Chemical Composition and PCT Data for the Initial Set of Hanford Enhanced Waste Loading Glasses

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EXECUTIVE SUMMARY

In this report, the Savannah River National Laboratory provides chemical analyses and Product Consistency Test results for 20 simulated high level waste glasses fabricated by the Pacific Northwest National Laboratory. The results of these analyses will be used as part of efforts to revise or extend the validation ranges of the current Hanford Waste Treatment and Immobilization Plant glass property models to cover a broader span of waste compositions.

The measured chemical composition data are reported and compared with the targeted values for each component for each glass. Two components of the study glasses, fluorine and silver, were not measured since each of these species would have required the use of an additional preparation method and their measured values were likely to be near or below analytical detection limits. Some of the glasses were difficult to prepare for chemical analysis. A sodium peroxide fusion dissolution method was successful in completely dissolving the glasses. Components present in the glasses in minor concentrations can be difficult to measure using this dissolution method due to dilution requirements. The use of a lithium metaborate preparation method for the minor components (planned for use since it is typically successful in digesting Defense Waste Processing Facility HLW glasses) resulted in an unacceptable amount of undissolved solids remaining in the sample solutions. An acid dissolution method was used instead, which provided more thorough dissolution of the glasses, although a small amount of undissolved material remained for some of the study glasses. The undissolved material was analyzed to determine those components of the glasses that did not fully dissolve. These components (e.g., calcium and chromium) were present in sufficient quantities to be reported from the measurements resulting from the sodium peroxide fusion preparation method, which did not leave undissolved material. Overall, the analyses resulted in sums of oxides that ranged from about 98 to 101.5 wt % for the study glasses, indicating excellent recovery of all the components in the chemical composition analyses.

Comparisons of the targeted and measured chemical compositions indicated that, in general, the measured values for the glasses met the targeted concentrations. Exceptions were Cr_2O_3, MgO, and P_2O_5. The measured values for Cr_2O_3 were somewhat low when compared to the targeted values for all of the study glasses targeting Cr_2O_3 concentrations above 0.5 wt %. Many of the measured MgO and P_2O_5 values were below the targeted values for those glasses that contained these components. Two of the study glasses exhibited differences from the targeted compositions that may indicate a batching error. Glasses EWG-HAI-Centroid-2 and EWG-OL-1672 had measured values for Al_2O_3 and SiO_2 that were lower than the targeted values, and measured values for B_2O_3 that were higher than the targeted values. Glass EWG-HAI-Centroid-2 also had a measured value for Fe_2O_3 that was lower than the targeted value.

A review of the PCT data, including standards and blanks, revealed no issues with the performance of the tests. The PCT results were normalized to both the targeted and measured compositions of the study glasses. Comparisons of the normalized PCT results for both the quenched and Canister Centerline Cooled versions of the study glasses are made with the Environmental Assessment benchmark glass for reference.

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LIST OF ABBREVIATIONS

AD	Acid Dissolution
ANOVA	Analysis of Variance
ARM	Approved Reference Material
CCC	Canister Centerline Cooled
DOE	U.S. Department of Energy
EA	Environmental Assessment benchmark glass
EDS	Energy Dispersive Spectroscopy
ES-VSL	Energy Solutions – Vitreous State Laboratory
HLW	High Level Waste
ICP-OES	Inductively Coupled Plasma – Optical Emission Spectroscopy
LAW	Low Activity Waste
LRM	Low-level Reference Material
ORP	U.S. Department of Energy – Office of River Protection
PCT	Product Consistency Test
PF	Peroxide Fusion
PNNL	Pacific Northwest National Laboratory
SEM	Scanning Electron Microscopy
SRNL	Savannah River National Laboratory
TTQAP	Task Technical and Quality Assurance Plan
WTP	Hanford Waste Treatment and Immobilization Plant

1.0 Introduction

The U.S. Department of Energy (DOE) Office of River Protection (ORP) has requested that the Savannah River National Laboratory (SRNL) provide expert evaluation and experimental work in support of the River Protection Project vitrification technology development. DOE is building a Waste Treatment and Immobilization Plant (WTP) at the Hanford Site in Washington to remediate 55 million gallons of radioactive waste that is temporarily stored in 177 underground tanks. The low-activity waste (LAW) fraction will be partitioned from the high-level waste (HLW). Both the LAW and HLW will then be vitrified in borosilicate glass with Joule-heated ceramic melters (JHCM).

Efforts are being made to increase the loading of Hanford tank wastes in glass while maintaining an adequate ability to process, maintaining regulatory compliance, and maintaining product quality. DOE-ORP has requested that SRNL support the advancement of glass formulations and process control strategies in various key technical areas, as defined in the Task Technical and Quality Assurance Plan (TTQAP) supporting this work.[1] One of these areas of current focus is enhanced HLW glass model applicability ranges.

The current WTP glass composition/properties models have been developed over a limited waste composition range. WTP has developed glass formulations, test data, and an operating strategy for processing the initial feed to be received.[2] The glass composition region is sufficient for start-up of the WTP with waste loadings at the minimum contract requirement. However, this composition region does not extend to glass compositions expected for a large fraction of tank wastes nor does it cover compositions from high waste loading glasses. The current WTP algorithms may only allow processing of the potential HLW compositions at significantly reduced waste loadings (see the recent summary of WTP glass properties models by Vienna et al.[3]). To ensure applicability to the overall mission, DOE-ORP has implemented a program to expand the composition range of the models.[4,5] New data will have to be generated in the glass regions of interest. Near term efforts for this task are focused on providing chemical composition analyses and chemical durability evaluations of HLW glasses formulated in new compositional regions of interest for WTP operation. These data will be used to support the expansion of the glass properties models.

In this report, SRNL provides chemical analyses and Product Consistency Test (PCT) results for select simulated HLW glasses fabricated by Pacific Northwest National Laboratory (PNNL).[4] The results of these analyses will be used to revise or extend the validation ranges of the current WTP glass property models to cover a broader span of waste compositions. PNNL provided 20 glasses for this first set of analyses. The identifiers for the glasses are given in Table 1-1. Two versions of each glass were provided to support the analyses. Rapidly cooled (quenched) versions of each glass were used for chemical analyses and the PCTs. Canister Centerline Cooled (CCC) versions of each glass, which were heat treated to simulate slow cooling at the center of a WTP canister, were also used for the PCTs.

Table 1-1. Identifiers for PNNL Glasses Characterized in this Study

Glass Identifier
RSM-EWG-1-034
EWG-HAI-Centroid-1
EWG-HAI-Centroid-2
EWG-OL-2619
EWG-OL-38552
EWG-OL-15968
EWG-OL-33115
EWG-OL-3872
EWG-OL-1672
EWG-OL-801
EWG-OL-5155
EWG-OL-14827
EWG-OL-26012
EWG-OL-29285
EWG-OL-1369
EWG-OL-1580
EWG-OL-2463
EWG-OL-5801
EWG-OL-6198
EWG-OL-31644

In the sections that follow, the methods used for measuring chemical composition and PCT performance are described and statistical reviews of the resulting data are provided. Detailed data from these analyses are included as appendices. The analytical plans developed in support of these analyses will be transmitted to PNNL for reference along with this report.

2.0 Experimental Procedure

2.1 Compositional Analysis

Chemical analysis was performed under the auspices of an analytical plan[6] on a representative sample from the quenched version of each of the study glasses to allow for comparisons with the targeted compositions. Two preparation techniques, sodium peroxide fusion (PF) and acid dissolution (AD), were used to prepare the glass samples, in duplicate, for analysis. Each of the samples was analyzed, twice for each element of interest, by Inductively Coupled Plasma – Optical Emission Spectroscopy (ICP-OES). Glass standards were also intermittently measured to assess the performance of the ICP-OES instrument over the course of these analyses. Specifically, several samples of the low-level reference material (LRM)[7] were included as part of the analytical plan.

Two components of the study glasses, fluorine and silver, were not measured since each of these species would have required the use of an additional preparation method.[a] Their targeted concentrations were also low, such that they were likely to be near or below analytical detection limits. After discussion with the PNNL client, it was determined that the effort needed to measure fluorine and silver was not worthwhile.

[a] Note that, as described in the analytical plan, measurement of the fluorine concentrations in the glasses was originally attempted. Undissolved solids remained in some of the sample solutions after separate potassium hydroxide preparations were performed specifically for determination of the fluorine concentrations. These difficulties with the preparation method contributed to the decision not to measure for fluorine.

The PF method was selected for measurement of the major components of the glasses since SRNL experience has shown it to be an effective method for complete dissolution of simulated HLW glass samples. Measurement of the minor components using samples prepared with this method is difficult due to the high concentration of salts in the resulting solutions. A 10x dilution is required before analysis of the PF prepared solutions to avoid issues with extinguishing the plasma in the ICP-OES instrument. This dilution results in higher detection limits.

As described in the analytical plan,[6] a lithium metaborate preparation method was originally selected and used to prepare samples of the glasses for measurement of the minor components, since the solutions prepared using this method do not require additional dilution prior to measurement. This preparation method typically results in complete dilution of simulated HLW glasses prepared in support of the Defense Waste Processing Facility (DWPF). However, undissolved solids were visible in the solutions after preparation of the EWG study glasses using this technique. The solutions prepared using the lithium metaborate method therefore were not measured. An acid dissolution preparation (AD) method was substituted for the lithium metaborate method, which resulted in fewer undissolved solids remaining in the solutions. However, some undissolved solids remained visible in the solutions for some of the study glasses.

Samples of some of the as-received, quenched EWG glasses were ground and analyzed via X-ray diffraction (XRD) to qualitatively determine the crystalline phases present which may have remained undissolved after the AD preparation method. An example XRD spectrum for glass EWG-OL-5155 is shown in Figure 2-1. Crystalline material in this glass was identified as trevorite ($NiFe_2O_4$). Glass EWG-OL-6198 contained trevorite along with baddeleyite (ZrO_2) (Figure 2-2). Glass EGW-OL-15968 did not contain Fe_2O_3. Crystalline magnesiochromite ($MgCr_2O_4$) was identified in this glass (Figure 2-3). As will be discussed further below, the elements contained in these phases are reported from the PF preparations rather than the AD preparations.

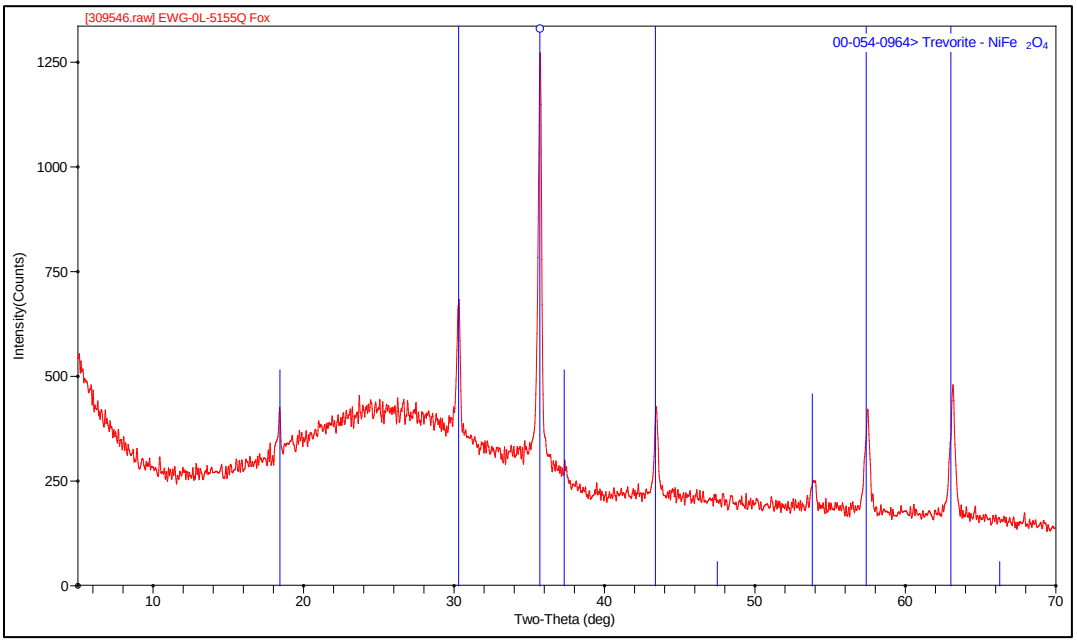

Figure 2-1. XRD spectrum from the as-received, quenched version of glass EWG-OL-5155.

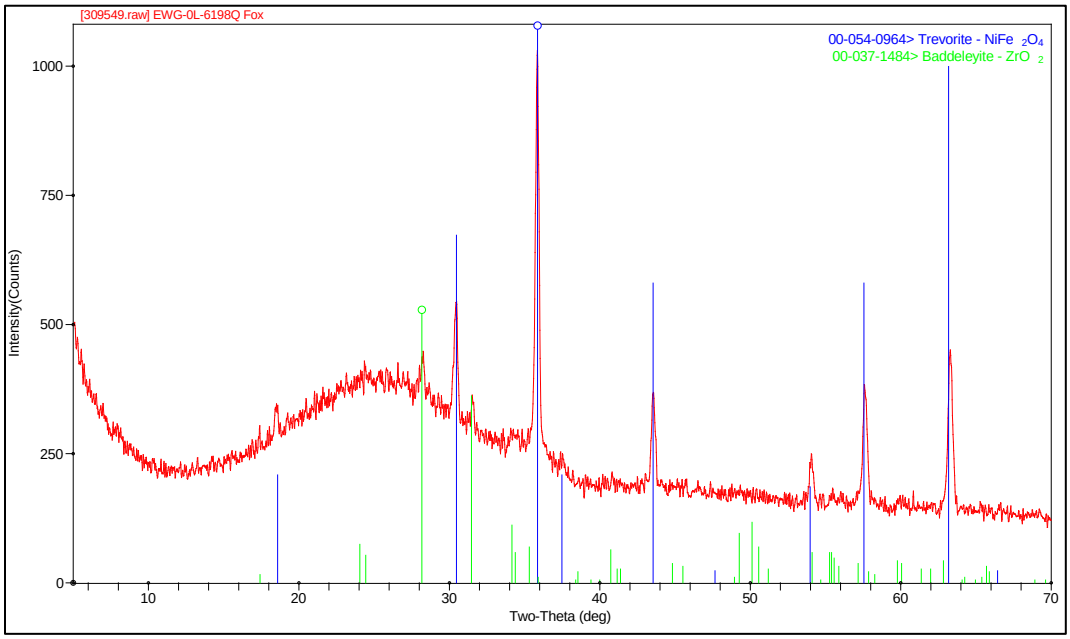

Figure 2-2. XRD spectrum from the as-received, quenched version of glass EWG-OL-6198.

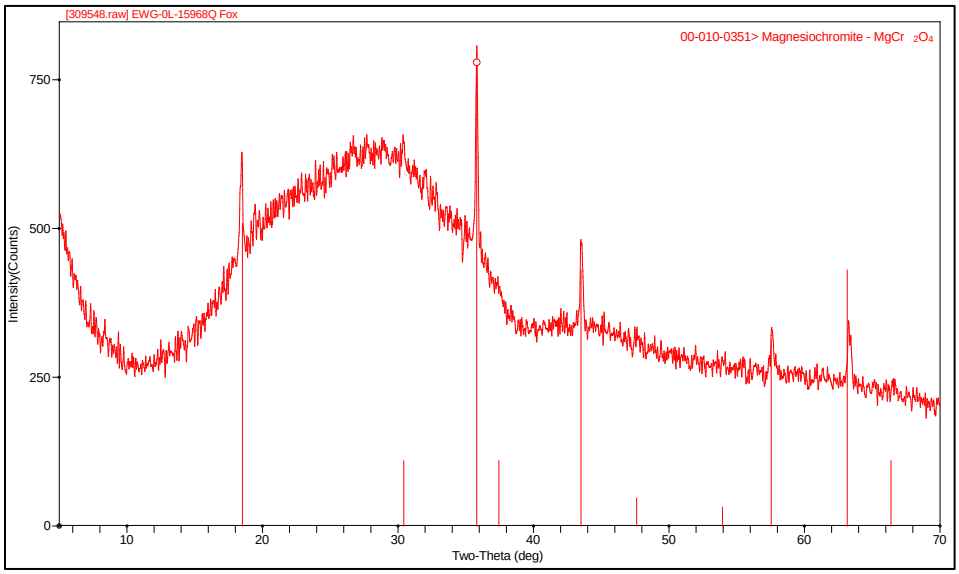

Figure 2-3. XRD spectrum from the as-received, quenched version of glass EWG-OL-15968.

The undissolved material from the AD prepared solutions was analyzed to determine those components of the glasses that did not dissolve. Samples of the undissolved material from several of the study glasses were filtered out of the solutions, dried, coated with a thin layer of carbon, and analyzed using Scanning Electron Microscopy (SEM) with Energy Dispersive Spectroscopy (EDS). An example SEM micrograph of the undissolved material from the AD preparation of glass EWG-OL-5155 captured on a filter is shown as Figure 2-1. A higher

magnification image of undissolved material from the AD preparation of glass EWG-HAI-Centroid-1 is shown as Figure 2-2. The particulates exhibit a spinel morphology. The white rectangle in Figure 2-2 indicates the area scanned to produce the EDS spectrum shown as Figure 2-3. Elements observed include Al, Cr, Fe, Mg, Mn, and Ni. Other elements observed during the analyses but not indicated by the example in Figure 2-3 include Ca, Cl, and F. The halides are residual from the AD preparation technique.

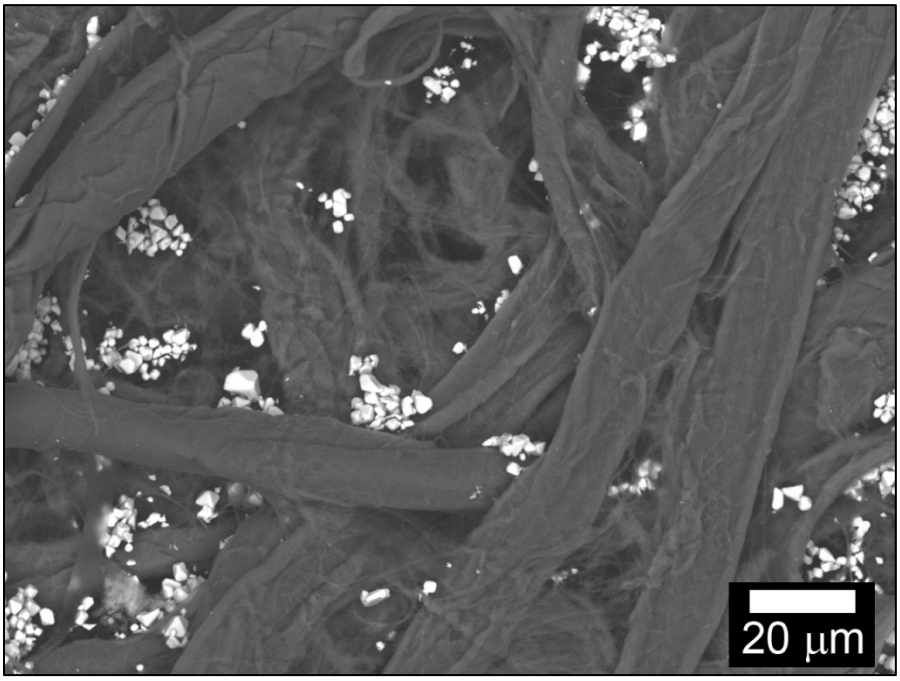

Figure 2-4. SEM Micrograph of Undissolved Material from the AD Preparation of Glass EWG-OL-5155 on Filter Paper.

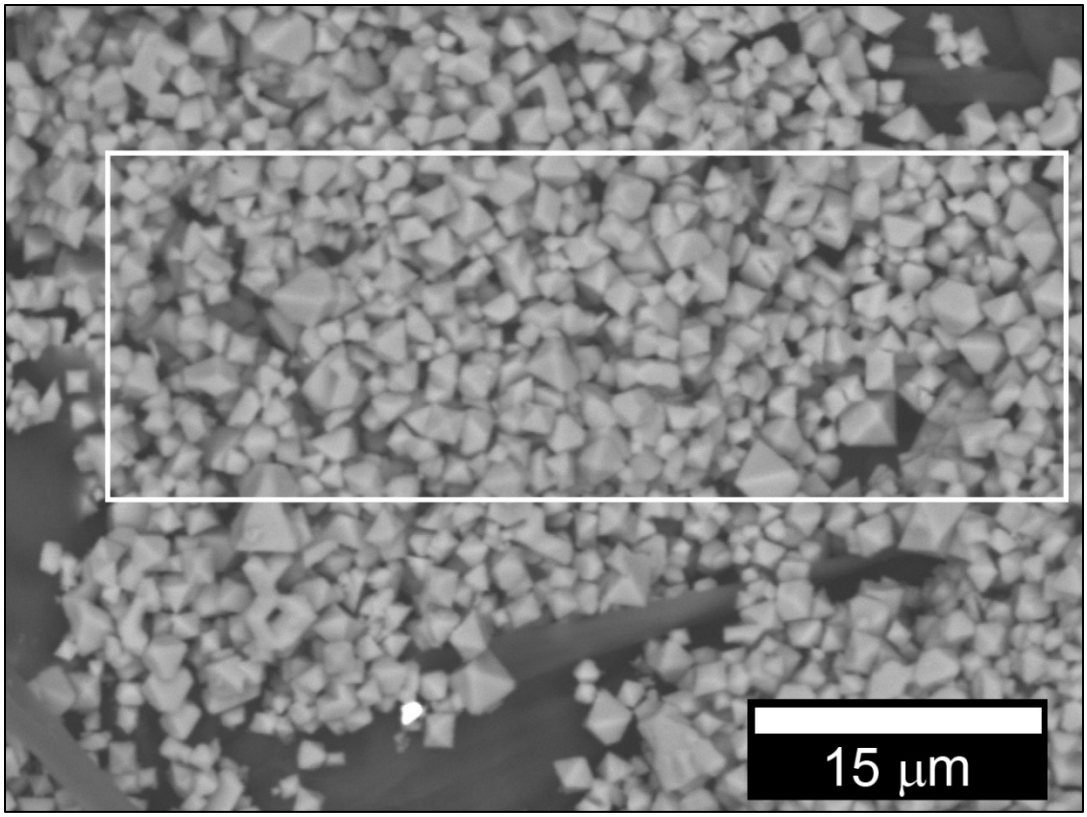

Figure 2-5. SEM Micrograph of Undissolved Material from the AD Preparation of Glass EWG-HAI-Centroid-1.

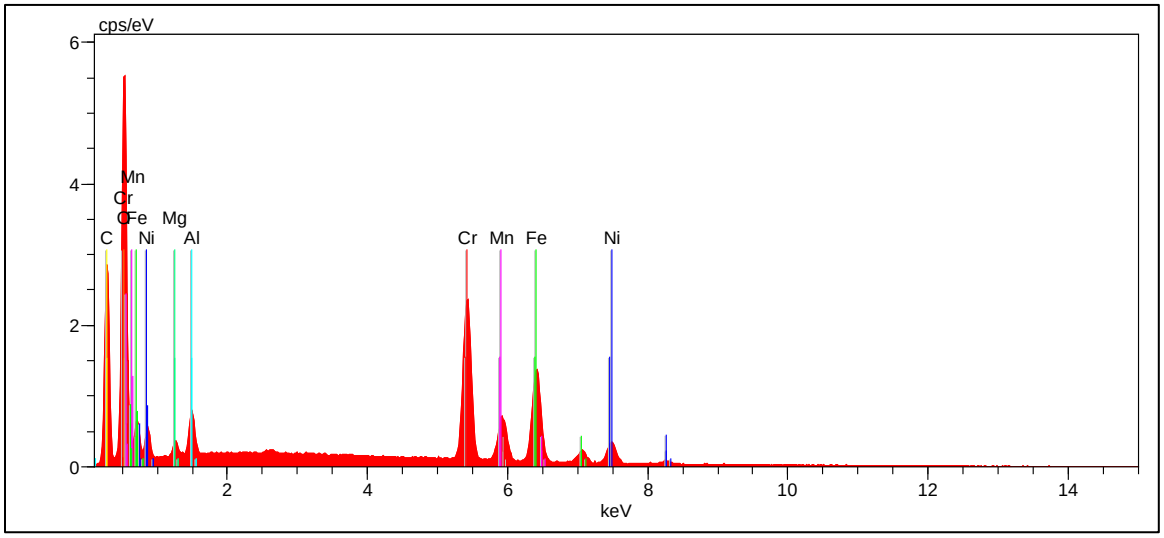

Figure 2-6. EDS Spectrum Corresponding to the White Rectangle Shown in Figure 2-2.

As a result of these analyses, the samples prepared with the PF method (which did not exhibit undissolved solids) were used in measuring and reporting the concentrations of Ca, Cr, and Mg,

in addition to the other major components of the glasses.[a] The targeted concentrations of these components in the study glasses were high enough that detection limits for the PF prepared solutions were not an issue. The preparation methods used for each of the reported glass components are listed in Table 2-1. As will be discussed later, the analyses resulted in sums of oxides that ranged from about 98 to 101.5 wt % for the study glasses. This indicates excellent recovery of all the components in the chemical composition analyses using the combination of PF and AD preparation methods.

Table 2-1. Preparation Methods Used in Reporting the Concentrations of Each of the Components of the Study Glasses.

Component	Preparation Method
Ag	Not Reported
Al	PF
B	PF
Bi	AD
Ca	PF
Cd	AD
Cr	PF
F	Not Reported
Fe	PF
K	AD
Li	PF
Mg	PF
Mn	PF
Na	AD
Ni	AD
P	AD
Pb	AD
Ru	AD
S	AD
Si	PF
Sr	AD
Zr	AD

2.2 Product Consistency Test

The PCT Method-A[8] was performed in triplicate on each of the quenched and CCC versions of the study glasses to assess chemical durability. Also included in the experimental test matrix was the Environmental Assessment (EA) benchmark glass,[9] the Approved Reference Material (ARM) glass,[10] and blanks from the sample cleaning batch. Samples were ground, washed, and prepared according to the standard procedure.[8] Fifteen milliliters of Type-I ASTM water were added to 1.5 g of glass in stainless steel vessels. The vessels were closed, sealed, and placed in an oven at 90 ± 2 °C where the samples were maintained at temperature for 7 days. Once cooled, the resulting solutions were sampled (filtered and acidified), then labeled and analyzed by ICP-OES under the auspices of an analytical plan.[11] Samples of a multi-element, standard solution were

[a] Nickel concentrations are reported from the samples prepared by the AD method since the PF solutions were not analyzed for nickel. After discussion with the PNNL client, it was determined that reporting the nickel concentrations from the samples prepared by the AD method would be sufficient despite the observation of nickel in the undissolved material since the targeted concentration of nickel in the study glasses is low (0.4 wt % for all glasses). Nickel will be measured from the samples prepared by the PF method in future studies of the EWG-series glasses.

also included in the analytical plans as a check on the accuracy of the ICP-OES instrument used for these measurements. Normalized release rates were calculated based on the targeted (provided via email by PNNL) and measured compositions using the average of the common logarithms of the leachate concentrations.

2.3 Quality Assurance

Requirements for performing reviews of technical reports and the extent of review are established in manual E7 2.60. SRNL documents the extent and type of review using the SRNL Technical Report Design Checklist contained in WSRC-IM-2002-00011, Rev. 2.

3.0 Results and Discussion

3.1 Statistical Review and Evaluation of Chemical Composition Measurements

Table A-1 and Table A-2 in Appendix A provide the elemental concentration measurements in wt % from the Set 1 study glasses that were analyzed by the AD method and Table A-3 in Appendix A provides the wt % measurements from these glasses as analyzed by the PF dissolution method. These elemental concentrations were converted to oxide concentrations by multiplying the values for each element by the gravimetric factor for the corresponding oxide. Elemental measurements for samples of the LRM standard glass are also provided in the tables of Appendix A. During the process of converting to oxide concentrations, an elemental concentration that was reported to be below the detection limit of the analytical process used was set to the detection limit as the oxide concentration was determined.

In the sections that follow, the analytical sequences of the measurements are explored, the measurements of the LRM standard glass are investigated, the measurements for each glass are reviewed, the average chemical composition for each glass is determined, and comparisons are made between the measurements and the targeted compositions for the glasses. JMP Version 11.1.1 (SAS Institute, Inc.)[12] was used to support these analyses.

3.1.1 Measurements in Analytical Sequence

Exhibit A-1 in Appendix A provides plots of the wt % measurements generated for prepared samples by oxide and analytical block. The plots are in analytical sequence within each calibration block with different symbols and colors being used to represent each of the study and standard glasses. These plots include all of the measurement data from Table A-1, Table A-2, and Table A-3, with each plotted point identified by its Lab ID. While identifying patterns in these plots is difficult, there do not appear to be any gross patterns or trends in the analytical process over the course of these measurements. A better opportunity for a review of the measurements for each glass is provided in the discussion that follows.

3.1.2 Composition Measurements by Glass Identifier

Exhibit A-2 in Appendix A provides plots of the oxide concentration measurements by the PNNL Glass ID (including LRM as the reference standard) by Lab ID grouped by targeted concentration. 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 instrument calibrations for each glass. A review of the plots presented in these exhibits reveals the repeatability of the four individual values for each oxide for each glass, which appears to be good across all of the oxides.

No issues of any practical importance are seen in these plots for the measurements across the duplicate preparations and the duplicate analyses. Thus, all of these data are to be used in

determining representative, measured compositions of these glasses. However, the plots of Exhibit A-2 also provide an opportunity to compare measured against targeted values, and these comparisons indicate differences for some oxides for some of the study glasses. For example: the measured Al_2O_3 values for EWG-HAI-Centroid-2-Q are below the targeted concentration for this oxide for this glass and the measured B_2O_3 values for EWG-HAI-Centroid-2-Q and EWG-OL-1672-Q are above their targeted values for this oxide for those glasses. A closer set of comparisons is provided in the discussions below. Note that a plot for RuO_2 was omitted from Exhibit A-2 since all measured values for Ru were below the analytical detection limit.

3.1.3 Results for the LRM Standard

Exhibit A-3 in Appendix A provides statistical analyses of the LRM results by calibration block for each oxide of interest for both preparation methods. The results include analysis of variance (ANOVA) investigations, which determine statistically significant differences among the means of these groups for each of the oxides for the LRM standard. A statistically significant calibration effect on the block averages at the 5% significance level is present for the following components:[a]

- AD preparation: CdO, K_2O, Na_2O, NiO, P_2O_5, PbO, and ZrO_2
- PF preparation: Al_2O_3, CaO, Cr_2O_3, Fe_2O_3, and SiO_2

Reference values for the oxide concentrations of the LRM standard are given in the header for each set of measurements in Exhibit A-3. Statistically significant calibration effects for a standard glass have been noted in previous glass variability studies for the DWPF that were conducted at SRNL[13] and at Energy Solutions – Vitreous State Laboratory (ES-VSL).[14] The observations of statistically significant calibration effects had no practical impact on the outcomes of those studies. In the following section, the results for the LRM standard are used to support the discussion of measured versus targeted compositions for the study glasses. As will be shown, the calibration effects have no practical influence on the outcome of this study.

3.1.4 Measured versus Targeted Compositions

From the discussion of Section 3.1.2, all of the measurements for each oxide for each glass (i.e., all of the measurements in Table A-1, Table A-2, and Table A-3) were averaged to determine a representative chemical composition for each glass. A sum of oxides was also computed for each glass based upon the measured values. Exhibit A-4 in Appendix A provides plots showing the result for each glass for each oxide to help highlight the comparisons between the measured and targeted values. Some observations from the plots of Exhibit A-4 are offered for the major oxides (i.e., those oxides in the study glasses or in LRM at a concentration of at least 0.5 wt %):

- While the measured Al_2O_3 values for the majority of study glasses and for LRM are on target, the measured Al_2O_3 values for EWG-HAI-Centroid-2 and EWG-OL-1672 are low when compared to the targeted values for these glasses.

- While the measured B_2O_3 values for the majority of study glasses and for LRM are on target, the measured B_2O_3 values for EWG-HAI-Centroid-2 and EWG-OL-1672 are high when compared to the targeted values for these glasses.

[a] The 5% significance level is used by SRNL for glass development work in support of the Defense Waste Processing Facility. Other significance levels may be used as considered appropriate for this study. The complete data are included in Exhibit A-3 to facilitate other interpretations.

- The measured Bi_2O_3 value for EWG-OL-1672 is somewhat low and the measured Bi_2O_3 value for EWG-OL-5155 is somewhat high.

- The measured CaO value for EWG-OL-1672 is low when compared against the targeted CaO value for this glass. The measured CaO value for EWG-OL-31644 is somewhat high when compared against the targeted CaO value for this glass. The CaO value for LRM is slightly low, although the targeted CaO value for this glass is also low (0.5 wt %).

- The measured Cr_2O_3 values are somewhat low when compared to the targeted values for all of the study glasses targeting Cr_2O_3 above 0.5 wt %. The Cr_2O_3 value for LRM is close to the targeted value.

- The measured Fe_2O_3 values for EQG-OL-5155 and EWG-HAI-Centroid-2 are low. The Fe_2O_3 value for LRM is high, although a systematic effect for all the study glasses is not seen.

- There is some variability in the measured K_2O values, and the values for EWG-OL-2619 and EWG-OL-33115 are somewhat low. The K_2O value for LRM is close to the targeted value.

- The measured MgO values for those glasses that contained MgO are below the targeted values. The targeted MgO value for LRM is below the detection limit.

- The measured MnO value for EWG-OL-1672 is below the targeted value. The targeted MnO value for LRM is below the detection limit.

- There is some variability in the measured Na_2O values. The measured value is high for LRM, although a systematic effect for all the study glasses is not seen.

- The measured P_2O_5 values are low for most of the glasses that targeted some amount of this component. This could be due to volatility of this component, depending upon the source used in batching the glasses. The P_2O_5 value for LRM is close to the targeted value.

- While the measured SiO_2 values for the majority of study glasses and for LRM are on target, the measured SiO_2 values for EWG-HAI-Centroid-2 and EWG-OL-1672 are low when compared to the targeted values for these glasses. The SiO_2 value for LRM is close to the targeted value.

- While the measured ZrO_2 values for the majority of study glasses and for LRM are on target, the measured ZrO_2 values for EWG-OL-2619, EWG-OL-38552, and EWG-OL-5801 are low when compared to the targeted values for these glasses. The ZrO_2 value for LRM is close to the targeted value.

Table A-3 in Appendix A provides a summary of the average compositions as well as the targeted compositions and some associated differences and relative differences. All of the measured sums of oxides for the study glasses fall within the interval of 98 to 101.5 wt%, indicating excellent recovery of all components. Entries in Table A-3 show the relative differences between the

measured values and the targeted values. For the oxides with targeted values above zero, the relative differences are shaded if the values of the relative differences are 5% or more.[a]

In summary, most of the observations above indicate differences among the targeted and measured compositions that have little or no practical significance. The two glasses whose measurements were most frequently off target (sometimes high and sometimes low) were EWG-HAI-Centroid-2 and EWG-OL-1672. This may be due to an error in the batching of these glasses.

3.2 Statistical Review and Evaluation of PCT Measurements

Table B-1 in Appendix B provides the elemental leachate concentration measurements for the solution samples generated by the PCTs for the study glasses and standards. The values for these measurements are given in the table as-received ("ar") from the laboratory analyses and after adjustments. A few of the "ar" measurements were below the detection limit of 1 ppm (prior to correction for dilution). These measurements (indicated by a "<") were replaced by their detection limits in subsequent analyses. In addition to adjustments for detection limits, the values were adjusted for the dilution factors: study glasses, blanks, and the ARM glass were multiplied by 1.6667 to determine the values in parts per million (ppm) and the values for EA were multiplied by 16.6667. Based on the masses of the PCT vessels before and after the 7-day procedures, there was no water loss issue with any vessel during any of the PCT testing. The ratio of leachant volume to the mass of ground glass was confirmed to be correct for each vessel. All of the measurements of the ARM glass fell within the control ranges.[10]

The measured pH values for each of the PCT leachates are provided in Table B-2 in Appendix B for reference.

In the sections that follow, the analytical sequences of the measurements are explored, the measurements for each glass are reviewed, the measurements of the multi-element solution standard are investigated, the normalized PCTs for each glass are determined, and comparisons are made between the PCTs for the two heat treatments of each glass. JMP Version 9.0.0 (SAS Institute, Inc.)[15] was used to support these analyses.

3.2.1 Measurements in Analytical Sequence

Exhibit B-1 in Appendix B provides plots of the common logarithms of the leachate (ppm) concentrations in analytical sequence by analytical block by analytical set. Each of the two analytical sets corresponds to an oven run that was used to conduct the PCT measurements needed to support the study of this first set of PNNL glasses. No issues were observed in these plots.

3.2.2 Measurements by Glass Identifier

Exhibit B-2 in Appendix B provides plots of the leachate concentrations for both the quenched and CCC version of each of the study glasses and for the standards for each analytical set. These plots are in common logarithms of the ppm values and allow for the assessment of the repeatability of the measurements and any differences between the quenched and CCC version of a given glass. For some of the glasses, minor scatter among the triplicate values of some analytes is observed; however, these results are not expected to affect the outcome of this study. In addition, there are differences in the PCT responses between the quenched and CCC versions of some of the study glasses. A closer look at the quenched and CCC outcomes is provided below.

[a] The 5% value was selected arbitrarily and does not necessarily indicate a difference of practical concern.

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

Exhibit B-3 in Appendix B provides analyses of the measurements of the multi-element solution standard by analytical block for each analytical set, including ANOVA investigations for each element of interest. The reference value of the solution standard for each element of interest is also provided as part of the header information in the exhibit.

There was no statistically significant difference (at a 5% level) among the averages of analytical blocks for these measurements for any of the analytes at positive concentrations for this standard. For reference, Table 3-1 provides the block averages, the reference values, and the percent differences between the measured and reference values for these measurements.

Table 3-1. Results from Samples of the Multi-Element Solution Standard

Analytical Set	Block	Mean (B) (ppm)	Mean (Ca) (ppm)	Mean (K) (ppm)	Mean (Li) (ppm)	Mean (Na) (ppm)	Mean (P) (ppm)	Mean (Si) (ppm)
1	1	21.00	1.00	10.21	10.38	79.87	1.00	50.03
1	2	19.83	1.00	9.67	10.13	81.30	1.00	48.43
1	3	20.50	1.00	9.97	10.33	81.70	1.00	48.73
2	1	20.87	1.00	10.05	10.27	81.10	1.00	47.70
2	2	20.73	1.00	10.37	10.47	81.70	1.00	49.07
2	3	20.10	1.00	10.02	10.23	80.67	1.00	47.77
Grand Average		20.51	1.00	10.05	10.30	81.06	1.00	48.62
Reference Value		20.00	0.00	10.00	10.00	81.00	0.00	50.00
% Relative Difference		2.5%	N/A	0.5%	3.0%	0.1%	N/A	-2.8%

3.2.4 Normalization of the PCT Results

For all of the PCT results, the PCT leachate concentrations were normalized using the targeted and measured compositions (wt %) of the glasses to obtain a grams-per-liter (g/L) leachate concentration. As is the usual convention, the common logarithm of the normalized PCT (normalized leachate, NL) for each element of interest was determined and used for comparison. To accomplish this computation, one must:

1. Determine the common logarithm of the elemental leachate concentration (ppm) 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.

Normalizing using the measured composition:

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

Or normalizing using the targeted composition:

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

3.2.5 Effects of Heat Treatments

Exhibit B-4 in Appendix B provides plots of the normalized PCT responses for the two heat treatments for each of the study glasses as well as the responses for ARM and EA. The results are grouped by compositional view. These plots provide a comparison between the PCT responses for the two heat treatments of each study glass. Table 3-2 provides a listing of the normalized PCT responses in common logarithms of the g/L values and Table 3-3 provides the g/L values themselves. In reading these tables, note that a single decimal point in a cell is used to indicate one of three conditions:

- The ARM glass does not contain K
- The EA glass does not contain P
- A PCT result normalized to the targeted composition is not provided for those components with a targeted concentration of zero for a given glass composition.

Table 3-2. Common Logarithms of Normalized PCT Results

Glass ID	Heat Treatment	Normalization	log NL[B (g/L)]	log NL[Ca (g/L)]	log NL[K (g/L)]	log NL[Li(g/L)]	log NL[Na (g/L)]	log NL[P (g/L)]	log NL[Si (g/L)]
ARM	ref	ref	-0.3277	-0.9806	.	-0.2371	-0.3200	-0.2310	-0.5768
ARM	ref	ref	-0.3072	-0.9393	.	-0.2666	-0.3513	-0.2158	-0.6079
EA	ref	ref	0.9101	0.3185	1.7006	0.7158	0.8045	.	0.3635
EA	ref	ref	1.1951	0.3185	1.7006	0.9733	1.0838	.	0.5593
EWG-HAI-Centroid-1	ccc	measured	-0.4507	-1.2087	-0.5223	-0.4100	-0.5437	-0.0883	-0.8556
EWG-HAI-Centroid-1	ccc	targeted	-0.4554	-1.1763	-0.5340	-0.4002	-0.5293	-0.1170	-0.8541
EWG-HAI-Centroid-1	quenched	measured	-0.3957	-1.2087	-0.4962	-0.3046	-0.4255	-0.0883	-0.6961
EWG-HAI-Centroid-1	quenched	targeted	-0.4004	-1.1763	-0.5078	-0.2949	-0.4110	-0.1170	-0.6946
EWG-HAI-Centroid-2	ccc	measured	0.4491	-1.1478	-0.1981	0.4127	0.2912	-0.3260	-0.5679
EWG-HAI-Centroid-2	ccc	targeted	0.6292	-1.1763	-0.3549	0.3809	0.2530	-0.4096	-0.6032
EWG-HAI-Centroid-2	quenched	measured	0.3954	-1.1478	-0.2169	0.3728	0.2485	-0.3344	-0.6240
EWG-HAI-Centroid-2	quenched	targeted	0.5755	-1.1763	-0.3737	0.3410	0.2103	-0.4180	-0.6593
EWG-OL-1369	ccc	measured	-0.5606	-1.4298	.	-0.4866	-0.8139	-0.8618	-1.0197
EWG-OL-1369	ccc	targeted	-0.5510	-1.4330	.	-0.4893	-0.8138	-0.8952	-1.0194
EWG-OL-1369	quenched	measured	-0.7230	-1.5566	.	-0.4911	-0.8139	-0.8618	-1.0173
EWG-OL-1369	quenched	targeted	-0.7134	-1.5598	.	-0.4937	-0.8138	-0.8952	-1.0169
EWG-OL-14827	ccc	measured	-0.2080	-1.0573	-0.2641	-0.1296	-0.1676	.	-0.9055
EWG-OL-14827	ccc	targeted	-0.2040	-1.0713	-0.2392	-0.1284	-0.1609	.	-0.8956
EWG-OL-14827	quenched	measured	-0.1533	-1.0792	-0.2113	-0.0857	-0.1178	.	-0.8804
EWG-OL-14827	quenched	targeted	-0.1494	-1.0932	-0.1864	-0.0845	-0.1111	.	-0.8705
EWG-OL-1580	ccc	measured	-0.5778	-1.4513	.	-0.5132	-0.7955	-0.8627	-1.0041
EWG-OL-1580	ccc	targeted	-0.5734	-1.4416	.	-0.5167	-0.7813	-0.8952	-1.0120
EWG-OL-1580	quenched	measured	-0.6385	-1.5322	.	-0.5069	-0.7589	-0.8627	-1.0037
EWG-OL-1580	quenched	targeted	-0.6341	-1.5225	.	-0.5104	-0.7447	-0.8952	-1.0115
EWG-OL-15968	ccc	measured	1.0552	.	.	1.0198	0.8508	.	-0.5643
EWG-OL-15968	ccc	targeted	1.0505	.	.	1.0191	0.8635	.	-0.5608
EWG-OL-15968	quenched	measured	0.8456	.	.	0.8359	0.7054	.	-0.3857
EWG-OL-15968	quenched	targeted	0.8409	.	.	0.8351	0.7181	.	-0.3823
EWG-OL-1672	ccc	measured	0.0342	-0.9583	.	.	0.0666	-0.8004	-1.2228
EWG-OL-1672	ccc	targeted	0.1840	-1.0183	.	.	0.0236	-0.8952	-1.2788
EWG-OL-1672	quenched	measured	-0.0002	-0.9278	.	.	0.0405	-0.8004	-1.2636
EWG-OL-1672	quenched	targeted	0.1496	-0.9878	.	.	-0.0024	-0.8952	-1.3195

Table 3-2. Common Logarithms of Normalized PCT Results (continued)

Glass ID	Heat Treatment	Normalization	log NL[B (g/L)]	log NL[Ca (g/L)]	log NL[K (g/L)]	log NL[Li(g/L)]	log NL[Na (g/L)]	log NL[P (g/L)]	log NL[Si (g/L)]
EWG-OL-2463	ccc	measured	1.5127	-0.7937	0.7035	.	1.4784	-0.8555	-0.7426
EWG-OL-2463	ccc	targeted	1.5197	-0.8044	0.7167	.	1.4895	-0.8952	-0.7396
EWG-OL-2463	quenched	measured	1.1670	-1.6187	0.9854	.	1.1302	-0.8555	-0.6091
EWG-OL-2463	quenched	targeted	1.1740	-1.6294	0.9986	.	1.1413	-0.8952	-0.6062
EWG-OL-26012	ccc	measured	-0.2715	.	-0.4251	0.7431	0.2341	1.0204	-0.4599
EWG-OL-26012	ccc	targeted	-0.2710	.	-0.4068	0.7417	0.2372	0.9906	-0.4619
EWG-OL-26012	quenched	measured	-0.3485	.	-0.7305	-0.6690	-0.2664	-0.5386	-0.5803
EWG-OL-26012	quenched	targeted	-0.3479	.	-0.7123	-0.6704	-0.2633	-0.5684	-0.5824
EWG-OL-2619	ccc	measured	-0.1409	-0.9029	-0.1547	.	-0.0940	.	-1.4200
EWG-OL-2619	ccc	targeted	-0.1395	-0.8990	-0.2111	.	-0.0954	.	-1.4123
EWG-OL-2619	quenched	measured	-0.1964	-0.8983	-0.2054	.	-0.1539	.	-1.4183
EWG-OL-2619	quenched	targeted	-0.1950	-0.8943	-0.2617	.	-0.1553	.	-1.4106
EWG-OL-29285	ccc	measured	-0.7335	-1.3359	.	.	-0.6169	-0.8663	-1.2118
EWG-OL-29285	ccc	targeted	-0.7367	-1.3270	.	.	-0.6116	-0.8952	-1.2117
EWG-OL-29285	quenched	measured	-0.6593	-1.3105	.	.	-0.6711	-0.8663	-1.2399
EWG-OL-29285	quenched	targeted	-0.6625	-1.3016	.	.	-0.6658	-0.8952	-1.2399
EWG-OL-31644	ccc	measured	-0.5767	-1.5631	.	-0.2935	-0.7993	.	-1.0924
EWG-OL-31644	ccc	targeted	-0.5658	-1.5410	.	-0.2872	-0.8060	.	-1.0883
EWG-OL-31644	quenched	measured	-0.4895	-1.1317	.	-0.5901	-0.6151	.	-1.1248
EWG-OL-31644	quenched	targeted	-0.4786	-1.1096	.	-0.5838	-0.6218	.	-1.1207
EWG-OL-33115	ccc	measured	-0.4950	-1.6226	-0.6339	.	-0.4551	-0.8609	-0.9095
EWG-OL-33115	ccc	targeted	-0.4811	-1.6323	-0.6917	.	-0.4441	-0.8952	-0.9058
EWG-OL-33115	quenched	measured	-0.5106	-1.5012	-0.6239	.	-0.4132	-0.8609	-1.0257
EWG-OL-33115	quenched	targeted	-0.4967	-1.5108	-0.6818	.	-0.4023	-0.8952	-1.0220
EWG-OL-38552	ccc	measured	1.2004	.	.	0.4301	0.9850	-0.5107	-1.5588
EWG-OL-38552	ccc	targeted	1.2139	.	.	0.4286	0.9904	-0.5495	-1.5545
EWG-OL-38552	quenched	measured	-0.1935	.	.	-0.1157	-0.4154	-0.2247	-0.6554
EWG-OL-38552	quenched	targeted	-0.1801	.	.	-0.1172	-0.4101	-0.2635	-0.6512
EWG-OL-3872	ccc	measured	1.5895	-1.6164	.	1.2064	1.4185	-0.4937	0.1395
EWG-OL-3872	ccc	targeted	1.5948	-1.6225	.	1.1966	1.4320	-0.5217	0.1335
EWG-OL-3872	quenched	measured	0.1483	-1.4384	.	0.2397	0.3123	-0.8672	-0.2855
EWG-OL-3872	quenched	targeted	0.1536	-1.4445	.	0.2300	0.3258	-0.8952	-0.2916
EWG-OL-5155	ccc	measured	0.8329	.	.	0.8147	0.6633	.	-1.7577

Table 3-2. Common Logarithms of Normalized PCT Results (continued)

Glass ID	Heat Treatment	Normalization	log NL[B (g/L)]	log NL[Ca (g/L)]	log NL[K (g/L)]	log NL[Li(g/L)]	log NL[Na (g/L)]	log NL[P (g/L)]	log NL[Si (g/L)]
EWG-OL-5155	ccc	targeted	0.8361	.	.	0.8167	0.6724	.	-1.7489
EWG-OL-5155	quenched	measured	0.3106	.	.	0.2992	0.2209	.	-0.6108
EWG-OL-5155	quenched	targeted	0.3137	.	.	0.3013	0.2299	.	-0.6021
EWG-OL-5801	ccc	measured	0.7466	.	0.2290	0.6470	0.6517	-0.0090	-1.7308
EWG-OL-5801	ccc	targeted	0.7407	.	0.2477	0.6428	0.6596	-0.0487	-1.7338
EWG-OL-5801	quenched	measured	0.3880	.	0.0557	0.3683	0.3179	0.0993	-0.6632
EWG-OL-5801	quenched	targeted	0.3821	.	0.0744	0.3641	0.3259	0.0597	-0.6662
EWG-OL-6198	ccc	measured	0.8021	.	0.0088	0.6734	0.5783	0.2196	-0.5426
EWG-OL-6198	ccc	targeted	0.8005	.	0.0131	0.6731	0.5746	0.1835	-0.5395
EWG-OL-6198	quenched	measured	0.3355	.	-0.1659	0.3123	0.2170	-0.2144	-0.6017
EWG-OL-6198	quenched	targeted	0.3340	.	-0.1616	0.3119	0.2132	-0.2504	-0.5986
EWG-OL-801	ccc	measured	0.8185	.	.	.	0.7156	0.4082	-0.6305
EWG-OL-801	ccc	targeted	0.8090	.	.	.	0.7122	0.3703	-0.6362
EWG-OL-801	quenched	measured	0.7558	.	.	.	0.6713	0.2907	-0.6441
EWG-OL-801	quenched	targeted	0.7464	.	.	.	0.6679	0.2529	-0.6498
RSM-EWG-1-034	ccc	measured	-0.3257	-1.3864	0.3242	-0.3379	-0.3881	-0.2594	-0.7747
RSM-EWG-1-034	ccc	targeted	-0.3439	-1.3789	0.1566	-0.3335	-0.3852	-0.2802	-0.7577
RSM-EWG-1-034	quenched	measured	-0.3700	-1.3864	0.3242	-0.3203	-0.4453	-0.3202	-0.8642
RSM-EWG-1-034	quenched	targeted	-0.3882	-1.3789	0.1566	-0.3159	-0.4424	-0.3411	-0.8472

Table 3-3. Normalized PCT Results

Glass ID	Heat Treatment	Normalization	NL B(g/L)	NL Ca(g/L)	NL K(g/L)	NL Li (g/L)	NL Na (g/L)	NL P(g/L)	NL Si (g/L)
ARM	ref	ref	0.470	0.105	.	0.579	0.479	0.588	0.265
ARM	ref	ref	0.493	0.115	.	0.541	0.445	0.608	0.247
EA	ref	ref	8.130	2.082	50.192	5.198	6.375	.	2.310
EA	ref	ref	15.670	2.082	50.192	9.403	12.127	.	3.625
EWG-HAI-Centroid-1	ccc	measured	0.354	0.062	0.300	0.389	0.286	0.816	0.139
EWG-HAI-Centroid-1	ccc	targeted	0.350	0.067	0.292	0.398	0.296	0.764	0.140
EWG-HAI-Centroid-1	quenched	measured	0.402	0.062	0.319	0.496	0.375	0.816	0.201
EWG-HAI-Centroid-1	quenched	targeted	0.398	0.067	0.311	0.507	0.388	0.764	0.202
EWG-HAI-Centroid-2	ccc	measured	2.813	0.071	0.634	2.587	1.955	0.472	0.270
EWG-HAI-Centroid-2	ccc	targeted	4.258	0.067	0.442	2.404	1.791	0.389	0.249
EWG-HAI-Centroid-2	quenched	measured	2.485	0.071	0.607	2.359	1.772	0.463	0.238
EWG-HAI-Centroid-2	quenched	targeted	3.762	0.067	0.423	2.193	1.623	0.382	0.219
EWG-OL-1369	ccc	measured	0.275	0.037	.	0.326	0.153	0.137	0.096
EWG-OL-1369	ccc	targeted	0.281	0.037	.	0.324	0.154	0.127	0.096
EWG-OL-1369	quenched	measured	0.189	0.028	.	0.323	0.153	0.137	0.096
EWG-OL-1369	quenched	targeted	0.193	0.028	.	0.321	0.154	0.127	0.096
EWG-OL-14827	ccc	measured	0.619	0.088	0.544	0.742	0.680	.	0.124
EWG-OL-14827	ccc	targeted	0.625	0.085	0.577	0.744	0.690	.	0.127
EWG-OL-14827	quenched	measured	0.703	0.083	0.615	0.821	0.762	.	0.132
EWG-OL-14827	quenched	targeted	0.709	0.081	0.651	0.823	0.774	.	0.135
EWG-OL-1580	ccc	measured	0.264	0.035	.	0.307	0.160	0.137	0.099
EWG-OL-1580	ccc	targeted	0.267	0.036	.	0.304	0.165	0.127	0.097
EWG-OL-1580	quenched	measured	0.230	0.029	.	0.311	0.174	0.137	0.099
EWG-OL-1580	quenched	targeted	0.232	0.030	.	0.309	0.180	0.127	0.097
EWG-OL-15968	ccc	measured	11.355	.	.	10.467	7.093	.	0.273
EWG-OL-15968	ccc	targeted	11.234	.	.	10.448	7.304	.	0.275
EWG-OL-15968	quenched	measured	7.008	.	.	6.853	5.075	.	0.411
EWG-OL-15968	quenched	targeted	6.933	.	.	6.841	5.226	.	0.415
EWG-OL-1672	ccc	measured	1.082	0.110	.	1.667	1.166	0.158	0.060

Table 3-3. Normalized PCT Results (continued)

Glass ID	Heat Treatment	Normalization	NL B(g/L)	NL Ca(g/L)	NL K(g/L)	NL Li (g/L)	NL Na (g/L)	NL P(g/L)	NL Si (g/L)
EWG-OL-1672	ccc	targeted	1.528	0.096	.	.	1.056	0.127	0.053
EWG-OL-1672	quenched	measured	1.000	0.118	.	.	1.098	0.158	0.055
EWG-OL-1672	quenched	targeted	1.411	0.103	.	.	0.994	0.127	0.048
EWG-OL-2463	ccc	measured	32.560	0.161	5.053	.	30.089	0.139	0.181
EWG-OL-2463	ccc	targeted	33.090	0.157	5.209	.	30.871	0.127	0.182
EWG-OL-2463	quenched	measured	14.689	0.024	9.669	.	13.496	0.139	0.246
EWG-OL-2463	quenched	targeted	14.928	0.023	9.968	.	13.847	0.127	0.248
EWG-OL-26012	ccc	measured	0.535	.	0.376	5.535	1.714	10.481	0.347
EWG-OL-26012	ccc	targeted	0.536	.	0.392	5.516	1.727	9.787	0.345
EWG-OL-26012	quenched	measured	0.448	.	0.186	0.214	0.542	0.289	0.263
EWG-OL-26012	quenched	targeted	0.449	.	0.194	0.214	0.545	0.270	0.262
EWG-OL-2619	ccc	measured	0.723	0.125	0.700	.	0.805	.	0.038
EWG-OL-2619	ccc	targeted	0.725	0.126	0.615	.	0.803	.	0.039
EWG-OL-2619	quenched	measured	0.636	0.126	0.623	.	0.702	.	0.038
EWG-OL-2619	quenched	targeted	0.638	0.128	0.547	.	0.699	.	0.039
EWG-OL-29285	ccc	measured	0.185	0.046	.	.	0.242	0.136	0.061
EWG-OL-29285	ccc	targeted	0.183	0.047	.	.	0.245	0.127	0.061
EWG-OL-29285	quenched	measured	0.219	0.049	.	.	0.213	0.136	0.058
EWG-OL-29285	quenched	targeted	0.218	0.050	.	.	0.216	0.127	0.058
EWG-OL-31644	ccc	measured	0.265	0.027	.	0.509	0.159	.	0.081
EWG-OL-31644	ccc	targeted	0.272	0.029	.	0.516	0.156	.	0.082
EWG-OL-31644	quenched	measured	0.324	0.074	.	0.257	0.243	.	0.075
EWG-OL-31644	quenched	targeted	0.332	0.078	.	0.261	0.239	.	0.076
EWG-OL-33115	ccc	measured	0.320	0.024	0.232	.	0.351	0.138	0.123
EWG-OL-33115	ccc	targeted	0.330	0.023	0.203	.	0.360	0.127	0.124
EWG-OL-33115	quenched	measured	0.309	0.032	0.238	.	0.386	0.138	0.094
EWG-OL-33115	quenched	targeted	0.319	0.031	0.208	.	0.396	0.127	0.095
EWG-OL-38552	ccc	measured	15.865	.	.	2.692	9.661	0.309	0.028
EWG-OL-38552	ccc	targeted	16.363	.	.	2.683	9.780	0.282	0.028

Table 3-3. Normalized PCT Results (continued)

Glass ID	Heat Treatment	Normalization	NL B(g/L)	NL Ca(g/L)	NL K(g/L)	NL Li (g/L)	NL Na (g/L)	NL P(g/L)	NL Si (g/L)
EWG-OL-38552	quenched	measured	0.641	.	.	0.766	0.384	0.596	0.221
EWG-OL-38552	quenched	targeted	0.661	.	.	0.763	0.389	0.545	0.223
EWG-OL-3872	ccc	measured	38.864	0.024	.	16.083	26.211	0.321	1.379
EWG-OL-3872	ccc	targeted	39.340	0.024	.	15.725	27.039	0.301	1.360
EWG-OL-3872	quenched	measured	1.407	0.036	.	1.737	2.053	0.136	0.518
EWG-OL-3872	quenched	targeted	1.424	0.036	.	1.698	2.118	0.127	0.511
EWG-OL-5155	ccc	measured	6.807	.	.	6.527	4.606	.	0.017
EWG-OL-5155	ccc	targeted	6.857	.	.	6.558	4.703	.	0.018
EWG-OL-5155	quenched	measured	2.044	.	.	1.992	1.663	.	0.245
EWG-OL-5155	quenched	targeted	2.059	.	.	2.001	1.698	.	0.250
EWG-OL-5801	ccc	measured	5.580	.	1.694	4.436	4.484	0.979	0.019
EWG-OL-5801	ccc	targeted	5.504	.	1.769	4.393	4.567	0.894	0.018
EWG-OL-5801	quenched	measured	2.443	.	1.137	2.335	2.079	1.257	0.217
EWG-OL-5801	quenched	targeted	2.410	.	1.187	2.312	2.118	1.147	0.216
EWG-OL-6198	ccc	measured	6.340	.	1.021	4.714	3.787	1.658	0.287
EWG-OL-6198	ccc	targeted	6.317	.	1.031	4.710	3.754	1.526	0.289
EWG-OL-6198	quenched	measured	2.165	.	0.683	2.052	1.648	0.610	0.250
EWG-OL-6198	quenched	targeted	2.158	.	0.689	2.051	1.634	0.562	0.252
EWG-OL-801	ccc	measured	6.584	.	.	.	5.195	2.560	0.234
EWG-OL-801	ccc	targeted	6.442	.	.	.	5.155	2.346	0.231
EWG-OL-801	quenched	measured	5.699	.	.	.	4.691	1.953	0.227
EWG-OL-801	quenched	targeted	5.577	.	.	.	4.655	1.790	0.224
RSM-EWG-1-034	ccc	measured	0.472	0.041	2.110	0.459	0.409	0.550	0.168
RSM-EWG-1-034	ccc	targeted	0.453	0.042	1.434	0.464	0.412	0.525	0.175
RSM-EWG-1-034	quenched	measured	0.427	0.041	2.110	0.478	0.359	0.478	0.137
RSM-EWG-1-034	quenched	targeted	0.409	0.042	1.434	0.483	0.361	0.456	0.142

4.0 Summary

In this report, SRNL provides chemical analyses and PCT results for 20 simulated HLW glasses fabricated by PNNL. The results of these analyses will be used as part of efforts to revise or extend the validation ranges of the current WTP glass property models to cover a broader span of waste compositions.

The measured chemical composition data are reported and compared with the targeted values for each component for each glass. Two components of the study glasses, fluorine and silver, were not measured since each of these species would have required the use of an additional preparation method and their measured values were likely to be near or below analytical detection limits. Some of the glasses were difficult to prepare for chemical analysis. The use of a lithium metaborate preparation method (planned for use since it is typically successful in digesting DWPF HLW glasses) resulted in an unacceptable amount of undissolved solids remaining in the sample solutions. An acid dissolution method was used instead, which provided better dissolution of the glasses, although a small amount of undissolved material remained for some of the study glasses. The undissolved material was analyzed and found to consist of spinels. The elements present in the material that was left undissolved by the AD preparation method were reported using the PF dissolution method.

All of the measured sums of oxides for the study glasses fall within the interval of 98 to 101.5 wt%. Comparisons of the targeted and measured chemical compositions indicated that, in general, the measured values for the glasses met the targeted concentrations. Exceptions were Cr_2O_3, MgO, and P_2O_5. The measured values for Cr_2O_3 were somewhat low when compared to the targeted values for all of the study glasses targeting Cr_2O_3 concentrations above 0.5 wt %. Many of the measured MgO and P_2O_5 values were below the targeted values for those glasses that contained these components. Two of the study glasses exhibited differences from the targeted compositions that may indicate a batching error. Glasses EWG-HAI-Centroid-2 and EWG-OL-1672 had measured values for Al_2O_3 and SiO_2 that were lower than the targeted values, and measured values for B_2O_3 that were higher than the targeted values. Glass EWG-HAI-Centroid-2 also had a measured value for Fe_2O_3 that was lower than the targeted value.

A review of the PCT data, including standards and blanks, revealed no issues with the performance of the tests. The PCT results were normalized to both the targeted and measured compositions of the study glasses. Comparisons of the normalized PCT results for both the quenched and CCC versions of the study glasses are made with the EA benchmark glass for reference.

Future analyses of the EWG-series glasses at SRNL will utilize the same dissolution methods described in this report. Spinel crystals that do not dissolve via the AD preparation method will be interrogated via SEM/EDS to ensure that the elements present in the undissolved material are reported from the PF prepared samples. Considerations should be made regarding the ability to dissolve and characterize spinels in WTP glasses as plans are made for analysis methods to be used during facility operation or waste qualification efforts.

