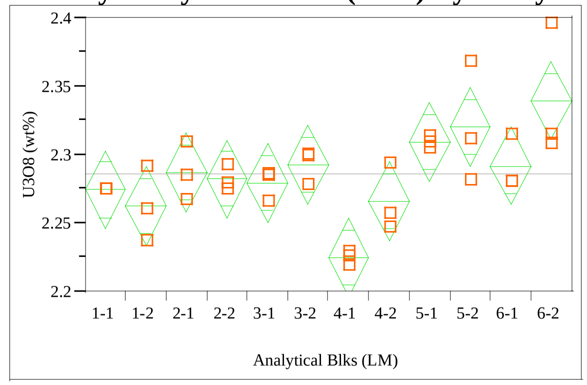
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Blks (LM)	11	1.56e-32	1.418e-33	.	.
Error	24	0	0		
C. Total	35	1.56e-32			

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			

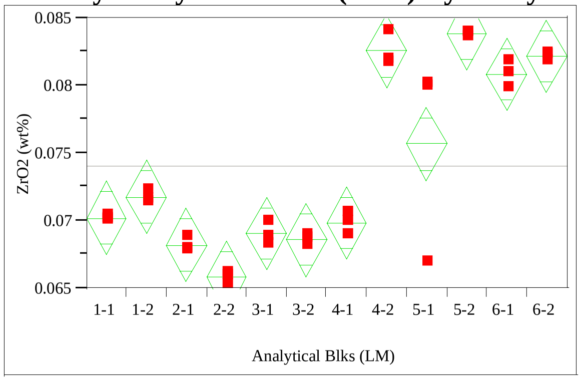
Means for Oneway Anova

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 A.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 – ZrO_2 reference value 0.098 wt%
Oneway Analysis of ZrO_2 (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

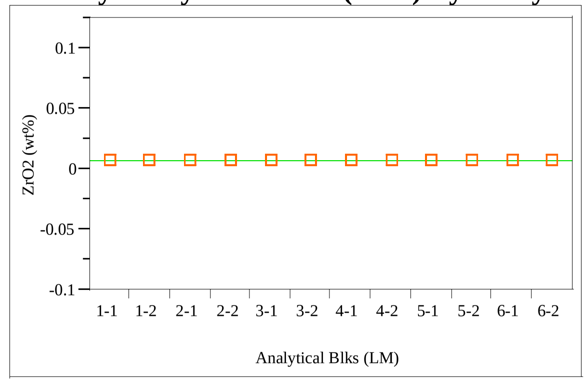
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Blks (LM)	11	0.00143390	0.000130	25.2860	<.0001
Error	24	0.00012372	0.000005		
C. Total	35	0.00155762			

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 – ZrO_2 reference value ~0 wt%
Oneway Analysis of ZrO_2 (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

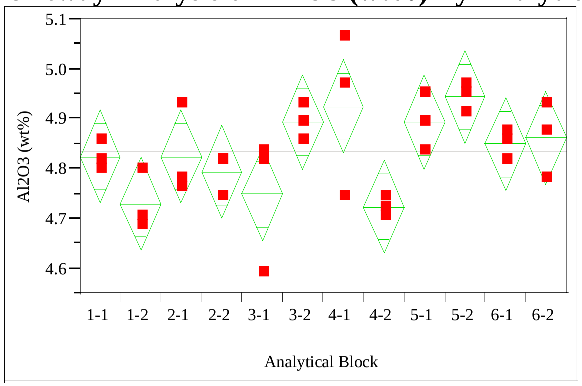
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	0.006754	0	0.00675	0.00675
1-2	3	0.006754	0	0.00675	0.00675
2-1	3	0.006754	0	0.00675	0.00675
2-2	3	0.006754	0	0.00675	0.00675
3-1	3	0.006754	0	0.00675	0.00675
3-2	3	0.006754	0	0.00675	0.00675
4-1	3	0.006754	0	0.00675	0.00675
4-2	3	0.006754	0	0.00675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

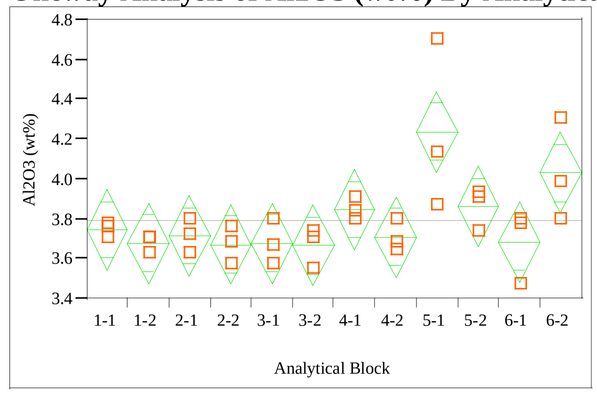
Means for Oneway Anova

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			

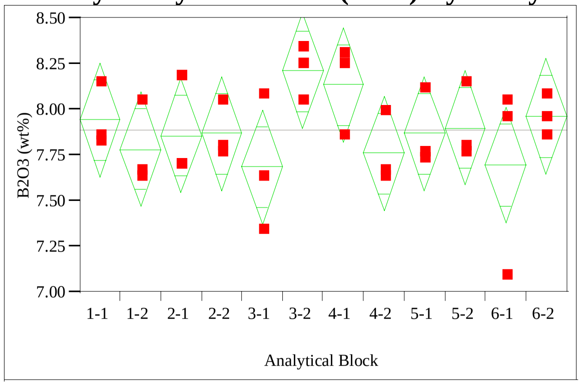
Means for Oneway Anova

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 A.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

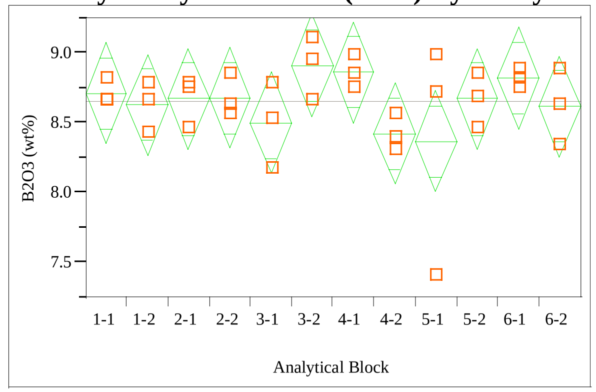
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Block	11	0.8467001	0.076973	1.1058	0.3983
Error	24	1.6705911	0.069608		
C. Total	35	2.5172912			

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			

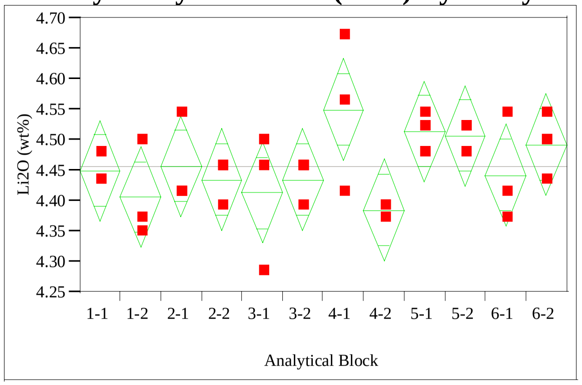
Means for Oneway Anova

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 A.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

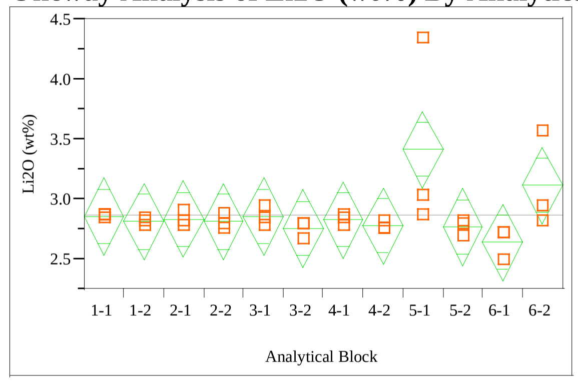
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Analytical Block	11	0.07955425	0.007232	1.4900	0.1994
Error	24	0.11649246	0.004854		
C. Total	35	0.19604671			

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

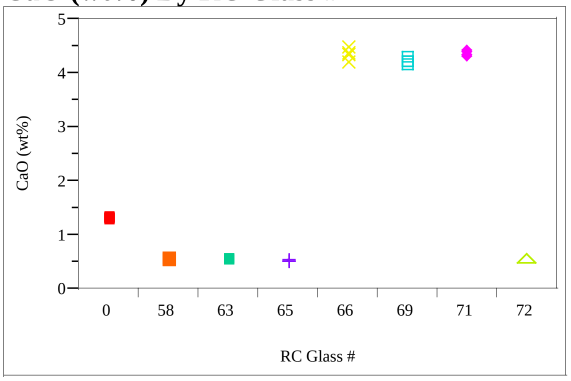
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	2.85618	0.15539	2.5355	3.1769
1-2	3	2.81312	0.15539	2.4924	3.1338
2-1	3	2.83465	0.15539	2.5140	3.1554
2-2	3	2.81312	0.15539	2.4924	3.1338
3-1	3	2.85618	0.15539	2.5355	3.1769
3-2	3	2.75571	0.15539	2.4350	3.0764
4-1	3	2.82748	0.15539	2.5068	3.1482
4-2	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

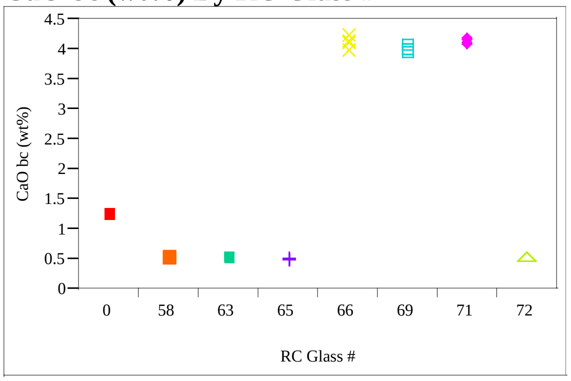
Exhibit A.9: SRTC-ML Measurements by Glass Number for Samples Prepared Using the LM Method for the Non-Radioactive Group

(0 – Batch 1)

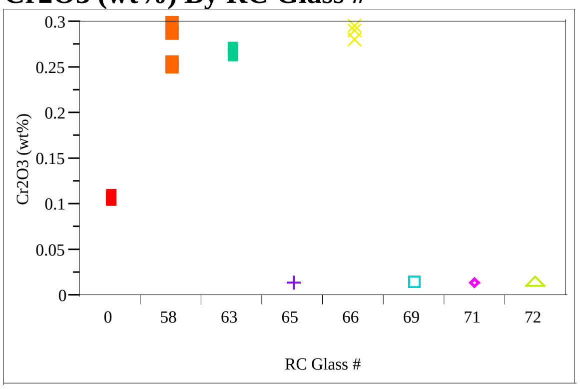
CaO (wt%) By RC Glass



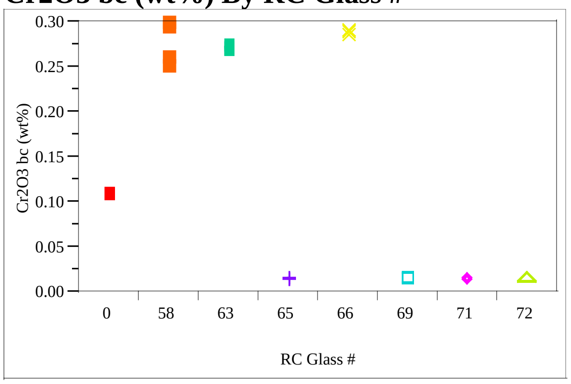
CaO bc (wt%) By RC Glass



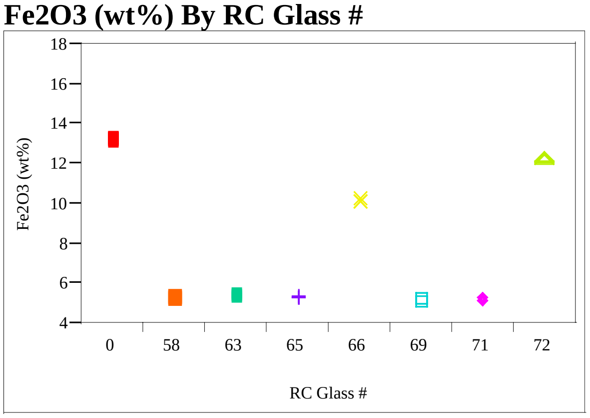
Cr2O3 (wt%) By RC Glass



Cr2O3 bc (wt%) By RC Glass



Fe2O3 (wt%) By RC Glass



Fe2O3 bc (wt%) By RC Glass

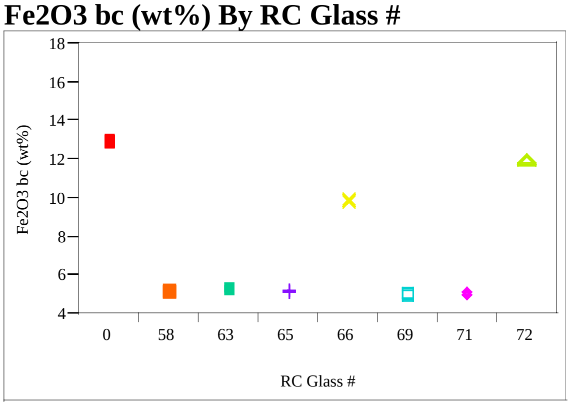
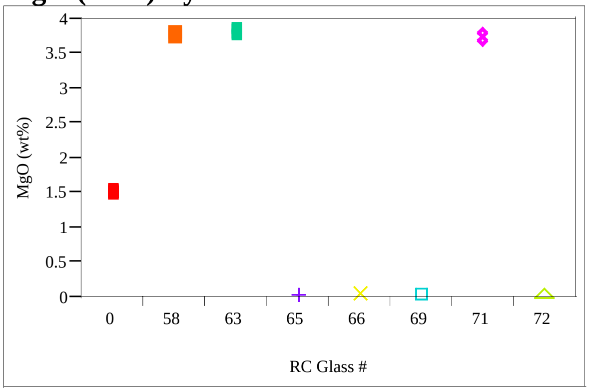
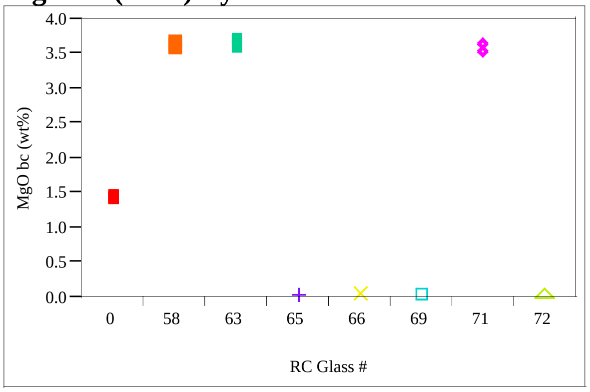


Exhibit A.9: SRTC-ML Measurements by Glass Number for Samples Prepared Using the LM Method for the Non-Radioactive Group *(continued)* (0 – Batch 1)

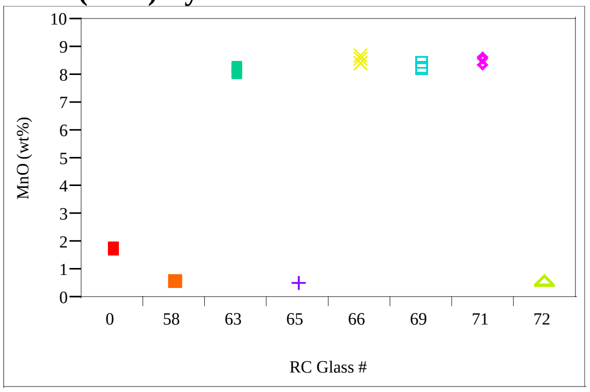
MgO (wt%) By RC Glass



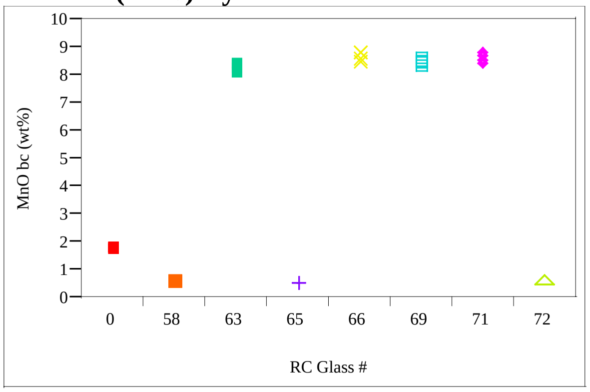
MgO bc (wt%) By RC Glass



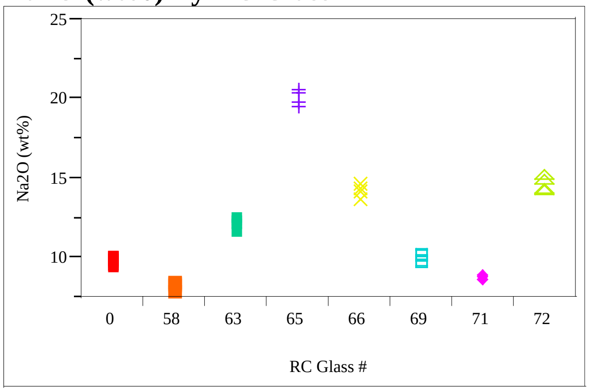
MnO (wt%) By RC Glass



MnO bc (wt%) By RC Glass



Na2O (wt%) By RC Glass



Na2O bc (wt%) By RC Glass

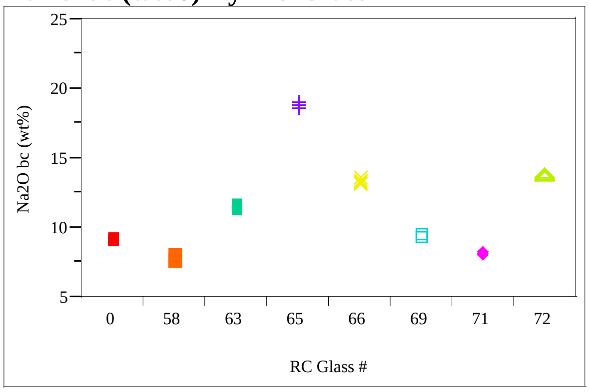
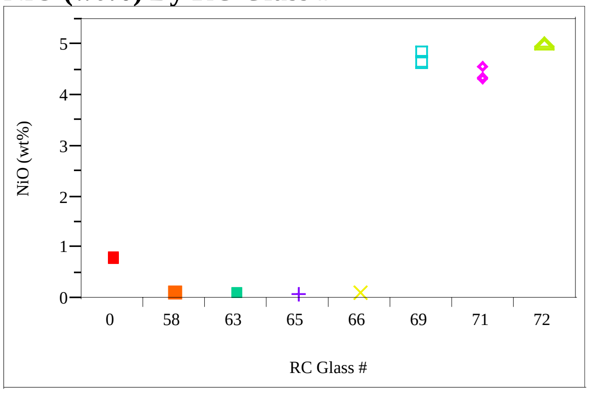
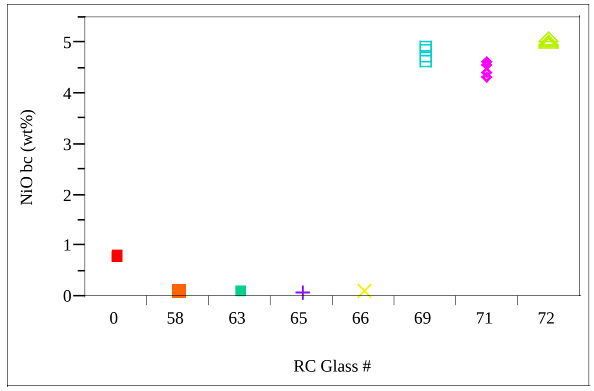


Exhibit A.9: SRTC-ML Measurements by Glass Number for Samples Prepared Using the LM Method for the Non-Radioactive Group *(continued)*
(0 – Batch 1)

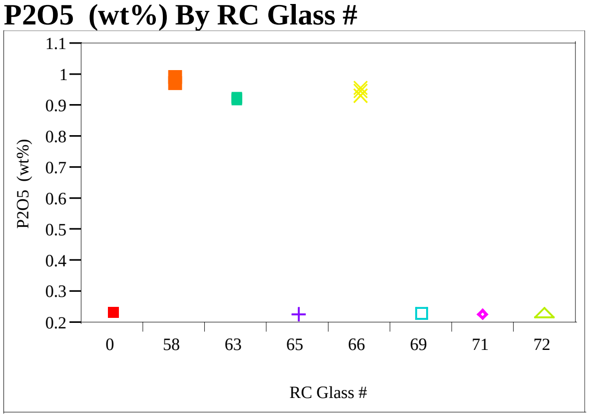
NiO (wt%) By RC Glass



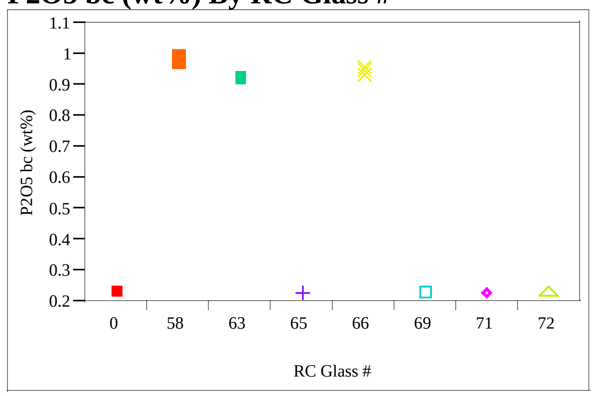
Oneway Analysis of NiO bc (wt%) By RC Glass



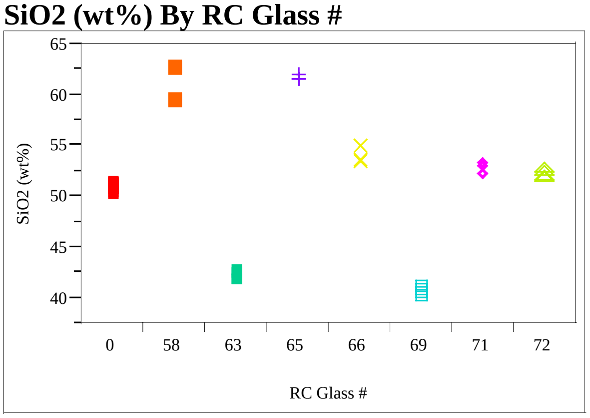
P2O5 (wt%) By RC Glass



P2O5 bc (wt%) By RC Glass



SiO2 (wt%) By RC Glass



SiO2 bc (wt%) By RC Glass

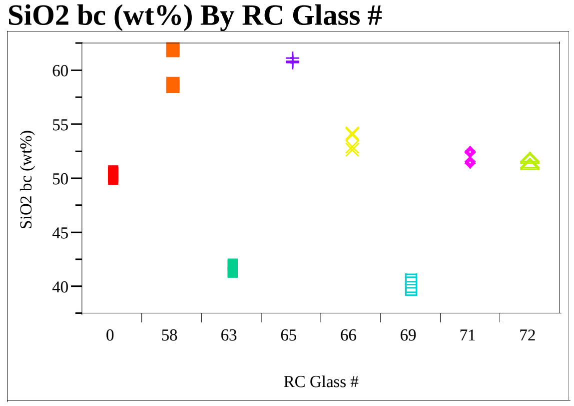
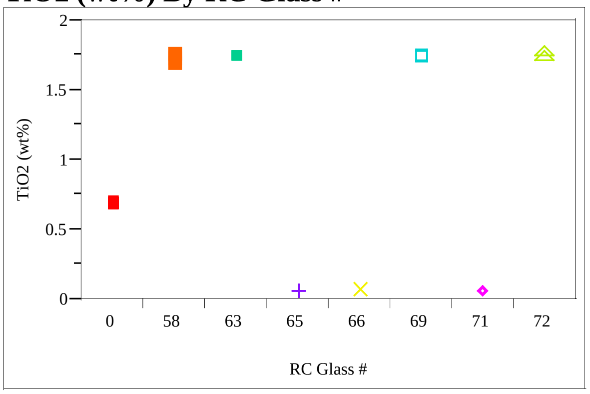
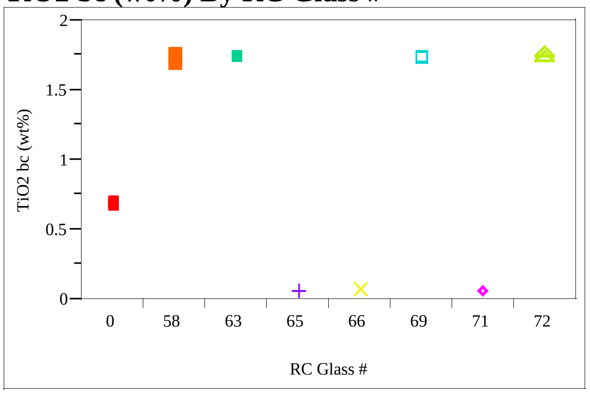


Exhibit A.9: SRTC-ML Measurements by Glass Number for Samples Prepared Using the LM Method for the Non-Radioactive Group *(continued)* (0 – Batch 1)

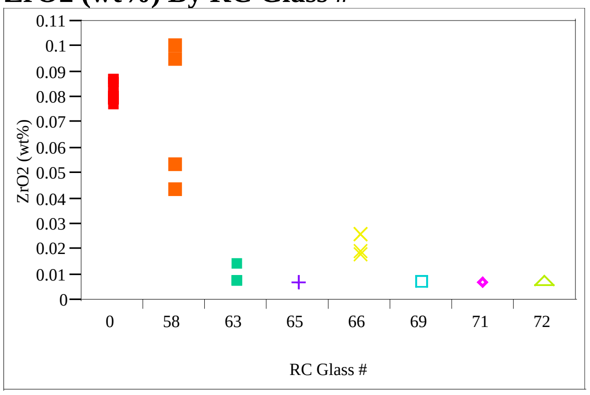
TiO2 (wt%) By RC Glass #



TiO2 bc (wt%) By RC Glass #



ZrO2 (wt%) By RC Glass #



ZrO2 bc (wt%) By RC Glass #

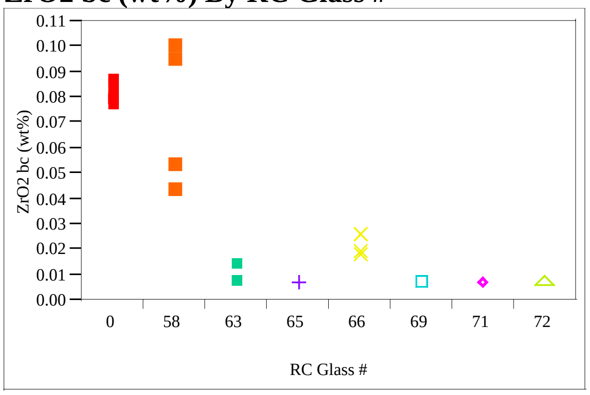
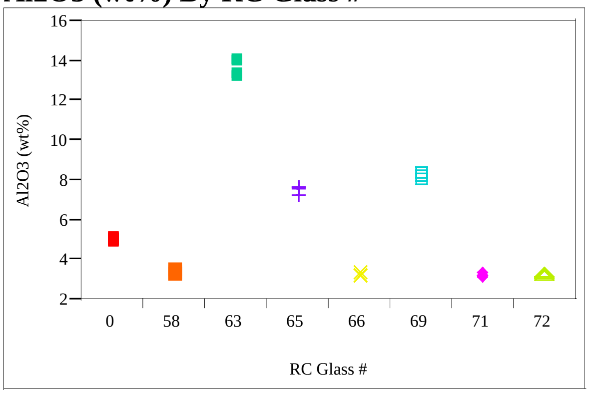
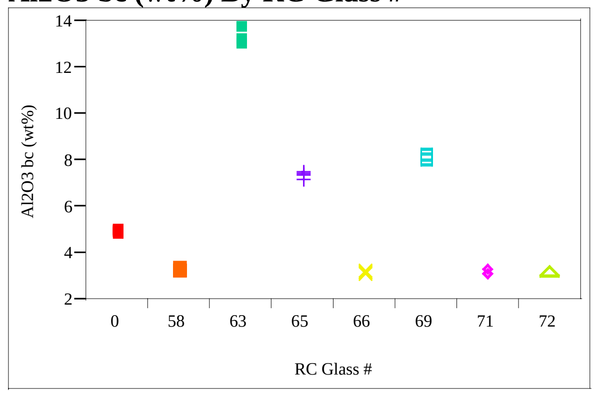


Exhibit A.10: SRTC-ML Measurements by Glass Number for Samples Prepared Using the PF Method for the Non-Radioactive Group (0 – Batch 1)

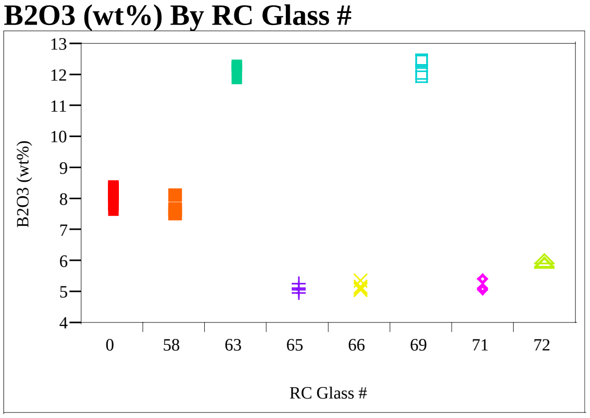
Al2O3 (wt%) By RC Glass



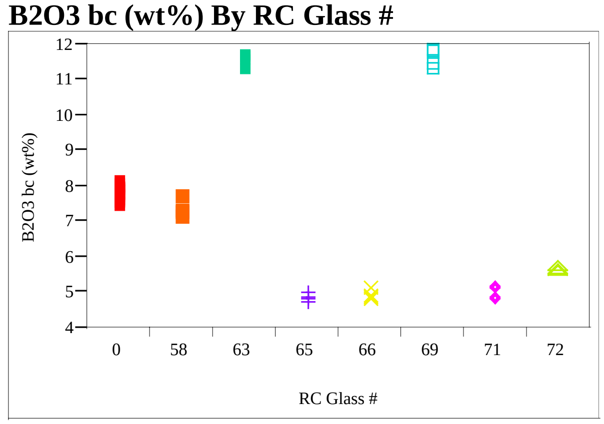
Al2O3 bc (wt%) By RC Glass



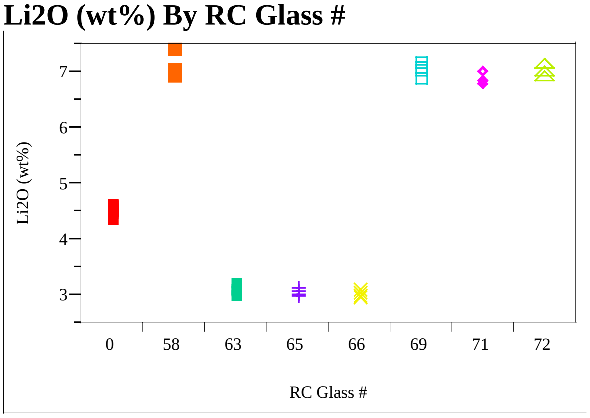
B2O3 (wt%) By RC Glass



B2O3 bc (wt%) By RC Glass



Li2O (wt%) By RC Glass



Li2O bc (wt%) By RC Glass

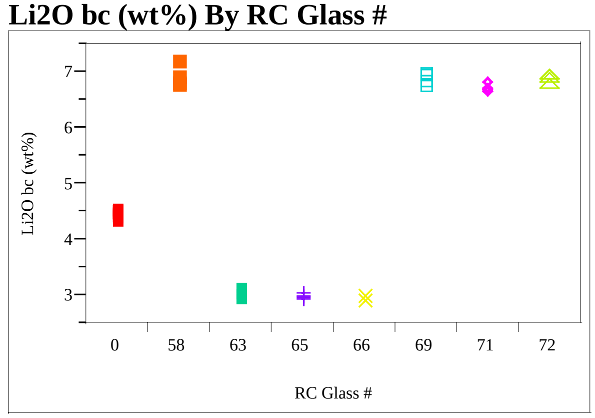
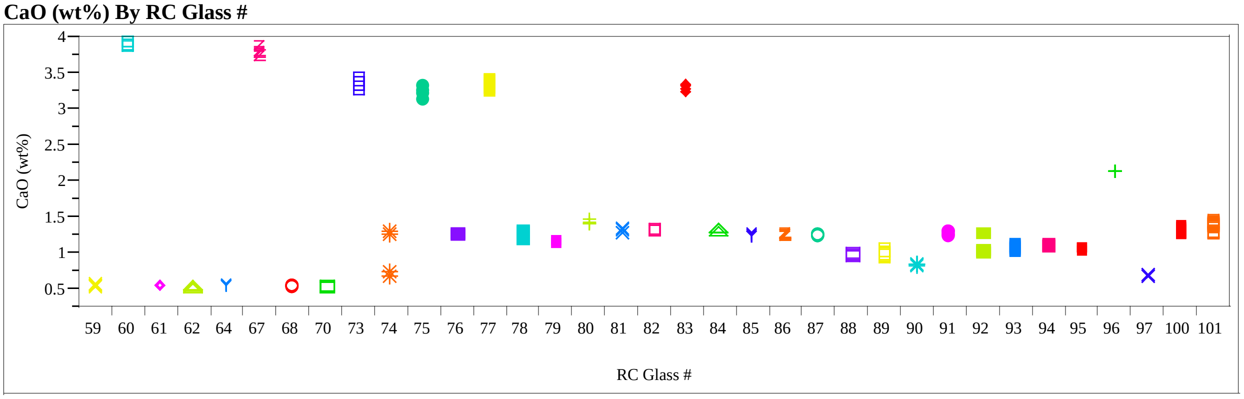
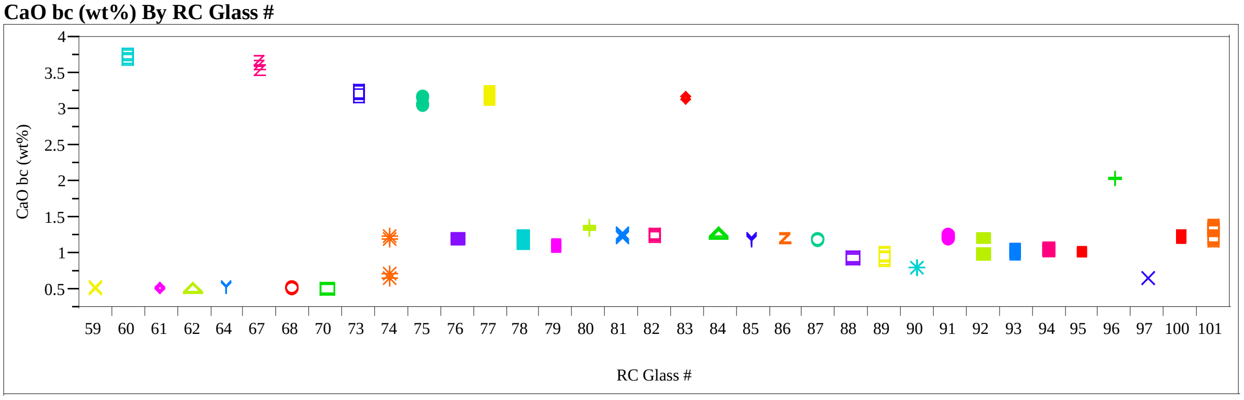


Exhibit A.11: SRTC-ML Measurements by Glass Number for Samples Prepared Using the LM Method for the Radioactive Group (100 – Batch 1; 101 – U std)

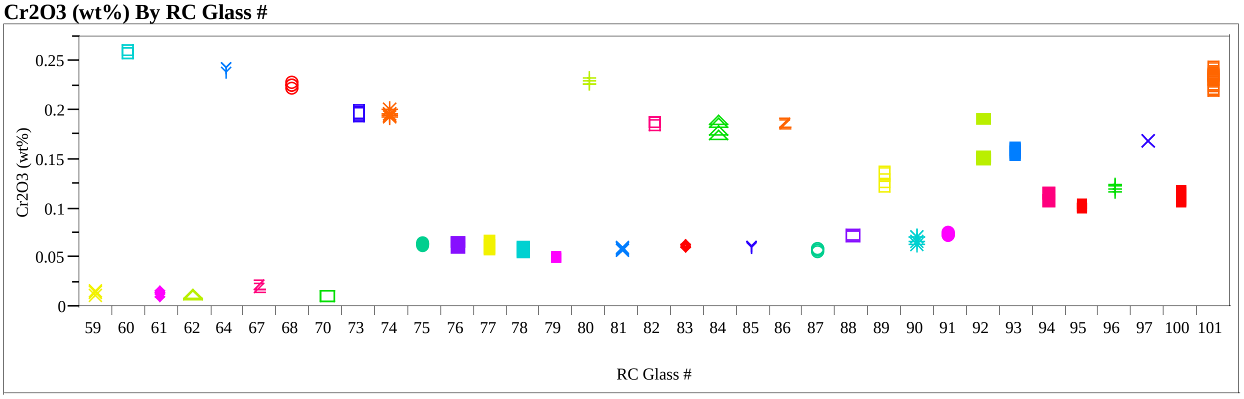
CaO (wt%) By RC Glass #



CaO bc (wt%) By RC Glass #



Cr2O3 (wt%) By RC Glass #



Cr2O3 bc (wt%) By RC Glass #

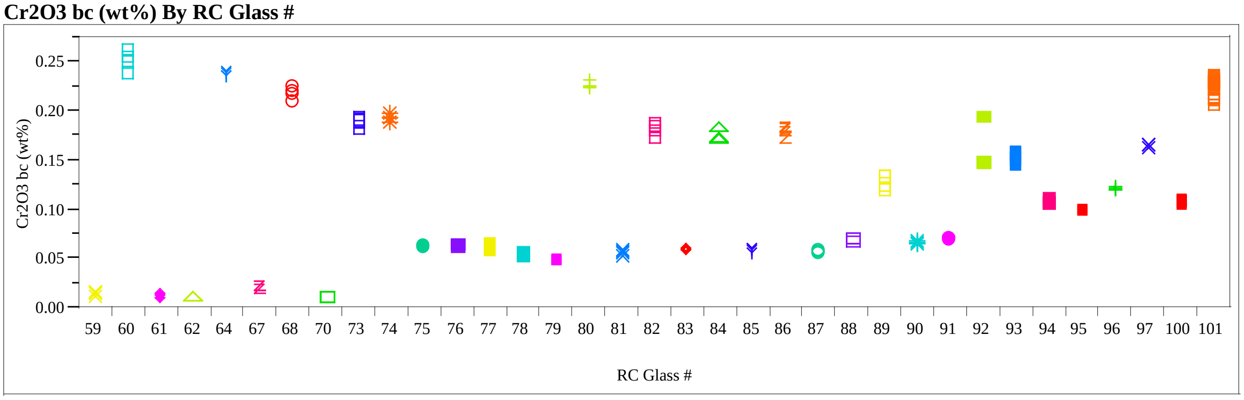
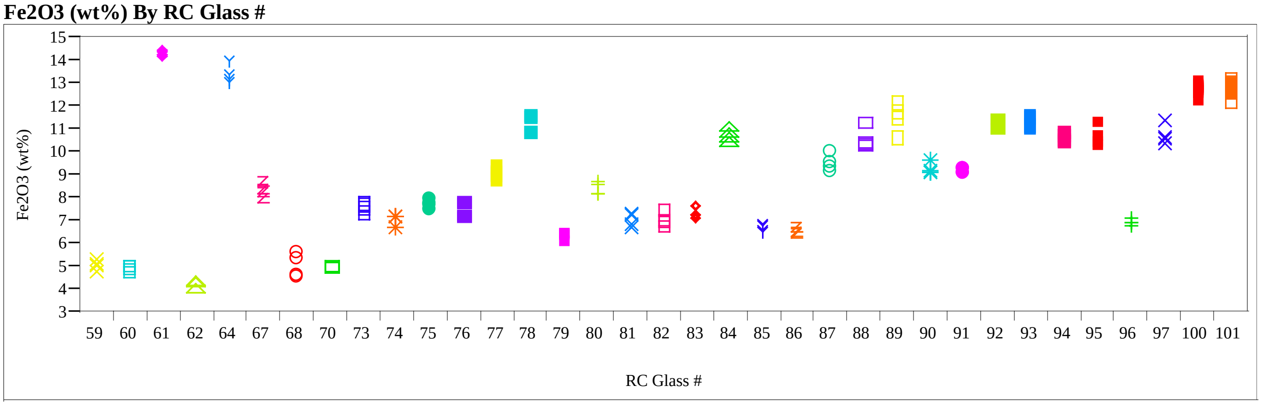
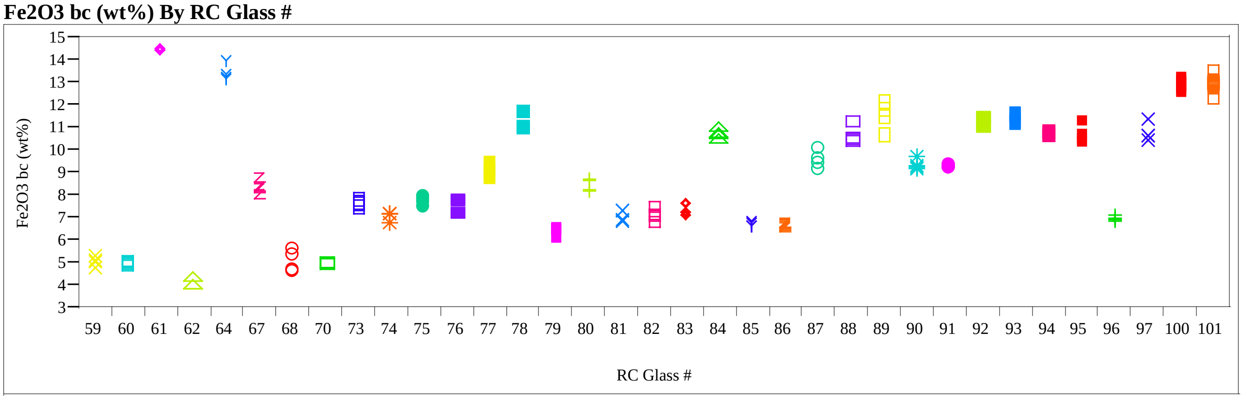


Exhibit A.11: SRTC-ML Measurements by Glass Number for Samples Prepared Using the LM Method for the Radioactive Group *(continued)* (100 – Batch 1; 101 – U std)

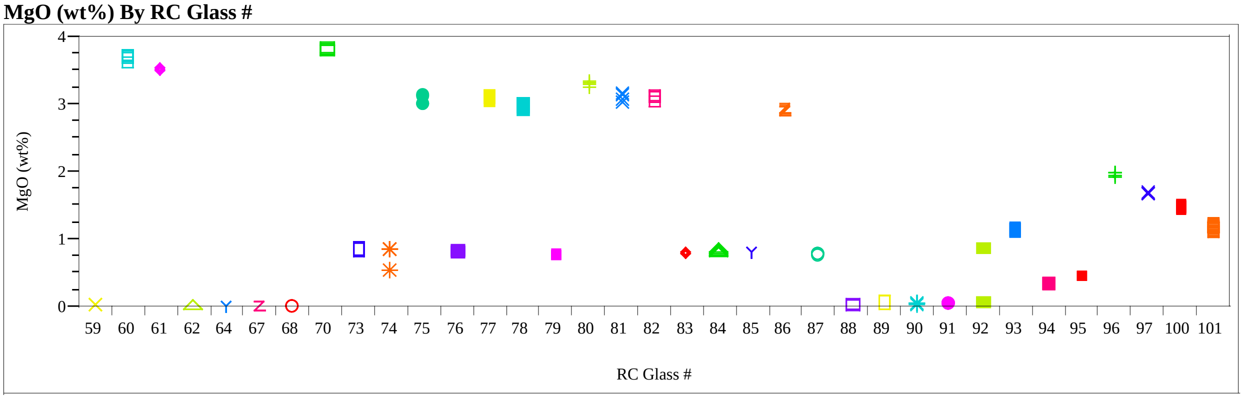
Fe2O3 (wt%) By RC Glass #



Fe2O3 bc (wt%) By RC Glass #



MgO (wt%) By RC Glass #



MgO bc (wt%) By RC Glass #

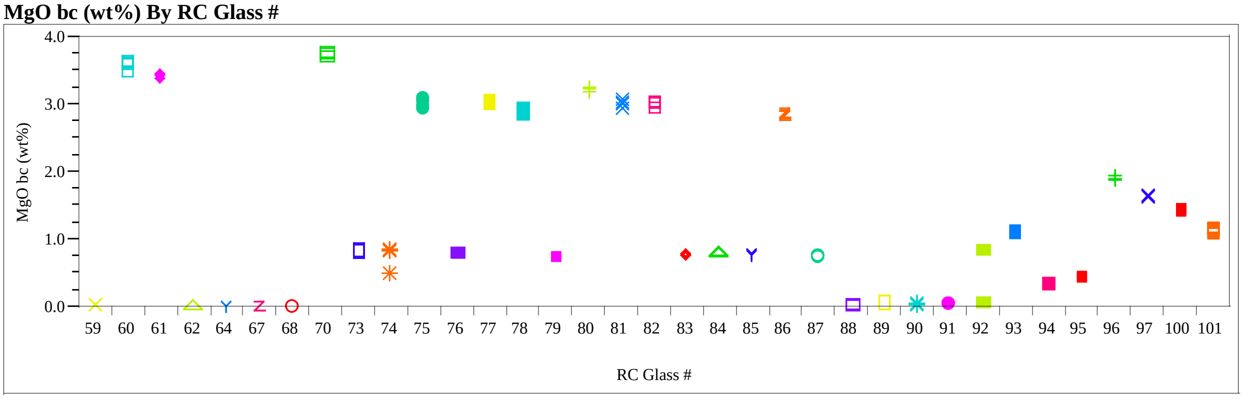
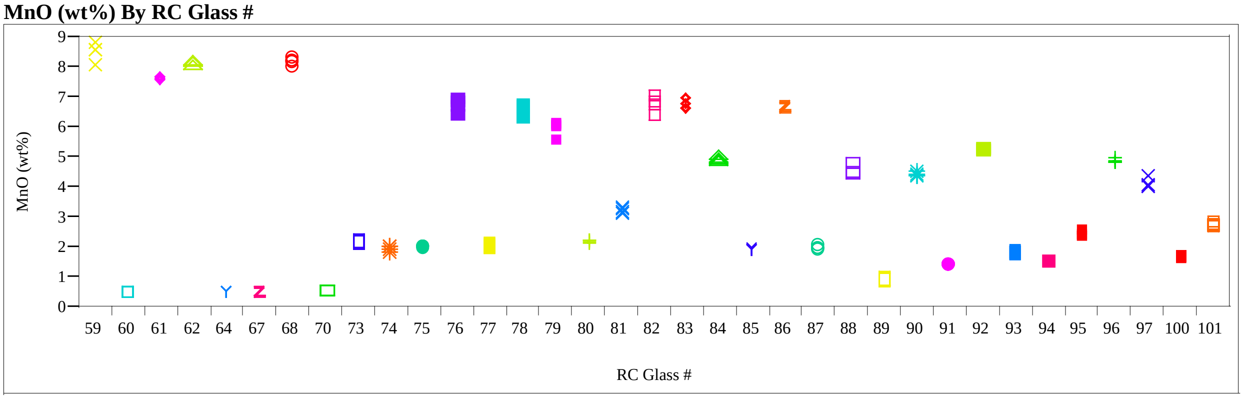
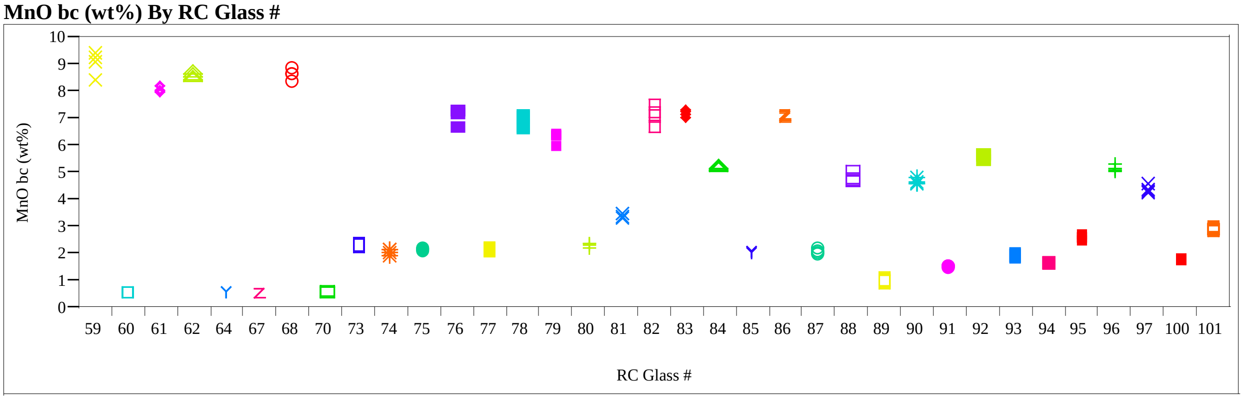


Exhibit A.11: SRTC-ML Measurements by Glass Number for Samples Prepared Using the LM Method for the Radioactive Group *(continued)*
(100 – Batch 1; 101 – U std)

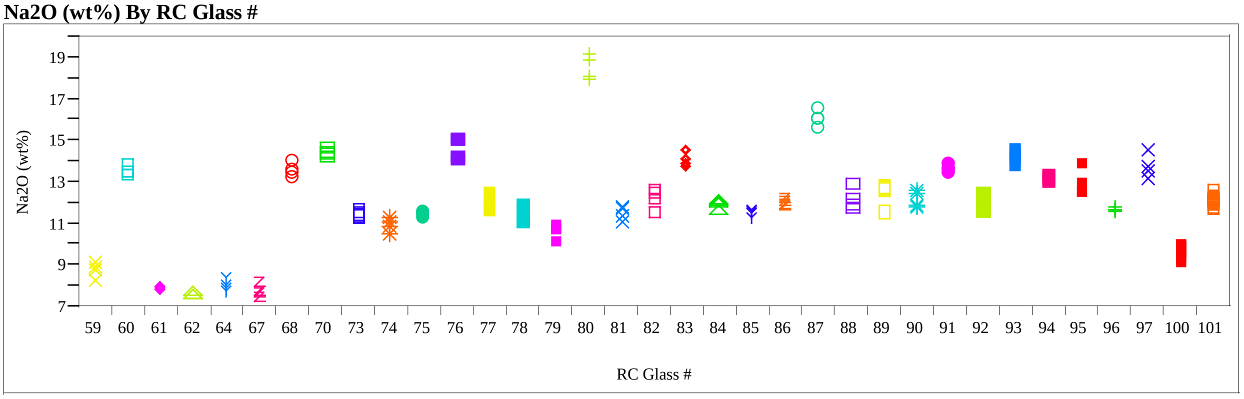
MnO (wt%) By RC Glass #



MnO bc (wt%) By RC Glass #



Na2O (wt%) By RC Glass #



Na2O bc (wt%) By RC Glass #

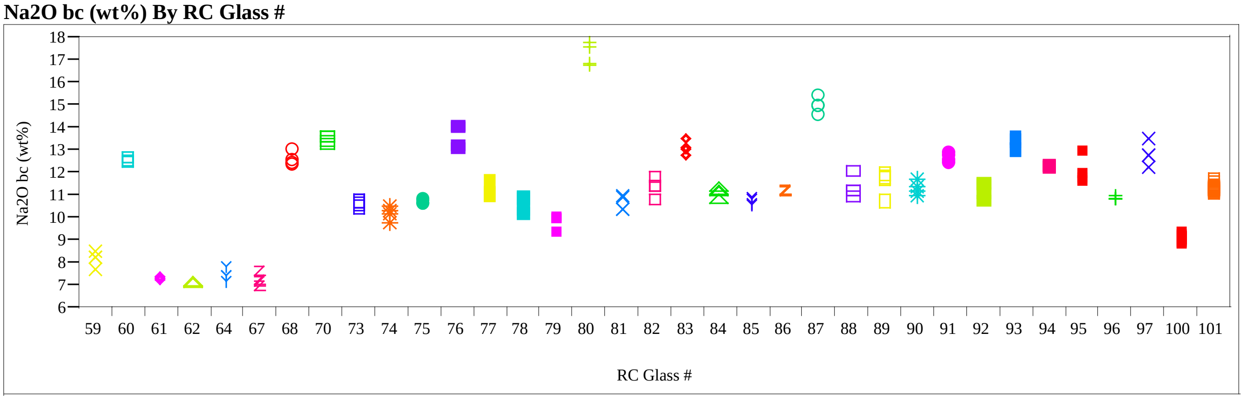
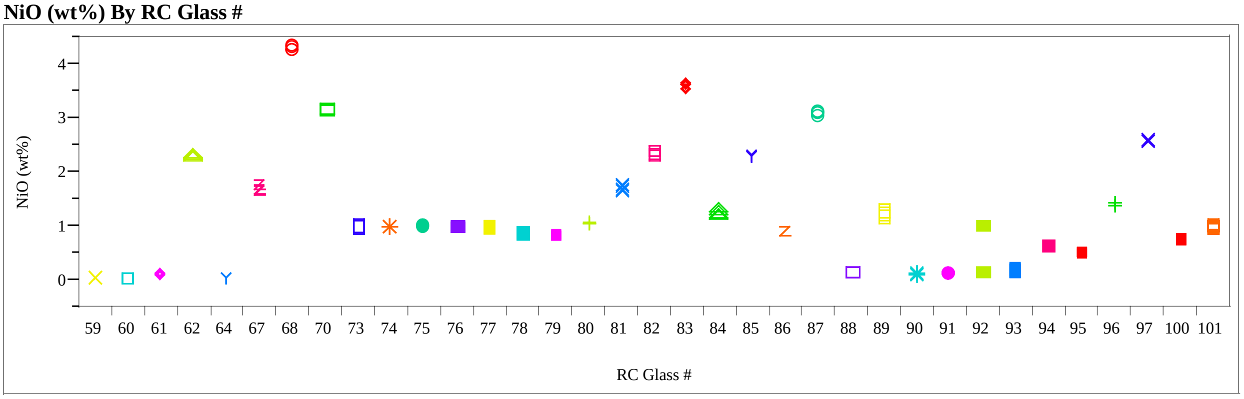
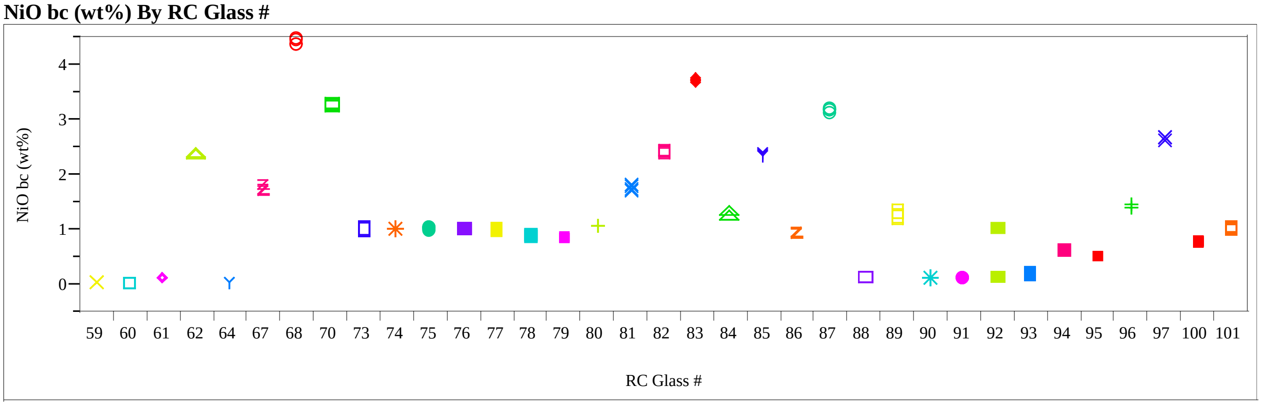


Exhibit A.11: SRTC-ML Measurements by Glass Number for Samples Prepared Using the LM Method for the Radioactive Group *(continued)* (100 – Batch 1; 101 – U std)

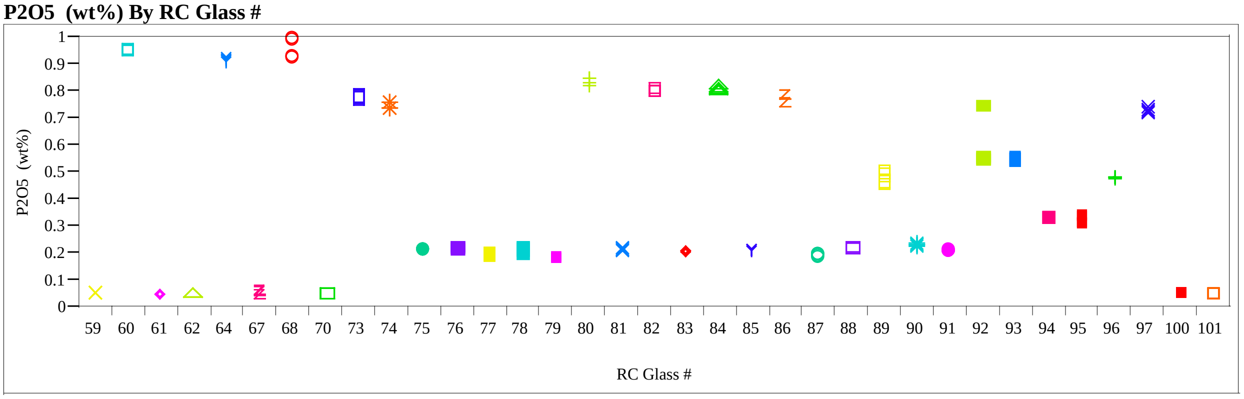
NiO (wt%) By RC Glass #



NiO bc (wt%) By RC Glass #



P2O5 (wt%) By RC Glass #



P2O5 bc (wt%) By RC Glass #

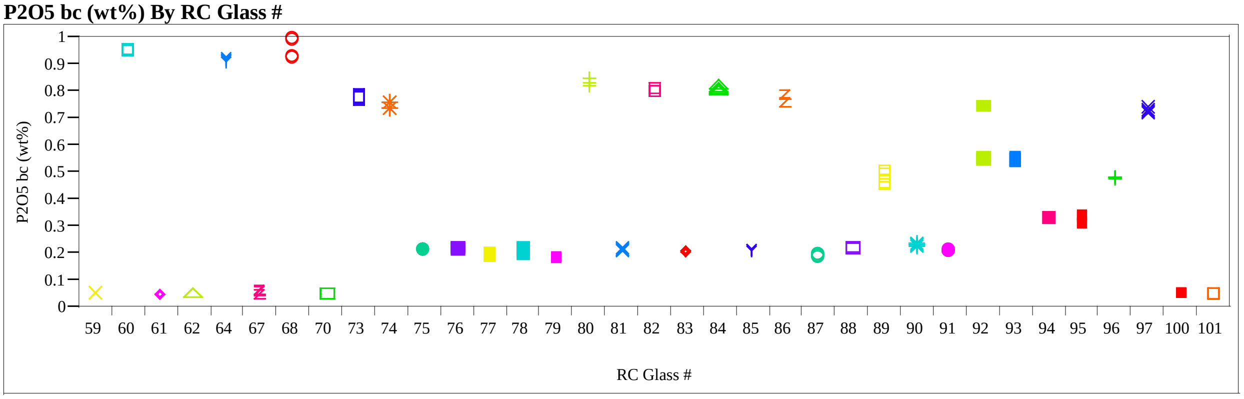
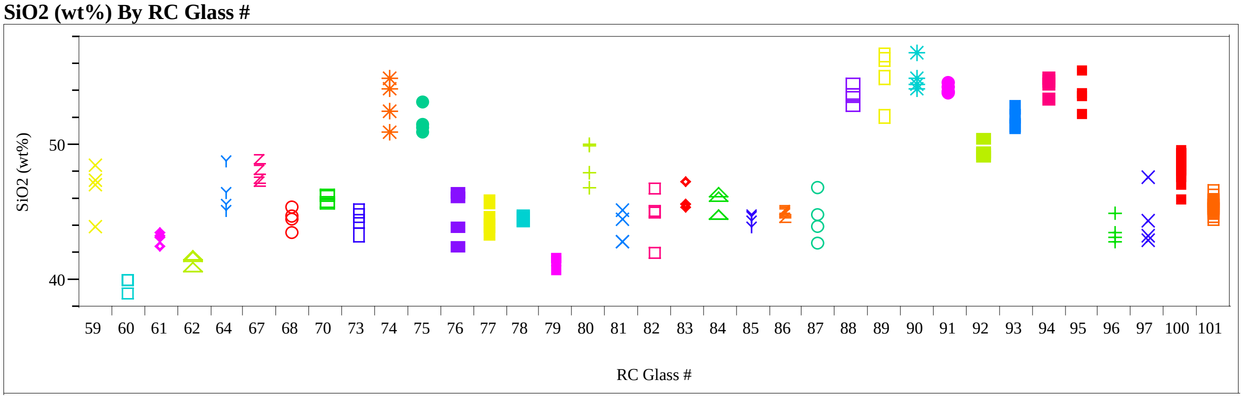
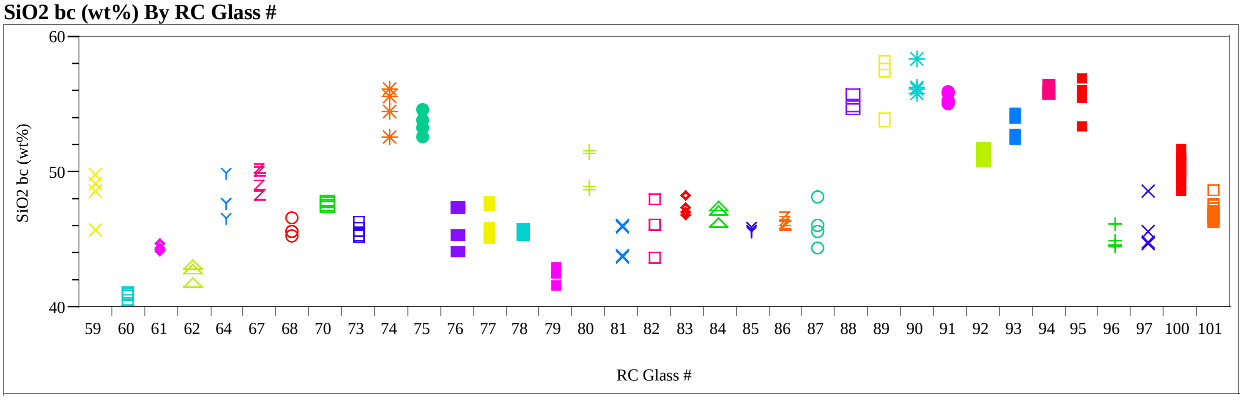


Exhibit A.11: SRTC-ML Measurements by Glass Number for Samples Prepared Using the LM Method for the Radioactive Group *(continued)* (100 – Batch 1; 101 – U std)

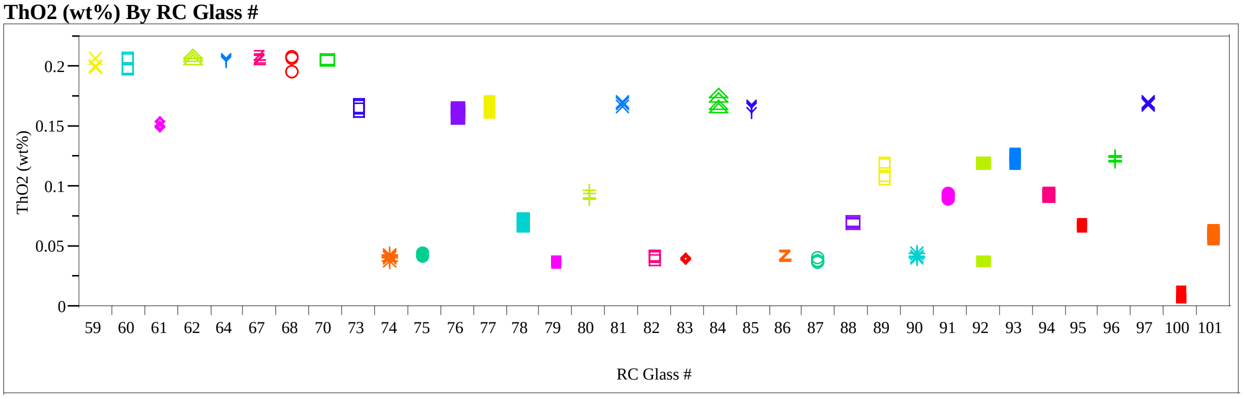
SiO2 (wt%) By RC Glass #



SiO2 bc (wt%) By RC Glass #



ThO2 (wt%) By RC Glass #



ThO2 bc (wt%) By RC Glass #

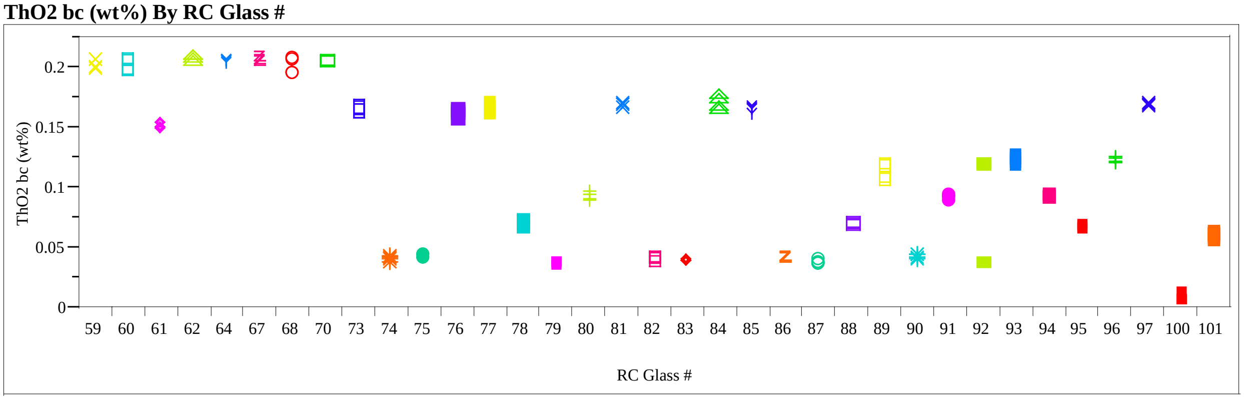
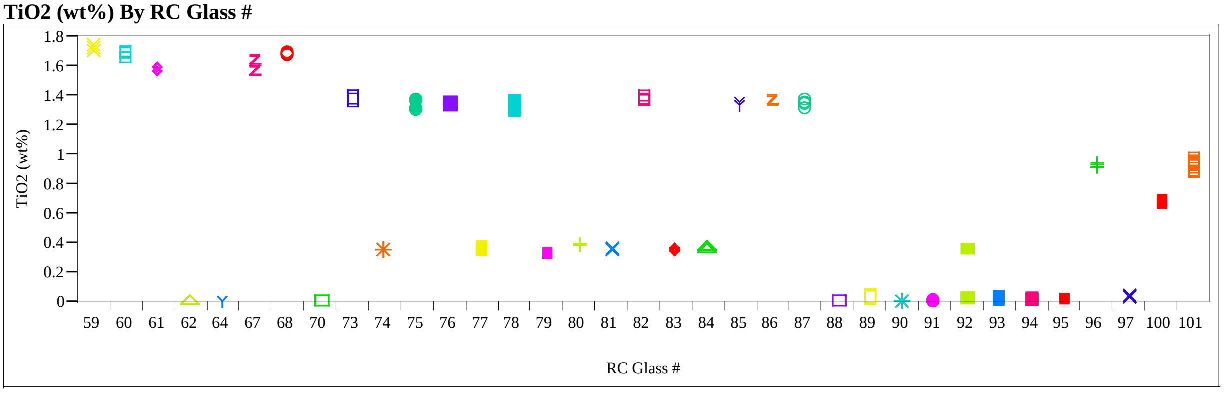
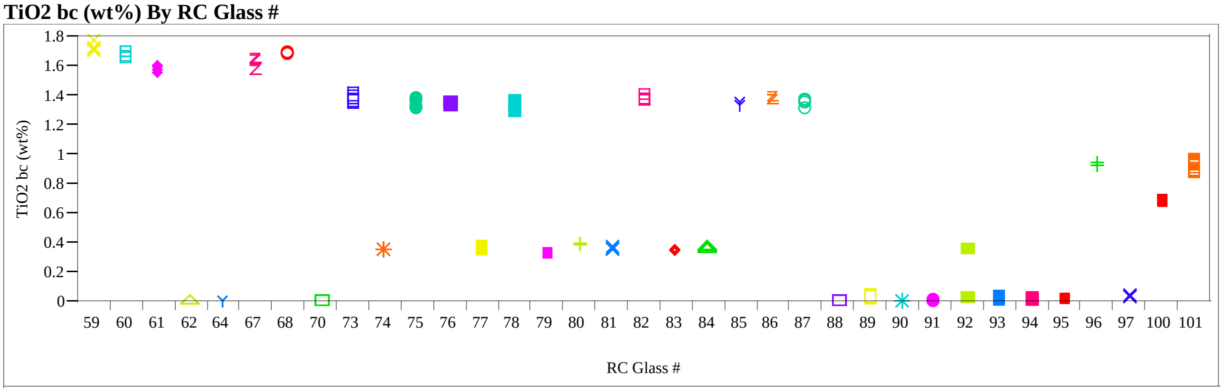


Exhibit A.11: SRTC-ML Measurements by Glass Number for Samples Prepared Using the LM Method for the Radioactive Group *(continued)* (100 – Batch 1; 101 – U std)

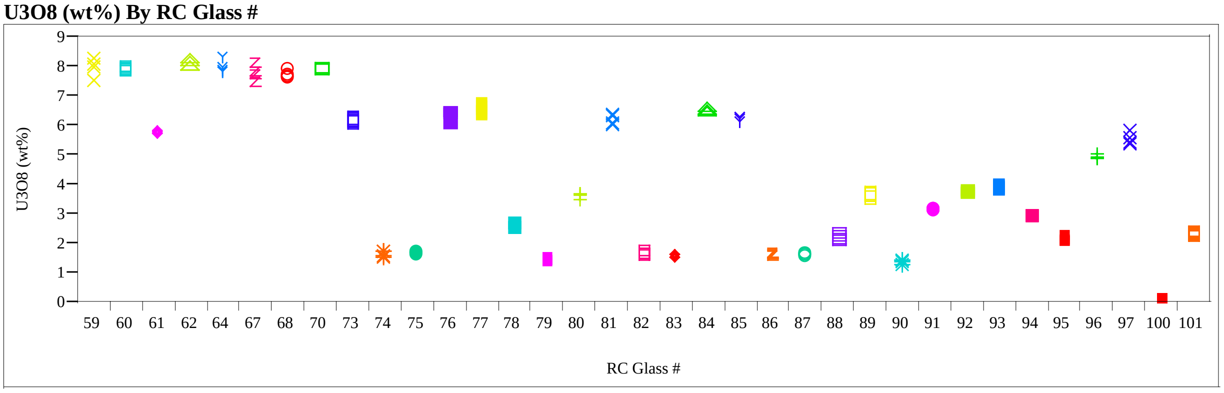
TiO2 (wt%) By RC Glass #



TiO2 bc (wt%) By RC Glass #



U3O8 (wt%) By RC Glass #



U3O8 bc (wt%) By RC Glass #

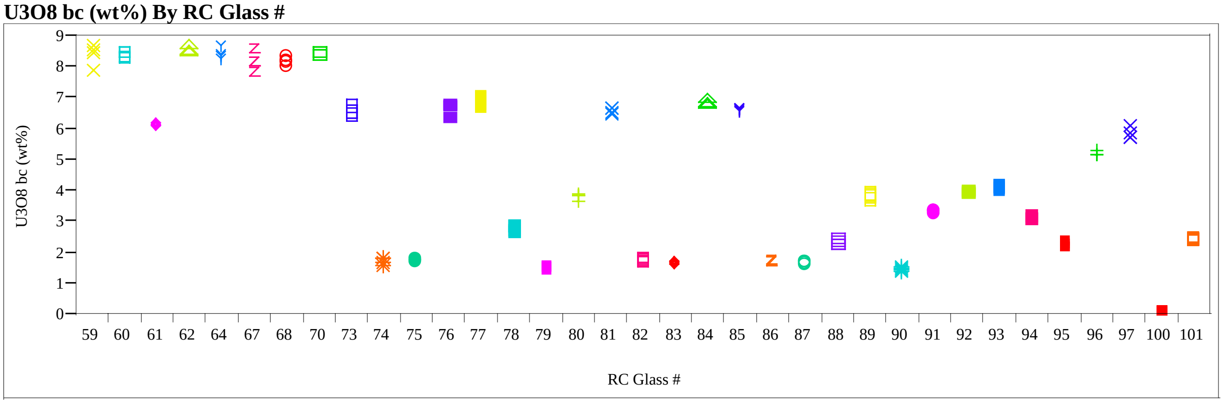
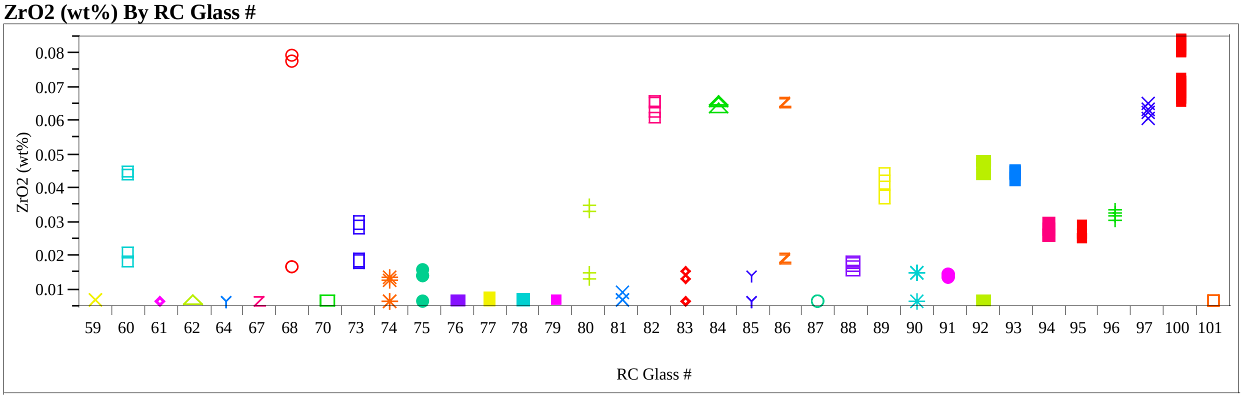


Exhibit A.11: SRTC-ML Measurements by Glass Number for Samples Prepared Using the LM Method for the Radioactive Group *(continued)* (100 – Batch 1; 101 – U std)