5.0 References

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Appendix A. Tables and Exhibits Supporting the Chemical Composition Measurements

Table A-1. AD Measurements of Set 1 Study Glasses – Part 1

Glass ID	Block	Sub-Blk	Sequence	Lab ID	Bi (wt%)	Cd (wt%)	K (wt%)	Na (wt%)	Ni (wt%)
LRM	1	1	1	LRMAD111	<0.100	0.099	1.21	15.5	0.126
EWG-OL-3872-Q	1	1	2	P02AD11	2.80	0.074	<0.010	13.7	0.289
EWG-OL-5801-Q	1	1	3	P08AD11	<0.100	0.075	2.63	3.83	0.286
RSM-EWG-1-034-Q	1	1	4	P09AD11	0.968	0.014	0.076	7.04	0.117
EWG-OL-26012-Q	1	1	5	P03AD21	2.67	0.075	2.59	13.4	0.302
EWG-HAI-Centroid-1-Q	1	1	6	P12AD11	0.865	0.075	0.567	8.84	0.137
EWG-OL-5155-Q	1	1	7	P17AD11	2.93	0.077	<0.010	3.75	0.134
EWG-OL-3872-Q	1	1	8	P02AD21	2.80	0.075	<0.010	13.8	0.294
EWG-OL-5155-Q	1	1	9	P17AD21	2.93	0.076	<0.010	3.80	0.135
EWG-OL-1672-Q	1	1	10	P18AD21	2.46	0.066	<0.010	3.37	0.258
EWG-OL-33115-Q	1	1	11	P04AD11	2.76	0.074	2.21	5.08	0.295
LRM	1	1	12	LRMAD112	<0.100	0.097	1.25	16.4	0.124
EWG-OL-5801-Q	1	1	13	P08AD21	<0.100	0.076	2.63	3.82	0.287
EWG-OL-26012-Q	1	1	14	P03AD11	2.66	0.076	2.65	13.6	0.303
EWG-OL-38552-Q	1	1	15	P06AD21	2.74	0.075	<0.010	3.79	0.290
EWG-OL-38552-Q	1	1	16	P06AD11	2.76	0.074	<0.010	3.79	0.289
EWG-OL-33115-Q	1	1	17	P04AD21	2.73	0.073	2.22	5.08	0.293
EWG-HAI-Centroid-1-Q	1	1	18	P12AD21	0.863	0.075	0.574	8.90	0.137
RSM-EWG-1-034-Q	1	1	19	P09AD21	0.971	0.014	0.083	7.29	0.116
EWG-OL-14827-Q	1	1	20	P05AD11	2.62	0.070	2.69	3.84	0.223
EWG-OL-14827-Q	1	1	21	P05AD21	2.63	0.070	2.70	3.86	0.225
EWG-OL-1672-Q	1	1	22	P18AD11	2.42	0.065	<0.010	3.41	0.256
LRM	1	1	23	LRMAD113	<0.100	0.102	1.25	16.2	0.125
LRM	1	2	1	LRMAD111	<0.100	0.109	1.23	16.1	0.115
EWG-OL-14827-Q	1	2	2	P05AD22	2.69	0.074	2.57	3.68	0.231
EWG-OL-26012-Q	1	2	3	P03AD22	2.72	0.077	2.58	13.4	0.305
EWG-OL-26012-Q	1	2	4	P03AD12	2.74	0.076	2.57	13.4	0.307
EWG-OL-38552-Q	1	2	5	P06AD22	2.79	0.076	<0.010	3.71	0.295
RSM-EWG-1-034-Q	1	2	6	P09AD22	0.987	0.015	0.079	7.14	0.118
EWG-OL-38552-Q	1	2	7	P06AD12	2.77	0.076	<0.010	3.73	0.292
EWG-OL-5801-Q	1	2	8	P08AD12	<0.100	0.077	2.61	3.78	0.288
EWG-OL-3872-Q	1	2	9	P02AD22	2.80	0.075	<0.010	13.8	0.291
EWG-OL-1672-Q	1	2	10	P18AD22	2.44	0.066	<0.010	3.35	0.257
EWG-OL-5801-Q	1	2	11	P08AD22	<0.100	0.078	2.53	3.68	0.289
LRM	1	2	12	LRMAD122	<0.100	0.109	1.21	15.7	0.112
EWG-OL-5155-Q	1	2	13	P17AD22	2.98	0.077	<0.010	3.74	0.136
RSM-EWG-1-034-Q	1	2	14	P09AD12	0.985	0.015	0.078	7.15	0.115
EWG-OL-33115-Q	1	2	15	P04AD22	2.81	0.074	2.14	4.91	0.295
EWG-OL-33115-Q	1	2	16	P04AD12	2.80	0.074	2.15	4.89	0.295

Table A-1. AD Measurements of Set 1 Study Glasses – Part 1 (continued)

Glass ID	Block	Sub-Blk	Sequence	Lab ID	Bi (wt%)	Cd (wt%)	K (wt%)	Na (wt%)	Ni (wt%)
EWG-OL-14827-Q	1	2	17	P05AD12	2.68	0.072	2.59	3.69	0.226
EWG-HAI-Centroid-1-Q	1	2	18	P12AD22	0.886	0.076	0.559	8.73	0.137
EWG-OL-3872-Q	1	2	19	P02AD12	2.83	0.075	<0.010	13.8	0.290
EWG-HAI-Centroid-1-Q	1	2	20	P12AD12	0.885	0.077	0.563	8.81	0.137
EWG-OL-5155-Q	1	2	21	P17AD12	3.00	0.078	<0.010	3.86	0.134
EWG-OL-1672-Q	1	2	22	P18AD12	2.48	0.067	<0.010	3.31	0.258
LRM	1	2	23	LRMAD123	<0.100	0.108	1.23	16.1	0.114
LRM	2	1	1	LRMAD211	<0.100	0.115	1.23	16.3	0.129
EWG-OL-1580-Q	2	1	2	P11AD11	<0.100	0.075	<0.010	3.84	0.292
EWG-HAI-Centroid-2-Q	2	1	3	P10AD11	0.789	0.068	0.396	7.69	0.117
EWG-OL-6198-Q	2	1	4	P16AD21	<0.100	0.076	2.47	3.66	0.076
EWG-OL-1369-Q	2	1	5	P19AD21	2.66	0.075	<0.010	3.65	0.291
EWG-OL-6198-Q	2	1	6	P16AD11	<0.100	0.076	2.58	3.75	0.076
EWG-OL-31644-Q	2	1	7	P07AD21	<0.100	0.074	<0.010	3.70	0.225
EWG-OL-2463-Q	2	1	8	P15AD11	<0.100	0.073	2.63	14.1	0.284
EWG-OL-1369-Q	2	1	9	P19AD11	2.65	0.075	<0.010	3.85	0.289
EWG-OL-15968-Q	2	1	10	P14AD21	<0.100	0.073	<0.010	14.2	0.250
EWG-OL-29285-Q	2	1	11	P01AD21	<0.100	0.076	<0.010	3.89	0.295
LRM	2	1	12	LRMAD212	<0.100	0.114	1.28	16.7	0.131
EWG-OL-2619-Q	2	1	13	P13AD11	2.80	0.076	2.29	3.82	0.235
EWG-OL-15968-Q	2	1	14	P14AD11	<0.100	0.074	<0.010	14.0	0.255
EWG-OL-1580-Q	2	1	15	P11AD21	<0.100	0.076	<0.010	3.83	0.291
EWG-HAI-Centroid-2-Q	2	1	16	P10AD21	0.791	0.068	0.430	8.13	0.117
EWG-OL-31644-Q	2	1	17	P07AD11	<0.100	0.073	<0.010	3.83	0.224
EWG-OL-29285-Q	2	1	18	P01AD11	<0.100	0.075	<0.010	3.83	0.294
EWG-OL-801-Q	2	1	19	P20AD21	2.67	0.075	<0.010	13.2	0.295
EWG-OL-2463-Q	2	1	20	P15AD21	<0.100	0.072	2.68	14.1	0.280
EWG-OL-801-Q	2	1	21	P20AD11	2.65	0.076	<0.010	13.3	0.294
EWG-OL-2619-Q	2	1	22	P13AD21	2.79	0.077	2.24	3.77	0.236
LRM	2	1	23	LRMAD213	<0.100	0.116	1.25	16.4	0.134
LRM	2	2	1	LRMAD221	<0.100	0.108	1.18	15.5	0.121
EWG-OL-1580-Q	2	2	2	P11AD12	<0.100	0.076	<0.010	3.85	0.293
EWG-OL-15968-Q	2	2	3	P14AD12	<0.100	0.073	<0.010	13.3	0.254
EWG-OL-1369-Q	2	2	4	P19AD12	2.64	0.073	<0.010	3.69	0.289
EWG-OL-2619-Q	2	2	5	P13AD22	2.77	0.077	2.10	3.59	0.236
EWG-HAI-Centroid-2-Q	2	2	6	P10AD12	0.794	0.068	0.395	7.68	0.117
EWG-OL-1369-Q	2	2	7	P19AD22	2.68	0.074	<0.010	3.65	0.291
EWG-OL-2463-Q	2	2	8	P15AD22	<0.100	0.073	2.46	13.2	0.284
EWG-OL-31644-Q	2	2	9	P07AD22	<0.100	0.073	<0.010	3.57	0.226

Table A-1. AD Measurements of Set 1 Study Glasses – Part 1 (continued)

Glass ID	Block	Sub-Blk	Sequence	Lab ID	Bi (wt%)	Cd (wt%)	K (wt%)	Na (wt%)	Ni (wt%)
EWG-OL-801-Q	2	2	10	P20AD12	2.66	0.076	<0.010	13.2	0.296
EWG-OL-31644-Q	2	2	11	P07AD12	<0.100	0.074	<0.010	3.51	0.226
LRM	2	2	12	LRMAD222	<0.100	0.110	1.16	15.4	0.122
EWG-OL-801-Q	2	2	13	P20AD22	2.66	0.077	<0.010	13.3	0.300
EWG-OL-29285-Q	2	2	14	P01AD12	<0.100	0.075	<0.010	3.64	0.296
EWG-OL-2463-Q	2	2	15	P15AD12	<0.100	0.073	2.50	13.4	0.284
EWG-OL-1580-Q	2	2	16	P11AD22	<0.100	0.075	<0.010	3.81	0.294
EWG-OL-2619-Q	2	2	17	P13AD12	2.77	0.077	2.12	3.61	0.232
EWG-OL-29285-Q	2	2	18	P01AD22	<0.100	0.076	<0.010	3.66	0.297
EWG-OL-6198-Q	2	2	19	P16AD12	<0.100	0.076	2.49	3.65	0.076
EWG-HAI-Centroid-2-Q	2	2	20	P10AD22	0.793	0.069	0.399	7.75	0.118
EWG-OL-15968-Q	2	2	21	P14AD22	<0.100	0.073	<0.010	13.5	0.255
EWG-OL-6198-Q	2	2	22	P16AD22	<0.100	0.075	2.52	3.65	0.075
LRM	2	2	23	LRMAD223	<0.100	0.110	1.17	15.5	0.122

Table A-2. AD Measurements of Set 1 Study Glasses – Part 2

Glass ID	Block	Sub-Blk	Sequence	Lab ID	P (wt%)	Pb (wt%)	Ru (wt%)	S (wt%)	Sr (wt%)	Zr (wt%)
LRM	1	1	1	LRMAD111	0.246	0.072	<0.010	0.099	<0.010	0.664
EWG-OL-3872-Q	1	1	2	P02AD11	1.23	0.236	<0.010	0.124	0.091	<0.100
EWG-OL-5801-Q	1	1	3	P08AD11	1.19	0.254	<0.010	0.129	0.098	2.41
RSM-EWG-1-034-Q	1	1	4	P09AD11	0.434	0.334	<0.010	0.054	<0.010	0.263
EWG-OL-26012-Q	1	1	5	P03AD21	1.21	0.257	<0.010	0.095	0.099	2.93
EWG-HAI-Centroid-1-Q	1	1	6	P12AD11	0.204	0.249	<0.010	0.101	0.099	0.664
EWG-OL-5155-Q	1	1	7	P17AD11	<0.100	0.257	<0.010	0.096	0.099	2.87
EWG-OL-3872-Q	1	1	8	P02AD21	1.23	0.243	<0.010	0.124	0.093	<0.100
EWG-OL-5155-Q	1	1	9	P17AD21	<0.100	0.255	<0.010	0.094	0.099	2.86
EWG-OL-1672-Q	1	1	10	P18AD21	1.05	0.226	<0.010	0.014	0.093	<0.100
EWG-OL-33115-Q	1	1	11	P04AD11	1.21	0.253	<0.010	0.084	0.095	<0.100
LRM	1	1	12	LRMAD112	0.230	0.072	<0.010	0.114	<0.010	0.657
EWG-OL-5801-Q	1	1	13	P08AD21	1.19	0.255	<0.010	0.128	0.098	2.39
EWG-OL-26012-Q	1	1	14	P03AD11	1.22	0.258	<0.010	0.098	0.099	2.91
EWG-OL-38552-Q	1	1	15	P06AD21	1.19	0.251	<0.010	0.090	0.095	2.31
EWG-OL-38552-Q	1	1	16	P06AD11	1.19	0.250	<0.010	0.090	0.095	2.32
EWG-OL-33115-Q	1	1	17	P04AD21	1.21	0.250	<0.010	0.082	0.094	<0.100
EWG-HAI-Centroid-1-Q	1	1	18	P12AD21	0.204	0.250	<0.010	0.096	0.099	0.645
RSM-EWG-1-034-Q	1	1	19	P09AD21	0.435	0.335	<0.010	0.053	<0.010	0.261
EWG-OL-14827-Q	1	1	20	P05AD11	<0.100	0.244	<0.010	0.127	0.097	<0.100
EWG-OL-14827-Q	1	1	21	P05AD21	<0.100	0.245	<0.010	0.123	0.096	<0.100
EWG-OL-1672-Q	1	1	22	P18AD11	1.05	0.223	<0.010	0.011	0.091	<0.100
LRM	1	1	23	LRMAD113	0.246	0.067	<0.010	0.113	<0.010	0.647
LRM	1	2	1	LRMAD111	0.246	0.052	<0.010	0.095	<0.010	0.695
EWG-OL-14827-Q	1	2	2	P05AD22	<0.100	0.252	<0.010	0.126	0.097	<0.100
EWG-OL-26012-Q	1	2	3	P03AD22	1.23	0.261	<0.010	0.092	0.099	3.00
EWG-OL-26012-Q	1	2	4	P03AD12	1.23	0.261	<0.010	0.093	0.100	3.01
EWG-OL-38552-Q	1	2	5	P06AD22	1.21	0.256	<0.010	0.082	0.096	2.37
RSM-EWG-1-034-Q	1	2	6	P09AD22	0.439	0.342	<0.010	0.050	<0.010	0.291
EWG-OL-38552-Q	1	2	7	P06AD12	1.20	0.252	<0.010	0.087	0.096	2.38
EWG-OL-5801-Q	1	2	8	P08AD12	1.20	0.257	<0.010	0.129	0.098	2.45
EWG-OL-3872-Q	1	2	9	P02AD22	1.23	0.240	<0.010	0.120	0.092	<0.100
EWG-OL-1672-Q	1	2	10	P18AD22	1.05	0.225	<0.010	0.007	0.091	<0.100
EWG-OL-5801-Q	1	2	11	P08AD22	1.20	0.257	<0.010	0.129	0.099	2.45
LRM	1	2	12	LRMAD122	0.225	0.055	<0.010	0.057	<0.010	0.690
EWG-OL-5155-Q	1	2	13	P17AD22	<0.100	0.259	<0.010	0.096	0.100	2.93
RSM-EWG-1-034-Q	1	2	14	P09AD12	0.439	0.337	<0.010	0.051	<0.010	0.288
EWG-OL-33115-Q	1	2	15	P04AD22	1.21	0.251	<0.010	0.077	0.094	<0.100
EWG-OL-33115-Q	1	2	16	P04AD12	1.21	0.251	<0.010	0.082	0.093	<0.100

Table A-2. AD Measurements of Set 1 Study Glasses – Part 2 (continued)

Glass ID	Block	Sub-Blk	Sequence	Lab ID	P (wt%)	Pb (wt%)	Ru (wt%)	S (wt%)	Sr (wt%)	Zr (wt%)
EWG-OL-14827-Q	1	2	17	P05AD12	<0.100	0.246	<0.010	0.123	0.097	<0.100
EWG-HAI-Centroid-1-Q	1	2	18	P12AD22	0.206	0.253	<0.010	0.097	0.099	0.686
EWG-OL-3872-Q	1	2	19	P02AD12	1.22	0.237	<0.010	0.122	0.091	<0.100
EWG-HAI-Centroid-1-Q	1	2	20	P12AD12	0.203	0.252	<0.010	0.096	0.098	0.699
EWG-OL-5155-Q	1	2	21	P17AD12	<0.100	0.259	<0.010	0.097	0.100	2.94
EWG-OL-1672-Q	1	2	22	P18AD12	1.06	0.226	<0.010	0.010	0.090	<0.100
LRM	1	2	23	LRMAD123	0.240	0.056	<0.010	0.073	<0.010	0.685
LRM	2	1	1	LRMAD211	0.191	0.069	<0.010	0.081	<0.010	0.714
EWG-OL-1580-Q	2	1	2	P11AD11	1.21	0.250	<0.010	0.110	0.089	2.94
EWG-HAI-Centroid-2-Q	2	1	3	P10AD11	0.357	0.225	<0.010	0.094	0.089	0.625
EWG-OL-6198-Q	2	1	4	P16AD21	1.20	0.256	<0.010	0.123	0.097	2.76
EWG-OL-1369-Q	2	1	5	P19AD21	1.21	0.248	<0.010	0.096	0.090	2.91
EWG-OL-6198-Q	2	1	6	P16AD11	1.21	0.259	<0.010	0.129	0.100	2.75
EWG-OL-31644-Q	2	1	7	P07AD21	<0.100	0.255	<0.010	0.052	0.102	<0.100
EWG-OL-2463-Q	2	1	8	P15AD11	1.20	0.250	<0.010	0.133	0.098	2.89
EWG-OL-1369-Q	2	1	9	P19AD11	1.21	0.246	<0.010	0.099	0.094	2.96
EWG-OL-15968-Q	2	1	10	P14AD21	<0.100	0.251	<0.010	0.117	0.097	2.95
EWG-OL-29285-Q	2	1	11	P01AD21	1.25	0.252	<0.010	0.014	0.097	2.96
LRM	2	1	12	LRMAD212	0.188	0.069	<0.010	0.123	<0.010	0.699
EWG-OL-2619-Q	2	1	13	P13AD11	<0.100	0.257	<0.010	0.082	0.104	1.94
EWG-OL-15968-Q	2	1	14	P14AD11	<0.100	0.254	<0.010	0.124	0.098	2.92
EWG-OL-1580-Q	2	1	15	P11AD21	1.22	0.251	<0.010	0.114	0.086	2.94
EWG-HAI-Centroid-2-Q	2	1	16	P10AD21	0.360	0.226	<0.010	0.099	0.090	0.631
EWG-OL-31644-Q	2	1	17	P07AD11	<0.100	0.254	<0.010	0.050	0.101	<0.100
EWG-OL-29285-Q	2	1	18	P01AD11	1.21	0.252	<0.010	0.018	0.101	2.97
EWG-OL-801-Q	2	1	19	P20AD21	1.20	0.253	<0.010	0.084	0.096	<0.100
EWG-OL-2463-Q	2	1	20	P15AD21	1.18	0.247	<0.010	0.129	0.099	2.90
EWG-OL-801-Q	2	1	21	P20AD11	1.19	0.255	<0.010	0.083	0.097	<0.100
EWG-OL-2619-Q	2	1	22	P13AD21	<0.100	0.254	<0.010	0.088	0.098	1.91
LRM	2	1	23	LRMAD213	0.195	0.073	<0.010	0.105	<0.010	0.702
LRM	2	2	1	LRMAD221	0.181	0.062	<0.010	0.093	<0.010	0.701
EWG-OL-1580-Q	2	2	2	P11AD12	1.22	0.251	<0.010	0.114	0.092	2.92
EWG-OL-15968-Q	2	2	3	P14AD12	<0.100	0.251	<0.010	0.123	0.099	2.93
EWG-OL-1369-Q	2	2	4	P19AD12	1.21	0.245	<0.010	0.100	0.095	2.95
EWG-OL-2619-Q	2	2	5	P13AD22	<0.100	0.254	<0.010	0.091	0.100	1.91
EWG-HAI-Centroid-2-Q	2	2	6	P10AD12	0.361	0.223	<0.010	0.096	0.090	0.619
EWG-OL-1369-Q	2	2	7	P19AD22	1.22	0.245	<0.010	0.100	0.091	2.93
EWG-OL-2463-Q	2	2	8	P15AD22	1.20	0.247	<0.010	0.131	0.099	2.90
EWG-OL-31644-Q	2	2	9	P07AD22	<0.100	0.253	<0.010	0.050	0.102	<0.100

Table A-2. AD Measurements of Set 1 Study Glasses – Part 2 (continued)

Glass ID	Block	Sub-Blk	Sequence	Lab ID	P (wt%)	Pb (wt%)	Ru (wt%)	S (wt%)	Sr (wt%)	Zr (wt%)
EWG-OL-801-Q	2	2	10	P20AD12	1.20	0.255	<0.010	0.087	0.098	<0.100
EWG-OL-31644-Q	2	2	11	P07AD12	<0.100	0.255	<0.010	0.048	0.102	<0.100
LRM	2	2	12	LRMAD222	0.185	0.071	<0.010	0.120	<0.010	0.690
EWG-OL-801-Q	2	2	13	P20AD22	1.21	0.258	<0.010	0.087	0.098	<0.100
EWG-OL-29285-Q	2	2	14	P01AD12	1.22	0.252	<0.010	0.020	0.102	2.96
EWG-OL-2463-Q	2	2	15	P15AD12	1.20	0.249	<0.010	0.129	0.099	2.86
EWG-OL-1580-Q	2	2	16	P11AD22	1.21	0.251	<0.010	0.110	0.087	2.91
EWG-OL-2619-Q	2	2	17	P13AD12	<0.100	0.254	<0.010	0.085	0.099	1.90
EWG-OL-29285-Q	2	2	18	P01AD22	1.22	0.254	<0.010	0.020	0.106	2.94
EWG-OL-6198-Q	2	2	19	P16AD12	1.20	0.258	<0.010	0.126	0.098	2.72
EWG-HAI-Centroid-2-Q	2	2	20	P10AD22	0.362	0.228	<0.010	0.099	0.092	0.609
EWG-OL-15968-Q	2	2	21	P14AD22	<0.100	0.252	<0.010	0.119	0.099	2.94
EWG-OL-6198-Q	2	2	22	P16AD22	1.21	0.255	<0.010	0.125	0.099	2.74
LRM	2	2	23	LRMAD223	0.198	0.070	<0.010	0.132	<0.010	0.684

Table A-3. PF Measurements of Set 1 Study Glasses

Glass ID	Block	Sub-Blk	Sequence	Lab ID	Al (wt%)	B (wt%)	Ca (wt%)	Cr (wt%)	Fe (wt%)	Li (wt%)	Mg (wt%)	Mn (wt%)	Si (wt%)
LRM	1	1	1	LRMPF111	5.12	2.45	0.210	0.203	1.02	<0.100	<0.100	<0.100	25.1
EWG-OL-1580-Q	1	1	2	P11PF11	7.92	2.45	7.19	0.952	<0.100	2.79	<0.100	2.40	19.7
RSM-EWG-1-034-Q	1	1	3	P09PF11	12.8	5.69	4.02	0.210	4.28	1.70	<0.100	<0.100	13.3
EWG-OL-31644-Q	1	1	4	P07PF21	7.93	2.52	7.45	0.997	6.95	0.640	2.26	2.41	18.9
EWG-OL-2619-Q	1	1	5	P13PF21	9.65	6.72	7.42	<0.100	6.92	<0.100	<0.100	2.40	9.33
EWG-OL-1672-Q	1	1	6	P18PF11	13.7	9.57	6.49	0.916	<0.100	<0.100	<0.100	2.08	8.53
EWG-HAI-Centroid-1-Q	1	1	7	P12PF11	11.7	4.73	2.69	0.493	3.94	1.43	0.134	0.799	14.7
EWG-OL-2619-Q	1	1	8	P13PF11	10.0	7.02	7.31	<0.100	7.23	<0.100	<0.100	2.51	9.69
EWG-OL-15968-Q	1	1	9	P14PF11	8.06	6.96	<0.100	0.956	<0.100	2.45	2.30	<0.100	13.7
EWG-OL-5155-Q	1	1	10	P17PF11	10.5	7.00	<0.100	0.732	6.47	2.85	2.15	2.33	9.55
EWG-OL-15968-Q	1	1	11	P14PF21	7.82	6.66	<0.100	0.937	<0.100	2.40	2.25	<0.100	13.3
LRM	1	1	12	LRMPF112	5.18	2.49	0.178	0.196	1.02	<0.100	<0.100	<0.100	25.0
EWG-OL-5801-Q	1	1	13	P08PF11	9.69	6.79	<0.100	<0.100	6.85	2.79	2.22	2.40	9.23
RSM-EWG-1-034-Q	1	1	14	P09PF21	12.5	5.77	4.13	0.212	4.16	1.69	<0.100	<0.100	12.9
EWG-HAI-Centroid-1-Q	1	1	15	P12PF21	11.5	4.81	2.72	0.481	3.88	1.43	0.130	0.788	14.5
EWG-OL-1580-Q	1	1	16	P11PF21	7.93	2.58	7.52	0.998	<0.100	2.76	<0.100	2.41	19.4
EWG-HAI-Centroid-2-Q	1	1	17	P10PF21	10.6	7.32	2.30	0.413	3.58	1.31	0.101	0.728	13.6
EWG-OL-1672-Q	1	1	18	P18PF21	13.8	9.60	6.09	0.844	<0.100	<0.100	<0.100	1.99	8.50
EWG-OL-5801-Q	1	1	19	P08PF21	9.51	6.61	<0.100	<0.100	6.70	2.74	2.13	2.35	9.14
EWG-OL-5155-Q	1	1	20	P17PF21	10.5	6.97	<0.100	0.747	6.52	2.84	2.19	2.35	9.49
EWG-HAI-Centroid-2-Q	1	1	21	P10PF11	10.6	7.34	2.38	0.420	3.57	1.32	0.106	0.727	13.5
EWG-OL-31644-Q	1	1	22	P07PF11	8.26	2.69	7.76	0.998	7.07	0.682	2.28	2.47	19.4
LRM	1	1	23	LRMPF113	5.22	2.53	0.198	0.198	1.04	<0.100	<0.100	<0.100	25.3
LRM	1	2	1	LRMPF111	5.14	2.43	0.245	0.220	0.966	<0.100	<0.100	<0.100	25.2
RSM-EWG-1-034-Q	1	2	2	P09PF22	12.4	5.66	4.09	0.224	4.07	1.63	<0.100	<0.100	12.9
EWG-HAI-Centroid-1-Q	1	2	3	P12PF12	12.0	4.78	2.71	0.506	3.99	1.43	0.149	0.747	15.2
EWG-HAI-Centroid-1-Q	1	2	4	P12PF22	11.6	4.73	2.66	0.482	3.85	1.41	0.141	0.725	14.7
EWG-OL-1672-Q	1	2	5	P18PF22	13.9	9.70	6.11	0.855	<0.100	<0.100	<0.100	1.91	8.60
EWG-OL-1580-Q	1	2	6	P11PF22	8.01	2.51	7.25	0.980	<0.100	2.76	<0.100	2.38	19.8
EWG-OL-5155-Q	1	2	7	P17PF12	10.4	6.78	<0.100	0.727	6.38	2.76	2.10	2.25	9.57
EWG-OL-5155-Q	1	2	8	P17PF22	10.5	6.78	<0.100	0.722	6.43	2.75	2.08	2.27	9.55
EWG-OL-15968-Q	1	2	9	P14PF12	7.93	6.71	<0.100	0.945	<0.100	2.36	2.25	<0.100	13.6
EWG-OL-31644-Q	1	2	10	P07PF22	7.84	2.45	7.43	0.998	6.83	0.614	2.24	2.32	18.7
EWG-OL-5801-Q	1	2	11	P08PF12	9.71	6.75	<0.100	<0.100	6.83	2.75	2.17	2.34	9.32
LRM	1	2	12	LRMPF122	5.21	2.41	0.235	0.216	0.975	<0.100	<0.100	<0.100	25.5
EWG-HAI-Centroid-2-Q	1	2	13	P10PF22	10.4	7.10	2.32	0.428	3.47	1.25	0.120	0.645	13.5
RSM-EWG-1-034-Q	1	2	14	P09PF12	12.9	5.74	3.99	0.222	4.25	1.68	<0.100	<0.100	13.4
EWG-OL-5801-Q	1	2	15	P08PF22	9.69	6.81	<0.100	<0.100	6.80	2.76	2.12	2.33	9.45

Table A-3. PF Measurements of Set 1 Study Glasses (continued)

Glass ID	Block	Sub-Blk	Sequence	Lab ID	Al (wt%)	B (wt%)	Ca (wt%)	Cr (wt%)	Fe (wt%)	Li (wt%)	Mg (wt%)	Mn (wt%)	Si (wt%)
EWG-OL-2619-Q	1	2	16	P13PF22	9.77	6.72	7.01	<0.100	6.96	<0.100	<0.100	2.37	9.44
EWG-HAI-Centroid-2-Q	1	2	17	P10PF12	10.7	7.39	2.37	0.432	3.56	1.30	0.122	0.668	13.7
EWG-OL-31644-Q	1	2	18	P07PF12	8.19	2.53	7.44	0.984	7.01	0.658	2.23	2.39	19.4
EWG-OL-15968-Q	1	2	19	P14PF22	7.86	6.71	<0.100	0.948	<0.100	2.34	2.26	<0.100	13.5
EWG-OL-1580-Q	1	2	20	P11PF12	7.92	2.50	7.27	0.963	<0.100	2.75	<0.100	2.35	19.8
EWG-OL-2619-Q	1	2	21	P13PF12	9.93	6.96	7.11	<0.100	7.16	<0.100	<0.100	2.43	9.61
EWG-OL-1672-Q	1	2	22	P18PF12	13.9	9.72	6.21	0.889	<0.100	<0.100	<0.100	2.05	8.65
LRM	1	2	23	LRMPF123	5.18	2.42	0.228	0.215	0.971	<0.100	<0.100	<0.100	25.3
LRM	2	1	1	LRMPF211	5.27	2.57	0.219	0.197	1.03	<0.100	<0.100	<0.100	25.8
EWG-OL-38552-Q	2	1	2	P06PF21	14.0	2.62	<0.100	<0.100	2.61	2.85	2.22	2.46	15.8
EWG-OL-29285-Q	2	1	3	P01PF11	8.08	5.80	7.38	<0.100	<0.100	<0.100	2.06	<0.100	18.4
EWG-OL-26012-Q	2	1	4	P03PF11	7.94	2.51	<0.100	<0.100	<0.100	0.784	<0.100	<0.100	20.1
EWG-OL-38552-Q	2	1	5	P06PF11	13.5	2.47	<0.100	<0.100	2.50	2.77	2.13	2.36	15.2
EWG-OL-29285-Q	2	1	6	P01PF21	7.95	5.75	7.16	<0.100	<0.100	<0.100	2.11	<0.100	18.2
EWG-OL-33115-Q	2	1	7	P04PF11	8.00	2.55	7.04	<0.100	7.02	<0.100	2.22	<0.100	16.9
EWG-OL-1369-Q	2	1	8	P19PF11	7.93	2.48	7.08	1.02	<0.100	2.77	<0.100	<0.100	20.0
EWG-OL-6198-Q	2	1	9	P16PF11	7.95	6.72	<0.100	1.05	7.00	2.80	2.15	<0.100	11.7
EWG-OL-801-Q	2	1	10	P20PF11	16.1	6.74	<0.100	<0.100	<0.100	<0.100	<0.100	2.43	9.58
EWG-OL-1369-Q	2	1	11	P19PF21	8.01	2.55	6.96	1.03	<0.100	2.84	<0.100	<0.100	20.2
LRM	2	1	12	LRMPF212	5.22	2.44	0.227	0.198	1.01	<0.100	<0.100	<0.100	25.5
EWG-OL-2463-Q	2	1	13	P15PF11	10.2	2.47	6.80	<0.100	6.87	<0.100	<0.100	2.37	9.41
EWG-OL-14827-Q	2	1	14	P05PF11	8.18	6.90	7.14	1.07	<0.100	2.82	<0.100	2.48	14.5
EWG-OL-801-Q	2	1	15	P20PF21	15.5	6.51	<0.100	<0.100	<0.100	<0.100	<0.100	2.33	9.14
EWG-OL-3872-Q	2	1	16	P02PF11	7.90	2.50	6.92	<0.100	<0.100	2.78	2.20	<0.100	14.6
EWG-OL-3872-Q	2	1	17	P02PF21	7.72	2.47	7.02	<0.100	<0.100	2.72	2.22	<0.100	14.3
EWG-OL-26012-Q	2	1	18	P03PF21	7.93	2.44	<0.100	<0.100	<0.100	0.780	<0.100	<0.100	19.8
EWG-OL-2463-Q	2	1	19	P15PF21	10.3	2.50	6.91	<0.100	6.97	<0.100	<0.100	2.40	9.35
EWG-OL-33115-Q	2	1	20	P04PF21	8.14	2.59	6.97	<0.100	7.15	<0.100	2.20	<0.100	17.1
EWG-OL-6198-Q	2	1	21	P16PF21	8.01	6.83	<0.100	1.02	7.02	2.83	2.10	<0.100	11.7
EWG-OL-14827-Q	2	1	22	P05PF21	7.92	6.77	6.76	1.01	<0.100	2.74	<0.100	2.39	14.1
LRM	2	1	23	LRMPF213	5.21	2.43	0.241	0.201	1.01	<0.100	<0.100	<0.100	25.2
LRM	2	2	1	LRMPF221	5.06	2.45	0.216	0.200	0.961	<0.100	<0.100	<0.100	24.8
EWG-OL-29285-Q	2	2	2	P01PF22	7.86	5.66	7.12	<0.100	<0.100	<0.100	2.11	<0.100	18.0
EWG-OL-3872-Q	2	2	3	P02PF12	7.77	2.52	7.04	<0.100	<0.100	2.67	2.23	<0.100	14.5
EWG-OL-38552-Q	2	2	4	P06PF22	13.8	2.58	<0.100	<0.100	2.55	2.75	2.25	2.39	15.6
EWG-OL-6198-Q	2	2	5	P16PF12	8.03	6.95	<0.100	1.07	7.08	2.77	2.18	<0.100	11.8
EWG-OL-14827-Q	2	2	6	P05PF22	7.92	6.92	6.90	1.02	<0.100	2.68	<0.100	2.36	14.2
EWG-OL-38552-Q	2	2	7	P06PF12	13.7	2.58	<0.100	<0.100	2.51	2.74	2.18	2.35	15.4

Table A-3. PF Measurements of Set 1 Study Glasses (continued)

Glass ID	Block	Sub-Blk	Sequence	Lab ID	Al (wt%)	B (wt%)	Ca (wt%)	Cr (wt%)	Fe (wt%)	Li (wt%)	Mg (wt%)	Mn (wt%)	Si (wt%)
EWG-OL-2463-Q	2	2	8	P15PF12	10.4	2.58	7.02	<0.100	6.99	<0.100	<0.100	2.37	9.57
EWG-OL-33115-Q	2	2	9	P04PF12	7.97	2.57	6.88	<0.100	6.96	<0.100	2.16	<0.100	16.8
EWG-OL-14827-Q	2	2	10	P05PF12	8.17	6.99	6.88	1.03	<0.100	2.75	<0.100	2.44	14.5
EWG-OL-801-Q	2	2	11	P20PF22	15.2	6.29	<0.100	<0.100	<0.100	<0.100	<0.100	2.25	8.95
LRM	2	2	12	LRMPF222	5.07	2.40	0.236	0.207	0.954	<0.100	<0.100	<0.100	24.7
EWG-OL-1369-Q	2	2	13	P19PF22	7.87	2.58	7.11	1.04	<0.100	2.74	<0.100	<0.100	19.9
EWG-OL-1369-Q	2	2	14	P19PF12	8.00	2.55	7.23	1.03	<0.100	2.73	<0.100	<0.100	20.1
EWG-OL-6198-Q	2	2	15	P16PF22	7.90	6.73	<0.100	1.04	6.93	2.74	2.12	<0.100	11.6
EWG-OL-26012-Q	2	2	16	P03PF12	7.93	2.53	<0.100	<0.100	<0.100	0.780	<0.100	<0.100	20.0
EWG-OL-801-Q	2	2	17	P20PF12	15.7	6.54	<0.100	<0.100	<0.100	<0.100	<0.100	2.33	9.24
EWG-OL-26012-Q	2	2	18	P03PF22	7.85	2.47	<0.100	<0.100	<0.100	0.767	<0.100	<0.100	19.7
EWG-OL-3872-Q	2	2	19	P02PF22	7.82	2.57	7.21	<0.100	<0.100	2.73	2.25	<0.100	14.6
EWG-OL-2463-Q	2	2	20	P15PF22	10.3	2.55	7.16	<0.100	6.95	<0.100	<0.100	2.36	9.32
EWG-OL-33115-Q	2	2	21	P04PF22	8.00	2.55	7.07	<0.100	7.04	<0.100	2.22	<0.100	16.9
EWG-OL-29285-Q	2	2	22	P01PF12	7.98	5.70	7.52	<0.100	<0.100	<0.100	2.10	<0.100	18.1
LRM	2	2	23	LRMPF223	5.15	2.37	0.235	0.204	0.979	<0.100	<0.100	<0.100	25.0

Table A-4. Comparison of Measured and Targeted Compositions for Set 1 Study Glasses

Glass ID	Oxide	Measured (wt %)	Targeted (wt %)	Difference of Measured versus Targeted	% Difference of Measured versus Targeted
EWG-HAI-Centroid-1-Q	Al_2O_3	22.1072	22.0000	0.1072	0.5%
EWG-HAI-Centroid-1-Q	B_2O_3	15.3348	15.5000	-0.1652	-1.1%
EWG-HAI-Centroid-1-Q	Bi_2O_3	0.9752	1.0000	-0.0248	-2.5%
EWG-HAI-Centroid-1-Q	CaO	3.7708	3.5000	0.2708	7.7%
EWG-HAI-Centroid-1-Q	CdO	0.0865	0.1000	-0.0135	-13.5%
EWG-HAI-Centroid-1-Q	Cr_2O_3	0.7169	0.7500	-0.0331	-4.4%
EWG-HAI-Centroid-1-Q	Fe_2O_3	5.5973	5.5000	0.0973	1.8%
EWG-HAI-Centroid-1-Q	K_2O	0.6815	0.7000	-0.0185	-2.6%
EWG-HAI-Centroid-1-Q	Li_2O	3.0679	3.0000	0.0679	2.3%
EWG-HAI-Centroid-1-Q	MgO	0.2297	0.5000	-0.2703	-54.1%
EWG-HAI-Centroid-1-Q	MnO	0.9874	1.0000	-0.0126	-1.3%
EWG-HAI-Centroid-1-Q	Na_2O	11.8894	11.5000	0.3894	3.4%
EWG-HAI-Centroid-1-Q	NiO	0.1743	0.4000	-0.2257	-56.4%
EWG-HAI-Centroid-1-Q	P_2O_5	0.4680	0.5000	-0.0320	-6.4%
EWG-HAI-Centroid-1-Q	PbO	0.2704	0.3000	-0.0296	-9.9%
EWG-HAI-Centroid-1-Q	RuO_2	0.0132	0.0100	0.0032	31.7%
EWG-HAI-Centroid-1-Q	SiO_2	31.6082	31.5000	0.1082	0.3%
EWG-HAI-Centroid-1-Q	SO_3	0.2434	0.3000	-0.0566	-18.9%
EWG-HAI-Centroid-1-Q	SrO	0.1168	0.1200	-0.0032	-2.7%
EWG-HAI-Centroid-1-Q	ZrO_2	0.9098	1.0000	-0.0902	-9.0%
EWG-HAI-Centroid-1-Q	Sum	99.2486	99.1800	0.0686	0.1%
EWG-HAI-Centroid-2-Q	Al_2O_3	19.9815	22.0000	-2.0185	-9.2%
EWG-HAI-Centroid-2-Q	B_2O_3	23.4650	15.5000	7.9650	51.4%
EWG-HAI-Centroid-2-Q	Bi_2O_3	0.8826	1.0000	-0.1174	-11.7%
EWG-HAI-Centroid-2-Q	CaO	3.2776	3.5000	-0.2224	-6.4%
EWG-HAI-Centroid-2-Q	CdO	0.0780	0.1000	-0.0220	-22.0%
EWG-HAI-Centroid-2-Q	Cr_2O_3	0.6186	0.7500	-0.1314	-17.5%
EWG-HAI-Centroid-2-Q	Fe_2O_3	5.0683	5.5000	-0.4317	-7.8%
EWG-HAI-Centroid-2-Q	K_2O	0.4879	0.7000	-0.2121	-30.3%
EWG-HAI-Centroid-2-Q	Li_2O	2.7880	3.0000	-0.2120	-7.1%
EWG-HAI-Centroid-2-Q	MgO	0.1861	0.5000	-0.3139	-62.8%
EWG-HAI-Centroid-2-Q	MnO	0.8935	1.0000	-0.1065	-10.6%
EWG-HAI-Centroid-2-Q	Na_2O	10.5313	11.5000	-0.9688	-8.4%
EWG-HAI-Centroid-2-Q	NiO	0.1492	0.4000	-0.2508	-62.7%
EWG-HAI-Centroid-2-Q	P_2O_5	0.8249	1.0000	-0.1751	-17.5%
EWG-HAI-Centroid-2-Q	PbO	0.2429	0.3000	-0.0571	-19.0%
EWG-HAI-Centroid-2-Q	RuO_2	0.0132	0.0100	0.0032	31.7%
EWG-HAI-Centroid-2-Q	SiO_2	29.0410	31.5000	-2.4590	-7.8%
EWG-HAI-Centroid-2-Q	SO_3	0.2422	0.3000	-0.0578	-19.3%
EWG-HAI-Centroid-2-Q	SrO	0.1067	0.1200	-0.0133	-11.1%
EWG-HAI-Centroid-2-Q	ZrO_2	0.8388	1.0000	-0.1612	-16.1%
EWG-HAI-Centroid-2-Q	Sum	99.7173	99.6800	0.0373	0.0%
EWG-OL-1369-Q	Al_2O_3	15.0262	15.0000	0.0262	0.2%
EWG-OL-1369-Q	B_2O_3	8.1785	8.0000	0.1785	2.2%
EWG-OL-1369-Q	Bi_2O_3	2.9626	3.0000	-0.0374	-1.2%
EWG-OL-1369-Q	CaO	9.9273	10.0000	-0.0727	-0.7%
EWG-OL-1369-Q	CdO	0.0848	0.1000	-0.0152	-15.2%
EWG-OL-1369-Q	Cr_2O_3	1.5054	1.6000	-0.0946	-5.9%
EWG-OL-1369-Q	Fe_2O_3	0.1430	0.0000	0.1430	
EWG-OL-1369-Q	K_2O	0.0120	0.0000	0.0120	
EWG-OL-1369-Q	Li_2O	5.9635	6.0000	-0.0365	-0.6%
EWG-OL-1369-Q	MgO	0.1658	0.0000	0.1658	
EWG-OL-1369-Q	MnO	0.1291	0.0000	0.1291	
EWG-OL-1369-Q	Na_2O	5.0011	5.0000	0.0011	0.0%
EWG-OL-1369-Q	NiO	0.3690	0.4000	-0.0310	-7.7%
EWG-OL-1369-Q	P_2O_5	2.7783	3.0000	-0.2217	-7.4%
EWG-OL-1369-Q	PbO	0.2650	0.3000	-0.0350	-11.7%
EWG-OL-1369-Q	RuO_2	0.0132	0.0100	0.0032	31.7%
EWG-OL-1369-Q	SiO_2	42.8930	42.8550	0.0380	0.1%
EWG-OL-1369-Q	SO_3	0.2466	0.3000	-0.0534	-17.8%

Table A-4. Comparison of Measured and Targeted Compositions for Set 1 Study Glasses **(continued)**

Glass ID	Oxide	Measured (wt %)	Targeted (wt %)	Difference of Measured versus Targeted	% Difference of Measured versus Targeted
EWG-OL-1369-Q	SrO	0.1094	0.1200	-0.0106	-8.8%
EWG-OL-1369-Q	ZrO_2	3.9680	4.0000	-0.0320	-0.8%
EWG-OL-1369-Q	Sum	99.7419	99.6850	0.0569	0.1%
EWG-OL-14827-Q	Al_2O_3	15.2058	15.0000	0.2058	1.4%
EWG-OL-14827-Q	B_2O_3	22.2012	22.0000	0.2012	0.9%
EWG-OL-14827-Q	Bi_2O_3	2.9598	3.0000	-0.0402	-1.3%
EWG-OL-14827-Q	CaO	9.6825	10.0000	-0.3175	-3.2%
EWG-OL-14827-Q	CdO	0.0817	0.1000	-0.0183	-18.3%
EWG-OL-14827-Q	Cr_2O_3	1.5091	1.6000	-0.0909	-5.7%
EWG-OL-14827-Q	Fe_2O_3	0.1430	0.0000	0.1430	
EWG-OL-14827-Q	K_2O	3.1771	3.0000	0.1771	5.9%
EWG-OL-14827-Q	Li_2O	5.9151	5.8994	0.0157	0.3%
EWG-OL-14827-Q	MgO	0.1658	0.0000	0.1658	
EWG-OL-14827-Q	MnO	3.1215	3.0000	0.1215	4.0%
EWG-OL-14827-Q	Na_2O	5.0786	5.0000	0.0786	1.6%
EWG-OL-14827-Q	NiO	0.2879	0.4000	-0.1121	-28.0%
EWG-OL-14827-Q	P_2O_5	0.2291	0.0000	0.2291	
EWG-OL-14827-Q	PbO	0.2658	0.3000	-0.0342	-11.4%
EWG-OL-14827-Q	RuO_2	0.0132	0.0100	0.0032	31.7%
EWG-OL-14827-Q	SiO_2	30.6455	29.9556	0.6899	2.3%
EWG-OL-14827-Q	SO_3	0.3115	0.3000	0.0115	3.8%
EWG-OL-14827-Q	SrO	0.1144	0.1200	-0.0056	-4.7%
EWG-OL-14827-Q	ZrO_2	0.1351	0.0000	0.1351	
EWG-OL-14827-Q	Sum	101.2436	99.6850	1.5586	1.6%
EWG-OL-1580-Q	Al_2O_3	15.0121	15.0000	0.0121	0.1%
EWG-OL-1580-Q	B_2O_3	8.0819	8.0000	0.0819	1.0%
EWG-OL-1580-Q	Bi_2O_3	0.1115	0.0000	0.1115	
EWG-OL-1580-Q	CaO	10.2247	10.0000	0.2247	2.2%
EWG-OL-1580-Q	CdO	0.0862	0.1000	-0.0138	-13.8%
EWG-OL-1580-Q	Cr_2O_3	1.4225	1.6000	-0.1775	-11.1%
EWG-OL-1580-Q	Fe_2O_3	0.1430	0.0000	0.1430	
EWG-OL-1580-Q	K_2O	0.0120	0.0000	0.0120	
EWG-OL-1580-Q	Li_2O	5.9528	6.0000	-0.0472	-0.8%
EWG-OL-1580-Q	MgO	0.1658	0.0000	0.1658	
EWG-OL-1580-Q	MnO	3.0795	3.0000	0.0795	2.7%
EWG-OL-1580-Q	Na_2O	5.1662	5.0000	0.1662	3.3%
EWG-OL-1580-Q	NiO	0.3722	0.4000	-0.0278	-6.9%
EWG-OL-1580-Q	P_2O_5	2.7841	3.0000	-0.2159	-7.2%
EWG-OL-1580-Q	PbO	0.2701	0.3000	-0.0299	-10.0%
EWG-OL-1580-Q	RuO_2	0.0132	0.0100	0.0032	31.7%
EWG-OL-1580-Q	SiO_2	42.0907	42.8550	-0.7643	-1.8%
EWG-OL-1580-Q	SO_3	0.2797	0.3000	-0.0203	-6.8%
EWG-OL-1580-Q	SrO	0.1047	0.1200	-0.0153	-12.8%
EWG-OL-1580-Q	ZrO_2	3.9545	4.0000	-0.0455	-1.1%
EWG-OL-1580-Q	Sum	99.3273	99.6850	-0.3577	-0.4%
EWG-OL-15968-Q	Al_2O_3	14.9601	15.0000	-0.0399	-0.3%
EWG-OL-15968-Q	B_2O_3	21.7665	22.0000	-0.2335	-1.1%
EWG-OL-15968-Q	Bi_2O_3	0.1115	0.0000	0.1115	
EWG-OL-15968-Q	CaO	0.1399	0.0000	0.1399	
EWG-OL-15968-Q	CdO	0.0837	0.1000	-0.0163	-16.3%
EWG-OL-15968-Q	Cr_2O_3	1.3834	1.6000	-0.2166	-13.5%
EWG-OL-15968-Q	Fe_2O_3	0.1430	0.0000	0.1430	
EWG-OL-15968-Q	K_2O	0.0120	0.0000	0.0120	
EWG-OL-15968-Q	Li_2O	5.1400	5.1490	-0.0090	-0.2%
EWG-OL-15968-Q	MgO	3.7560	4.0000	-0.2440	-6.1%
EWG-OL-15968-Q	MnO	0.1291	0.0000	0.1291	
EWG-OL-15968-Q	Na_2O	18.5350	18.0000	0.5350	3.0%
EWG-OL-15968-Q	NiO	0.3226	0.4000	-0.0774	-19.4%
EWG-OL-15968-Q	P_2O_5	0.2291	0.0000	0.2291	

Table A-4. Comparison of Measured and Targeted Compositions for Set 1 Study Glasses **(continued)**

Glass ID	Oxide	Measured (wt %)	Targeted (wt %)	Difference of Measured versus Targeted	% Difference of Measured versus Targeted
EWG-OL-15968-Q	PbO	0.2715	0.3000	-0.0285	-9.5%
EWG-OL-15968-Q	RuO_2	0.0132	0.0100	0.0032	31.7%
EWG-OL-15968-Q	SiO_2	28.9340	28.7060	0.2280	0.8%
EWG-OL-15968-Q	SO_3	0.3015	0.3000	0.0015	0.5%
EWG-OL-15968-Q	SrO	0.1162	0.1200	-0.0038	-3.2%
EWG-OL-15968-Q	ZrO_2	3.9646	4.0000	-0.0354	-0.9%
EWG-OL-15968-Q	Sum	100.3130	99.6850	0.6280	0.6%
EWG-OL-1672-Q	Al_2O_3	26.1223	30.0000	-3.8777	-12.9%
EWG-OL-1672-Q	B_2O_3	31.0640	22.0000	9.0640	41.2%
EWG-OL-1672-Q	Bi_2O_3	2.7313	3.0000	-0.2687	-9.0%
EWG-OL-1672-Q	CaO	8.7100	10.0000	-1.2900	-12.9%
EWG-OL-1672-Q	CdO	0.0754	0.1000	-0.0246	-24.6%
EWG-OL-1672-Q	Cr_2O_3	1.2804	1.6000	-0.3196	-20.0%
EWG-OL-1672-Q	Fe_2O_3	0.1430	0.0000	0.1430	
EWG-OL-1672-Q	K_2O	0.0120	0.0000	0.0120	
EWG-OL-1672-Q	Li_2O	0.2153	0.0000	0.2153	
EWG-OL-1672-Q	MgO	0.1658	0.0000	0.1658	
EWG-OL-1672-Q	MnO	2.5921	3.0000	-0.4079	-13.6%
EWG-OL-1672-Q	Na_2O	4.5293	5.0000	-0.4707	-9.4%
EWG-OL-1672-Q	NiO	0.3274	0.4000	-0.0726	-18.2%
EWG-OL-1672-Q	P_2O_5	2.4117	3.0000	-0.5883	-19.6%
EWG-OL-1672-Q	PbO	0.2424	0.3000	-0.0576	-19.2%
EWG-OL-1672-Q	RuO_2	0.0132	0.0100	0.0032	31.7%
EWG-OL-1672-Q	SiO_2	18.3338	20.8550	-2.5212	-12.1%
EWG-OL-1672-Q	SO_3	0.0262	0.3000	-0.2738	-91.3%
EWG-OL-1672-Q	SrO	0.1079	0.1200	-0.0121	-10.1%
EWG-OL-1672-Q	ZrO_2	0.1351	0.0000	0.1351	
EWG-OL-1672-Q	Sum	99.2385	99.6850	-0.4465	-0.4%
EWG-OL-2463-Q	Al_2O_3	19.4619	19.4550	0.0069	0.0%
EWG-OL-2463-Q	B_2O_3	8.1302	8.0000	0.1302	1.6%
EWG-OL-2463-Q	Bi_2O_3	0.1115	0.0000	0.1115	
EWG-OL-2463-Q	CaO	9.7559	10.0000	-0.2441	-2.4%
EWG-OL-2463-Q	CdO	0.0831	0.1000	-0.0169	-16.9%
EWG-OL-2463-Q	Cr_2O_3	0.1462	0.0000	0.1462	
EWG-OL-2463-Q	Fe_2O_3	9.9293	10.0000	-0.0707	-0.7%
EWG-OL-2463-Q	K_2O	3.0928	3.0000	0.0928	3.1%
EWG-OL-2463-Q	Li_2O	0.2153	0.0000	0.2153	
EWG-OL-2463-Q	MgO	0.1658	0.0000	0.1658	
EWG-OL-2463-Q	MnO	3.0666	3.0000	0.0666	2.2%
EWG-OL-2463-Q	Na_2O	18.4676	18.0000	0.4676	2.6%
EWG-OL-2463-Q	NiO	0.3601	0.4000	-0.0399	-10.0%
EWG-OL-2463-Q	P_2O_5	2.7382	3.0000	-0.2618	-8.7%
EWG-OL-2463-Q	PbO	0.2674	0.3000	-0.0326	-10.9%
EWG-OL-2463-Q	RuO_2	0.0132	0.0100	0.0032	31.7%
EWG-OL-2463-Q	SiO_2	20.1362	20.0000	0.1362	0.7%
EWG-OL-2463-Q	SO_3	0.3258	0.3000	0.0258	8.6%
EWG-OL-2463-Q	SrO	0.1168	0.1200	-0.0032	-2.7%
EWG-OL-2463-Q	ZrO_2	3.9004	4.0000	-0.0996	-2.5%
EWG-OL-2463-Q	Sum	100.4843	99.6850	0.7993	0.8%
EWG-OL-26012-Q	Al_2O_3	14.9507	15.0000	-0.0493	-0.3%
EWG-OL-26012-Q	B_2O_3	8.0095	8.0000	0.0095	0.1%
EWG-OL-26012-Q	Bi_2O_3	3.0072	3.0000	0.0072	0.2%
EWG-OL-26012-Q	CaO	0.1399	0.0000	0.1399	
EWG-OL-26012-Q	CdO	0.0868	0.1000	-0.0132	-13.2%
EWG-OL-26012-Q	Cr_2O_3	0.1462	0.0000	0.1462	
EWG-OL-26012-Q	Fe_2O_3	0.1430	0.0000	0.1430	
EWG-OL-26012-Q	K_2O	3.1289	3.0000	0.1289	4.3%
EWG-OL-26012-Q	Li_2O	1.6744	1.6800	-0.0056	-0.3%
EWG-OL-26012-Q	MgO	0.1658	0.0000	0.1658	

Table A-4. Comparison of Measured and Targeted Compositions for Set 1 Study Glasses **(continued)**

Glass ID	Oxide	Measured (wt %)	Targeted (wt %)	Difference of Measured versus Targeted	% Difference of Measured versus Targeted
EWG-OL-26012-Q	MnO	0.1291	0.0000	0.1291	
EWG-OL-26012-Q	Na_2O	18.1306	18.0000	0.1306	0.7%
EWG-OL-26012-Q	NiO	0.3872	0.4000	-0.0128	-3.2%
EWG-OL-26012-Q	P_2O_5	2.8012	3.0000	-0.1988	-6.6%
EWG-OL-26012-Q	PbO	0.2793	0.3000	-0.0207	-6.9%
EWG-OL-26012-Q	RuO_2	0.0132	0.0100	0.0032	31.7%
EWG-OL-26012-Q	SiO_2	42.5721	42.7750	-0.2029	-0.5%
EWG-OL-26012-Q	SO_3	0.2360	0.3000	-0.0640	-21.3%
EWG-OL-26012-Q	SrO	0.1174	0.1200	-0.0026	-2.2%
EWG-OL-26012-Q	ZrO_2	4.0017	4.0000	0.0017	0.0%
EWG-OL-26012-Q	Sum	100.1201	99.6850	0.4351	0.4%
EWG-OL-2619-Q	Al_2O_3	18.5880	18.4550	0.1330	0.7%
EWG-OL-2619-Q	B_2O_3	22.0724	22.0000	0.0724	0.3%
EWG-OL-2619-Q	Bi_2O_3	3.1019	3.0000	0.1019	3.4%
EWG-OL-2619-Q	CaO	10.0917	10.0000	0.0917	0.9%
EWG-OL-2619-Q	CdO	0.0877	0.1000	-0.0123	-12.3%
EWG-OL-2619-Q	Cr_2O_3	0.1462	0.0000	0.1462	
EWG-OL-2619-Q	Fe_2O_3	10.1044	10.0000	0.1044	1.0%
EWG-OL-2619-Q	K_2O	2.6351	3.0000	-0.3649	-12.2%
EWG-OL-2619-Q	Li_2O	0.2153	0.0000	0.2153	
EWG-OL-2619-Q	MgO	0.1658	0.0000	0.1658	
EWG-OL-2619-Q	MnO	3.1344	3.0000	0.1344	4.5%
EWG-OL-2619-Q	Na_2O	4.9842	5.0000	-0.0158	-0.3%
EWG-OL-2619-Q	NiO	0.2987	0.4000	-0.1013	-25.3%
EWG-OL-2619-Q	P_2O_5	0.2291	0.0000	0.2291	
EWG-OL-2619-Q	PbO	0.2744	0.3000	-0.0256	-8.5%
EWG-OL-2619-Q	RuO_2	0.0132	0.0100	0.0032	31.7%
EWG-OL-2619-Q	SiO_2	20.3608	20.0000	0.3608	1.8%
EWG-OL-2619-Q	SO_3	0.2160	0.3000	-0.0840	-28.0%
EWG-OL-2619-Q	SrO	0.1186	0.1200	-0.0014	-1.2%
EWG-OL-2619-Q	ZrO_2	2.5868	4.0000	-1.4132	-35.3%
EWG-OL-2619-Q	Sum	99.4246	99.6850	-0.2604	-0.3%
EWG-OL-29285-Q	Al_2O_3	15.0546	15.0000	0.0546	0.4%
EWG-OL-29285-Q	B_2O_3	18.4420	18.5762	-0.1342	-0.7%
EWG-OL-29285-Q	Bi_2O_3	0.1115	0.0000	0.1115	
EWG-OL-29285-Q	CaO	10.2072	10.0000	0.2072	2.1%
EWG-OL-29285-Q	CdO	0.0862	0.1000	-0.0138	-13.8%
EWG-OL-29285-Q	Cr_2O_3	0.1462	0.0000	0.1462	
EWG-OL-29285-Q	Fe_2O_3	0.1430	0.0000	0.1430	
EWG-OL-29285-Q	K_2O	0.0120	0.0000	0.0120	
EWG-OL-29285-Q	Li_2O	0.2153	0.0000	0.2153	
EWG-OL-29285-Q	MgO	3.4741	4.0000	-0.5259	-13.1%
EWG-OL-29285-Q	MnO	0.1291	0.0000	0.1291	
EWG-OL-29285-Q	Na_2O	5.0617	5.0000	0.0617	1.2%
EWG-OL-29285-Q	NiO	0.3760	0.4000	-0.0240	-6.0%
EWG-OL-29285-Q	P_2O_5	2.8070	3.0000	-0.1930	-6.4%
EWG-OL-29285-Q	PbO	0.2720	0.3000	-0.0280	-9.3%
EWG-OL-29285-Q	RuO_2	0.0132	0.0100	0.0032	31.7%
EWG-OL-29285-Q	SiO_2	38.8818	38.8788	0.0030	0.0%
EWG-OL-29285-Q	SO_3	0.0449	0.3000	-0.2551	-85.0%
EWG-OL-29285-Q	SrO	0.1200	0.1200	0.0000	0.0%
EWG-OL-29285-Q	ZrO_2	3.9950	4.0000	-0.0050	-0.1%
EWG-OL-29285-Q	Sum	99.5928	99.6850	-0.0922	-0.1%
EWG-OL-31644-Q	Al_2O_3	15.2199	15.0000	0.2199	1.5%
EWG-OL-31644-Q	B_2O_3	8.2027	8.0000	0.2027	2.5%
EWG-OL-31644-Q	Bi_2O_3	0.1115	0.0000	0.1115	
EWG-OL-31644-Q	CaO	10.5220	10.0000	0.5220	5.2%
EWG-OL-31644-Q	CdO	0.0840	0.1000	-0.0160	-16.0%
EWG-OL-31644-Q	Cr_2O_3	1.4532	1.6000	-0.1468	-9.2%

Table A-4. Comparison of Measured and Targeted Compositions for Set 1 Study Glasses **(continued)**

Glass ID	Oxide	Measured (wt %)	Targeted (wt %)	Difference of Measured versus Targeted	% Difference of Measured versus Targeted
EWG-OL-31644-Q	Fe_2O_3	9.9579	10.0000	-0.0421	-0.4%
EWG-OL-31644-Q	K_2O	0.0120	0.0000	0.0120	
EWG-OL-31644-Q	Li_2O	1.3962	1.3761	0.0201	1.5%
EWG-OL-31644-Q	MgO	3.7353	4.0000	-0.2647	-6.6%
EWG-OL-31644-Q	MnO	3.0957	3.0000	0.0957	3.2%
EWG-OL-31644-Q	Na_2O	4.9236	5.0000	-0.0764	-1.5%
EWG-OL-31644-Q	NiO	0.2866	0.4000	-0.1134	-28.3%
EWG-OL-31644-Q	P_2O_5	0.2291	0.0000	0.2291	
EWG-OL-31644-Q	PbO	0.2739	0.3000	-0.0261	-8.7%
EWG-OL-31644-Q	RuO_2	0.0132	0.0100	0.0032	31.7%
EWG-OL-31644-Q	SiO_2	40.8606	40.4789	0.3817	0.9%
EWG-OL-31644-Q	SO_3	0.1248	0.3000	-0.1752	-58.4%
EWG-OL-31644-Q	SrO	0.1203	0.1200	0.0003	0.3%
EWG-OL-31644-Q	ZrO_2	0.1351	0.0000	0.1351	
EWG-OL-31644-Q	Sum	100.7575	99.6850	1.0725	1.1%
EWG-OL-33115-Q	Al_2O_3	15.1680	15.0000	0.1680	1.1%
EWG-OL-33115-Q	B_2O_3	8.2590	8.0000	0.2590	3.2%
EWG-OL-33115-Q	Bi_2O_3	3.0936	3.0000	0.0936	3.1%
EWG-OL-33115-Q	CaO	9.7804	10.0000	-0.2196	-2.2%
EWG-OL-33115-Q	CdO	0.0842	0.1000	-0.0158	-15.8%
EWG-OL-33115-Q	Cr_2O_3	0.1462	0.0000	0.1462	
EWG-OL-33115-Q	Fe_2O_3	10.0687	10.0000	0.0687	0.7%
EWG-OL-33115-Q	K_2O	2.6260	3.0000	-0.3740	-12.5%
EWG-OL-33115-Q	Li_2O	0.2153	0.0000	0.2153	
EWG-OL-33115-Q	MgO	3.6483	4.0000	-0.3517	-8.8%
EWG-OL-33115-Q	MnO	0.1291	0.0000	0.1291	
EWG-OL-33115-Q	Na_2O	6.7265	6.5593	0.1672	2.5%
EWG-OL-33115-Q	NiO	0.3748	0.4000	-0.0252	-6.3%
EWG-OL-33115-Q	P_2O_5	2.7726	3.0000	-0.2274	-7.6%
EWG-OL-33115-Q	PbO	0.2706	0.3000	-0.0294	-9.8%
EWG-OL-33115-Q	RuO_2	0.0132	0.0100	0.0032	31.7%
EWG-OL-33115-Q	SiO_2	36.2077	35.8957	0.3120	0.9%
EWG-OL-33115-Q	SO_3	0.2029	0.3000	-0.0971	-32.4%
EWG-OL-33115-Q	SrO	0.1112	0.1200	-0.0088	-7.4%
EWG-OL-33115-Q	ZrO_2	0.1351	0.0000	0.1351	
EWG-OL-33115-Q	Sum	100.0332	99.6850	0.3482	0.3%
EWG-OL-38552-Q	Al_2O_3	25.9806	26.0000	-0.0194	-0.1%
EWG-OL-38552-Q	B_2O_3	8.2510	8.0000	0.2510	3.1%
EWG-OL-38552-Q	Bi_2O_3	3.0824	3.0000	0.0824	2.7%
EWG-OL-38552-Q	CaO	0.1399	0.0000	0.1399	
EWG-OL-38552-Q	CdO	0.0860	0.1000	-0.0140	-14.0%
EWG-OL-38552-Q	Cr_2O_3	0.1462	0.0000	0.1462	
EWG-OL-38552-Q	Fe_2O_3	3.6350	3.6173	0.0177	0.5%
EWG-OL-38552-Q	K_2O	0.0120	0.0000	0.0120	
EWG-OL-38552-Q	Li_2O	5.9797	6.0000	-0.0203	-0.3%
EWG-OL-38552-Q	MgO	3.6400	4.0000	-0.3600	-9.0%
EWG-OL-38552-Q	MnO	3.0860	3.0000	0.0860	2.9%
EWG-OL-38552-Q	Na_2O	5.0617	5.0000	0.0617	1.2%
EWG-OL-38552-Q	NiO	0.3709	0.4000	-0.0291	-7.3%
EWG-OL-38552-Q	P_2O_5	2.7440	3.0000	-0.2560	-8.5%
EWG-OL-38552-Q	PbO	0.2717	0.3000	-0.0283	-9.4%
EWG-OL-38552-Q	RuO_2	0.0132	0.0100	0.0032	31.7%
EWG-OL-38552-Q	SiO_2	33.1592	32.8377	0.3214	1.0%
EWG-OL-38552-Q	SO_3	0.2179	0.3000	-0.0821	-27.4%
EWG-OL-38552-Q	SrO	0.1129	0.1200	-0.0071	-5.9%
EWG-OL-38552-Q	ZrO_2	3.1676	4.0000	-0.8324	-20.8%
EWG-OL-38552-Q	Sum	99.1578	99.6850	-0.5272	-0.5%
EWG-OL-3872-Q	Al_2O_3	14.7428	15.0000	-0.2572	-1.7%
EWG-OL-3872-Q	B_2O_3	8.0980	8.0000	0.0980	1.2%

Table A-4. Comparison of Measured and Targeted Compositions for Set 1 Study Glasses **(continued)**