ZrO2 (wt%) By RC Glass #



ZrO2 bc (wt%) By RC Glass #

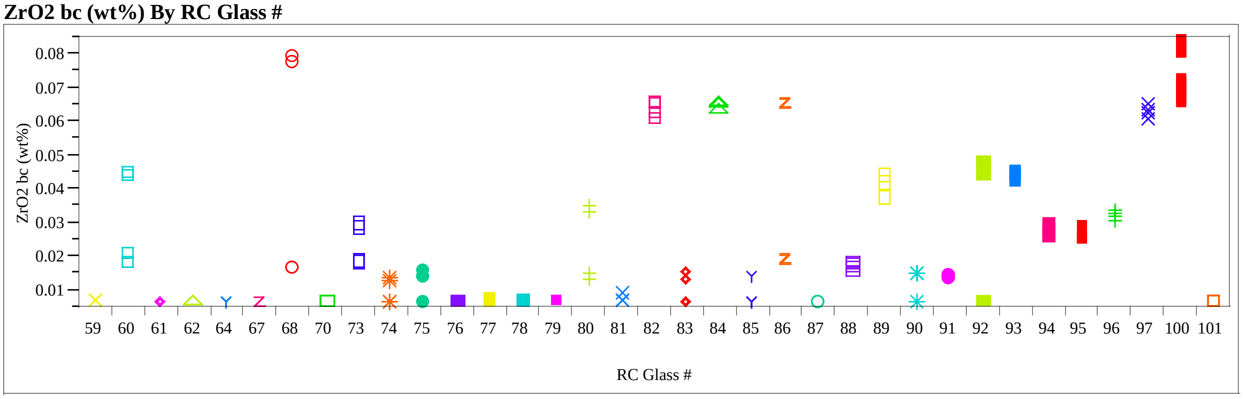
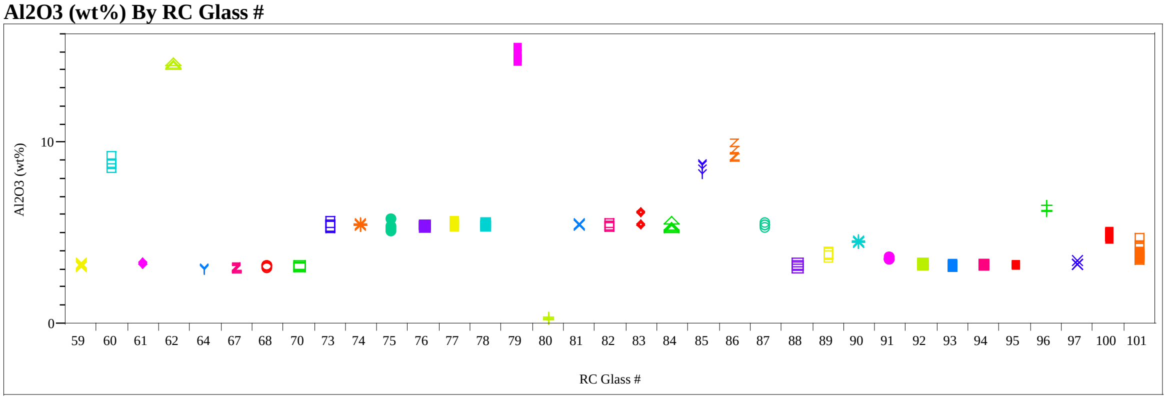
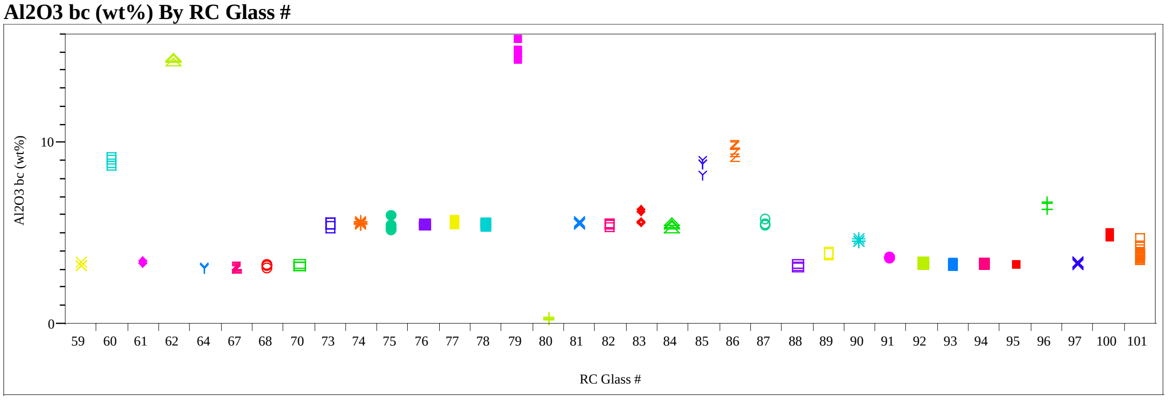


Exhibit A.12: SRTC-ML Measurements by Glass Number for Samples Prepared Using the PF Method for the Radioactive Group (100 – Batch 1; 101 – U std)

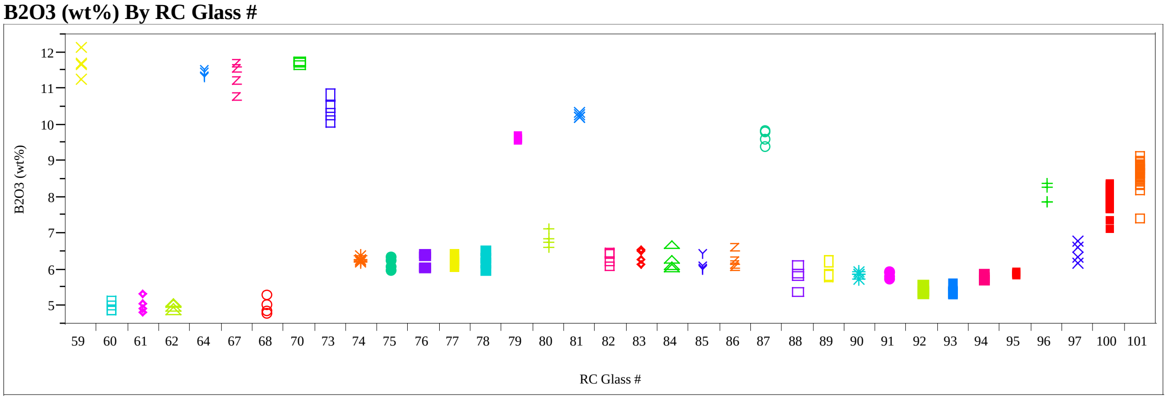
Al2O3 (wt%) By RC Glass #



Al2O3 bc (wt%) By RC Glass #



B2O3 (wt%) By RC Glass #



B2O3 bc (wt%) By RC Glass #

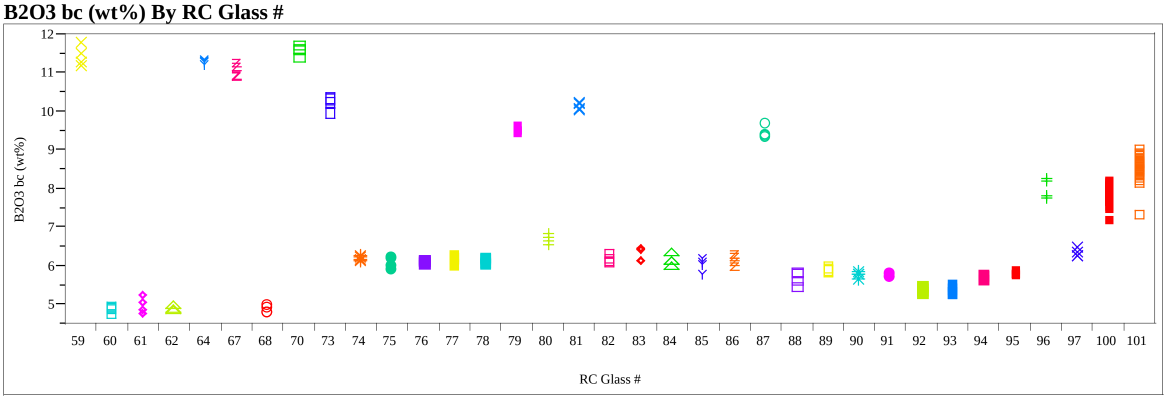
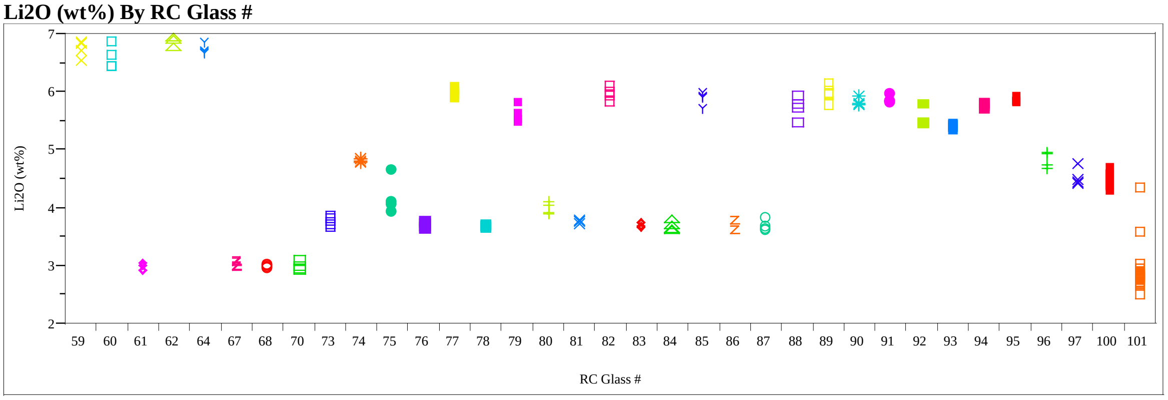


Exhibit A.12: SRTC-ML Measurements by Glass Number for Samples Prepared Using the PF Method for the Radioactive Group *(continued)*
(100 – Batch 1; 101 – U std)

Li2O (wt%) By RC Glass #



Li2O bc (wt%) By RC Glass #

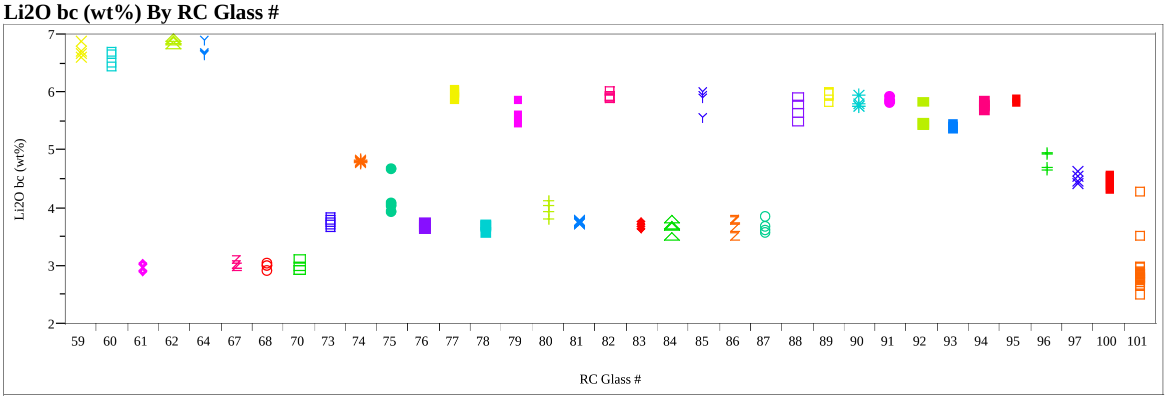
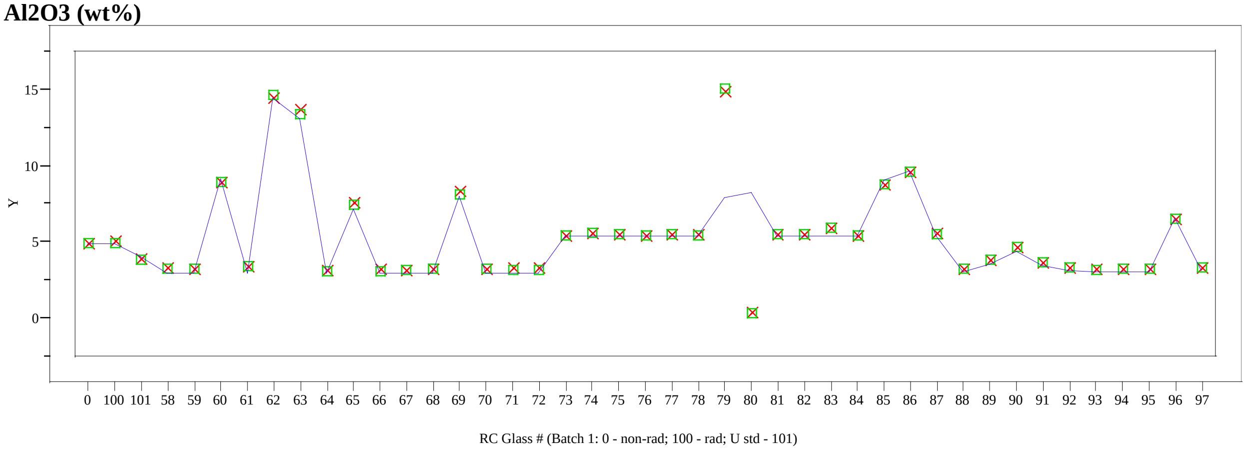
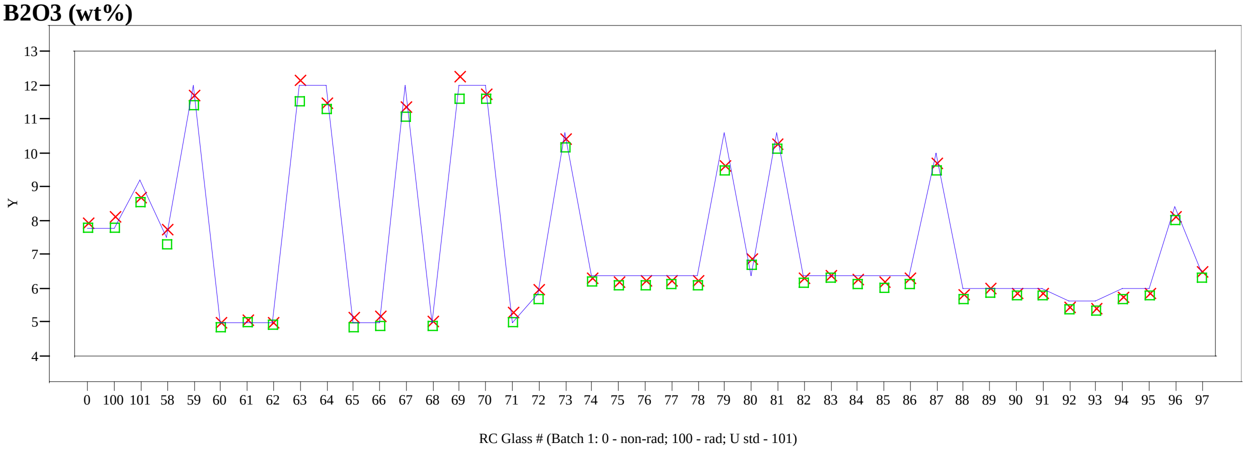


Exhibit A.13: Average Measured and Bias-Corrected (bc) Versus Targeted Compositions by RC Glass #by Oxide
(0 – Batch 1 non-rad group; 100 – Batch 1 rad group; and 101 – U std)

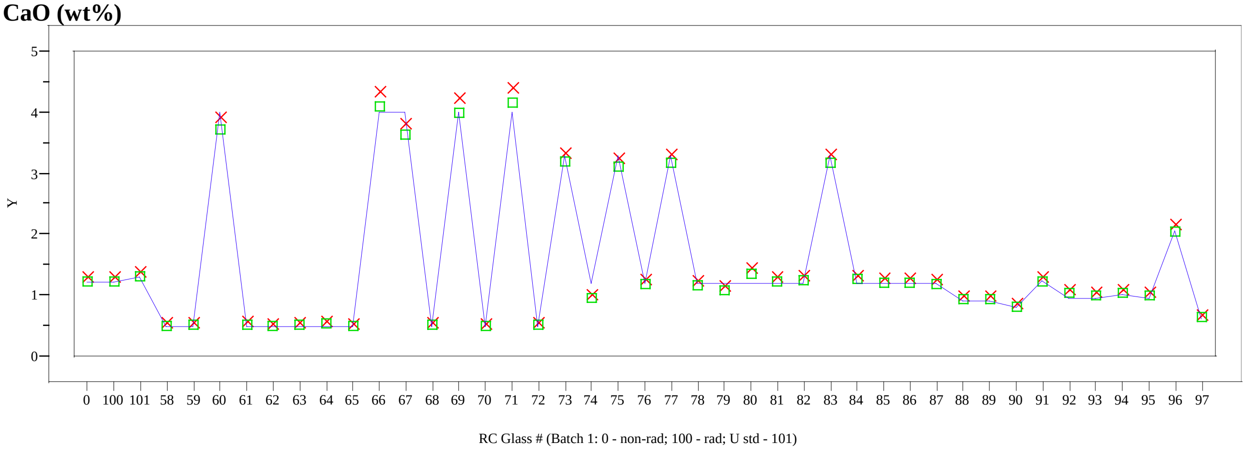
Al2O3 (wt%)



B2O3 (wt%)



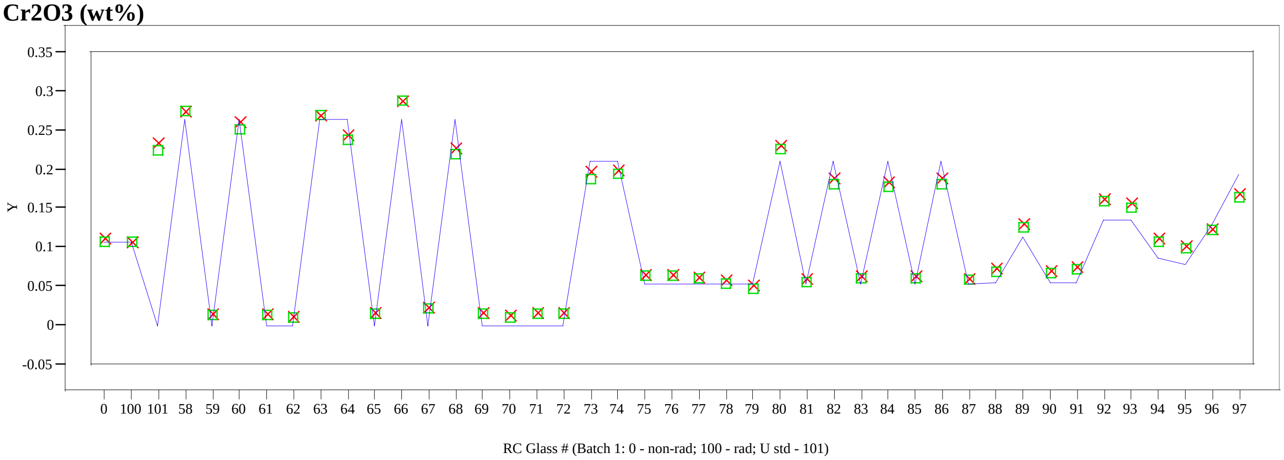
CaO (wt%)



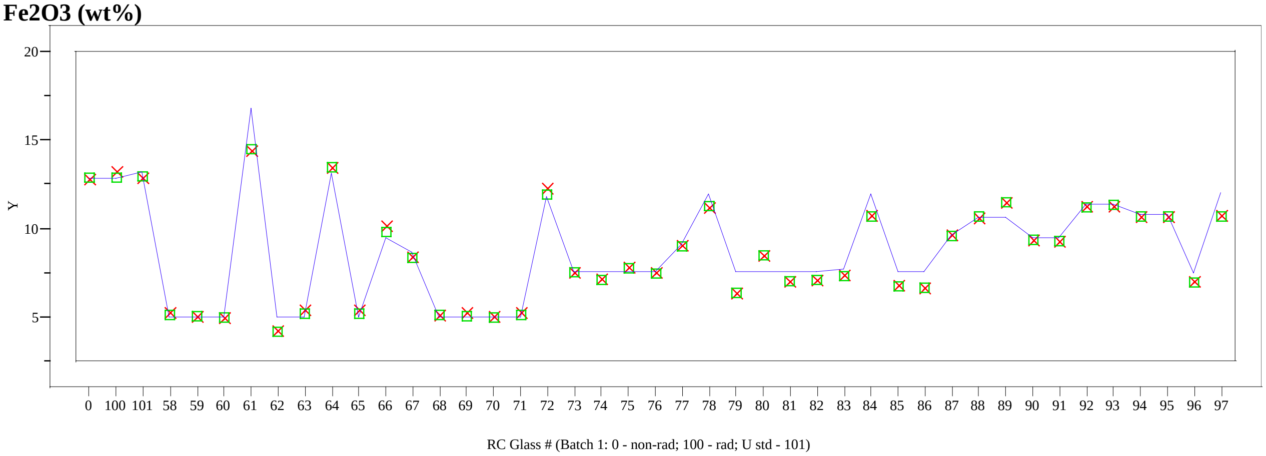
Y × Measured ▫ Measured bc — Targeted

Exhibit A.13: Average Measured and Bias-Corrected (bc) Versus Targeted Compositions by RC Glass #by Oxide *(continued)*
(0 – Batch 1 non-rad group; 100 – Batch 1 rad group; and 101 – U std)

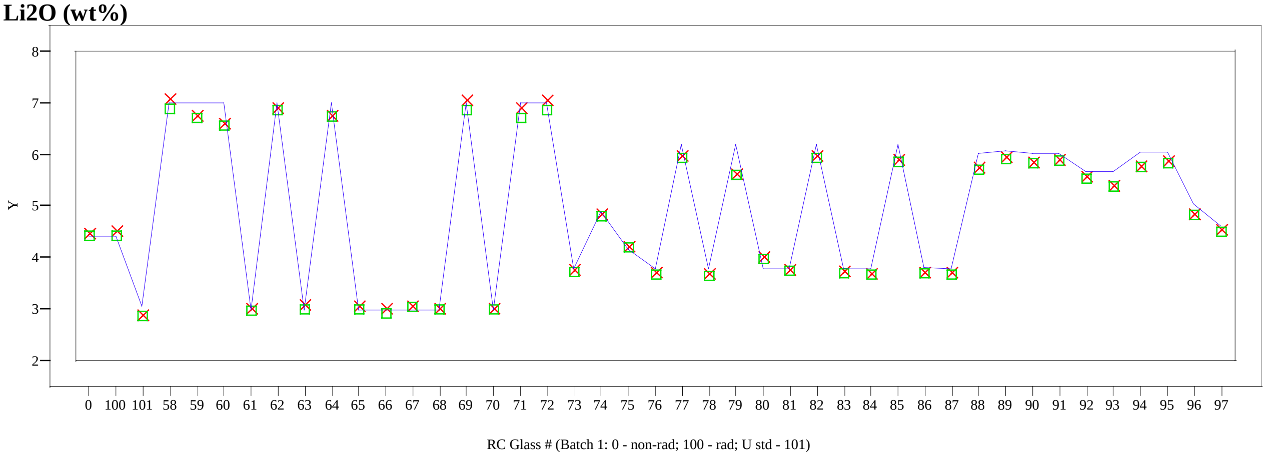
Cr2O3 (wt%)



Fe2O3 (wt%)



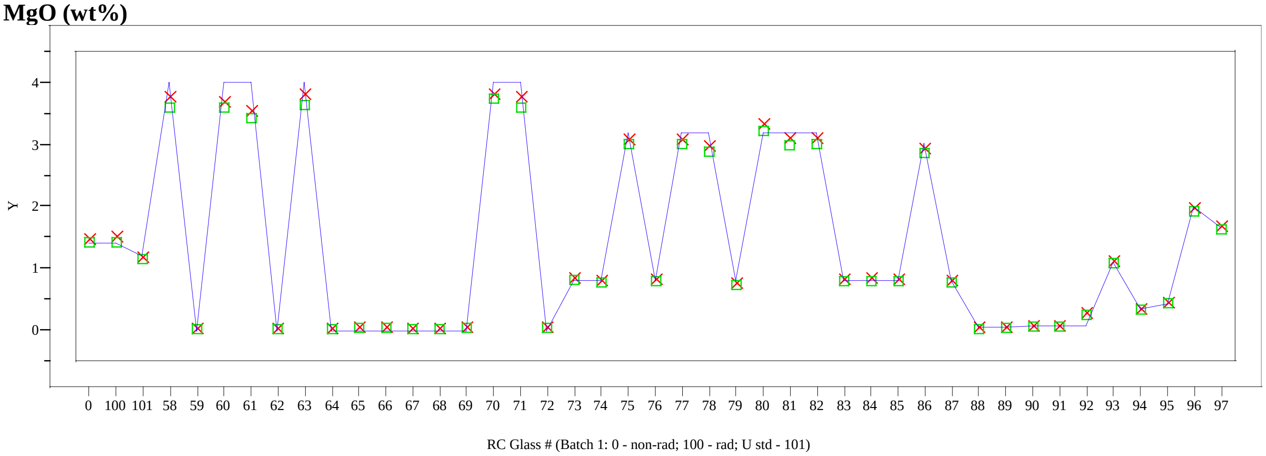
Li2O (wt%)



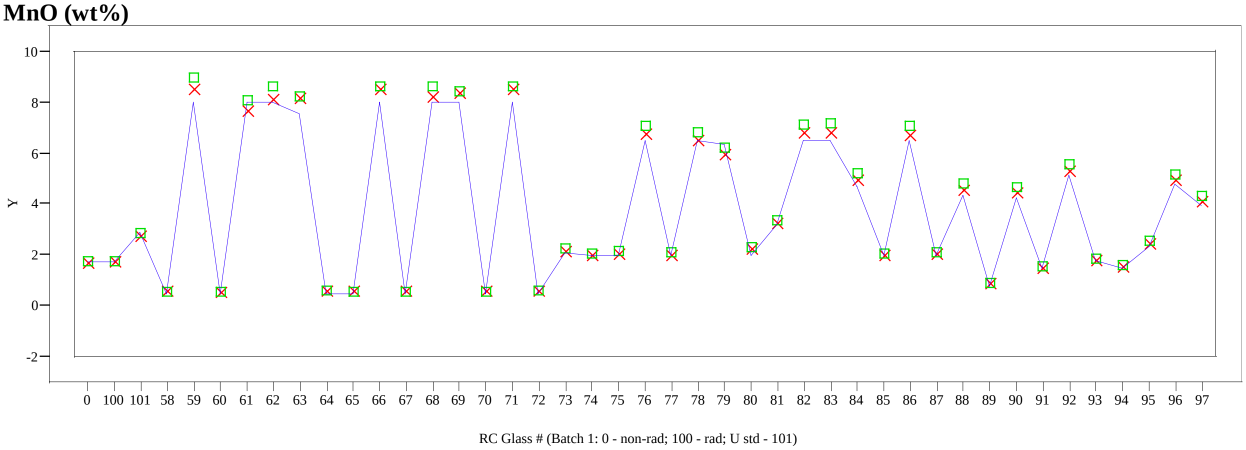
Y × Measured ▫ Measured bc — Targeted

Exhibit A.13: Average Measured and Bias-Corrected (bc) Versus Targeted Compositions by RC Glass #by Oxide *(continued)*
(0 – Batch 1 non-rad group; 100 – Batch 1 rad group; and 101 – U std)

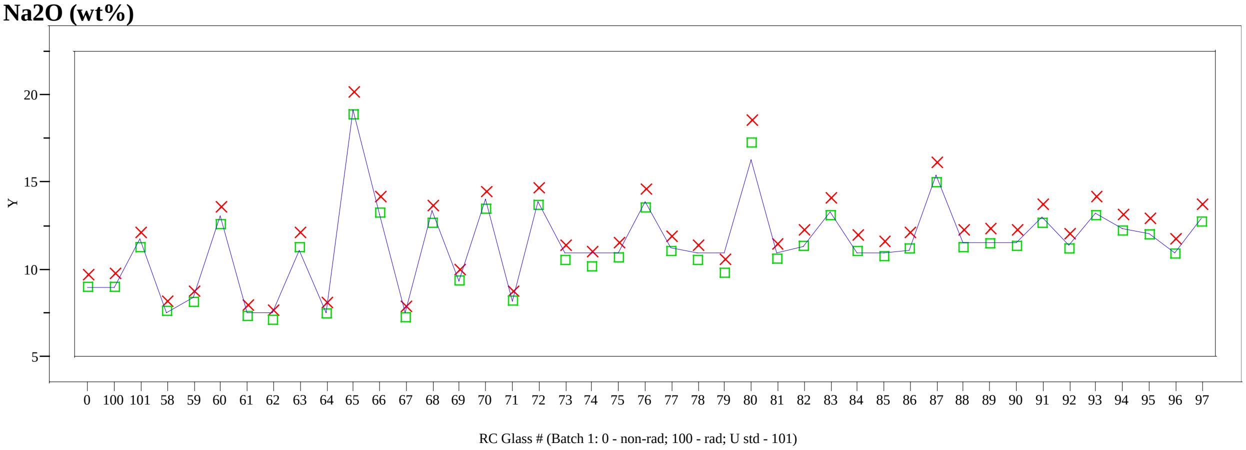
MgO (wt%)



MnO (wt%)



Na2O (wt%)

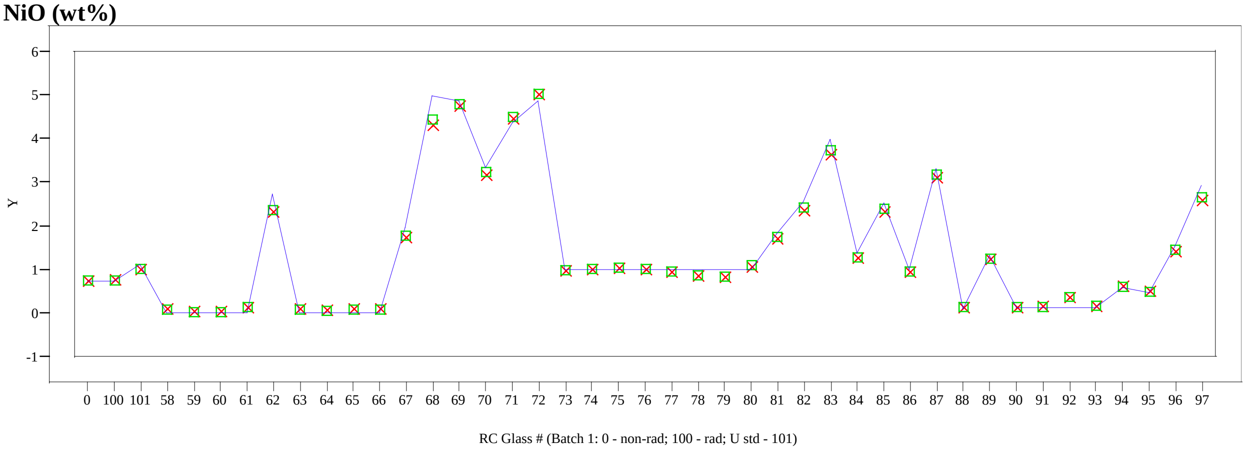


Y ✕ Measured ▫ Measured bc — Targeted

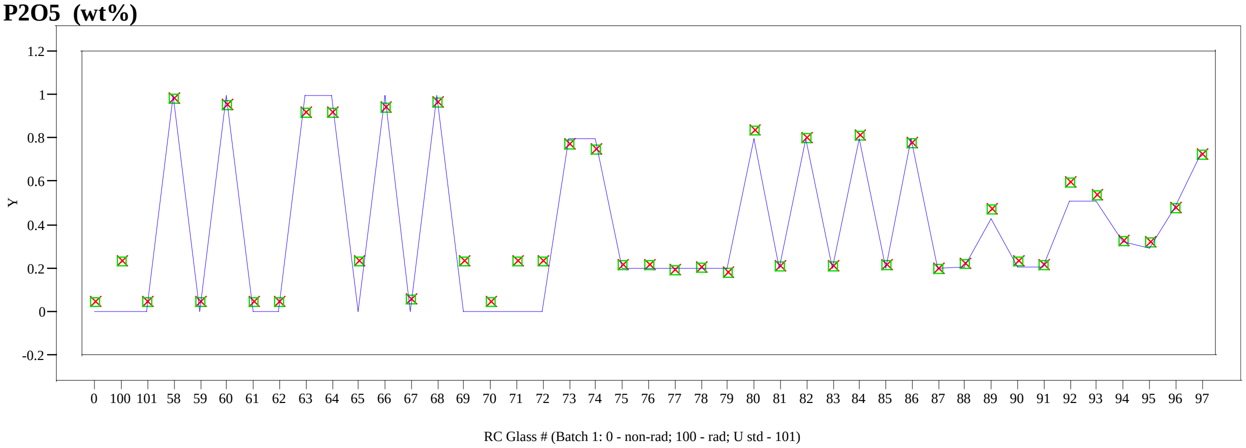
Exhibit A.13: Average Measured and Bias-Corrected (bc) Versus Targeted Compositions by RC Glass #by Oxide *(continued)*

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

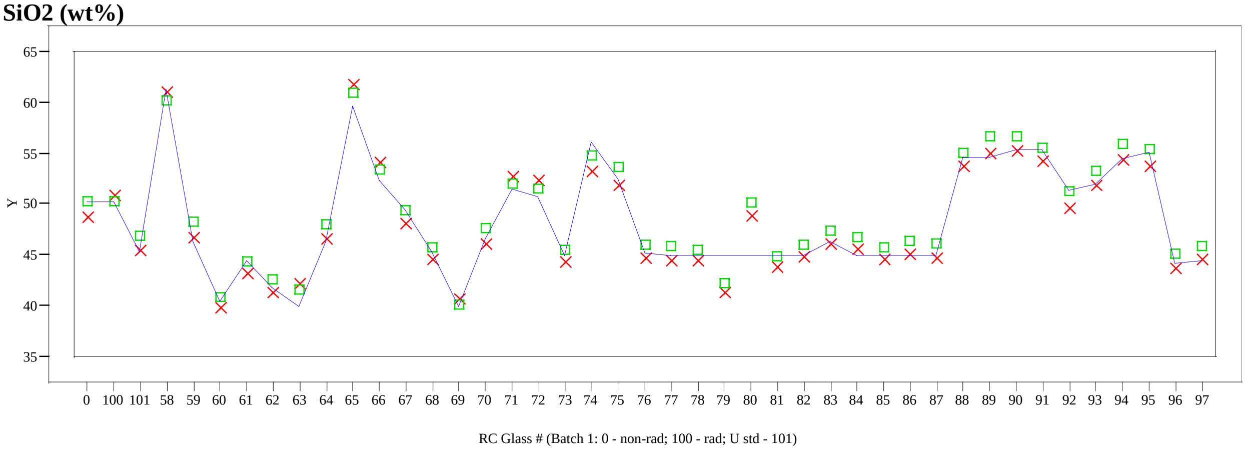
NiO (wt%)



P2O5 (wt%)



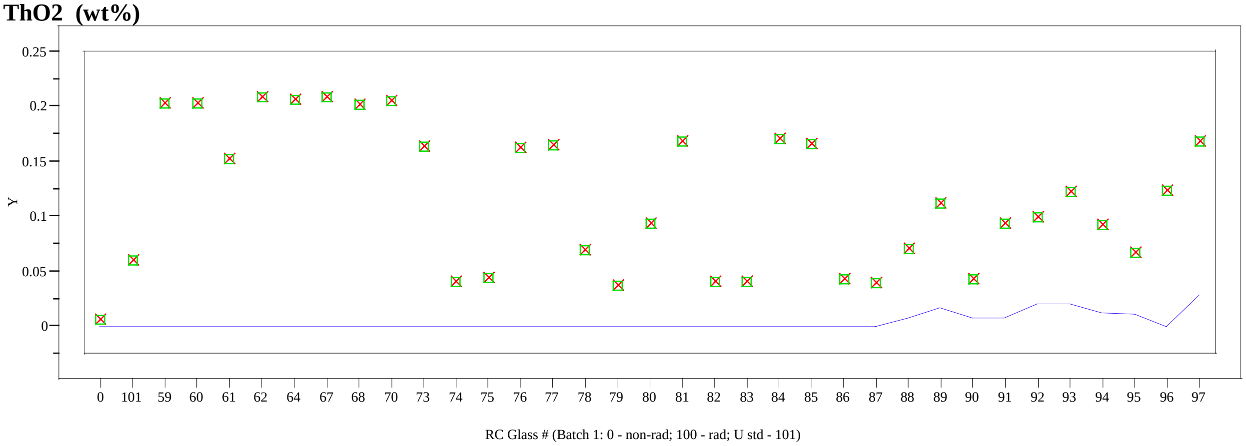
SiO2 (wt%)



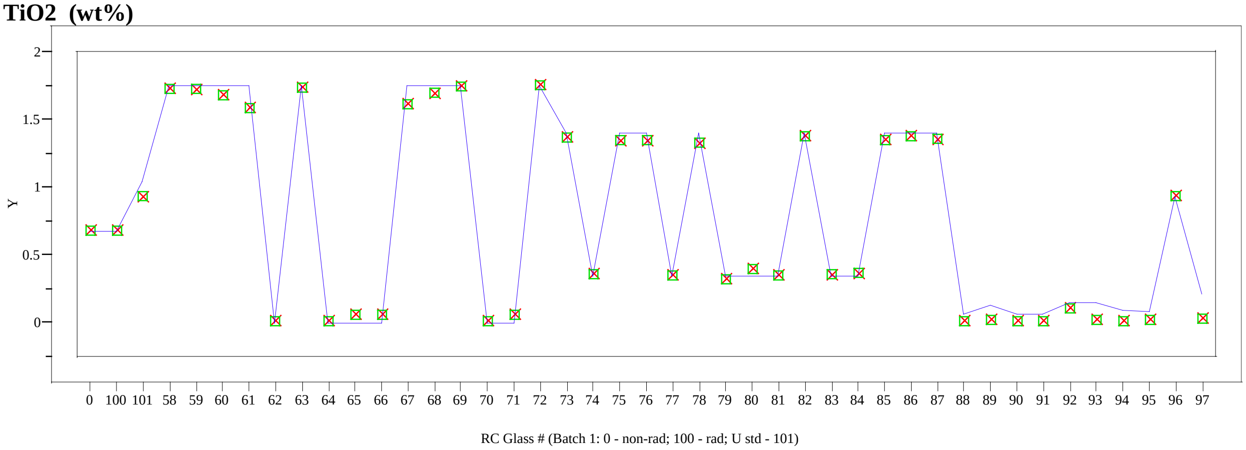
Y × Measured □ Measured bc — Targeted

Exhibit A.13: Average Measured and Bias-Corrected (bc) Versus Targeted Compositions by RC 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%)