Glass ID	Oxide	Measured (wt %)	Targeted (wt %)	Difference of Measured versus Targeted	% Difference of Measured versus Targeted
EWG-OL-3872-Q	Bi_2O_3	3.1298	3.0000	0.1298	4.3%
EWG-OL-3872-Q	CaO	9.8609	10.0000	-0.1391	-1.4%
EWG-OL-3872-Q	CdO	0.0854	0.1000	-0.0146	-14.6%
EWG-OL-3872-Q	Cr_2O_3	0.1462	0.0000	0.1462	
EWG-OL-3872-Q	Fe_2O_3	0.1430	0.0000	0.1430	
EWG-OL-3872-Q	K_2O	0.0120	0.0000	0.0120	
EWG-OL-3872-Q	Li_2O	5.8667	6.0000	-0.1333	-2.2%
EWG-OL-3872-Q	MgO	3.6897	4.0000	-0.3103	-7.8%
EWG-OL-3872-Q	MnO	0.1291	0.0000	0.1291	
EWG-OL-3872-Q	Na_2O	18.5687	18.0000	0.5687	3.2%
EWG-OL-3872-Q	NiO	0.3703	0.4000	-0.0297	-7.4%
EWG-OL-3872-Q	P_2O_5	2.8127	3.0000	-0.1873	-6.2%
EWG-OL-3872-Q	PbO	0.2575	0.3000	-0.0425	-14.2%
EWG-OL-3872-Q	RuO_2	0.0132	0.0100	0.0032	31.7%
EWG-OL-3872-Q	SiO_2	31.0199	31.4550	-0.4351	-1.4%
EWG-OL-3872-Q	SO_3	0.3059	0.3000	0.0059	2.0%
EWG-OL-3872-Q	SrO	0.1085	0.1200	-0.0115	-9.6%
EWG-OL-3872-Q	ZrO_2	0.1351	0.0000	0.1351	
EWG-OL-3872-Q	Sum	99.4952	99.6850	-0.1898	-0.2%
EWG-OL-5155-Q	Al_2O_3	19.7925	19.8550	-0.0625	-0.3%
EWG-OL-5155-Q	B_2O_3	22.1610	22.0000	0.1610	0.7%
EWG-OL-5155-Q	Bi_2O_3	3.2998	3.0000	0.2998	10.0%
EWG-OL-5155-Q	CaO	0.1399	0.0000	0.1399	
EWG-OL-5155-Q	CdO	0.0880	0.1000	-0.0120	-12.0%
EWG-OL-5155-Q	Cr_2O_3	1.0699	1.6000	-0.5301	-33.1%
EWG-OL-5155-Q	Fe_2O_3	9.2216	10.0000	-0.7784	-7.8%
EWG-OL-5155-Q	K_2O	0.0120	0.0000	0.0120	
EWG-OL-5155-Q	Li_2O	6.0281	6.0000	0.0281	0.5%
EWG-OL-5155-Q	MgO	3.5322	4.0000	-0.4678	-11.7%
EWG-OL-5155-Q	MnO	2.9698	3.0000	-0.0302	-1.0%
EWG-OL-5155-Q	Na_2O	5.1056	5.0000	0.1056	2.1%
EWG-OL-5155-Q	NiO	0.1715	0.4000	-0.2285	-57.1%
EWG-OL-5155-Q	P_2O_5	0.2291	0.0000	0.2291	
EWG-OL-5155-Q	PbO	0.2774	0.3000	-0.0226	-7.5%
EWG-OL-5155-Q	RuO_2	0.0132	0.0100	0.0032	31.7%
EWG-OL-5155-Q	SiO_2	20.4089	20.0000	0.4089	2.0%
EWG-OL-5155-Q	SO_3	0.2391	0.3000	-0.0609	-20.3%
EWG-OL-5155-Q	SrO	0.1177	0.1200	-0.0023	-1.9%
EWG-OL-5155-Q	ZrO_2	3.9173	4.0000	-0.0827	-2.1%
EWG-OL-5155-Q	Sum	98.7944	99.6850	-0.8906	-0.9%
EWG-OL-5801-Q	Al_2O_3	18.2337	18.4550	-0.2213	-1.2%
EWG-OL-5801-Q	B_2O_3	21.7021	22.0000	-0.2979	-1.4%
EWG-OL-5801-Q	Bi_2O_3	0.1115	0.0000	0.1115	
EWG-OL-5801-Q	CaO	0.1399	0.0000	0.1399	
EWG-OL-5801-Q	CdO	0.0874	0.1000	-0.0126	-12.6%
EWG-OL-5801-Q	Cr_2O_3	0.1462	0.0000	0.1462	
EWG-OL-5801-Q	Fe_2O_3	9.7148	10.0000	-0.2852	-2.9%
EWG-OL-5801-Q	K_2O	3.1320	3.0000	0.1320	4.4%
EWG-OL-5801-Q	Li_2O	5.9420	6.0000	-0.0580	-1.0%
EWG-OL-5801-Q	MgO	3.5819	4.0000	-0.4181	-10.5%
EWG-OL-5801-Q	MnO	3.0408	3.0000	0.0408	1.4%
EWG-OL-5801-Q	Na_2O	5.0921	5.0000	0.0921	1.8%
EWG-OL-5801-Q	NiO	0.3658	0.4000	-0.0342	-8.5%
EWG-OL-5801-Q	P_2O_5	2.7382	3.0000	-0.2618	-8.7%
EWG-OL-5801-Q	PbO	0.2755	0.3000	-0.0245	-8.2%
EWG-OL-5801-Q	RuO_2	0.0132	0.0100	0.0032	31.7%
EWG-OL-5801-Q	SiO_2	19.8634	20.0000	-0.1366	-0.7%
EWG-OL-5801-Q	SO_3	0.3215	0.3000	0.0215	7.2%
EWG-OL-5801-Q	SrO	0.1162	0.1200	-0.0038	-3.2%

Table A-4. Comparison of Measured and Targeted Compositions for Set 1 Study Glasses **(continued)**

Glass ID	Oxide	Measured (wt %)	Targeted (wt %)	Difference of Measured versus Targeted	% Difference of Measured versus Targeted
EWG-OL-5801-Q	ZrO_2	3.2757	4.0000	-0.7243	-18.1%
EWG-OL-5801-Q	Sum	97.8938	99.6850	-1.7912	-1.8%
EWG-OL-6198-Q	Al_2O_3	15.0640	15.0000	0.0640	0.4%
EWG-OL-6198-Q	B_2O_3	21.9195	22.0000	-0.0805	-0.4%
EWG-OL-6198-Q	Bi_2O_3	0.1115	0.0000	0.1115	
EWG-OL-6198-Q	CaO	0.1399	0.0000	0.1399	
EWG-OL-6198-Q	CdO	0.0865	0.1000	-0.0135	-13.5%
EWG-OL-6198-Q	Cr_2O_3	1.5274	1.6000	-0.0726	-4.5%
EWG-OL-6198-Q	Fe_2O_3	10.0186	10.0000	0.0186	0.2%
EWG-OL-6198-Q	K_2O	3.0296	3.0000	0.0296	1.0%
EWG-OL-6198-Q	Li_2O	5.9958	6.0000	-0.0042	-0.1%
EWG-OL-6198-Q	MgO	3.5446	4.0000	-0.4554	-11.4%
EWG-OL-6198-Q	MnO	0.1291	0.0000	0.1291	
EWG-OL-6198-Q	Na_2O	4.9573	5.0000	-0.0427	-0.9%
EWG-OL-6198-Q	NiO	0.0964	0.4000	-0.3036	-75.9%
EWG-OL-6198-Q	P_2O_5	2.7611	3.0000	-0.2389	-8.0%
EWG-OL-6198-Q	PbO	0.2768	0.3000	-0.0232	-7.7%
EWG-OL-6198-Q	RuO_2	0.0132	0.0100	0.0032	31.7%
EWG-OL-6198-Q	SiO_2	25.0298	24.8550	0.1748	0.7%
EWG-OL-6198-Q	SO_3	0.3140	0.3000	0.0140	4.7%
EWG-OL-6198-Q	SrO	0.1165	0.1200	-0.0035	-2.9%
EWG-OL-6198-Q	ZrO_2	3.7046	4.0000	-0.2954	-7.4%
EWG-OL-6198-Q	Sum	98.8362	99.6850	-0.8488	-0.9%
EWG-OL-801-Q	Al_2O_3	29.5234	30.0000	-0.4766	-1.6%
EWG-OL-801-Q	B_2O_3	20.9937	21.4550	-0.4613	-2.1%
EWG-OL-801-Q	Bi_2O_3	2.9654	3.0000	-0.0346	-1.2%
EWG-OL-801-Q	CaO	0.1399	0.0000	0.1399	
EWG-OL-801-Q	CdO	0.0868	0.1000	-0.0132	-13.2%
EWG-OL-801-Q	Cr_2O_3	0.1462	0.0000	0.1462	
EWG-OL-801-Q	Fe_2O_3	0.1430	0.0000	0.1430	
EWG-OL-801-Q	K_2O	0.0120	0.0000	0.0120	
EWG-OL-801-Q	Li_2O	0.2153	0.0000	0.2153	
EWG-OL-801-Q	MgO	0.1658	0.0000	0.1658	
EWG-OL-801-Q	MnO	3.0150	3.0000	0.0150	0.5%
EWG-OL-801-Q	Na_2O	17.8610	18.0000	-0.1390	-0.8%
EWG-OL-801-Q	NiO	0.3770	0.4000	-0.0230	-5.8%
EWG-OL-801-Q	P_2O_5	2.7497	3.0000	-0.2503	-8.3%
EWG-OL-801-Q	PbO	0.2750	0.3000	-0.0250	-8.3%
EWG-OL-801-Q	RuO_2	0.0132	0.0100	0.0032	31.7%
EWG-OL-801-Q	SiO_2	19.7404	20.0000	-0.2596	-1.3%
EWG-OL-801-Q	SO_3	0.2129	0.3000	-0.0871	-29.0%
EWG-OL-801-Q	SrO	0.1150	0.1200	-0.0050	-4.2%
EWG-OL-801-Q	ZrO_2	0.1351	0.0000	0.1351	
EWG-OL-801-Q	Sum	98.8857	99.6850	-0.7993	-0.8%
LRM	Al_2O_3	9.7671	10.0000	-0.2329	-2.3%
LRM	B_2O_3	7.8861	8.0000	-0.1139	-1.4%
LRM	Bi_2O_3	0.1115	0.0000	0.1115	
LRM	CaO	0.3111	0.5000	-0.1889	-37.8%
LRM	CdO	0.1235	0.2000	-0.0765	-38.3%
LRM	Cr_2O_3	0.2990	0.2000	0.0990	49.5%
LRM	Fe_2O_3	1.4221	1.0000	0.4221	42.2%
LRM	K_2O	1.4706	1.5000	-0.0294	-2.0%
LRM	Li_2O	0.2153	0.1000	0.1153	115.3%
LRM	MgO	0.1658	0.1000	0.0658	65.8%
LRM	MnO	0.1291	0.1000	0.0291	29.1%
LRM	Na_2O	21.5455	20.0000	1.5455	7.7%
LRM	NiO	0.1564	0.1000	0.0564	56.4%
LRM	P_2O_5	0.4909	0.5000	-0.0091	-1.8%
LRM	PbO	0.0707	0.1000	-0.0293	-29.3%

Table A-4. Comparison of Measured and Targeted Compositions for Set 1 Study Glasses **(continued)**

Glass ID	Oxide	Measured (wt %)	Targeted (wt %)	Difference of Measured versus Targeted	% Difference of Measured versus Targeted
LRM	RuO_2	0.0132	0.0000	0.0132	
LRM	SiO_2	53.9104	54.0000	-0.0896	-0.2%
LRM	SO_3	0.2507	0.2000	0.0507	25.4%
LRM	SrO	0.0118	0.0000	0.0118	
LRM	ZrO_2	0.9262	1.0000	-0.0738	-7.4%
LRM	Sum	99.2771	97.6000	1.6771	1.7%
RSM-EWG-1-034-Q	Al_2O_3	23.9022	23.9700	-0.0678	-0.3%
RSM-EWG-1-034-Q	B_2O_3	18.4017	19.1900	-0.7883	-4.1%
RSM-EWG-1-034-Q	Bi_2O_3	1.0900	1.1400	-0.0500	-4.4%
RSM-EWG-1-034-Q	CaO	5.6773	5.5800	0.0973	1.7%
RSM-EWG-1-034-Q	CdO	0.0166	0.0200	-0.0034	-17.2%
RSM-EWG-1-034-Q	Cr_2O_3	0.3172	0.5200	-0.2028	-39.0%
RSM-EWG-1-034-Q	Fe_2O_3	5.9904	5.9000	0.0904	1.5%
RSM-EWG-1-034-Q	K_2O	0.0952	0.1400	-0.0448	-32.0%
RSM-EWG-1-034-Q	Li_2O	3.6061	3.5700	0.0361	1.0%
RSM-EWG-1-034-Q	MgO	0.1658	0.1200	0.0458	38.2%
RSM-EWG-1-034-Q	MnO	0.1291	0.0000	0.1291	
RSM-EWG-1-034-Q	Na_2O	9.6449	9.5800	0.0649	0.7%
RSM-EWG-1-034-Q	NiO	0.1482	0.4000	-0.2518	-62.9%
RSM-EWG-1-034-Q	P_2O_5	1.0008	1.0500	-0.0492	-4.7%
RSM-EWG-1-034-Q	PbO	0.3630	0.4100	-0.0470	-11.5%
RSM-EWG-1-034-Q	RuO_2	0.0132	0.0000	0.0132	
RSM-EWG-1-034-Q	SiO_2	28.0783	27.0000	1.0783	4.0%
RSM-EWG-1-034-Q	SO_3	0.1298	0.2000	-0.0702	-35.1%
RSM-EWG-1-034-Q	SrO	0.0118	0.0000	0.0118	
RSM-EWG-1-034-Q	ZrO_2	0.3725	0.3900	-0.0175	-4.5%
RSM-EWG-1-034-Q	Sum	99.1541	99.1800	-0.0259	0.0%

Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence Grouped by Analytical Block

Oxide=Al2O3 (wt%), Prep Method=PF
Variability Chart for measured

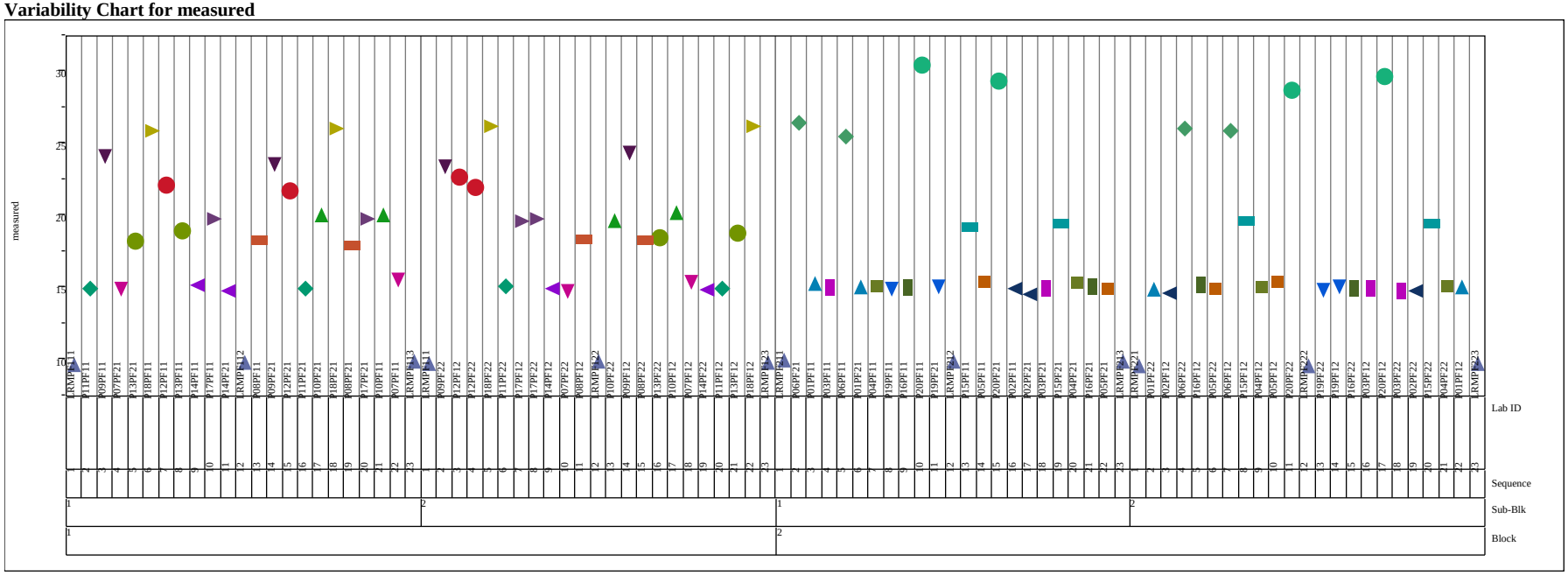


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence Grouped by Analytical Block (continued)

Oxide=B2O3 (wt%), Prep Method=PF
Variability Chart for measured

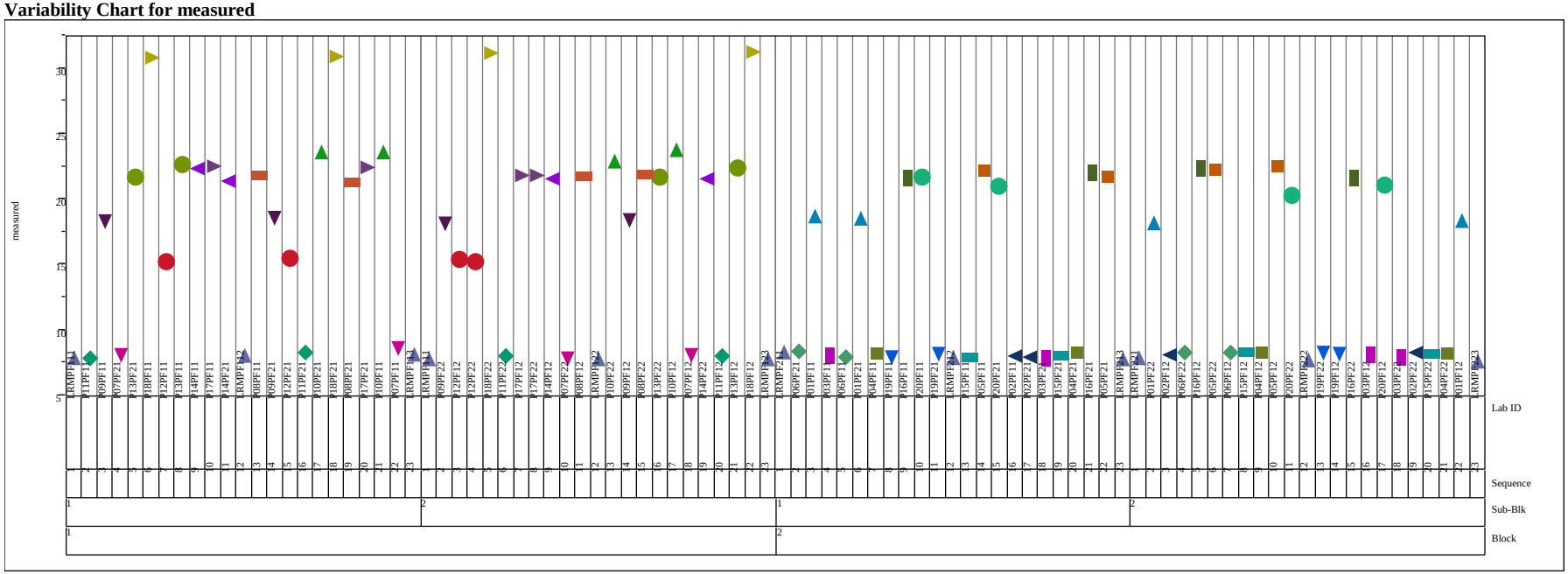


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence Grouped by Analytical Block (continued)

Oxide=Bi2O3 (wt%), Prep Method=AD
Variability Chart for measured

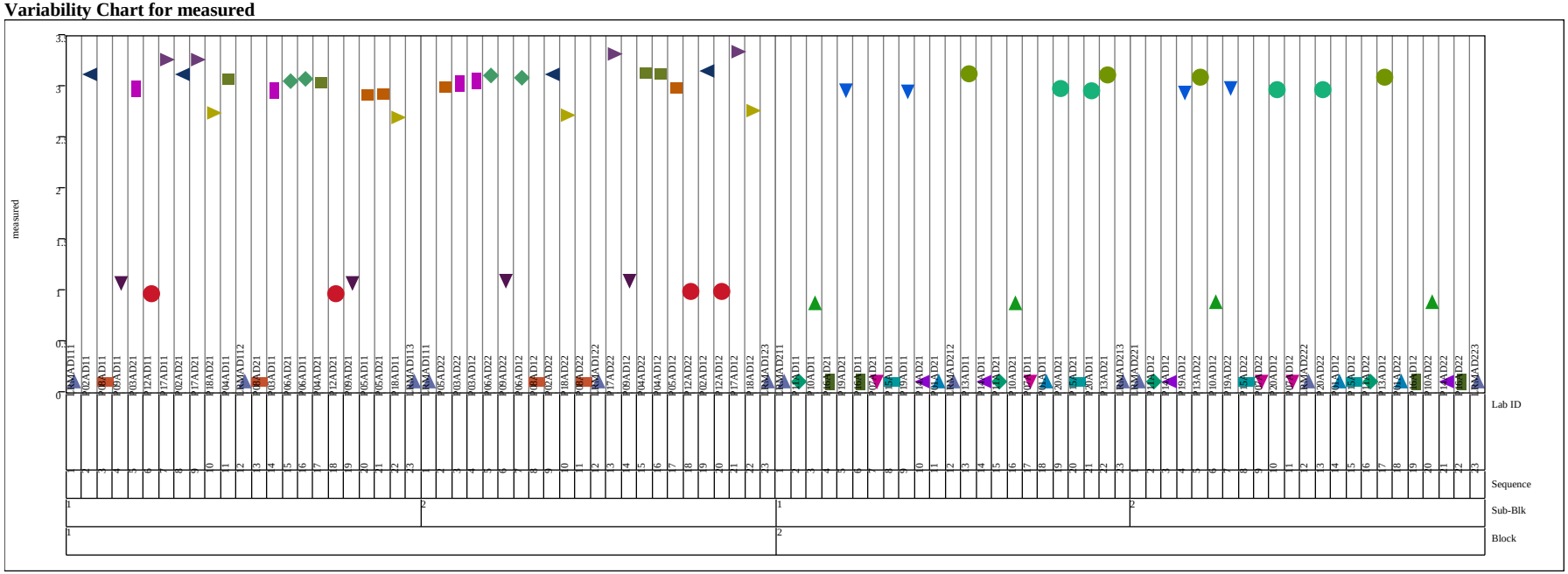


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence Grouped by Analytical Block (continued)

Oxide=CaO (wt%), Prep Method=PF
Variability Chart for measured

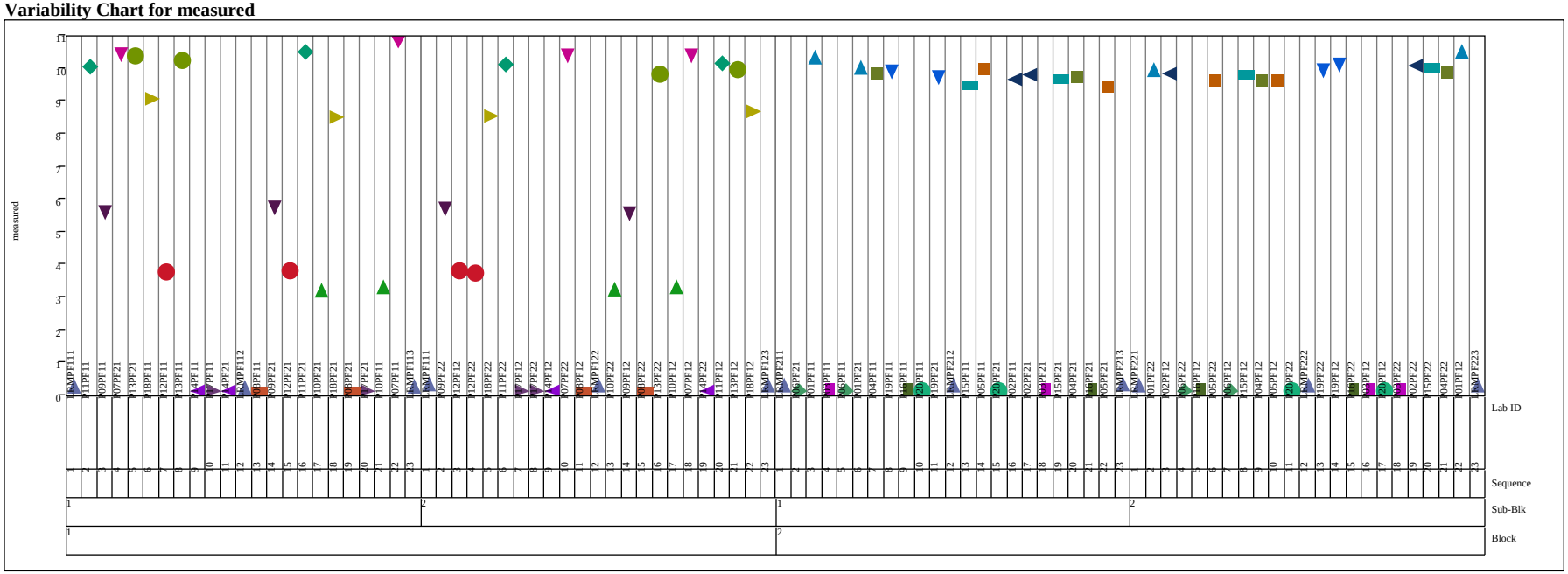


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence Grouped by Analytical Block (continued)

Oxide=CdO (wt%), Prep Method=AD
Variability Chart for measured

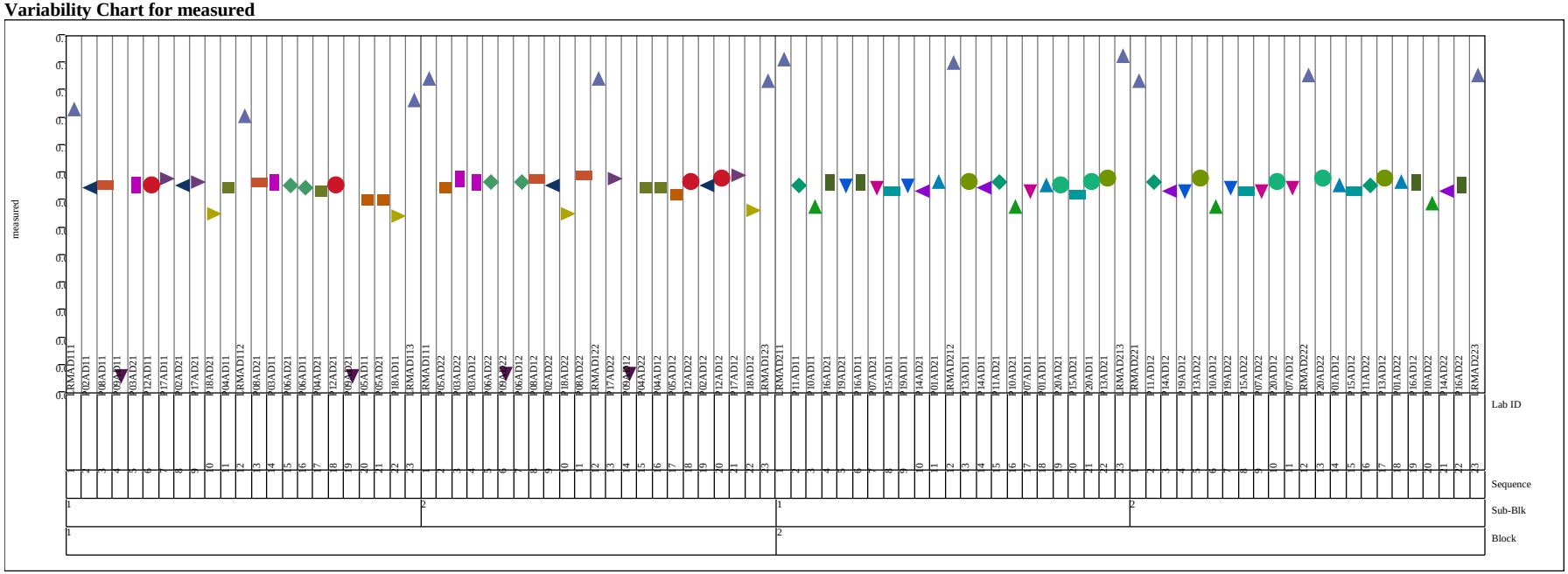


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence Grouped by Analytical Block (continued)

Oxide=Cr2O3 (wt%), Prep Method=PF
Variability Chart for measured

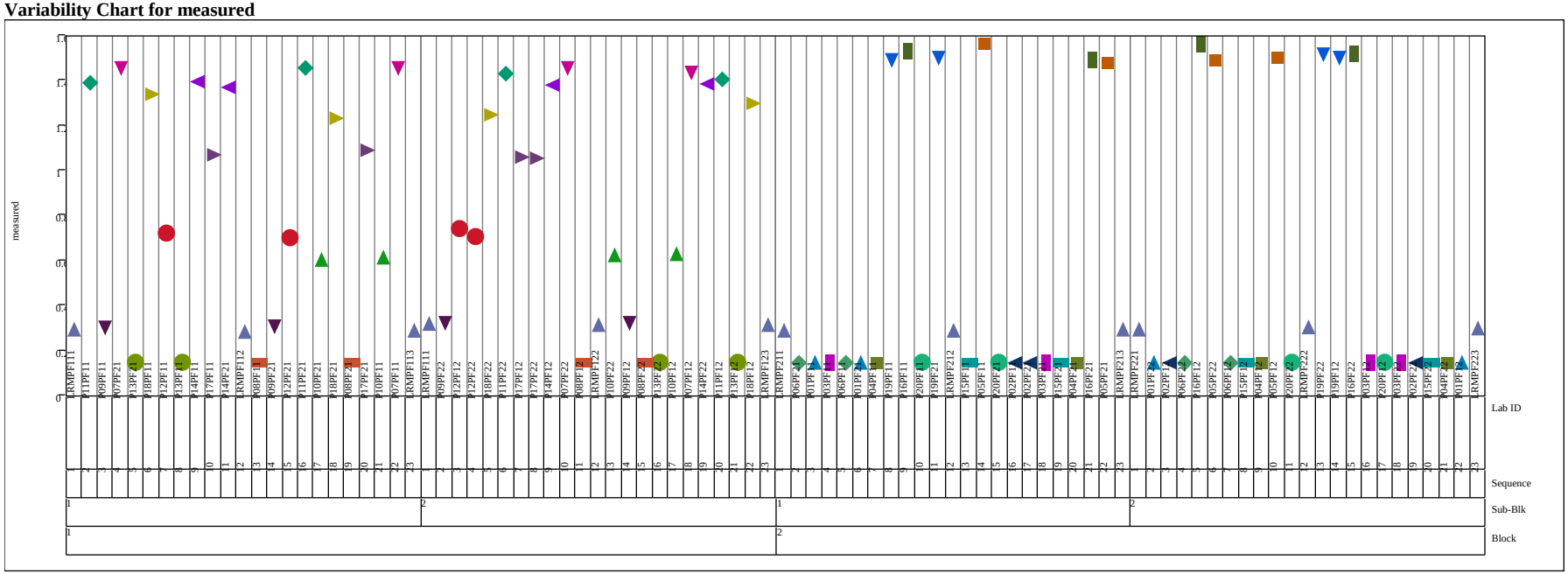


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence Grouped by Analytical Block (continued)

Oxide=Fe2O3 (wt%), Prep Method=PF
Variability Chart for measured

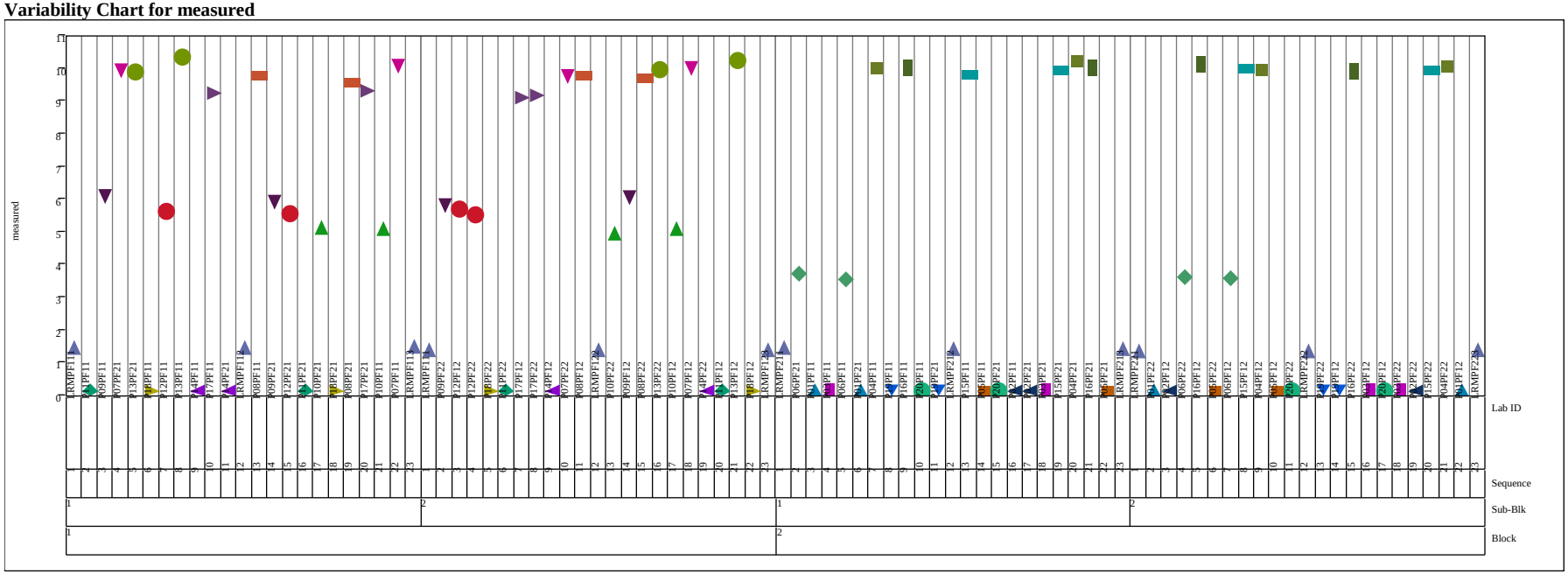


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence Grouped by Analytical Block (continued)

Oxide=K2O (wt%), Prep Method=AD
Variability Chart for measured

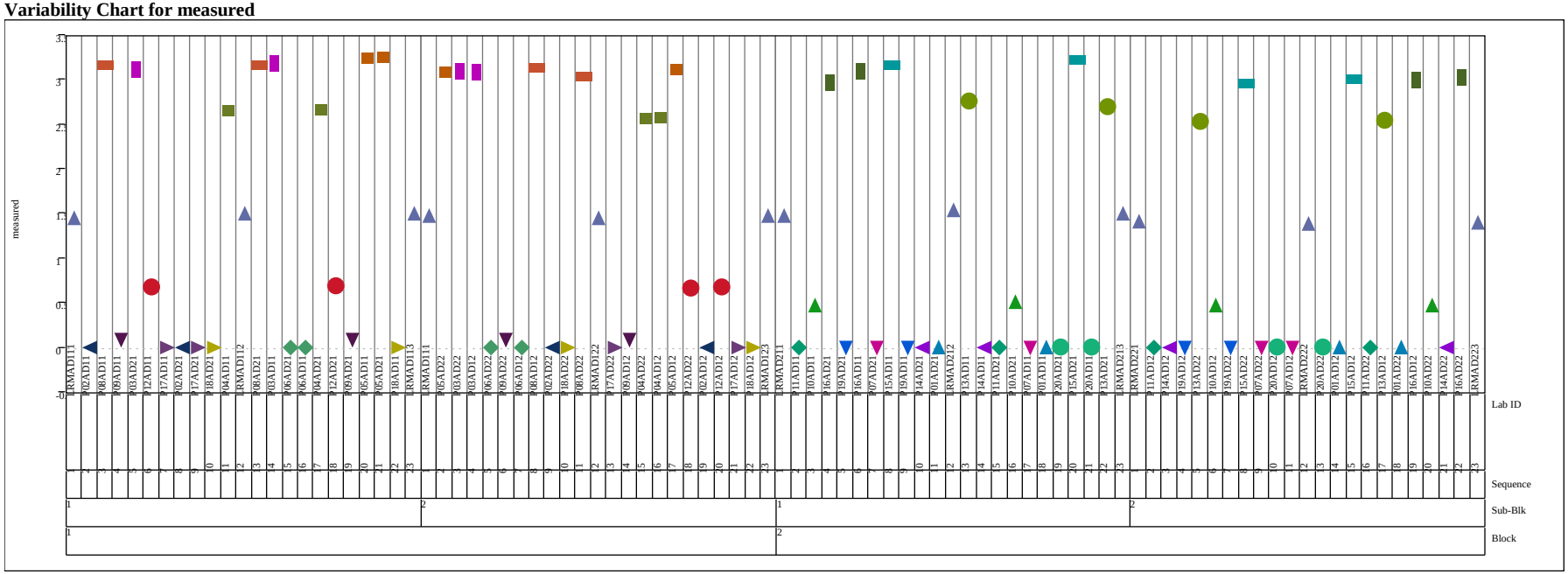


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence Grouped by Analytical Block (continued)

Oxide=Li2O (wt%), Prep Method=PF
Variability Chart for measured

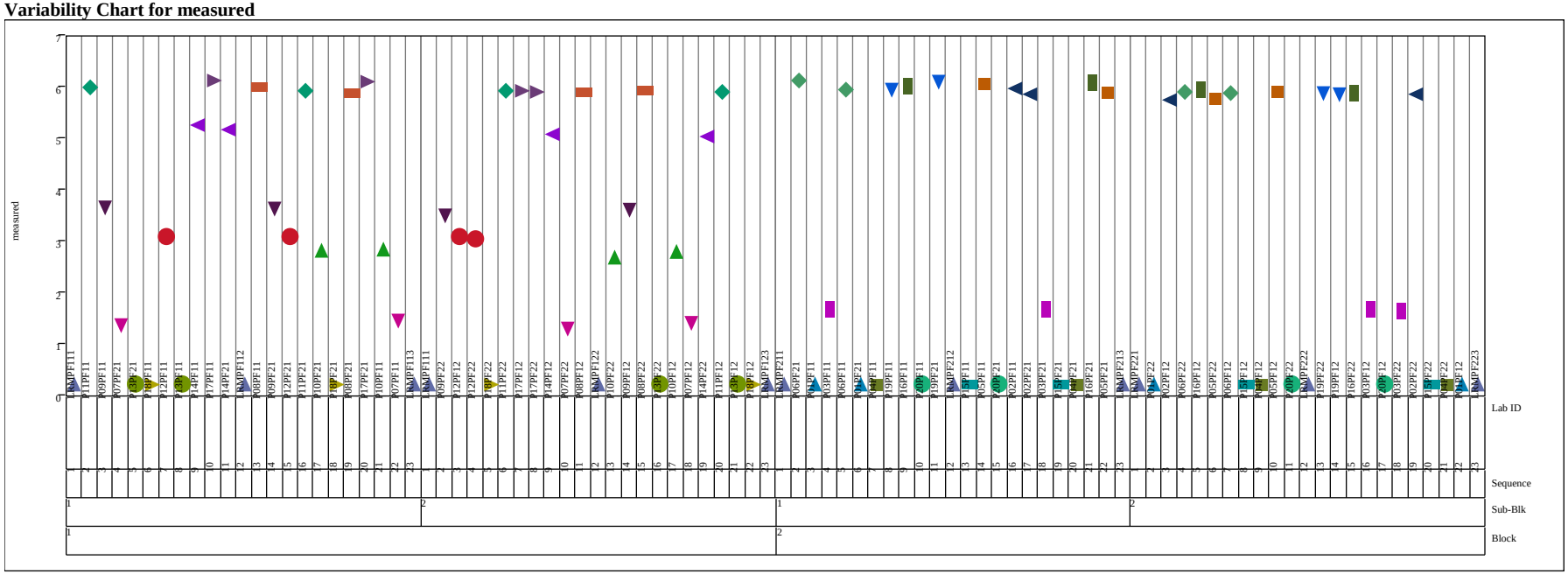


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence Grouped by Analytical Block (continued)

Oxide=MgO (wt%), Prep Method=PF
Variability Chart for measured

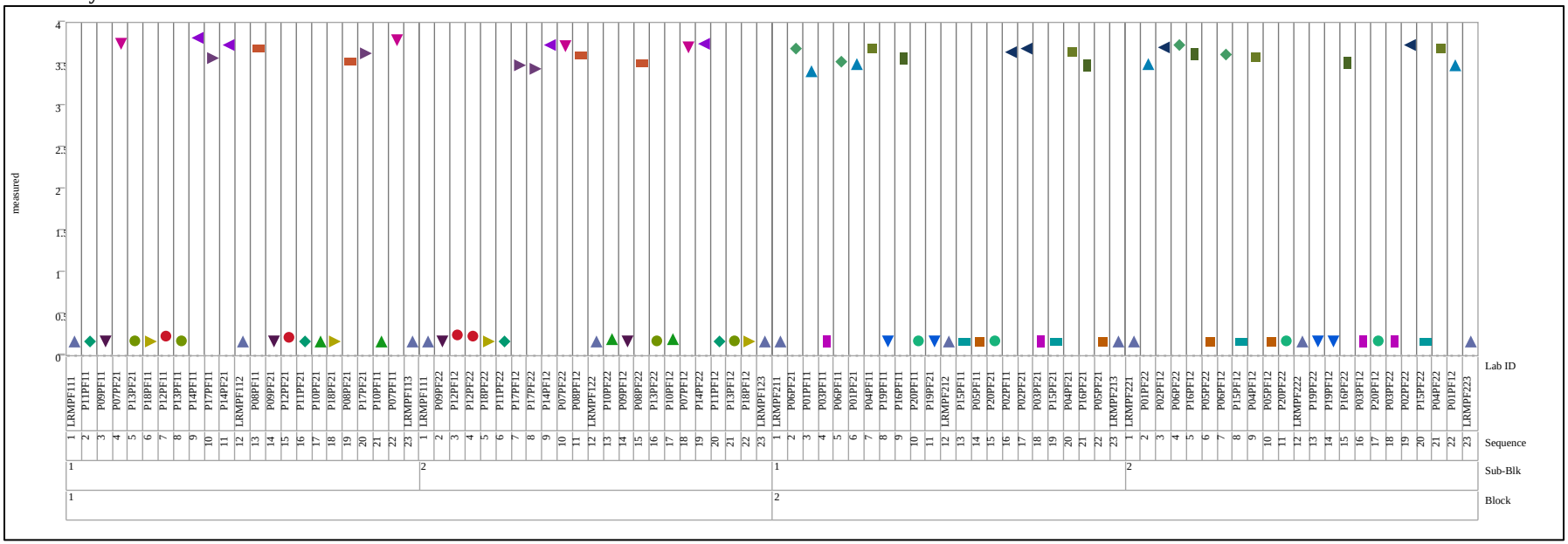


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence Grouped by Analytical Block (continued)

Oxide=MnO (wt%), Prep Method=PF
Variability Chart for measured

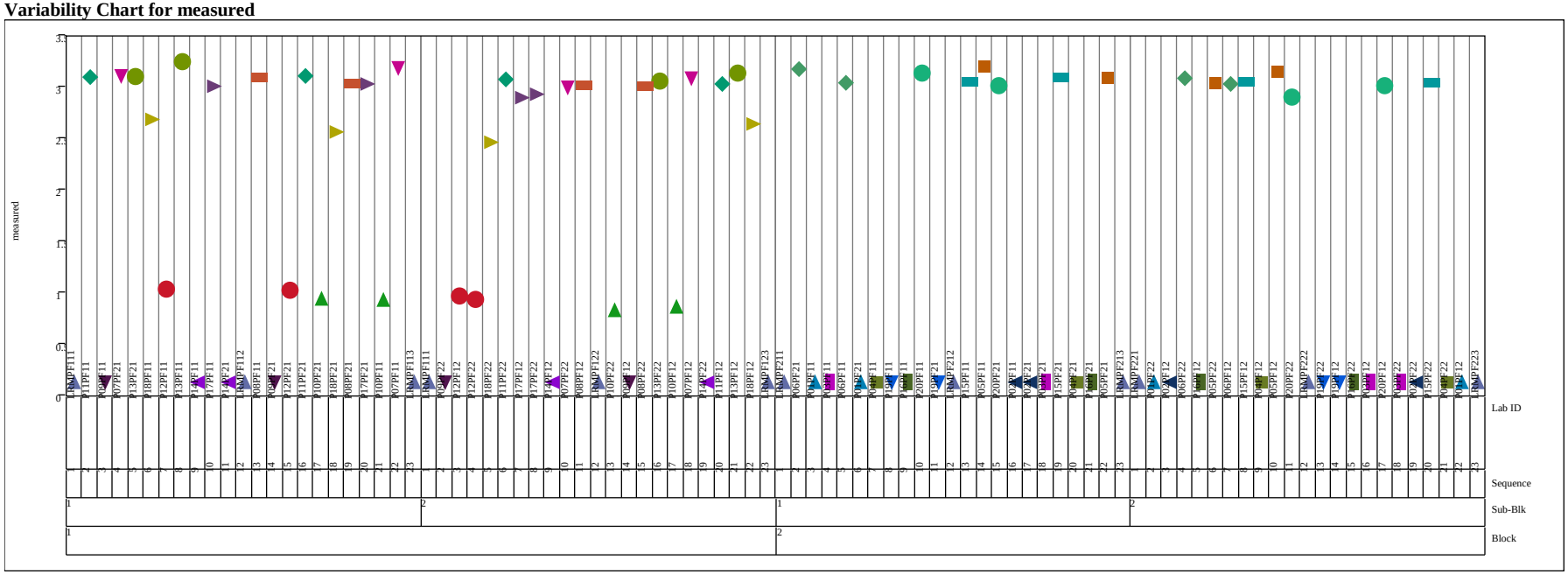


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence Grouped by Analytical Block (continued)

Oxide=Na2O (wt%), Prep Method=AD
Variability Chart for measured

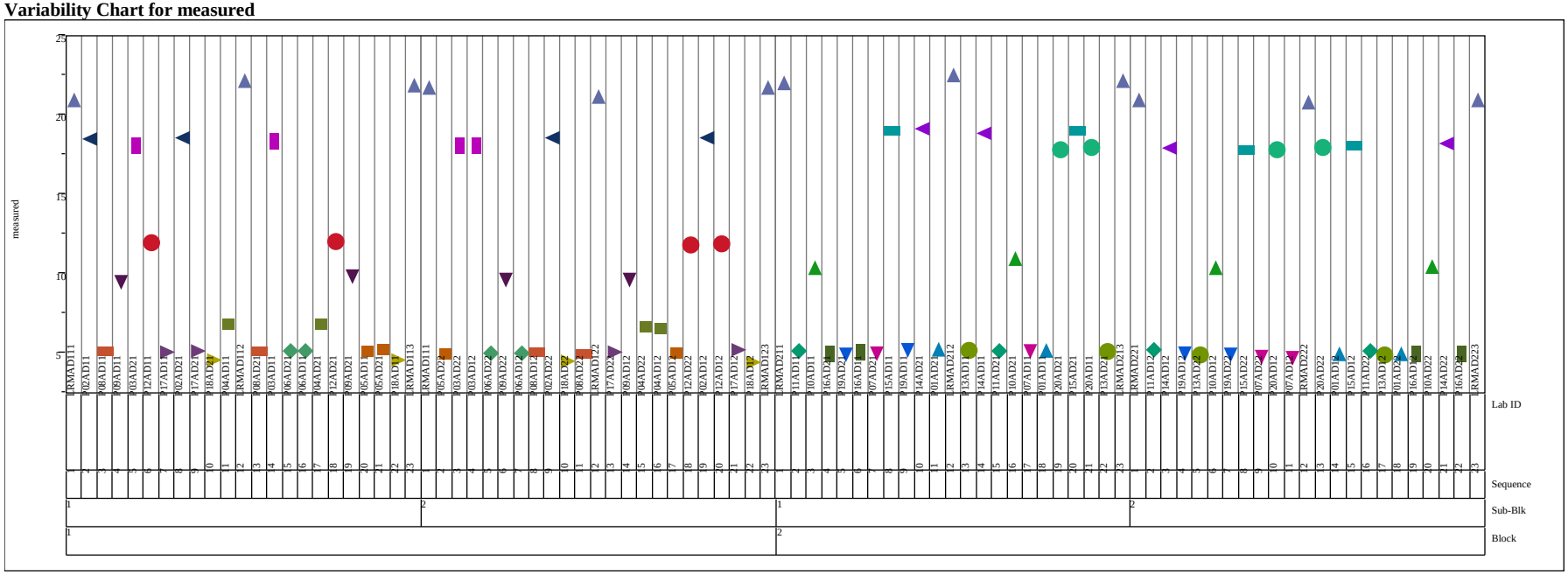


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence Grouped by Analytical Block (continued)

Oxide=NiO (wt%), Prep Method=AD
Variability Chart for measured

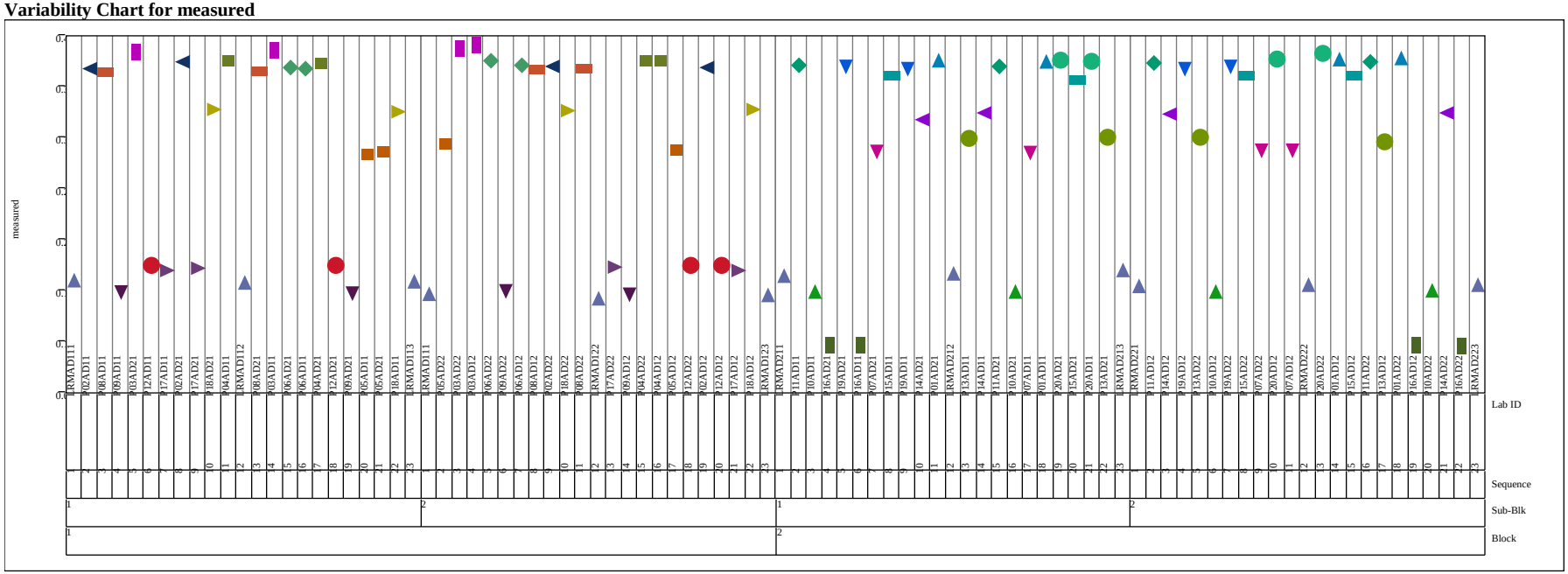


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence Grouped by Analytical Block (continued)

Oxide=P2O5 (wt%), Prep Method=AD
Variability Chart for measured

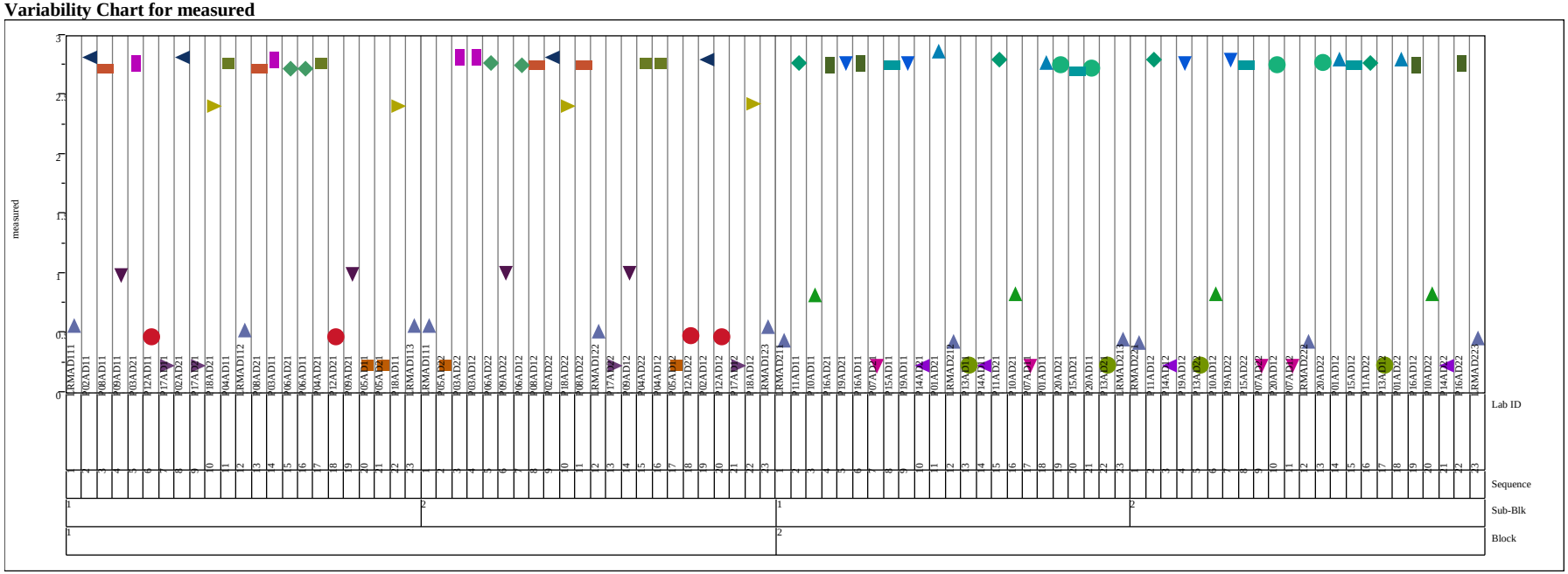


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence Grouped by Analytical Block (continued)

Oxide=PbO (wt%), Prep Method=AD
Variability Chart for measured

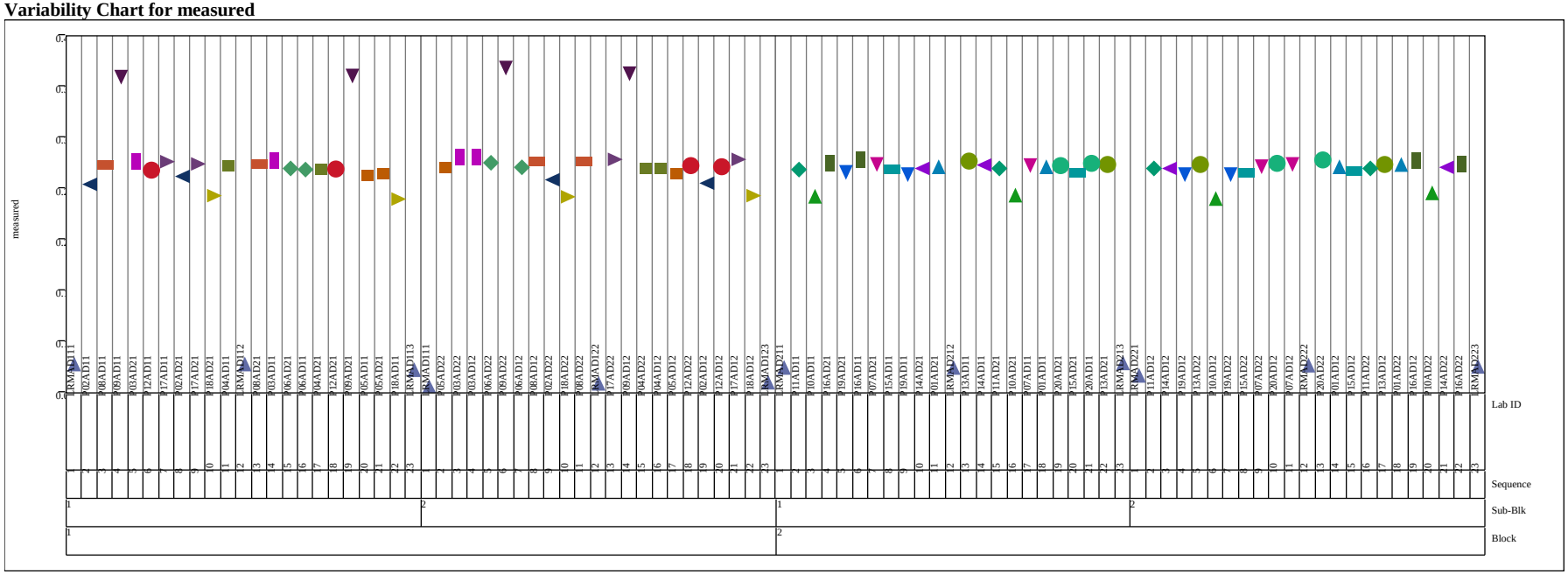


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence Grouped by Analytical Block (continued)

Oxide=RuO2 (wt%), Prep Method=AD
Variability Chart for measured

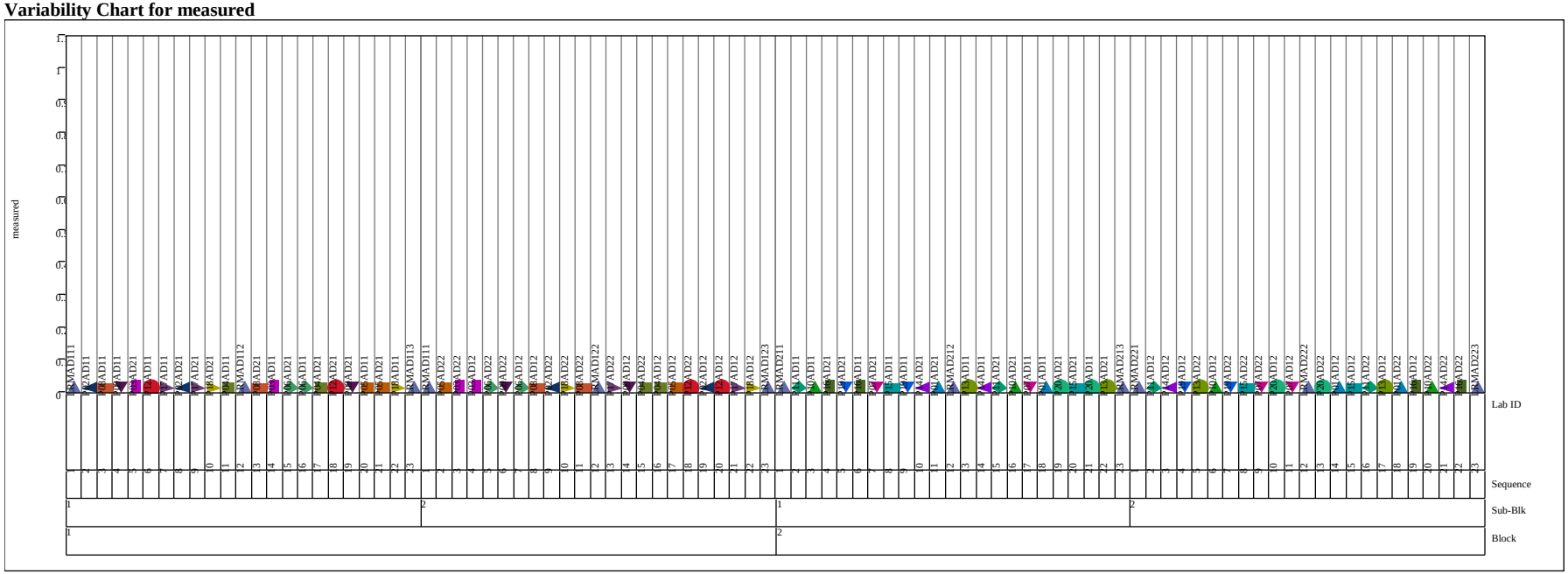


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence Grouped by Analytical Block (continued)

Oxide=SiO2 (wt%), Prep Method=PF
Variability Chart for measured

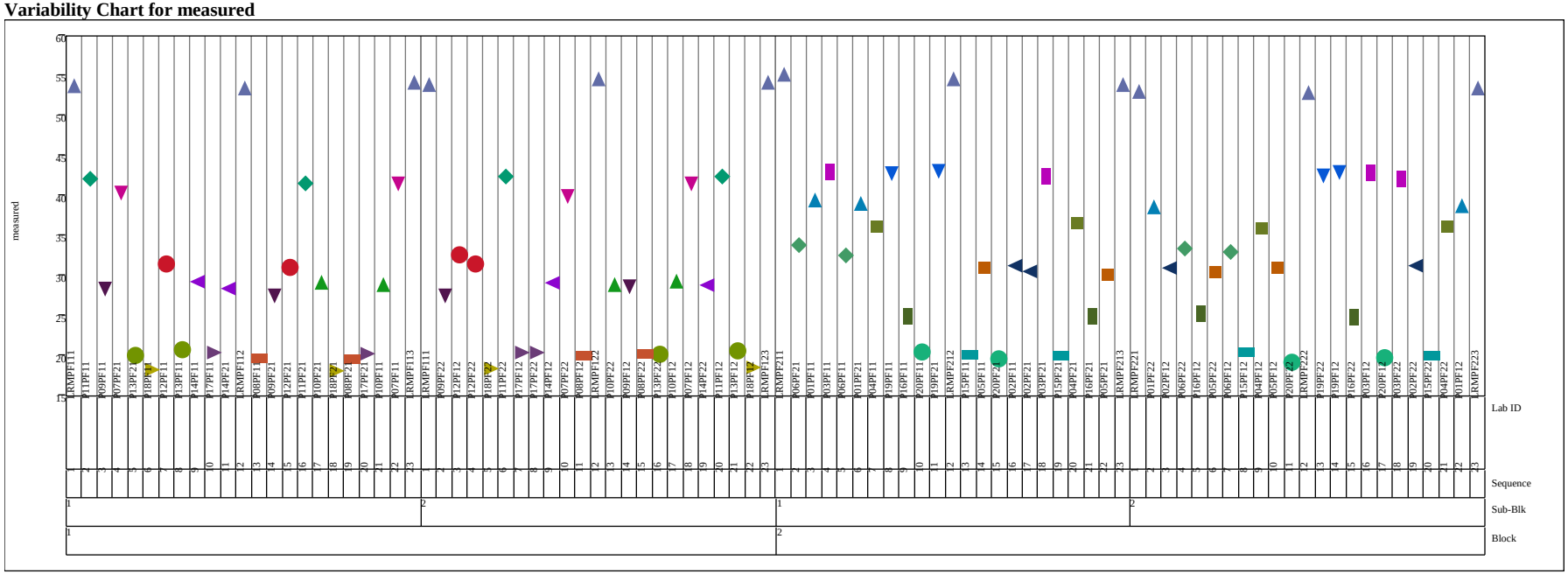


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence Grouped by Analytical Block (continued)

Oxide=SO3 (wt%), Prep Method=AD
Variability Chart for measured

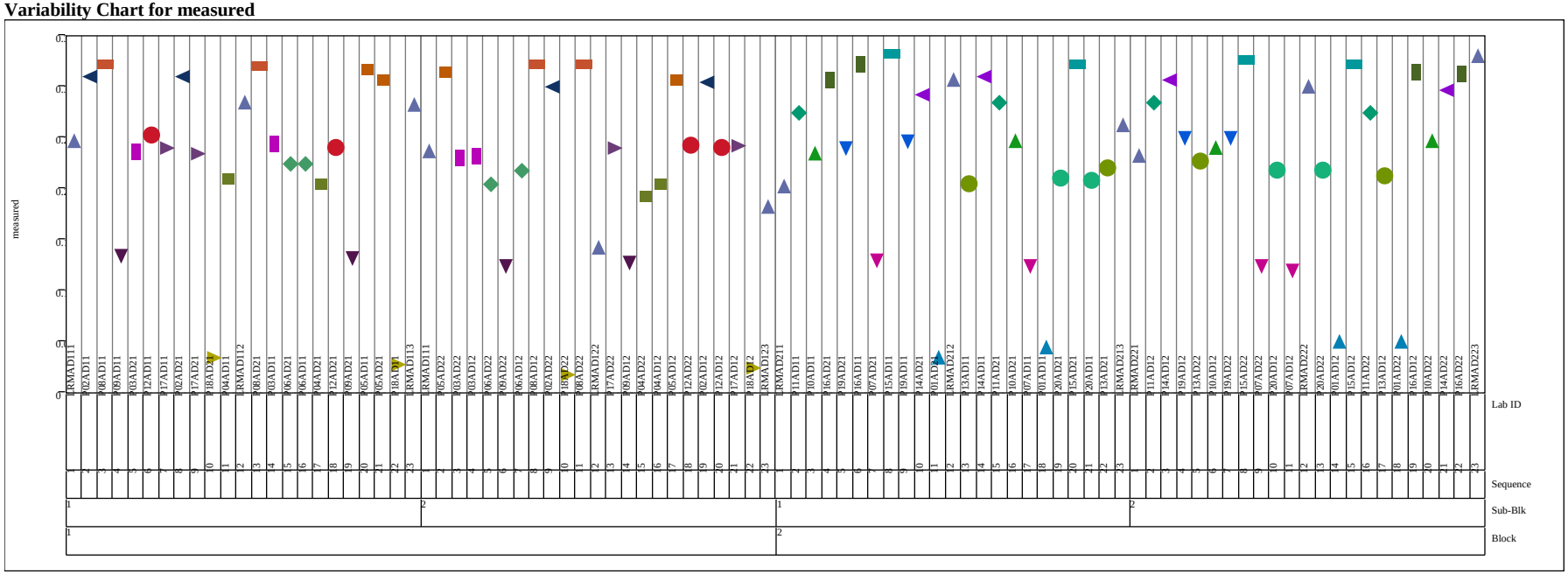


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence Grouped by Analytical Block (continued)

Oxide=SrO (wt%), Prep Method=AD
Variability Chart for measured

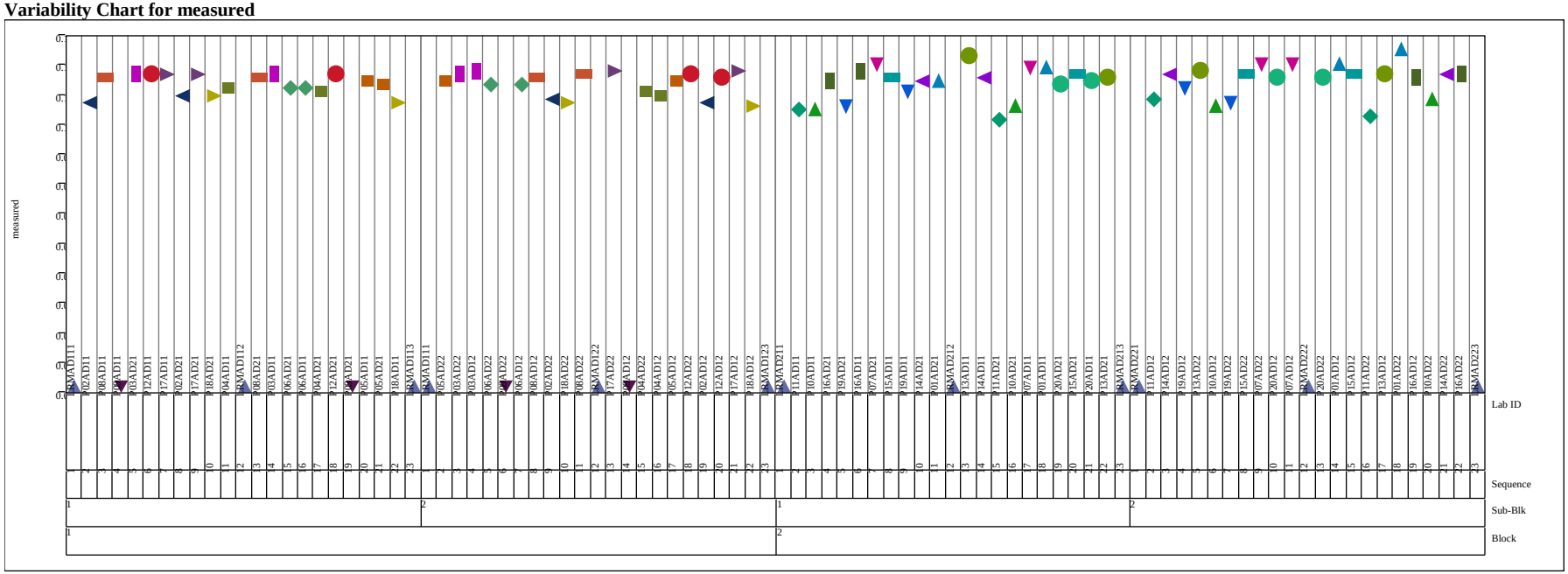


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence Grouped by Analytical Block (continued)

Oxide=ZrO2 (wt%), Prep Method=AD
Variability Chart for measured

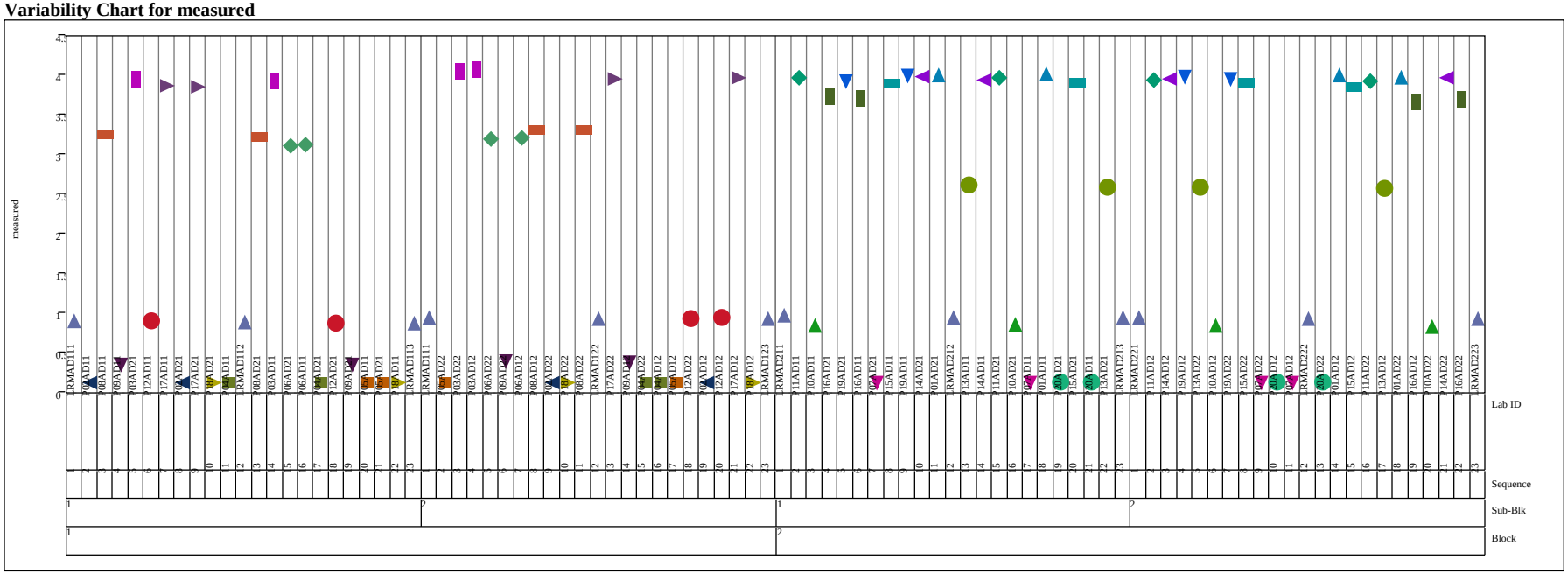


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations

Oxide=Al2O3 (wt%), Prep Method=PF
Variability Chart for measured

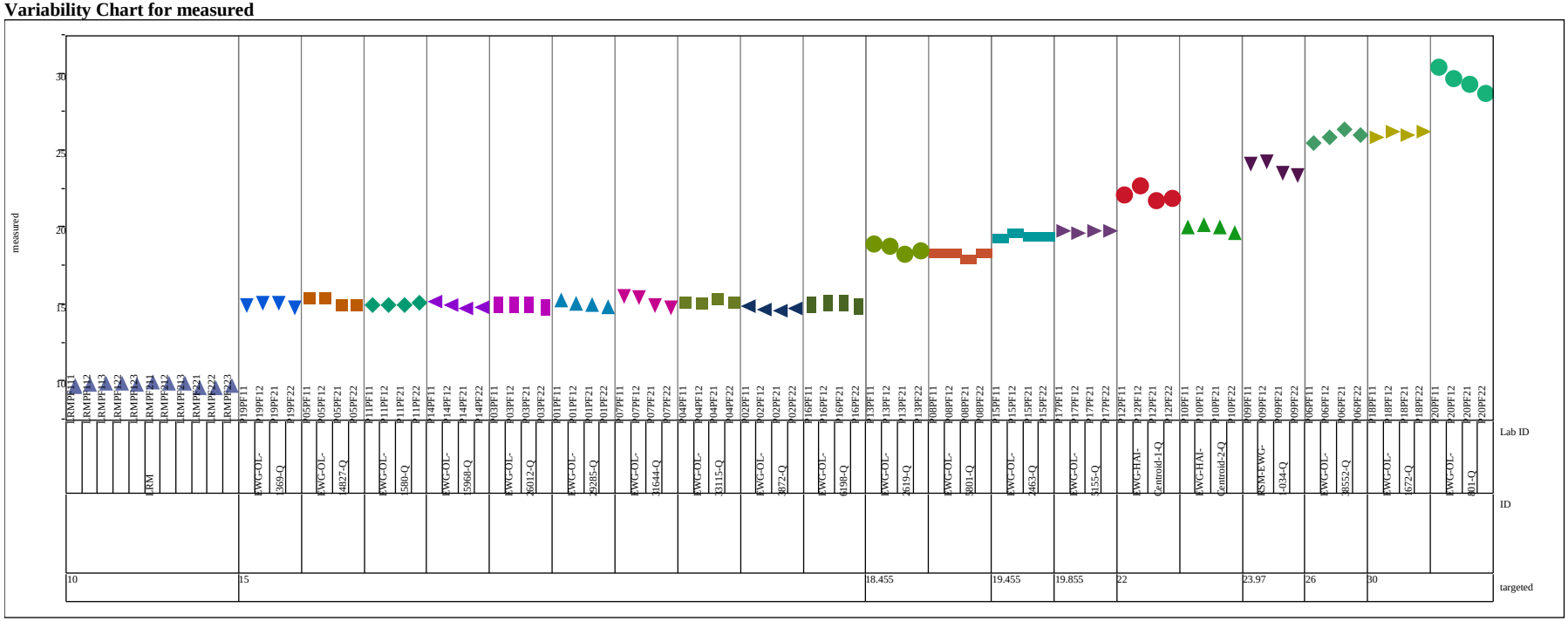


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations. (continued)

Oxide=B2O3 (wt%), Prep Method=PF
Variability Chart for measured

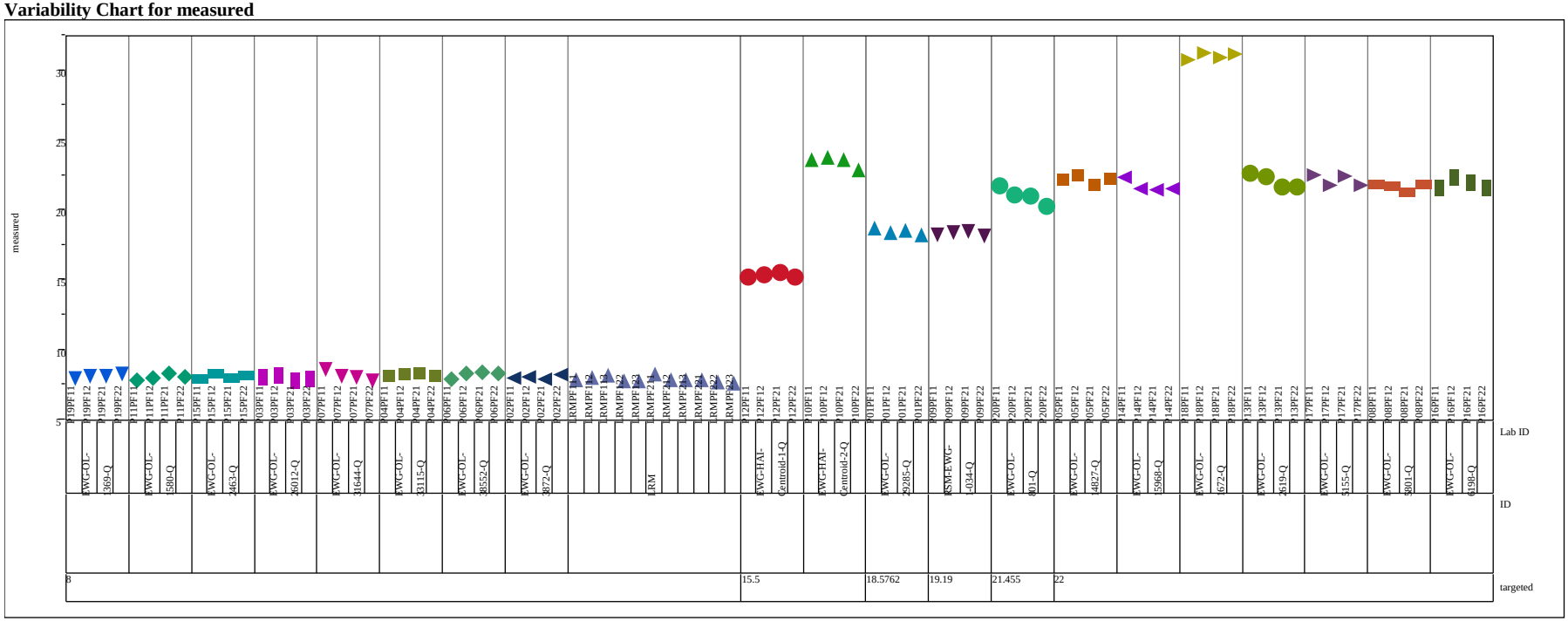


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations. (continued)

Oxide=Bi2O3 (wt%), Prep Method=AD
Variability Chart for measured

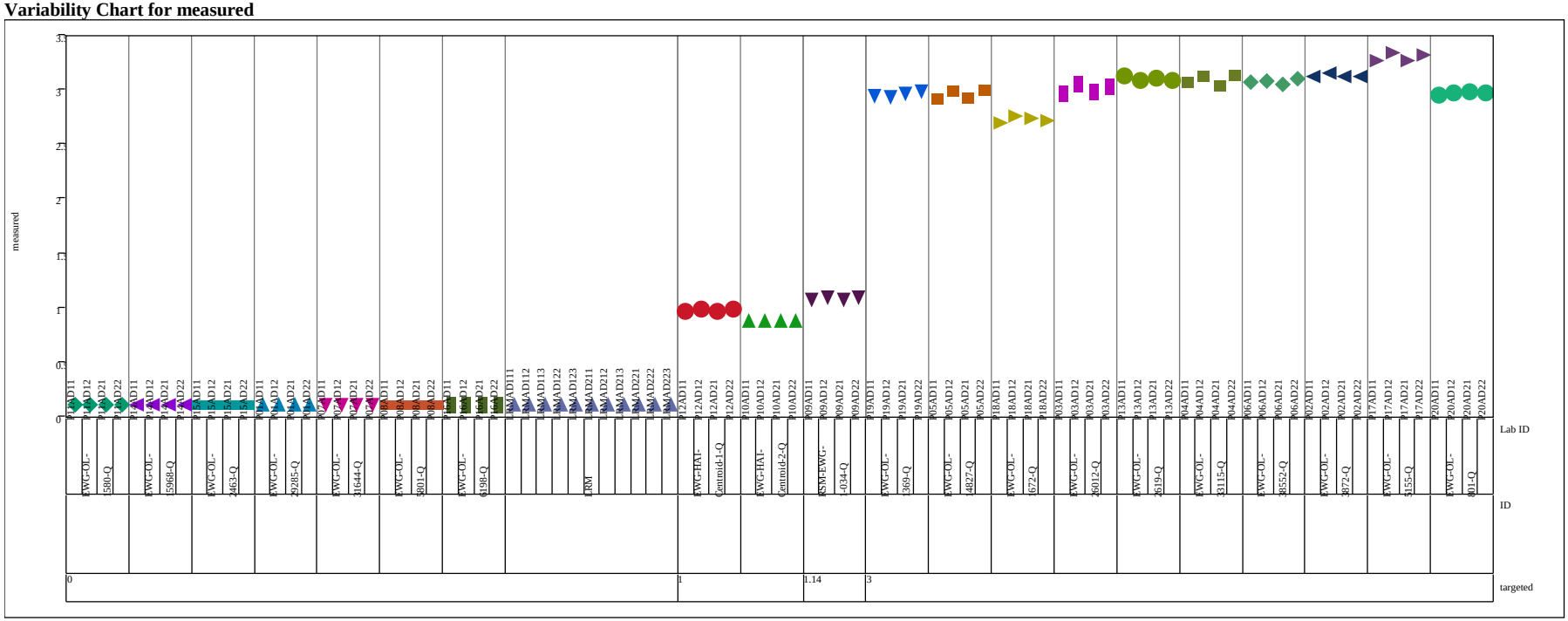


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations. (continued)

Oxide=CaO (wt%), Prep Method=PF
Variability Chart for measured

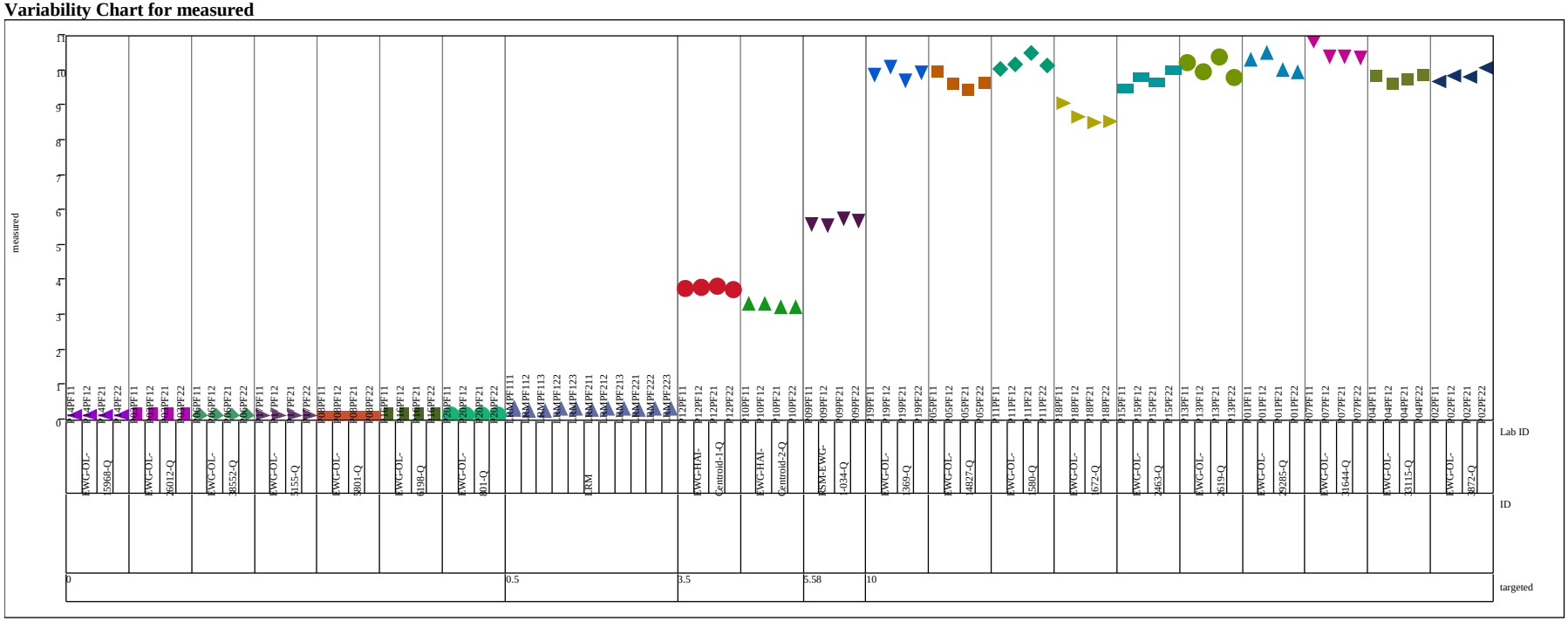


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations. (continued)

Oxide=CdO (wt%), Prep Method=AD
Variability Chart for measured

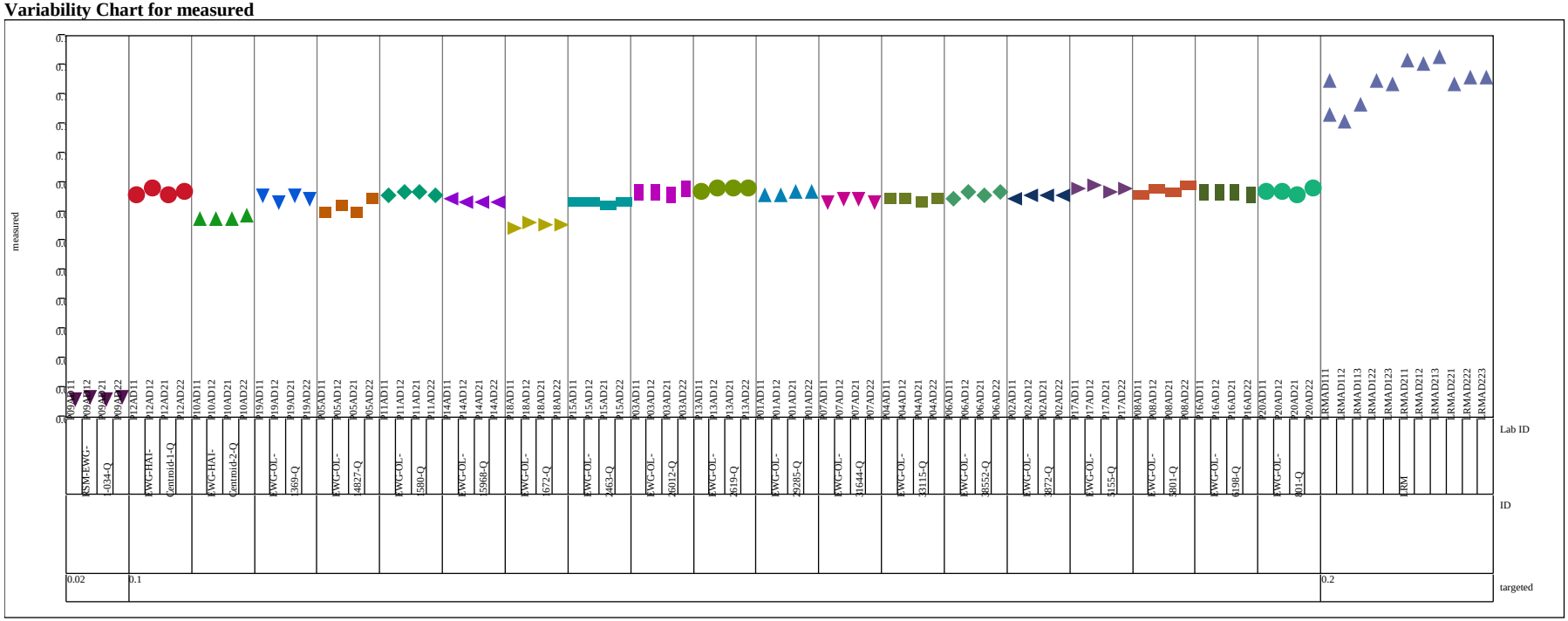


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations. (continued)

Oxide=Cr2O3 (wt%), Prep Method=PF
Variability Chart for measured

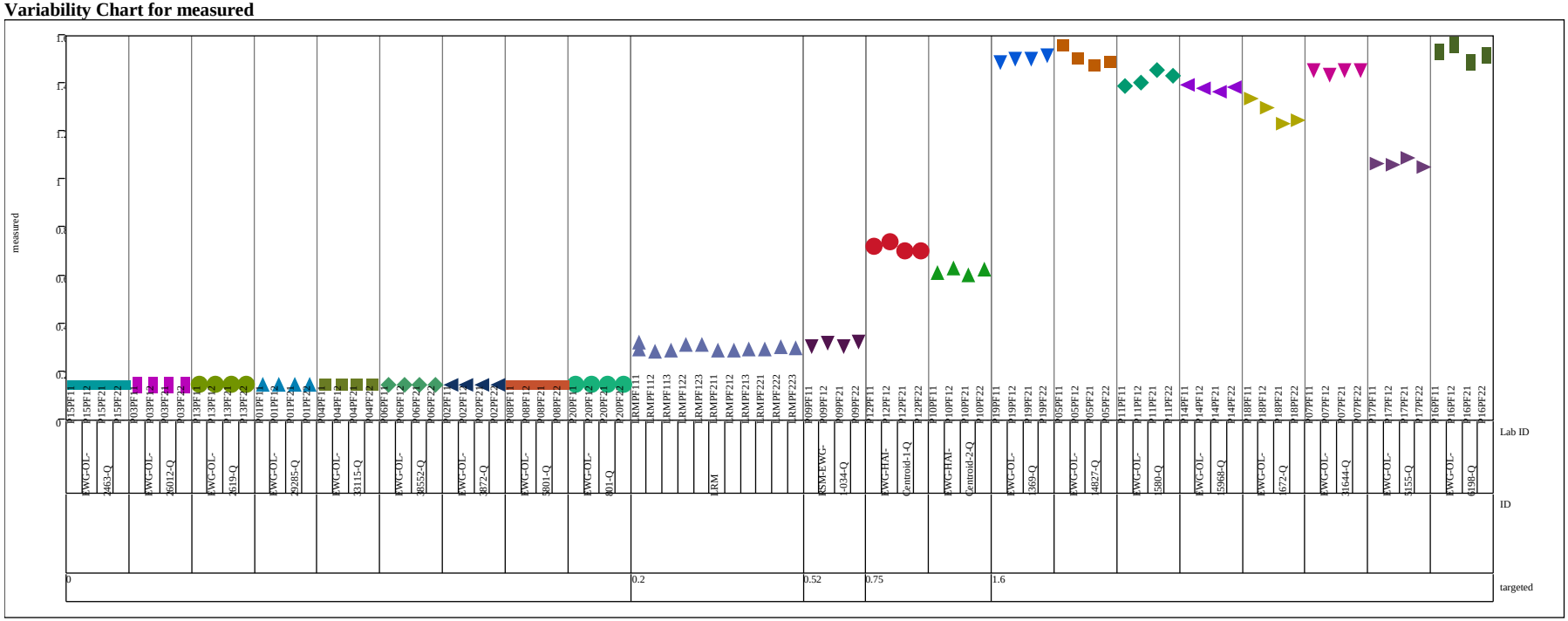


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations. (continued)

Oxide=Fe2O3 (wt%), Prep Method=PF
Variability Chart for measured

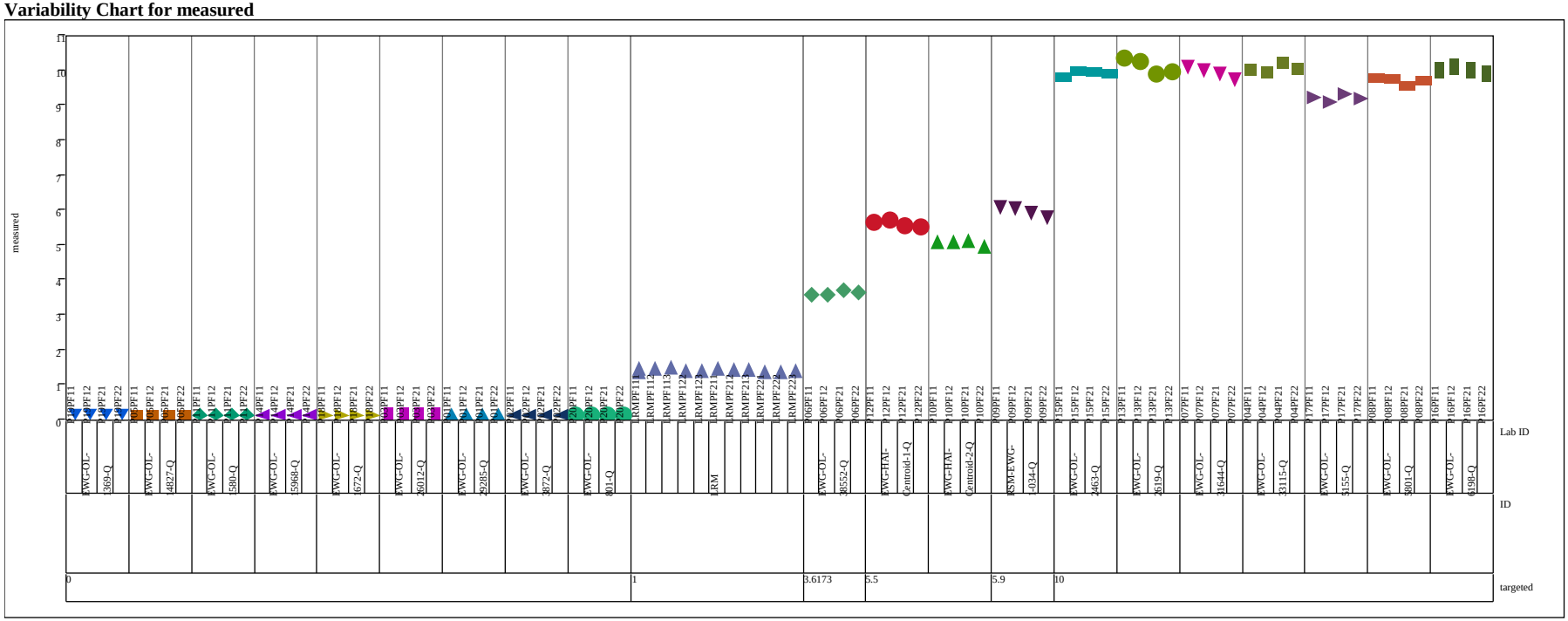


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations. (continued)

Oxide=K2O (wt%), Prep Method=AD
Variability Chart for measured

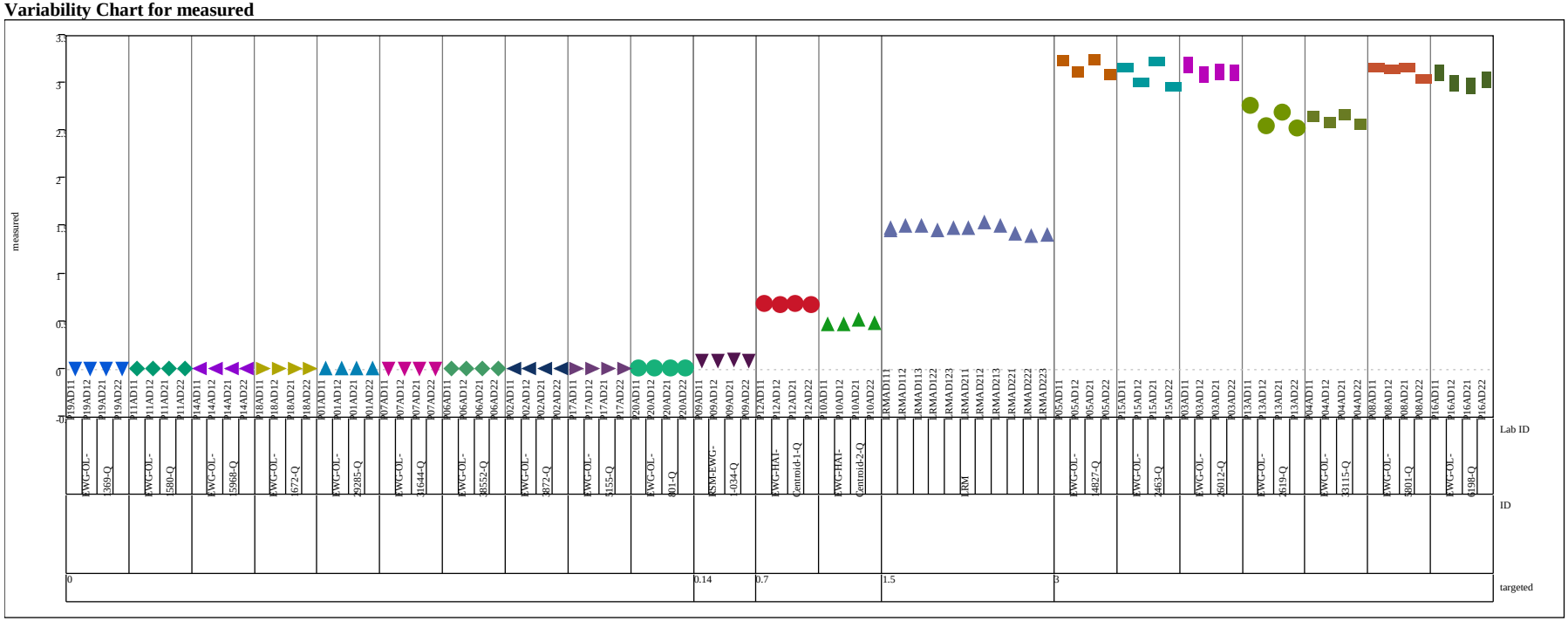


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations. (continued)

Oxide=Li2O (wt%), Prep Method=PF
Variability Chart for measured

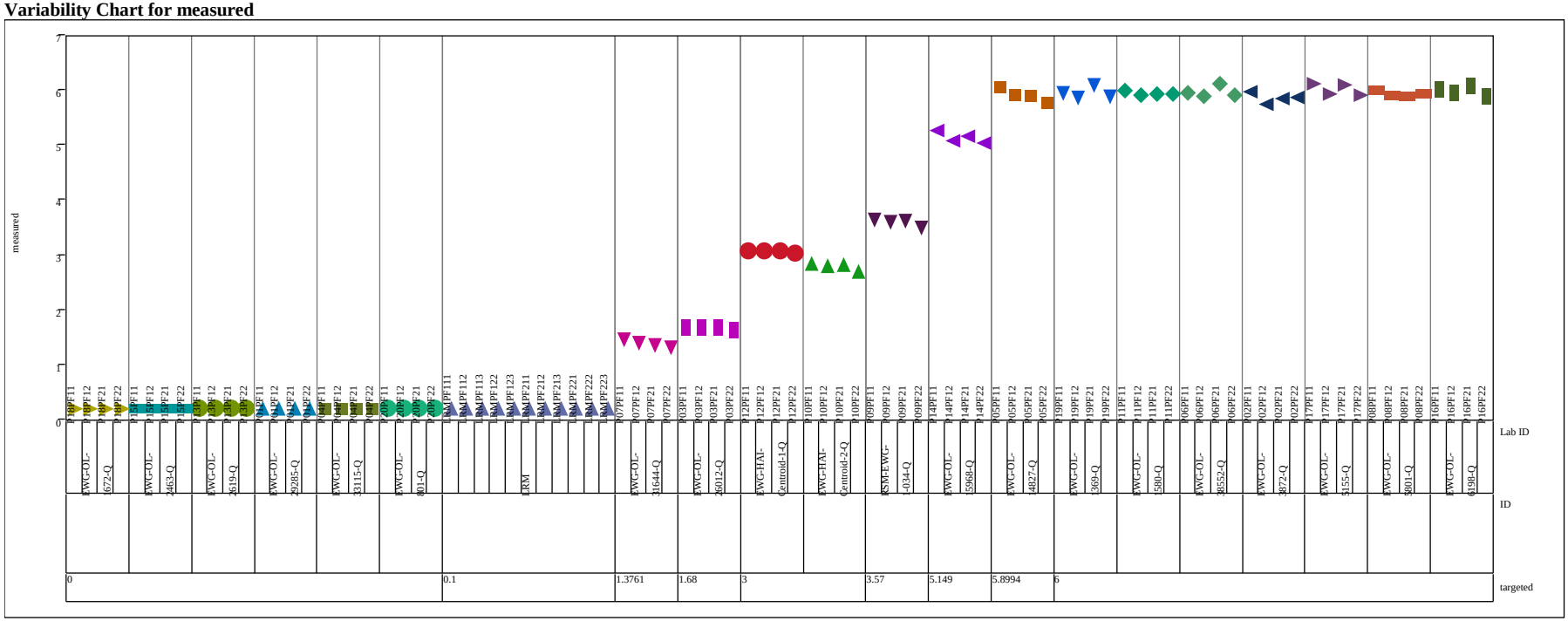


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations. (continued)

Oxide=MgO (wt%), Prep Method=PF
Variability Chart for measured

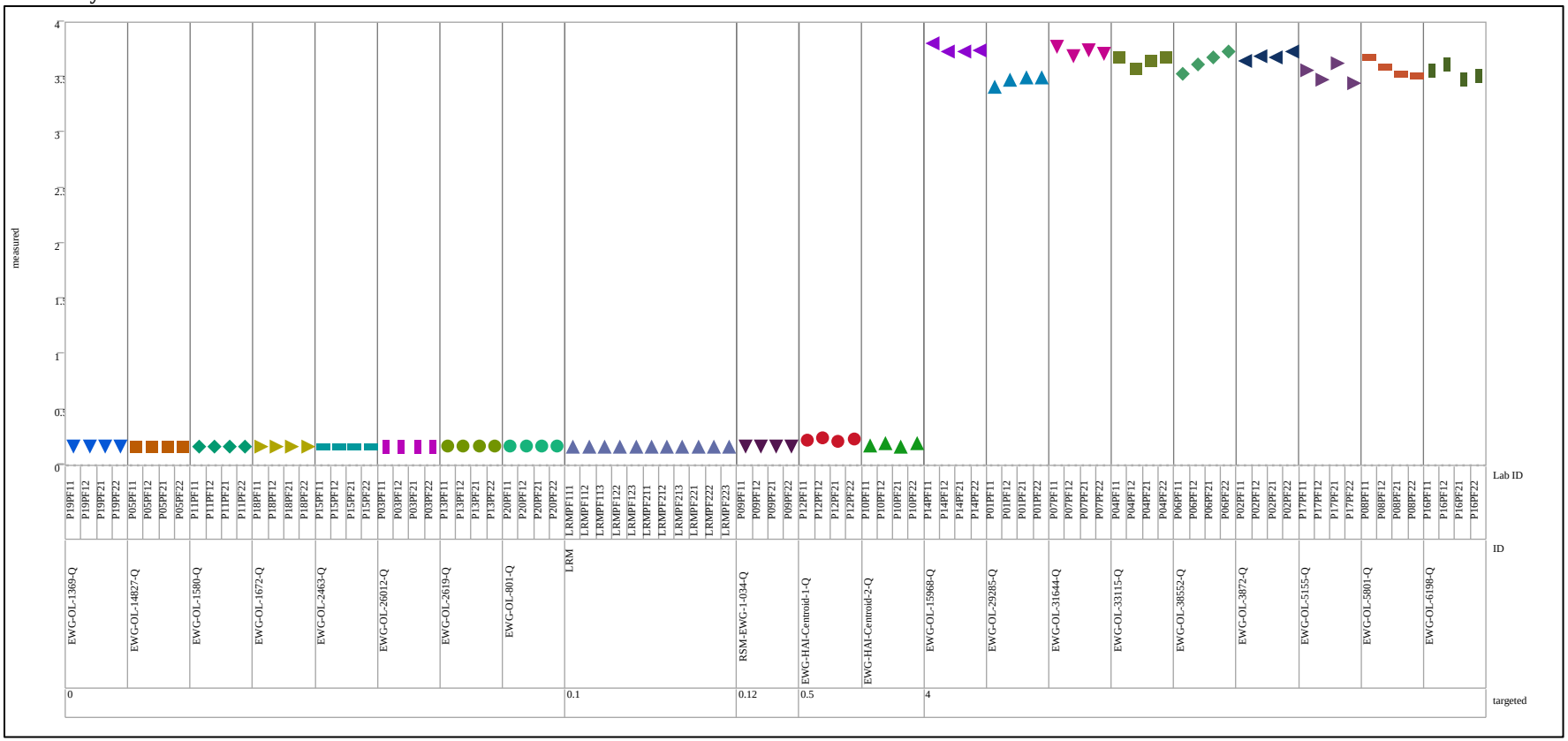


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations. (continued)

Oxide=MnO (wt%), Prep Method=PF
Variability Chart for measured

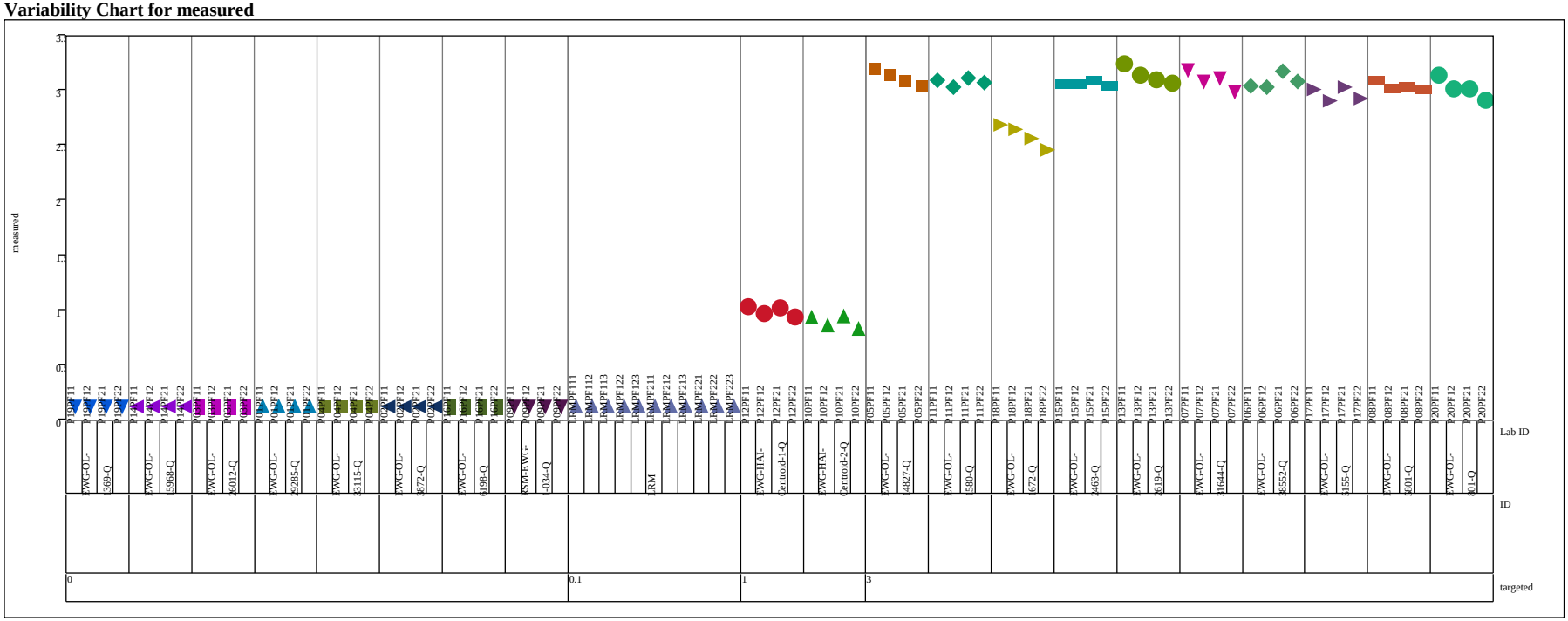


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations. (continued)

Oxide=Na2O (wt%), Prep Method=AD
Variability Chart for measured

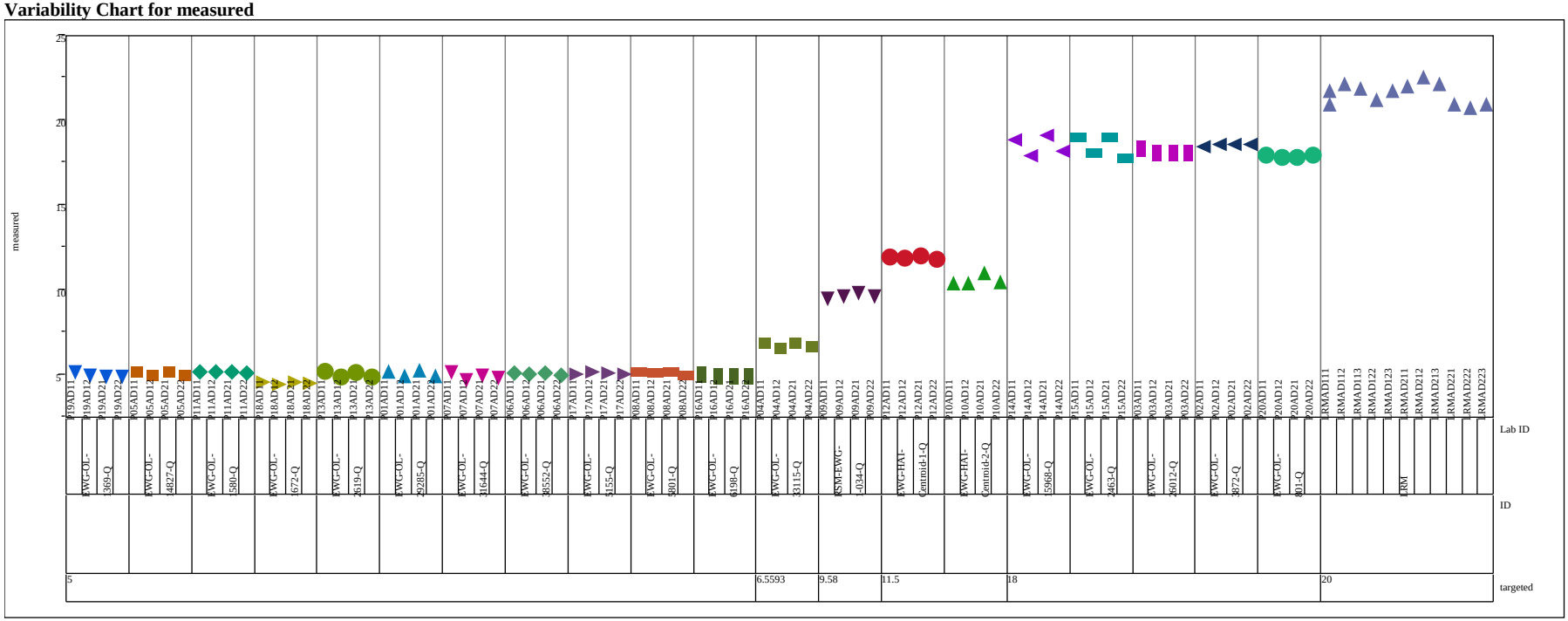


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations. (continued)

Oxide=NiO (wt%), Prep Method=AD
Variability Chart for measured

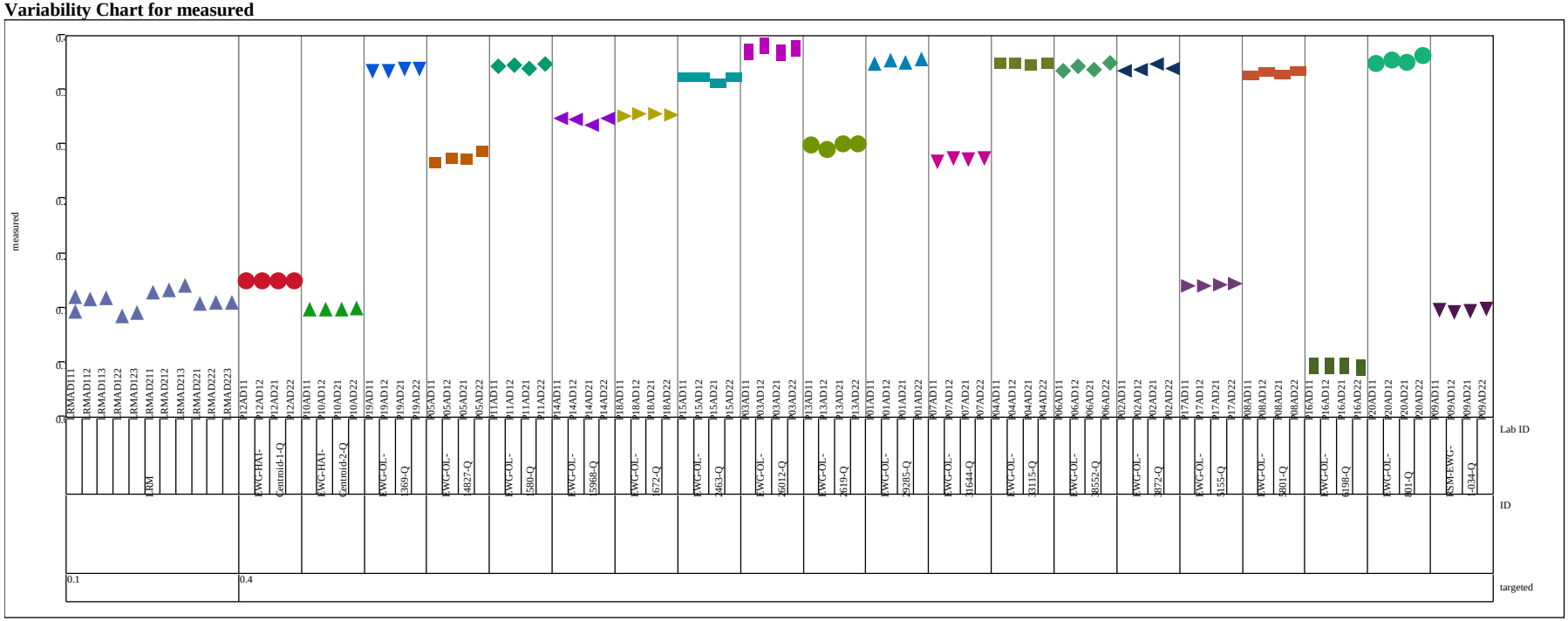


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations. (continued)

Oxide=P2O5 (wt%), Prep Method=AD
Variability Chart for measured

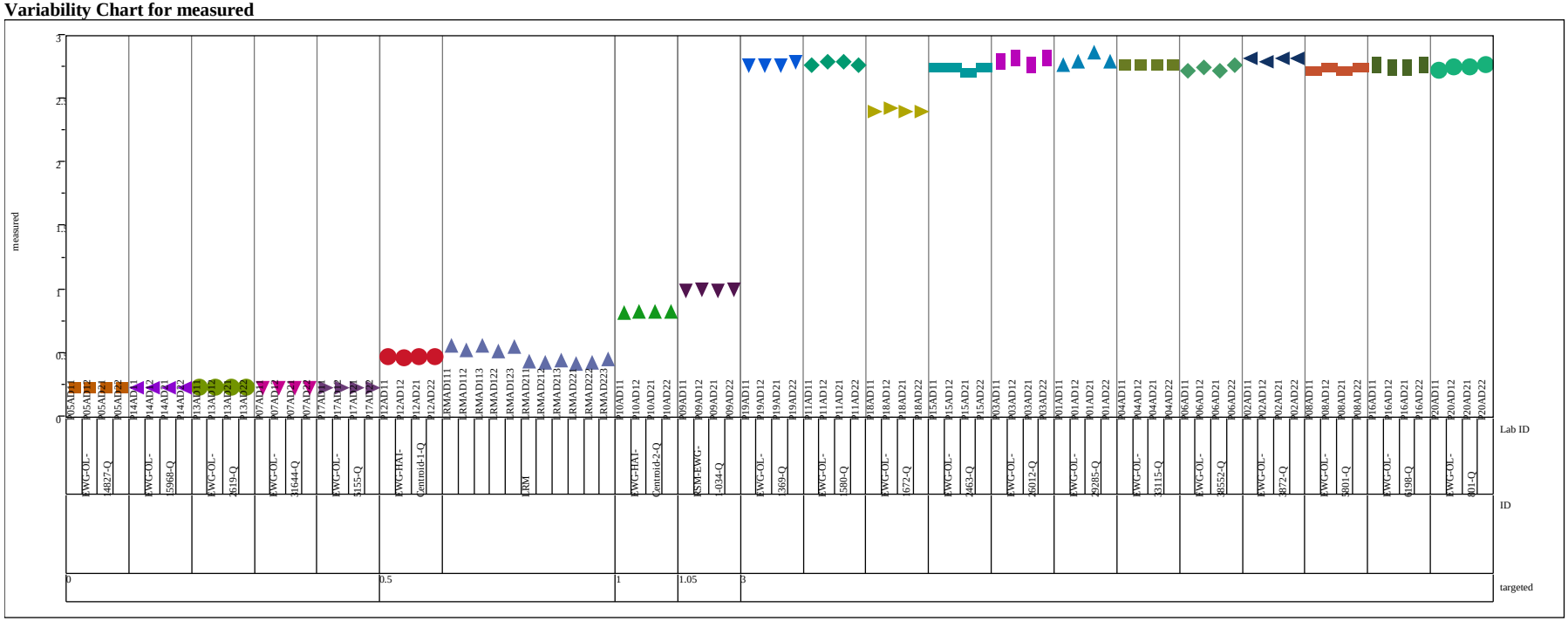


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations. (continued)

Oxide=PbO (wt%), Prep Method=AD
Variability Chart for measured

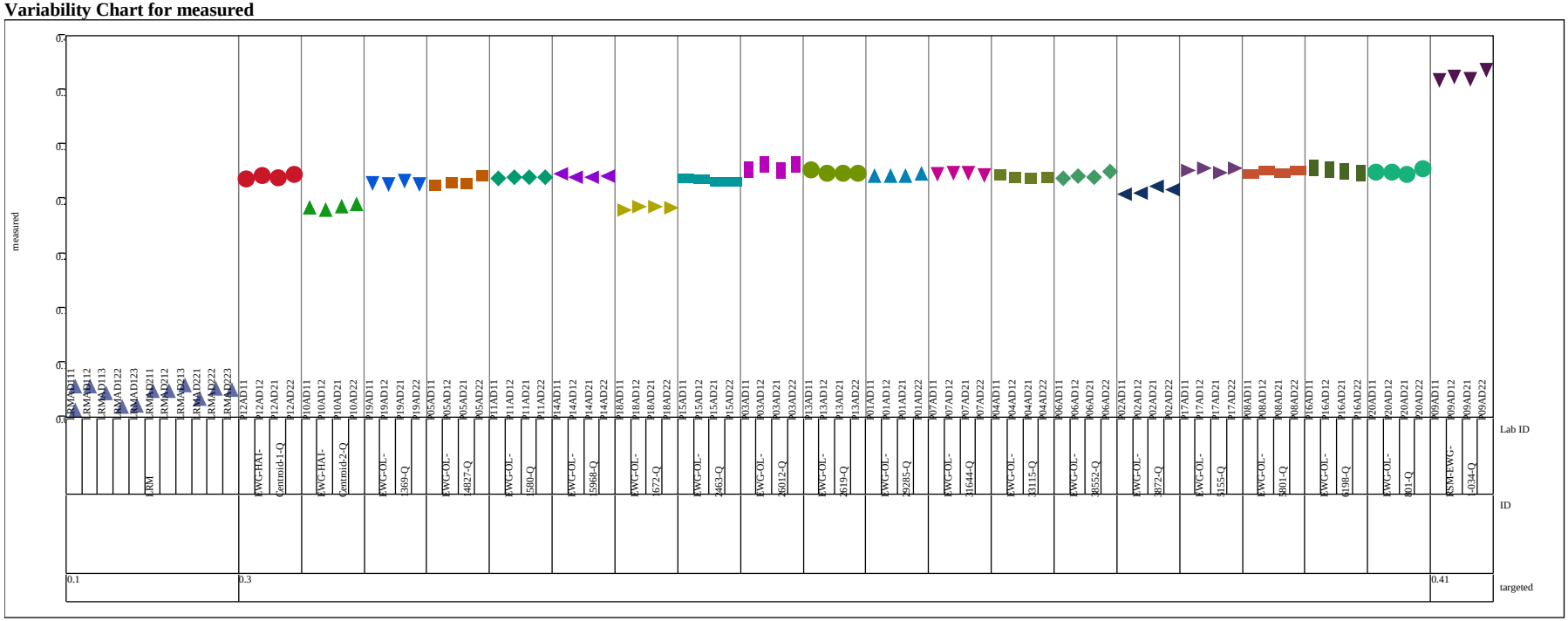


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations. (continued)

Oxide=SiO2 (wt%), Prep Method=PF
Variability Chart for measured

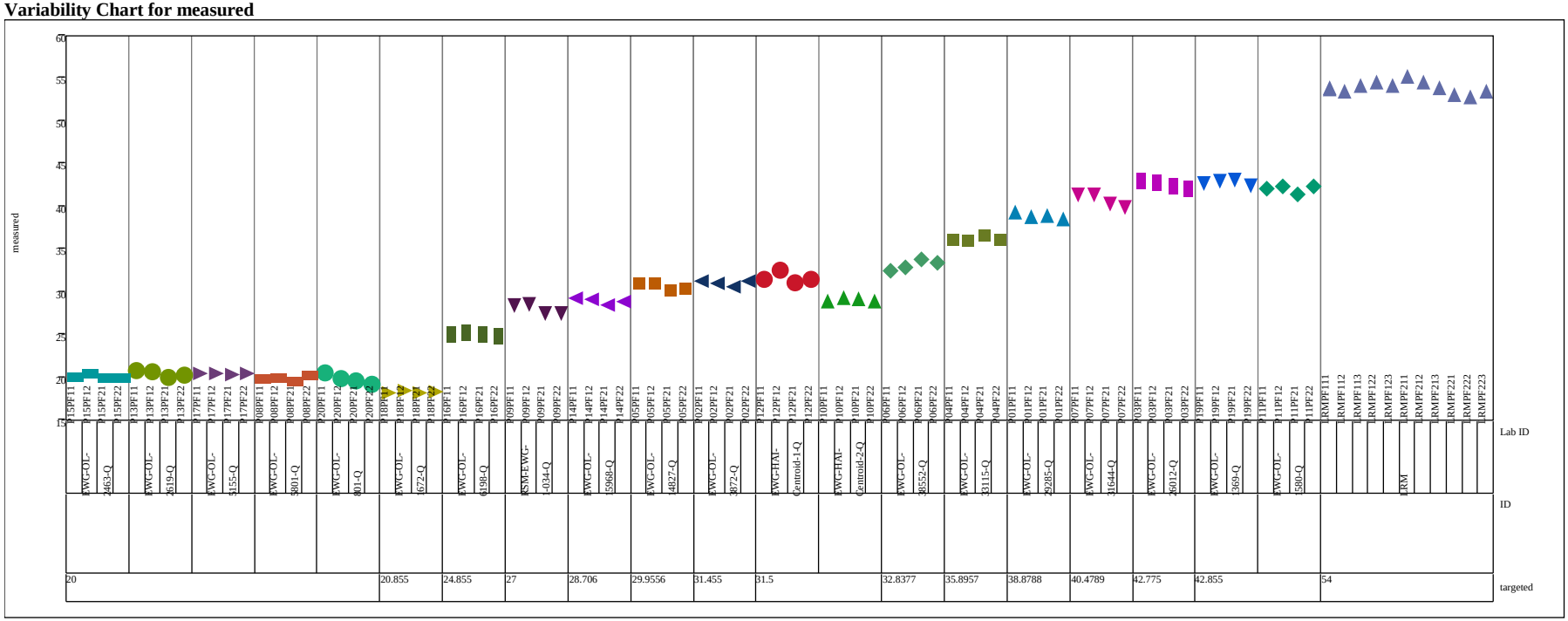


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations. (continued)

Oxide=SO3 (wt%), Prep Method=AD
Variability Chart for measured

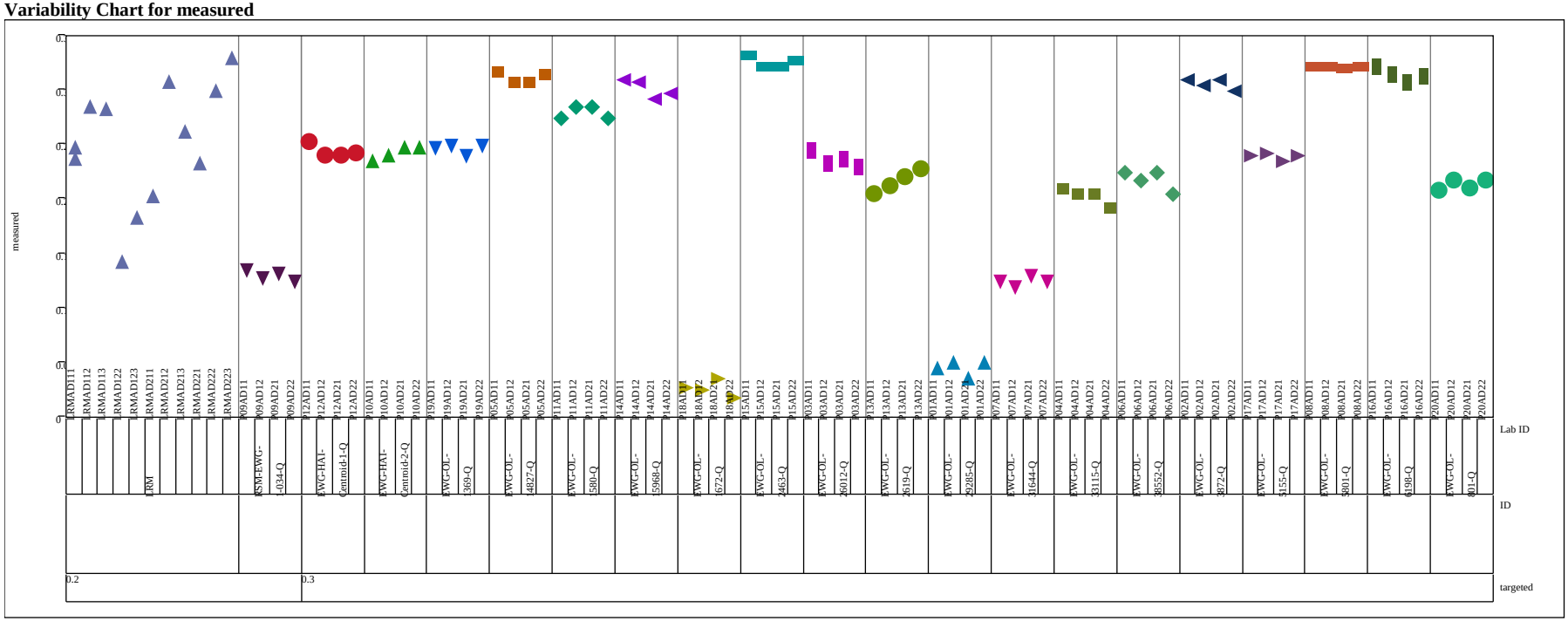


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations. (continued)

Oxide=SrO (wt%), Prep Method=AD
Variability Chart for measured

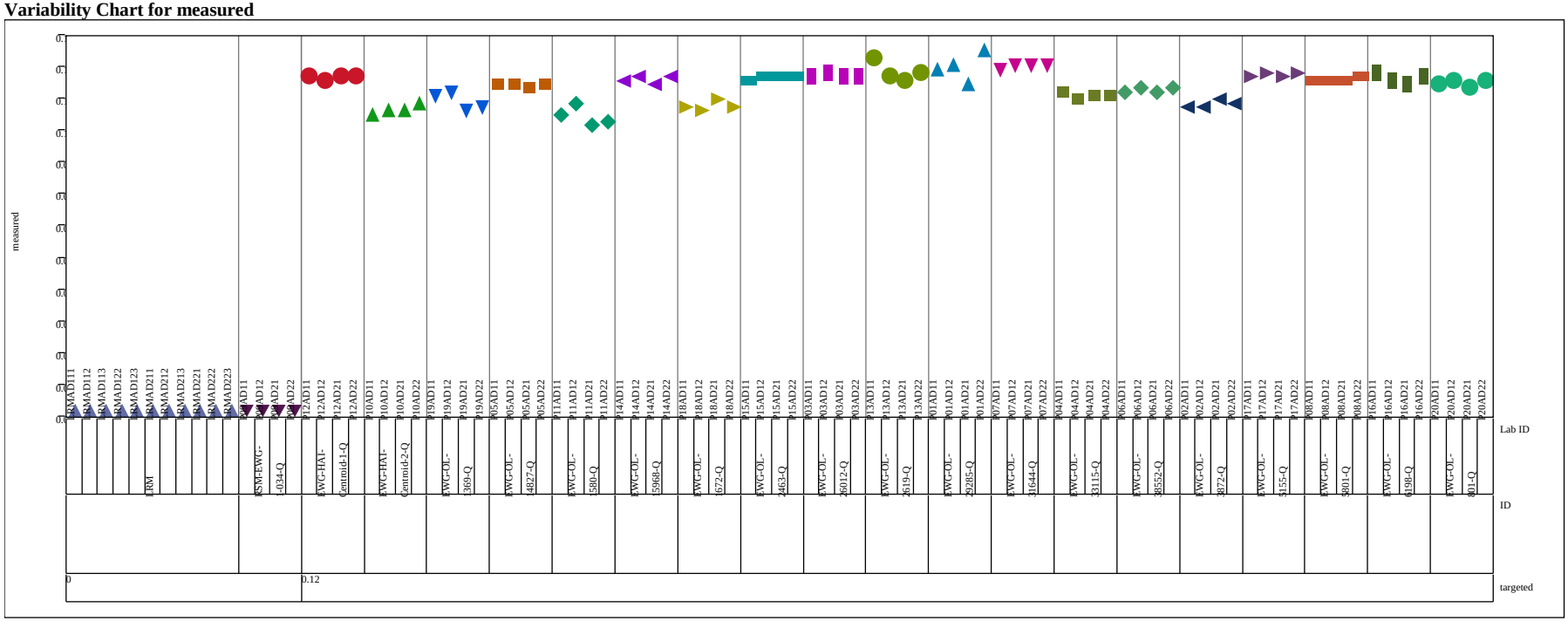


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations. (continued)

Oxide=ZrO2 (wt%), Prep Method=AD
Variability Chart for measured

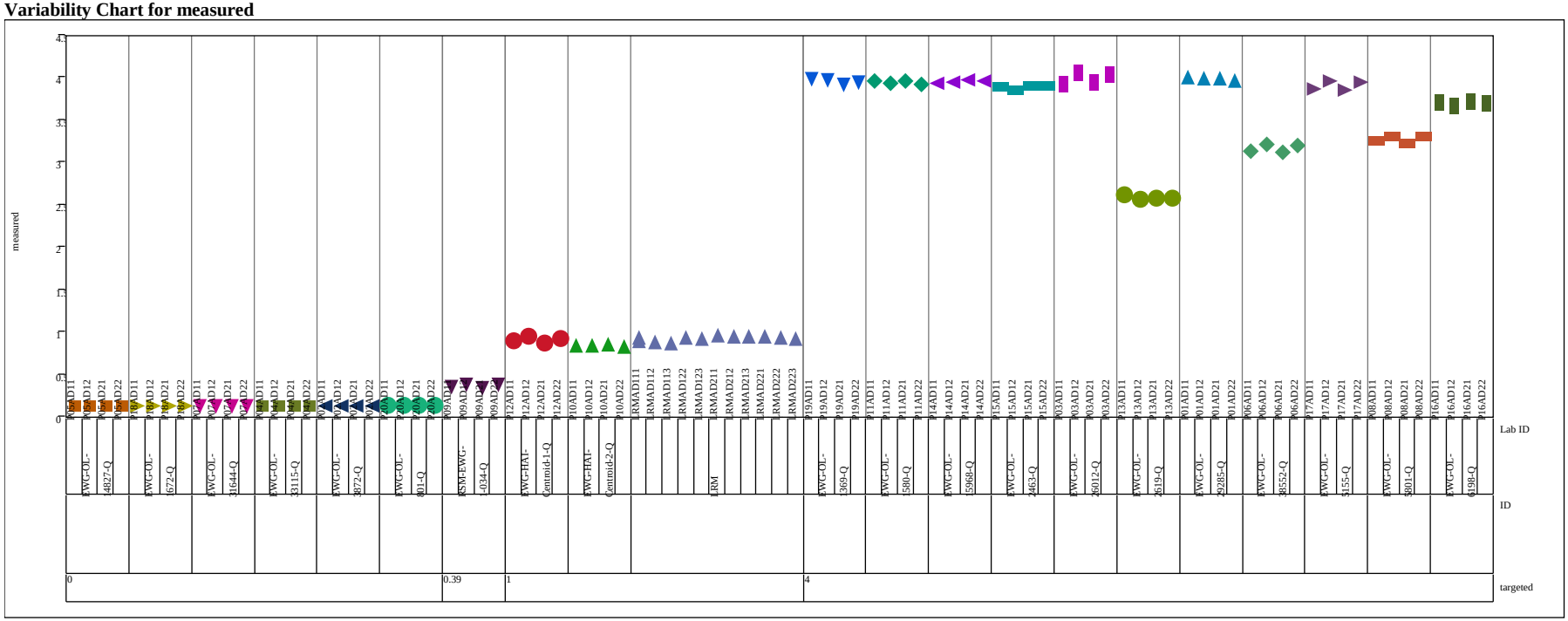
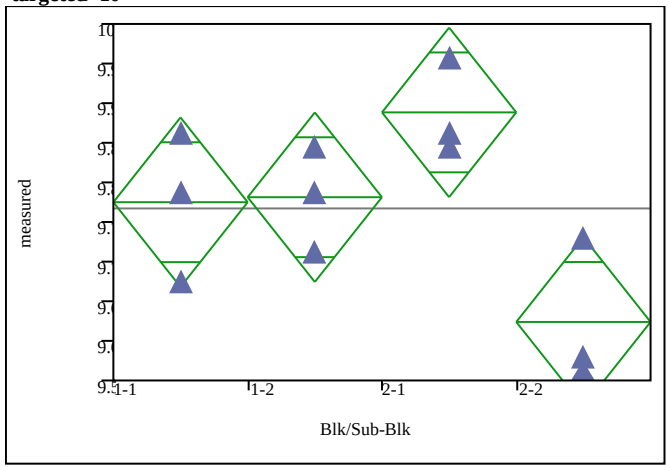