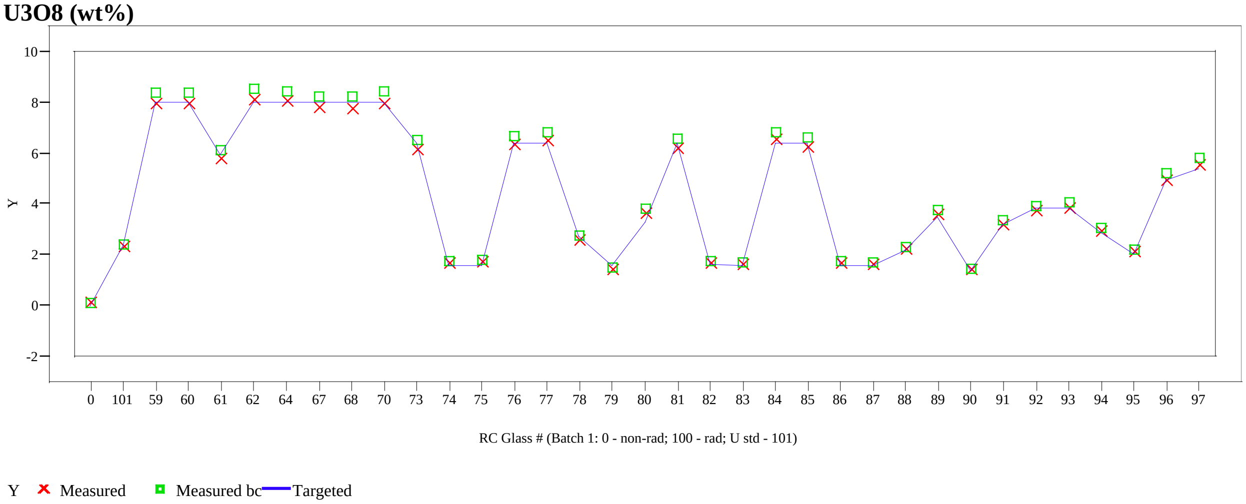
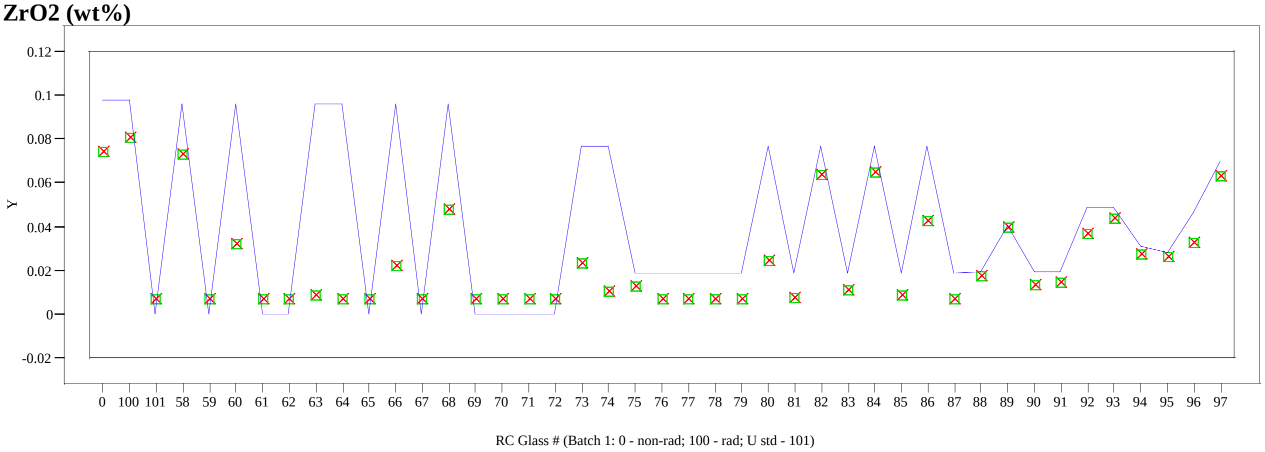
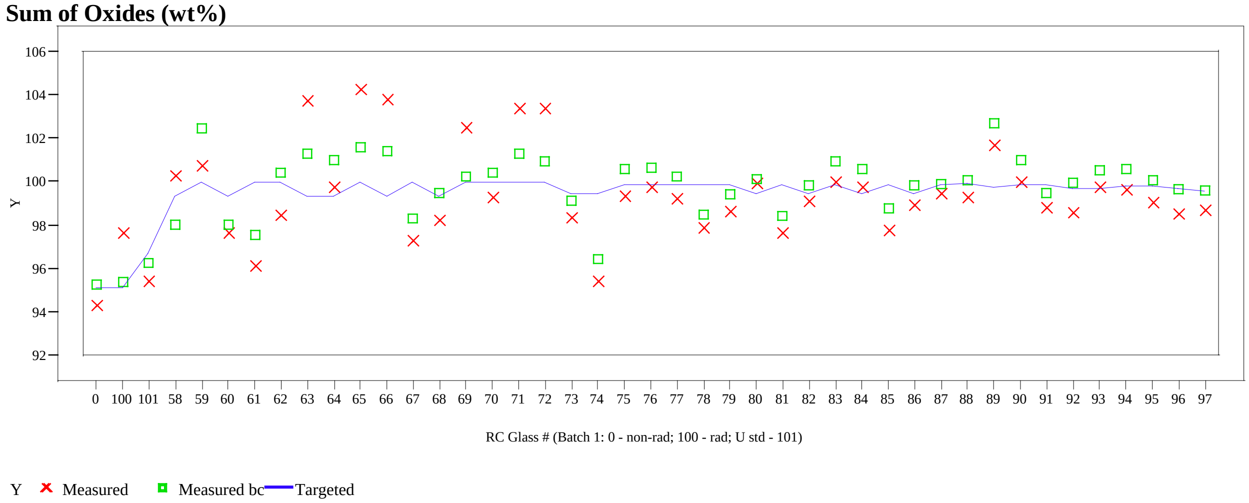


Exhibit A.13: Average Measured and Bias-Corrected (bc) Versus Targeted Compositions by RC Glass #by Oxide *(continued)*
(0 – Batch 1 non-rad group; 100 – Batch 1 rad group; and 101 – U std)

ZrO2 (wt%)



Sum of Oxides (wt%)



Appendix B:

Tables and Exhibits Supporting the Analysis of the PCT-A Results for the RC Glasses

Table B.1: SRTC-ML Measurements of the PCT-A Solutions for the 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	
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	

Table B.1: SRTC-ML Measurements of the PCT-A Solutions for the 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	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	
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	

Table B.1: SRTC-ML Measurements of the PCT-A Solutions for the 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-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	
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	

Table B.1: SRTC-ML Measurements of the PCT-A Solutions for the 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	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	
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-00036	soln std	std-b1-1		1	1	4.27	21.2	<0.060	3.72	9.56	<0.040	<0.010	83.9	<0.100	49.3	<0.100
SCS-00036	RC74ccc	D069	ccc	1	2	10.1	12.7	<0.060	4.33	16.3	<0.040	0.672	47.1	0.018	116	4.04
SCS-00036	RC80ccc	D068	ccc	1	3	0.603	682	<0.060	<0.040	254	<0.040	<0.010	2870	<0.100	1760	3.06
SCS-00036	RC73	D052	quenched	1	4	5.79	30.3	<0.060	0.554	14.1	<0.040	<0.010	58.3	<0.100	86.1	0.599
SCS-00036	RC79ccc	D040	ccc	1	5	36.6	23.0	<0.060	2.80	19.2	<0.040	2.91	46.0	<0.100	90.0	3.11
SCS-00036	blank	D008		1	6	0.489	1.84	<0.060	<0.040	<0.500	<0.040	<0.010	<0.100	<0.100	<0.790	<0.100
SCS-00036	RC79	D053	quenched	1	7	36.3	23.1	<0.060	1.69	20.0	<0.040	1.01	48.5	<0.100	85.7	2.93
SCS-00036	RC67	D070	quenched	1	8	1.71	29.3	0.175	0.108	12.8	<0.040	<0.010	34.9	<0.100	96.2	0.567
SCS-00036	soln std	std-b1-2		1	9	4.28	21.2	<0.060	3.63	9.52	<0.040	<0.010	83.0	<0.100	49.5	<0.100
SCS-00036	RC67ccc	D007	ccc	1	10	2.01	25.9	0.230	0.295	11.5	<0.040	<0.010	31.9	<0.100	89.3	0.591
SCS-00036	RC73ccc	D037	ccc	1	11	7.03	22.3	<0.060	1.10	12.5	<0.040	<0.010	50.2	<0.100	80.0	0.629
SCS-00036	RC76	D085	quenched	1	12	12.0	22.8	<0.060	3.00	17.4	<0.040	2.43	113	0.100	138	3.23
SCS-00036	RC80	D034	quenched	1	13	0.600	691	<0.060	<0.040	260	<0.040	<0.010	3020	<0.100	1810	2.83
SCS-00036	RC76ccc	D080	ccc	1	14	11.7	27.4	<0.060	2.72	17.8	<0.040	1.86	112	<0.100	142	3.15
SCS-00036	RC74	D083	quenched	1	15	8.60	18.0	<0.060	3.31	16.8	<0.040	0.417	52.1	0.188	124	4.02
SCS-00036	soln std	std-b1-3		1	16	4.32	22.4	<0.060	3.60	9.53	<0.040	<0.010	84.1	<0.100	49.7	<0.100
SCS-00036	soln std	std-b2-1		2	1	4.26	21.0	<0.060	4.16	9.66	<0.040	<0.010	85.6	<0.100	50.1	<0.100
SCS-00036	RC80ccc	D062	ccc	2	2	0.589	661	<0.060	0.353	241	<0.040	<0.010	2740	<0.100	1660	2.80
SCS-00036	RC80	D090	quenched	2	3	0.578	704	<0.060	0.169	263	<0.040	<0.010	3120	<0.100	1880	2.60
SCS-00036	RC79	D102	quenched	2	4	36.8	29.7	<0.060	2.43	20.5	<0.040	1.29	50.2	0.090	87.6	2.82
SCS-00036	RC74ccc	D077	ccc	2	5	10.2	15.4	<0.060	4.58	16.4	<0.040	0.624	48.8	0.113	118	3.86

Table B.1: SRTC-ML Measurements of the PCT-A Solutions for the 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-00036	RC76ccc	D019	ccc	2	6	12.0	23.3	<0.060	3.39	17.7	<0.040	2.16	109	0.168	140	3.13
SCS-00036	RC76	D106	quenched	2	7	12.2	24.3	<0.060	3.47	18.2	<0.040	2.38	121	0.206	141	3.08
SCS-00036	RC79ccc	D022	ccc	2	8	35.7	20.2	<0.060	3.46	18.5	<0.040	3.31	45.3	<0.100	87.6	2.84
SCS-00036	soln std	std-b2-2		2	9	4.28	21.2	<0.060	4.06	9.61	<0.040	<0.010	86.4	<0.100	49.7	<0.100
SCS-00036	RC73	D004	quenched	2	10	5.78	26.2	<0.060	1.00	14.3	<0.040	<0.010	59.4	<0.100	87.2	0.548
SCS-00036	RC74	D044	quenched	2	11	8.92	15.8	<0.060	3.61	17.9	<0.040	0.273	56.5	0.24	128	3.99
SCS-00036	RC73ccc	D091	ccc	2	12	7.01	22.5	<0.060	1.31	12.9	<0.040	<0.010	52.7	<0.100	82.0	0.516
SCS-00036	RC67ccc	D075	ccc	2	13	2.00	24.6	<0.060	0.781	11.5	<0.040	<0.010	32.5	0.062	88.0	0.362
SCS-00036	RC67	D082	quenched	2	14	1.69	28.2	0.244	0.537	12.9	<0.040	<0.010	35.3	0.159	101	0.390
SCS-00036	blank	D056		2	15	0.413	<0.150	<0.060	<0.040	<0.500	<0.040	<0.010	<0.100	<0.100	<0.790	<0.100
SCS-00036	soln std	std-b2-3		2	16	4.77	20.8	<0.060	4.25	9.80	<0.040	<0.010	87.5	<0.100	50.8	<0.100
SCS-00036	soln std	std-b3-1		3	1	4.25	21.4	<0.060	4.35	9.85	<0.040	<0.010	86.1	<0.100	50.2	<0.100
SCS-00036	RC67ccc	D036	ccc	3	2	1.99	24.9	<0.060	0.994	11.7	<0.040	<0.010	32.9	0.163	84.5	0.450
SCS-00036	RC80ccc	D046	ccc	3	3	0.814	651	<0.060	0.406	236	<0.040	<0.010	3090	0.150	1850	2.95
SCS-00036	RC76ccc	D057	ccc	3	4	12.2	26.7	<0.060	3.51	18.0	<0.040	2.13	108	0.273	132	3.06
SCS-00036	RC79	D039	quenched	3	5	37.8	25.9	<0.060	2.86	21.2	<0.040	1.45	51.0	0.213	91.2	2.85
SCS-00036	RC73ccc	D092	ccc	3	6	6.95	22.9	<0.060	1.62	12.6	<0.040	<0.010	50.6	<0.100	79.3	0.593
SCS-00036	RC74ccc	D100	ccc	3	7	9.97	12.7	<0.060	4.83	15.7	<0.040	0.788	46.6	0.260	115	3.89
SCS-00036	RC73	D063	quenched	3	8	5.88	25.9	<0.060	1.27	14.4	<0.040	<0.010	59.6	<0.100	86.5	0.551
SCS-00036	soln std	std-b3-2		3	9	3.97	20.1	<0.060	4.15	9.54	<0.040	<0.010	77.7	<0.100	48.9	<0.100
SCS-00036	RC79ccc	D065	ccc	3	10	35.3	20.0	<0.060	3.23	18.6	<0.040	2.84	45.0	0.128	86.1	2.95
SCS-00036	RC74	D109	quenched	3	11	8.65	15.5	<0.060	3.53	17.5	<0.040	0.346	54.4	0.339	122	3.94
SCS-00036	RC76	D015	quenched	3	12	12.0	22.3	<0.060	3.75	17.8	<0.040	2.54	108	0.336	140	3.15
SCS-00036	RC67	D049	quenched	3	13	1.64	28.5	<0.060	0.747	13.0	<0.040	<0.010	35.5	0.110	101	0.458
SCS-00036	RC80	D061	quenched	3	14	0.531	690	<0.060	0.323	250	<0.040	<0.010	3080	<0.100	1870	2.68
SCS-00036	soln std	std-b3-3		3	15	4.24	26.1	<0.060	4.31	9.72	<0.040	<0.010	85.0	<0.100	49.9	<0.100
SCS-00036	soln std	std-b4-1		4	1	4.32	20.5	<0.060	4.28	9.88	<0.040	<0.010	88.4	<0.100	50.4	<0.100
SCS-00036	RC77	D107	quenched	4	2	10.2	40.3	0.950	6.93	53.3	1.22	1.39	159	0.472	182	3.02
SCS-00036[a]	RC70ccc	D047	ccc	4	3	0.433	574	<0.060	0.172	155	<0.040	<0.010	1030	<0.100	474	0.582
SCS-00036	RC70	D009	quenched	4	4	0.410	726	<0.060	0.168	193	<0.040	<0.010	1350	<0.100	560	0.389
SCS-00036	RC75ccc	D055	ccc	4	5	9.51	23.2	<0.060	2.60	14.7	0.10	0.370	58.2	0.144	101	0.777
SCS-00036	RC77ccc	D029	ccc	4	6	18.3	41.4	1.98	14.5	50.7	4.14	3.97	139	1.00	178	4.18
SCS-00036	ARM	D041		4	7	5.59	22.4	<0.060	0.229	15.7	<0.040	<0.010	43.2	<0.100	66.9	0.199
SCS-00036	RC62	D088	quenched	4	8	52.2	16.3	<0.060	2.15	33.5	<0.040	2.81	40.0	0.479	130	4.10
SCS-00036	soln std	std-b4-2		4	9	4.43	20.7	<0.060	4.16	9.83	<0.040	<0.010	89.0	<0.100	49.0	<0.100
SCS-00036	RC62ccc	D051	ccc	4	10	58.8	30.5	<0.060	2.83	66.9	<0.040	8.72	49.9	1.08	190	6.28
SCS-00036	RC60ccc	D031	ccc	4	11	28.3	29.6	<0.060	2.59	68.3	0.642	<0.010	185	<0.100	176	4.60
SCS-00036	EA	D087		4	12	1.63	599	<0.060	0.176	178	<0.040	<0.010	1710	<0.100	841	0.216
SCS-00036	RC75	D021	quenched	4	13	4.47	20.0	<0.060	1.45	16.0	<0.040	<0.010	67.7	0.102	109	0.943
SCS-00036	RC60	D097	quenched	4	14	23.9	26.5	<0.060	1.52	49.1	<0.040	<0.010	146	<0.100	127	3.06
SCS-00036	soln std	std-b4-3		4	15	4.23	21.4	<0.060	4.19	9.72	<0.040	<0.010	86.9	<0.100	49.3	<0.100
SCS-00036	soln std	std-b5-1		5	1	4.39	21.4	<0.060	4.06	9.72	<0.040	<0.010	86.9	<0.100	50.6	<0.100
SCS-00036	RC62	D071	quenched	5	2	50.9	15.5	<0.060	1.89	32.5	<0.040	2.52	38.1	0.139	122	3.87

[a] This row is shaded to indicate that there was a leachate volume to sample mass problem with this PCT result. It is, thus, excluded from all of the analyses of this report.

Table B.1: SRTC-ML Measurements of the PCT-A Solutions for the 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-00036	RC60	D094	quenched	5	3	24.5	25.2	<0.060	1.89	49.3	0.111	<0.010	170	<0.100	153	2.90
SCS-00036	RC60ccc	D013	ccc	5	4	27.5	29.3	<0.060	2.52	66.9	0.649	<0.010	173	<0.100	171	4.40
SCS-00036	RC62ccc	D084	ccc	5	5	57.9	29.5	<0.060	3.08	64.8	<0.040	12.5	47.8	0.925	189	7.52
SCS-00036	RC77ccc	D096	ccc	5	6	17.1	36.0	1.81	13.7	47.4	3.64	3.46	156	0.591	188	4.59
SCS-00036	ARM	D095		5	7	5.04	18.2	<0.060	<0.040	13.7	<0.040	<0.010	37.1	<0.100	60.6	0.197
SCS-00036	RC75	D002	quenched	5	8	4.78	15.6	0.111	1.86	15.5	<0.040	<0.010	63.0	<0.100	105	1.07
SCS-00036	soln std	std-b5-2		5	9	4.38	20.5	<0.060	3.98	9.68	<0.040	<0.010	86.1	<0.100	50.1	<0.100
SCS-00036	EA	D005		5	10	1.53	608	<0.060	<0.040	182	<0.040	<0.010	1690	<0.100	856	0.111
SCS-00036	RC77	D001	quenched	5	11	10.1	42.9	1.26	7.98	51.1	1.54	1.45	164	0.253	201	3.25
SCS-00036	RC70ccc	D059	ccc	5	12	0.525	611	<0.060	<0.040	168	<0.040	<0.010	1100	<0.100	521	0.575
SCS-00036	RC70	D110	quenched	5	13	0.522	728	<0.060	<0.040	193	<0.040	<0.010	1320	<0.100	572	0.372
SCS-00036	RC75ccc	D078	ccc	5	14	9.53	23.9	<0.060	2.53	14.1	<0.040	0.173	55.6	<0.100	111	1.04
SCS-00036	soln std	std-b5-3		5	15	4.28	25.4	<0.060	4.00	9.61	<0.040	<0.010	85.5	<0.100	49.7	<0.100
SCS-00036	soln std	std-b6-1		6	1	4.45	19.9	<0.060	4.00	9.74	<0.040	<0.010	85.4	<0.100	49.6	<0.100
SCS-00036	RC70ccc	D025	ccc	6	2	0.637	613	<0.060	<0.040	159	<0.040	<0.010	1090	<0.100	510	0.797
SCS-00036	RC77	D045	quenched	6	3	5.41	25.8	0.164	3.03	30.2	<0.040	0.127	161.0	<0.100	191	2.94
SCS-00036	RC62	D086	quenched	6	4	41.2	13.0	<0.060	1.53	26.5	<0.040	1.80	32.5	<0.100	124	3.88
SCS-00036	RC75	D018	quenched	6	5	4.48	15.5	<0.060	1.09	15.8	<0.040	<0.010	66.1	<0.100	103	0.855
SCS-00036	ARM	D033		6	6	3.94	13.4	<0.060	<0.040	10.8	<0.040	<0.010	31.4	<0.100	45.7	0.171
SCS-00036	RC62ccc	D030	ccc	6	7	60.9	29.4	<0.060	3.34	67.4	<0.040	14.4	51.3	0.974	195	7.72
SCS-00036	RC60ccc	D027	ccc	6	8	17.0	17.5	<0.060	1.70	42.7	0.046	<0.010	160	<0.100	164	4.59
SCS-00036	soln std	std-b6-2		6	9	4.51	19.4	<0.060	4.01	9.93	<0.040	<0.010	88.1	<0.100	50.3	<0.100
SCS-00036	RC70	D054	quenched	6	10	0.627	712	<0.060	<0.040	181	<0.040	<0.010	1200	<0.100	551	0.693
SCS-00036	RC60	D006	quenched	6	11	15.9	21.3	<0.060	0.581	34.1	<0.040	<0.010	163	<0.100	149	2.94
SCS-00036	RC75ccc	D035	ccc	6	12	8.64	15.1	<0.060	1.99	13.3	<0.040	<0.010	53.5	<0.100	100	0.856
SCS-00036	RC77ccc	D012	ccc	6	13	16.7	36.4	1.62	12.1	48.5	2.96	2.91	130	0.417	181	4.46
SCS-00036	EA	D011		6	14	1.90	615	<0.060	<0.040	175	<0.040	<0.010	1650	<0.100	863	0.354
SCS-00036	soln std	std-b6-3		6	15	4.55	24.8	<0.060	4.02	10.0	<0.040	<0.010	89.0	<0.100	50.3	<0.100
SCS-00036	soln std	std-b7-1		7	1	4.53	20.3	<0.060	4.13	9.87	<0.040	<0.010	86.4	<0.100	49.9	<0.100
SCS-00036	RC78ccc	D079	ccc	7	2	14.0	25.6	<0.060	5.61	20.8	0.718	3.72	87.8	<0.100	125	2.56
SCS-00036	RC59	D101	quenched	7	3	3.42	237	<0.060	5.75	172	<0.040	22.0	244	<0.100	392	13.7
SCS-00036	RC61ccc	D072	ccc	7	4	12.4	153	<0.060	2.51	62.9	0.802	7.87	219	<0.100	129	8.36
SCS-00036	RC68	D093	quenched	7	5	3.57	46.2	<0.060	2.98	32.1	<0.040	7.20	228	2.88	253	9.19
SCS-00036	RC81	D108	quenched	7	6	7.19	38.3	<0.060	2.64	18.4	0.237	0.713	82.5	0.219	111	2.54
SCS-00036	RC64ccc	D024	ccc	7	7	4.80	86.2	<0.060	15.9	69.6	<0.040	0.653	77.1	<0.100	205	5.52
SCS-00036	RC78	D048	quenched	7	8	7.79	31.0	<0.060	3.54	22.2	<0.040	1.47	104	<0.100	130	1.63
SCS-00036	soln std	std-b7-2		7	9	4.53	20.4	<0.060	4.12	9.9	<0.040	<0.010	86.1	<0.100	50.0	<0.100
SCS-00036	RC64	D016	quenched	7	10	2.87	119.0	<0.060	10.5	74.6	<0.040	0.170	78.5	0.574	248	7.06
SCS-00036	RC68ccc	D060	ccc	7	11	2.91	65.2	<0.060	4.07	51.1	<0.040	10.8	290	0.251	339	11.0
SCS-00036	RC59ccc	D017	ccc	7	12	4.31	295	<0.060	8.76	212	<0.040	31.6	306	<0.100	486	18.1
SCS-00036	RC81ccc	D089	ccc	7	13	7.47	38.9	<0.060	2.89	18.9	0.345	0.868	85.0	0.237	112	2.60
SCS-00036	RC61	D028	quenched	7	14	3.77	26.2	<0.060	1.10	19.7	<0.040	<0.010	67.8	<0.100	134	6.24
SCS-00036	soln std	std-b7-3		7	15	4.56	20.6	0.106	4.30	10.0	<0.040	<0.010	87.5	<0.100	50.7	<0.100
SCS-00036	soln std	std-b8-1		8	1	4.53	21.1	<0.060	4.29	9.89	<0.040	<0.010	85.6	<0.100	50.3	<0.100
SCS-00036	RC81	D010	quenched	8	2	7.62	39.1	<0.060	3.04	19.2	<0.040	0.894	85.2	0.305	114	2.78
SCS-00036	RC61	D081	quenched	8	3	3.59	25.9	<0.060	1.29	19.6	<0.040	0.022	66.3	<0.100	129	6.12

Table B.1: SRTC-ML Measurements of the PCT-A Solutions for the 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-00036	RC68	D050	quenched	8	4	2.86	44.7	<0.060	1.90	33.1	<0.040	4.05	222	1.55	235	8.11
SCS-00036	RC78	D058	quenched	8	5	8.24	30.7	<0.060	3.71	22.3	0.151	1.66	115	<0.100	138	1.70
SCS-00036	RC64	D032	quenched	8	6	3.60	123	<0.060	19.0	105	<0.040	1.06	106	<0.100	244	7.42
SCS-00036	RC59ccc	D067	ccc	8	7	4.37	265	<0.060	8.75	196	<0.040	31.5	296	<0.100	436	17.2
SCS-00036	RC68ccc	D105	ccc	8	8	2.76	69.4	<0.060	4.08	53.5	<0.040	10.9	326	0.255	352	10.3
SCS-00036	soln std	std-b8-2		8	9	4.38	22.0	<0.060	4.25	10.0	<0.040	<0.010	86.9	<0.100	50.6	<0.100
SCS-00036	RC61ccc	D098	ccc	8	10	10.1	149	<0.060	2.09	52.6	0.603	6.78	216	<0.100	127	8.55
SCS-00036	RC81ccc	D026	ccc	8	11	6.70	35.5	<0.060	3.16	17.3	0.288	0.688	79.0	0.188	111	2.59
SCS-00036	RC59	D043	quenched	8	12	4.91	296	<0.060	9.50	217	<0.040	37.4	309	<0.100	464	18.3
SCS-00036	RC78ccc	D103	ccc	8	13	14.5	26.5	<0.060	5.79	19.8	0.856	4.00	84.4	<0.100	107	2.81
SCS-00036	RC64ccc	D066	ccc	8	14	4.89	91.1	<0.060	18.3	73.7	<0.040	0.927	81.3	<0.100	212	5.93
SCS-00036	blank	D111		8	15	0.640	0.940	<0.060	0.222	0.701	<0.040	<0.010	<0.100	<0.100	<0.790	<0.100
SCS-00036	soln std	std-b8-3		8	16	4.44	21.3	<0.060	4.25	10.0	<0.040	<0.010	87.3	<0.100	50.7	<0.100
SCS-00036	soln std	std-b9-1		9	1	4.34	20.9	<0.060	4.15	9.78	<0.040	<0.010	86.2	<0.100	50.2	<0.100
SCS-00036	RC81ccc	D042	ccc	9	2	5.26	28.7	<0.060	2.07	14.1	<0.040	0.205	65.8	<0.100	85.8	2.67
SCS-00036	RC78	D020	quenched	9	3	6.97	27.9	<0.060	2.65	19.9	<0.040	0.649	94.7	<0.100	127	1.57
SCS-00036	RC64	D099	quenched	9	4	3.15	99.1	<0.060	12.1	79.6	<0.040	<0.010	80.3	<0.100	214	6.73
SCS-00036	RC81	D014	quenched	9	5	5.24	27.5	<0.060	2.02	13.3	<0.040	0.241	61.1	<0.100	103	2.76
SCS-00036	RC61	D038	quenched	9	6	1.86	13.2	<0.060	0.404	9.95	<0.040	<0.010	37.0	<0.100	109	5.97
SCS-00036	RC61ccc	D073	ccc	9	7	7.10	136.0	<0.060	1.55	35.6	0.275	5.95	215	<0.100	121	8.54
SCS-00036	RC78ccc	D076	ccc	9	8	8.76	15.7	<0.060	3.21	12.5	<0.040	1.66	56.1	<0.100	105	2.85
SCS-00036	soln std	std-b9-2		9	9	4.46	20.5	<0.060	4.12	9.81	<0.040	<0.010	87.4	<0.100	50.3	<0.100
SCS-00036	RC68	D023	quenched	9	10	2.05	30.6	<0.060	1.29	22.1	<0.040	2.55	226	0.924	243	8.89
SCS-00036	RC64ccc	D003	ccc	9	11	4.19	78.6	<0.060	17.6	63.2	<0.040	0.680	71.2	<0.100	203	5.91
SCS-00036	RC59	D104	quenched	9	12	3.50	306	<0.060	6.87	226	<0.040	28.3	322	<0.100	470	18.1
SCS-00036	RC68ccc	D074	ccc	9	13	2.75	52.1	<0.060	3.75	40.2	<0.040	11.03	262	0.253	287	9.93
SCS-00036	RC59ccc	D064	ccc	9	14	3.78	246	<0.060	7.60	186	<0.040	25.8	269	<0.100	405	16.8
SCS-00036	blank	D112		9	15	0.461	1.61	<0.060	<0.040	0.563	<0.040	<0.010	<0.100	<0.100	<0.790	<0.100
SCS-00036	soln std	std-b9-3		9	16	4.31	21.3	<0.060	4.12	9.66	<0.040	<0.010	85.6	<0.100	50.2	<0.100
SCS-00040	soln std	STD-B1-1	soln std	1	1	3.94	20.9	<0.060	4.18	9.55	<0.040	<0.010	83.8	<0.100	49.6	<1.00
SCS-00040	RC85	E049	quenched	1	2	21.46	17.0	<0.060	3.05	24.5	<0.040	0.264	66.5	0.570	112	1.28
SCS-00040	RC90	E092	quenched	1	3	11.12	17.6	<0.060	14.9	28.3	<0.040	7.29	81.2	0.135	171	5.93
SCS-00040	RC85ccc	E096	ccc	1	4	26.06	15.3	<0.060	6.76	28.0	<0.040	2.25	66.3	0.475	121	6.39
SCS-00040	RC93	E061	quenched	1	5	5.74	28.1	<0.060	9.97	38.0	<0.040	0.948	153	<0.100	227	5.15
SCS-00040	RC90ccc	E041	ccc	1	6	11.52	18.8	<0.060	13.7	28.7	<0.040	6.34	76.9	0.136	157	5.69
SCS-00040	RC96	E081	quenched	1	7	10.67	25.4	<0.060	1.50	22.1	<0.040	0.399	75.6	<0.100	106	2.51
SCS-00040	soln std	STD-B1-2	soln std	1	8	3.81	20.4	<0.060	4.01	9.56	<0.040	<0.010	84.6	<0.100	49.6	<1.00
SCS-00040	blank	E047	blank	1	9	<0.090	0.288	<0.060	<0.040	<1.00	<0.040	<0.010	<0.100	<0.100	<0.790	<1.00
SCS-00040	RC83ccc	E099	ccc	1	10	14.3	21.9	<0.060	2.71	18.9	<0.040	2.94	105	0.176	120	4.84
SCS-00040	RC92ccc	E001	ccc	1	11	6.23	22.2	<0.060	7.96	33.4	<0.040	3.50	93.9	<0.100	182	10.3
SCS-00040	RC96ccc	E055	ccc	1	12	11.6	24.4	<0.060	2.04	21.7	<0.040	0.818	72.7	<0.100	106	2.68
SCS-00040	RC83	E018	quenched	1	13	5.88	24.8	<0.060	1.41	20.2	<0.040	0.690	121	0.397	134	2.52
SCS-00040	RC92	E013	quenched	1	14	5.40	23.2	<0.060	7.71	34.0	<0.040	3.21	97.7	<0.100	192	10.1
SCS-00040	RC93ccc	E031	ccc	1	15	6.07	24.0	<0.060	9.84	34.0	<0.040	0.901	123	<0.100	204	4.59
SCS-00040	soln std	STD-B1-3	soln std	1	16	3.78	20.0	<0.060	3.99	9.42	<0.040	<0.010	81.2	<0.100	50.4	<1.00
SCS-00040	soln std	STD-B2-1	soln std	2	1	3.99	20.9	<0.060	3.80	9.55	<0.040	<0.010	86.0	<0.100	49.0	<1.00

Table B.1: SRTC-ML Measurements of the PCT-A Solutions for the 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-00040	RC93	E098	quenched	2	2	7.33	26.4	<0.060	17.7	35.9	1.01	3.09	156	0.121	222	6.00
SCS-00040	RC90ccc	E028	ccc	2	3	11.5	16.1	<0.060	13.4	26.5	<0.040	6.38	75.7	0.102	157	5.73
SCS-00040	RC93ccc	E073	ccc	2	4	6.24	24.2	<0.060	9.31	34.3	<0.040	0.875	122	<0.100	186	4.81
SCS-00040	RC83ccc	E004	ccc	2	5	14.8	22.5	<0.060	2.92	19.3	<0.040	3.31	117	0.219	120	5.07
SCS-00040	RC96	E088	quenched	2	6	11.0	26.5	<0.060	1.03	22.8	<0.040	0.365	80.8	<0.100	108	2.79
SCS-00040	RC85ccc	E082	ccc	2	7	25.9	15.1	<0.060	5.58	27.8	<0.040	2.03	67.2	0.393	122	5.77
SCS-00040	soln std	STD-B2-2	soln std	2	8	4.02	20.3	<0.060	3.75	9.58	<0.040	<0.010	87.4	<0.100	49.5	<1.00
SCS-00040	RC96ccc	E085	ccc	2	9	12.4	24.3	<0.060	3.18	21.2	<0.040	1.88	74.5	0.298	104	3.35
SCS-00040	RC90	E053	quenched	2	10	11.3	17.8	<0.060	14.5	28.7	<0.040	7.21	84.8	0.128	170	6.08
SCS-00040	blank	E019	blank	2	11	<0.090	<0.150	<0.060	<0.040	<1.00	<0.040	<0.010	<0.100	<0.100	<0.790	<1.00
SCS-00040	RC85	E048	quenched	2	12	21.9	16.7	<0.060	2.83	25.2	<0.040	0.379	70.8	0.555	113	1.45
SCS-00040	RC92	E036	quenched	2	13	5.71	23.9	<0.060	8.10	35.3	<0.040	3.51	106	<0.100	190	10.7
SCS-00040	RC83	E008	quenched	2	14	5.98	25.2	<0.060	1.07	20.4	<0.040	0.878	134	0.466	135	2.69
SCS-00040	RC92ccc	E027	ccc	2	15	6.33	22.6	<0.060	7.70	34.0	<0.040	3.56	98.1	<0.100	183	10.30
SCS-00040	soln std	STD-B2-3	soln std	2	16	4.05	20.6	<0.060	3.89	9.73	<0.040	<0.010	88.2	<0.100	50.9	<1.00
SCS-00040	soln std	STD-B3-1	soln std	3	1	3.98	21.1	<0.060	4.00	9.57	<0.040	<0.010	85.5	<0.100	50.1	<1.00
SCS-00040	RC93ccc	E067	ccc	3	2	6.01	24.3	<0.060	8.97	34.1	<0.040	0.510	131	<0.100	201	4.68
SCS-00040	RC96ccc	E103	ccc	3	3	11.7	24.5	<0.060	1.66	21.8	<0.040	0.473	74.2	<0.100	103	2.83
SCS-00040	RC90ccc	E074	ccc	3	4	11.4	16.5	<0.060	14.0	27.4	<0.040	6.46	77.4	0.127	157	5.58
SCS-00040	RC83ccc	E064	ccc	3	5	15.4	20.8	<0.060	4.39	18.4	<0.040	5.40	109	0.223	117	5.13
SCS-00040	RC85ccc	E102	ccc	3	6	26.3	15.4	<0.060	5.42	28.7	<0.040	1.60	67.7	0.160	121	4.90
SCS-00040	RC92	E084	quenched	3	7	5.59	23.4	<0.060	8.38	34.8	<0.040	4.16	101	<0.100	184	9.62
SCS-00040	soln std	STD-B3-2	soln std	3	8	3.93	20.6	<0.060	3.67	9.74	<0.040	<0.010	87.4	<0.100	50.6	<1.00
SCS-00040	RC93	E016	quenched	3	9	7.19	27.3	<0.060	17.0	37.1	0.728	2.61	149	<0.100	219	5.69
SCS-00040	RC92ccc	E021	ccc	3	10	6.31	22.8	<0.060	9.02	34.2	<0.040	4.26	96.8	<0.100	175	9.04
SCS-00040	RC85	E024	quenched	3	11	22.5	17.4	<0.060	3.18	26.1	<0.040	0.174	71.7	0.439	115	1.28
SCS-00040	RC90	E087	quenched	3	12	11.2	17.7	<0.060	14.8	28.8	<0.040	7.12	82.6	<0.100	162	5.65
SCS-00040	RC96	E066	quenched	3	13	10.7	26.3	<0.060	0.911	22.8	<0.040	<0.010	78.4	<0.100	108	2.65
SCS-00040	RC83	E003	quenched	3	14	5.88	25.4	<0.060	1.06	20.6	<0.040	0.480	135	0.216	134	2.46
SCS-00040	soln std	STD-B3-3	soln std	3	15	3.89	20.7	<0.060	3.93	9.75	<0.040	<0.010	86.1	<0.100	50.6	<1.00
SCS-00040	soln std	STD-B4-1	soln std	4	1	3.78	21.3	<0.060	3.81	9.66	<0.040	<0.010	87.0	<0.100	50.9	<1.00
SCS-00040	RC82	E078	quenched	4	2	11.2	49.6	<0.060	6.62	57.8	2.30	7.41	183	1.577	216	5.43
SCS-00040	RC89	E007	quenched	4	3	8.33	19.7	<0.060	13.9	30.6	<0.040	0.804	90.5	1.215	181	4.75
SCS-00040	RC94	E063	quenched	4	4	6.36	25.8	<0.060	16.9	36.8	<0.040	2.84	126	0.914	216	7.07
SCS-00040	RC89ccc	E042	ccc	4	5	9.19	18.5	<0.060	14.9	31.0	<0.040	0.969	85.9	1.116	175	4.41
SCS-00040	RC87ccc	E006	ccc	4	6	11.4	29.4	<0.060	5.90	14.9	<0.040	1.30	112	0.433	109	<1.00
SCS-00040	RC94ccc	E060	ccc	4	7	5.90	26.4	<0.060	10.7	35.0	<0.040	1.29	115	0.364	199	6.74
SCS-00040	soln std	STD-B4-2	soln std	4	8	3.78	20.7	<0.060	3.78	9.65	<0.040	<0.010	86.8	<0.100	50.0	<1.00
SCS-00040	RC84ccc	E039	ccc	4	9	11.6	14.0	<0.060	5.33	13.3	<0.040	1.13	57.5	<0.100	94.5	3.03
SCS-00040	EA	E032	EA	4	10	1.23	597	<0.060	<0.040	171.0	<0.040	<0.010	1550	<0.100	835	<1.00
SCS-00040	RC84	E083	quenched	4	11	10.3	23.1	<0.060	2.56	15.2	<0.040	0.602	66.0	<0.100	102	3.01
SCS-00040	RC87	E094	quenched	4	12	9.08	35.2	<0.060	3.32	15.5	<0.040	0.467	124	0.762	113	1.42
SCS-00040	RC82ccc	E038	ccc	4	13	18.1	38.3	<0.060	7.82	50.9	5.11	13.1	143	0.262	204	8.61
SCS-00040	soln std	STD-B4-3	soln std	4	14	3.76	21.6	<0.060	3.78	9.73	<0.040	<0.010	86.3	<0.100	50.5	<1.00
SCS-00040	soln std	STD-B5-1	soln std	5	1	3.97	21.2	<0.060	4.22	9.78	<0.040	<0.010	85.9	<0.100	49.8	<1.00
SCS-00040	RC94	E089	quenched	5	2	5.49	26.1	<0.060	11.5	36.9	<0.040	1.28	127	0.367	217	6.83

Table B.1: SRTC-ML Measurements of the PCT-A Solutions for the 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-00040	RC82ccc	E091	ccc	5	3	17.6	34.7	<0.060	6.95	48.0	4.82	12.4	138	0.213	198	8.27
SCS-00040	RC89	E044	quenched	5	4	8.80	18.6	<0.060	18.4	29.7	<0.040	1.46	88.0	2.019	176	5.67
SCS-00040	RC82	E029	quenched	5	5	9.44	53.5	<0.060	4.17	61.9	1.09	4.64	206	1.021	234	5.56
SCS-00040	RC87	E035	quenched	5	6	9.39	33.4	<0.060	4.02	15.6	<0.040	0.525	131	0.891	115	1.39
SCS-00040	EA	E009	EA	5	7	1.38	622	<0.060	<0.040	177	<0.040	<0.010	1620	<0.100	859	<1.00
SCS-00040	soln std	STD-B5-2	soln std	5	8	3.85	26.8	<0.060	4.16	9.73	<0.040	<0.010	85.8	<0.100	49.9	<1.00
SCS-00040	RC87ccc	E070	ccc	5	9	10.8	30.5	<0.060	5.78	14.7	<0.040	1.16	113.0	0.372	109	<1.00
SCS-00040	RC89ccc	E030	ccc	5	10	9.22	18.6	<0.060	15.0	30.3	<0.040	0.849	83.2	1.11	172	4.36
SCS-00040	RC84	E051	quenched	5	11	10.3	17.1	<0.060	2.81	15.1	<0.040	0.532	64.8	<0.100	102	2.85
SCS-00040	RC84ccc	E005	ccc	5	12	11.7	13.9	<0.060	2.88	13.5	<0.040	0.924	59.3	<0.100	97.7	3.06
SCS-00040	RC94ccc	E071	ccc	5	13	5.80	25.5	<0.060	10.5	34.1	<0.040	1.15	111	0.328	195	7.27
SCS-00040	soln std	STD-B5-3	soln std	5	14	3.82	20.4	<0.060	3.90	9.63	<0.040	<0.010	84.7	<0.100	49.4	<1.00
SCS-00040	soln std	STD-B6-1	soln std	6	1	4.02	21.4	<0.060	3.64	9.79	<0.040	<0.010	84.1	<0.100	50.9	<1.00
SCS-00040	RC94	E010	quenched	6	2	5.76	26.9	<0.060	11.3	37.4	<0.040	1.22	131	0.345	218	7.38
SCS-00040	RC84ccc	E062	ccc	6	3	11.9	14.0	<0.060	2.85	13.6	<0.040	0.989	58.3	<0.100	100	3.37
SCS-00040	EA	E033	EA	6	4	1.77	336	<0.060	<0.040	110	<0.040	<0.010	970	<0.100	570	<1.00
SCS-00040	RC82ccc	E079	ccc	6	5	18.1	40.2	<0.060	6.89	51.2	4.94	13.0	153	0.197	213	9.14
SCS-00040	RC82	E095	quenched	6	6	8.89	53.7	<0.060	2.53	60.3	0.141	2.77	205	0.556	228	5.63
SCS-00040	RC89ccc	E011	ccc	6	7	9.67	18.4	<0.060	15.1	31.2	<0.040	0.812	87.8	1.10	181	4.72
SCS-00040	soln std	STD-B6-2	soln std	6	8	4.16	20.8	<0.060	3.62	10.1	<0.040	<0.010	90.4	<0.100	50.2	<1.00
SCS-00040	RC87	E022	quenched	6	9	9.52	33.8	<0.060	3.82	15.8	<0.040	0.481	131	0.878	116	1.76
SCS-00040	RC89	E046	quenched	6	10	8.56	20.4	<0.060	14.5	31.7	<0.040	0.764	94.4	1.32	185	5.05
SCS-00040	RC94ccc	E015	ccc	6	11	6.51	26.1	<0.060	10.7	35.1	<0.040	1.18	120	0.331	201	7.91
SCS-00040	RC87ccc	E075	ccc	6	12	11.2	29.4	<0.060	5.06	15.0	<0.040	0.910	116	0.293	108	1.10
SCS-00040	RC84	E045	quenched	6	13	10.7	17.5	<0.060	2.32	15.6	<0.040	0.430	67.2	0.052	105	3.18
SCS-00040	soln std	STD-B6-3	soln std	6	14	4.13	20.6	<0.060	3.81	9.93	<0.040	<0.010	87.3	<0.100	50.5	<1.00
SCS-00040	soln std	STD-B7-1	soln std	7	1	3.99	21.5	<0.060	4.05	9.79	<0.040	<0.010	85.9	<0.100	50.2	<1.00
SCS-00040	RC88ccc	E002	ccc	7	2	5.22	27.6	<0.060	11.7	39.4	<0.040	4.62	110	<0.100	215	8.88
SCS-00040	RC97	E097	quenched	7	3	4.77	71.5	<0.060	7.41	57.3	<0.040	2.60	285	0.921	292	4.85
SCS-00040	RC97ccc	E076	ccc	7	4	8.84	90.9	<0.060	19.2	80.4	3.76	13.3	338	0.762	399	9.18
SCS-00040	RC95	E017	quenched	7	5	4.82	30.7	<0.060	10.0	40.5	<0.040	2.00	134	0.306	229	9.71
SCS-00040	RC91ccc	E093	ccc	7	6	8.12	21.3	<0.060	15.9	33.4	<0.040	2.61	117	0.180	197	5.77
SCS-00040	RC86	E072	quenched	7	7	16.4	15.1	<0.060	0.771	12.8	<0.040	0.229	58.1	<0.100	81.7	<1.00
SCS-00040	soln std	STD-B7-2	soln std	7	8	3.91	20.6	<0.060	3.88	9.69	<0.040	<0.010	85.2	<0.100	50.1	<1.00
SCS-00040	RC95ccc	E104	ccc	7	9	5.05	26.5	<0.060	10.0	37.9	<0.040	1.94	117	0.280	212	9.25
SCS-00040	RC91	E101	quenched	7	10	7.21	26.2	<0.060	16.3	37.9	<0.040	2.75	136	0.155	216	7.09
SCS-00040	RC88	E056	quenched	7	11	4.11	28.7	<0.060	7.29	39.7	<0.040	2.80	119	<0.100	211	9.26
SCS-00040	RC86ccc	E023	ccc	7	12	18.3	13.0	<0.060	0.513	11.9	<0.040	0.355	53.9	<0.100	78.8	<1.00
SCS-00040	ARM	E020	ARM	7	13	5.10	17.6	<0.060	<0.040	13.5	<0.040	<0.010	37.1	<0.100	61.0	<1.00
SCS-00040	soln std	STD-B7-3	soln std	7	14	3.87	20.3	<0.060	3.84	9.60	<0.040	<0.010	84.0	<0.100	50.3	<1.00
SCS-00040	soln std	STD-B8-1	soln std	8	1	4.02	21.4	<0.060	3.71	9.72	<0.040	<0.010	86.0	<0.100	50.1	<1.00
SCS-00040	RC86ccc	E026	ccc	8	2	18.7	13.1	<0.060	0.169	11.8	<0.040	0.061	53.8	<0.100	78.0	<1.00
SCS-00040	RC97ccc	E037	ccc	8	3	9.39	90.6	<0.060	21.1	81.3	4.68	15.6	340	0.809	411	9.72
SCS-00040	RC88ccc	E069	ccc	8	4	5.38	27.5	<0.060	11.3	39.1	<0.040	4.57	105	<0.100	215	9.16
SCS-00040	ARM	E057	ARM	8	5	5.21	20.2	<0.060	<0.040	14.9	<0.040	<0.010	41.6	<0.100	59.5	<1.00
SCS-00040	RC91ccc	E065	ccc	8	6	8.21	21.5	<0.060	13.9	34.5	<0.040	2.02	113	<0.100	195	5.79

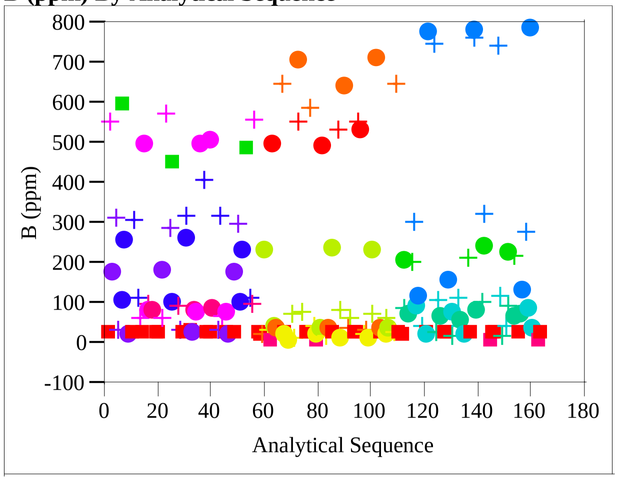
Table B.1: SRTC-ML Measurements of the PCT-A Solutions for the RC Glasses by Analytical Planning Group

Analytical Plan	Glass ID	SRTC-ML ID	Heat Treatment	Block	Seq #	Al	B	Ca	Fe	Li	Mg	Mn	Na	Ni	Si	U
SCS-00040	RC95	E090	quenched	8	7	4.59	29.6	<0.060	9.67	40.5	<0.040	1.82	129	0.133	229	9.45
SCS-00040	soln std	STD-B8-2	soln std	8	8	4.05	20.7	<0.060	3.70	9.80	<0.040	<0.010	86.0	<0.100	50.1	<1.00
SCS-00040	RC91	E058	quenched	8	9	7.34	26.2	<0.060	16.8	37.9	<0.040	2.79	142	<0.100	224	6.75
SCS-00040	RC88	E068	quenched	8	10	4.99	31.0	<0.060	11.7	42.6	<0.040	4.79	126	<0.100	235	9.45
SCS-00040	RC86	E034	quenched	8	11	16.4	15.0	<0.060	0.555	12.8	<0.040	0.118	57.2	<0.100	81.4	<1.00
SCS-00040[a]	RC97	E100	quenched	8	12	5.61	71.6	<0.060	10.7	57.5	0.599	4.43	289	1.59	299	5.26
SCS-00040	RC95ccc	E059	ccc	8	13	5.85	26.0	<0.060	12.7	37.5	<0.040	3.03	112	0.378	210	9.72
SCS-00040	blank	E105	blank	8	14	<0.090	<0.150	<0.060	<0.040	<1.00	<0.040	<0.010	<0.100	<0.100	<0.790	<1.00
SCS-00040	soln std	STD-B8-3	soln std	8	15	4.04	20.5	<0.060	3.77	9.85	<0.040	<0.010	86.6	<0.100	50.7	<1.00
SCS-00040	soln std	STD-B9-1	soln std	9	1	4.18	21.7	<0.060	3.95	9.85	<0.040	<0.010	87.0	<0.100	50.5	<1.00
SCS-00040	RC88ccc	E025	ccc	9	2	5.49	27.7	<0.060	11.3	39.7	<0.040	4.53	89.0	<0.100	219	9.39
SCS-00040	RC91ccc	E040	ccc	9	3	8.08	21.0	<0.060	13.3	33.4	<0.040	1.90	143	<0.100	198	5.99
SCS-00040	RC86ccc	E077	ccc	9	4	18.9	13.0	<0.060	0.22	12.0	<0.040	0.071	54.3	<0.100	81.4	<1.00
SCS-00040	ARM	E086	ARM	9	5	5.19	21.1	<0.060	<0.040	15.5	<0.040	<0.010	43.9	<0.100	65.3	<1.00
SCS-00040	RC88	E012	quenched	9	6	5.37	30.6	<0.060	14.6	42.5	<0.040	7.16	132	<0.100	232	9.32
SCS-00040	RC95	E014	quenched	9	7	4.73	29.5	<0.060	9.66	40.5	<0.040	1.81	118	0.166	230	9.60
SCS-00040	soln std	STD-B9-2	soln std	9	8	4.11	20.8	<0.060	4.12	9.82	<0.040	<0.010	86.0	<0.100	50.5	<1.00
SCS-00040	RC86	E080	quenched	9	9	16.7	14.7	<0.060	0.935	12.5	<0.040	0.434	57.2	<0.100	80.5	<1.00
SCS-00040	RC97ccc	E052	ccc	9	10	12.8	88.2	<0.060	30.6	79.5	8.03	23.9	123	1.40	426	12.2
SCS-00040	RC91	E050	quenched	9	11	7.36	26.0	<0.060	15.8	37.3	<0.040	2.60	347	<0.100	227	7.05
SCS-00040	RC95ccc	E054	ccc	9	12	5.44	26.7	<0.060	9.62	38.5	<0.040	1.66	285	0.140	217	9.80
SCS-00040	RC97	E043	quenched	9	13	5.11	69.1	<0.060	8.15	55.1	<0.040	2.90	54.0	0.963	290	5.01
SCS-00040	blank	E106	blank	9	14	0.112	0.441	<0.060	<0.040	<1.00	<0.040	<0.010	<0.100	<0.100	<0.790	<1.00
SCS-00040	soln std	STD-B9-3	soln std	9	15	4.11	20.6	<0.060	3.80	9.77	<0.040	<0.010	85.7	<0.100	51.0	<1.00

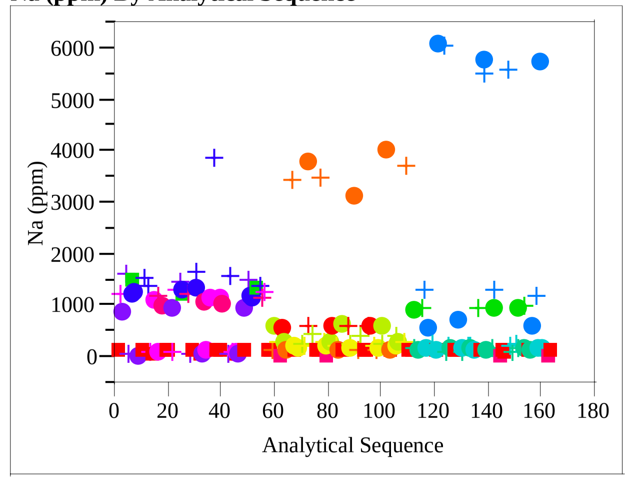
a This row is shaded to indicate that there was a leachate volume to sample mass problem with this PCT result. It is, thus, excluded from all of the analyses of this report.

Exhibit B.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

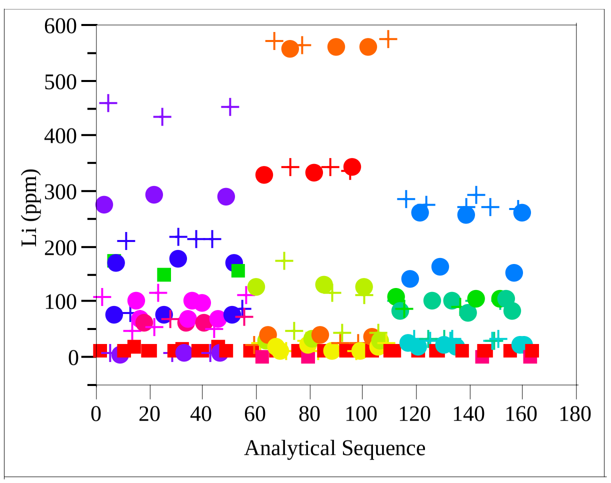
B (ppm) By Analytical Sequence



Na (ppm) By Analytical Sequence



Li (ppm) By Analytical Sequence



Si (ppm) By Analytical Sequence

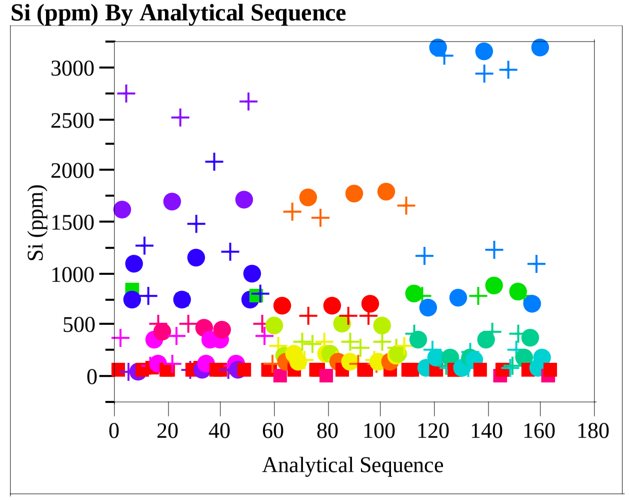
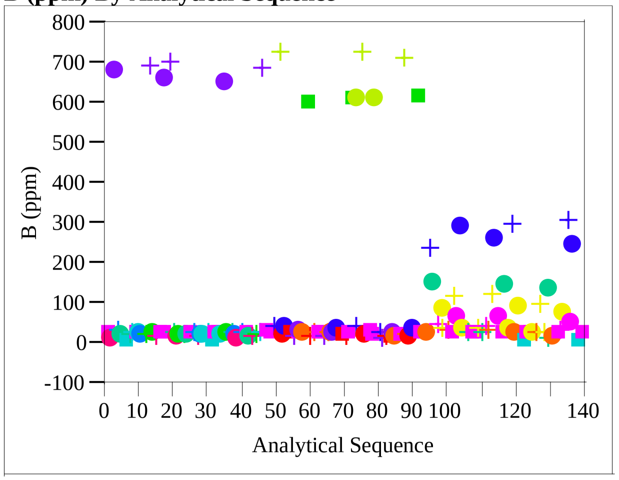
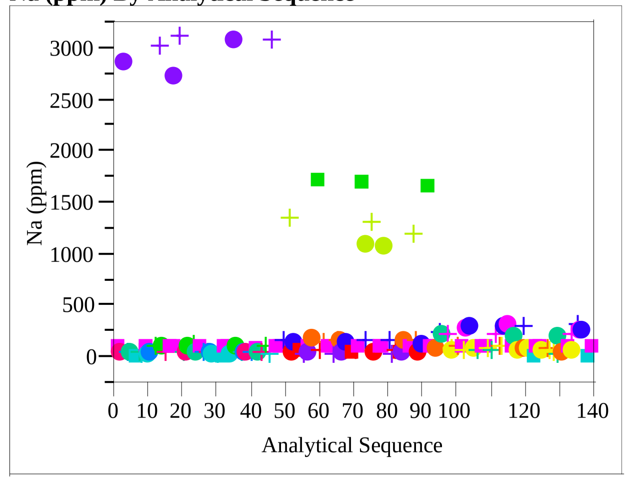


Exhibit B.2: SRTC-ML PCT Measurements in Overall Analytical Sequence Including All RC Glasses, EA, ARM, Blanks, and Samples of the Solution Standard for Group 1 of the Radioactive Glasses

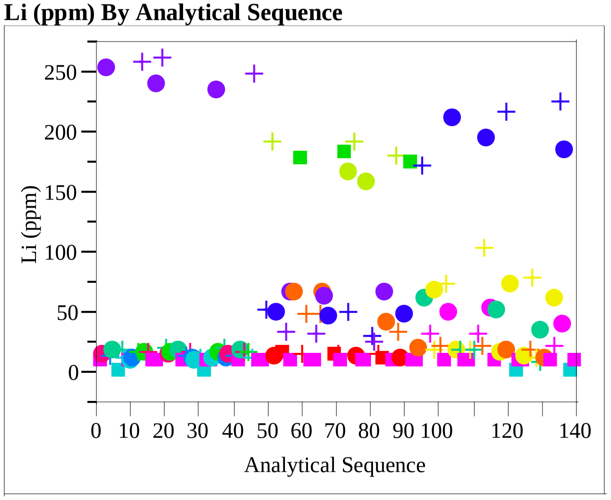
B (ppm) By Analytical Sequence



Na (ppm) By Analytical Sequence



Li (ppm) By Analytical Sequence



Si (ppm) By Analytical Sequence

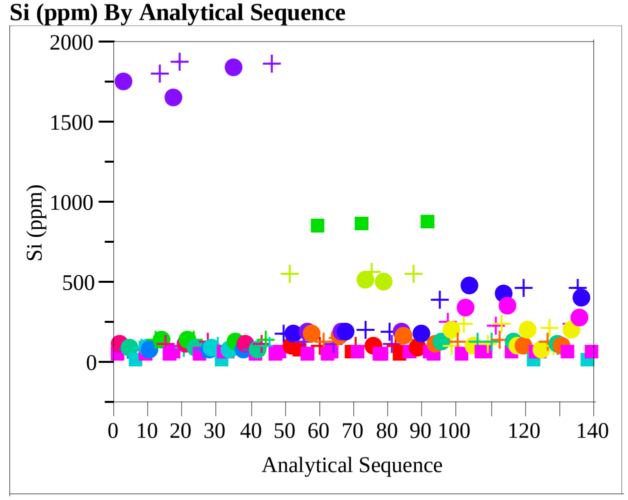
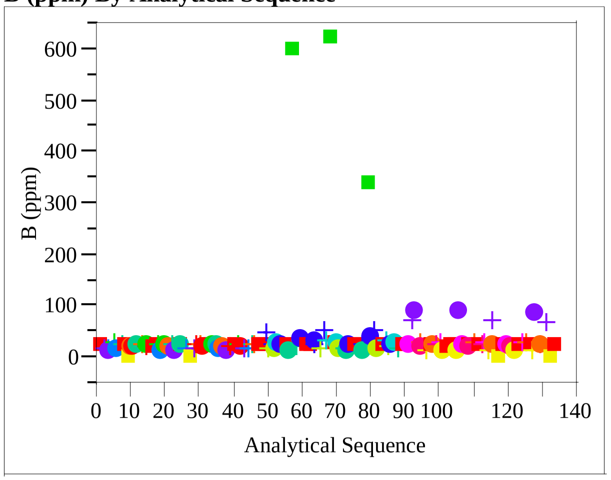
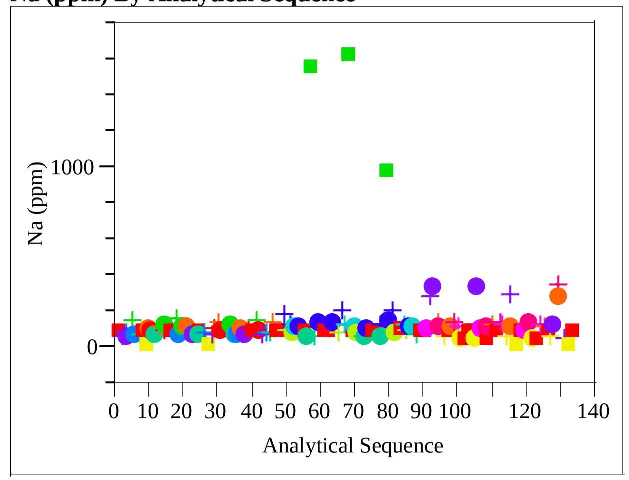


Exhibit B.3: SRTC-ML PCT Measurements in Overall Analytical Sequence Including All RC Glasses, EA, ARM, Blanks, and Samples of the Solution Standard for Group 2 of the Radioactive Glasses

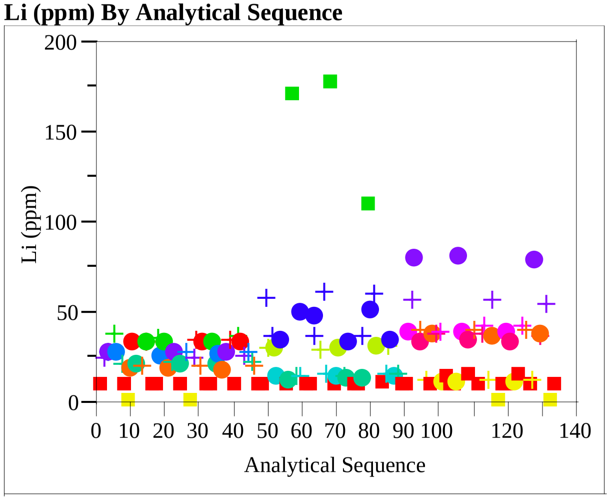
B (ppm) By Analytical Sequence



Na (ppm) By Analytical Sequence



Li (ppm) By Analytical Sequence



Si (ppm) By Analytical Sequence

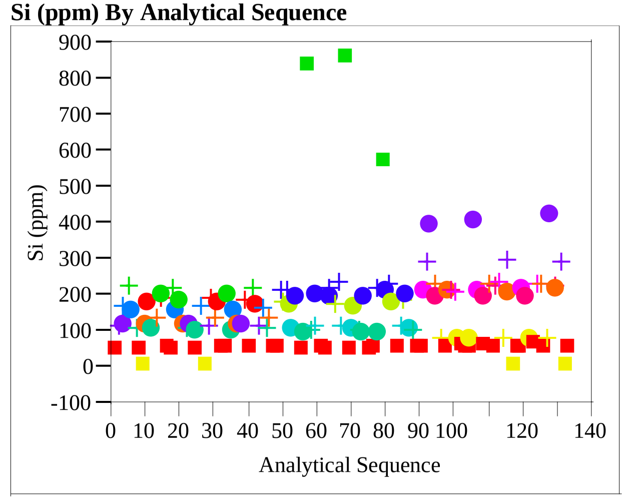
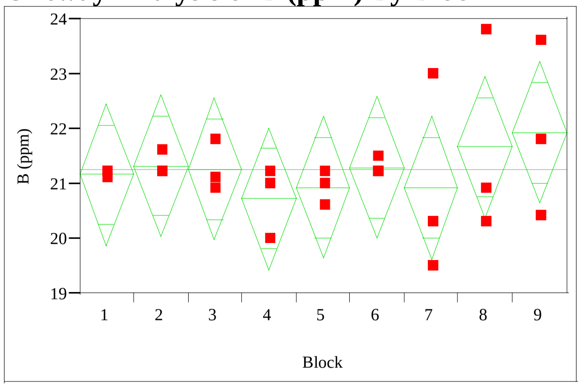


Exhibit B.4: Measurements of the Multi-Element Solution Standard by ICP Block for Non-Radioactive Group

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

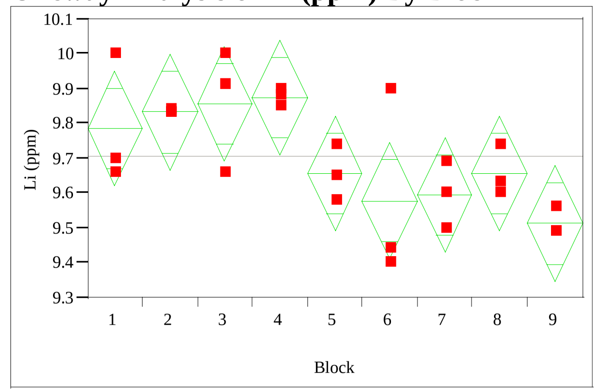
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	8	3.380474	0.42256	0.3715	0.9222
Error	18	20.472067	1.13734		
C. Total	26	23.852541			

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			

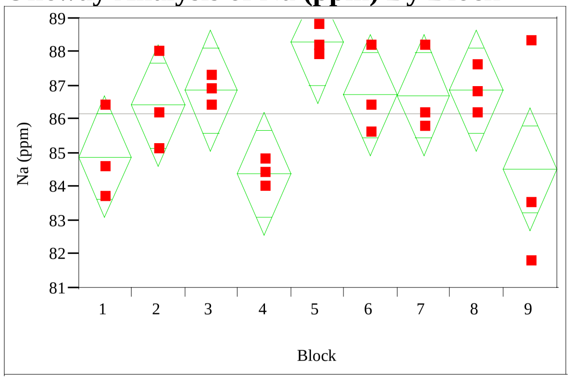
Means for Oneway Anova

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 B.4: 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

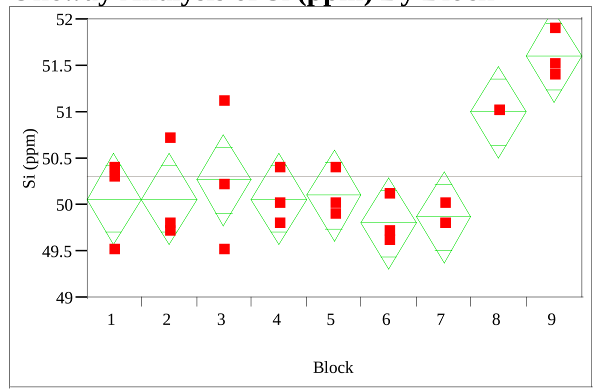
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	8	40.889630	5.11120	2.3128	0.0666
Error	18	39.780000	2.21000		
C. Total	26	80.669630			

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			

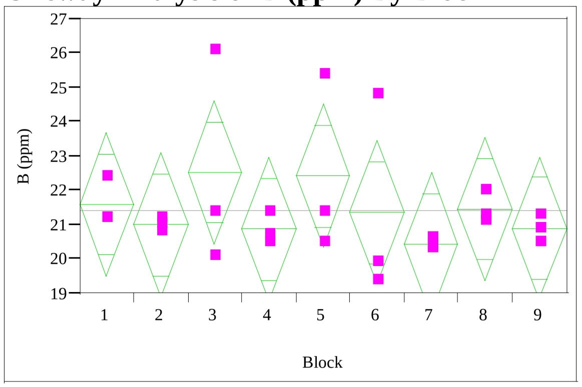
Means for Oneway Anova

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 B.5: Measurements of the Multi-Element Solution Standard by ICP Block for Radioactive Group 1

Oneway Analysis of B (ppm) By Block



Oneway Anova

Summary of Fit

Rsquare	0.18381
Adj Rsquare	-0.17894
Root Mean Square Error	1.726268
Mean of Response	21.4
Observations (or Sum Wgts)	27

Analysis of Variance

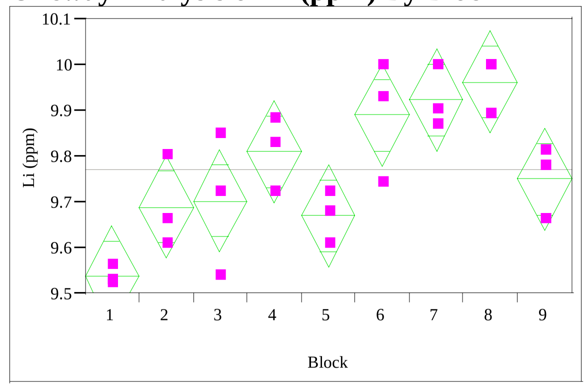
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	8	12.080000	1.51000	0.5067	0.8357
Error	18	53.640000	2.98000		
C. Total	26	65.720000			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	21.6000	0.99666	19.506	23.694
2	3	21.0000	0.99666	18.906	23.094
3	3	22.5333	0.99666	20.439	24.627
4	3	20.8667	0.99666	18.773	22.961
5	3	22.4333	0.99666	20.339	24.527
6	3	21.3667	0.99666	19.273	23.461
7	3	20.4333	0.99666	18.339	22.527
8	3	21.4667	0.99666	19.373	23.561
9	3	20.9000	0.99666	18.806	22.994

Std Error uses a pooled estimate of error variance

Oneway Analysis of Li (ppm) By Block



Oneway Anova

Summary of Fit

Rsquare	0.74768
Adj Rsquare	0.635538
Root Mean Square Error	0.092636
Mean of Response	9.770741
Observations (or Sum Wgts)	27

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	8	0.45771852	0.057215	6.6672	0.0004
Error	18	0.15446667	0.008581		
C. Total	26	0.61218519			

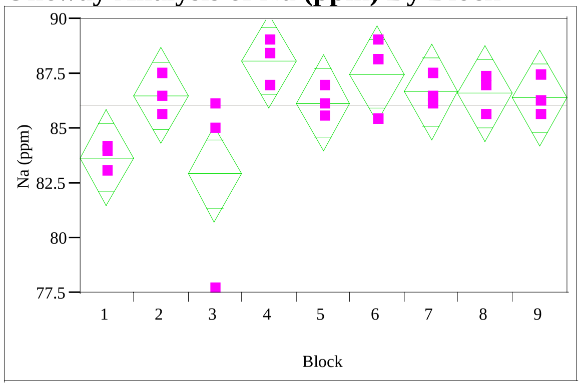
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	9.53667	0.05348	9.4243	9.649
2	3	9.69000	0.05348	9.5776	9.802
3	3	9.70333	0.05348	9.5910	9.816
4	3	9.81000	0.05348	9.6976	9.922
5	3	9.67000	0.05348	9.5576	9.782
6	3	9.89000	0.05348	9.7776	10.002
7	3	9.92333	0.05348	9.8110	10.036
8	3	9.96333	0.05348	9.8510	10.076
9	3	9.75000	0.05348	9.6376	9.862

Std Error uses a pooled estimate of error variance

Exhibit B.5: Measurements of the Multi-Element Solution Standard by ICP Block for Radioactive Group 1 *(continued)*

Oneway Analysis of Na (ppm) By Block



Oneway Anova
Summary of Fit

Rsquare	0.53649
Adj Rsquare	0.330486
Root Mean Square Error	1.808724
Mean of Response	86.05926
Observations (or Sum Wgts)	27

Analysis of Variance

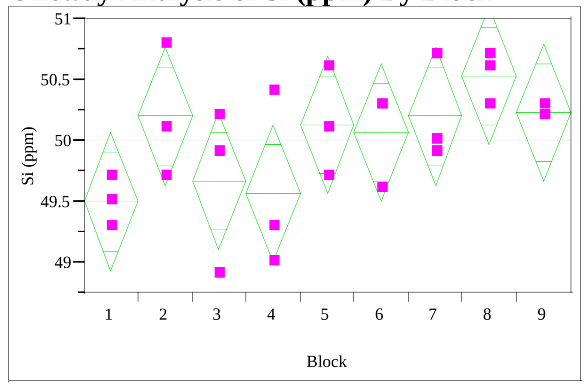
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	8	68.15852	8.51981	2.6043	0.0437
Error	18	58.88667	3.27148		
C. Total	26	127.04519			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	83.6667	1.0443	81.473	85.861
2	3	86.5000	1.0443	84.306	88.694
3	3	82.9333	1.0443	80.739	85.127
4	3	88.1000	1.0443	85.906	90.294
5	3	86.1667	1.0443	83.973	88.361
6	3	87.5000	1.0443	85.306	89.694
7	3	86.6667	1.0443	84.473	88.861
8	3	86.6000	1.0443	84.406	88.794
9	3	86.4000	1.0443	84.206	88.594

Std Error uses a pooled estimate of error variance

Oneway Analysis of Si (ppm) By Block



Oneway Anova
Summary of Fit

Rsquare	0.430784
Adj Rsquare	0.177799
Root Mean Square Error	0.466667
Mean of Response	50.01111
Observations (or Sum Wgts)	27

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	8	2.9666667	0.370833	1.7028	0.1657
Error	18	3.9200000	0.217778		
C. Total	26	6.8866667			

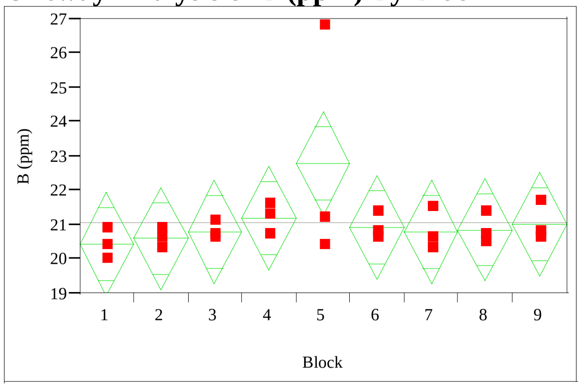
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	49.5000	0.26943	48.934	50.066
2	3	50.2000	0.26943	49.634	50.766
3	3	49.6667	0.26943	49.101	50.233
4	3	49.5667	0.26943	49.001	50.133
5	3	50.1333	0.26943	49.567	50.699
6	3	50.0667	0.26943	49.501	50.633
7	3	50.2000	0.26943	49.634	50.766
8	3	50.5333	0.26943	49.967	51.099
9	3	50.2333	0.26943	49.667	50.799

Std Error uses a pooled estimate of error variance

Exhibit B.6: Measurements of the Multi-Element Solution Standard by ICP Block for Radioactive Group 2

Oneway Analysis of B (ppm) By Block



Oneway Anova

Summary of Fit

Rsquare	0.293541
Adj Rsquare	-0.02044
Root Mean Square Error	1.241117
Mean of Response	21.05185
Observations (or Sum Wgts)	27

Analysis of Variance

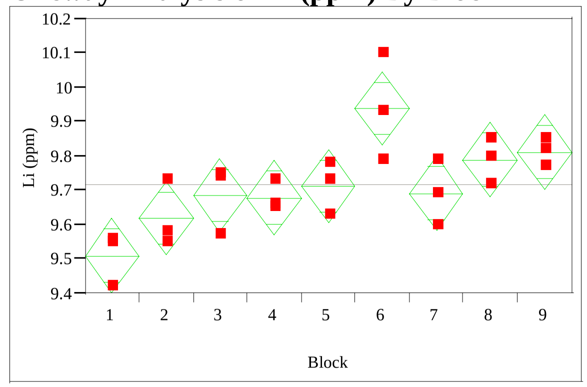
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	8	11.520741	1.44009	0.9349	0.5125
Error	18	27.726667	1.54037		
C. Total	26	39.247407			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	20.4333	0.71656	18.928	21.939
2	3	20.6000	0.71656	19.095	22.105
3	3	20.8000	0.71656	19.295	22.305
4	3	21.2000	0.71656	19.695	22.705
5	3	22.8000	0.71656	21.295	24.305
6	3	20.9333	0.71656	19.428	22.439
7	3	20.8000	0.71656	19.295	22.305
8	3	20.8667	0.71656	19.361	22.372
9	3	21.0333	0.71656	19.528	22.539

Std Error uses a pooled estimate of error variance

Oneway Analysis of Li (ppm) By Block



Oneway Anova

Summary of Fit

Rsquare	0.712126
Adj Rsquare	0.584182
Root Mean Square Error	0.089711
Mean of Response	9.716296
Observations (or Sum Wgts)	27

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	8	0.35836296	0.044795	5.5659	0.0012
Error	18	0.14486667	0.008048		
C. Total	26	0.50322963			

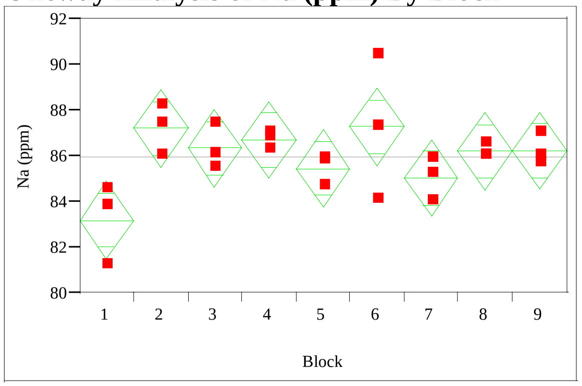
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	9.51000	0.05179	9.4012	9.619
2	3	9.62000	0.05179	9.5112	9.729
3	3	9.68667	0.05179	9.5778	9.795
4	3	9.68000	0.05179	9.5712	9.789
5	3	9.71333	0.05179	9.6045	9.822
6	3	9.94000	0.05179	9.8312	10.049
7	3	9.69333	0.05179	9.5845	9.802
8	3	9.79000	0.05179	9.6812	9.899
9	3	9.81333	0.05179	9.7045	9.922

Std Error uses a pooled estimate of error variance

Exhibit B.6: Measurements of the Multi-Element Solution Standard by ICP Block for Radioactive Group 2 *(continued)*

Oneway Analysis of Na (ppm) By Block



Oneway Anova

Summary of Fit

Rsquare	0.525043
Adj Rsquare	0.313951
Root Mean Square Error	1.388311
Mean of Response	85.95926
Observations (or Sum Wgts)	27