Exhibit A-3. Analysis of Variance of Analytical Block Effects for Measurements of the LRM Standard Glass

Oneway Analysis of measured By Blk/Sub-Blk ID=LRM, Oxide=Al2O3 (wt%), targeted=10



Oneway Anova
Summary of Fit

Rsquare	0.673377
Adj Rsquare	0.550894
Root Mean Square Error	0.08035
Mean of Response	9.76714
Observations (or Sum Wgts)	12

Analysis of Variance

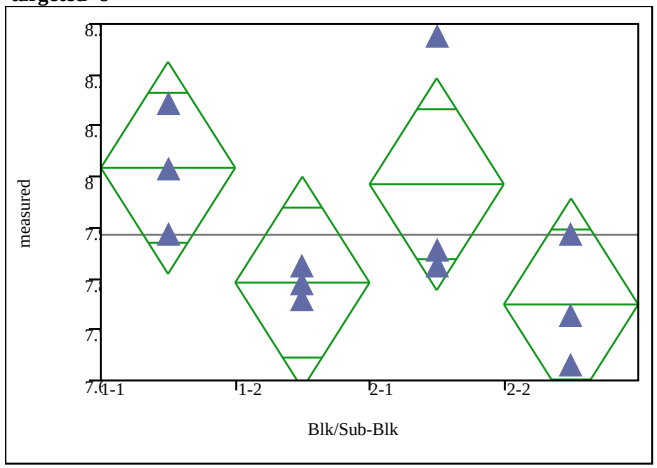
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/Sub-Blk	3	0.10648152	0.035494	5.4977	0.0241*
Error	8	0.05164904	0.006456		
C. Total	11	0.15813056			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	9.77501	0.04639	9.6680	9.8820
1-2	3	9.78131	0.04639	9.6743	9.8883
2-1	3	9.88838	0.04639	9.7814	9.9954
2-2	3	9.62385	0.04639	9.5169	9.7308

Std Error uses a pooled estimate of error variance

Oneway Analysis of measured By Blk/Sub-Blk ID=LRM, Oxide=B2O3 (wt%), targeted=8



Oneway Anova
Summary of Fit

Rsquare	0.456161
Adj Rsquare	0.252222
Root Mean Square Error	0.156367
Mean of Response	7.886072
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/Sub-Blk	3	0.16406974	0.054690	2.2367	0.1613
Error	8	0.19560500	0.024451		
C. Total	11	0.35967474			

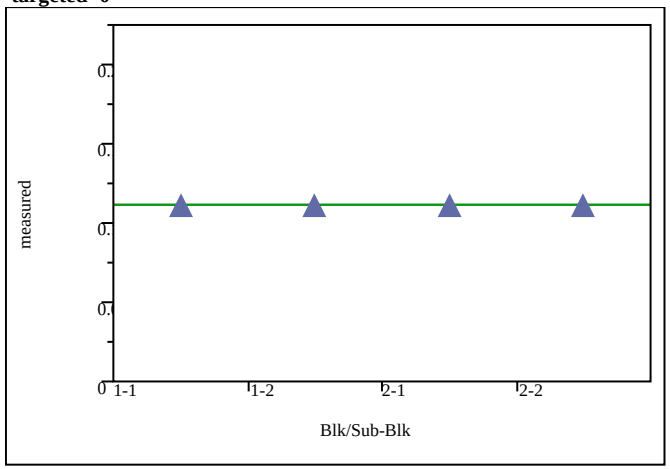
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	8.01755	0.09028	7.8094	8.2257
1-2	3	7.79216	0.09028	7.5840	8.0003
2-1	3	7.98535	0.09028	7.7772	8.1935
2-2	3	7.74923	0.09028	7.5410	7.9574

Std Error uses a pooled estimate of error variance

Exhibit A-3. Analysis of Variance of Analytical Block Effects for Measurements of the LRM Standard Glass (continued)

Oneway Analysis of measured By Blk/Sub-Blk ID=LRM, Oxide=Bi2O3 (wt%), targeted=0



Oneway Anova
Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	0.11148
Observations (or Sum Wgts)	12

Analysis of Variance

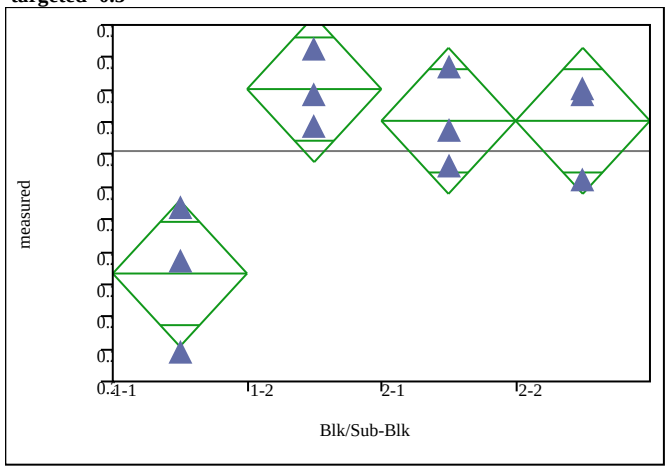
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	0.111480	0	0.11148	0.11148
1-2	3	0.111480	0	0.11148	0.11148
2-1	3	0.111480	0	0.11148	0.11148
2-2	3	0.111480	0	0.11148	0.11148

Std Error uses a pooled estimate of error variance

Oneway Analysis of measured By Blk/Sub-Blk ID=LRM, Oxide=CaO (wt%), targeted=0.5



Oneway Anova
Summary of Fit

Rsquare	0.720249
Adj Rsquare	0.615342
Root Mean Square Error	0.016926
Mean of Response	0.311089
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/Sub-Blk	3	0.00590069	0.001967	6.8656	0.0133*
Error	8	0.00229189	0.000286		
C. Total	11	0.00819258			

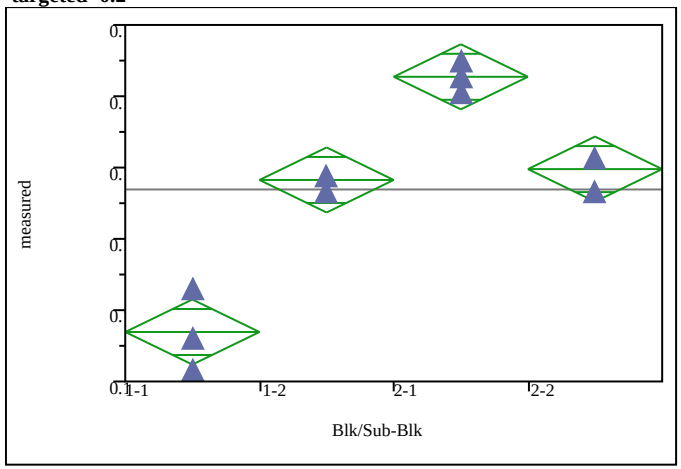
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	0.273310	0.00977	0.25078	0.29585
1-2	3	0.330211	0.00977	0.30768	0.35275
2-1	3	0.320417	0.00977	0.29788	0.34295
2-2	3	0.320417	0.00977	0.29788	0.34295

Std Error uses a pooled estimate of error variance

Exhibit A-3. Analysis of Variance of Analytical Block Effects for Measurements of the LRM Standard Glass (continued)

Oneway Analysis of measured By Blk/Sub-Blk ID=LRM, Oxide=CdO (wt%), targeted=0.2



Oneway Anova
Summary of Fit

Rsquare	0.95465
Adj Rsquare	0.937644
Root Mean Square Error	0.001713
Mean of Response	0.123464
Observations (or Sum Wgts)	12

Analysis of Variance

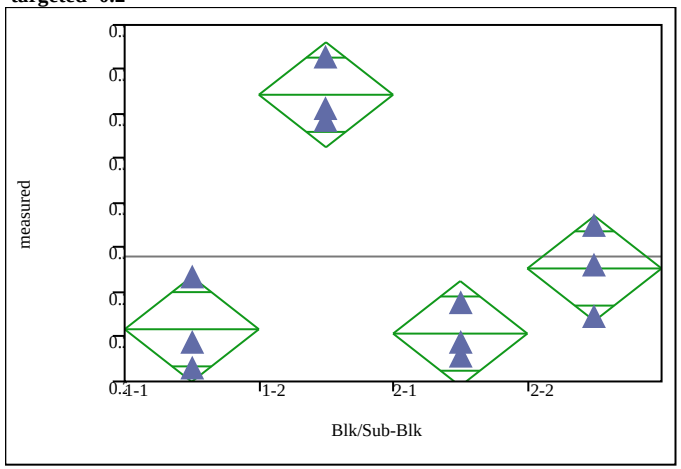
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/Sub-Blk	3	0.00049443	0.000165	56.1358	<.0001*
Error	8	0.00002349	2.936e-6		
C. Total	11	0.00051792			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	0.113468	0.00099	0.11119	0.11575
1-2	3	0.124130	0.00099	0.12185	0.12641
2-1	3	0.131365	0.00099	0.12908	0.13365
2-2	3	0.124891	0.00099	0.12261	0.12717

Std Error uses a pooled estimate of error variance

Oneway Analysis of measured By Blk/Sub-Blk ID=LRM, Oxide=Cr2O3 (wt%), targeted=0.2



Oneway Anova
Summary of Fit

Rsquare	0.900486
Adj Rsquare	0.863169
Root Mean Square Error	0.004425
Mean of Response	0.299019
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/Sub-Blk	3	0.00141760	0.000473	24.1303	0.0002*
Error	8	0.00015666	0.000020		
C. Total	11	0.00157426			

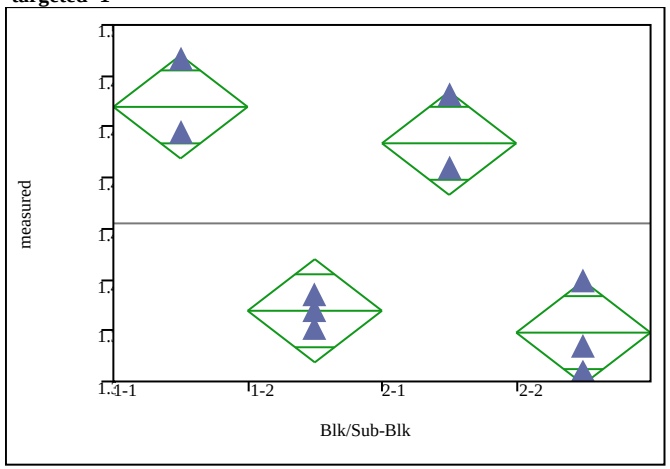
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	0.290858	0.00255	0.28497	0.29675
1-2	3	0.317167	0.00255	0.31128	0.32306
2-1	3	0.290371	0.00255	0.28448	0.29626
2-2	3	0.297679	0.00255	0.29179	0.30357

Std Error uses a pooled estimate of error variance

Exhibit A-3. Analysis of Variance of Analytical Block Effects for Measurements of the LRM Standard Glass (continued)

Oneway Analysis of measured By Blk/Sub-Blk ID=LRM, Oxide=Fe2O3 (wt%), targeted=1



Oneway Anova
Summary of Fit

Rsquare	0.908034
Adj Rsquare	0.873546
Root Mean Square Error	0.01522
Mean of Response	1.422075
Observations (or Sum Wgts)	12

Analysis of Variance

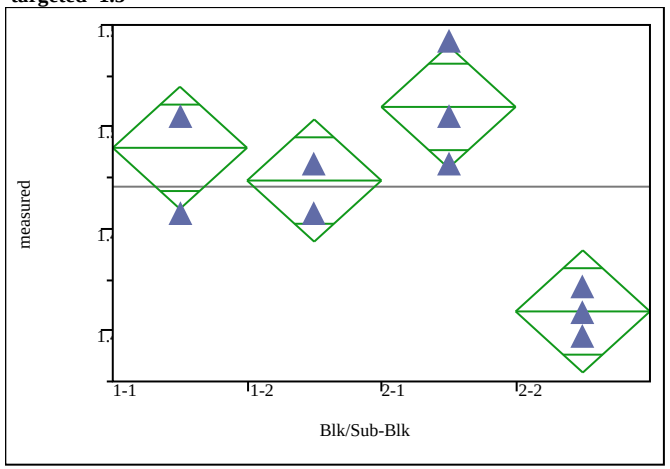
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/Sub-Blk	3	0.01829826	0.006099	26.3294	0.0002*
Error	8	0.00185326	0.000232		
C. Total	11	0.02015153			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	1.46783	0.00879	1.4476	1.4881
1-2	3	1.38776	0.00879	1.3675	1.4080
2-1	3	1.45353	0.00879	1.4333	1.4738
2-2	3	1.37918	0.00879	1.3589	1.3994

Std Error uses a pooled estimate of error variance

Oneway Analysis of measured By Blk/Sub-Blk ID=LRM, Oxide=K2O (wt%), targeted=1.5



Oneway Anova
Summary of Fit

Rsquare	0.806786
Adj Rsquare	0.73433
Root Mean Square Error	0.022536
Mean of Response	1.470616
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/Sub-Blk	3	0.01696532	0.005655	11.1349	0.0032*
Error	8	0.00406297	0.000508		
C. Total	11	0.02102829			

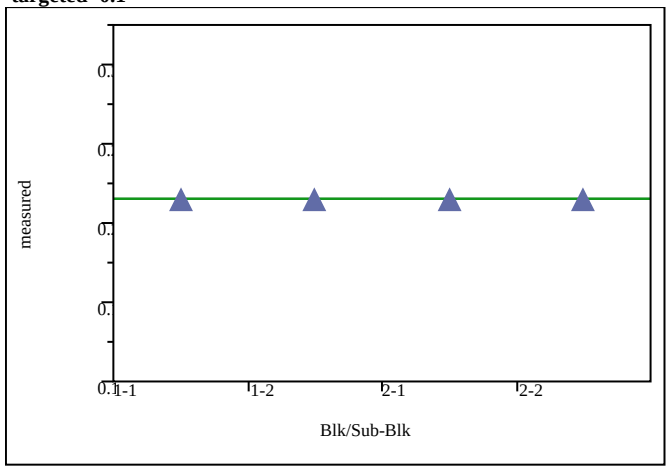
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	1.48969	0.01301	1.4597	1.5197
1-2	3	1.47363	0.01301	1.4436	1.5036
2-1	3	1.50977	0.01301	1.4798	1.5398
2-2	3	1.40938	0.01301	1.3794	1.4394

Std Error uses a pooled estimate of error variance

Exhibit A-3. Analysis of Variance of Analytical Block Effects for Measurements of the LRM Standard Glass (continued)

Oneway Analysis of measured By Blk/Sub-Blk ID=LRM, Oxide=Li2O (wt%), targeted=0.1



Oneway Anova
Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	0.21529
Observations (or Sum Wgts)	12

Analysis of Variance

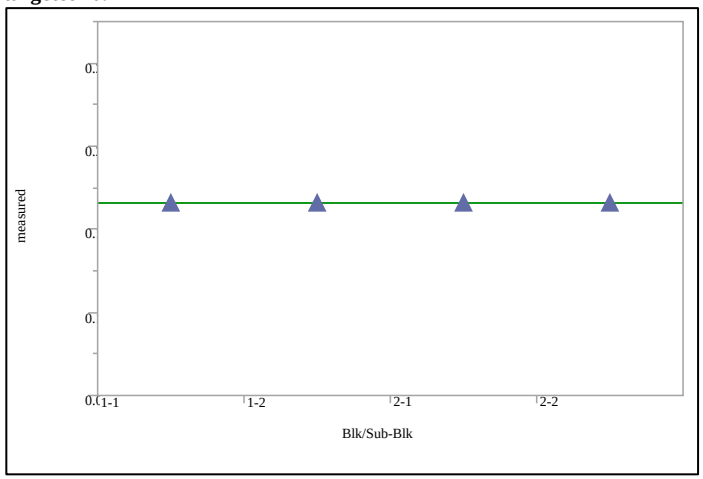
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	0.215290	0	0.21529	0.21529
1-2	3	0.215290	0	0.21529	0.21529
2-1	3	0.215290	0	0.21529	0.21529
2-2	3	0.215290	0	0.21529	0.21529

Std Error uses a pooled estimate of error variance

Oneway Analysis of measured By Blk/Sub-Blk ID=LRM, Oxide=MgO (wt%), targeted=0.1



Oneway Anova
Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	0.16583
Observations (or Sum Wgts)	12

Analysis of Variance

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

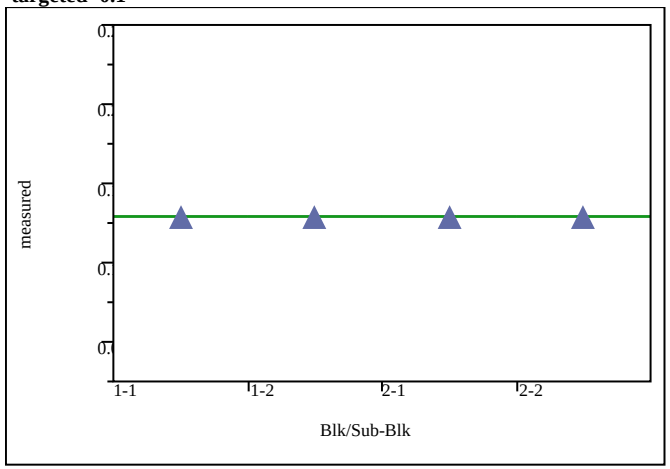
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	0.165830	0	0.16583	0.16583
1-2	3	0.165830	0	0.16583	0.16583
2-1	3	0.165830	0	0.16583	0.16583
2-2	3	0.165830	0	0.16583	0.16583

Std Error uses a pooled estimate of error variance

Exhibit A-3. Analysis of Variance of Analytical Block Effects for Measurements of the LRM Standard Glass (continued)

Oneway Analysis of measured By Blk/Sub-Blk ID=LRM, Oxide=MnO (wt%), targeted=0.1



Oneway Anova
Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	0.12912
Observations (or Sum Wgts)	12

Analysis of Variance

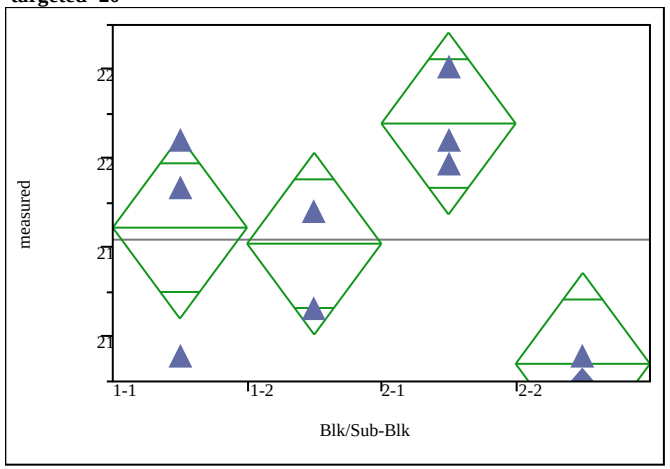
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	0.129120	0	0.12912	0.12912
1-2	3	0.129120	0	0.12912	0.12912
2-1	3	0.129120	0	0.12912	0.12912
2-2	3	0.129120	0	0.12912	0.12912

Std Error uses a pooled estimate of error variance

Oneway Analysis of measured By Blk/Sub-Blk ID=LRM, Oxide=Na2O (wt%), targeted=20



Oneway Anova
Summary of Fit

Rsquare	0.700155
Adj Rsquare	0.587713
Root Mean Square Error	0.383253
Mean of Response	21.54553
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/Sub-Blk	3	2.7438270	0.914609	6.2268	0.0173*
Error	8	1.1750606	0.146883		
C. Total	11	3.9188876			

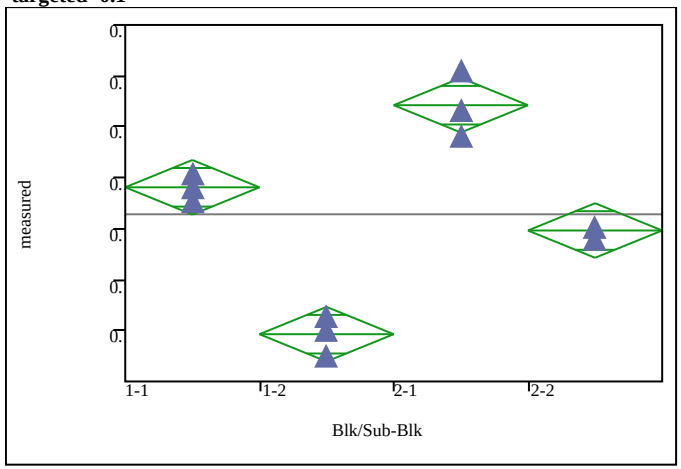
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	21.6129	0.22127	21.103	22.123
1-2	3	21.5231	0.22127	21.013	22.033
2-1	3	22.1971	0.22127	21.687	22.707
2-2	3	20.8491	0.22127	20.339	21.359

Std Error uses a pooled estimate of error variance

Exhibit A-3. Analysis of Variance of Analytical Block Effects for Measurements of the LRM Standard Glass (continued)

Oneway Analysis of measured By Blk/Sub-Blk ID=LRM, Oxide=NiO (wt%), targeted=0.1



Oneway Anova
Summary of Fit

Rsquare	0.960546
Adj Rsquare	0.94575
Root Mean Square Error	0.002012
Mean of Response	0.156411
Observations (or Sum Wgts)	12

Analysis of Variance

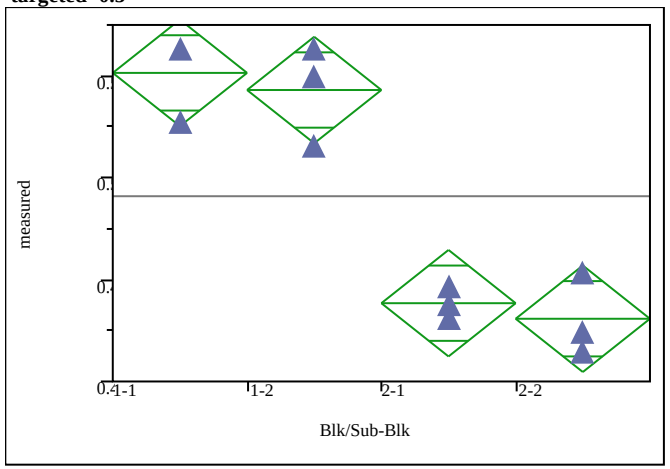
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/Sub-Blk	3	0.00078844	0.000263	64.9222	<.0001*
Error	8	0.00003239	4.048e-6		
C. Total	11	0.00082083			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	0.159063	0.00116	0.15638	0.16174
1-2	3	0.144641	0.00116	0.14196	0.14732
2-1	3	0.167122	0.00116	0.16444	0.16980
2-2	3	0.154821	0.00116	0.15214	0.15750

Std Error uses a pooled estimate of error variance

Oneway Analysis of measured By Blk/Sub-Blk ID=LRM, Oxide=P2O5 (wt%), targeted=0.5



Oneway Anova
Summary of Fit

Rsquare	0.92543
Adj Rsquare	0.897466
Root Mean Square Error	0.019634
Mean of Response	0.490932
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/Sub-Blk	3	0.03827056	0.012757	33.0938	<.0001*
Error	8	0.00308380	0.000385		
C. Total	11	0.04135436			

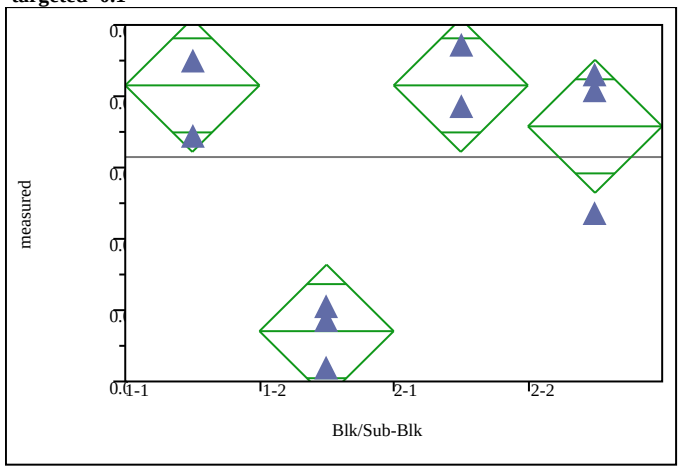
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	0.551464	0.01134	0.52532	0.57760
1-2	3	0.543062	0.01134	0.51692	0.56920
2-1	3	0.438421	0.01134	0.41228	0.46456
2-2	3	0.430783	0.01134	0.40464	0.45692

Std Error uses a pooled estimate of error variance

Exhibit A-3. Analysis of Variance of Analytical Block Effects for Measurements of the LRM Standard Glass (continued)

Oneway Analysis of measured By Blk/Sub-Blk ID=LRM, Oxide=PbO (wt%), targeted=0.1



Oneway Anova
Summary of Fit

Rsquare	0.861806
Adj Rsquare	0.809984
Root Mean Square Error	0.003504
Mean of Response	0.070736
Observations (or Sum Wgts)	12

Analysis of Variance

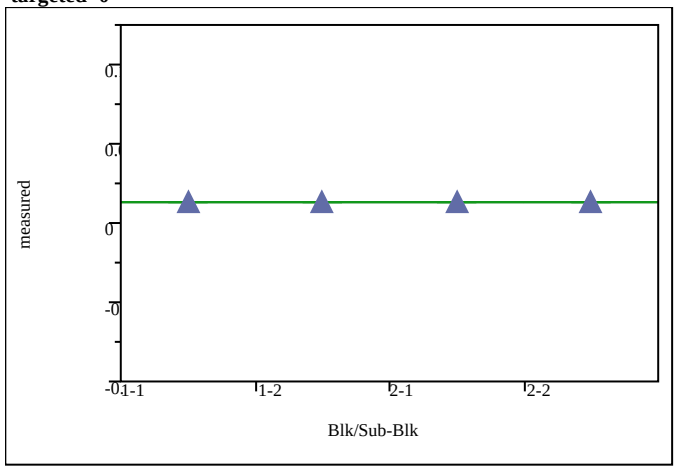
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/Sub-Blk	3	0.00061267	0.000204	16.6299	0.0008*
Error	8	0.00009824	0.000012		
C. Total	11	0.00071091			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	0.075763	0.00202	0.07110	0.08043
1-2	3	0.058528	0.00202	0.05386	0.06319
2-1	3	0.075763	0.00202	0.07110	0.08043
2-2	3	0.072891	0.00202	0.06822	0.07756

Std Error uses a pooled estimate of error variance

Oneway Analysis of measured By Blk/Sub-Blk ID=LRM, Oxide=RuO2 (wt%), targeted=0



Oneway Anova
Summary of Fit

Rsquare	0
Adj Rsquare	-0.375
Root Mean Square Error	2.12e-18
Mean of Response	0.013166
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/Sub-Blk	3	0	0	0.0000	1.0000
Error	8	3.6111e-35	4.514e-36		
C. Total	11	3.6111e-35			

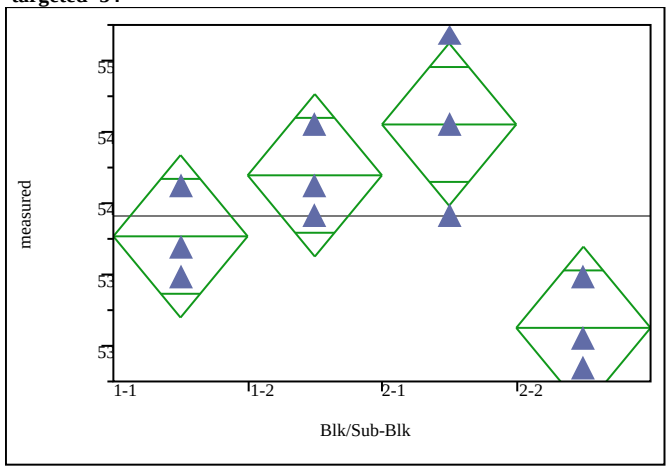
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	0.013166	1.227e-18	0.01317	0.01317
1-2	3	0.013166	1.227e-18	0.01317	0.01317
2-1	3	0.013166	1.227e-18	0.01317	0.01317
2-2	3	0.013166	1.227e-18	0.01317	0.01317

Std Error uses a pooled estimate of error variance

Exhibit A-3. Analysis of Variance of Analytical Block Effects for Measurements of the LRM Standard Glass (continued)

Oneway Analysis of measured By Blk/Sub-Blk ID=LRM, Oxide=SiO2 (wt%), targeted=54



Oneway Anova
Summary of Fit

Rsquare	0.698113
Adj Rsquare	0.584906
Root Mean Square Error	0.42786
Mean of Response	53.91036
Observations (or Sum Wgts)	12

Analysis of Variance

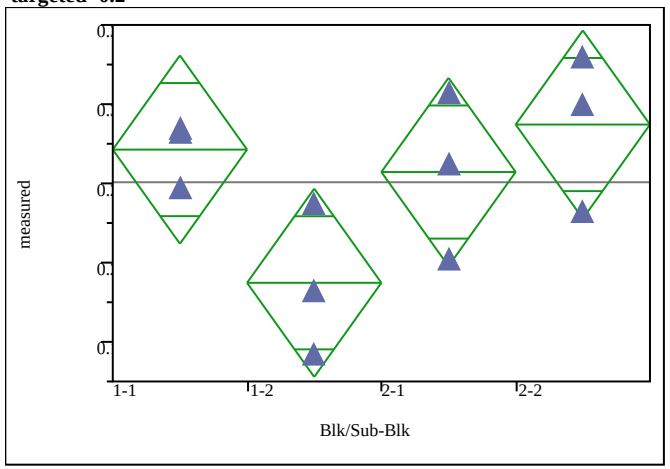
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/Sub-Blk	3	3.3866873	1.12890	6.1667	0.0178*
Error	8	1.4645134	0.18306		
C. Total	11	4.8512008			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	53.7677	0.24703	53.198	54.337
1-2	3	54.1956	0.24703	53.626	54.765
2-1	3	54.5522	0.24703	53.983	55.122
2-2	3	53.1260	0.24703	52.556	53.696

Std Error uses a pooled estimate of error variance

Oneway Analysis of measured By Blk/Sub-Blk ID=LRM, Oxide=SO3 (wt%), targeted=0.2



Oneway Anova
Summary of Fit

Rsquare	0.522931
Adj Rsquare	0.34403
Root Mean Square Error	0.044619
Mean of Response	0.25073
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/Sub-Blk	3	0.01745819	0.005819	2.9230	0.1001
Error	8	0.01592709	0.001991		
C. Total	11	0.03338528			

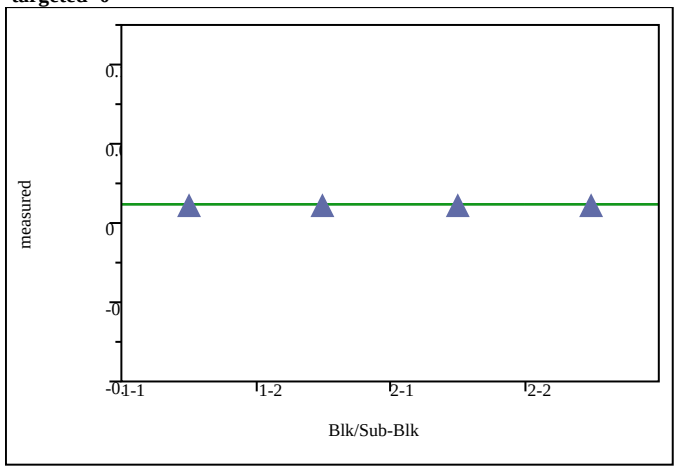
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	0.271330	0.02576	0.21192	0.33073
1-2	3	0.187268	0.02576	0.12786	0.24667
2-1	3	0.257181	0.02576	0.19778	0.31659
2-2	3	0.287144	0.02576	0.22774	0.34655

Std Error uses a pooled estimate of error variance

Exhibit A-3. Analysis of Variance of Analytical Block Effects for Measurements of the LRM Standard Glass (continued)

Oneway Analysis of measured By Blk/Sub-Blk ID=LRM, Oxide=SrO (wt%), targeted=0



Oneway Anova
Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	0.011826
Observations (or Sum Wgts)	12

Analysis of Variance

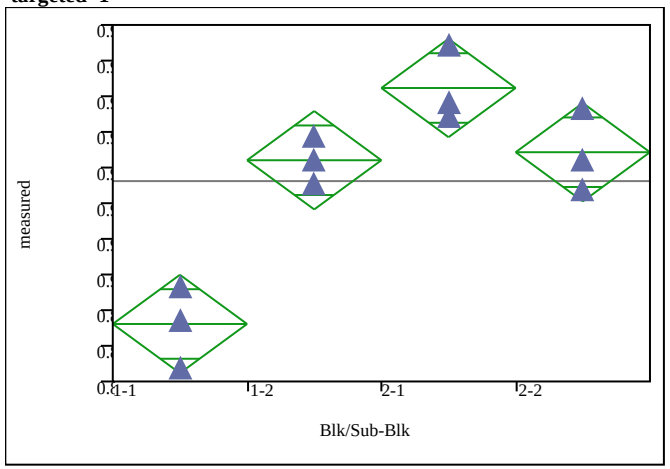
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	0.011826	0	0.01183	0.01183
1-2	3	0.011826	0	0.01183	0.01183
2-1	3	0.011826	0	0.01183	0.01183
2-2	3	0.011826	0	0.01183	0.01183

Std Error uses a pooled estimate of error variance

Oneway Analysis of measured By Blk/Sub-Blk ID=LRM, Oxide=ZrO2 (wt%), targeted=1



Oneway Anova
Summary of Fit

Rsquare	0.892949
Adj Rsquare	0.852805
Root Mean Square Error	0.010361
Mean of Response	0.926199
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/Sub-Blk	3	0.00716362	0.002388	22.2436	0.0003*
Error	8	0.00085881	0.000107		
C. Total	11	0.00802242			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1	3	0.886125	0.00598	0.87233	0.89992
1-2	3	0.932052	0.00598	0.91826	0.94585
2-1	3	0.952314	0.00598	0.93852	0.96611
2-2	3	0.934303	0.00598	0.92051	0.94810

Std Error uses a pooled estimate of error variance

Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide.

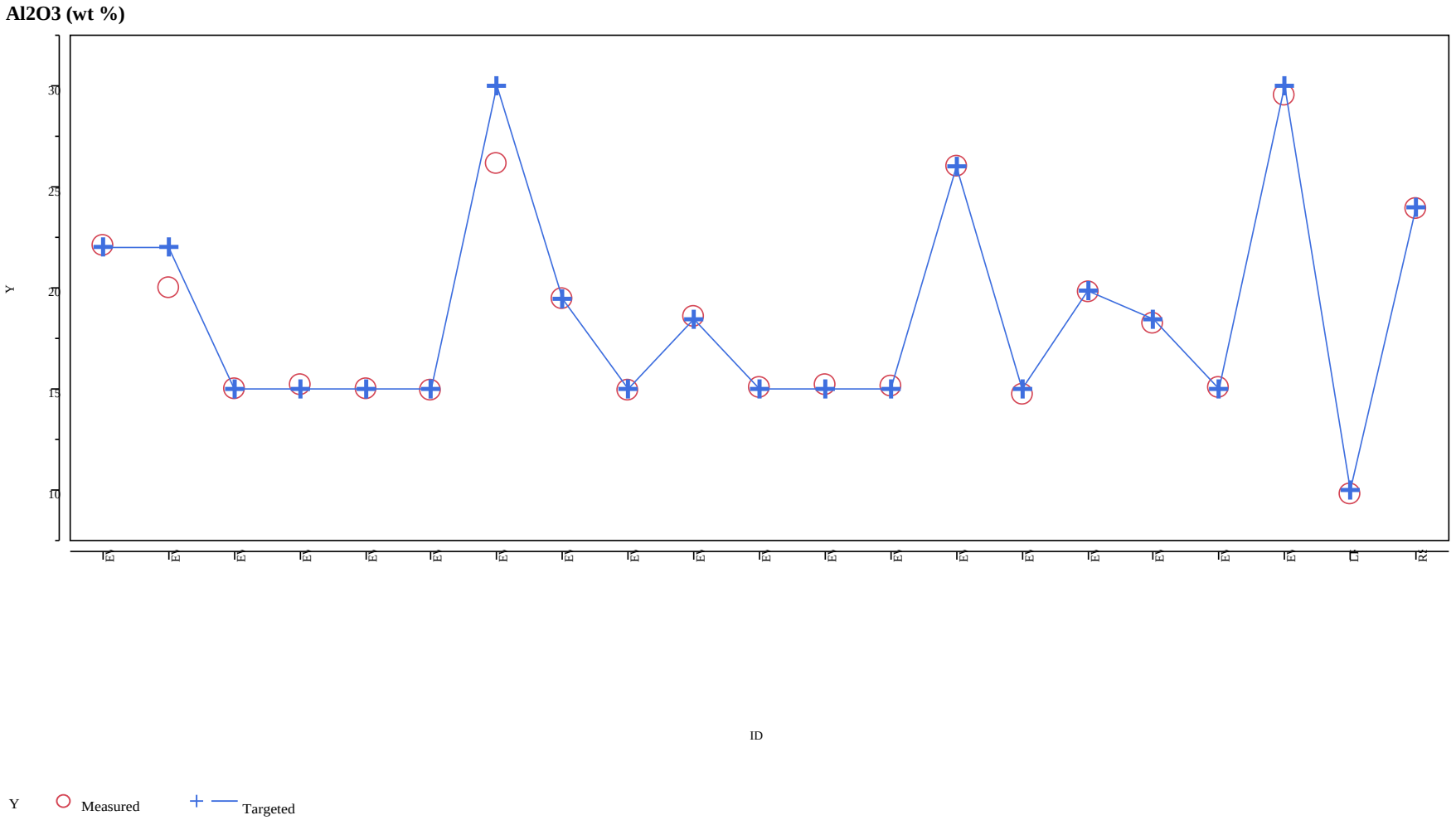


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide. (continued)

B2O3 (wt %)

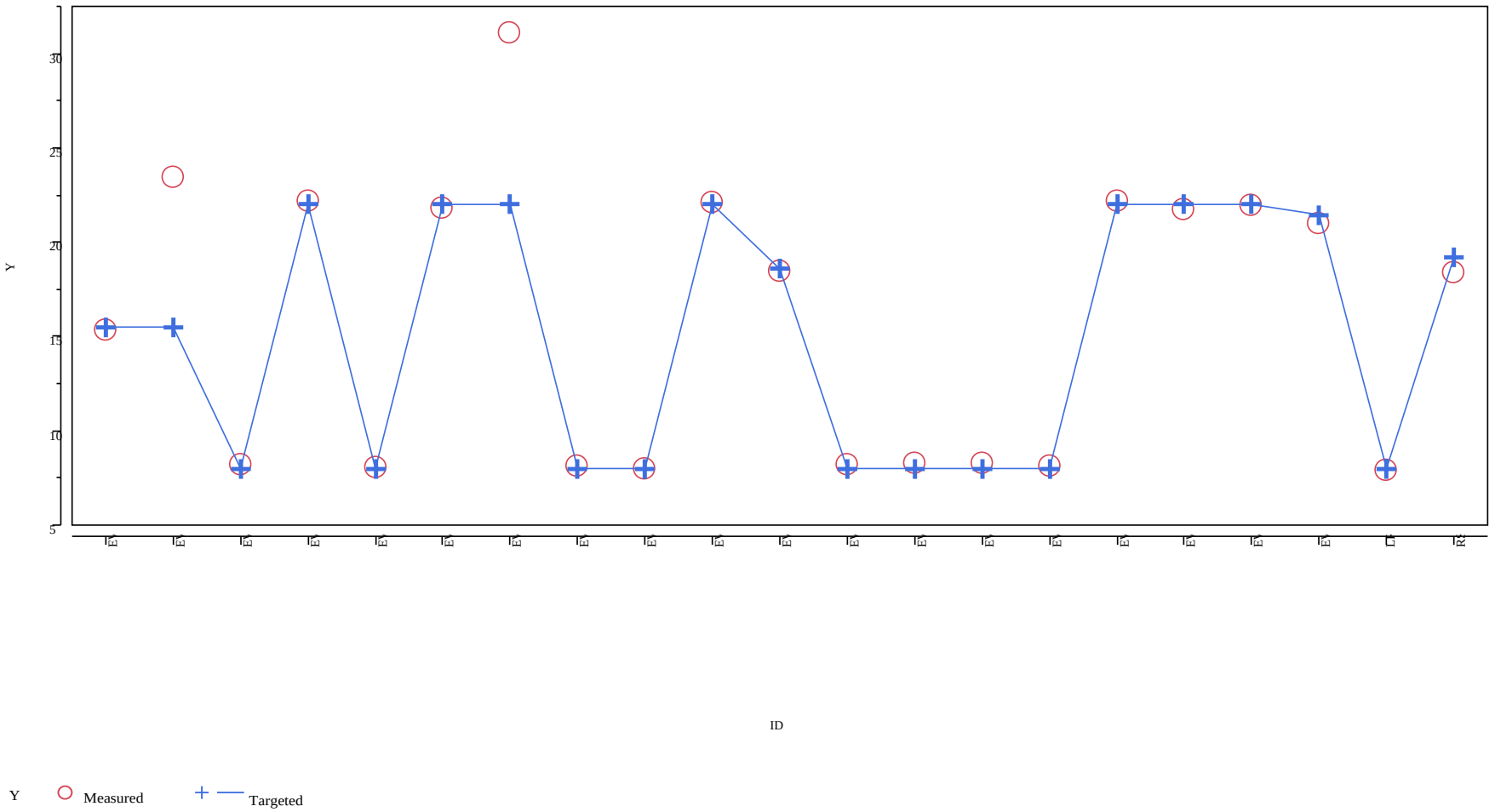


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide. (continued)

Bi2O3 (wt %)

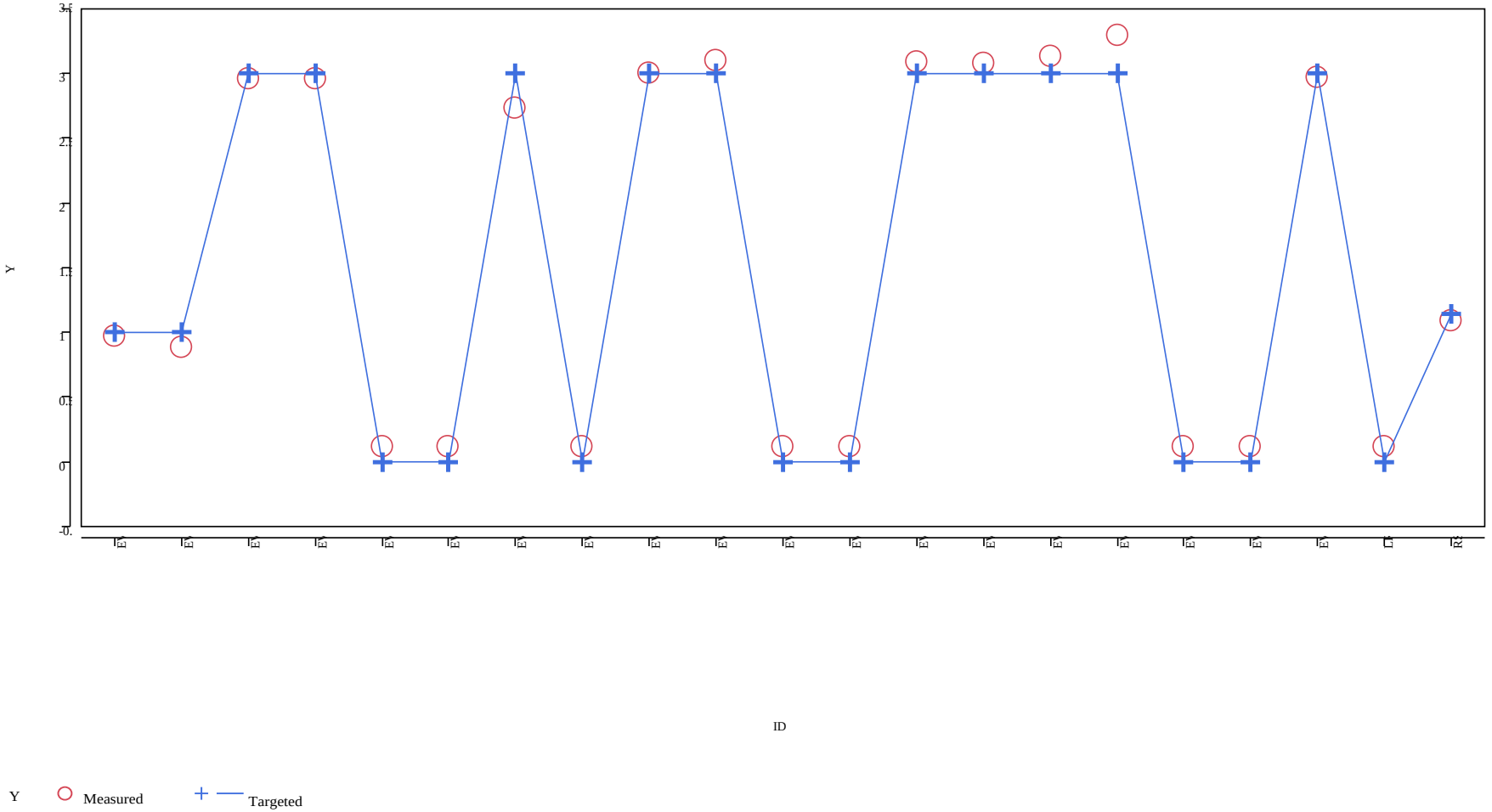


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide. (continued)

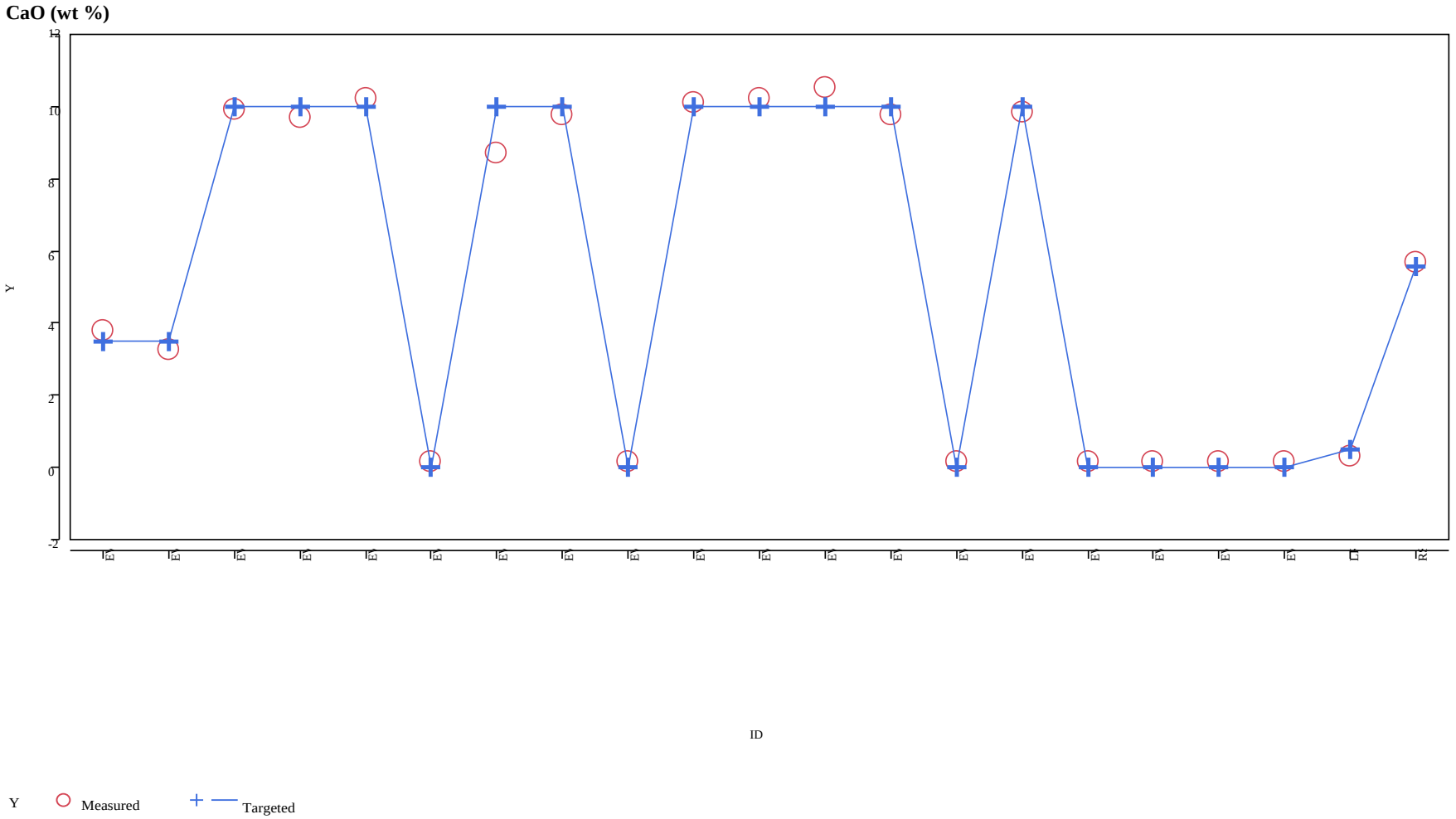


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide. (continued)

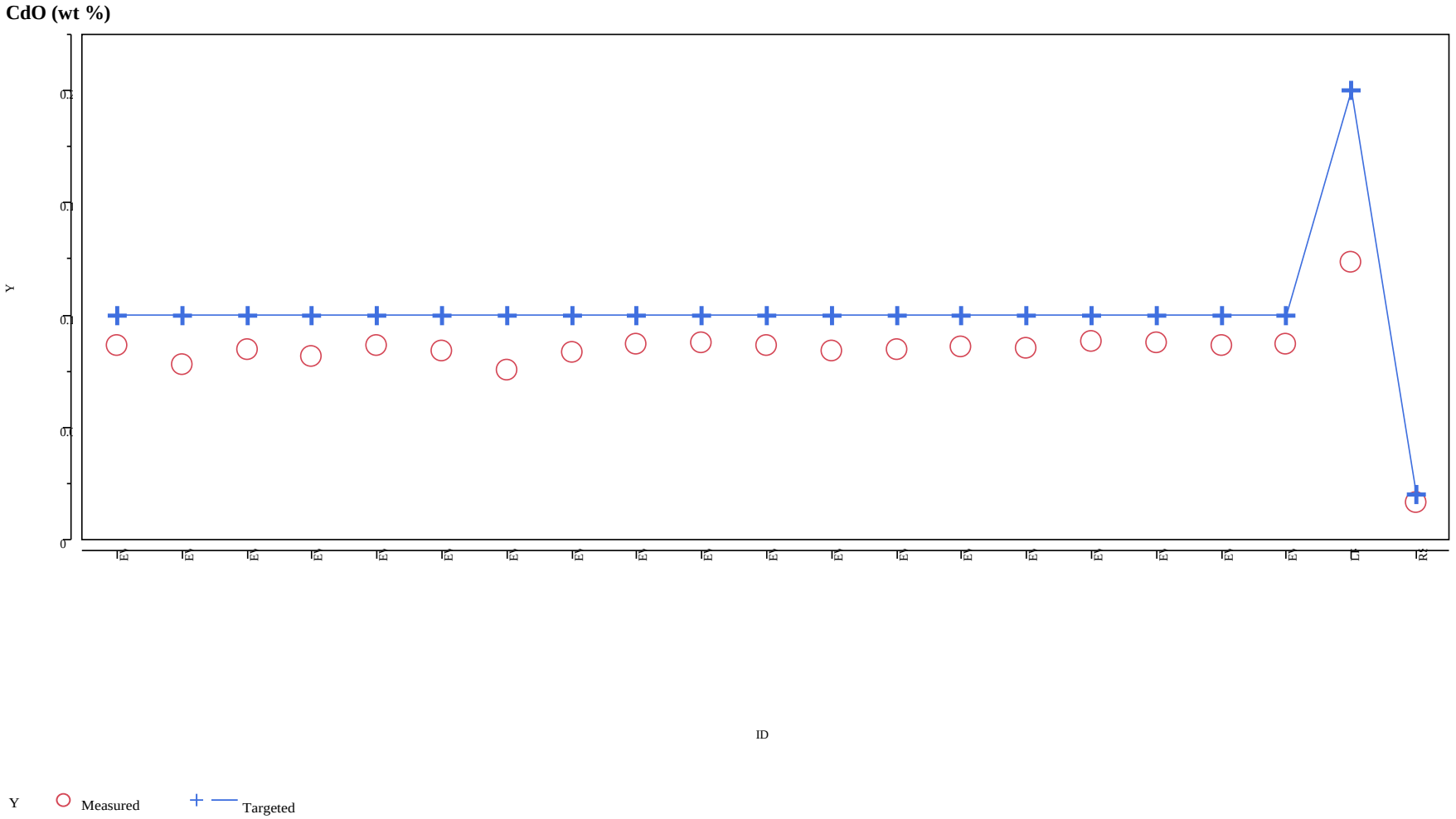


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide. (continued)

Cr2O3 (wt %)

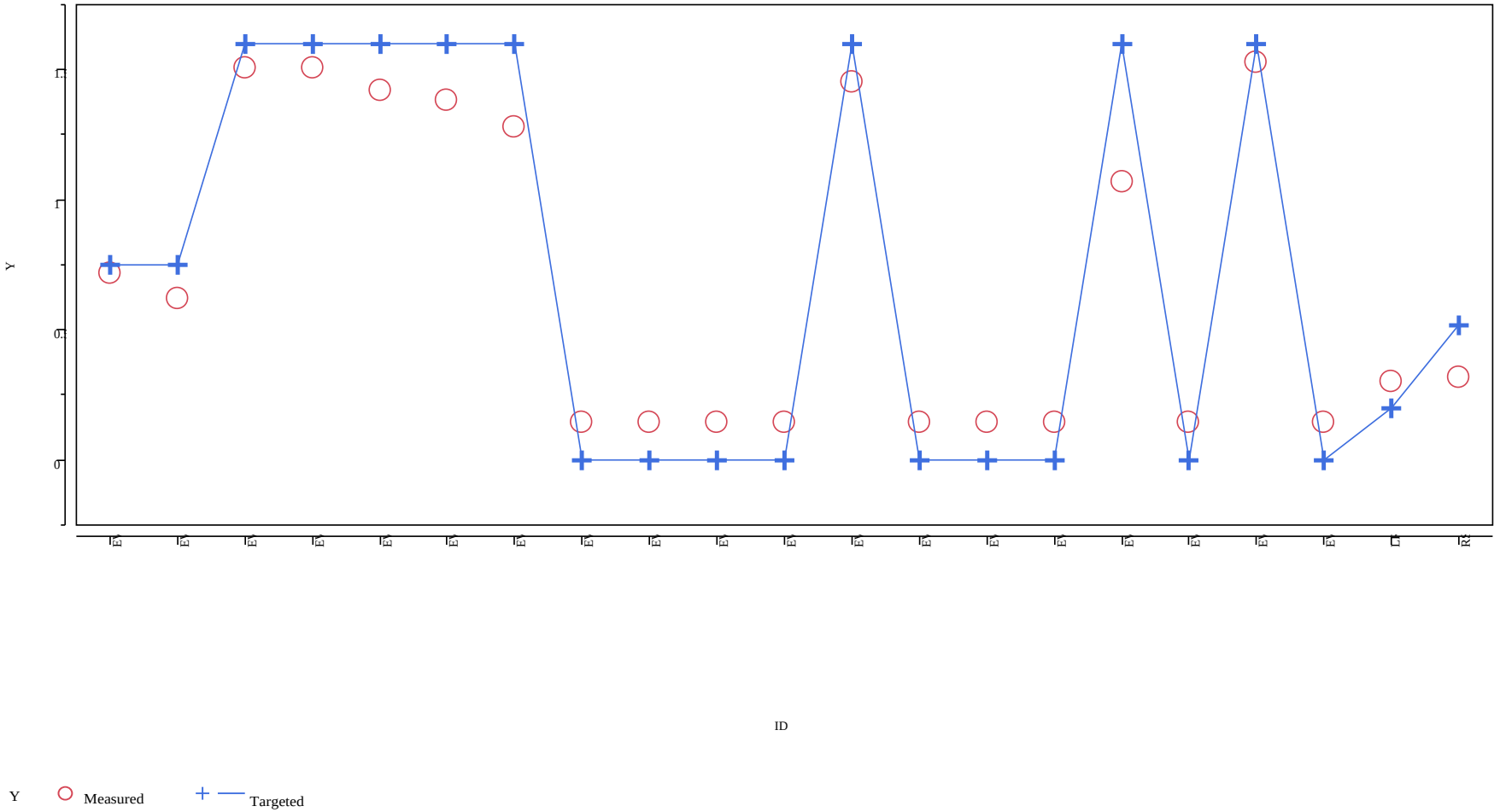


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide. (continued)

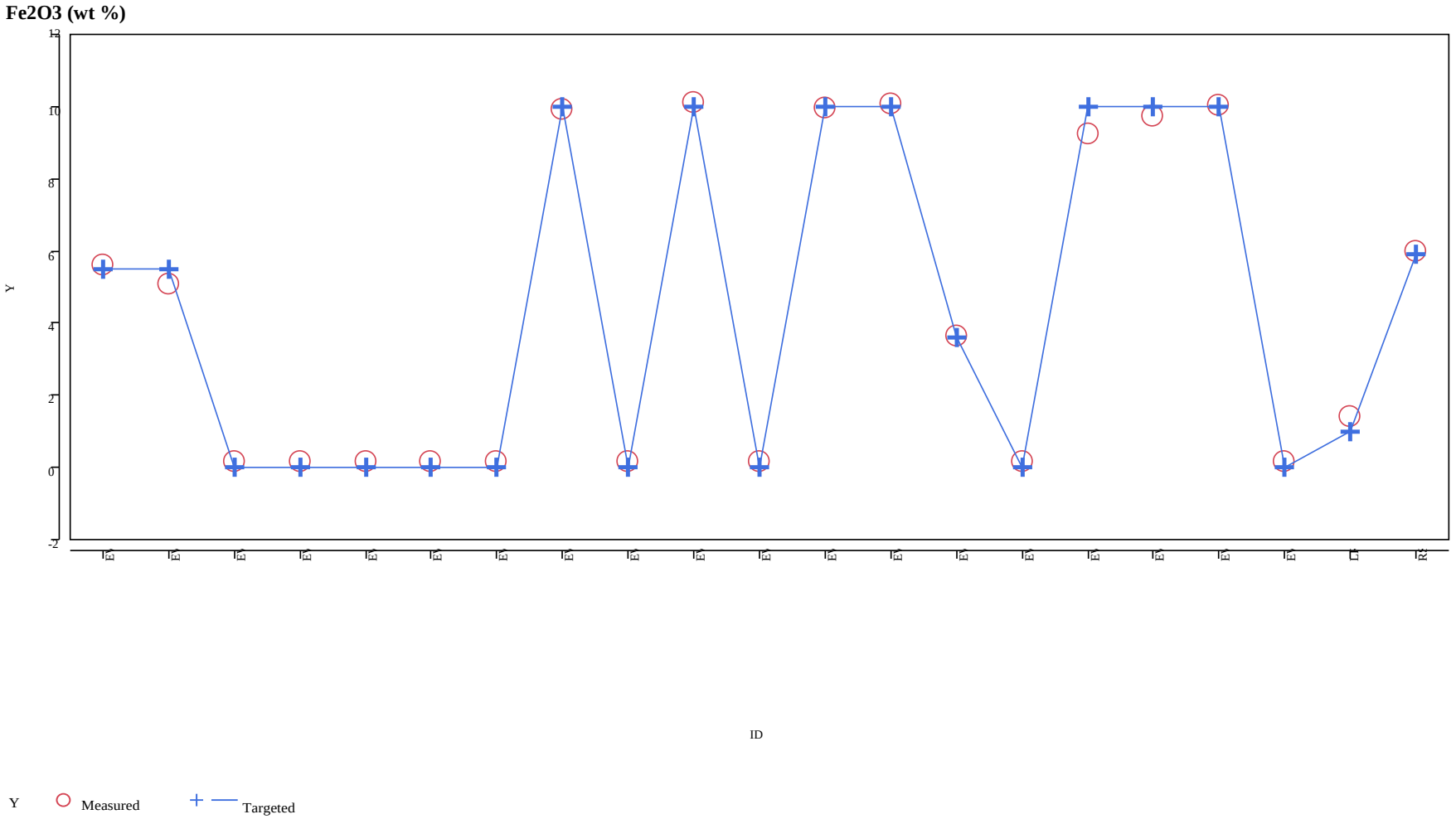


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide. (continued)

K2O (wt %)

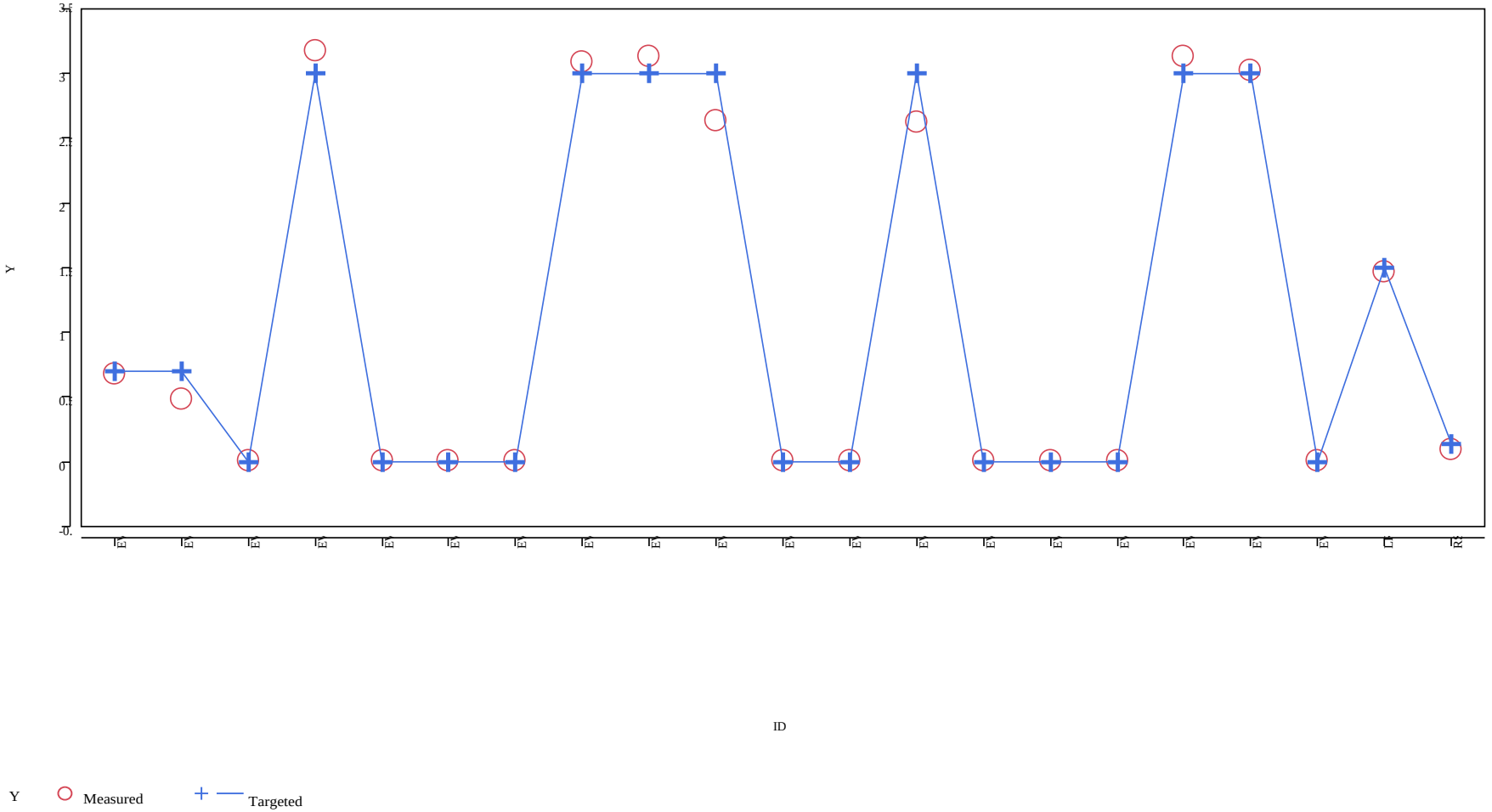


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide. (continued)

Li2O (wt %)

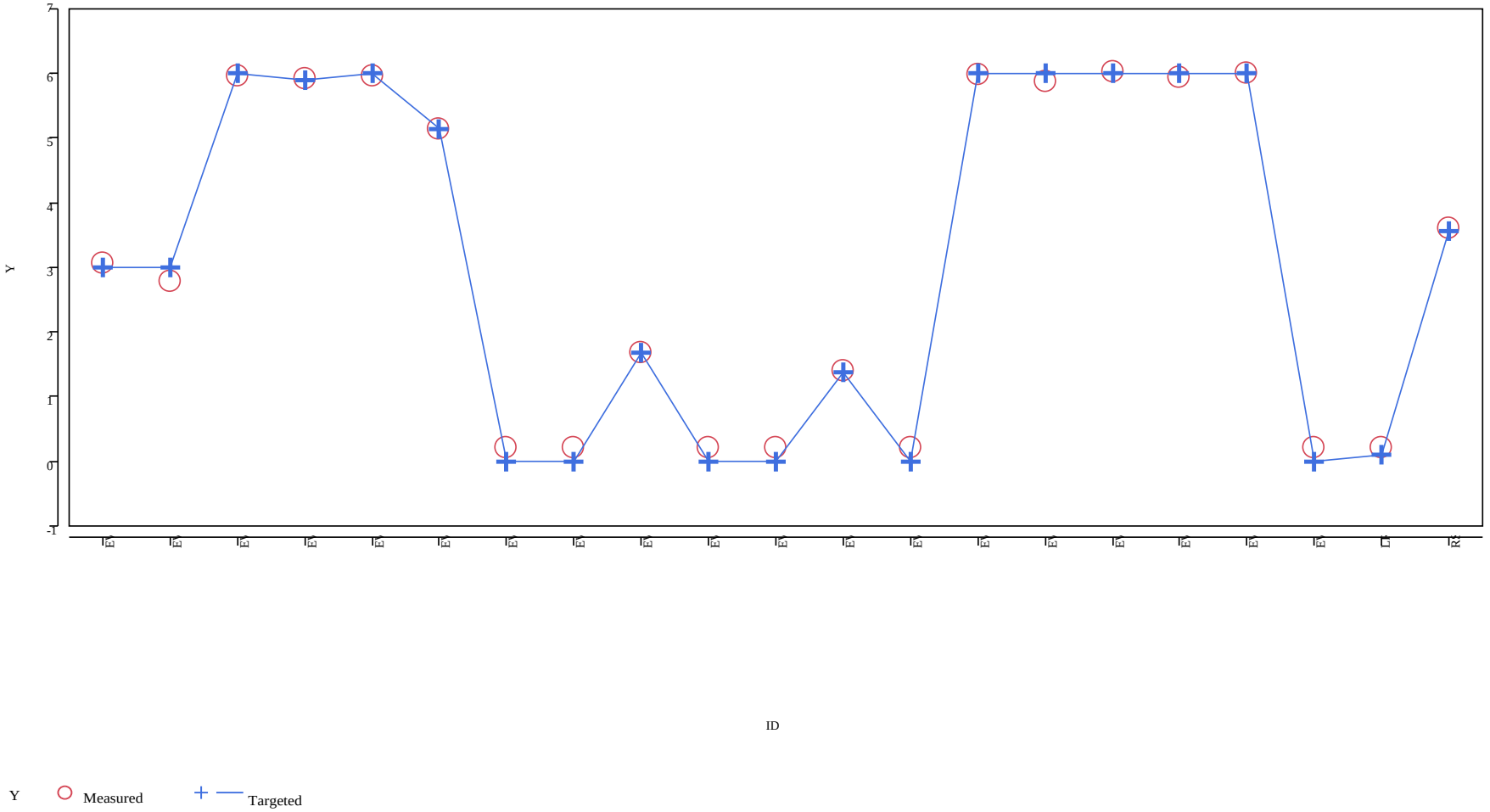


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide. (continued)

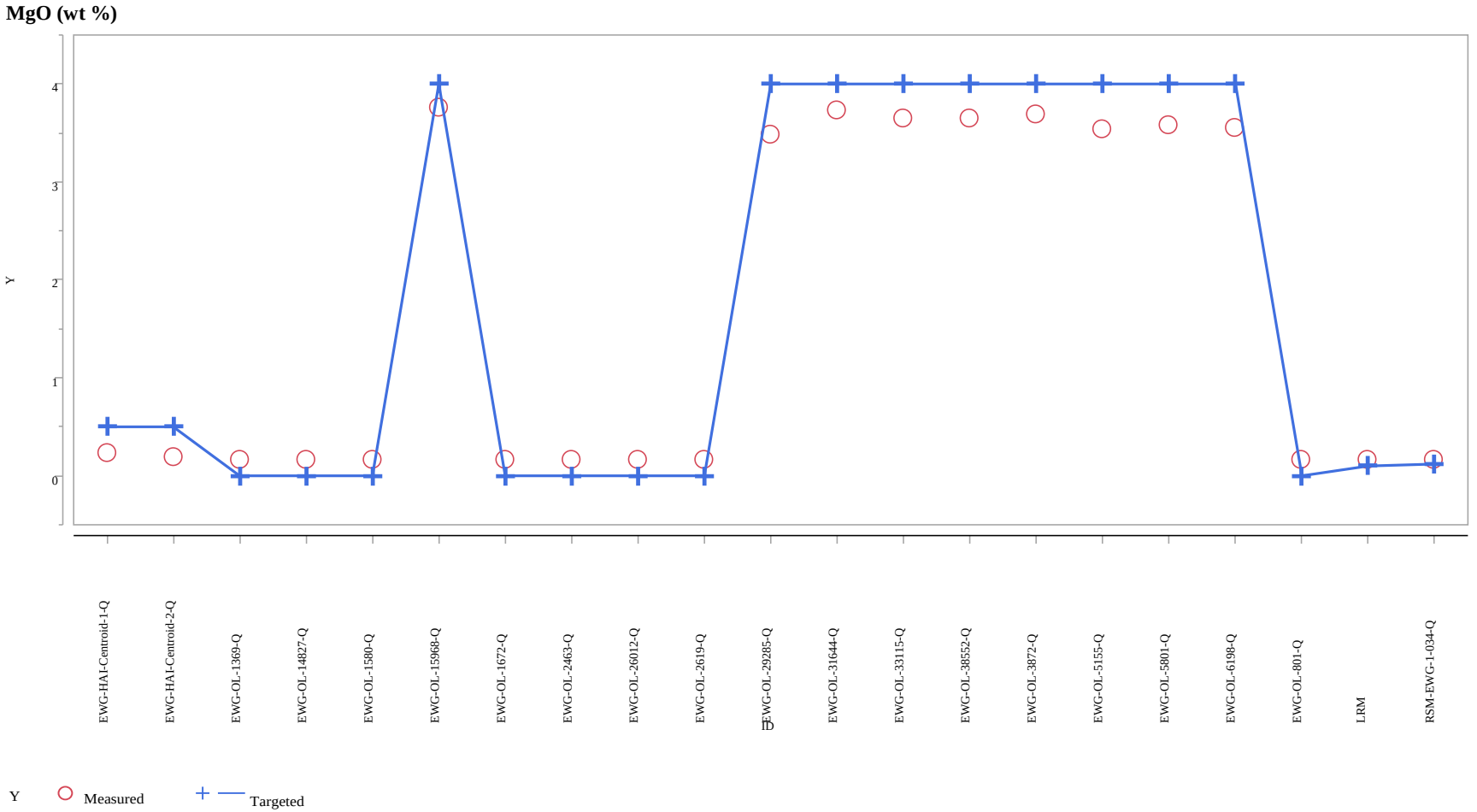


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide. (continued)

MnO (wt %)

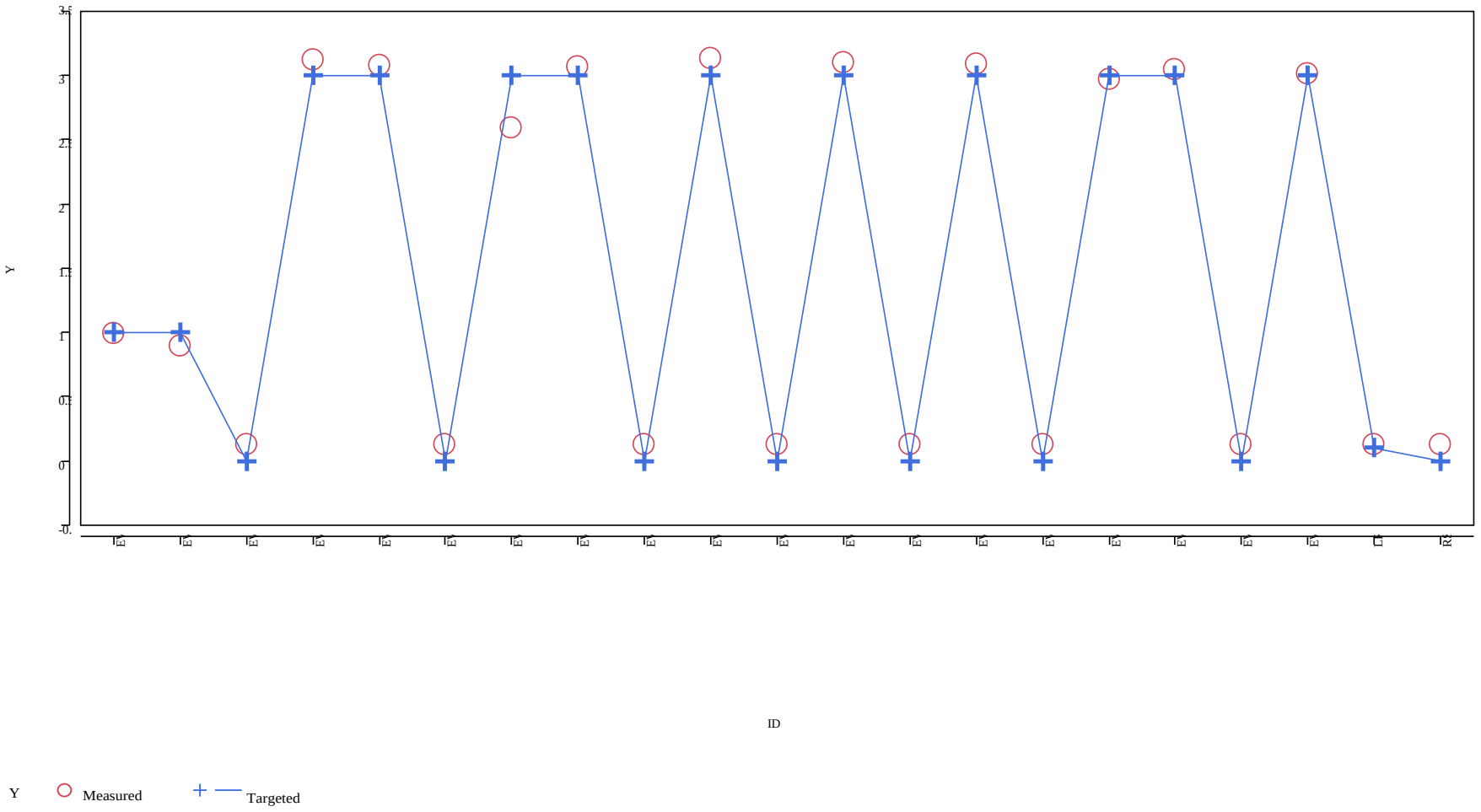


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide. (continued)

Na2O (wt %)

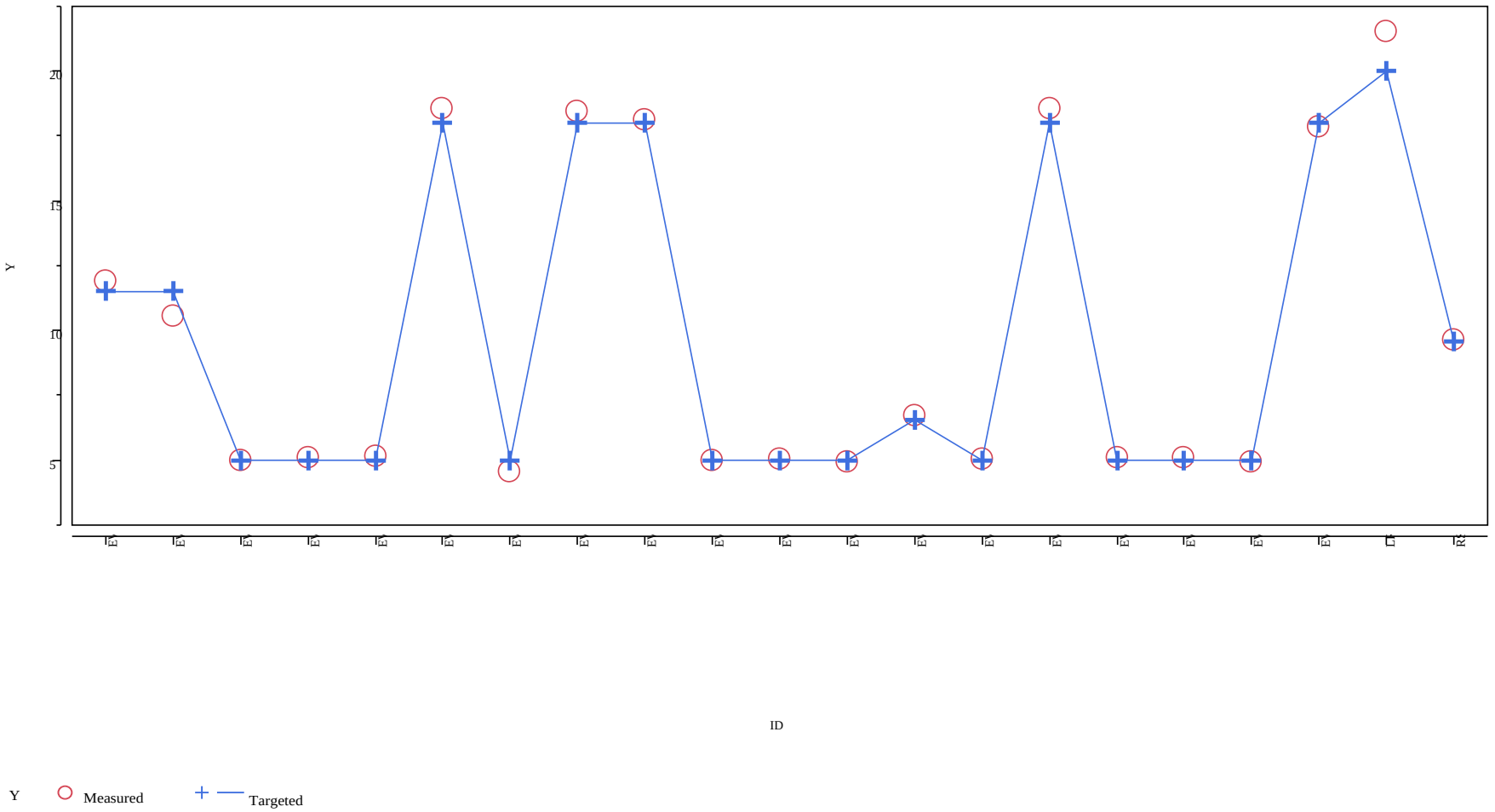


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide. (continued)

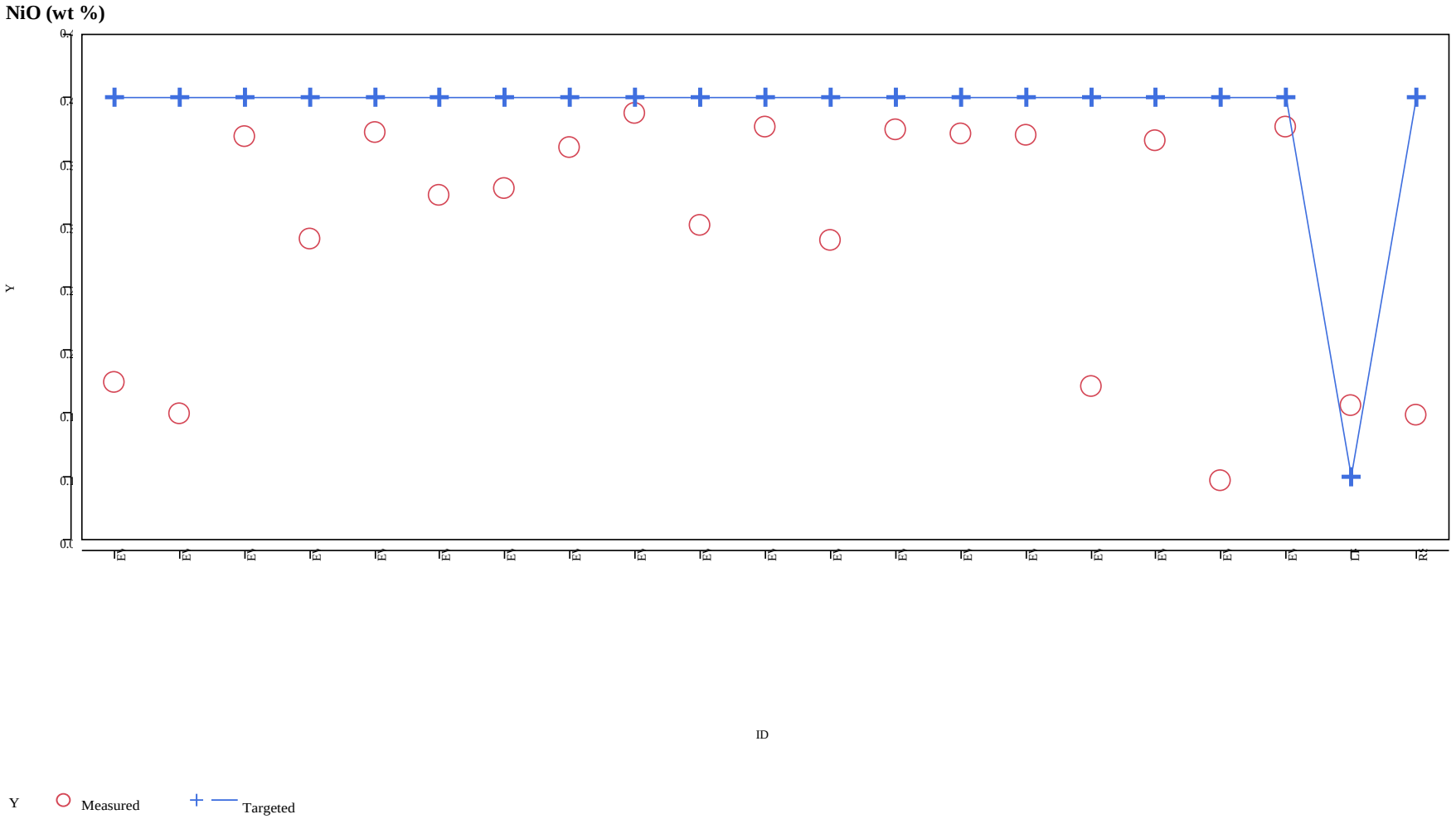


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide. (continued)

P2O5 (wt %)

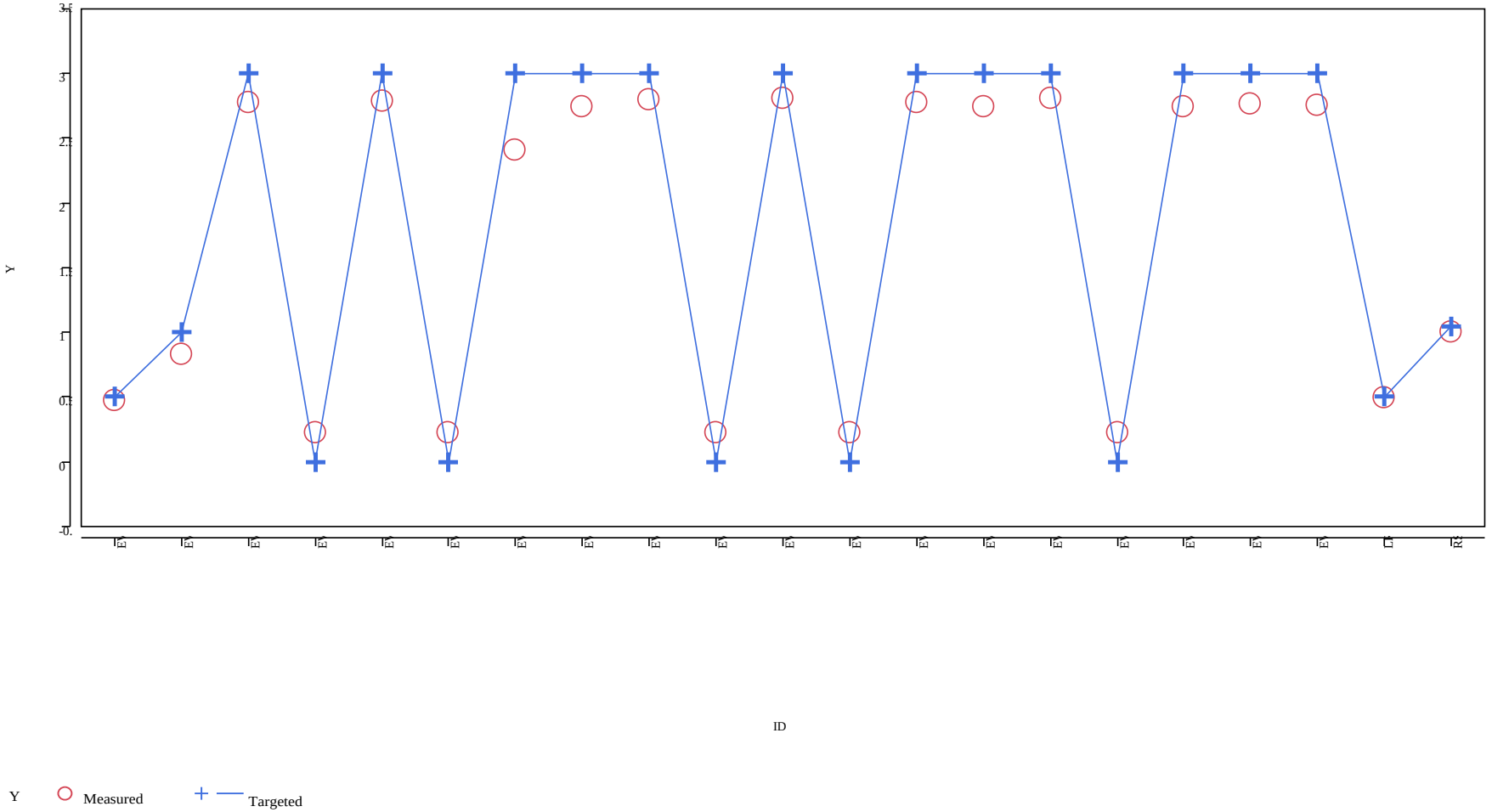


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide. (continued)

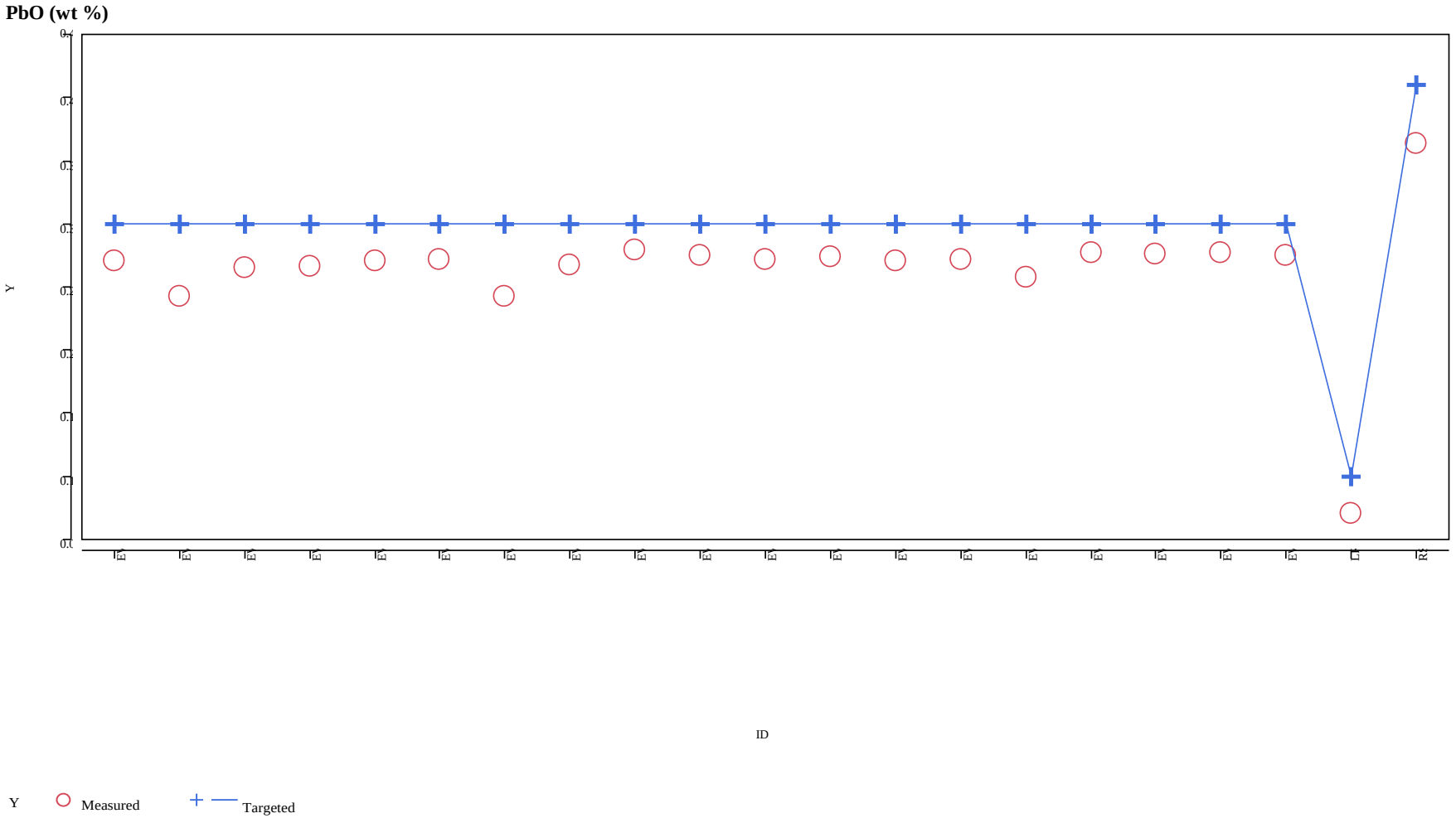


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide. (continued)

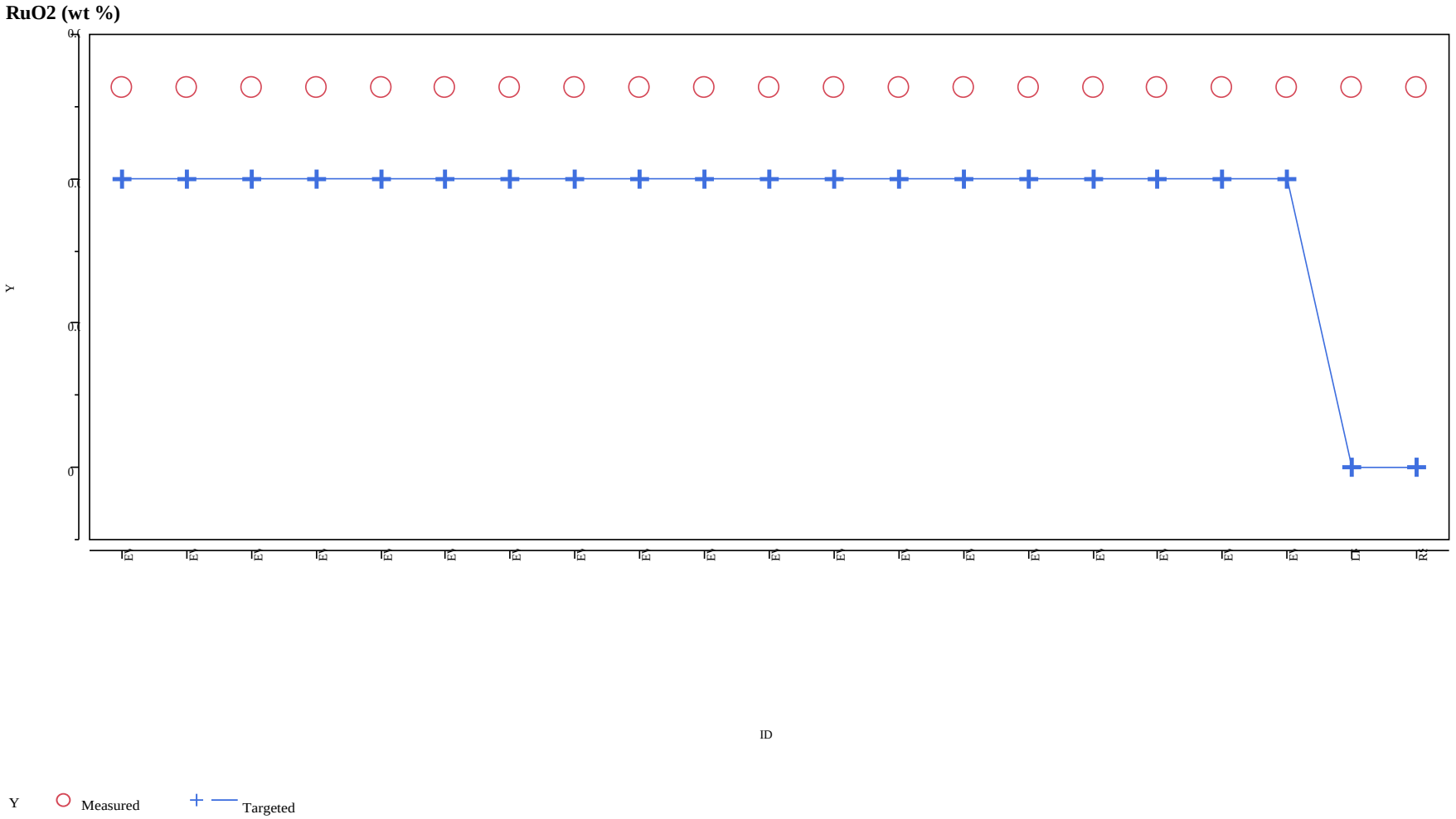


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide. (continued)

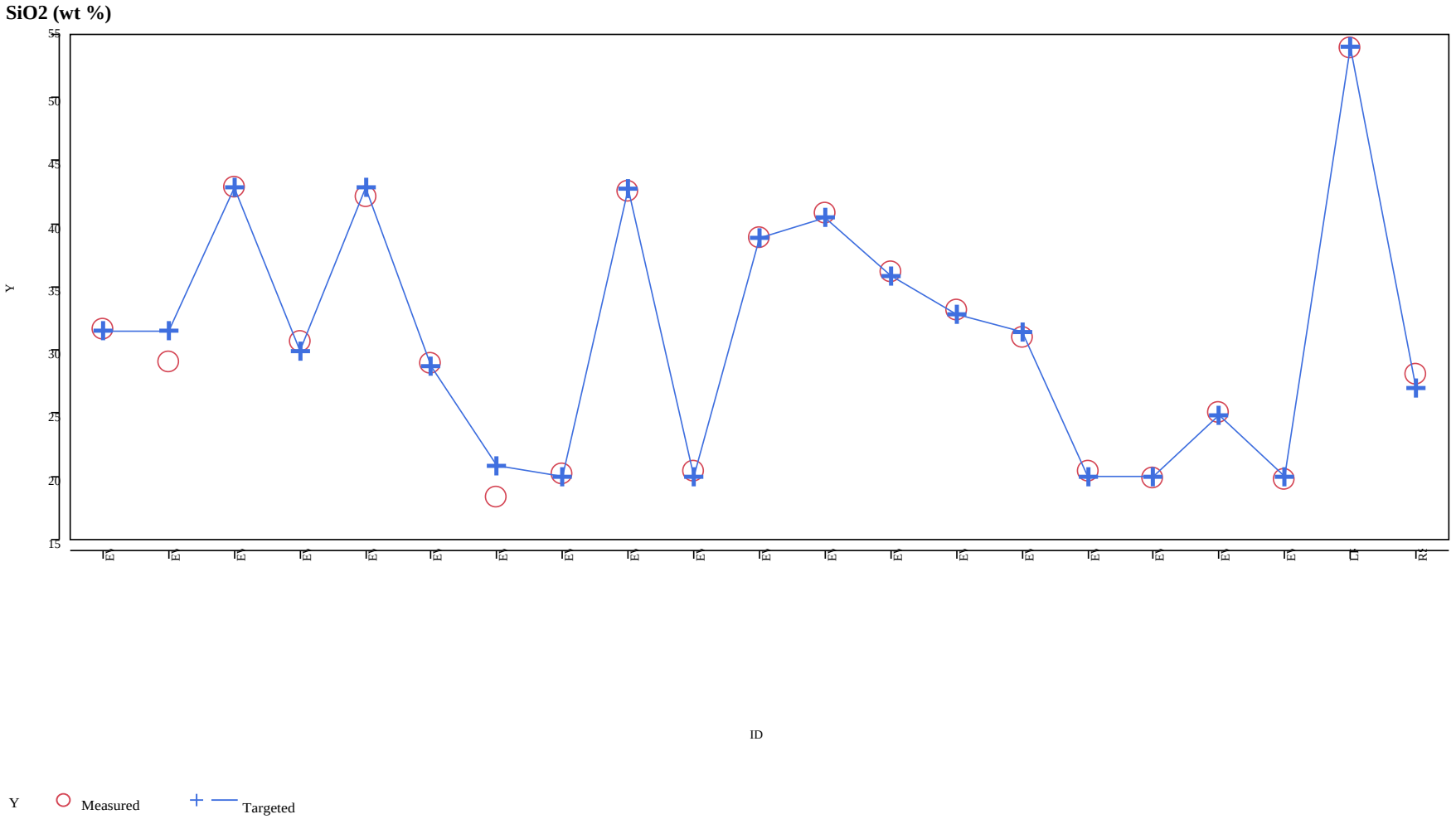


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide. (continued)

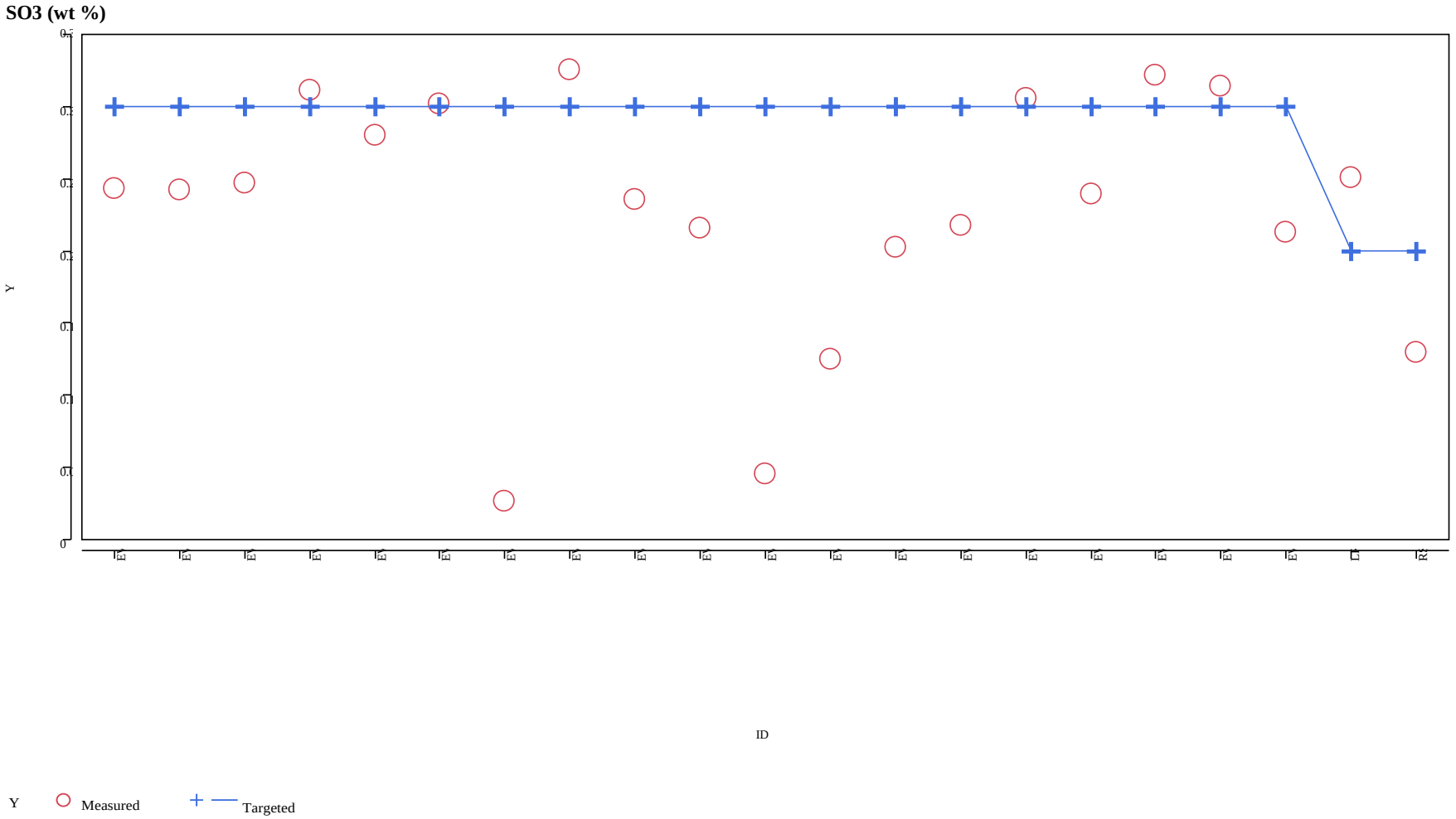


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide. (continued)

SrO (wt %)

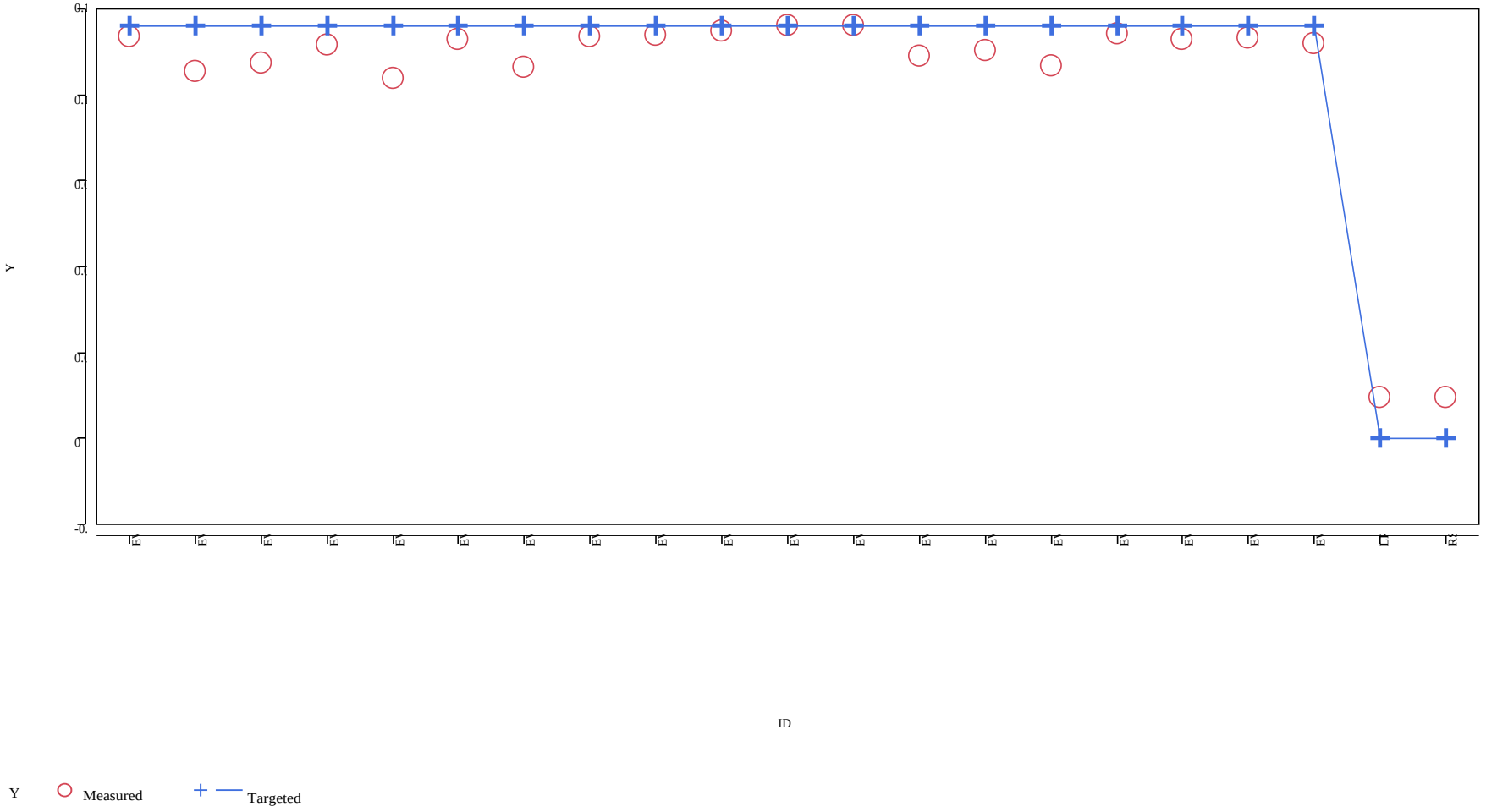


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide. (continued)

ZrO2 (wt %)

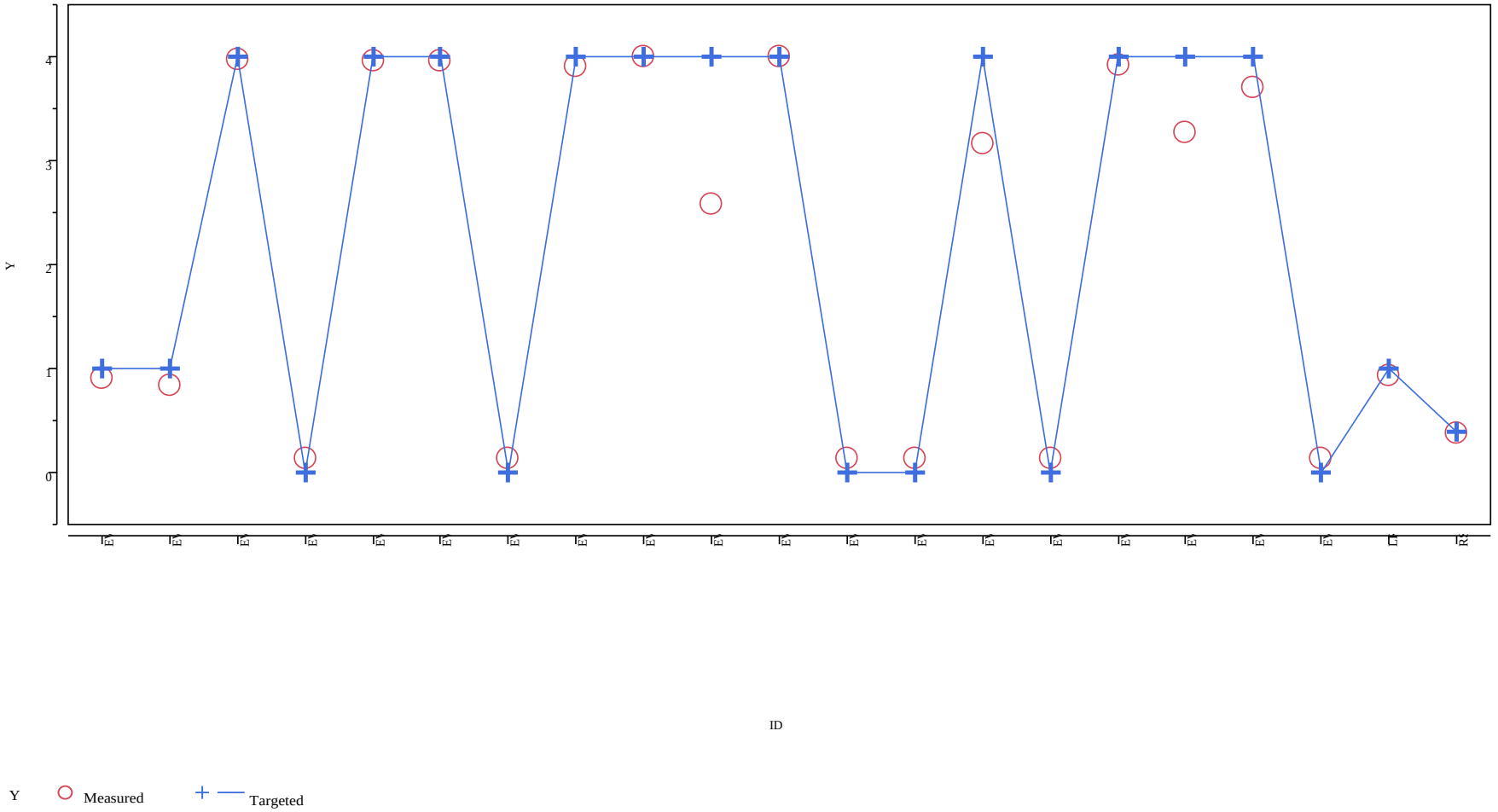
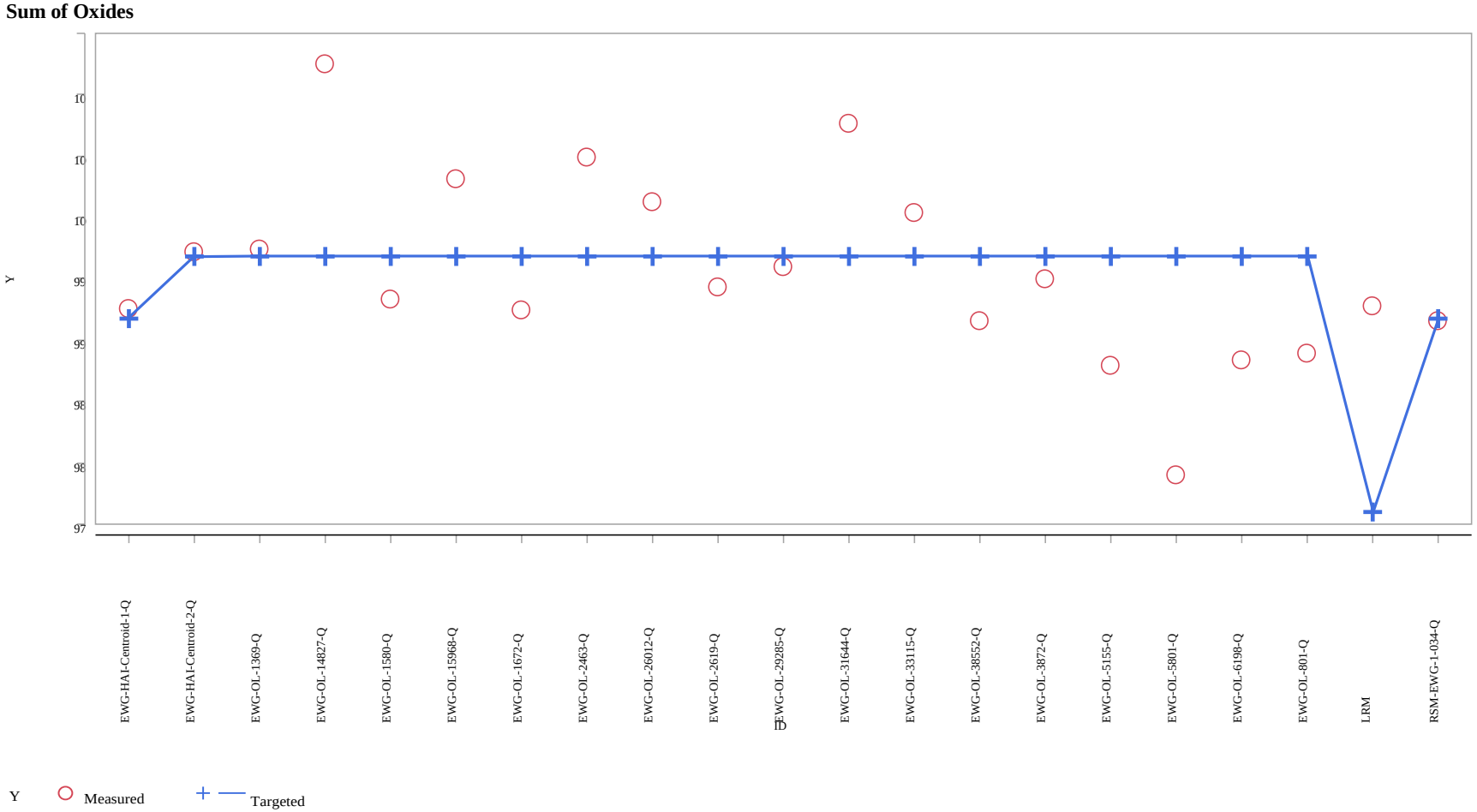


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide. (continued)



Appendix B. Tables and Exhibits Supporting the PCT Results

Table B-1. PCT Measurements for Set 1 Glasses (ar – as received)

Glass ID	Heat Treatment	Set	Block	Seq	Lab ID	B ar	Ca ar	K ar	Li ar	Na ar	P ar	Si ar	B (ppm)	Ca (ppm)	K (ppm)	Li (ppm)	Na (ppm)	P (ppm)	Si (ppm)
Std Soln	ref	1	1	1	std-a1-1	20.4	<1.00	10.4	10.6	82.1	<1.00	50.8	20.400	1.000	10.400	10.600	82.100	1.000	50.800
ARM-1	ref	1	1	2	A58	10.0	<1.00	<1.00	8.29	20.6	<1.00	35.6	16.667	1.667	1.667	13.817	34.334	1.667	59.335
blank	ref	1	1	3	A16	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	1.667	1.667	1.667	1.667	1.667	1.667	1.667
EWG-OL-2619	quenched	1	1	4	A45	26.4	5.68	8.43	<1.00	15.5	<1.00	2.55	44.001	9.467	14.050	1.667	25.834	1.667	4.250
EWG-OL-2463	quenched	1	1	5	A57	230	1.02	154	<1.00	1150	<1.00	14.3	383.341	1.700	256.672	1.667	1916.705	1.667	23.834
EWG-OL-2619	ccc	1	1	6	A62	33.3	6.13	10.5	<1.00	19.8	<1.00	3.04	55.501	10.217	17.500	1.667	33.001	1.667	5.067
EWG-HAI-Centroid-2	ccc	1	1	7	A33	120	<1.00	1.94	20.2	90.1	<1.00	22.6	200.004	1.667	3.233	33.667	150.170	1.667	37.667
EWG-OL-14827	quenched	1	1	8	A64	28.6	3.68	9.92	13.6	17.1	<1.00	12.0	47.668	6.133	16.534	22.667	28.501	1.667	20.000
EWG-OL-14827	ccc	1	1	9	A07	26.5	3.89	9.00	12.5	15.4	<1.00	11.5	44.168	6.483	15.000	20.834	25.667	1.667	19.167
EWG-OL-1369	quenched	1	1	10	A66	3.64	1.46	<1.00	5.34	3.60	<1.00	12.0	6.067	2.433	1.667	8.900	6.000	1.667	20.000
EWG-HAI-Centroid-2	quenched	1	1	11	A04	109	<1.00	1.90	18.6	82.2	<1.00	20.2	181.670	1.667	3.167	31.001	137.003	1.667	33.667
EWG-OL-15968	ccc	1	1	12	A21	473	<1.00	0.524	<1.00	603	<1.00	22.3	788.349	1.667	0.873	260.005	1005.020	1.667	37.167
EWG-OL-1672	quenched	1	1	13	A08	59.1	4.63	<1.00	<1.00	21.8	<1.00	3.14	98.502	7.717	1.667	1.667	36.334	1.667	5.233
Std Soln	ref	1	1	14	std-a1-2	20.4	<1.00	9.82	9.93	76.2	<1.00	48.2	20.400	1.000	9.820	9.930	76.200	1.000	48.200
EWG-HAI-Centroid-1	quenched	1	1	15	A55	12.2	<1.00	1.27	4.29	19.7	<1.00	19.0	20.334	1.667	2.117	7.150	32.834	1.667	31.667
EWG-HAI-Centroid-1	ccc	1	1	16	A63	10.5	<1.00	1.06	3.31	14.8	<1.00	12.8	17.500	1.667	1.767	5.517	24.667	1.667	21.334
EWG-OL-26012	quenched	1	1	17	A19	7.40	<1.00	3.43	<1.00	44.1	2.09	33.0	12.334	1.667	5.717	1.667	73.501	3.483	55.001
EWG-OL-15968	quenched	1	1	18	A36	277	<1.00	<1.00	97.8	415	<1.00	35.9	461.676	1.667	1.667	163.003	691.681	1.667	59.835
EWG-OL-26012	ccc	1	1	19	A43	8.98	<1.00	6.23	26.3	138	79.2	43.3	14.967	1.667	10.384	43.834	230.005	132.003	72.168
EWG-OL-1369	ccc	1	1	20	A09	5.03	1.84	<1.00	5.39	3.59	<1.00	11.9	8.384	3.067	1.667	8.984	5.983	1.667	19.834
EWG-OL-1580	ccc	1	1	21	A10	4.56	1.85	<1.00	5.12	3.78	<1.00	12.2	7.600	3.083	1.667	8.534	6.300	1.667	20.334
EA	ref	1	1	22	A06	19.6	<1.00	<1.00	6.89	52.1	<1.00	35.9	326.667	16.667	16.667	114.834	868.335	16.667	598.335
EWG-OL-1580	quenched	1	1	23	A40	4.55	1.54	<1.00	5.43	4.34	<1.00	12.8	7.583	2.567	1.667	9.050	7.233	1.667	21.334
EWG-OL-1672	ccc	1	1	24	A18	61.9	4.50	<1.00	<1.00	23.3	<1.00	3.66	103.169	7.500	1.667	1.667	38.834	1.667	6.100
EWG-OL-2463	ccc	1	1	25	A29	503	6.97	77.5	<1.00	2480	<1.00	11.2	838.350	11.617	129.169	1.667	4133.416	1.667	18.667
Std Soln	ref	1	1	26	std-a1-3	22.2	<1.00	10.4	10.6	81.3	<1.00	51.1	22.200	1.000	10.400	10.600	81.300	1.000	51.100
Std Soln	ref	1	2	1	std-a2-1	19.8	<1.00	9.78	10.2	82.4	<1.00	48.9	19.800	1.000	9.780	10.200	82.400	1.000	48.900
EWG-OL-1369	quenched	1	2	2	A25	2.44	<1.00	<1.00	5.21	3.23	<1.00	11.1	4.067	1.667	1.667	8.684	5.383	1.667	18.500
EWG-OL-15968	quenched	1	2	3	A56	281	<1.00	<1.00	98.1	419	<1.00	32.5	468.343	1.667	1.667	163.503	698.347	1.667	54.168
EWG-HAI-Centroid-1	quenched	1	2	4	A42	11.0	<1.00	<1.00	4.18	20.0	<1.00	17.5	18.334	1.667	1.667	6.967	33.334	1.667	29.167
EWG-OL-1369	ccc	1	2	5	A23	3.47	1.38	<1.00	5.39	3.22	<1.00	11.1	5.783	2.300	1.667	8.984	5.367	1.667	18.500
EWG-OL-2619	ccc	1	2	6	A47	23.7	4.33	7.11	<1.00	14.4	<1.00	1.58	39.501	7.217	11.850	1.667	24.000	1.667	2.633
EWG-OL-2463	ccc	1	2	7	A03	493	6.52	77.6	<1.00	2450	<1.00	9.52	821.683	10.867	129.336	1.667	4083.415	1.667	15.867
EWG-OL-1580	ccc	1	2	8	A52	3.73	1.31	<1.00	4.93	3.70	<1.00	11.7	6.217	2.183	1.667	8.217	6.167	1.667	19.500
EWG-HAI-Centroid-2	quenched	1	2	9	A20	108	<1.00	1.18	18.1	83.4	<1.00	19.1	180.004	1.667	1.967	30.167	139.003	1.667	31.834
EWG-OL-2619	quenched	1	2	10	A26	25.7	5.19	7.81	<1.00	15.4	<1.00	2.36	42.834	8.650	13.017	1.667	25.667	1.667	3.933
ARM-1	ref	1	2	11	A31	9.61	<1.00	<1.00	8.00	20.3	<1.00	33.6	16.017	1.667	1.667	13.334	33.834	1.667	56.001
EWG-OL-26012	quenched	1	2	12	A67	6.16	<1.00	2.61	<1.00	43.7	2.22	30.7	10.267	1.667	4.350	1.667	72.835	3.700	51.168

Table B-1. PCT Measurements for Set 1 Glasses (ar – as received) (continued)

Glass ID	Heat Treatment	Set	Block	Seq	Lab ID	B ar	Ca ar	K ar	Li ar	Na ar	P ar	Si ar	B (ppm)	Ca (ppm)	K (ppm)	Li (ppm)	Na (ppm)	P (ppm)	Si (ppm)
EA	ref	1	2	13	A14	15.8	<1.00	<1.00	5.81	45.6	<1.00	29.7	263.334	16.667	16.667	96.834	760.002	16.667	495.001
Std Soln	ref	1	2	14	std-a2-2	19.2	<1.00	9.45	9.90	79.2	<1.00	47.3	19.200	1.000	9.450	9.900	79.200	1.000	47.300
EWG-OL-1672	ccc	1	2	15	A22	62.2	3.85	<1.00	<1.00	23.4	<1.00	3.42	103.669	6.417	1.667	1.667	39.001	1.667	5.700
EWG-HAI-Centroid-1	ccc	1	2	16	A44	9.59	<1.00	<1.00	3.33	15.4	<1.00	12.3	15.984	1.667	1.667	5.550	25.667	1.667	20.500
EWG-OL-1580	quenched	1	2	17	A12	3.00	1.10	<1.00	4.81	3.76	<1.00	10.8	5.000	1.833	1.667	8.017	6.267	1.667	18.000
EWG-OL-15968	ccc	1	2	18	A54	462	1.43	<1.00	149	585	<1.00	21.7	770.015	2.383	1.667	248.338	975.020	1.667	36.167
EWG-HAI-Centroid-2	ccc	1	2	19	A49	123	<1.00	1.23	19.7	91.4	1.06	21.7	205.004	1.667	2.050	32.834	152.336	1.767	36.167
EWG-OL-26012	ccc	1	2	20	A39	7.72	<1.00	5.50	25.1	138	74.9	40.3	12.867	1.667	9.167	41.834	230.005	124.836	67.168
EWG-OL-1672	quenched	1	2	21	A46	56.8	4.22	<1.00	<1.00	22.2	<1.00	2.76	94.669	7.033	1.667	1.667	37.001	1.667	4.600
EWG-OL-14827	ccc	1	2	22	A50	25.1	3.44	8.29	12.0	15.3	<1.00	10.5	41.834	5.733	13.817	20.000	25.501	1.667	17.500
EWG-OL-2463	quenched	1	2	23	A28	212	<1.00	144	<1.00	1060	<1.00	14.2	353.340	1.667	240.005	1.667	1766.702	1.667	23.667
EWG-OL-14827	quenched	1	2	24	A59	29.3	3.30	9.56	13.4	17.3	<1.00	11.3	48.834	5.500	15.934	22.334	28.834	1.667	18.834
Std Soln	ref	1	2	25	std-a2-3	20.5	<1.00	9.79	10.3	82.3	<1.00	49.1	20.500	1.000	9.790	10.300	82.300	1.000	49.100
Std Soln	ref	1	3	1	std-a3-1	20.0	<1.00	9.90	10.3	80.9	<1.00	48.5	20.000	1.000	9.900	10.300	80.900	1.000	48.500
EWG-OL-2619	quenched	1	3	2	A51	26.4	5.55	8.31	<1.00	15.8	<1.00	1.72	44.001	9.250	13.850	1.667	26.334	1.667	2.867
EWG-OL-14827	ccc	1	3	3	A53	25.3	3.60	8.57	12.2	15.4	<1.00	10.1	42.168	6.000	14.284	20.334	25.667	1.667	16.834
EWG-OL-26012	ccc	1	3	4	A48	7.35	<1.00	5.86	26.1	139	76.6	40.7	12.250	1.667	9.767	43.501	231.671	127.669	67.835
blank	ref	1	3	5	A37	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	1.667	1.667	1.667	1.667	1.667	1.667	1.667
EWG-OL-1580	quenched	1	3	6	A34	3.04	1.26	<1.00	5.27	3.94	<1.00	11.6	5.067	2.100	1.667	8.784	6.567	1.667	19.334
EWG-OL-1369	quenched	1	3	7	A13	2.70	1.13	<1.00	5.55	3.43	<1.00	11.6	4.500	1.883	1.667	9.250	5.717	1.667	19.334
EWG-OL-15968	quenched	1	3	8	A02	295	<1.00	<1.00	98.6	422	<1.00	31.9	491.677	1.667	1.667	164.337	703.347	1.667	53.168
EWG-OL-2463	ccc	1	3	9	A32	484	6.70	78.4	<1.00	2490	<1.00	10.0	806.683	11.167	130.669	1.667	4150.083	1.667	16.667
EWG-HAI-Centroid-1	ccc	1	3	10	A60	10.3	<1.00	<1.00	3.34	15.2	<1.00	12.0	17.167	1.667	1.667	5.567	25.334	1.667	20.000
EA	ref	1	3	11	A30	16.2	<1.00	<1.00	5.87	45.6	<1.00	29.5	270.001	16.667	16.667	97.834	760.002	16.667	491.668
EWG-OL-1672	quenched	1	3	12	A41	57.7	4.39	<1.00	<1.00	22.4	<1.00	2.54	96.169	7.317	1.667	1.667	37.334	1.667	4.233
EWG-OL-15968	ccc	1	3	13	A27	447	<1.00	<1.00	145	568	<1.00	22.4	745.015	1.667	1.667	241.672	946.686	1.667	37.334
Std Soln	ref	1	3	14	std-a3-2	20.8	<1.00	9.91	10.3	81.2	<1.00	48.3	20.800	1.000	9.910	10.300	81.200	1.000	48.300
EWG-OL-14827	quenched	1	3	15	A38	29.3	3.41	9.71	13.6	17.3	<1.00	10.7	48.834	5.683	16.184	22.667	28.834	1.667	17.834
EWG-OL-26012	quenched	1	3	16	A65	6.57	<1.00	2.72	<1.00	43.3	2.06	30.5	10.950	1.667	4.533	1.667	72.168	3.433	50.834
EWG-OL-1369	ccc	1	3	17	A61	4.22	1.56	<1.00	5.48	3.45	<1.00	11.5	7.033	2.600	1.667	9.134	5.750	1.667	19.167
EWG-HAI-Centroid-2	ccc	1	3	18	A15	126	<1.00	1.53	20.4	93.5	<1.00	21.8	210.004	1.667	2.550	34.001	155.836	1.667	36.334
EWG-HAI-Centroid-1	quenched	1	3	19	A05	11.3	<1.00	<1.00	4.25	19.9	<1.00	17.1	18.834	1.667	1.667	7.083	33.167	1.667	28.501
ARM-1	ref	1	3	20	A68	10.1	<1.00	<1.00	8.32	20.9	<1.00	34.5	16.834	1.667	1.667	13.867	34.834	1.667	57.501
EWG-HAI-Centroid-2	quenched	1	3	21	A24	109	<1.00	1.43	18.3	83.6	<1.00	18.8	181.670	1.667	2.383	30.501	139.336	1.667	31.334
EWG-OL-1580	ccc	1	3	22	A11	3.71	1.54	<1.00	5.22	3.57	<1.00	11.2	6.183	2.567	1.667	8.700	5.950	1.667	18.667
EWG-OL-1672	ccc	1	3	23	A17	63.8	4.01	<1.00	<1.00	23.8	<1.00	2.33	106.335	6.683	1.667	1.667	39.667	1.667	3.883
EWG-OL-2619	ccc	1	3	24	A35	33.3	5.97	10.4	<1.00	20.0	<1.00	2.13	55.501	9.950	17.334	1.667	33.334	1.667	3.550
EWG-OL-2463	quenched	1	3	25	A01	226	<1.00	149	<1.00	1120	<1.00	13.2	376.674	1.667	248.338	1.667	1866.704	1.667	22.000

Table B-1. PCT Measurements for Set 1 Glasses (ar – as received) (continued)