Analysis of Variance

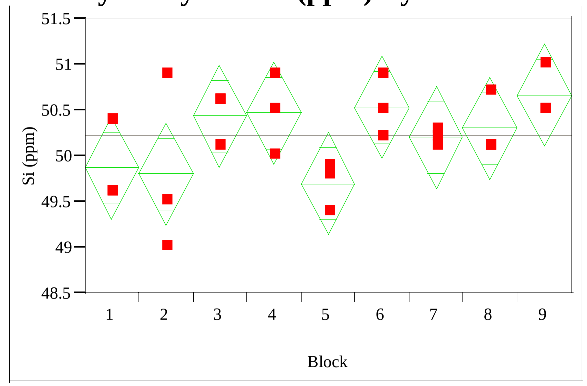
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	8	38.351852	4.79398	2.4873	0.0517
Error	18	34.693333	1.92741		
C. Total	26	73.045185			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	83.2000	0.80154	81.516	84.884
2	3	87.2000	0.80154	85.516	88.884
3	3	86.3333	0.80154	84.649	88.017
4	3	86.7000	0.80154	85.016	88.384
5	3	85.4667	0.80154	83.783	87.151
6	3	87.2667	0.80154	85.583	88.951
7	3	85.0333	0.80154	83.349	86.717
8	3	86.2000	0.80154	84.516	87.884
9	3	86.2333	0.80154	84.549	87.917

Std Error uses a pooled estimate of error variance

Oneway Analysis of Si (ppm) By Block



Oneway Anova

Summary of Fit

Rsquare	0.439863
Adj Rsquare	0.190913
Root Mean Square Error	0.456638
Mean of Response	50.21852
Observations (or Sum Wgts)	27

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	8	2.9474074	0.368426	1.7669	0.1504
Error	18	3.7533333	0.208519		
C. Total	26	6.7007407			

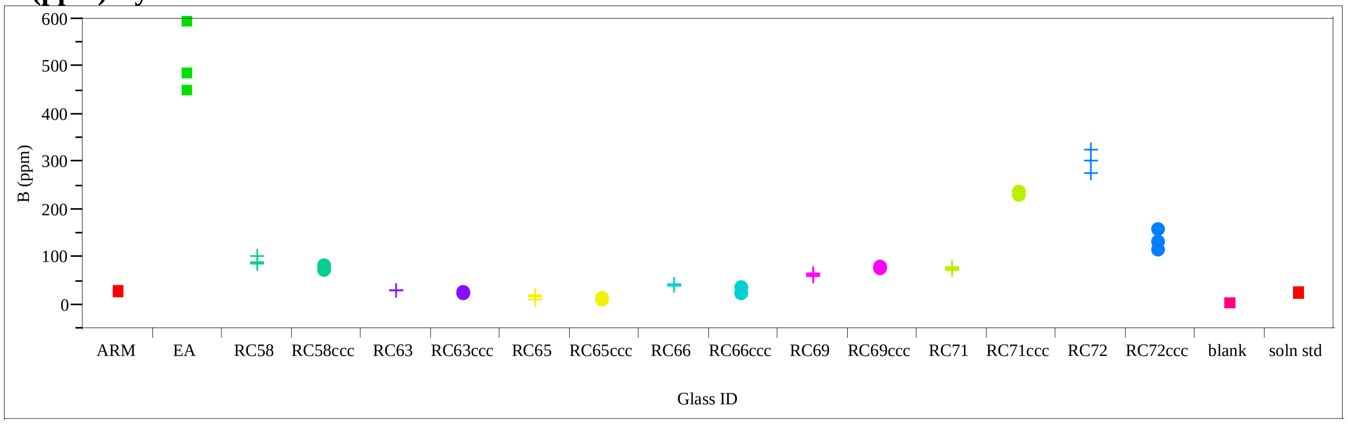
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	49.8667	0.26364	49.313	50.421
2	3	49.8000	0.26364	49.246	50.354
3	3	50.4333	0.26364	49.879	50.987
4	3	50.4667	0.26364	49.913	51.021
5	3	49.7000	0.26364	49.146	50.254
6	3	50.5333	0.26364	49.979	51.087
7	3	50.2000	0.26364	49.646	50.754
8	3	50.3000	0.26364	49.746	50.854
9	3	50.6667	0.26364	50.113	51.221

Std Error uses a pooled estimate of error variance

Exhibit B.7: SRTC-ML PCT Measurements by Glass ID or Standard for Non-Radioactive Group Centerline-Cooled (ccc)

B (ppm) By Glass ID



Li (ppm) By Glass ID

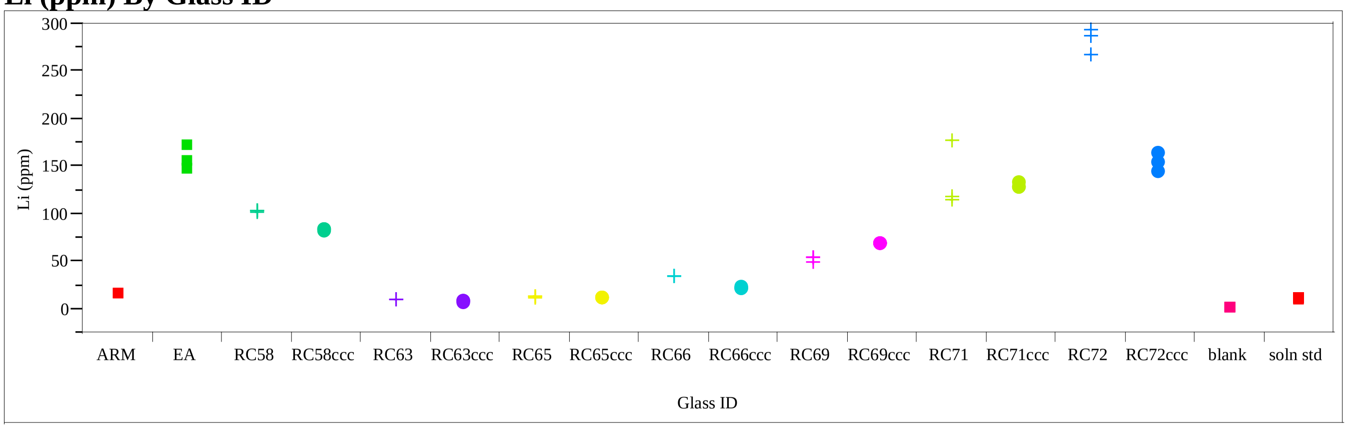
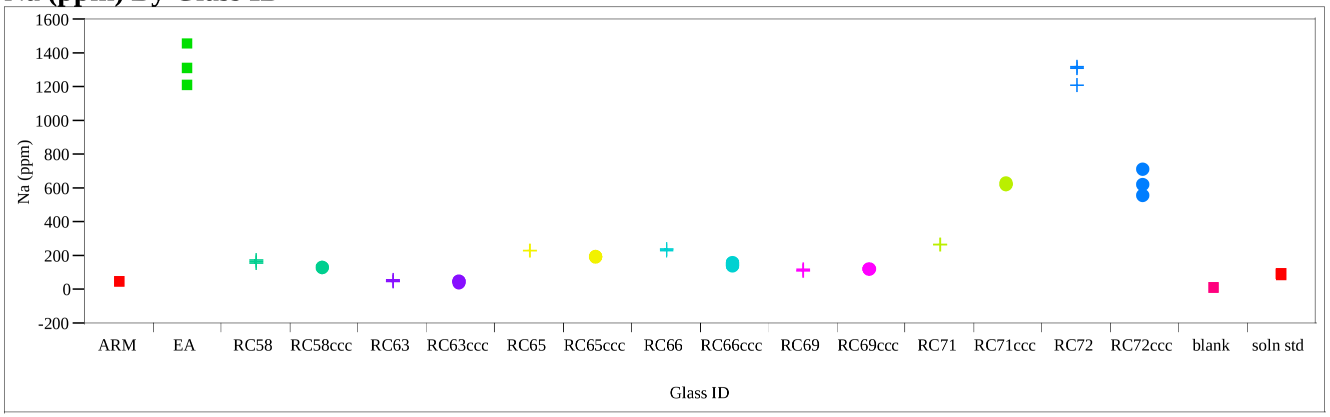


Exhibit B.7: SRTC-ML PCT Measurements by Glass ID or Standard for Non-Radioactive Group
Centerline-Cooled (ccc) *Continued*

Na (ppm) By Glass ID



Oneway Analysis of Si (ppm) By Glass ID

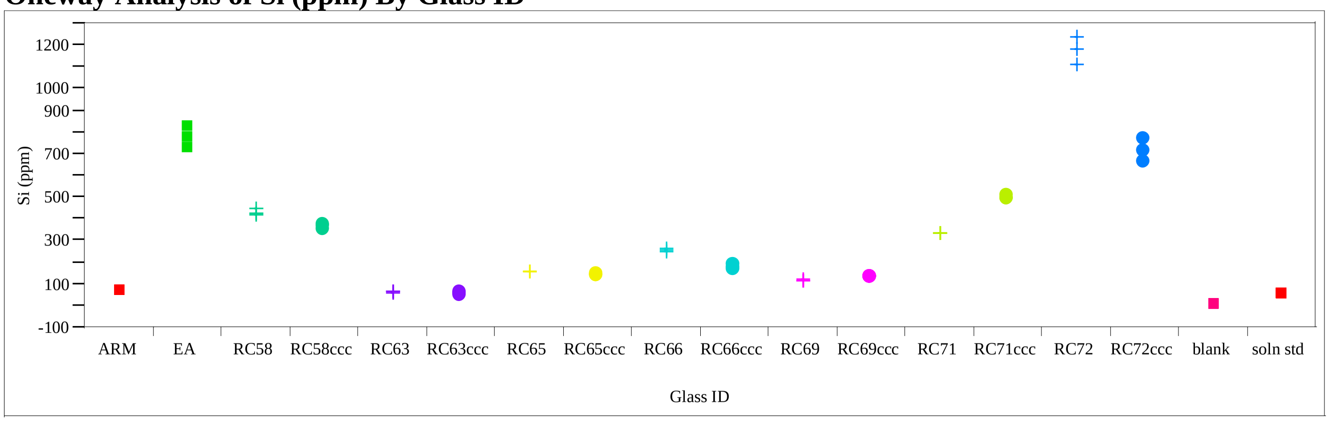
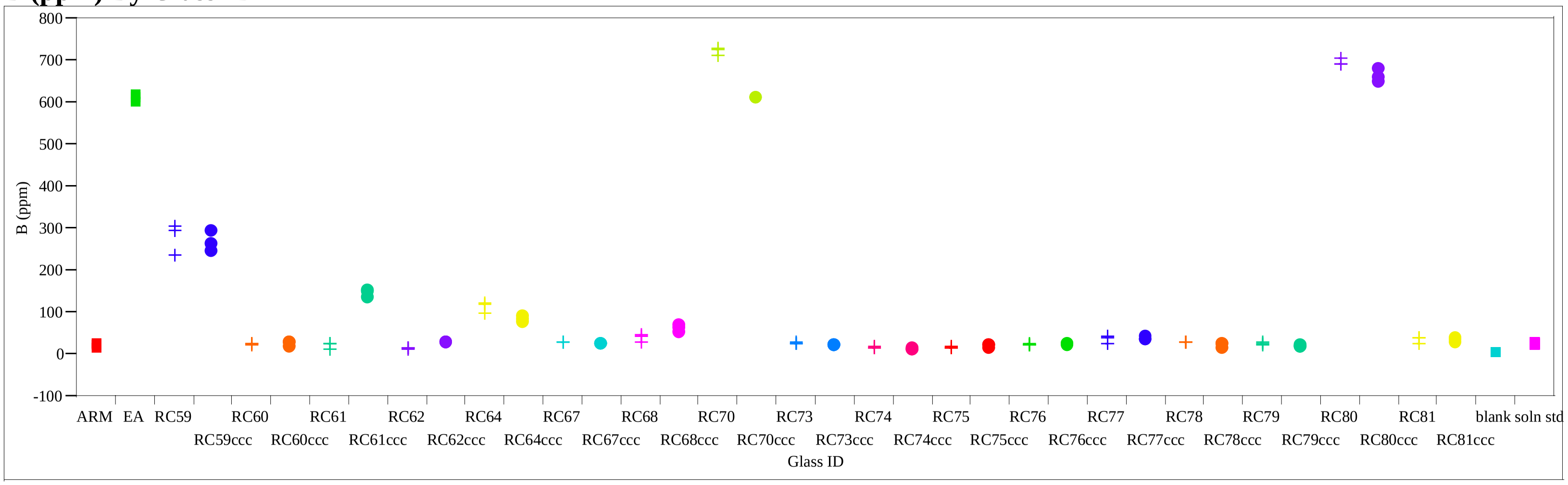


Exhibit B.8: SRTC-ML PCT Measurements by Glass ID or Standard for Radioactive Group 1
Centerline-Cooled (ccc)

B (ppm) By Glass ID



Li (ppm) By Glass ID

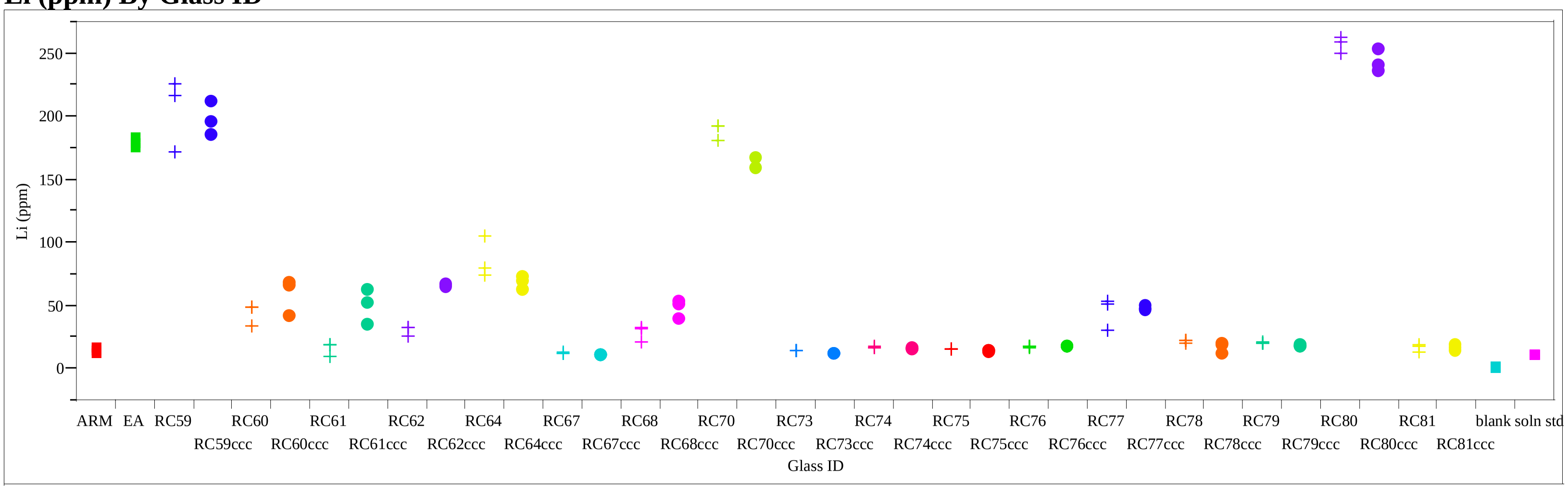
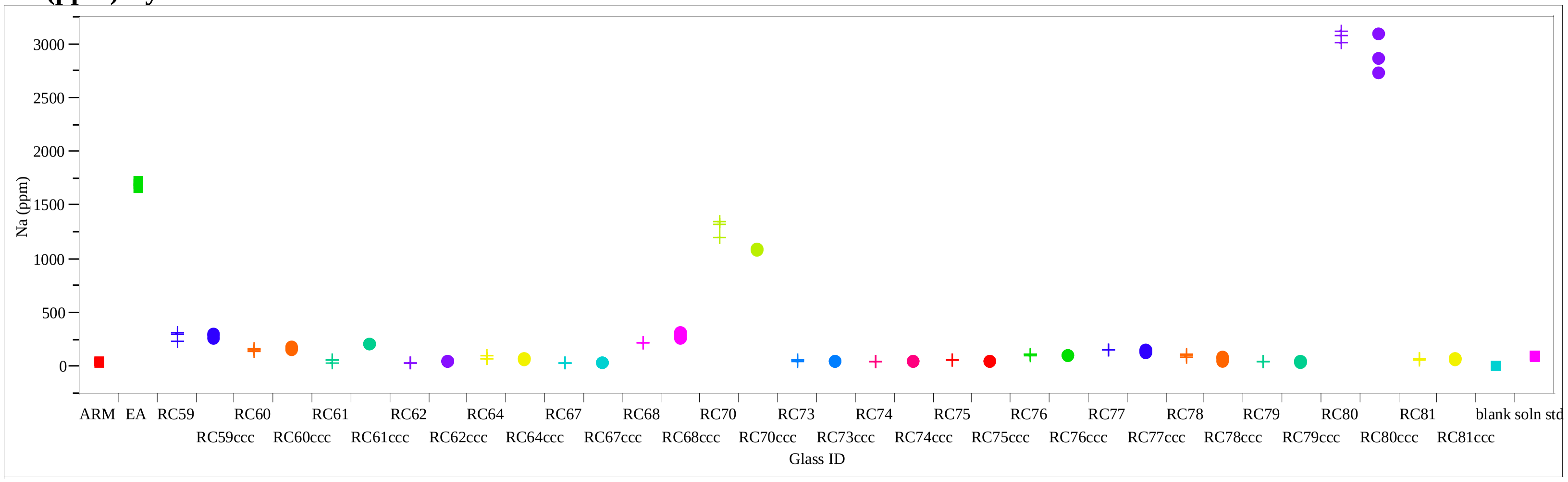


Exhibit B.8: SRTC-ML PCT Measurements by Glass ID or Standard for Radioactive Group 1
Centerline-Cooled (ccc) *Continued*

Na (ppm) By Glass ID



Si (ppm) By Glass ID

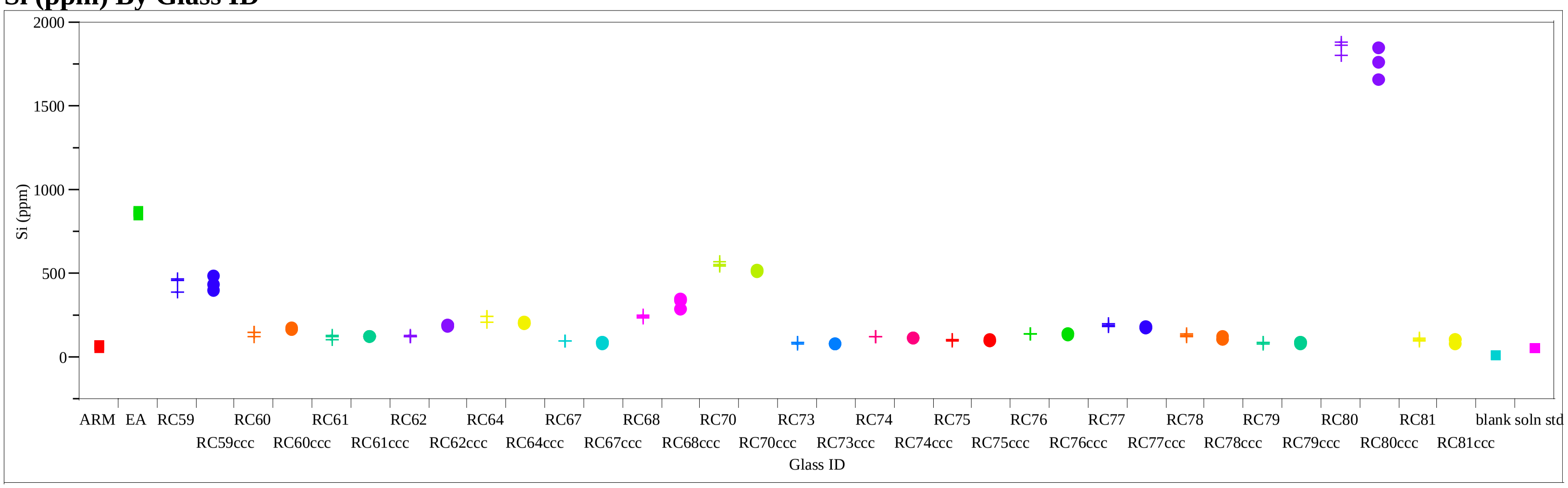
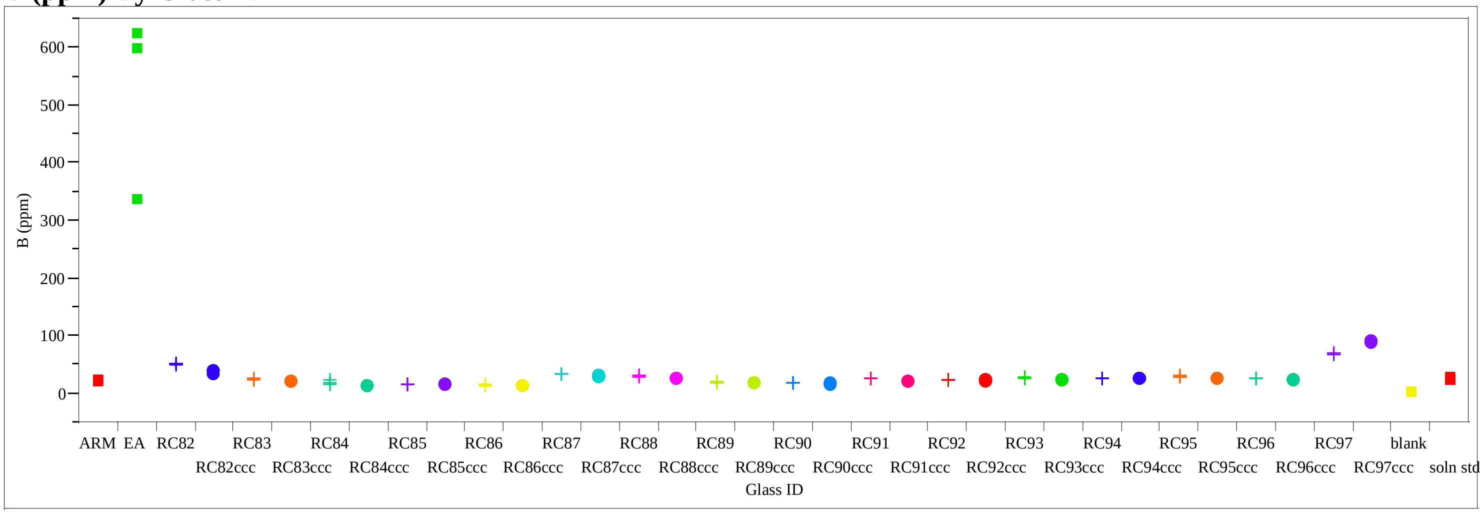


Exhibit B.9: SRTC-ML PCT Measurements by Glass ID or Standard for Radioactive Group 2 Centerline-Cooled (ccc)

B (ppm) By Glass ID



Li (ppm) By Glass ID

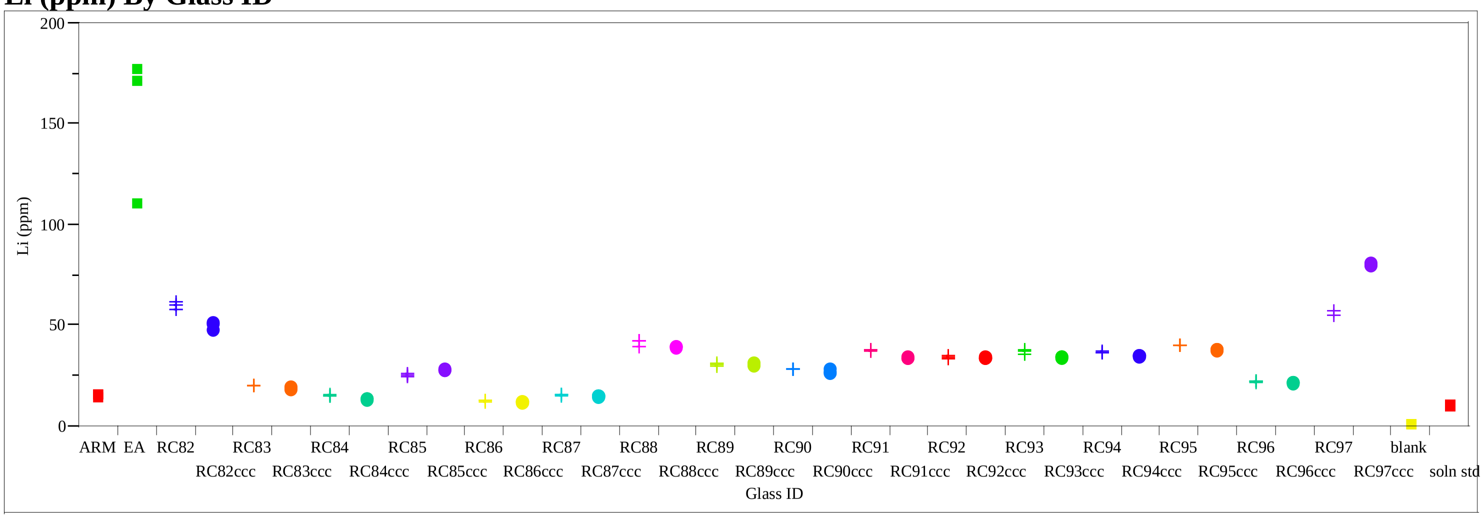
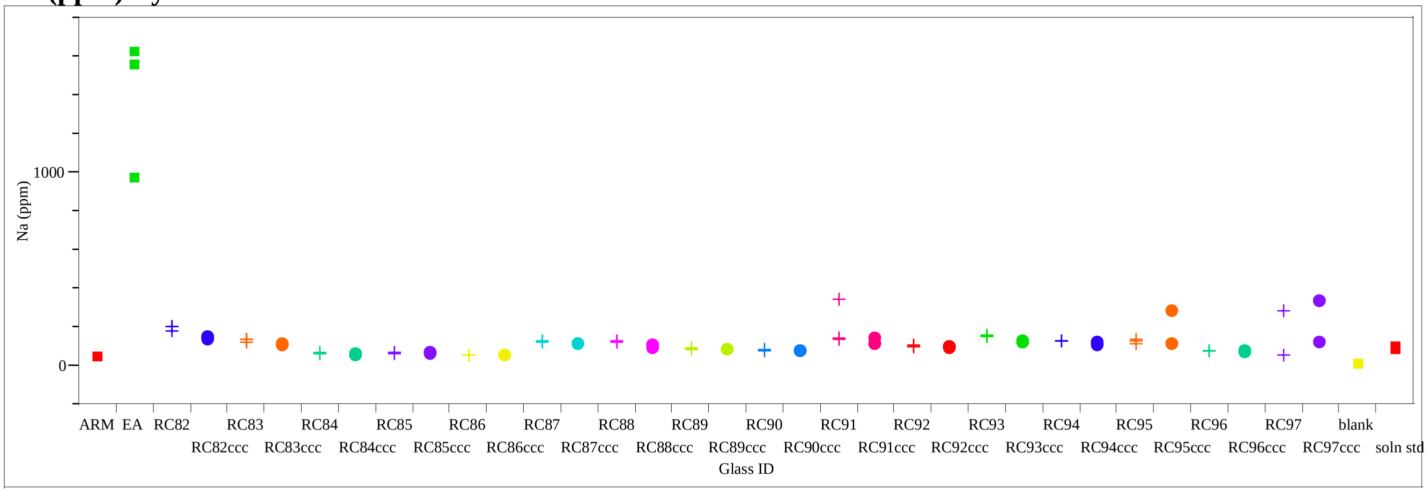


Exhibit B.9: SRTC-ML PCT Measurements by Glass ID or Standard for Radioactive Group 2
Centerline-Cooled (ccc) *Continued*

Na (ppm) By Glass ID



Si (ppm) By Glass ID

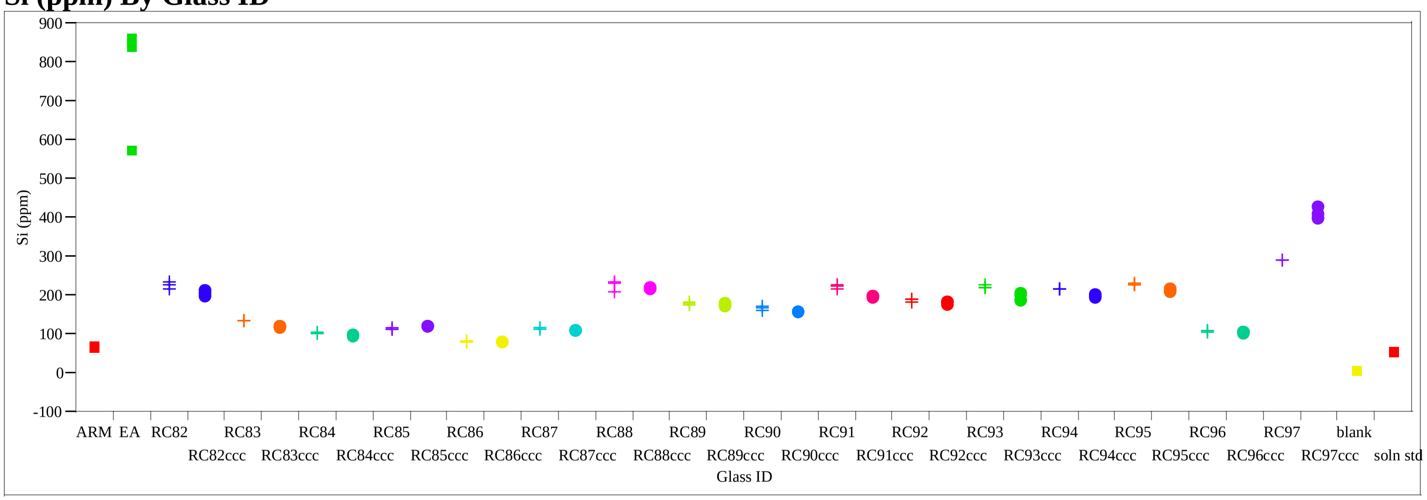
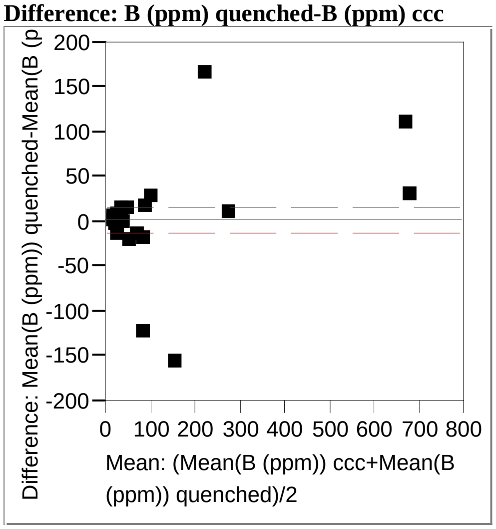


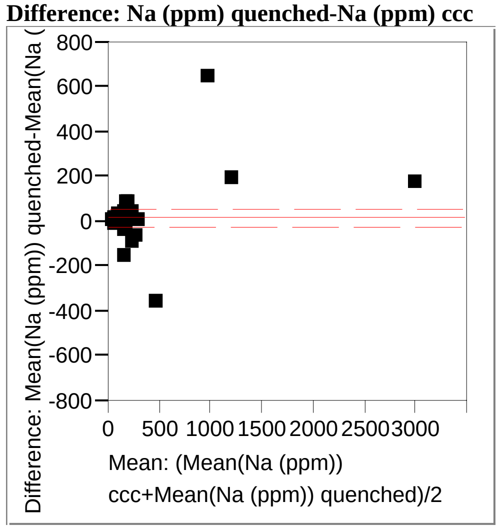
Exhibit B.10: Pairwise Comparisons between the PCTs (in ppm) for the Two Heat Treatments (Quenched and Centerline-Cooled)

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



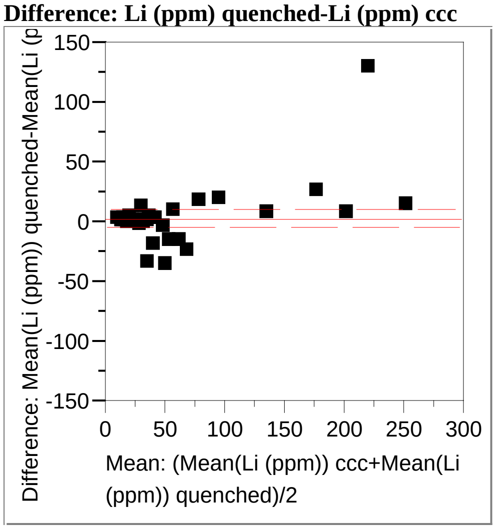
Mean(B (ppm)) quenched	80.9383	t-Ratio	0.343064
Mean(B (ppm)) ccc	78.4275	DF	39
Mean Difference	2.51083	Prob > |t|	0.7334
Std Error	7.31885	Prob > t	0.3667
Upper95%	17.3146	Prob < t	0.6333
Lower95%	-12.293		
N	40		
Correlation	0.95788		

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



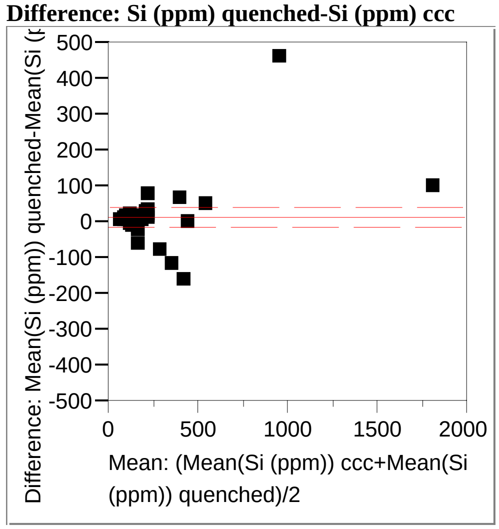
Mean(Na (ppm)) quenched	255.268	t-Ratio	0.959707
Mean(Na (ppm)) ccc	235.447	DF	39
Mean Difference	19.8217	Prob > |t|	0.3431
Std Error	20.6539	Prob > t	0.1716
Upper95%	61.5981	Prob < t	0.8284
Lower95%	-21.955		
N	40		
Correlation	0.97145		

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



Mean(Li (ppm)) quenched	54.7857	t-Ratio	0.842543
Mean(Li (ppm)) ccc	51.6131	DF	39
Mean Difference	3.17267	Prob > |t|	0.4046
Std Error	3.76558	Prob > t	0.2023
Upper95%	10.7893	Prob < t	0.7977
Lower95%	-4.4439		
N	40		
Correlation	0.94323		

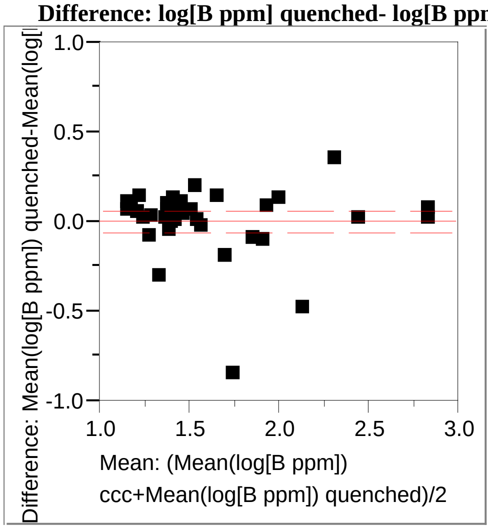
Difference: Si (ppm) quenched-Si (ppm) ccc



Mean(Si (ppm)) quenched	254.362	t-Ratio	0.993578
Mean(Si (ppm)) ccc	240.985	DF	39
Mean Difference	13.3767	Prob > |t|	0.3266
Std Error	13.4631	Prob > t	0.1633
Upper95%	40.6084	Prob < t	0.8367
Lower95%	-13.855		
N	40		
Correlation	0.96773		

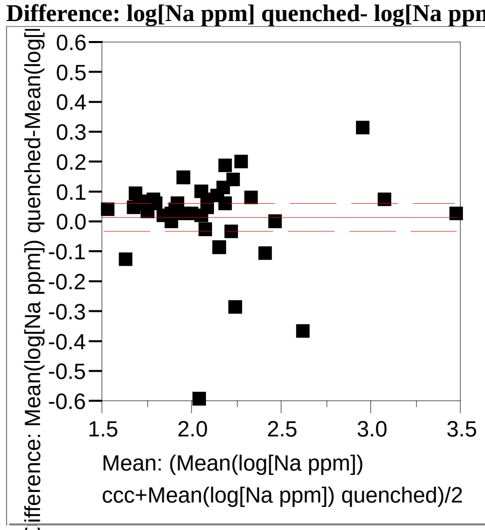
Exhibit B.11: Pairwise Comparisons between the PCTs (in log ppm) for the Two Heat Treatments (Quenched and Centerline-Cooled)

Difference: log[B ppm] quenched- log[B ppm] ccc



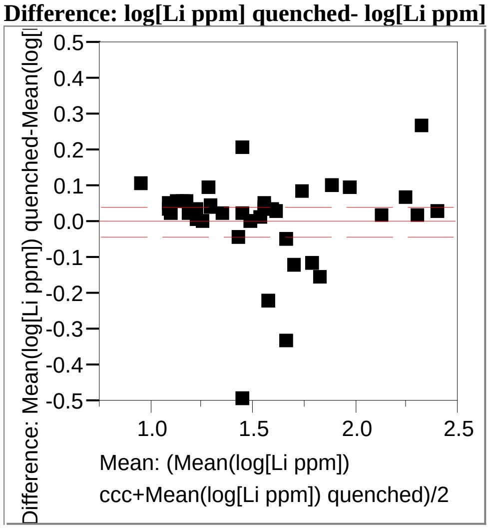
Mean(log[B ppm]) quenched	1.58886	t-Ratio	0.14291
Mean(log[B ppm]) ccc	1.58453	DF	39
Mean Difference	0.00433	Prob > |t|	0.8871
Std Error	0.03028	Prob > t	0.4435
Upper95%	0.06557	Prob < t	0.5565
Lower95%	-0.0569		
N	40		
Correlation	0.90118		

Difference: log[Na ppm] quenched- log[Na ppm] ccc



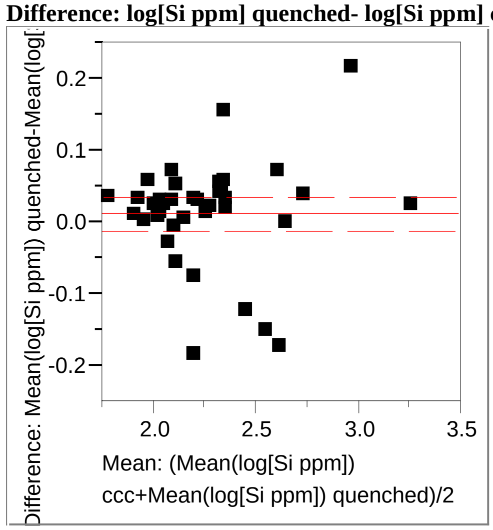
Mean(log[Na ppm]) quenched	2.11139	t-Ratio	0.674896
Mean(log[Na ppm]) ccc	2.09521	DF	39
Mean Difference	0.01619	Prob > |t|	0.5037
Std Error	0.02399	Prob > t	0.2519
Upper95%	0.06471	Prob < t	0.7481
Lower95%	-0.0323		
N	40		
Correlation	0.92827		

Difference: log[Li ppm] quenched- log[Li ppm] ccc



Mean(log[Li ppm]) quenched	1.54089	t-Ratio	0.096057
Mean(log[Li ppm]) ccc	1.53893	DF	39
Mean Difference	0.00196	Prob > |t|	0.9240
Std Error	0.02036	Prob > t	0.4620
Upper95%	0.04313	Prob < t	0.5380
Lower95%	-0.0392		
N	40		
Correlation	0.94184		

Difference: log[Si ppm] quenched- log[Si ppm] ccc



Mean(log[Si ppm]) quenched	2.26452	t-Ratio	1.045547
Mean(log[Si ppm]) ccc	2.25222	DF	39
Mean Difference	0.0123	Prob > |t|	0.3022
Std Error	0.01176	Prob > t	0.1511
Upper95%	0.03609	Prob < t	0.8489
Lower95%	-0.0115		
N	40		
Correlation	0.96886		

Exhibit B.12: 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	0.9801	0.9691	0.9350
log NL[Li(g/L)]	0.9801	1.0000	0.9546	0.9472
log NL[Na (g/L)]	0.9691	0.9546	1.0000	0.9365
log NL[Si (g/L)]	0.9350	0.9472	0.9365	1.0000

Scatterplot Matrix

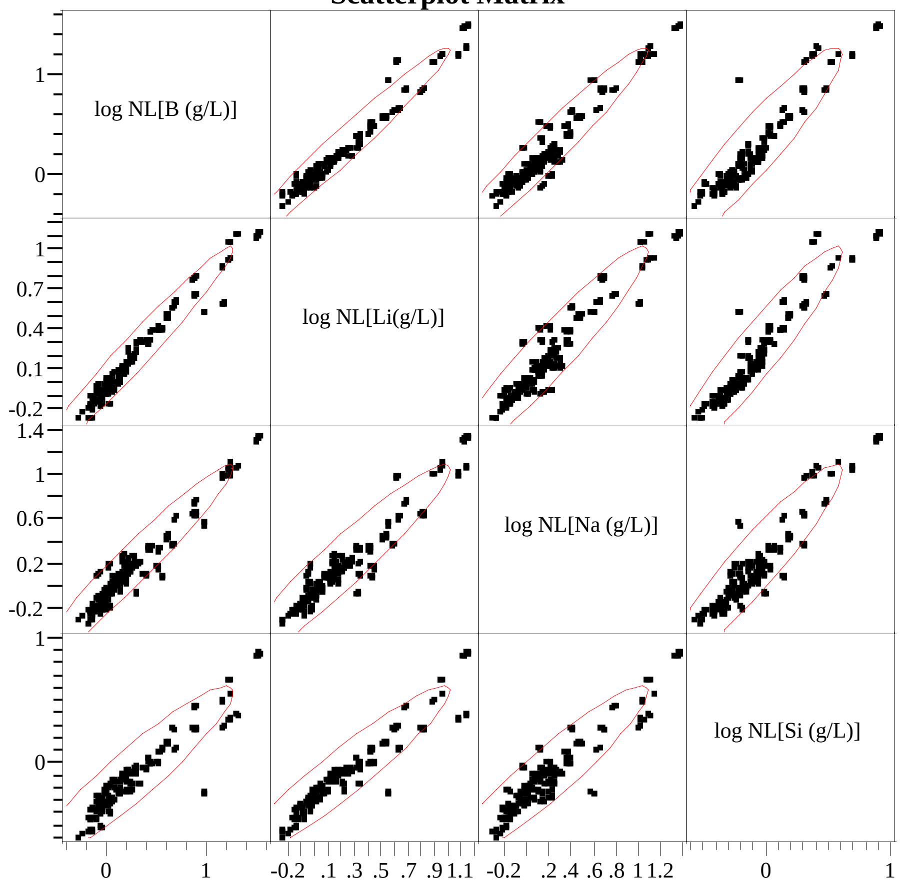
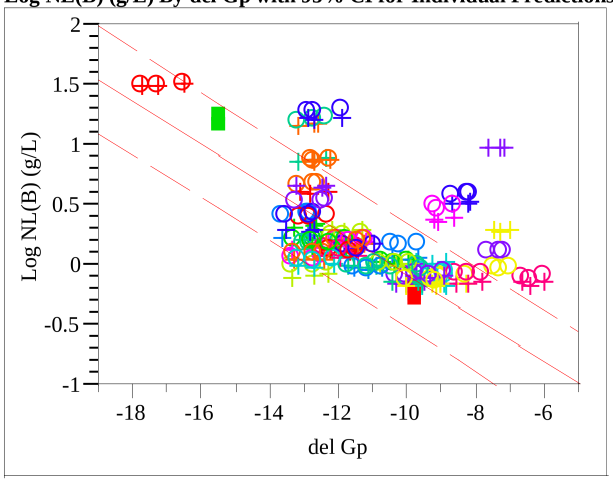


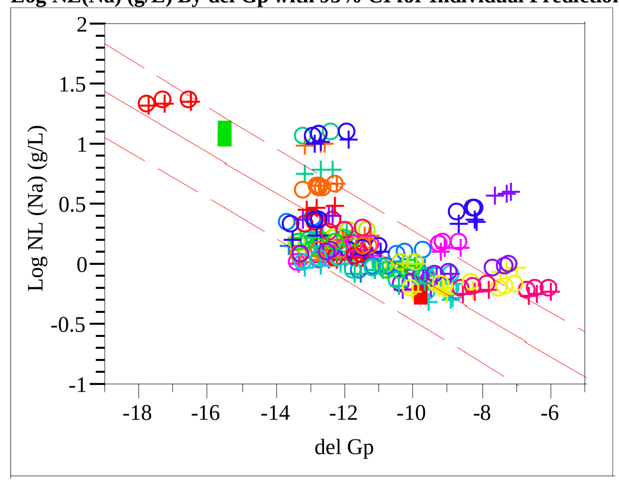
Exhibit B.13: del Gp (ΔG_p) Predictions versus Common Logarithm Normalized Leachate (log NL[.]) for B, Li, Na, and Si by Compositional View/Heat Treatment

All Data

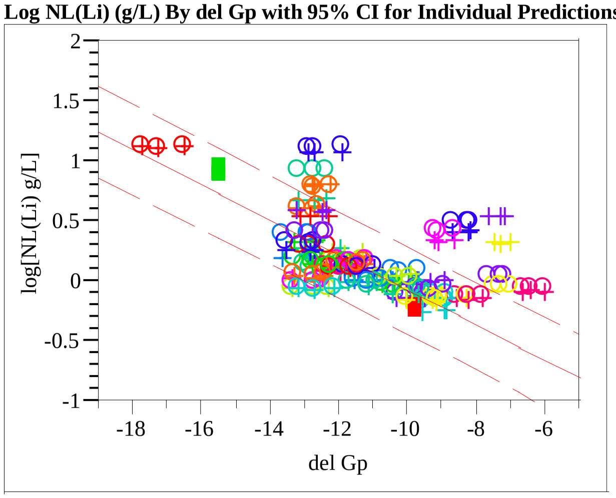
Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions



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 Individual Predictions



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

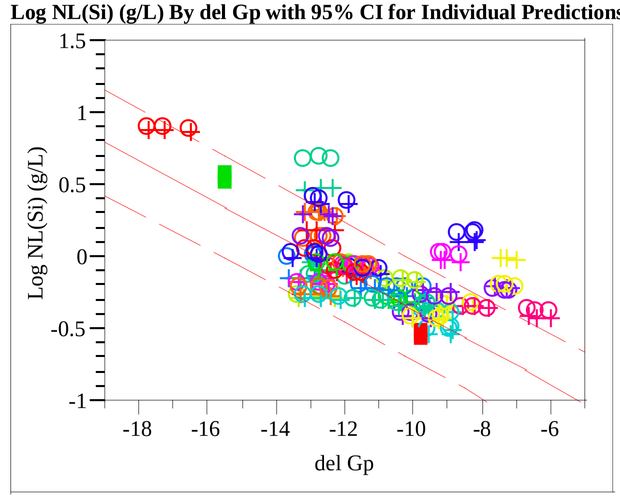
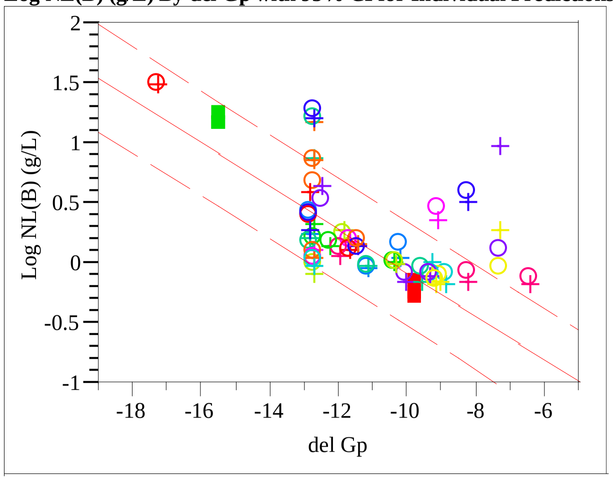


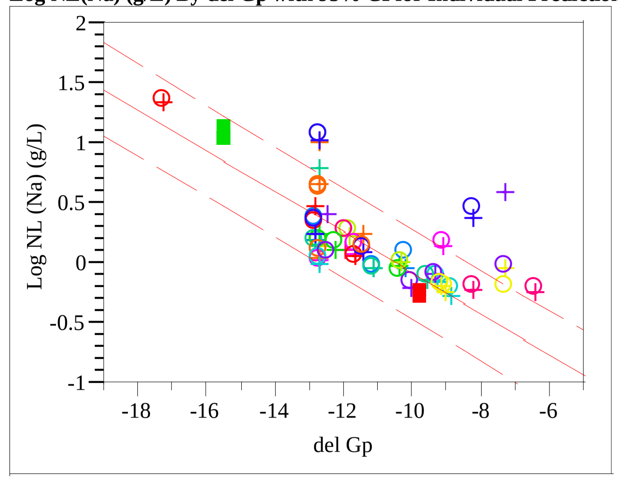
Exhibit B.13: del Gp (ΔG_p) Predictions versus Common Logarithm Normalized Leachate (log NL[.]) for B, Li, Na, and Si by Compositional View/Heat Treatment *(continued)*

Targeted Compositions

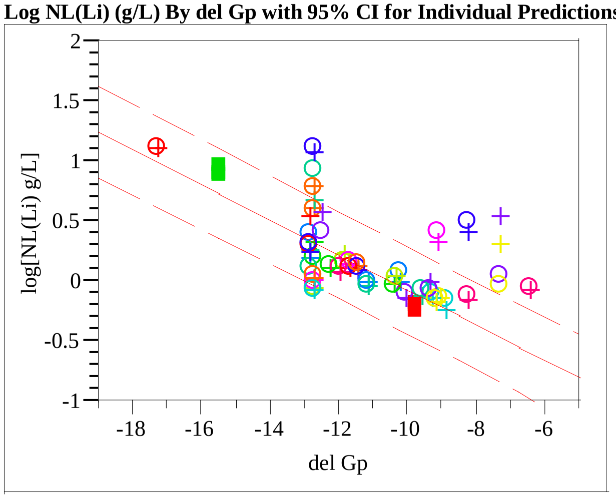
Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions



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

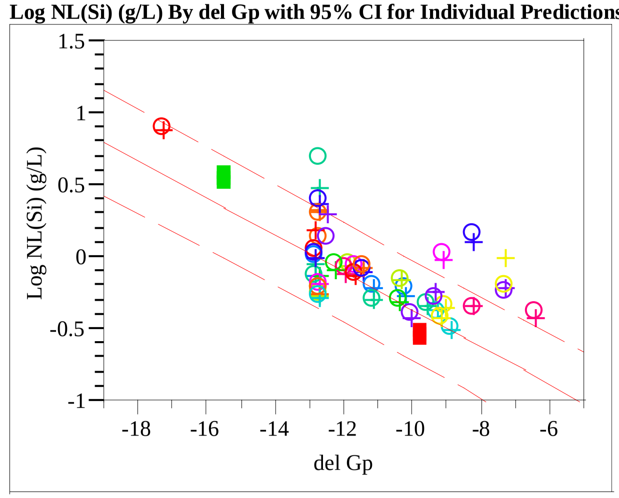
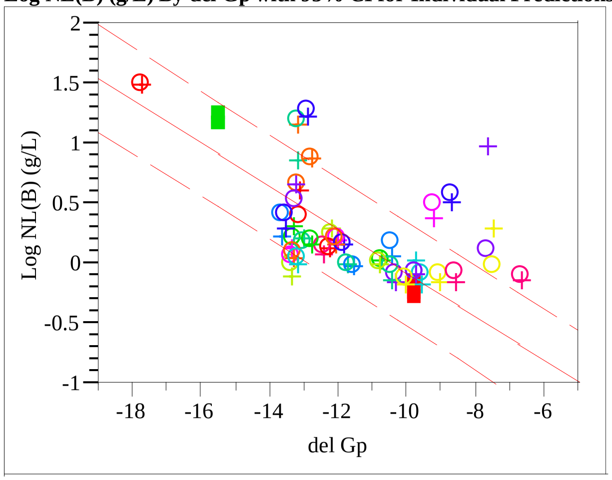


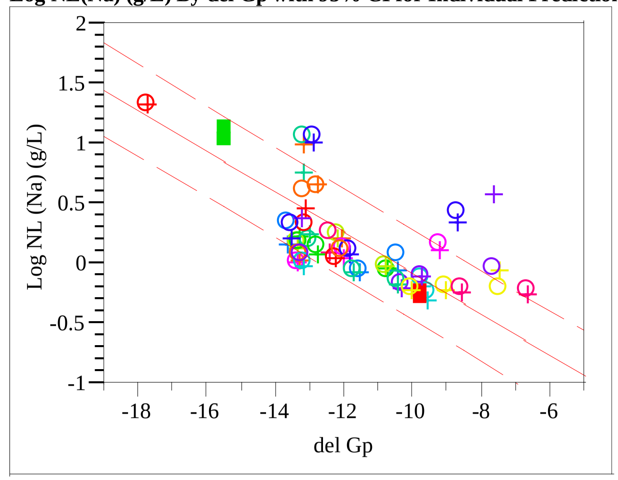
Exhibit B.13: del Gp (ΔG_p) Predictions versus Common Logarithm Normalized Leachate (log NL[.]) for B, Li, Na, and Si by Compositional View/Heat Treatment *(continued)*

Measured Compositions

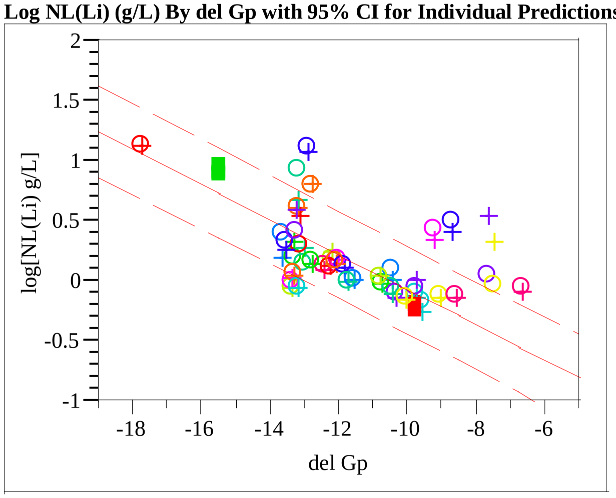
Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions



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

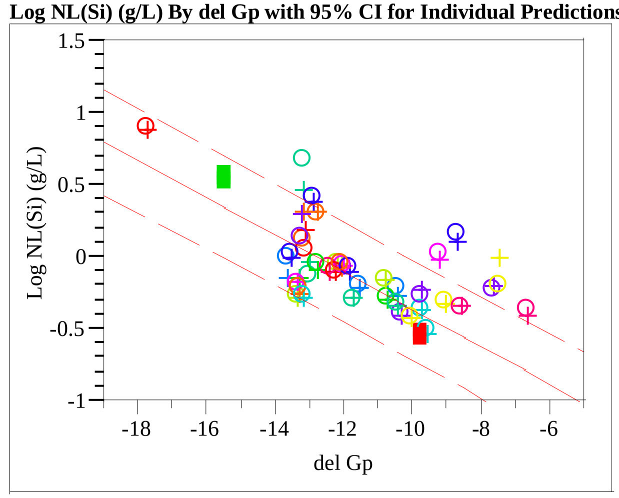
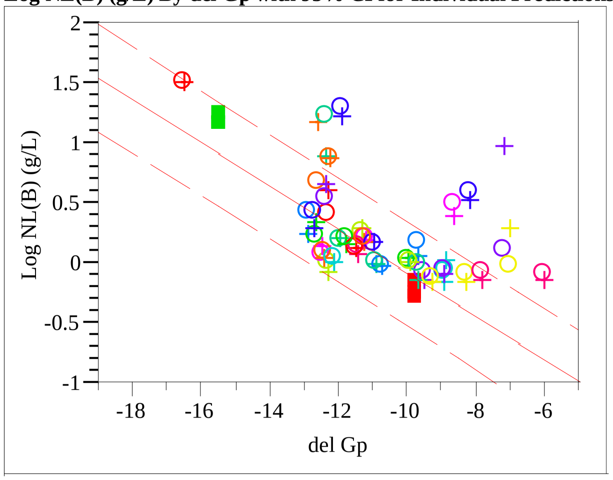


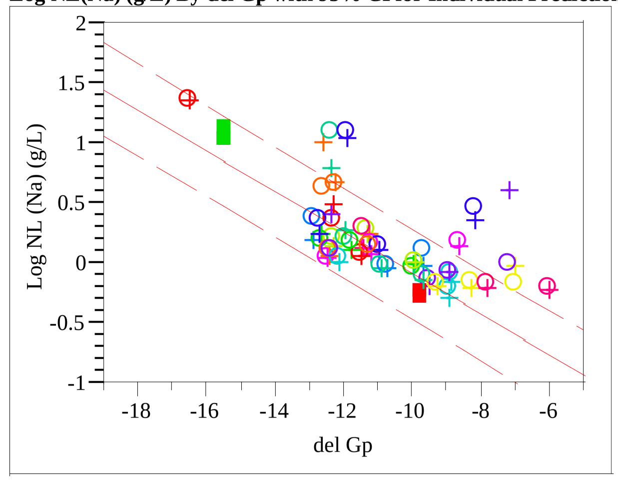
Exhibit B.13: del Gp (ΔG_p) Predictions versus Common Logarithm Normalized Leachate (log NL[.]) for B, Li, Na, and Si by Compositional View/Heat Treatment *(continued)*

Measured bc Compositions

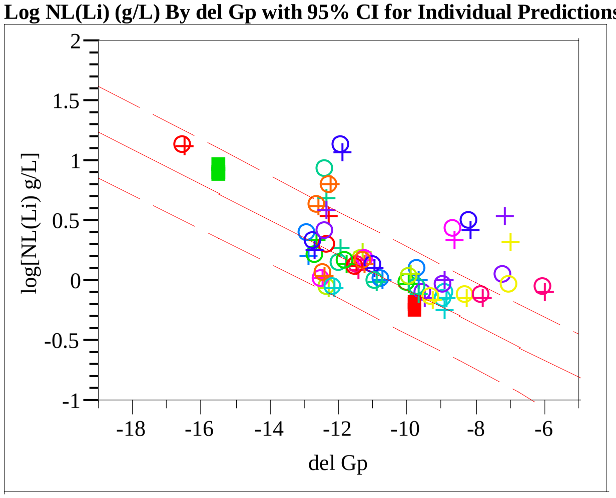
Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions



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

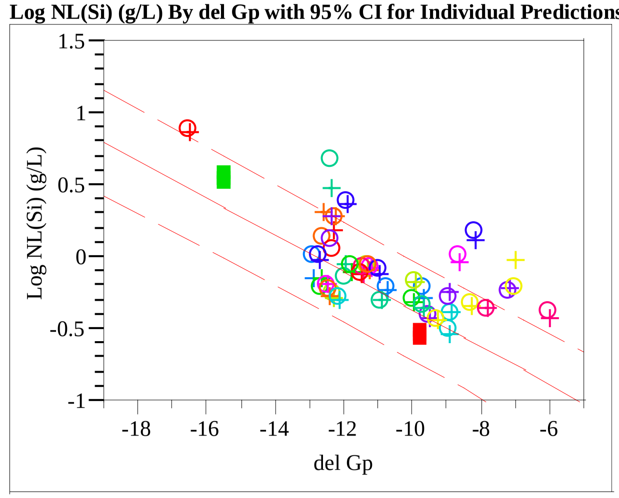
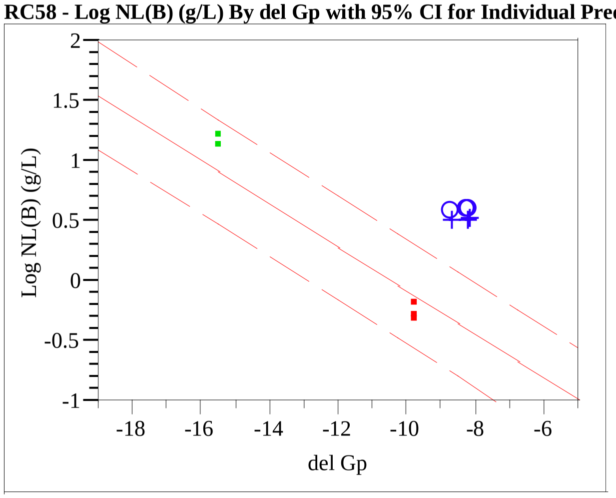
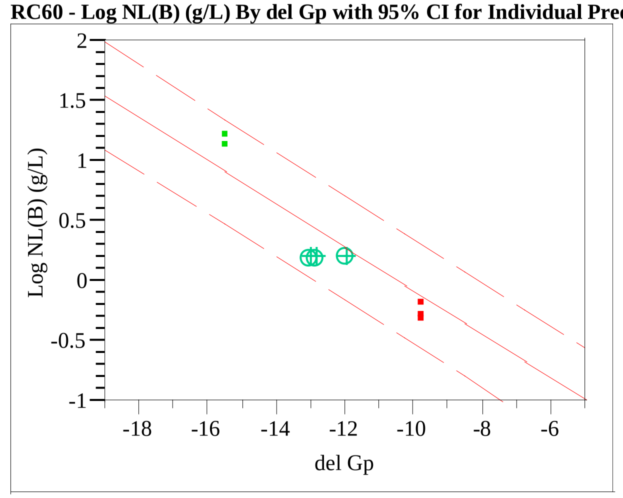


Exhibit B.14: del Gp (ΔG_p) Predictions versus Common Logarithm Normalized Leachate for B, (log NL[.]) by Glass ID – All Compositional Views/Heat Treatments with EA and ARM

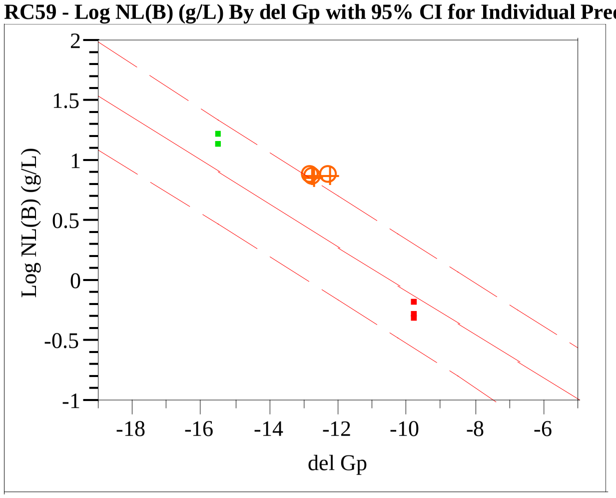
RC58 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions



RC60 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions



RC59 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions



RC61 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions

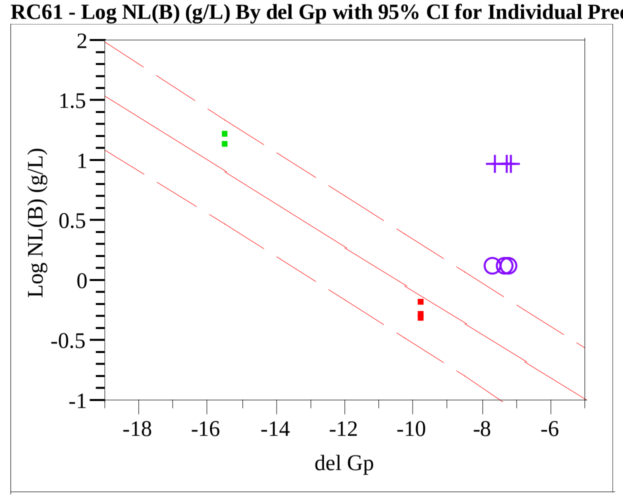
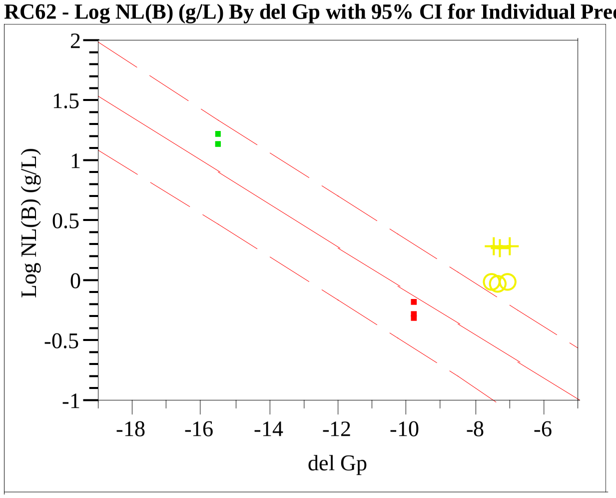
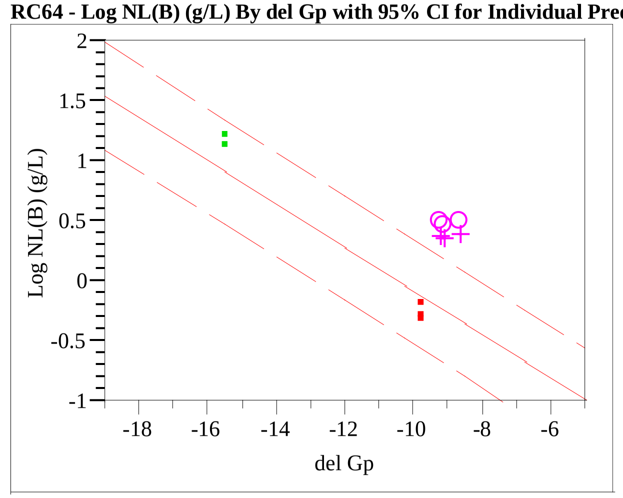


Exhibit B.14: del Gp (ΔG_p) Predictions versus Common Logarithm Normalized Leachate for B, (log NL[.]) by Glass ID – All Compositional Views/Heat Treatments with EA and ARM *(continued)*

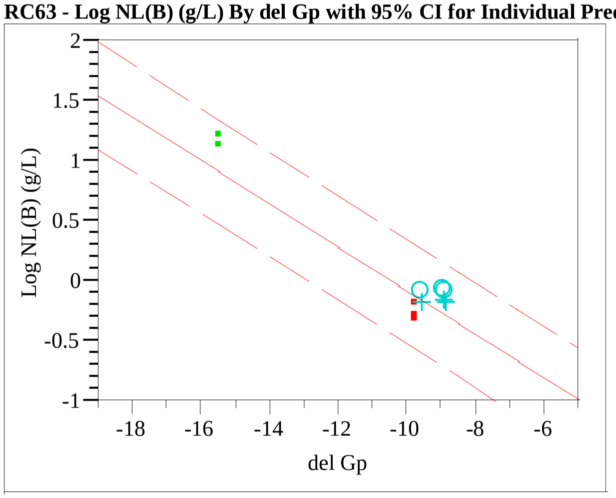
RC62 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions



RC64 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions



RC63 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions



RC65 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions

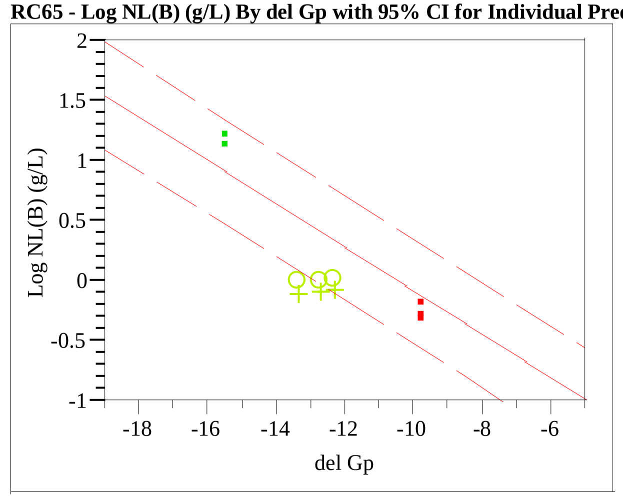
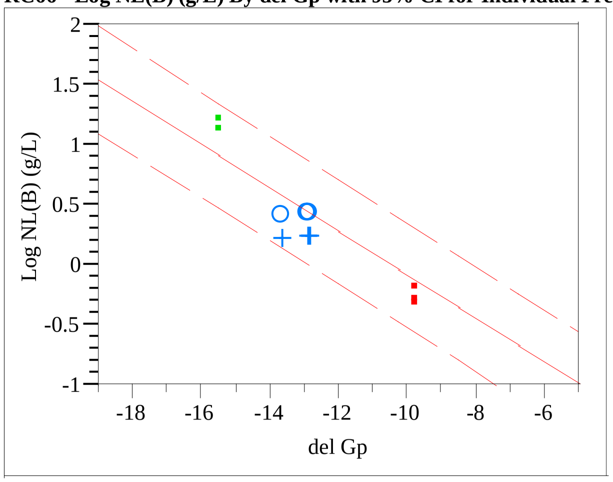
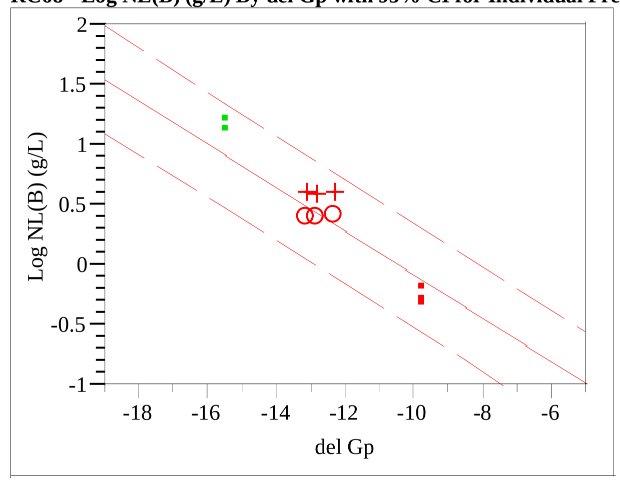


Exhibit B.14: del Gp (ΔG_p) Predictions versus Common Logarithm Normalized Leachate for B, (log NL[.]) by Glass ID – All Compositional Views/Heat Treatments with EA and ARM *(continued)*

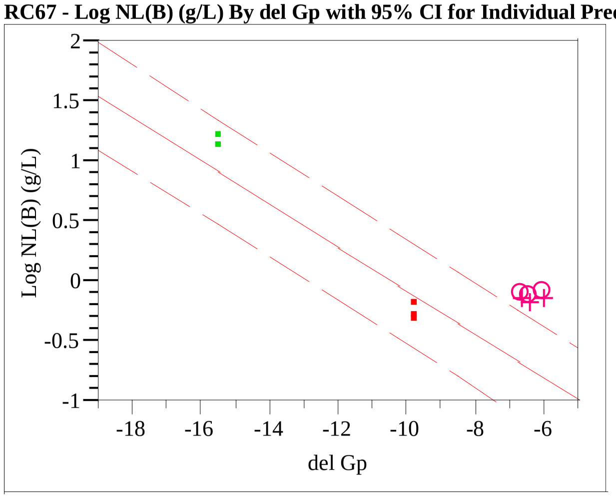
RC66 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions



RC68 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions



RC67 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions



RC69 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions

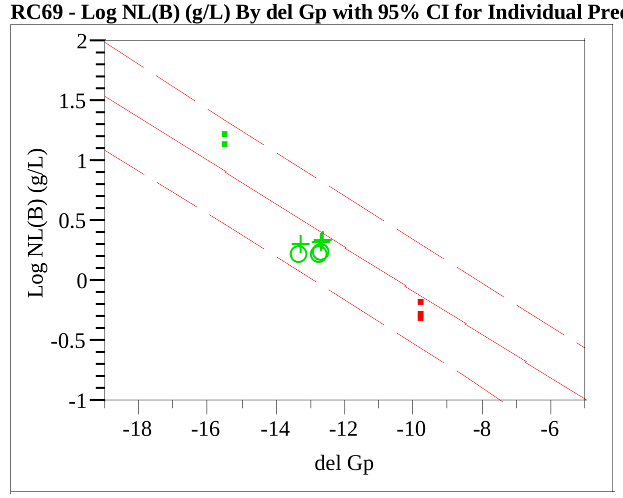
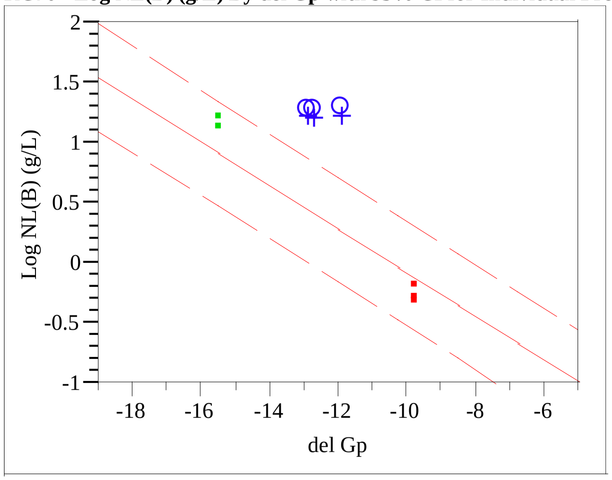
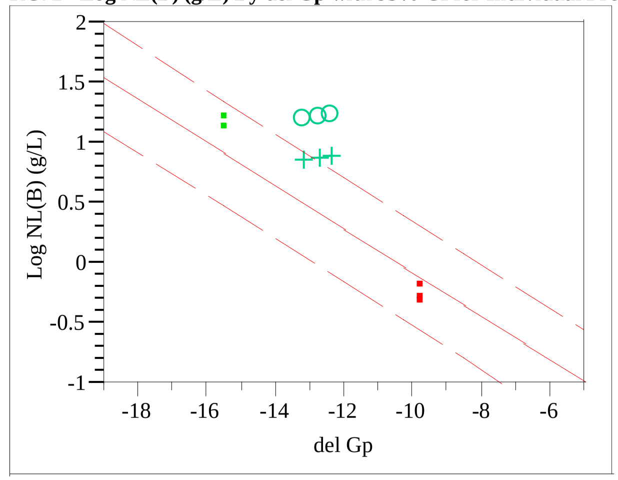


Exhibit B.14: del Gp (ΔG_p) Predictions versus Common Logarithm Normalized Leachate for B, (log NL[.]) by Glass ID – All Compositional Views/Heat Treatments with EA and ARM *(continued)*

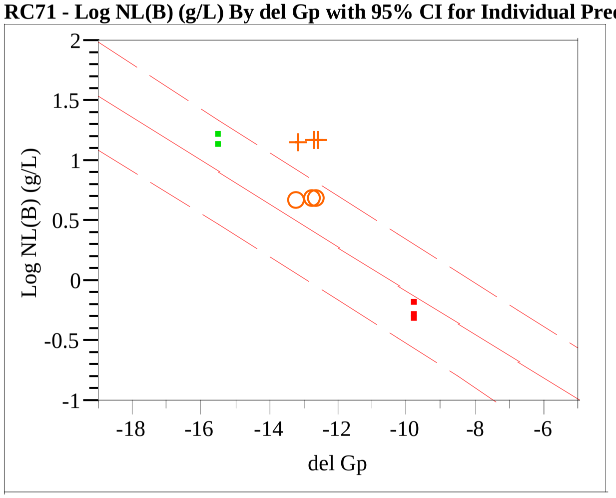
RC70 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions



RC72 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions



RC71 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions



RC73 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions

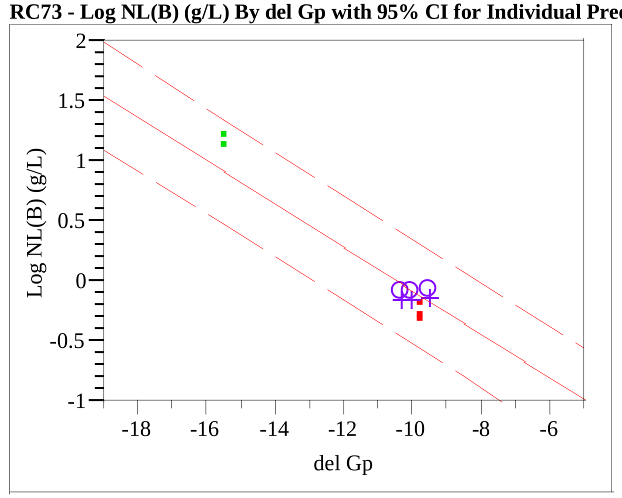
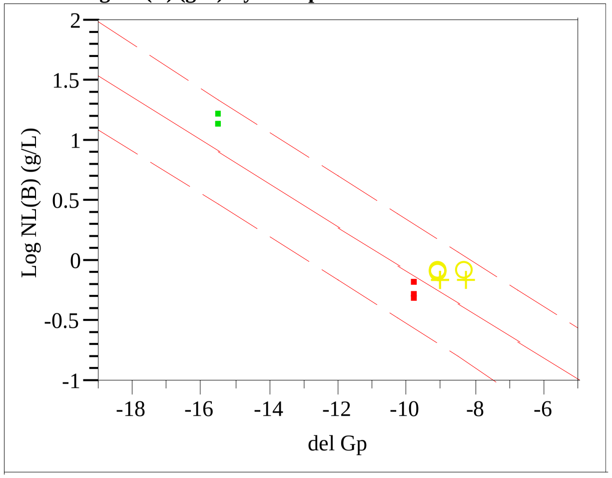
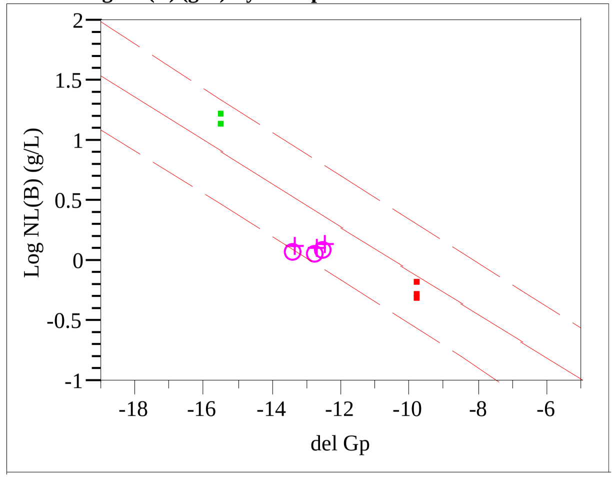