Glass ID	Heat Treatment	Set	Block	Seq	Lab ID	B ar	Ca ar	K ar	Li ar	Na ar	P ar	Si ar	B (ppm)	Ca (ppm)	K (ppm)	Li (ppm)	Na (ppm)	P (ppm)	Si (ppm)
Std Soln	ref	1	3	26	std-a3-3	20.7	<1.00	10.1	10.4	83.0	<1.00	49.4	20.700	1.000	10.100	10.400	83.000	1.000	49.400
Std Soln	ref	2	1	1	std-b1-1	19.4	<1.00	9.94	10.2	79.1	<1.00	48.1	19.400	1.000	9.940	10.200	79.100	1.000	48.100
EWG-OL-33115	ccc	2	1	2	B10	4.44	<1.00	3.08	<1.00	10.6	<1.00	13.7	7.400	1.667	5.133	1.667	17.667	1.667	22.834
EWG-OL-3872	quenched	2	1	3	B25	20.9	1.86	<1.00	28.7	171	<1.00	46.6	34.834	2.900	1.667	47.834	285.006	1.667	77.668
EWG-OL-33115	quenched	2	1	4	B35	3.79	1.65	3.13	<1.00	11.3	<1.00	10.6	6.317	2.550	5.217	1.667	18.834	1.667	17.667
EWG-OL-38552	ccc	2	1	5	B37	240	<1.00	<1.00	44.4	220	2.43	4.38	400.008	1.667	1.667	74.001	366.674	4.050	7.300
EWG-OL-6198	ccc	2	1	6	B17	253	<1.00	15.2	78.2	81.9	12.7	20.9	421.675	1.667	25.334	130.336	136.503	21.167	34.834
EWG-OL-38552	quenched	2	1	7	B04	11.3	<1.00	<1.00	12.6	8.55	4.39	21.2	18.834	1.667	1.667	21.000	14.250	7.317	35.334
EWG-OL-5155	quenched	2	1	8	B49	81.8	<1.00	<1.00	32.9	37.0	<1.00	14.7	136.336	1.667	1.667	54.834	61.668	1.667	24.500
ARM-1	ref	2	1	9	B13	10.5	<1.00	<1.00	7.60	19.0	1.11	32.3	17.500	2.217	1.667	12.667	31.667	1.850	53.834
EWG-OL-801	quenched	2	1	10	B52	217	<1.00	<1.00	<1.00	373	13.7	12.9	361.674	1.667	1.667	1.667	621.679	22.834	21.500
RSM-EWG-1-034	ccc	2	1	11	B43	16.0	<1.00	<1.00	4.55	17.3	1.59	13.7	26.667	1.667	1.667	7.583	28.834	2.650	22.834
EWG-OL-6198	quenched	2	1	12	B50	82.2	<1.00	10.1	33.4	35.7	4.40	17.3	137.003	1.667	16.834	55.668	59.501	7.333	28.834
EWG-OL-801	ccc	2	1	13	B01	256	<1.00	<1.00	<1.00	410	17.9	13.3	426.675	1.667	1.667	1.667	683.347	29.834	22.167
Std Soln	ref	2	1	14	std-b1-2	21.2	<1.00	9.92	10.1	80.4	<1.00	46.9	21.200	1.000	9.920	10.100	80.400	1.000	46.900
EWG-OL-5801	quenched	2	1	15	B36	97.8	<1.00	17.7	39.1	48.0	8.94	12.0	163.003	1.667	29.501	65.168	80.002	14.900	20.000
EWG-OL-29285	quenched	2	1	16	B32	7.10	2.45	<1.00	<1.00	4.88	<1.00	6.32	11.834	3.783	1.667	1.667	8.133	1.667	10.534
EWG-OL-5155	ccc	2	1	17	B41	265	21.9	<1.00	107	104	<1.00	<1.00	441.676	1.667	1.667	178.337	173.337	1.667	1.667
EA	ref	2	1	18	B62	32.4	<1.00	<1.00	10.9	88.2	<1.00	48.0	540.001	16.667	16.667	181.667	1470.003	16.667	800.002
EWG-OL-29285	ccc	2	1	19	B46	7.21	2.28	<1.00	<1.00	4.53	<1.00	6.96	12.017	3.433	1.667	1.667	7.550	1.667	11.600
EWG-OL-31644	ccc	2	1	20	B15	4.96	1.58	<1.00	2.02	3.43	<1.00	9.83	8.267	2.367	1.667	3.367	5.717	1.667	16.384
blank	ref	2	1	21	B45	1.65	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	2.750	1.667	1.667	1.667	1.667	1.667	1.667
EWG-OL-3872	ccc	2	1	22	B51	600	1.22	<1.00	268	2210	2.38	117	1000.020	1.783	1.667	446.676	3683.407	3.967	195.004
RSM-EWG-1-034	quenched	2	1	23	B34	16.8	<1.00	<1.00	4.79	15.8	1.43	10.6	28.001	1.667	1.667	7.983	26.334	2.383	17.667
EWG-OL-5801	ccc	2	1	24	B28	227	<1.00	26.8	74.9	105	7.08	1.11	378.341	1.667	44.668	124.836	175.004	11.800	1.850
EWG-OL-31644	quenched	2	1	25	B06	6.37	3.64	<1.00	<1.00	5.33	<1.00	9.13	10.617	5.783	1.667	1.667	8.884	1.667	15.217
Std Soln	ref	2	1	26	std-b1-3	22.0	<1.00	10.3	10.5	83.8	<1.00	48.1	22.000	1.000	10.300	10.500	83.800	1.000	48.100
Std Soln	ref	2	2	1	std-b2-1	20.5	<1.00	10.4	10.6	82.2	<1.00	49.8	20.500	1.000	10.400	10.600	82.200	1.000	49.800
EWG-OL-29285	ccc	2	2	2	B26	5.39	2.29	<1.00	<1.00	4.53	<1.00	6.71	8.984	3.417	1.667	1.667	7.550	1.667	11.184
EWG-OL-3872	quenched	2	2	3	B47	21.1	1.73	<1.00	28.8	171	<1.00	45.2	35.167	2.400	1.667	48.001	285.006	1.667	75.335
EWG-OL-3872	ccc	2	2	4	B54	596	1.09	<1.00	265	2180	2.32	119	993.353	1.667	1.667	441.676	3633.406	3.867	198.337
EWG-OL-6198	quenched	2	2	5	B21	92.7	<1.00	10.4	34.8	36.6	4.37	17.9	154.503	1.667	17.334	58.001	61.001	7.283	29.834
EWG-OL-31644	quenched	2	2	6	B22	4.10	3.47	<1.00	<1.00	5.27	<1.00	8.42	6.833	5.500	1.667	1.667	8.784	1.667	14.034
EWG-OL-31644	ccc	2	2	7	B11	4.05	1.42	<1.00	2.01	3.40	<1.00	9.35	6.750	1.933	1.667	3.350	5.667	1.667	15.584
EWG-OL-5801	quenched	2	2	8	B66	96.7	<1.00	17.7	38.6	46.7	8.88	12.0	161.170	1.667	29.501	64.335	77.835	14.800	20.000
EWG-OL-38552	quenched	2	2	9	B44	9.67	<1.00	<1.00	12.9	8.76	4.28	20.2	16.117	1.667	1.667	21.500	14.600	7.133	33.667
EWG-OL-5155	ccc	2	2	10	B14	287	<1.00	<1.00	111	105	<1.00	<1.00	478.343	1.667	1.667	185.004	175.004	1.667	1.667
EA	ref	2	2	11	B58	33.8	<1.00	<1.00	11.1	91.7	<1.00	49.1	563.334	16.667	16.667	185.000	1528.336	16.667	818.335
EWG-OL-801	ccc	2	2	12	B53	249	27.8	<1.00	<1.00	409	18.7	12.9	415.008	1.667	1.667	1.667	681.680	31.167	21.500

Table B-1. PCT Measurements for Set 1 Glasses (ar – as received) (continued)

Glass ID	Heat Treatment	Set	Block	Seq	Lab ID	B ar	Ca ar	K ar	Li ar	Na ar	P ar	Si ar	B (ppm)	Ca (ppm)	K (ppm)	Li (ppm)	Na (ppm)	P (ppm)	Si (ppm)
EWG-OL-33115	quenched	2	2	13	B19	5.03	1.59	3.18	<1.00	11.4	<1.00	9.06	8.384	2.083	5.300	1.667	19.000	1.667	15.100
Std Soln	ref	2	2	14	std-b2-2	20.6	<1.00	10.3	10.4	81.6	<1.00	48.4	20.600	1.000	10.300	10.400	81.600	1.000	48.400
EWG-OL-5801	ccc	2	2	15	B07	221	<1.00	26.0	72.7	99.0	7.12	<1.00	368.341	1.667	43.334	121.169	165.003	11.867	1.667
EWG-OL-29285	quenched	2	2	16	B56	7.05	2.33	<1.00	<1.00	4.61	<1.00	6.37	11.750	3.533	1.667	1.667	7.683	1.667	10.617
EWG-OL-5155	quenched	2	2	17	B38	83.3	<1.00	<1.00	33.1	37.3	<1.00	13.4	138.836	1.667	1.667	55.168	62.168	1.667	22.334
EWG-OL-38552	ccc	2	2	18	B27	239	<1.00	<1.00	45.2	216	1.80	<1.00	398.341	1.667	1.667	75.335	360.007	3.000	1.667
ARM-1	ref	2	2	19	B63	10.9	<1.00	<1.00	7.73	19.3	<1.00	32.4	18.167	1.667	1.667	12.884	32.167	1.667	54.001
RSM-EWG-1-034	quenched	2	2	20	B48	13.8	<1.00	<1.00	4.81	15.2	1.23	11.0	23.000	1.667	1.667	8.017	25.334	2.050	18.334
EWG-OL-6198	ccc	2	2	21	B18	261	<1.00	15.5	79.1	83.5	11.3	19.7	435.009	1.667	25.834	131.836	139.169	18.834	32.834
RSM-EWG-1-034	ccc	2	2	22	B16	16.1	<1.00	<1.00	4.56	17.5	1.44	12.9	26.834	1.667	1.667	7.600	29.167	2.400	21.500
EWG-OL-801	quenched	2	2	23	B09	227	<1.00	<1.00	<1.00	365	14.0	12.4	378.341	1.667	1.667	1.667	608.346	23.334	20.667
EWG-OL-33115	ccc	2	2	24	B20	5.78	<1.00	3.11	<1.00	10.4	<1.00	12.1	9.634	1.667	5.183	1.667	17.334	1.667	20.167
Std Soln	ref	2	2	25	std-b2-3	21.1	<1.00	10.4	10.4	81.3	<1.00	49.0	21.100	1.000	10.400	10.400	81.300	1.000	49.000
Std Soln	ref	2	3	1	std-b3-1	19.9	<1.00	10.1	10.2	80.5	<1.00	48.2	19.900	1.000	10.100	10.200	80.500	1.000	48.200
EWG-OL-38552	quenched	2	3	2	B24	8.74	<1.00	<1.00	12.8	8.66	4.18	20.3	14.567	1.667	1.667	21.334	14.434	6.967	33.834
EWG-OL-801	ccc	2	3	3	B02	268	40.1	<1.00	<1.00	420	18.7	12.7	446.676	1.667	1.667	1.667	700.014	31.167	21.167
EWG-OL-5801	quenched	2	3	4	B55	102	<1.00	17.8	38.3	46.7	9.22	12.3	170.003	1.667	29.667	63.835	77.835	15.367	20.500
ARM-1	ref	2	3	5	B39	9.77	<1.00	<1.00	7.66	19.2	<1.00	31.8	16.284	1.667	1.667	12.767	32.001	1.667	53.001
EA	ref	2	3	6	B65	32.8	1.02	<1.00	11.5	92.2	<1.00	51.6	546.668	16.667	16.667	191.667	1536.670	16.667	860.002
EWG-OL-6198	ccc	2	3	7	B08	263	<1.00	15.5	79.0	85.3	12.0	19.8	438.342	1.667	25.834	131.669	142.170	20.000	33.001
EWG-OL-5155	ccc	2	3	8	B05	292	<1.00	<1.00	111	105	<1.00	<1.00	486.676	1.667	1.667	185.004	175.004	1.667	1.667
EWG-OL-29285	ccc	2	3	9	B68	6.58	2.12	<1.00	<1.00	7.86	<1.00	6.43	10.967	3.250	1.667	1.667	13.100	1.667	10.717
EWG-OL-5801	ccc	2	3	10	B59	229	<1.00	26.5	72.8	101	6.87	<1.00	381.674	1.667	44.168	121.336	168.337	11.450	1.667
EWG-OL-38552	ccc	2	3	11	B29	253	<1.00	<1.00	45.0	217	2.49	3.87	421.675	1.667	1.667	75.002	361.674	4.150	6.450
EWG-OL-801	quenched	2	3	12	B12	225	<1.00	<1.00	<1.00	381	14.5	12.4	375.008	1.667	1.667	1.667	635.013	24.167	20.667
EWG-OL-33115	quenched	2	3	13	B42	5.62	20.8	3.02	<1.00	12.0	<1.00	9.13	9.367	2.017	5.033	1.667	20.000	1.667	15.217
Std Soln	ref	2	3	14	std-b3-2	21.2	<1.00	10.1	10.4	81.8	<1.00	48.4	21.200	1.000	10.100	10.400	81.800	1.000	48.400
EWG-OL-3872	ccc	2	3	15	B67	564	1.01	<1.00	256	2110	2.39	124	940.019	1.667	1.667	426.675	3516.737	3.983	206.671
EWG-OL-29285	quenched	2	3	16	B61	8.53	2.26	<1.00	<1.00	4.93	<1.00	6.14	14.217	3.400	1.667	1.667	8.217	1.667	10.234
EWG-OL-31644	quenched	2	3	17	B40	4.65	3.54	<1.00	<1.00	5.35	<1.00	8.27	7.750	5.383	1.667	1.667	8.917	1.667	13.784
EWG-OL-3872	quenched	2	3	18	B23	21.7	1.84	<1.00	27.7	167	<1.00	43.5	36.167	2.433	1.667	46.168	278.339	1.667	72.501
EWG-OL-5155	quenched	2	3	19	B64	88.3	<1.00	<1.00	34.4	39.1	<1.00	14.0	147.170	1.667	1.667	57.334	65.168	1.667	23.334
RSM-EWG-1-034	ccc	2	3	20	B57	16.5	<1.00	<1.00	4.74	17.9	1.31	13.1	27.501	1.667	1.667	7.900	29.834	2.183	21.834
blank	ref	2	3	21	B30	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	1.667	1.667	1.667	1.667	1.667	1.667	1.667
EWG-OL-6198	quenched	2	3	22	B33	90.8	<1.00	10.4	34.7	36.8	4.47	17.5	151.336	1.667	17.334	57.834	61.335	7.450	29.167
EWG-OL-33115	ccc	2	3	23	B60	4.65	<1.00	2.93	<1.00	10.5	<1.00	11.8	7.750	1.667	4.883	1.667	17.500	1.667	19.667
RSM-EWG-1-034	quenched	2	3	24	B03	13.5	<1.00	<1.00	4.82	15.2	1.12	10.7	22.500	1.667	1.667	8.033	25.334	1.867	17.834
EWG-OL-31644	ccc	2	3	25	B31	3.31	76.8	<1.00	1.91	3.61	<1.00	8.65	5.517	1.900	1.667	3.183	6.017	1.667	14.417
Std Soln	ref	2	3	26	std-b3-3	19.2	<1.00	9.87	10.1	79.7	<1.00	46.7	19.200	1.000	9.870	10.100	79.700	1.000	46.700

Table B-2. PCT Leachate pH Values

Set 1					Set 2				
Identifier	**pH**		**Identifier**	**pH**	**Identifier**	**pH**		**Identifier**	**pH**
ARM-1-1	10.12		EWG-OL-1580-ccc-3	10.32	ARM-1-1	10.18		EWG-OL-3872-ccc-3	12.49
ARM-1-2	10.15		EWG-OL-1580-Q-1	10.29	ARM-1-2	10.18		EWG-OL-3872-Q-1	11.89
ARM-1-3	10.11		EWG-OL-1580-Q-2	10.33	ARM-1-3	10.20		EWG-OL-3872-Q-2	11.85
blank-1	6.92		EWG-OL-1580-Q-3	10.31	blank-1	6.97		EWG-OL-3872-Q-3	11.80
blank-2	6.93		EWG-OL-15968-ccc-1	11.31	blank-2	6.95		EWG-OL-5155-ccc-1	9.53
EA-1	11.55		EWG-OL-15968-ccc-2	11.36	EA-1	11.77		EWG-OL-5155-ccc-2	9.45
EA-2	11.54		EWG-OL-15968-ccc-3	11.36	EA-2	11.75		EWG-OL-5155-ccc-3	9.44
EA-3	11.55		EWG-OL-15968-Q-1	11.75	EA-3	11.77		EWG-OL-5155-Q-1	9.67
EWG-HAI-Centroid-1-ccc-1	9.43		EWG-OL-15968-Q-2	11.69	EWG-OL-29285-ccc-1	8.63		EWG-OL-5155-Q-2	9.65
EWG-HAI-Centroid-1-ccc-2	9.43		EWG-OL-15968-Q-3	11.67	EWG-OL-29285-ccc-2	8.66		EWG-OL-5155-Q-3	9.58
EWG-HAI-Centroid-1-ccc-3	9.44		EWG-OL-1672-ccc-1	8.58	EWG-OL-29285-ccc-3	8.71		EWG-OL-5801-ccc-1	9.61
EWG-HAI-Centroid-1-Q-1	9.80		EWG-OL-1672-ccc-2	8.59	EWG-OL-29285-Q-1	8.92		EWG-OL-5801-ccc-2	9.49
EWG-HAI-Centroid-1-Q-2	9.79		EWG-OL-1672-ccc-3	8.46	EWG-OL-29285-Q-2	8.83		EWG-OL-5801-ccc-3	9.49
EWG-HAI-Centroid-1-Q-3	9.76		EWG-OL-1672-Q-1	8.83	EWG-OL-29285-Q-3	8.92		EWG-OL-5801-Q-1	9.51
EWG-HAI-Centroid-2-ccc-1	9.44		EWG-OL-1672-Q-2	8.78	EWG-OL-31644-ccc-1	9.29		EWG-OL-5801-Q-2	9.52
EWG-HAI-Centroid-2-ccc-2	9.39		EWG-OL-1672-Q-3	8.71	EWG-OL-31644-ccc-2	9.28		EWG-OL-5801-Q-3	9.45
EWG-HAI-Centroid-2-ccc-3	9.25		EWG-OL-2463-ccc-1	12.65	EWG-OL-31644-ccc-3	9.31		EWG-OL-6198-ccc-1	9.45
EWG-HAI-Centroid-2-Q-1	9.30		EWG-OL-2463-ccc-2	12.70	EWG-OL-31644-Q-1	9.84		EWG-OL-6198-ccc-2	9.38
EWG-HAI-Centroid-2-Q-2	9.24		EWG-OL-2463-ccc-3	12.70	EWG-OL-31644-Q-2	9.82		EWG-OL-6198-ccc-3	9.42
EWG-HAI-Centroid-2-Q-3	9.28		EWG-OL-2463-Q-1	12.15	EWG-OL-31644-Q-3	9.81		EWG-OL-6198-Q-1	9.68
EWG-OL-1369-ccc-1	10.24		EWG-OL-2463-Q-2	12.21	EWG-OL-33115-ccc-1	8.80		EWG-OL-6198-Q-2	9.58
EWG-OL-1369-ccc-2	10.22		EWG-OL-2463-Q-3	12.21	EWG-OL-33115-ccc-2	8.85		EWG-OL-6198-Q-3	9.54
EWG-OL-1369-ccc-3	10.24		EWG-OL-26012-ccc-1	11.36	EWG-OL-33115-ccc-3	8.93		EWG-OL-801-ccc-1	9.65
EWG-OL-1369-Q-1	10.41		EWG-OL-26012-ccc-2	11.38	EWG-OL-33115-Q-1	9.70		EWG-OL-801-ccc-2	9.63
EWG-OL-1369-Q-2	10.41		EWG-OL-26012-ccc-3	11.38	EWG-OL-33115-Q-2	9.65		EWG-OL-801-ccc-3	9.63
EWG-OL-1369-Q-3	10.43		EWG-OL-26012-Q-1	10.51	EWG-OL-33115-Q-3	9.72		EWG-OL-801-Q-1	9.79
EWG-OL-14827-ccc-1	10.20		EWG-OL-26012-Q-2	10.54	EWG-OL-38552-ccc-1	9.34		EWG-OL-801-Q-2	9.68
EWG-OL-14827-ccc-2	10.26		EWG-OL-26012-Q-3	10.61	EWG-OL-38552-ccc-2	9.38		EWG-OL-801-Q-3	9.69
EWG-OL-14827-ccc-3	10.26		EWG-OL-2619-ccc-1	9.09	EWG-OL-38552-ccc-3	9.32		RSM-EWG-1-034-ccc-1	9.31
EWG-OL-14827-Q-1	10.14		EWG-OL-2619-ccc-2	9.00	EWG-OL-38552-Q-1	9.50		RSM-EWG-1-034-ccc-2	9.31
EWG-OL-14827-Q-2	10.17		EWG-OL-2619-ccc-3	8.98	EWG-OL-38552-Q-2	9.58		RSM-EWG-1-034-ccc-3	9.22
EWG-OL-14827-Q-3	10.19		EWG-OL-2619-Q-1	9.07	EWG-OL-38552-Q-3	9.68		RSM-EWG-1-034-Q-1	9.61
EWG-OL-1580-ccc-1	10.32		EWG-OL-2619-Q-2	9.06	EWG-OL-3872-ccc-1	12.48		RSM-EWG-1-034-Q-2	9.38
EWG-OL-1580-ccc-2	10.30		EWG-OL-2619-Q-3	9.07	EWG-OL-3872-ccc-2	12.49		RSM-EWG-1-034-Q-3	9.40

Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set

Analytical Set=1
Variability Chart for log[B ppm]

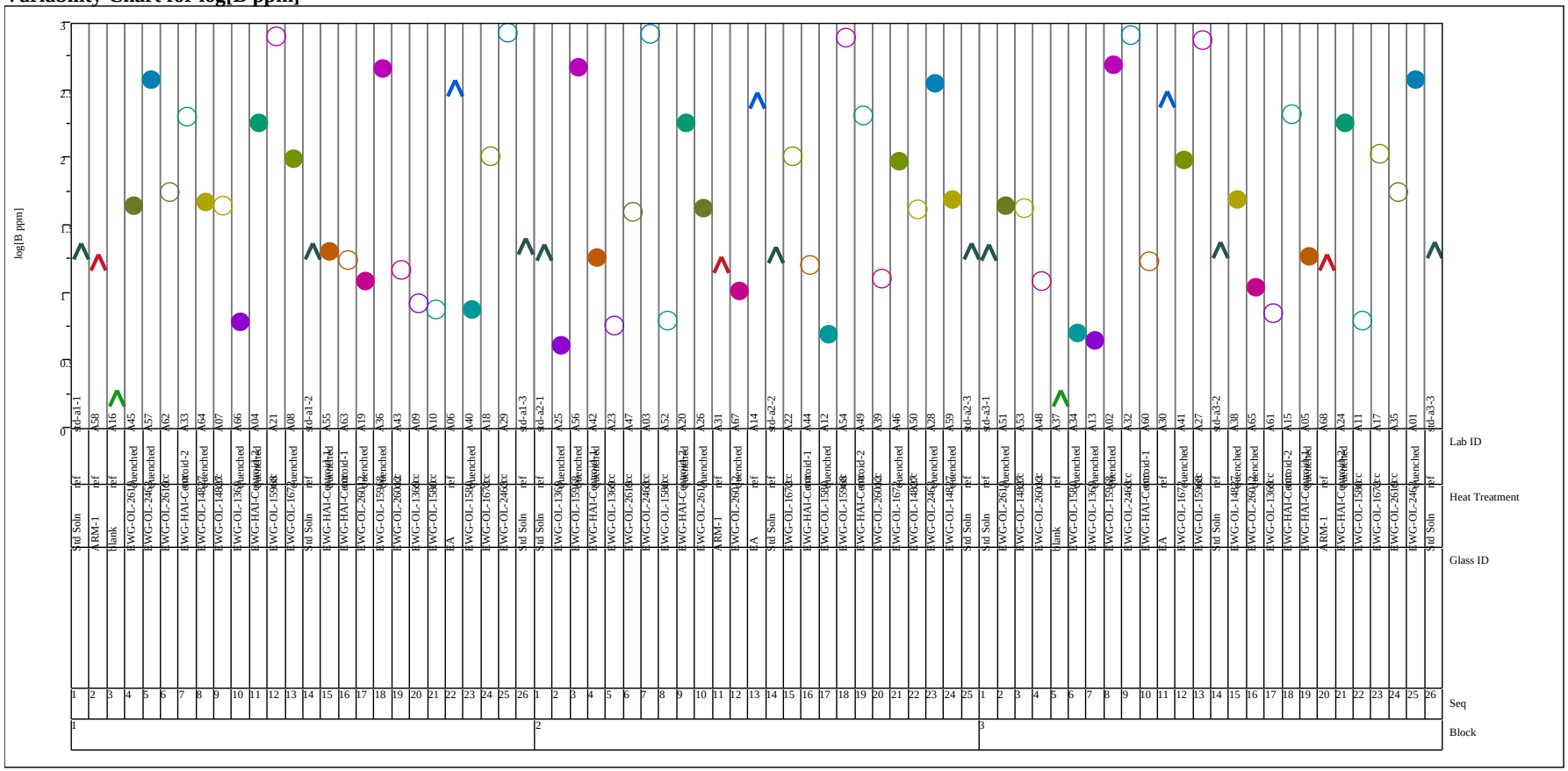


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

Analytical Set=1
Variability Chart for log[Ca ppm]

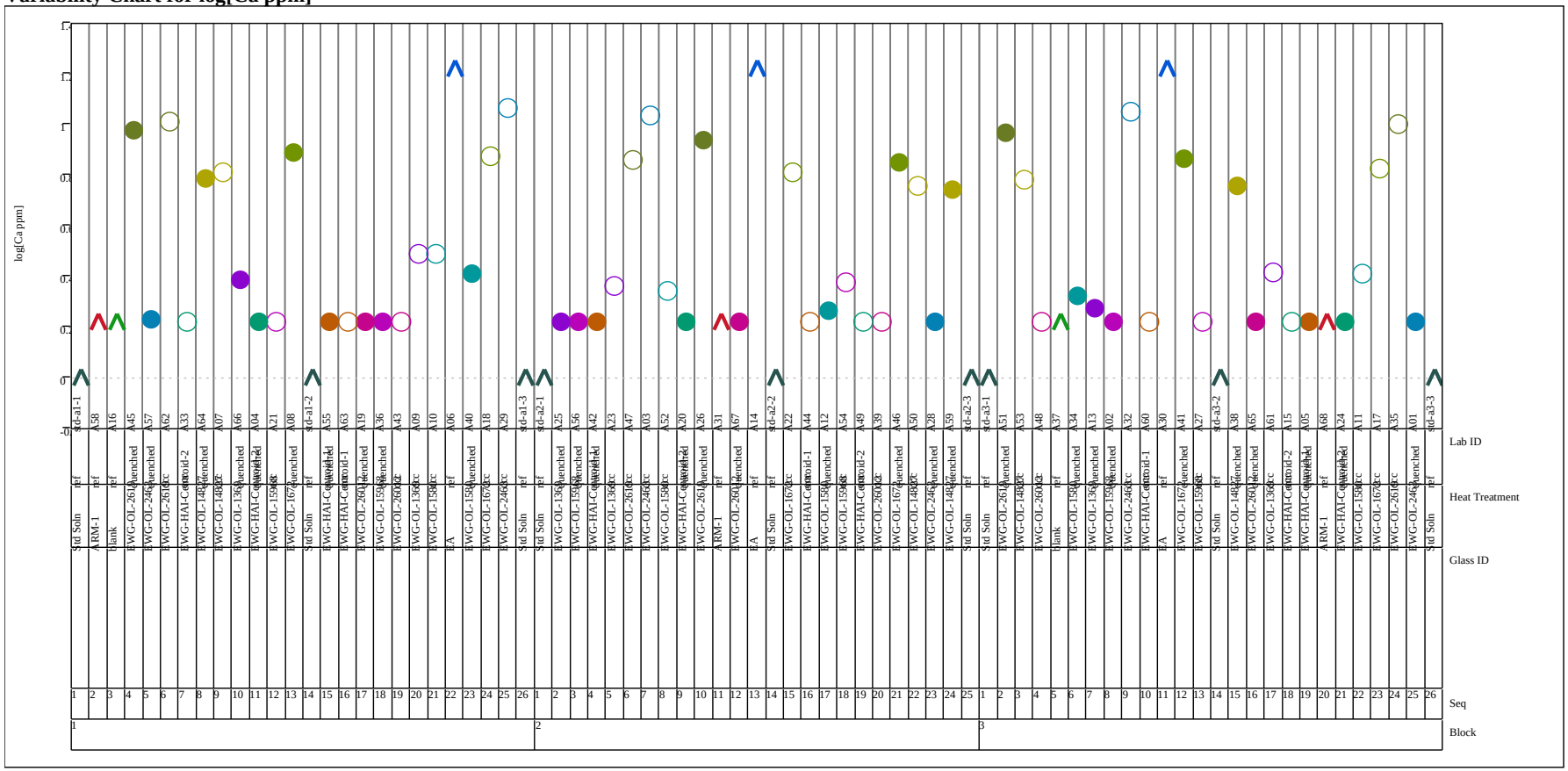


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

Analytical Set=1
Variability Chart for log[K ppm]

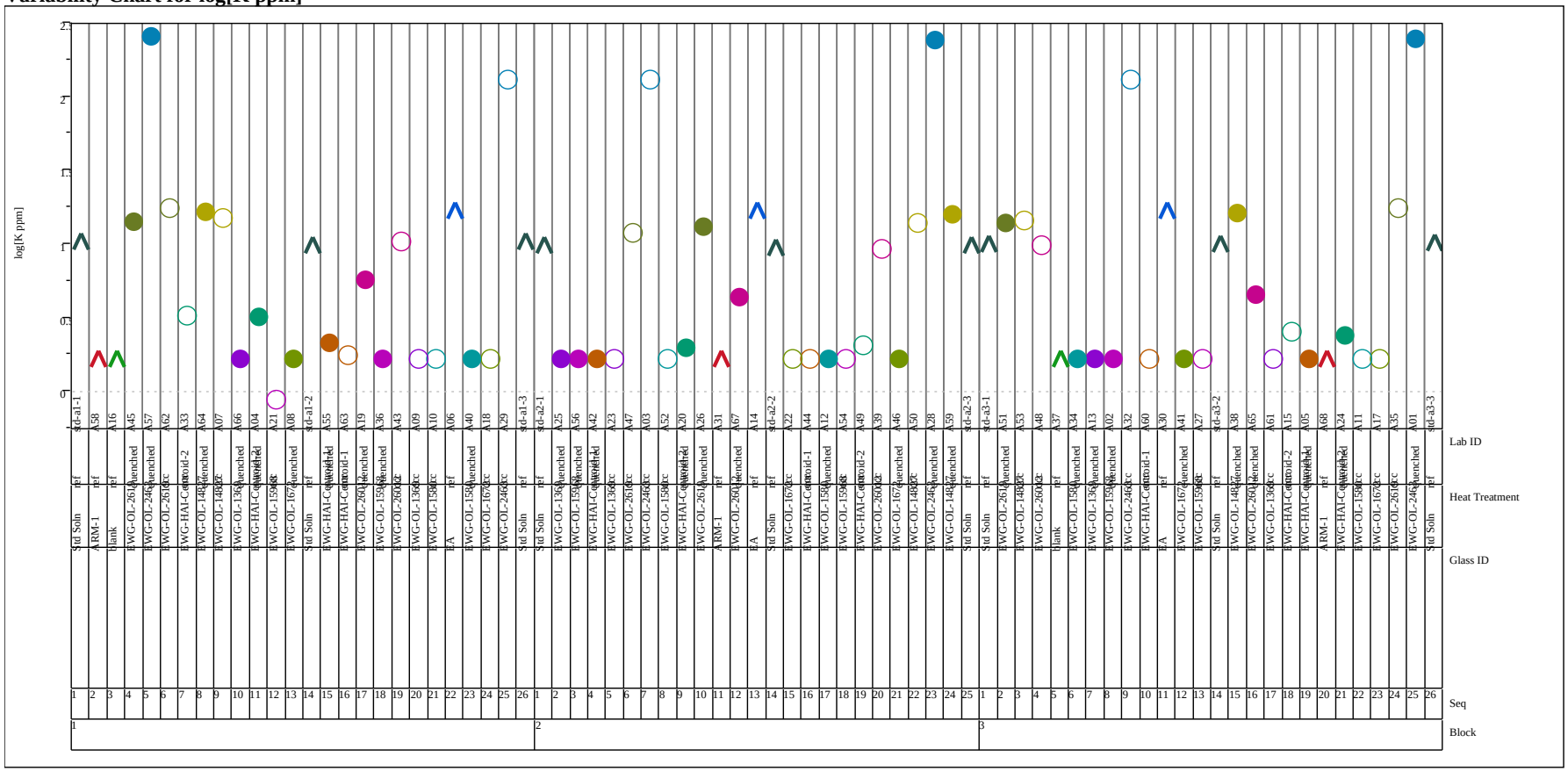


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

Analytical Set=1
Variability Chart for log[Li ppm]

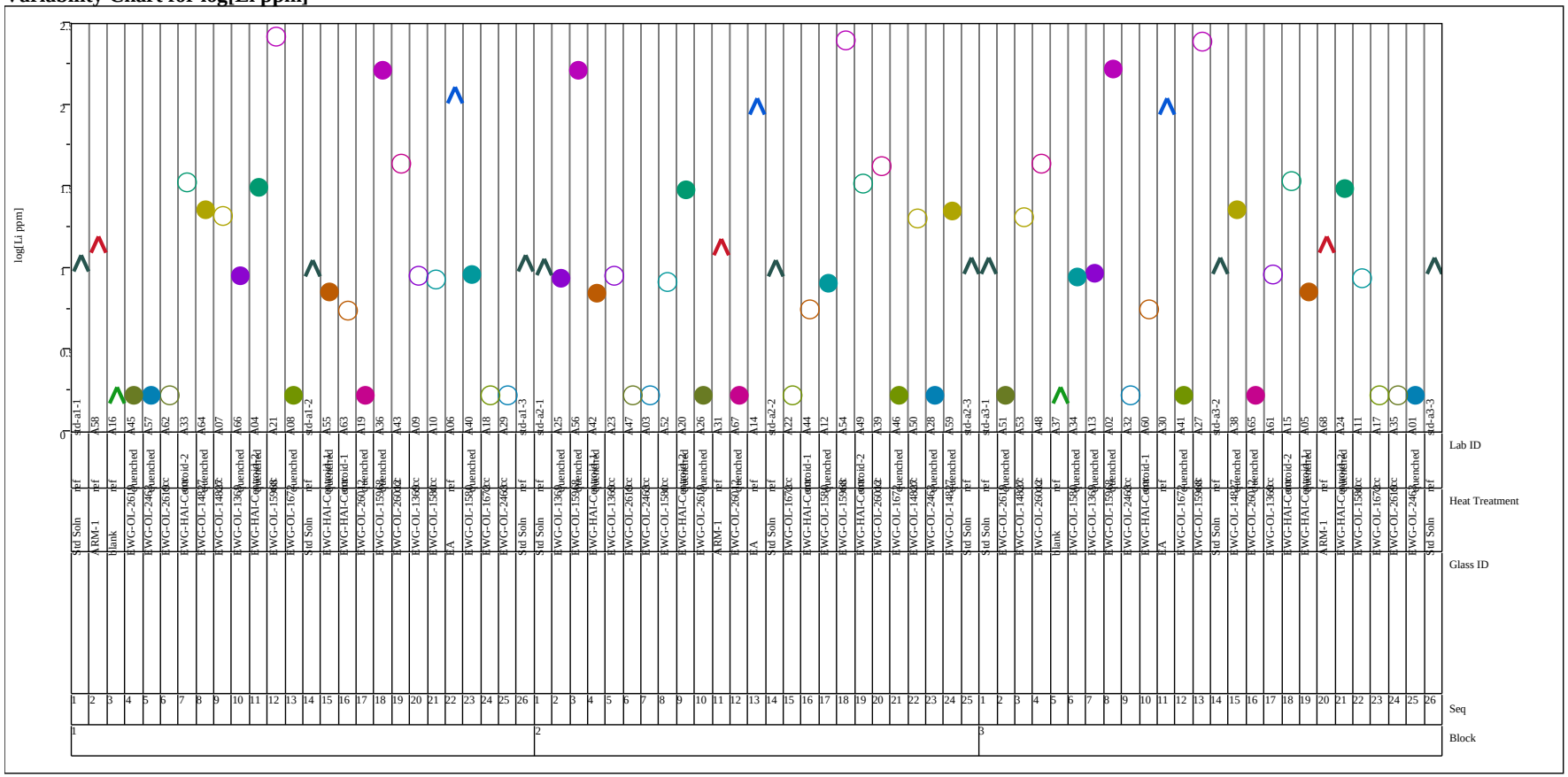


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

Analytical Set=1
Variability Chart for log[Na ppm]

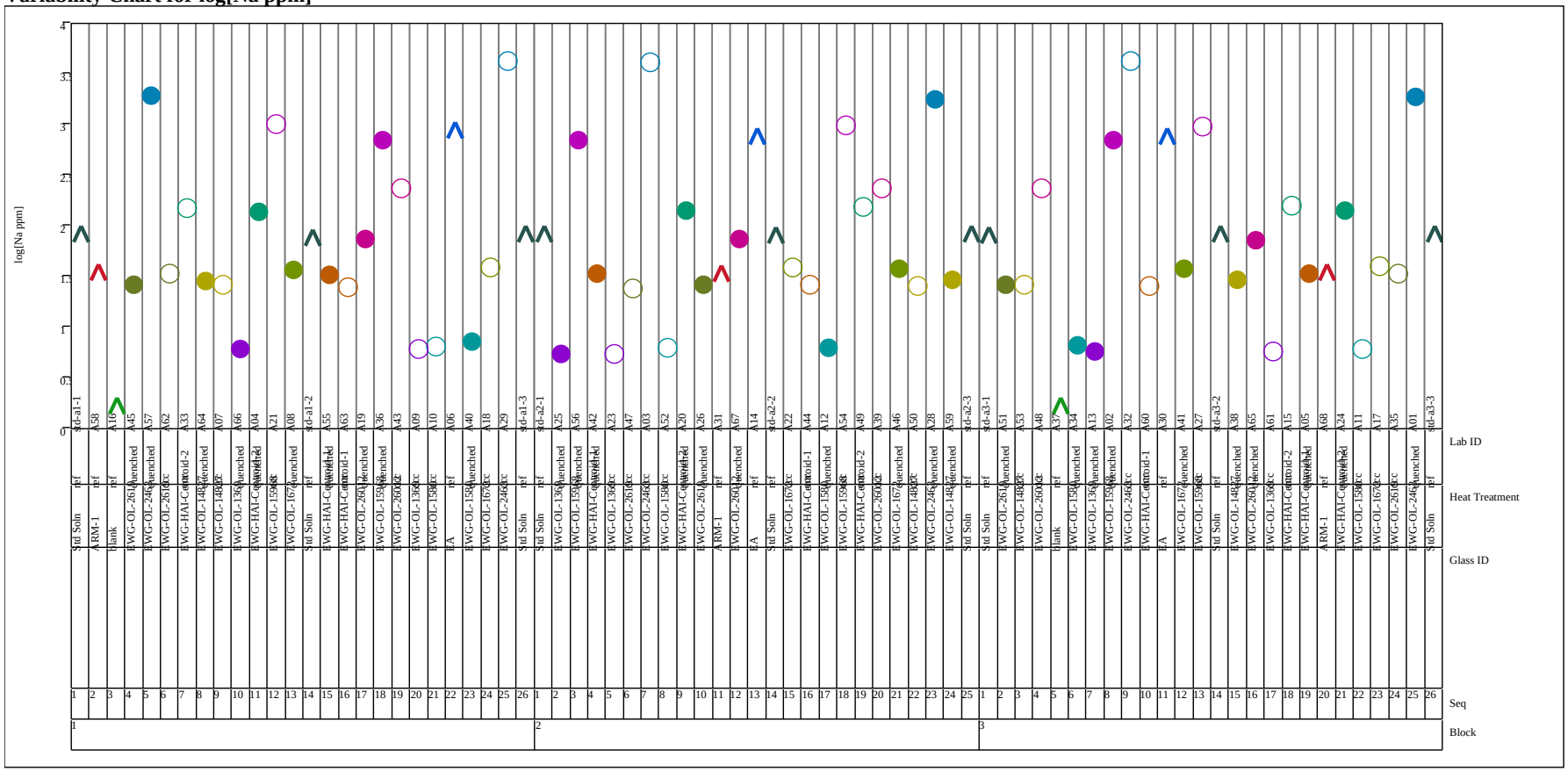


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

Analytical Set=1
Variability Chart for log[P ppm]

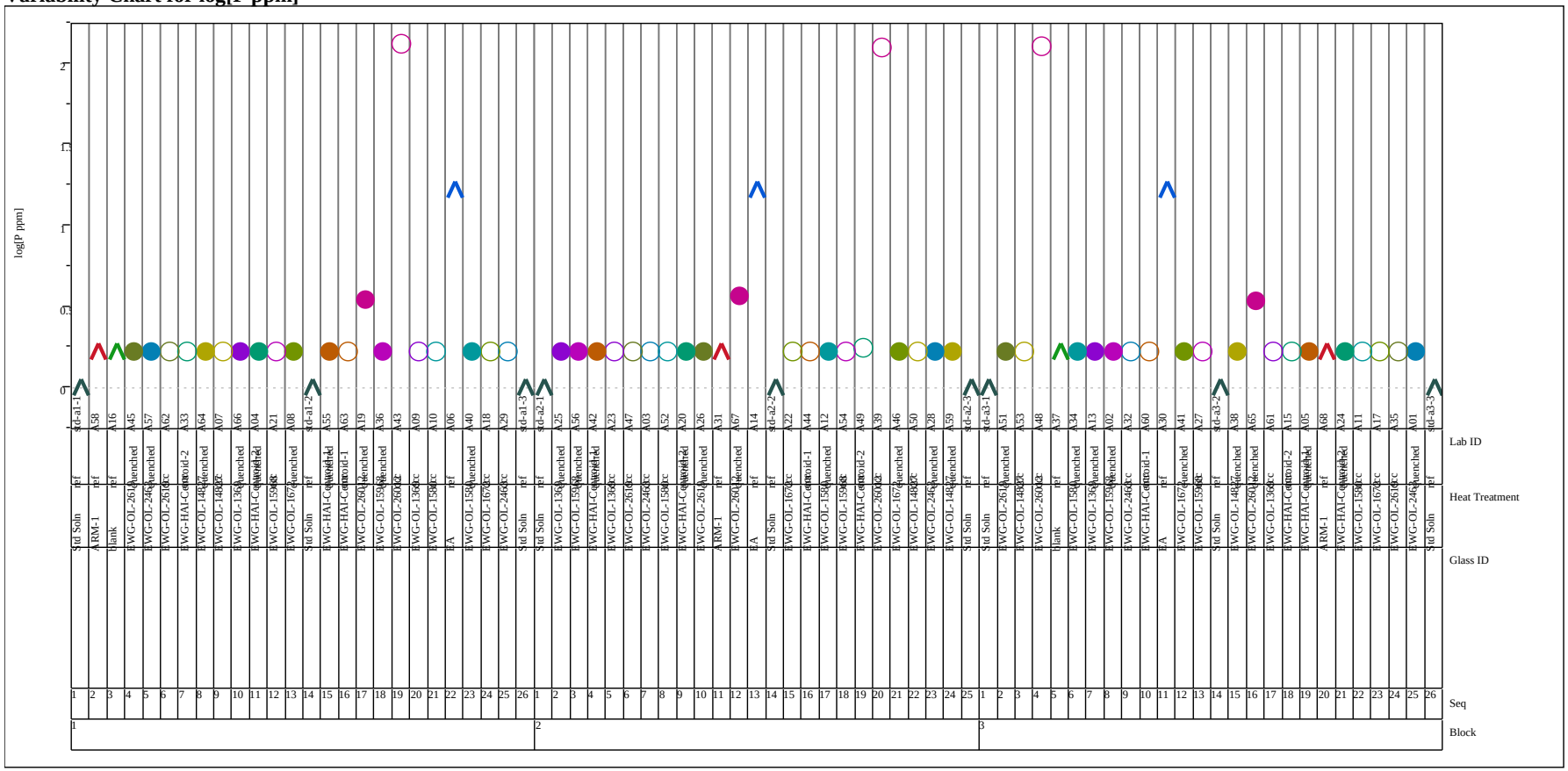


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

Analytical Set=1
Variability Chart for log[Si ppm]

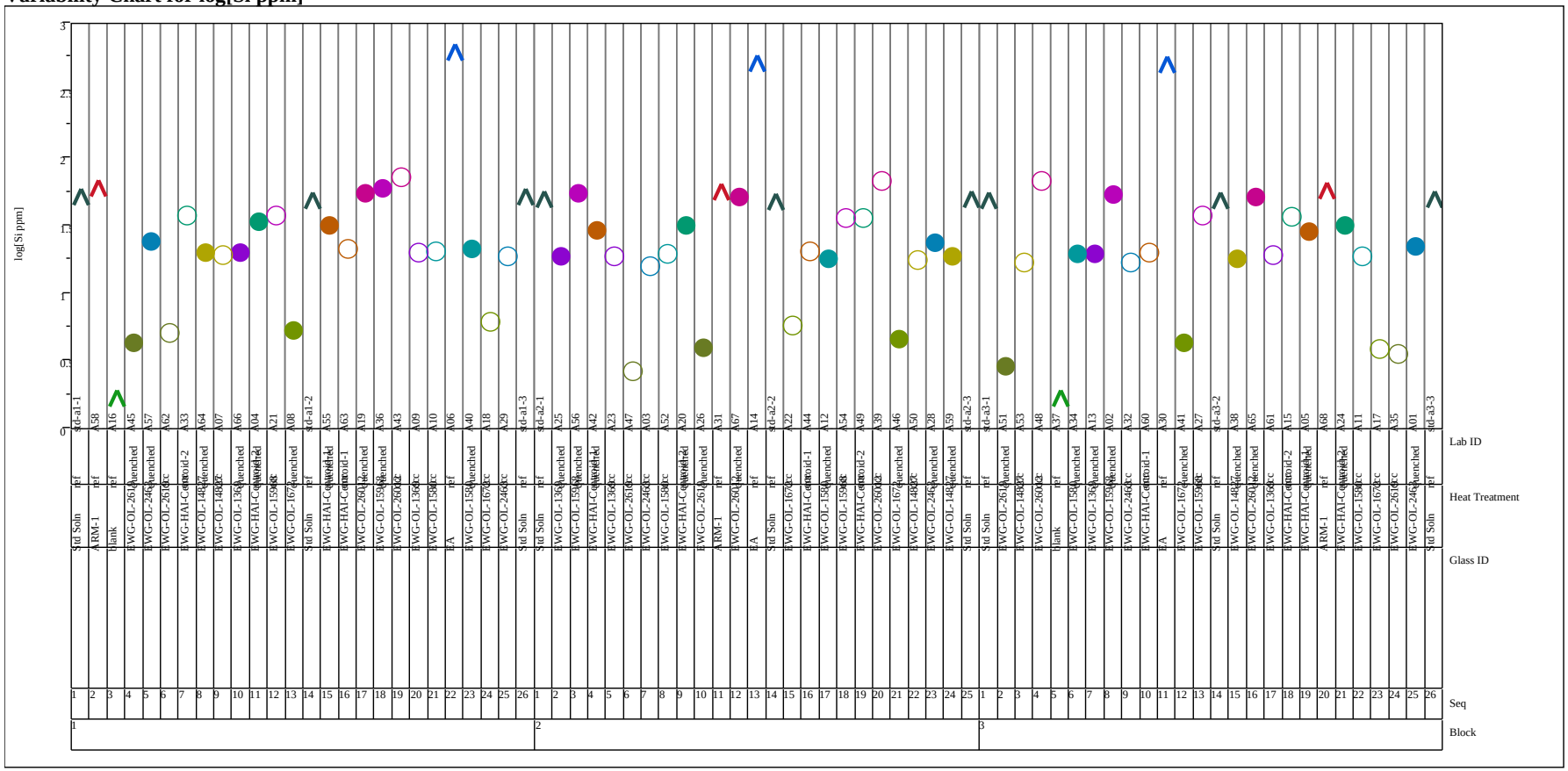


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

Analytical Set=2
Variability Chart for log[B ppm]

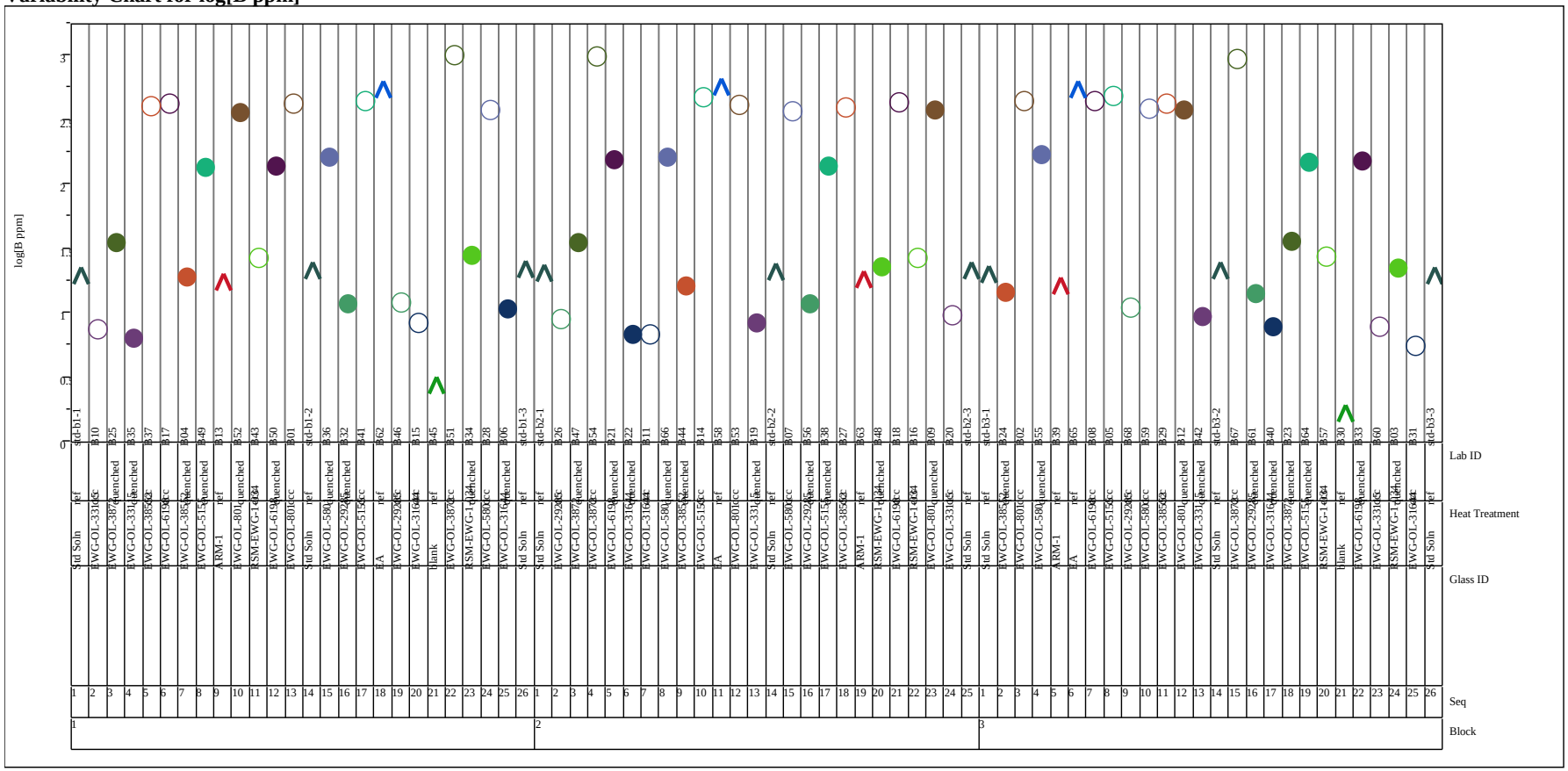


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

Analytical Set=2
Variability Chart for log[Ca ppm]

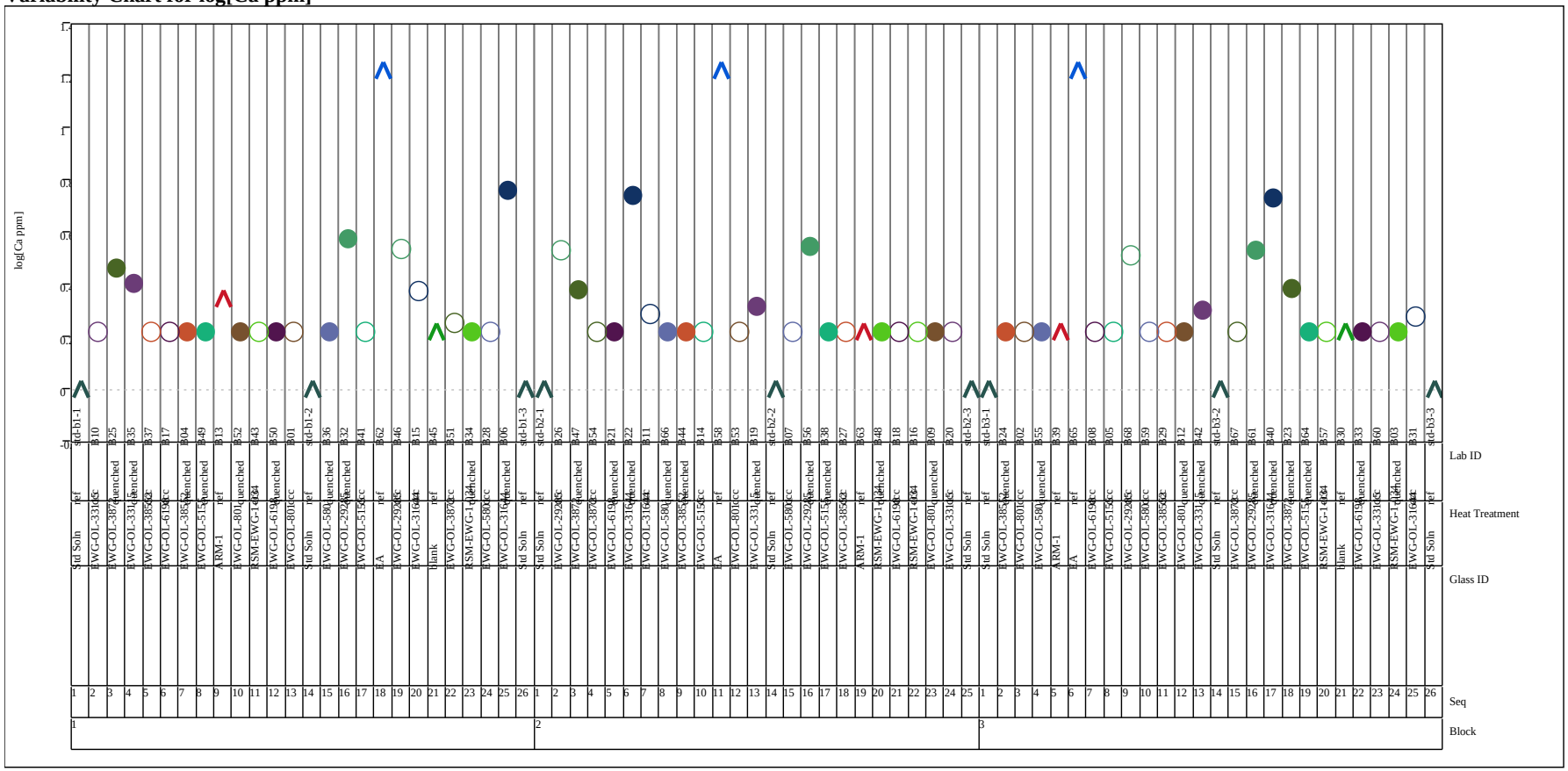


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

Analytical Set=2
Variability Chart for log[K ppm]

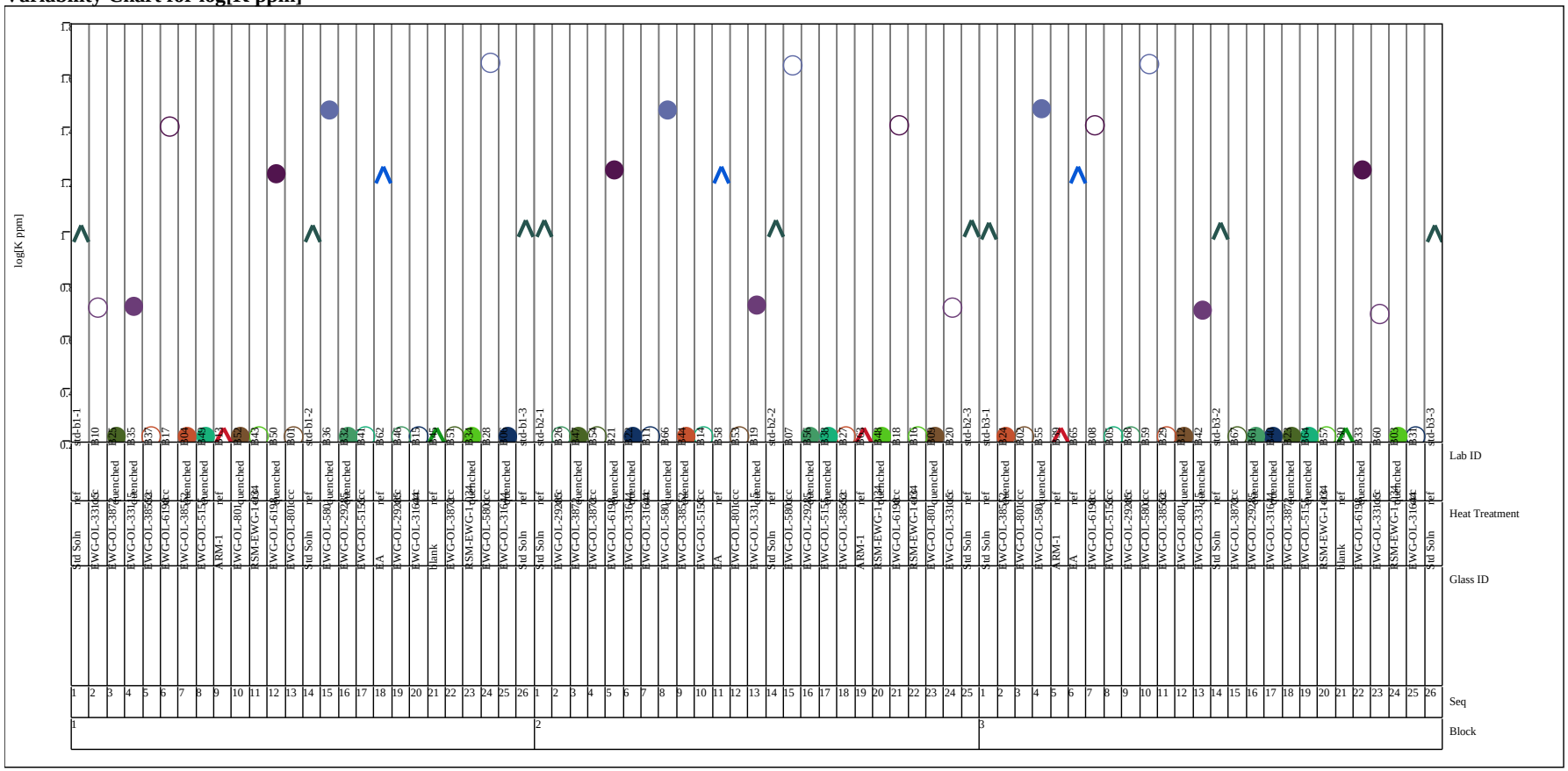


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

Analytical Set=2
Variability Chart for log[Li ppm]

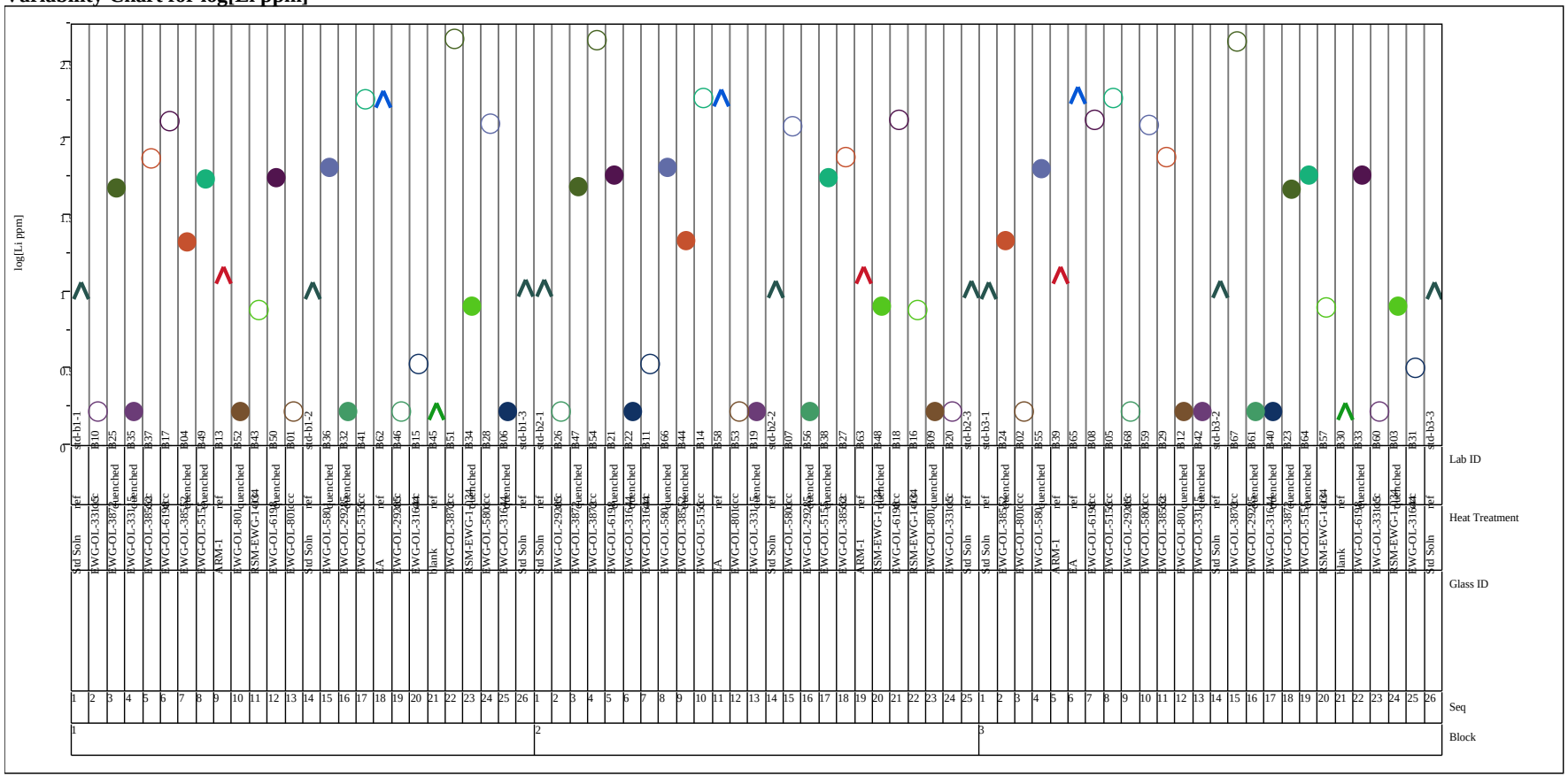


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

Analytical Set=2
Variability Chart for log[Na ppm]

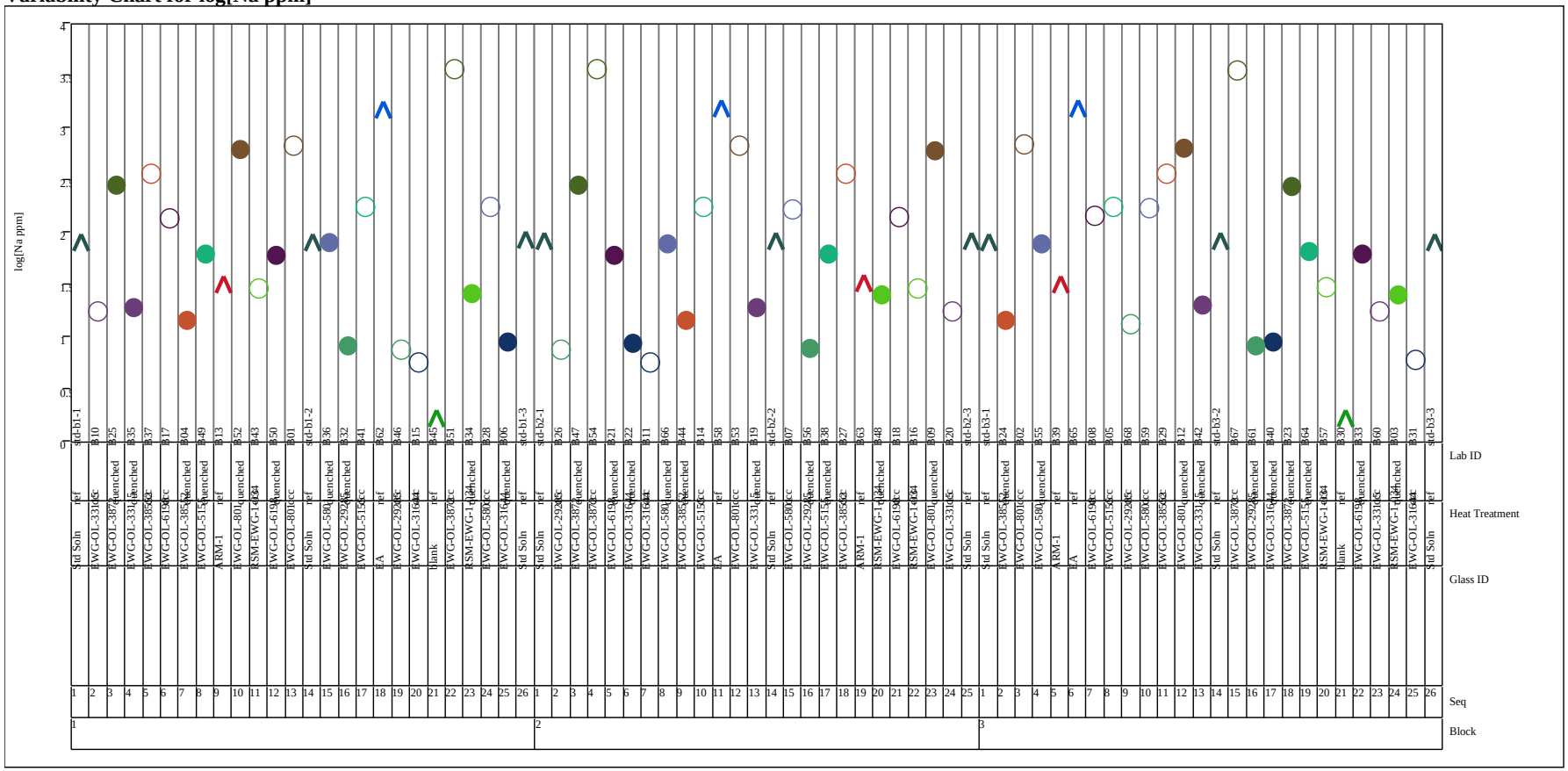


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

Analytical Set=2
Variability Chart for log[P ppm]