Exhibit B.14: del Gp (ΔG_p) Predictions versus Common Logarithm Normalized Leachate for B, (log NL[.]) by Glass ID – All Compositional Views/Heat Treatments with EA and ARM *(continued)*

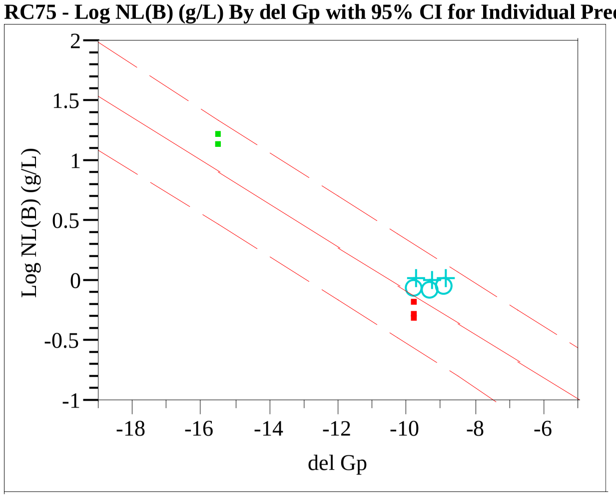
RC74 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions



RC76 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions



RC75 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions



RC77 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions

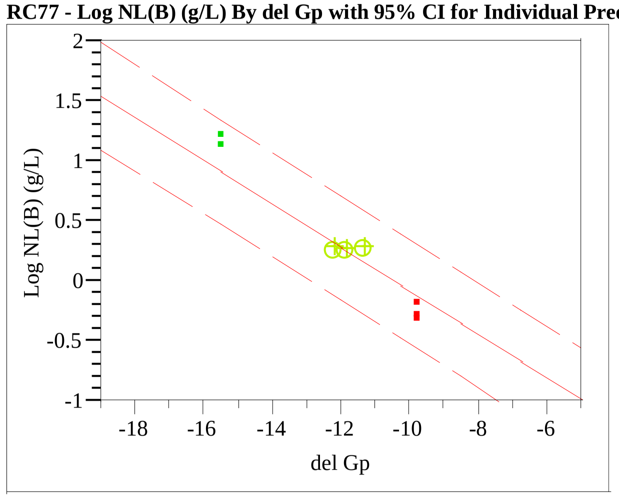
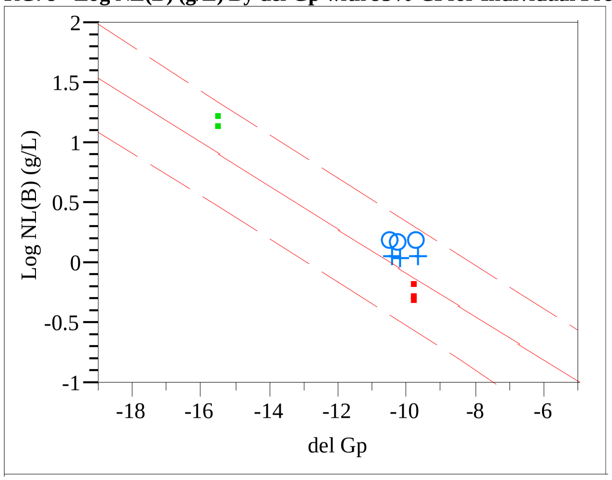
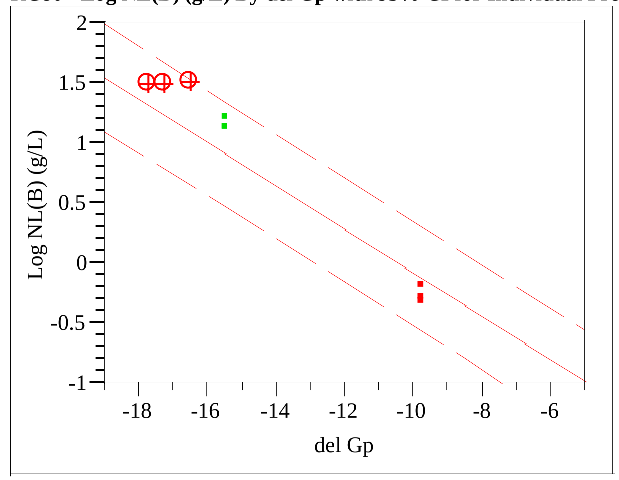


Exhibit B.14: del Gp (ΔG_p) Predictions versus Common Logarithm Normalized Leachate for B, (log NL[.]) by Glass ID – All Compositional Views/Heat Treatments with EA and ARM *(continued)*

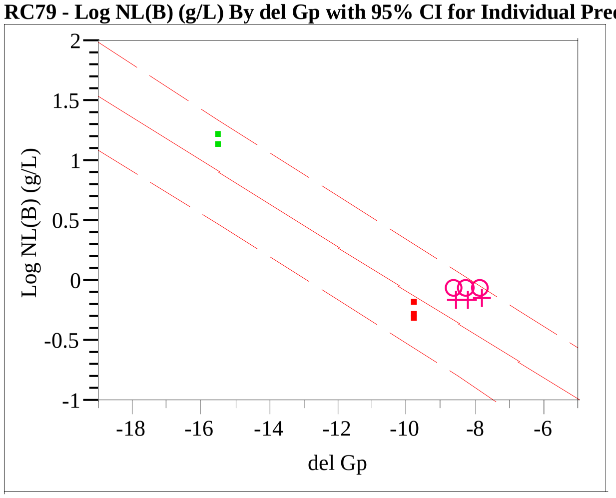
RC78 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions



RC80 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions



RC79 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions



RC81 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions

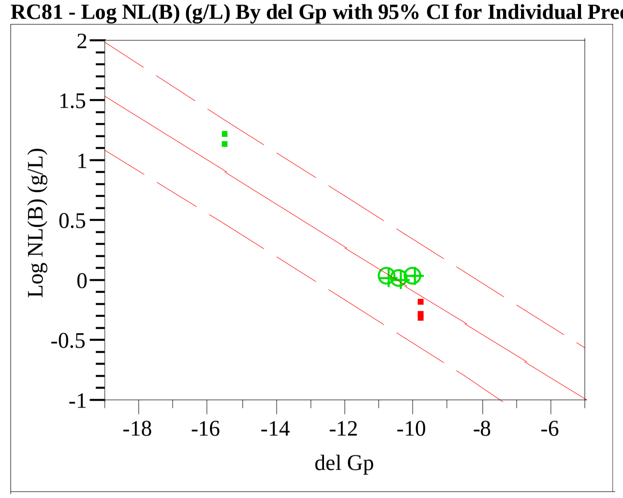
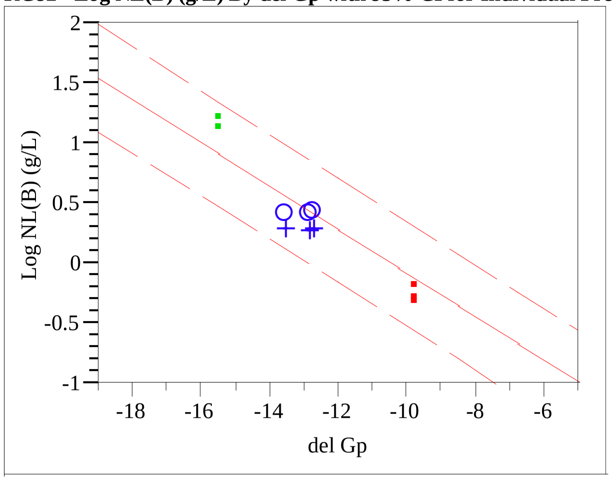
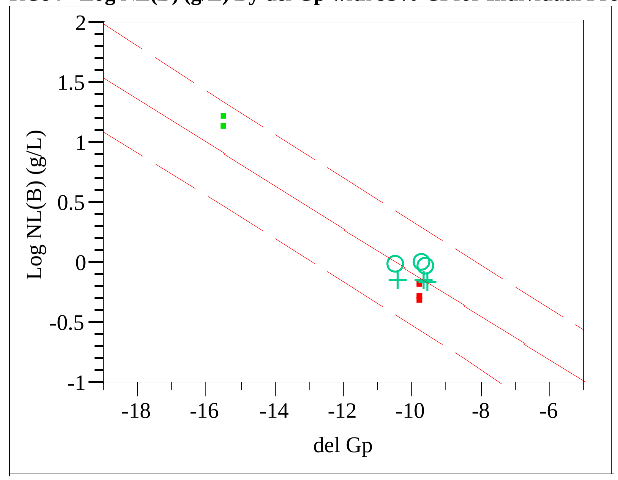


Exhibit B.14: del Gp (ΔG_p) Predictions versus Common Logarithm Normalized Leachate for B, (log NL[.]) by Glass ID – All Compositional Views/Heat Treatments with EA and ARM *(continued)*

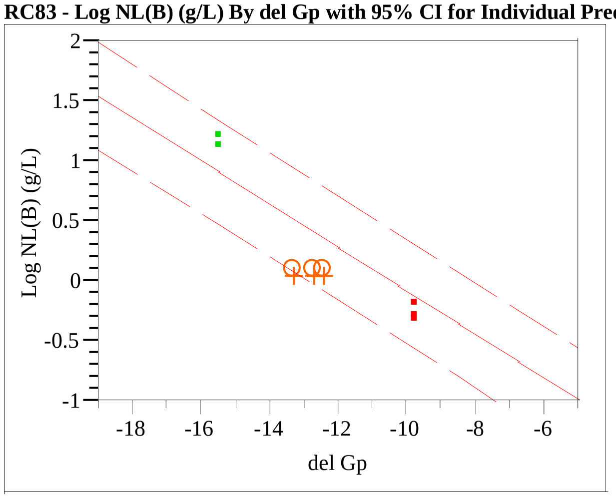
RC82 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions



RC84 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions



RC83 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions



RC85 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions

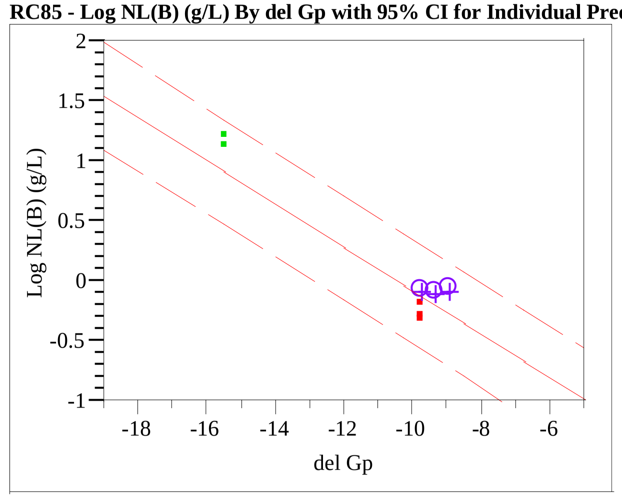
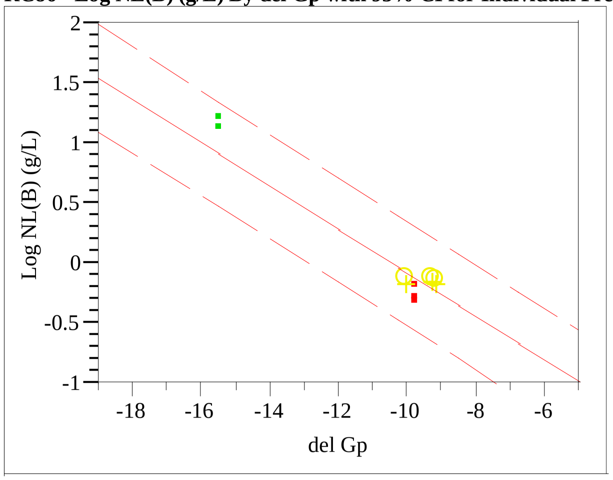
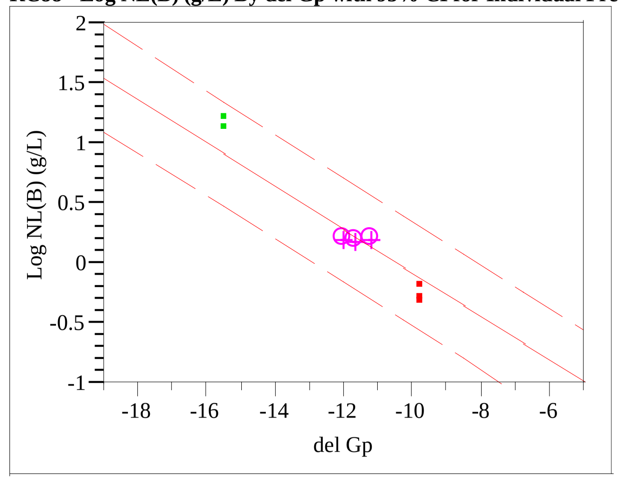


Exhibit B.14: del Gp (ΔG_p) Predictions versus Common Logarithm Normalized Leachate for B, (log NL[.]) by Glass ID – All Compositional Views/Heat Treatments with EA and ARM *(continued)*

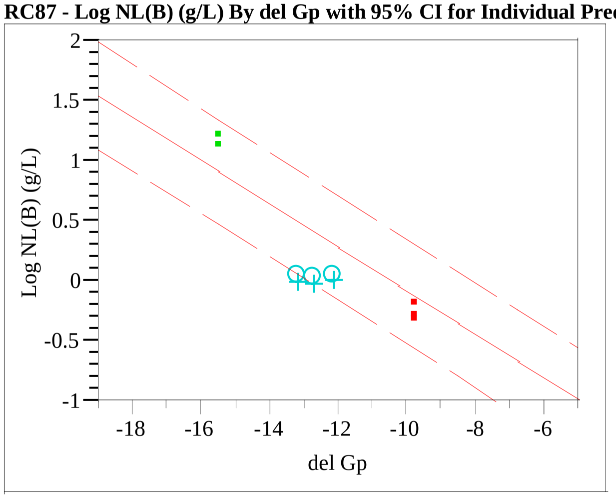
RC86 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions



RC88 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions



RC87 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions



RC89 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions

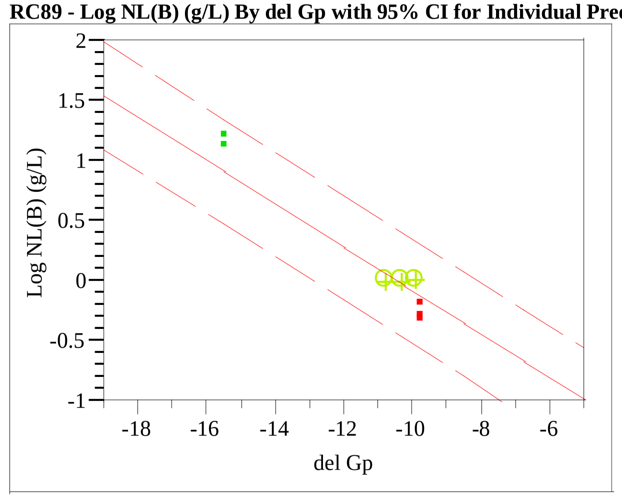
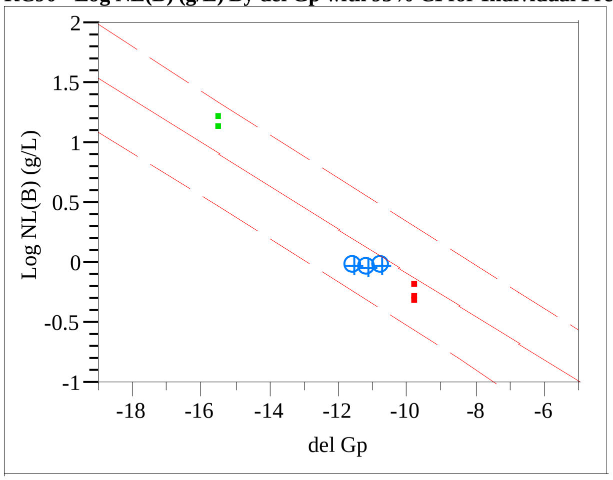
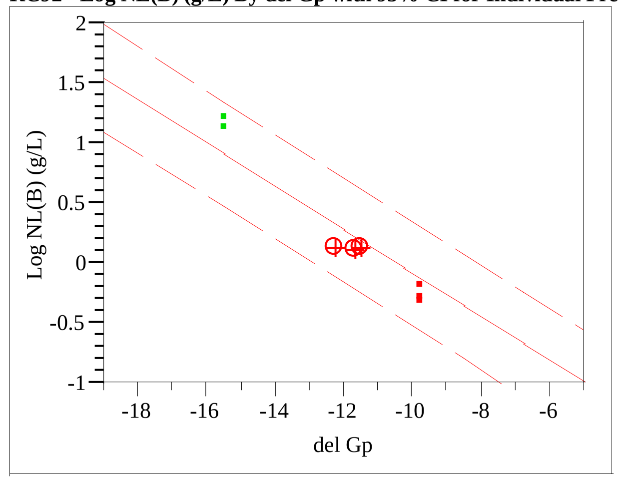


Exhibit B.14: del Gp (ΔG_p) Predictions versus Common Logarithm Normalized Leachate for B, (log NL[.]) by Glass ID – All Compositional Views/Heat Treatments with EA and ARM *(continued)*

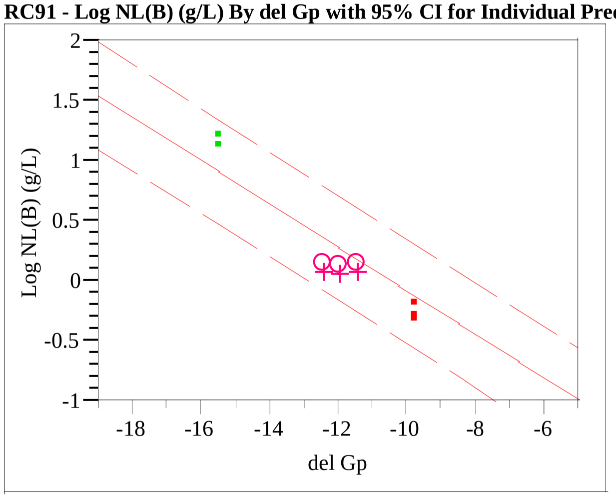
RC90 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions



RC92 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions



RC91 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions



RC93 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions

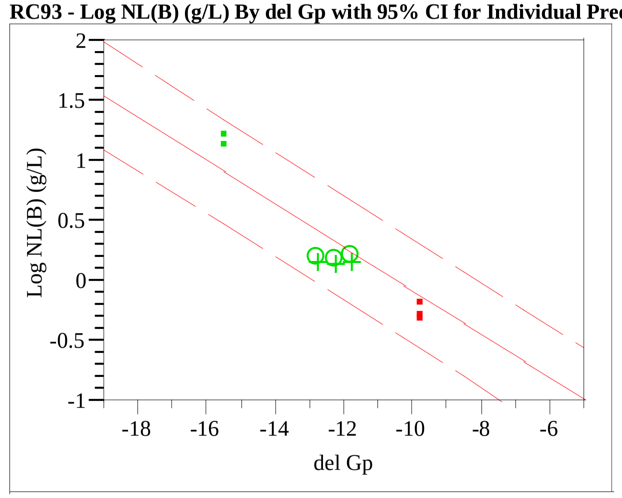
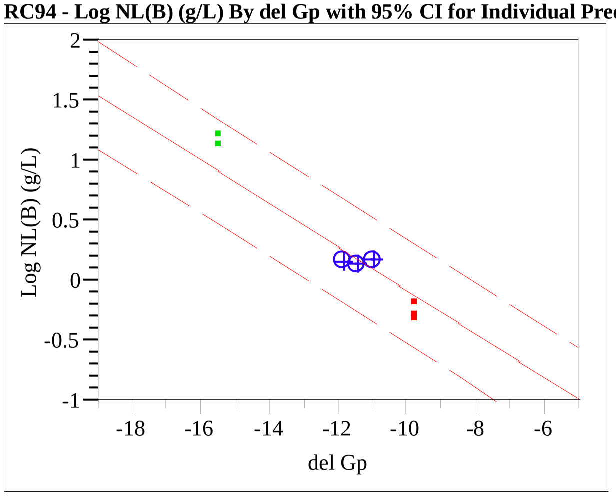
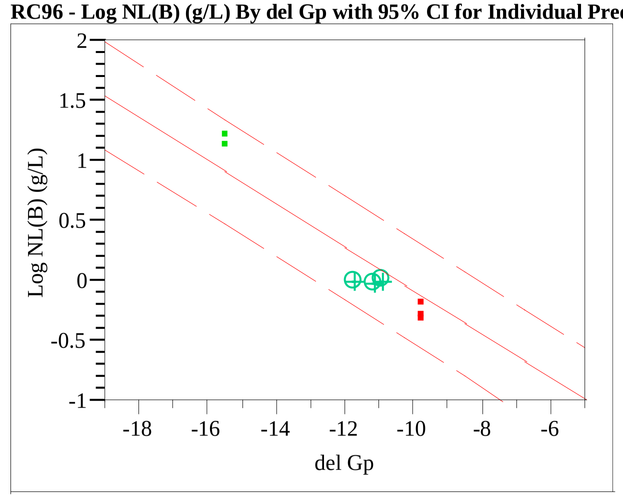


Exhibit B.14: del Gp (ΔG_p) Predictions versus Common Logarithm Normalized Leachate for B, (log NL[.]) by Glass ID – All Compositional Views/Heat Treatments with EA and ARM *(continued)*

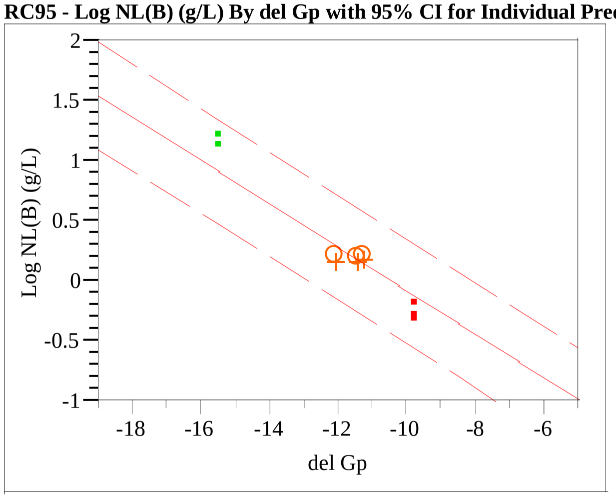
RC94 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions



RC96 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions



RC95 - Log NL(B) (g/L) By del Gp with 95% CI for Individual Predictions



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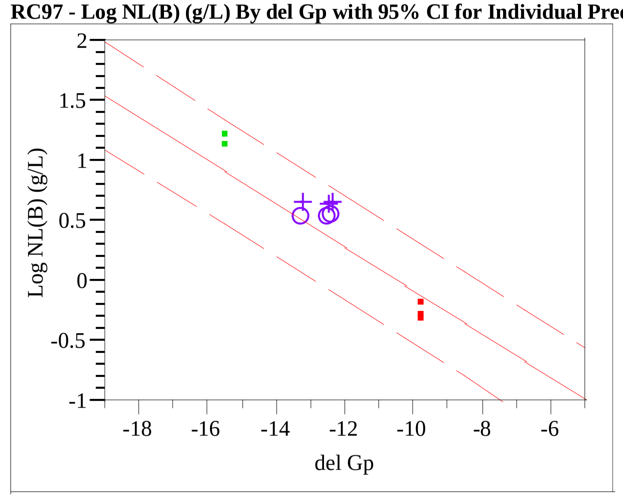

Appendix C:

Analytical Plans for the Measurement of Chemical Compositions

SRS savannah river site

WESTINGHOUSE SAVANNAH RIVER COMPANY
INTEROFFICE MEMORANDUM

SRT-SCS-2002-00029

May 22, 2002

To: A. D. Cozzi, 999-W
C. C. Herman, 773-43A

cc: D. R. Best, 773-41A (wo)
S. P. Harris, 773-42A
D. M. Marsh, 773-A
S. L. Marra, 999-W (es)
D. K. Peeler, 999-W
I. A. Reamer, 773-A
R. C. Tuckfield, 773-42A
V. J. Williams, 773-A
R. J. Workman, 999-1W

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

wo – without glass identifiers
es – executive summary only

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

R. C. Tuckfield, Manager, Statistical Consulting Section — Date: 5/23/02

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.[1]

[1] 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.

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WESTINGHOUSE SAVANNAH RIVER COMPANY
INTEROFFICE MEMORANDUM

SRT-SCS-2002-00033

May 28, 2002

To: A. D. Cozzi, 999-W
C. C. Herman, 773-43A

cc: D. R. Best, 773-41A (wo)
S. P. Harris, 773-42A (es)
D. M. Marsh, 773-A
S. L. Marra, 999-W (es)
D. K. Peeler, 999-W
I. A. Reamer, 773-A
R. C. Tuckfield, 773-42A
V. J. Williams, 773-A
R. J. Workman, 999-1W

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

wo – without glass identifiers
es – executive summary only

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

R. C. Tuckfield, Manager, Statistical Consulting Section — Date: 6/3/2002

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.[1]

[1] 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	BCHLM521	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.

savannah river site

WESTINGHOUSE SAVANNAH RIVER COMPANY
INTEROFFICE MEMORANDUM

SRT-SCS-2002-00035

May 29, 2002

To: A. D. Cozzi, 999-W
C. C. Herman, 773-43A

cc: R. A. Baker, 773-42A
D. R. Best, 773-41A (wo)
D. M. Marsh, 773-A
S. L. Marra, 999-W (es)
D. K. Peeler, 999-W
I. A. Reamer, 773-A
R. C. Tuckfield, 773-42A
V. J. Williams, 773-A
R. J. Workman, 999-1W

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

wo – without glass identifiers
es – executive summary only

R. A. Baker, Technical Reviewer — Date: 6/3/2002

R. C. Tuckfield, Manager
Statistical Consulting Section — Date: 6/3/02

An Analytical Plan for Measuring PCT Solutions for Non-Radioactive Glasses from the Reduction of Constraints and PCT Assessment Studies (U)

Appendix D:

Analytical Plans for the Measurement of PCT Leachates

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.[1]

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		

1 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.

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WESTINGHOUSE SAVANNAH RIVER COMPANY
INTEROFFICE MEMORANDUM

SRT-SCS-2002-00036

June 4, 2002

To: C. C. Herman, 773-43A

cc: A. D. Cozzi, 999-W
R. A. Baker, 773-42A
D. R. Best, 773-41A (wo)
D. M. Marsh, 773-A
S. L. Marra, 999-W (es)
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I. A. Reamer, 773-A
R. C. Tuckfield, 773-42A
V. J. Williams, 773-A
R. J. Workman, 999-1W

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

wo – without glass identifiers
es – executive summary only

R. A. Baker, Technical Reviewer — Date: 6/10/2002

R. C. Tuckfield, Manager, Statistical Consulting Section — Date: 6/10/2002

An Analytical Plan for Measuring PCT Solutions for the First Group of Radioactive Glasses from the Reduction of Constraints 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 data for the Defense Waste Processing Facility (DWPF). The Reduction of Constraints (Phase 2) study focuses on generating data to further the investigation of the constraints associated with product quality. Forty glass compositions were selected for batching and testing to support Phase 2 of this study. Thirty-three of these 40 glasses are radioactive, and a set of 17 of the 33 radioactive glasses is the focus of this analytical plan. The remaining 16 radioactive glasses from this study are to be covered in an analytical plan to follow.

The 17 study glasses covered by this analytical plan were cooled both by quenching and centerline canister cooling, and the durabilities of the resulting 34 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

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 data for the Defense Waste Processing Facility (DWPF). The Reduction of Constraints (Phase 2) study [1] focuses on generating data to further the investigation of the constraints associated with product quality. Forty glass compositions were selected for batching and testing to support Phase 2 of this study. Thirty-three of these 40 glasses are radioactive, and a set of 17 of the 33 radioactive glasses is the focus of this analytical plan. The remaining 16 radioactive glasses from this study are to be covered in an analytical plan to follow.

The 17 study glasses were cooled both by quenching and by centerline canister cooling, and the durabilities of the resulting 34 glasses are to be measured in triplicate using the Product Consistency Test, or PCT. 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 – Group 1

Quenched	Centerline Canister Cooled	Quenched	Centerline Canister Cooled
RC59	RC59ccc	RC74	RC74ccc
RC60	RC60ccc	RC75	RC75ccc
RC61	RC61ccc	RC76	RC76ccc
RC62	RC62ccc	RC77	RC77ccc
RC64	RC64ccc	RC78	RC78ccc
RC67	RC67ccc	RC79	RC79ccc
RC68	RC68ccc	RC80	RC80ccc
RC70	RC70ccc	RC81	RC81ccc
RC73	RC73ccc		

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 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, d001 through d110, 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.[1]

Table 2: Identifiers for the PCT Solutions

Original Sample	Solution Identifier	Original Sample	Solution Identifier	Original Sample	Solution Identifier	Original Sample	Solution Identifier
RC59	d101	RC67	d070	RC75	d021	RC80	d034
RC59	d043	RC67	d082	RC75	d002	RC80	d090
RC59	d104	RC67	d049	RC75	d018	RC80	d061
RC59ccc	d017	RC67ccc	d007	RC75ccc	d055	RC80ccc	d068
RC59ccc	d067	RC67ccc	d075	RC75ccc	d078	RC80ccc	d062
RC59ccc	d064	RC67ccc	d036	RC75ccc	d035	RC80ccc	d046
RC60	d097	RC68	d093	RC76	d085	RC81	d108
RC60	d094	RC68	d050	RC76	d106	RC81	d010
RC60	d006	RC68	d023	RC76	d015	RC81	d014
RC60ccc	d031	RC68ccc	d060	RC76ccc	d080	RC81ccc	d089
RC60ccc	d013	RC68ccc	d105	RC76ccc	d019	RC81ccc	d026
RC60ccc	d027	RC68ccc	d074	RC76ccc	d057	RC81ccc	d042
RC61	d028	RC70	d009	RC77	d107	EA	d087
RC61	d081	RC70	d110	RC77	d001	EA	d005
RC61	d038	RC70	d054	RC77	d045	EA	d011
RC61ccc	d072	RC70ccc	d047	RC77ccc	d029	ARM	d041
RC61ccc	d098	RC70ccc	d059	RC77ccc	d096	ARM	d095
RC61ccc	d073	RC70ccc	d025	RC77ccc	d012	ARM	d033
RC62	d088	RC73	d052	RC78	d048	blank	d008
RC62	d071	RC73	d004	RC78	d058	blank	d056
RC62	d086	RC73	d063	RC78	d020		
RC62ccc	d051	RC73ccc	d037	RC78ccc	d079		
RC62ccc	d084	RC73ccc	d091	RC78ccc	d103		
RC62ccc	d030	RC73ccc	d092	RC78ccc	d076		
RC64	d016	RC74	d083	RC79	d053		
RC64	d032	RC74	d044	RC79	d102		
RC64	d099	RC74	d109	RC79	d039		
RC64ccc	d024	RC74ccc	d069	RC79ccc	d040		
RC64ccc	d066	RC74ccc	d077	RC79ccc	d022		
RC64ccc	d003	RC74ccc	d100	RC79ccc	d065		

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.

1 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
d069	d062	d036	d107	d071	d025	d079	d010	d042
d068	d090	d046	d047	d094	d045	d101	d081	d020
d052	d102	d057	d009	d013	d086	d072	d050	d099
d040	d077	d039	d055	d084	d018	d093	d058	d014
d008	d019	d092	d029	d096	d033	d108	d032	d038
d053	d106	d100	d041	d095	d030	d024	d067	d073
d070	d022	d063	d088	d002	d027	d048	d105	d076
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
d007	d004	d065	d051	d005	d054	d016	d098	d023
d037	d044	d109	d031	d001	d006	d060	d026	d003
d085	d091	d015	d087	d059	d035	d017	d043	d104
d034	d075	d049	d021	d110	d012	d089	d103	d074
d080	d082	d061	d097	d078	d011	d028	d066	d064
d083	d056	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), 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] ASTM C1285-97, "Standard Test Methods for Determining Chemical Durability of Nuclear Waste Glasses: The Product Consistency Test (PCT)," 1997.

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WESTINGHOUSE SAVANNAH RIVER COMPANY
INTEROFFICE MEMORANDUM

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An Analytical Plan for Measuring PCT Solutions for the Second Group of Radioactive Glasses from the Reduction of Constraints 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 Reduction of Constraints (Phase 2) study focuses on generating data to further the investigation of the constraints associated with product quality. Forty glass compositions were selected for batching and testing to support Phase 2 of this study. Thirty-three of these 40 glasses are radioactive, and a set of 16 of the 33 radioactive glasses is the focus of this analytical plan. The remaining 17 radioactive glasses from this study were covered in an earlier analytical plan.

The 16 study glasses covered by this analytical plan were cooled both by quenching and centerline canister cooling, and the durabilities of the resulting thirty-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 these 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). The Reduction of Constraints (Phase 2) study [1] focuses on generating data to further the investigation of the constraints associated with product quality. Forty glass compositions were selected for batching and testing to support Phase 2 of this study. Thirty-three of these 40 glasses are radioactive, and a set of 16 of the 33 radioactive glasses is the focus of this analytical plan. The remaining 17 radioactive glasses from this study were covered in an earlier analytical plan.

The sixteen study glasses were cooled both by quenching and by centerline canister cooling, and the durabilities of the resulting thirty-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) [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 – Group 2

Quenched	Centerline Canister Cooled	Quenched	Centerline Canister Cooled
RC82	RC82ccc	RC90	RC90ccc
RC83	RC83ccc	RC91	RC91ccc
RC84	RC84ccc	RC92	RC92ccc
RC85	RC85ccc	RC93	RC93ccc
RC86	RC86ccc	RC94	RC94ccc
RC87	RC87ccc	RC95	RC95ccc
RC88	RC88ccc	RC96	RC96ccc
RC89	RC89ccc	RC97	RC97ccc

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 16 glasses lead to 32 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 104 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, E001 through E104, 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.[1]

Table 2: Identifiers for the PCT Solutions

Original Sample	Solution Identifier	Original Sample	Solution Identifier	Original Sample	Solution Identifier	Original Sample	Solution Identifier
RC82	E078	RC87	E094	RC92	E013	RC97	E097
RC82	E029	RC87	E035	RC92	E036	RC97	E100
RC82	E095	RC87	E022	RC92	E084	RC97	E043
RC82ccc	E038	RC87ccc	E006	RC92ccc	E001	RC97ccc	E076
RC82ccc	E091	RC87ccc	E070	RC92ccc	E027	RC97ccc	E037
RC82ccc	E079	RC87ccc	E075	RC92ccc	E021	RC97ccc	E052
RC83	E018	RC88	E056	RC93	E061	EA	E032
RC83	E008	RC88	E068	RC93	E098	EA	E009
RC83	E003	RC88	E012	RC93	E016	EA	E033
RC83ccc	E099	RC88ccc	E002	RC93ccc	E031	ARM	E020
RC83ccc	E004	RC88ccc	E069	RC93ccc	E073	ARM	E057
RC83ccc	E064	RC88ccc	E025	RC93ccc	E067	ARM	E086
RC84	E083	RC89	E007	RC94	E063	blank	E047
RC84	E051	RC89	E044	RC94	E089	blank	E019
RC84	E045	RC89	E046	RC94	E010		
RC84ccc	E039	RC89ccc	E042	RC94ccc	E060		
RC84ccc	E005	RC89ccc	E030	RC94ccc	E071		
RC84ccc	E062	RC89ccc	E011	RC94ccc	E015		
RC85	E049	RC90	E092	RC95	E017		
RC85	E048	RC90	E053	RC95	E090		
RC85	E024	RC90	E087	RC95	E014		
RC85ccc	E096	RC90ccc	E041	RC95ccc	E104		
RC85ccc	E082	RC90ccc	E028	RC95ccc	E059		
RC85ccc	E102	RC90ccc	E074	RC95ccc	E054		
RC86	E072	RC91	E101	RC96	E081		
RC86	E034	RC91	E058	RC96	E088		
RC86	E080	RC91	E050	RC96	E066		
RC86ccc	E023	RC91ccc	E093	RC96ccc	E055		
RC86ccc	E026	RC91ccc	E065	RC96ccc	E085		
RC86ccc	E077	RC91ccc	E040	RC96ccc	E103		

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), 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.

1 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
E049	E098	E067	E078	E089	E010	E002	E026	E025
E092	E028	E103	E007	E091	E062	E097	E037	E040
E096	E073	E074	E063	E044	E033	E076	E069	E077
E061	E004	E064	E042	E029	E079	E017	E057	E086
E041	E088	E102	E006	E035	E095	E093	E065	E012
E081	E082	E084	E060	E009	E011	E072	E090	E014
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
E047	E085	E016	E039	E070	E022	E104	E058	E080
E099	E053	E021	E032	E030	E046	E101	E068	E052
E001	E019	E024	E083	E051	E015	E056	E034	E050
E055	E048	E087	E094	E005	E075	E023	E100	E054
E018	E036	E066	E038	E071	E045	E020	E059	E043
E013	E008	E003	std-b4-3	std-b5-3	std-b6-3	std-b7-3	std-b8-3	std-b9-3
E031	E027	std-b3-3						
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), and silicon (Si) 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] Herman, C. C., "Task Technical/Quality Assurance Plan: Reduction of Constraints – Phase 2," WSRC-RP-2002-00150, Revision 0, March 11, 2002.

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