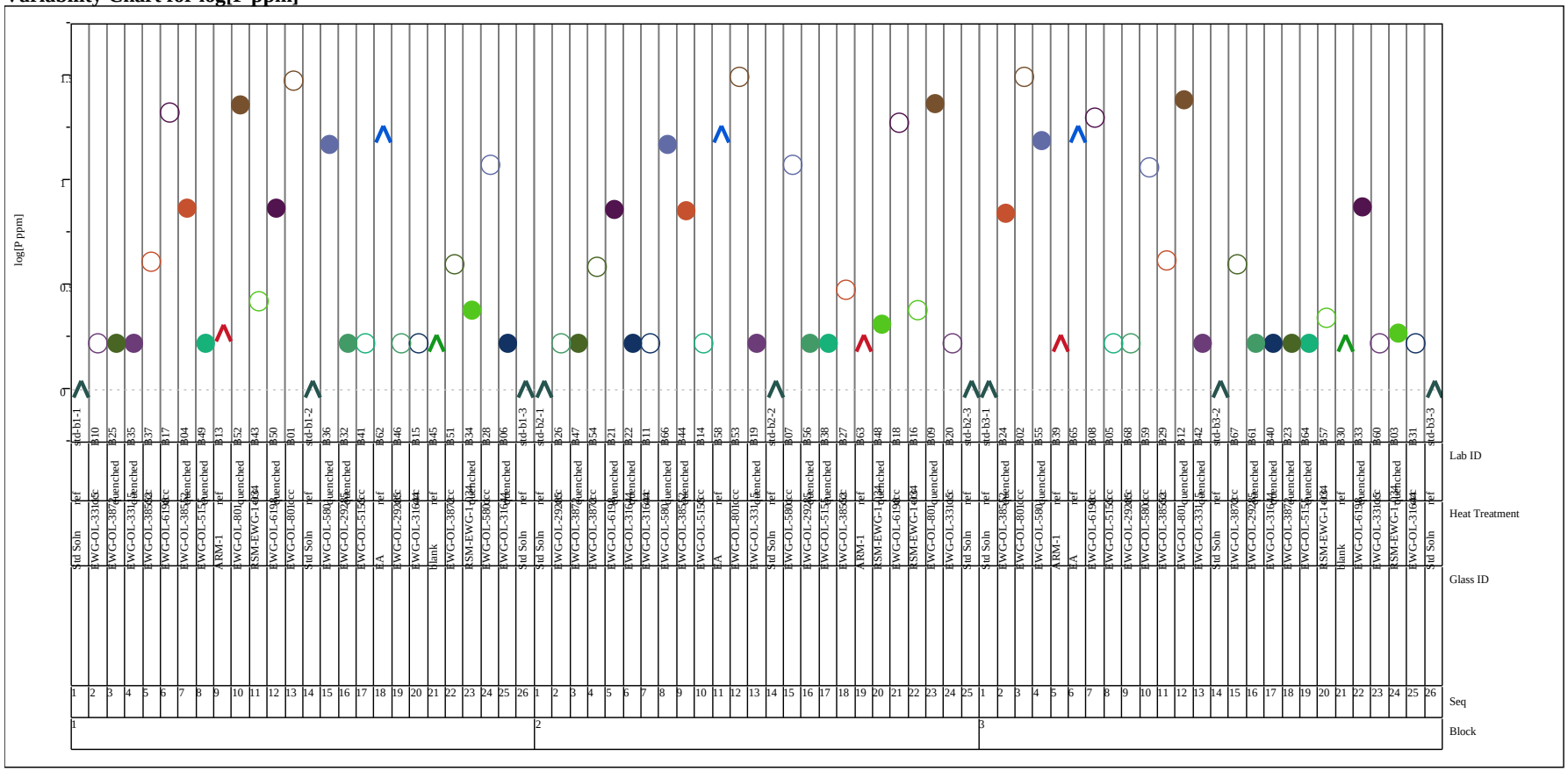


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

Analytical Set=2
Variability Chart for log[Si ppm]

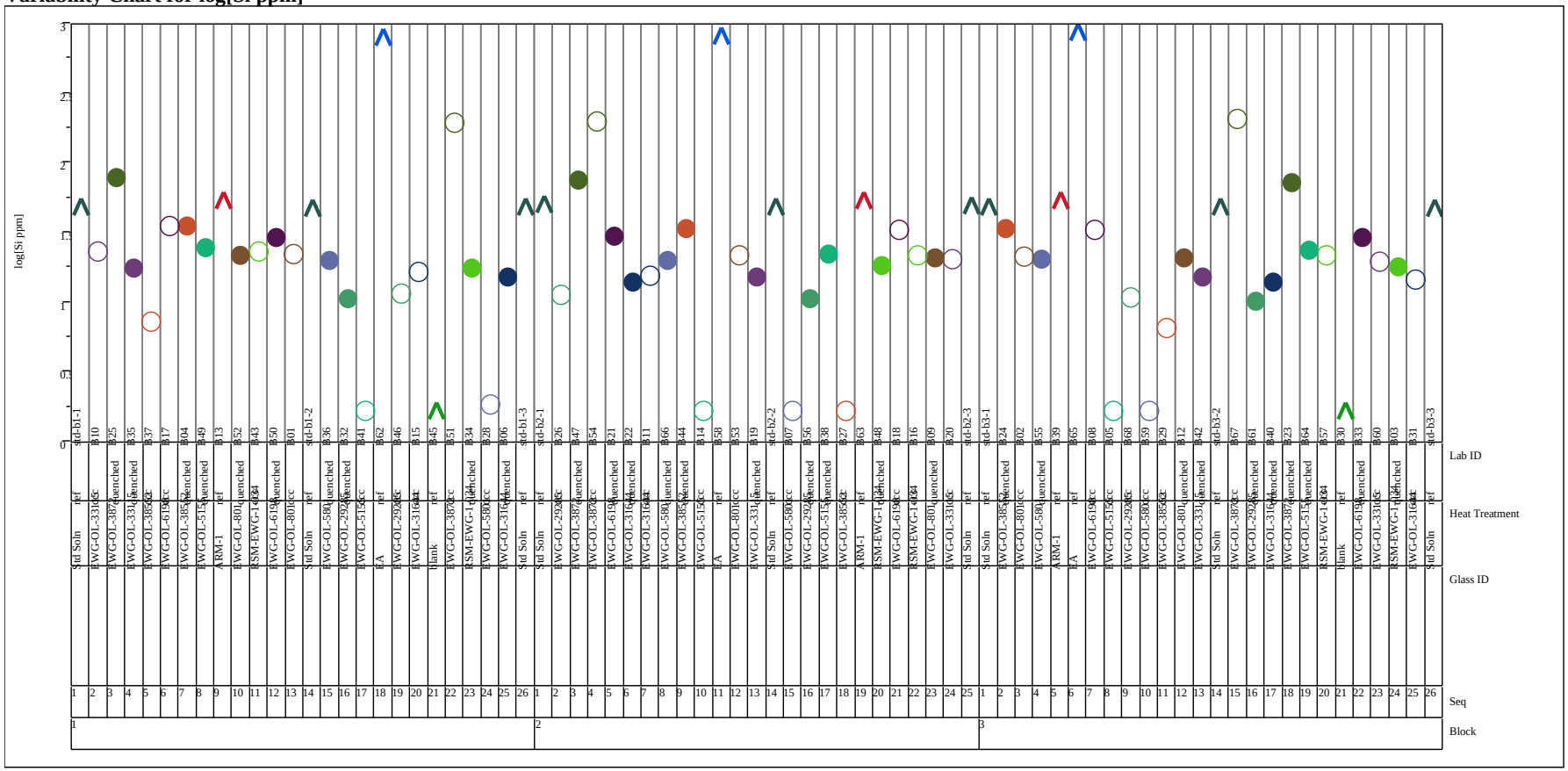


Exhibit B-2. PCT Measurements for Each Glass Grouped by Heat Treatment

Analytical Set=1
Variability Chart for log[B ppm]

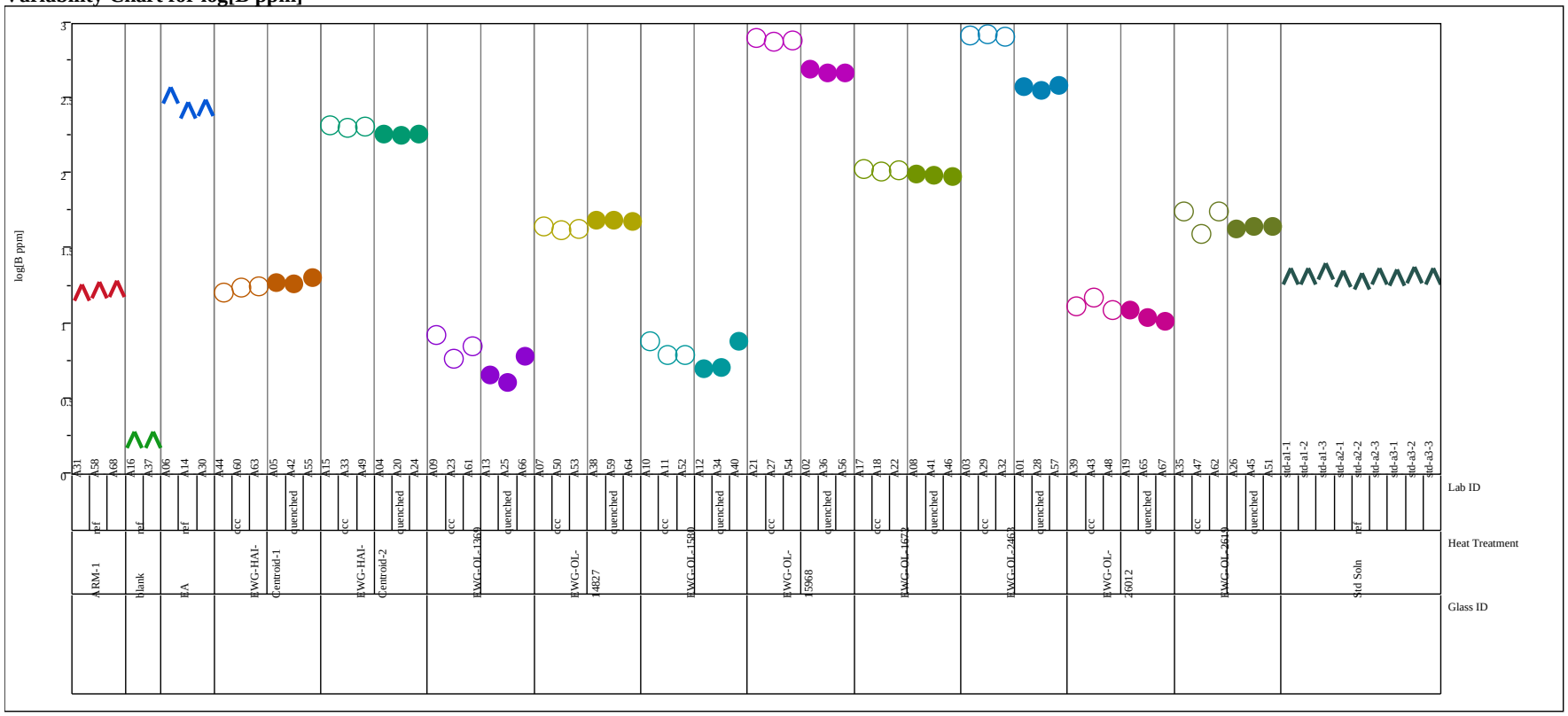


Exhibit B-2. PCT Measurements for Each Glass Grouped by Heat Treatment (continued)

Analytical Set=1
Variability Chart for log[Ca ppm]

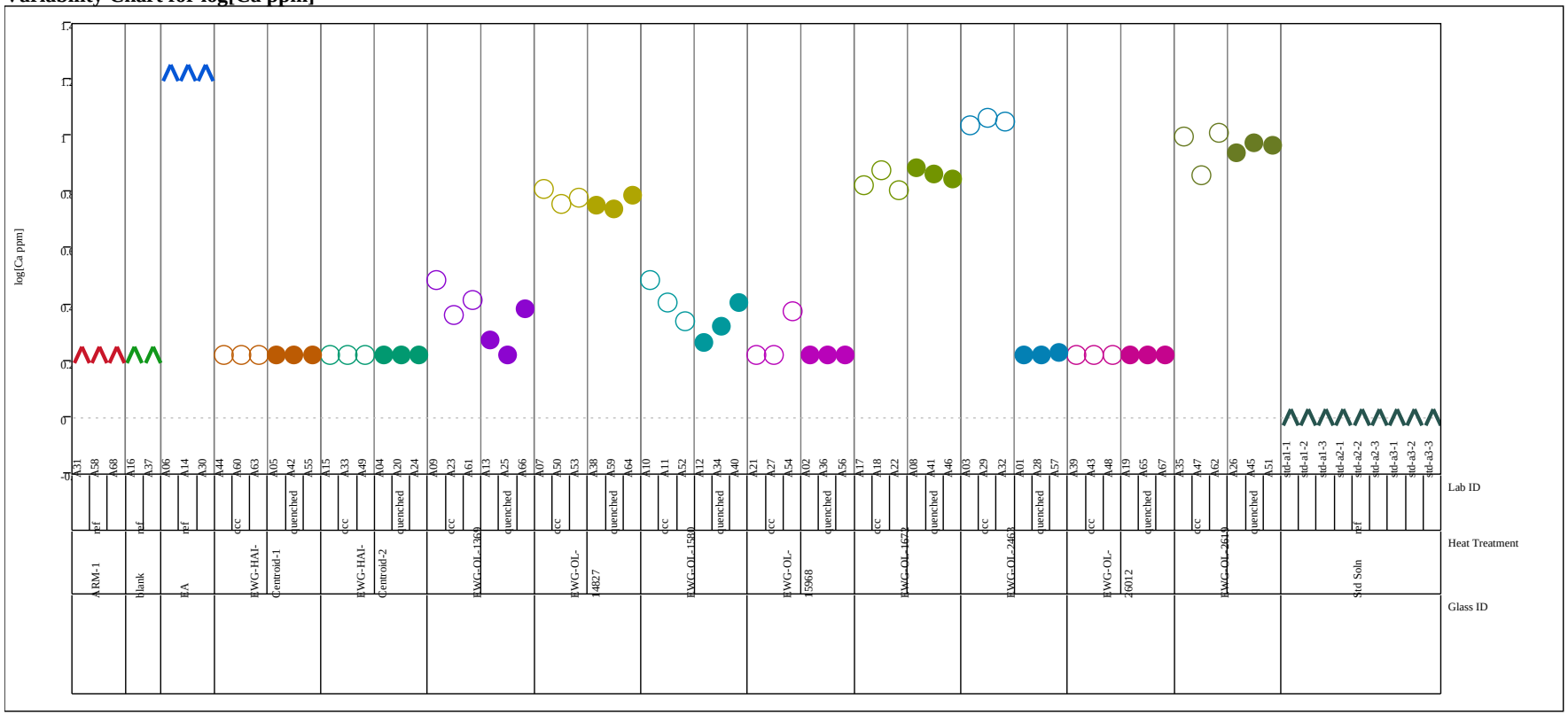


Exhibit B-2. PCT Measurements for Each Glass Grouped by Heat Treatment (continued)

Analytical Set=1
Variability Chart for log[K ppm]

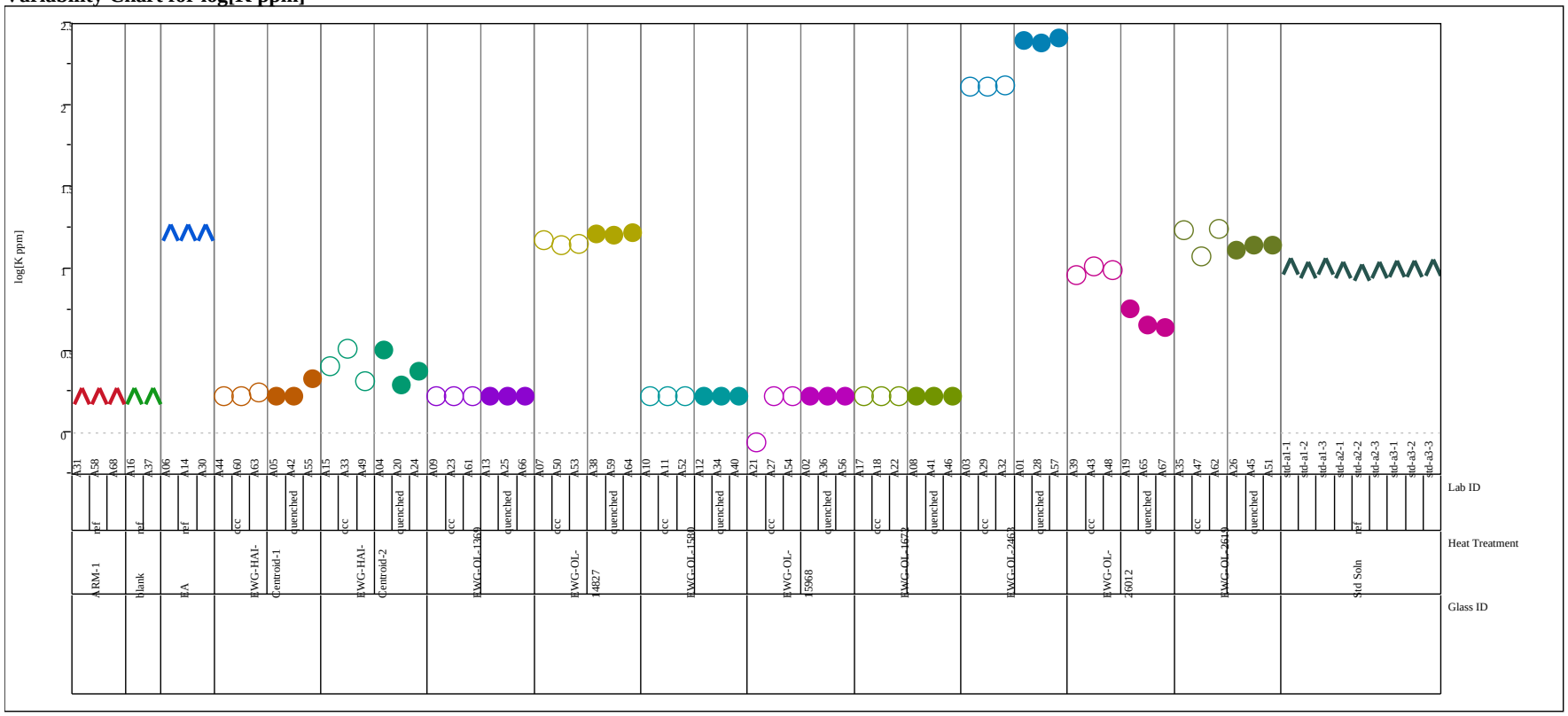


Exhibit B-2. PCT Measurements for Each Glass Grouped by Heat Treatment (continued)

Analytical Set=1
Variability Chart for log[Li ppm]

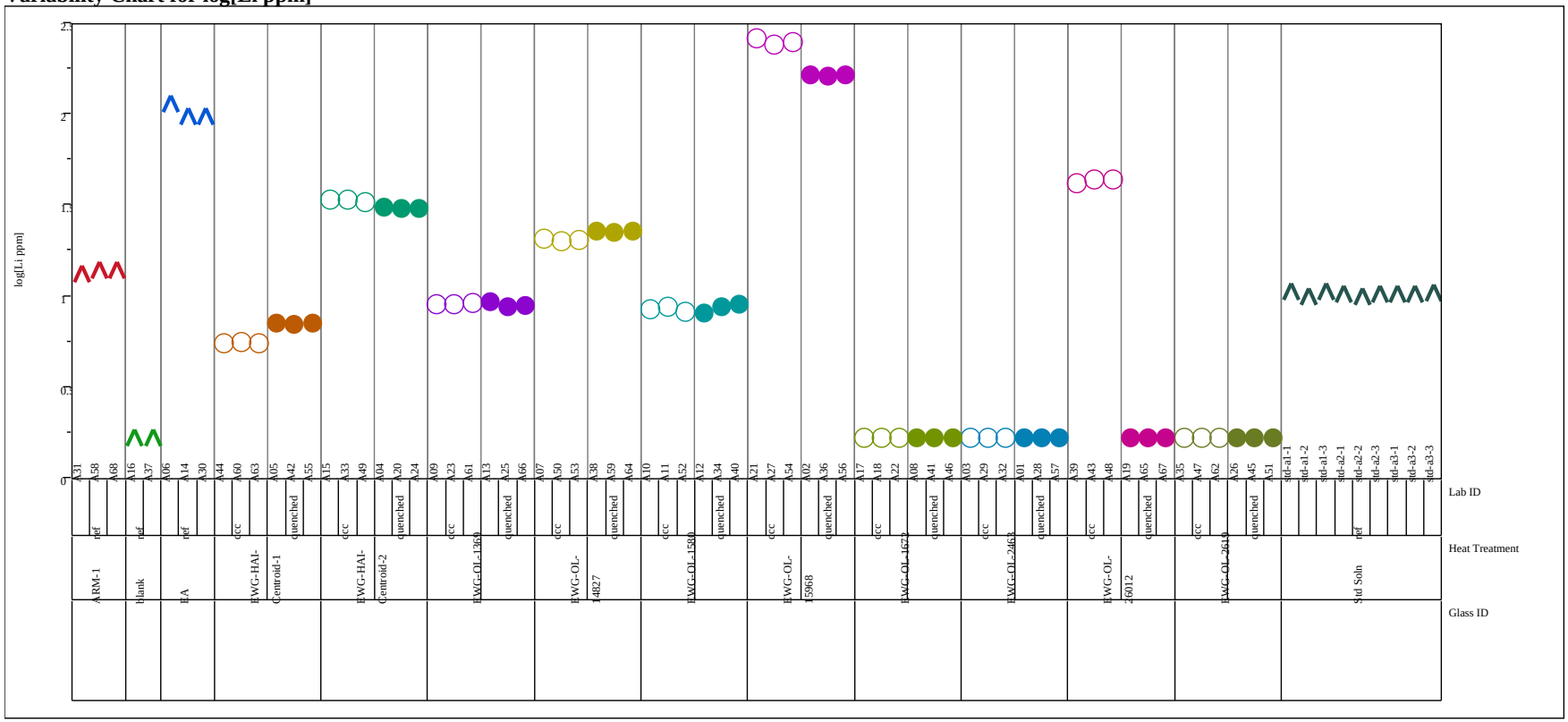


Exhibit B-2. PCT Measurements for Each Glass Grouped by Heat Treatment (continued)

Analytical Set=1
Variability Chart for log[Na ppm]

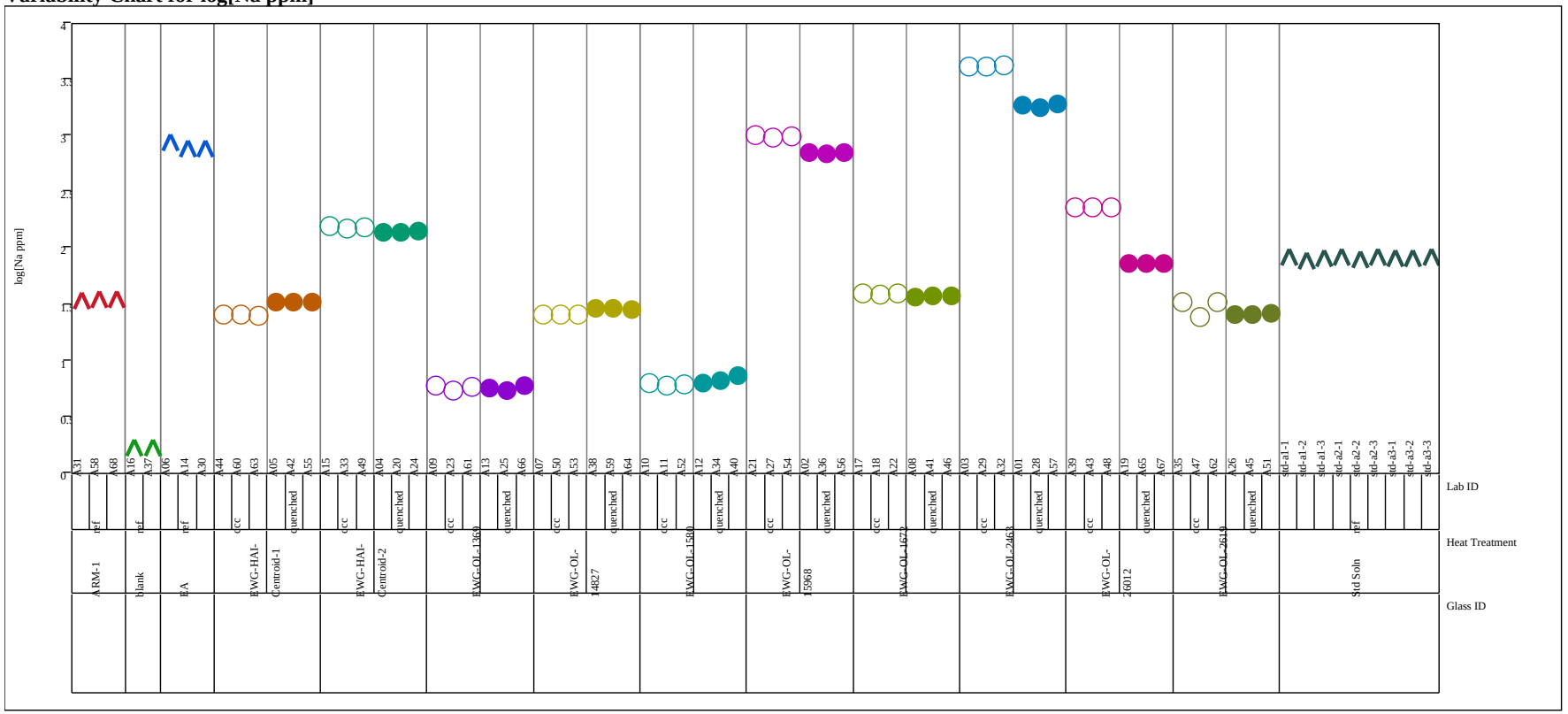


Exhibit B-2. PCT Measurements for Each Glass Grouped by Heat Treatment (continued)

Analytical Set=1
Variability Chart for log[P ppm]

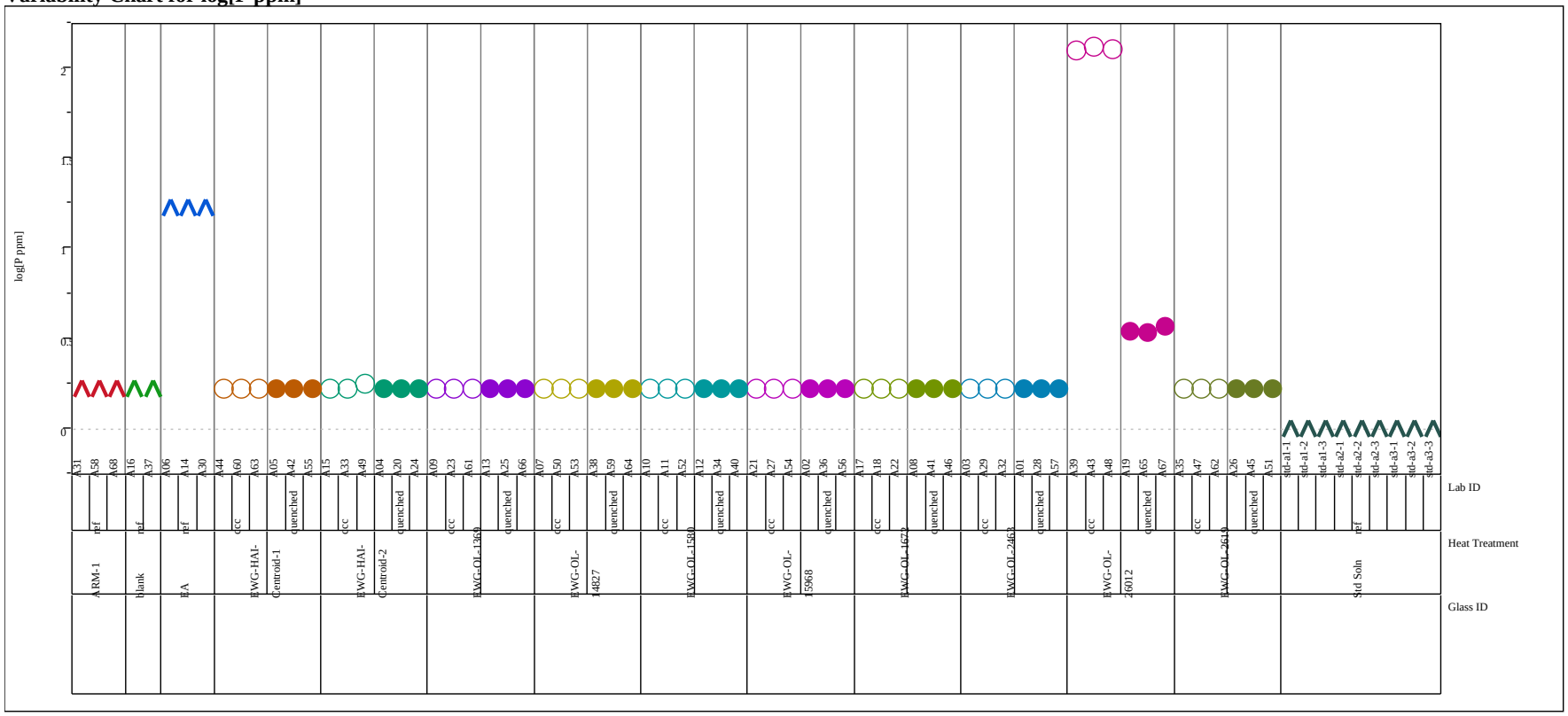


Exhibit B-2. PCT Measurements for Each Glass Grouped by Heat Treatment (continued)

Analytical Set=1
Variability Chart for log[Si ppm]

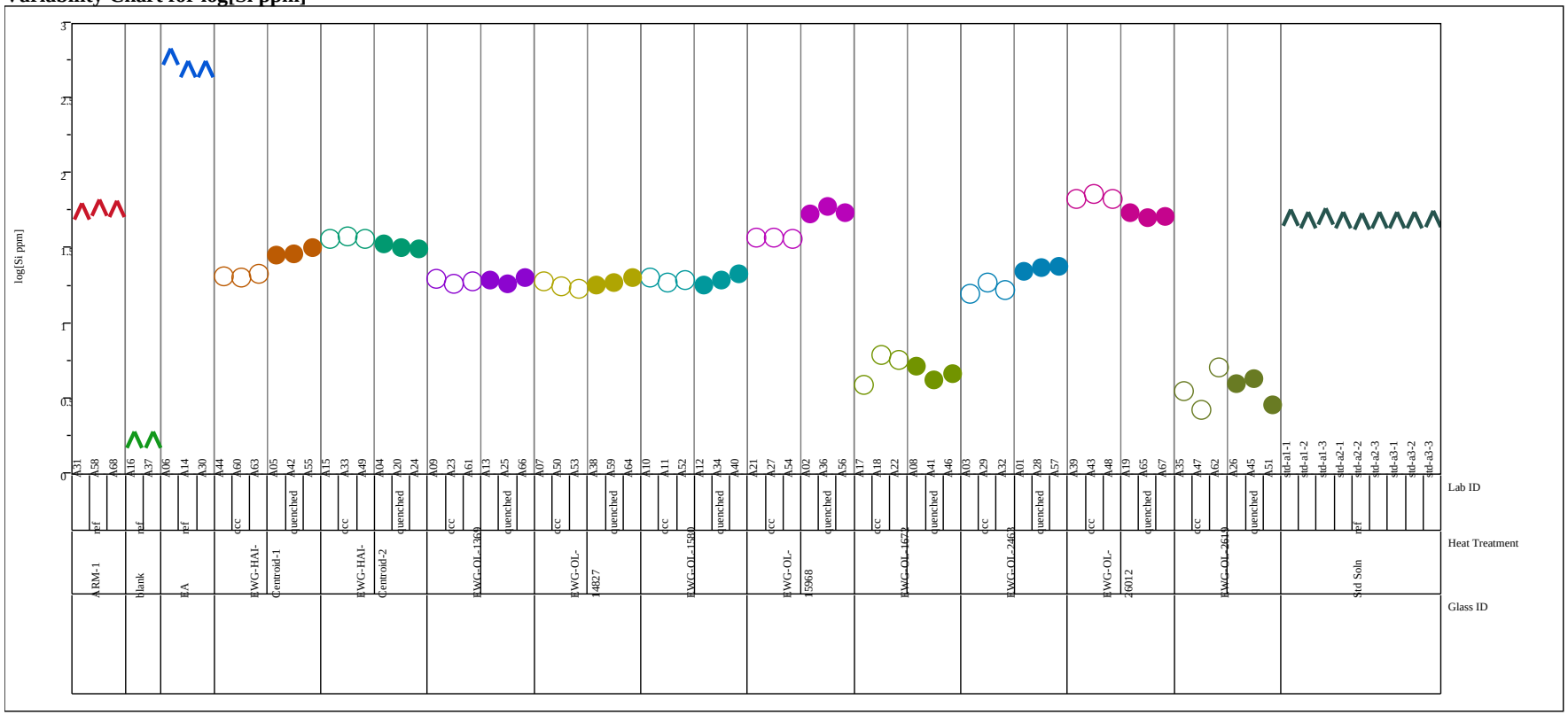


Exhibit B-2. PCT Measurements for Each Glass Grouped by Heat Treatment (continued)

Analytical Set=2
Variability Chart for log[B ppm]

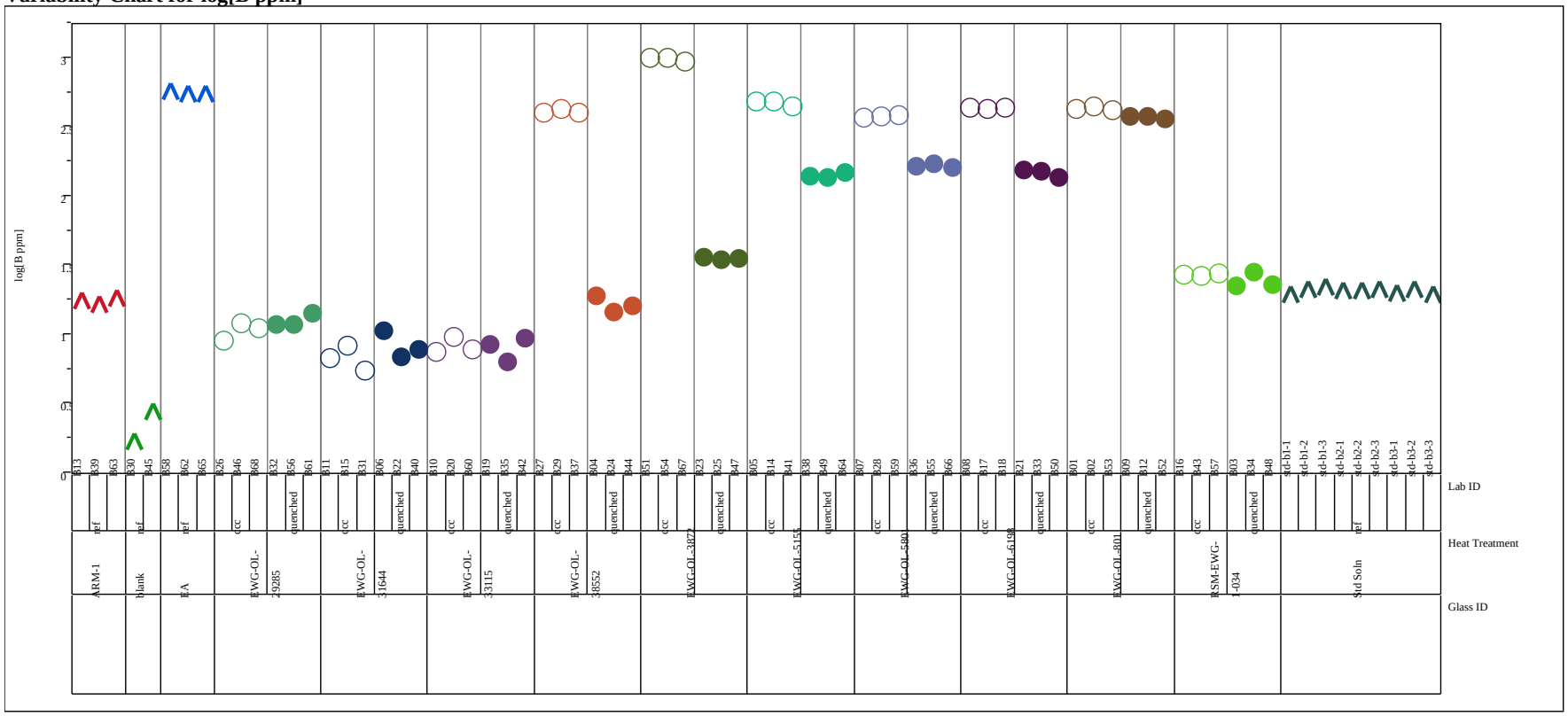


Exhibit B-2. PCT Measurements for Each Glass Grouped by Heat Treatment (continued)

Analytical Set=2
Variability Chart for log[Ca ppm]

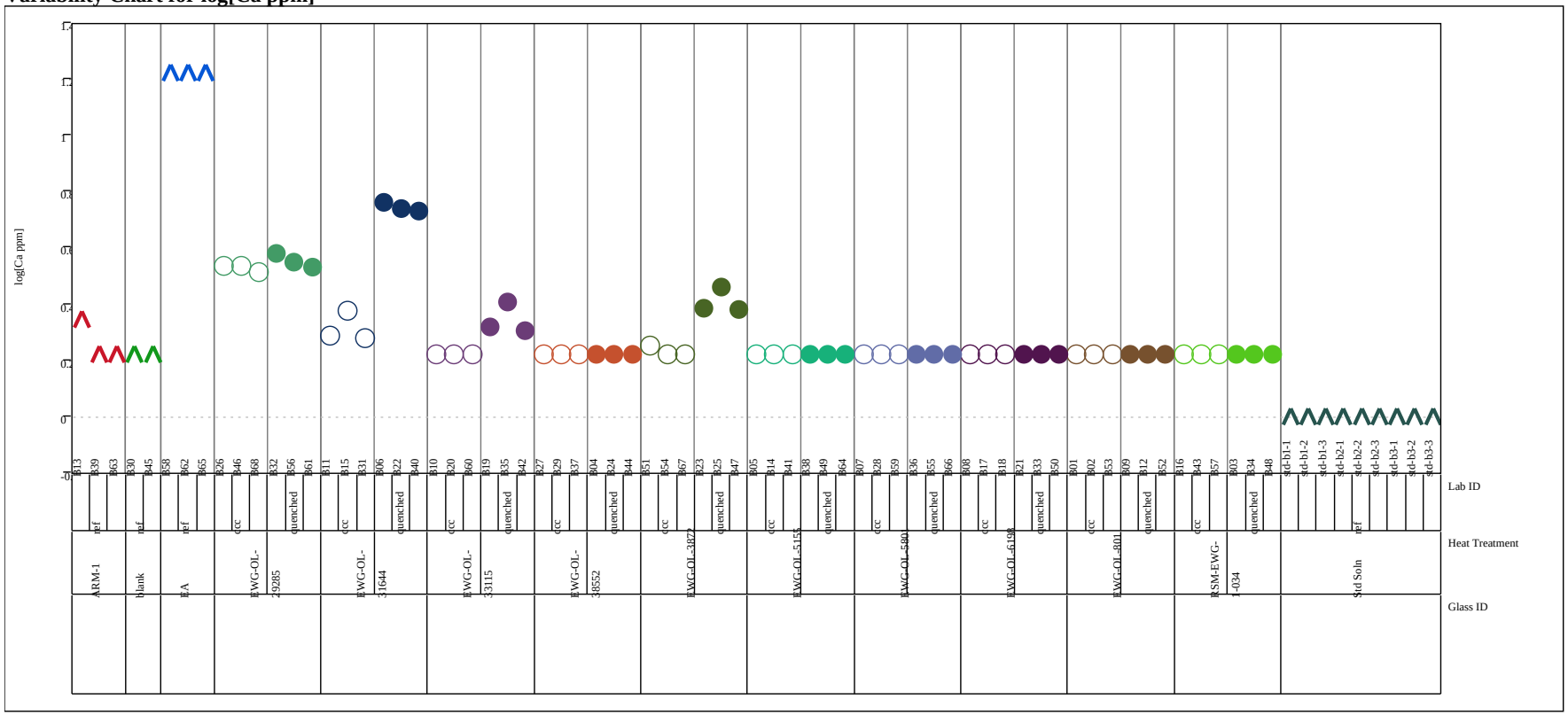


Exhibit B-2. PCT Measurements for Each Glass Grouped by Heat Treatment (continued)

Analytical Set=2
Variability Chart for log[K ppm]

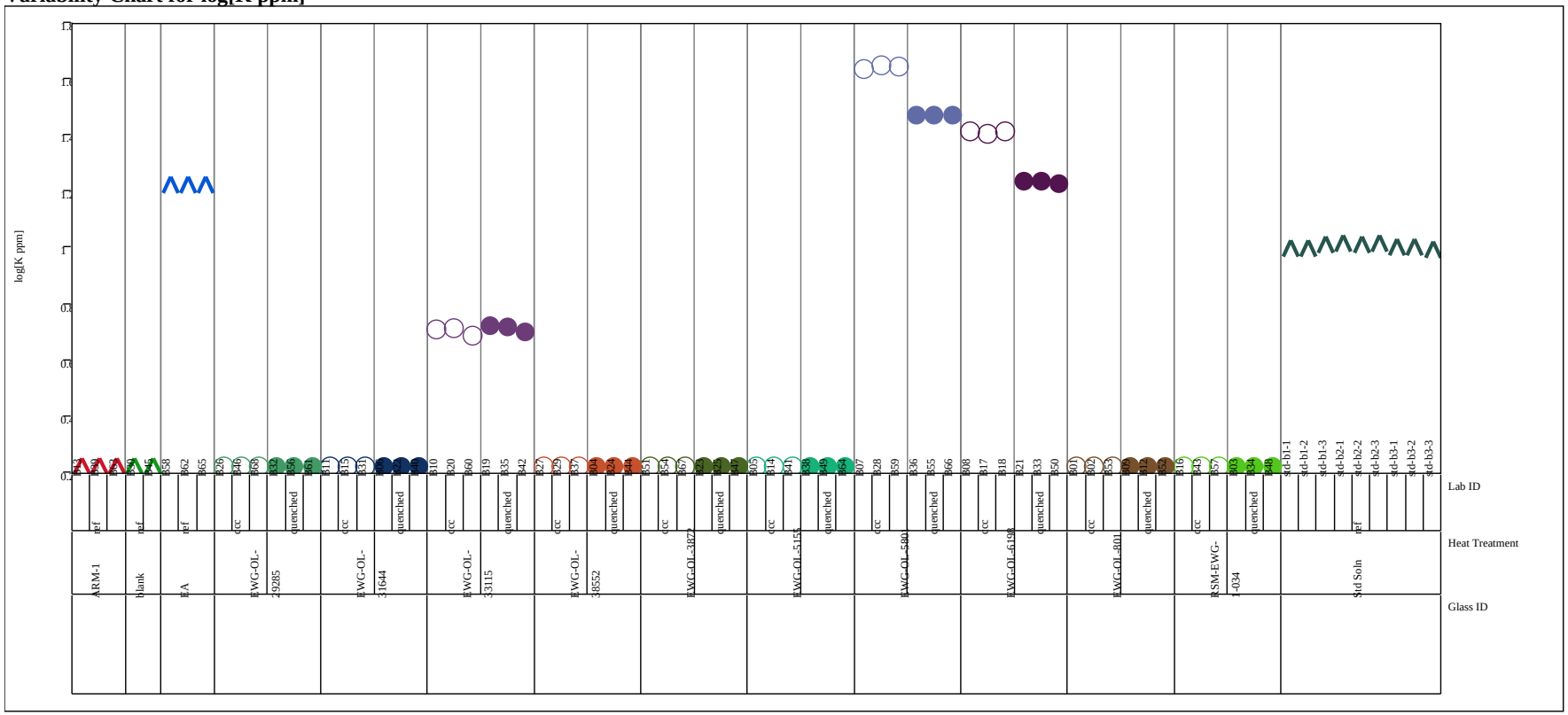


Exhibit B-2. PCT Measurements for Each Glass Grouped by Heat Treatment (continued)

Analytical Set=2
Variability Chart for log[Li ppm]

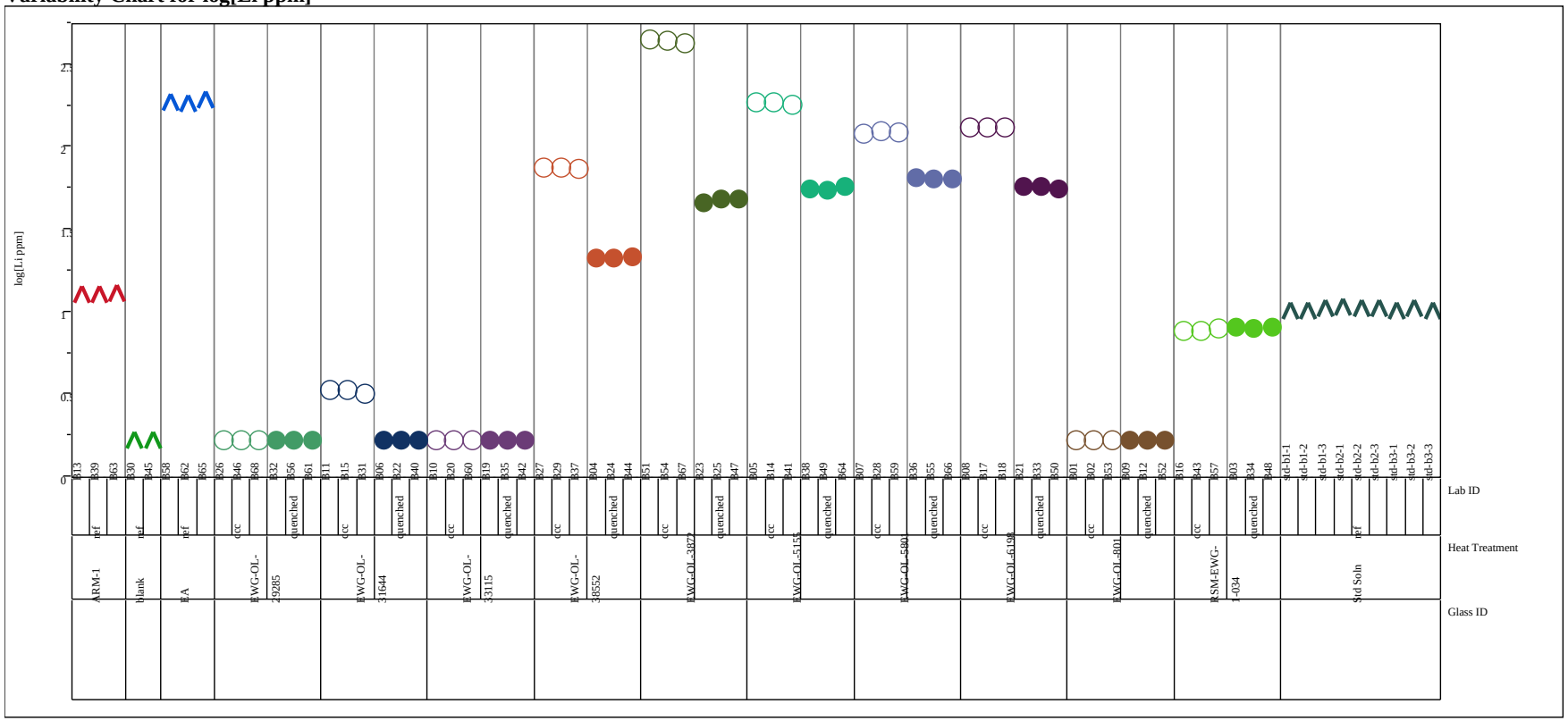


Exhibit B-2. PCT Measurements for Each Glass Grouped by Heat Treatment (continued)

Analytical Set=2
Variability Chart for log[Na ppm]

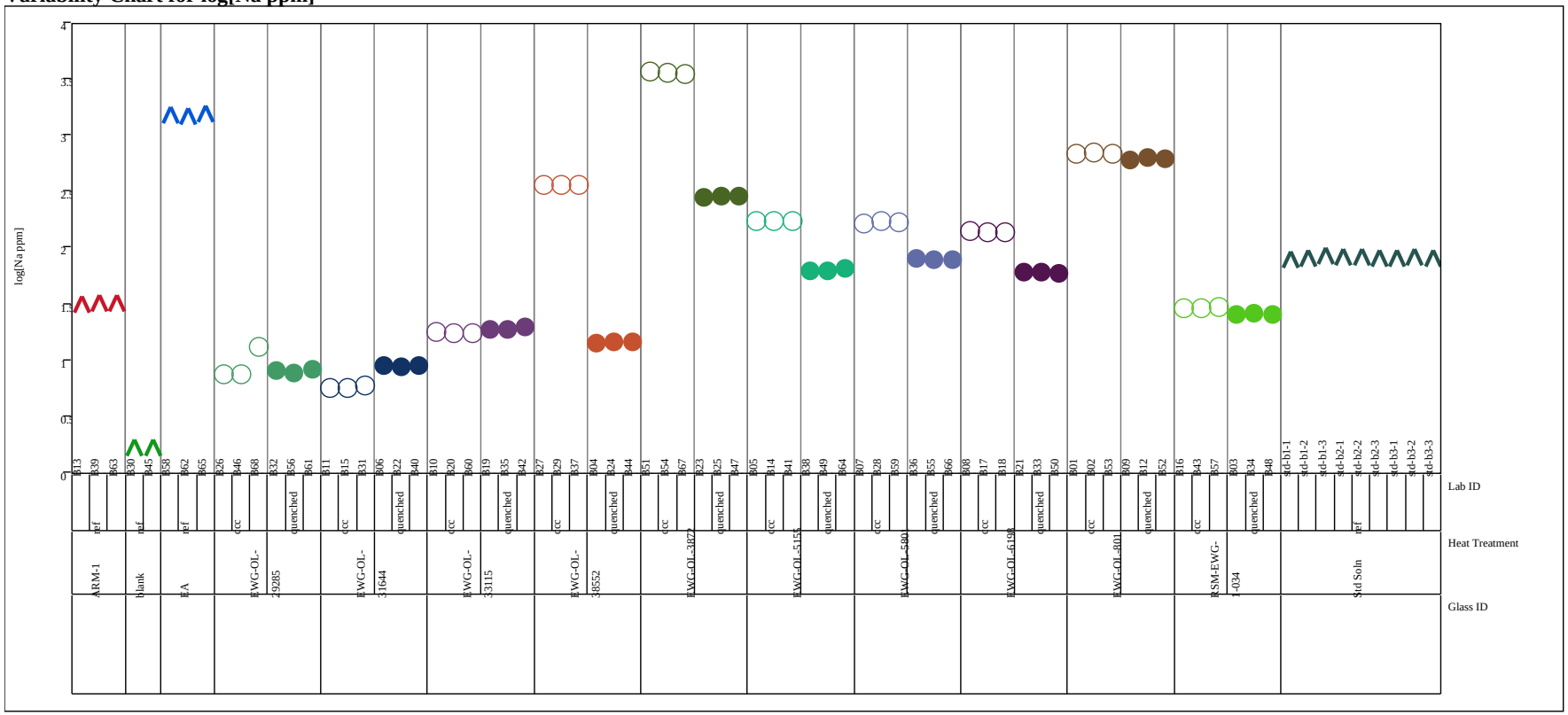


Exhibit B-2. PCT Measurements for Each Glass Grouped by Heat Treatment (continued)

Analytical Set=2
Variability Chart for log[P ppm]

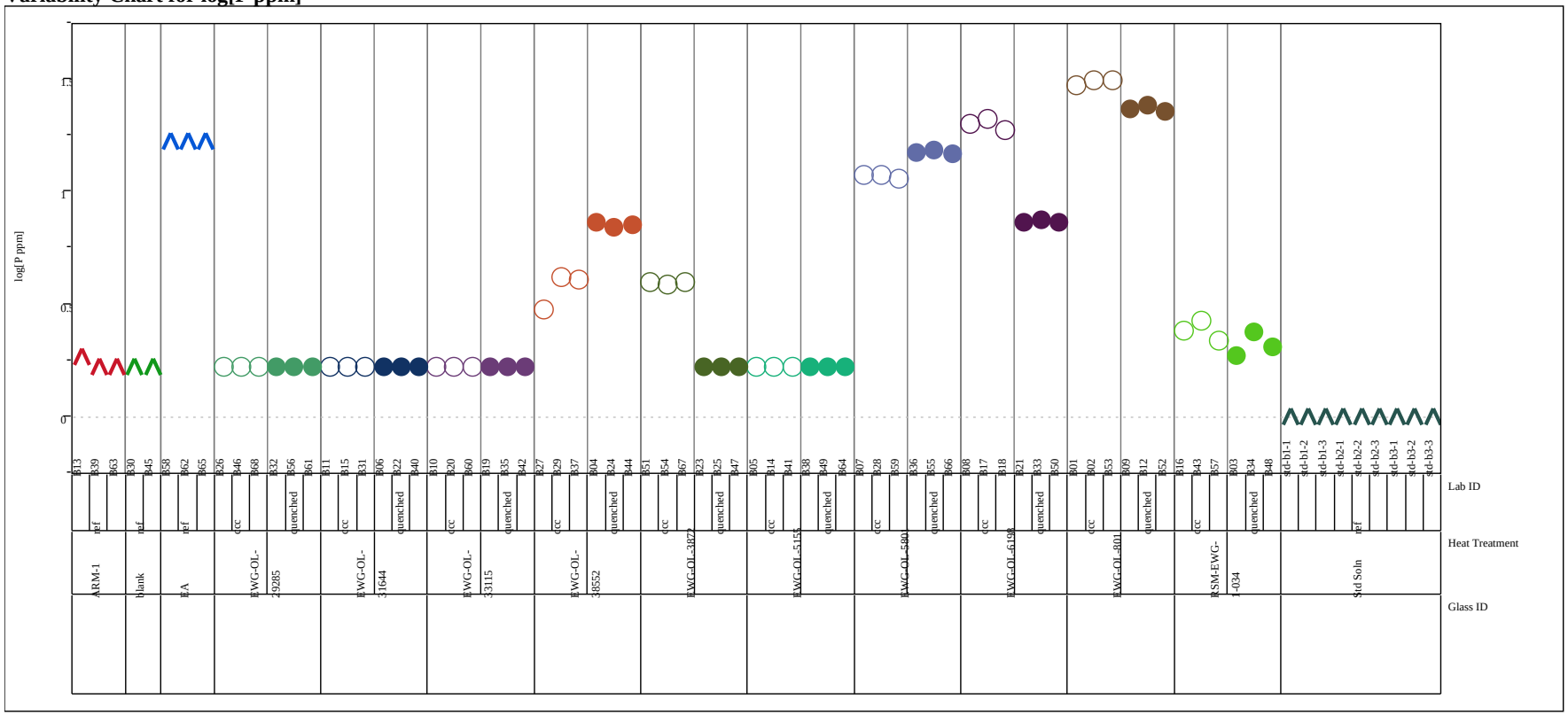


Exhibit B-2. PCT Measurements for Each Glass Grouped by Heat Treatment (continued)

Analytical Set=2
Variability Chart for log[Si ppm]

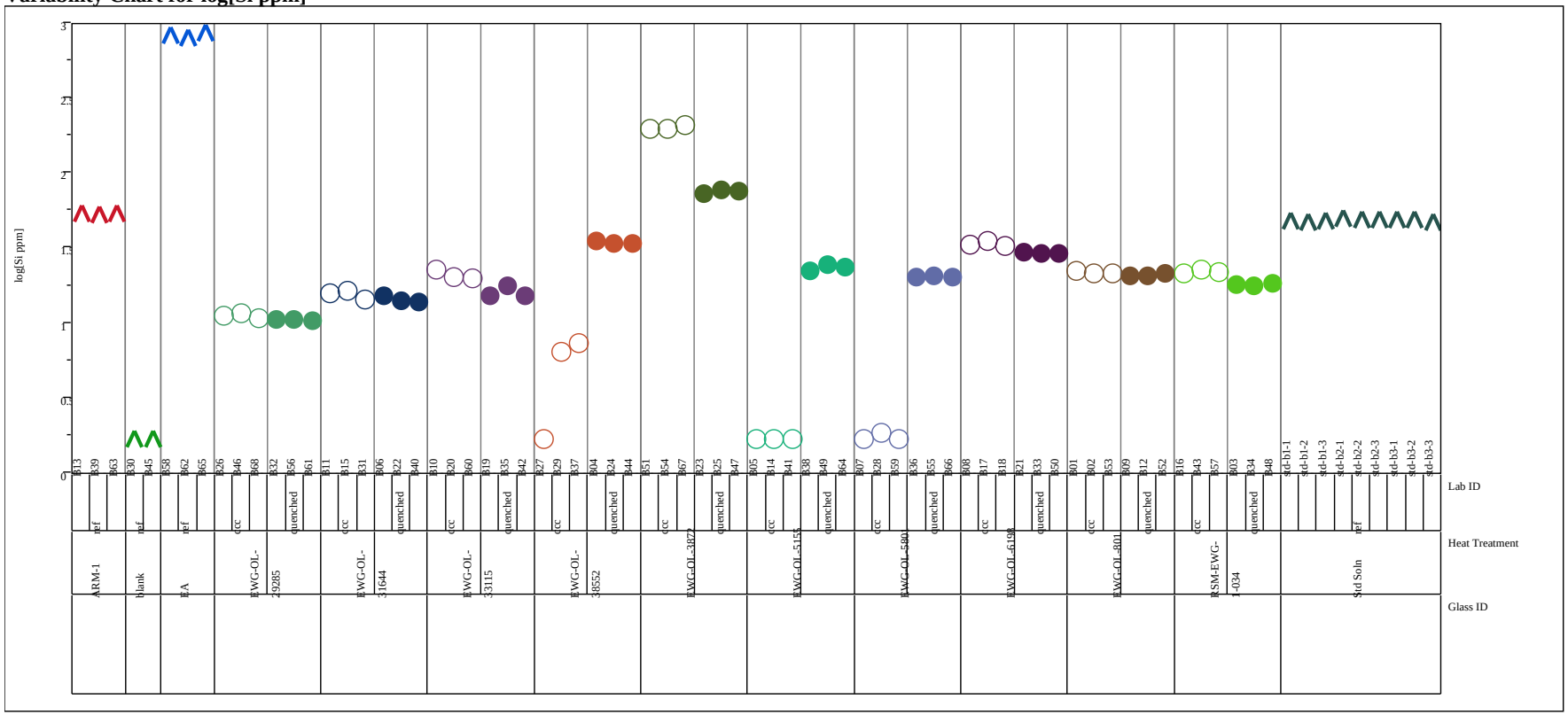
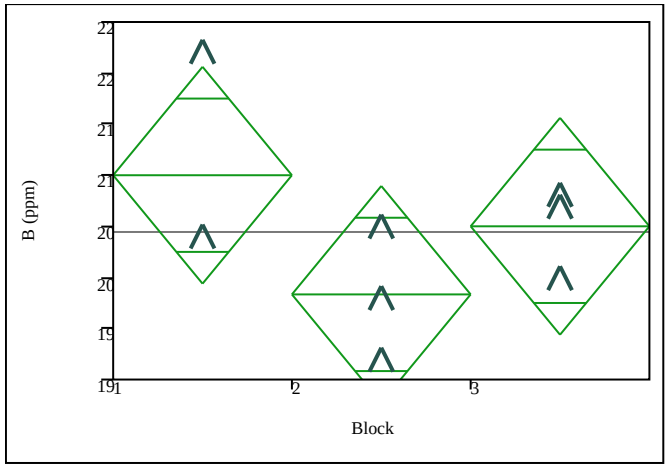


Exhibit B-3. Measurements of the Solution Standard by Analytical Block

Oneway Analysis of B (ppm) By Block Glass ID=Std Soln, Set=1
Reference Value = 20



Oneway Anova
Summary of Fit

Rsquare	0.377705
Adj Rsquare	0.170274
Root Mean Square Error	0.751295
Mean of Response	20.44444
Observations (or Sum Wgts)	9

Analysis of Variance

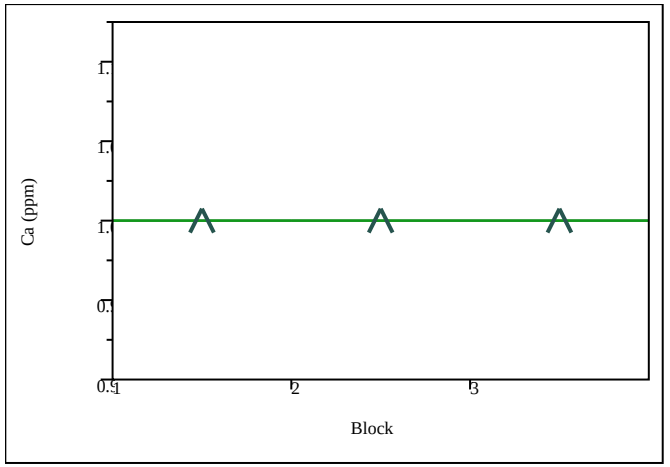
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	2	2.0555556	1.02778	1.8209	0.2410
Error	6	3.3866667	0.56444		
C. Total	8	5.4422222			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	21.0000	0.43376	19.939	22.061
2	3	19.8333	0.43376	18.772	20.895
3	3	20.5000	0.43376	19.439	21.561

Std Error uses a pooled estimate of error variance

Oneway Analysis of Ca (ppm) By Block Glass ID=Std Soln, Set=1
Reference Value = 0



Oneway Anova
Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	1
Observations (or Sum Wgts)	9

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	2	0	0	.	.
Error	6	0	0		
C. Total	8	0			

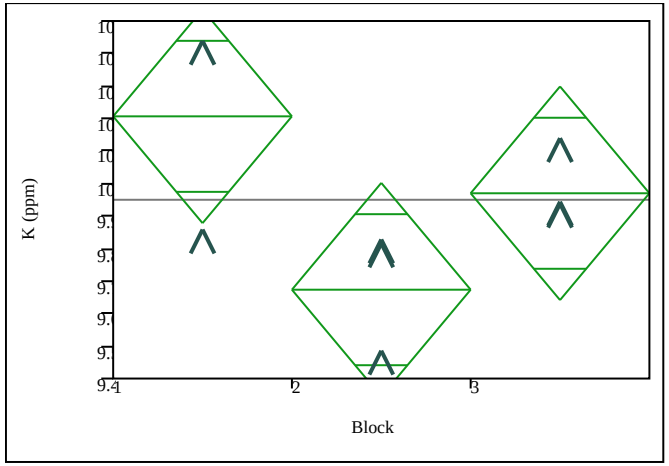
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	1.00000	0	1.0000	1.0000
2	3	1.00000	0	1.0000	1.0000
3	3	1.00000	0	1.0000	1.0000

Std Error uses a pooled estimate of error variance

Exhibit B-3. Measurements of the Solution Standard by Analytical Block (continued)

Oneway Analysis of K (ppm) By Block Glass ID=Std Soln, Set=1
Reference Value = 10



Oneway Anova
Summary of Fit

Rsquare	0.569013
Adj Rsquare	0.42535
Root Mean Square Error	0.23257
Mean of Response	9.95
Observations (or Sum Wgts)	9

Analysis of Variance

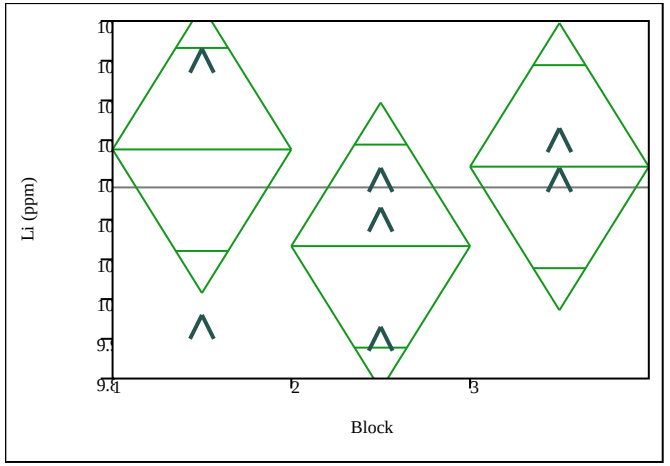
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	2	0.42846667	0.214233	3.9608	0.0801
Error	6	0.32453333	0.054089		
C. Total	8	0.75300000			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	10.2067	0.13427	9.8781	10.535
2	3	9.6733	0.13427	9.3448	10.002
3	3	9.9700	0.13427	9.6414	10.299

Std Error uses a pooled estimate of error variance

Oneway Analysis of Li (ppm) By Block Glass ID=Std Soln, Set=1
Reference Value = 10



Oneway Anova
Summary of Fit

Rsquare	0.204762
Adj Rsquare	-0.06032
Root Mean Square Error	0.255799
Mean of Response	10.28111
Observations (or Sum Wgts)	9

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	2	0.10108889	0.050544	0.7725	0.5029
Error	6	0.39260000	0.065433		
C. Total	8	0.49368889			

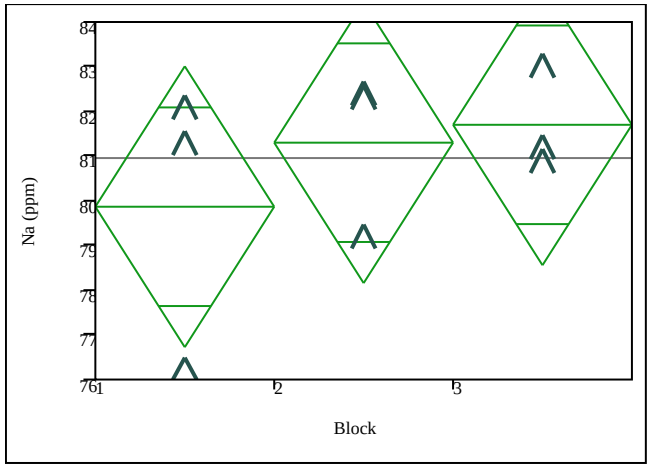
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	10.3767	0.14769	10.015	10.738
2	3	10.1333	0.14769	9.772	10.495
3	3	10.3333	0.14769	9.972	10.695

Std Error uses a pooled estimate of error variance

Exhibit B-3. Measurements of the Solution Standard by Analytical Block (continued)

Oneway Analysis of Na (ppm) By Block Glass ID=Std Soln, Set=1
Reference Value = 81



Oneway Anova
Summary of Fit

Rsquare	0.158117
Adj Rsquare	-0.12251
Root Mean Square Error	2.22436
Mean of Response	80.95556
Observations (or Sum Wgts)	9

Analysis of Variance

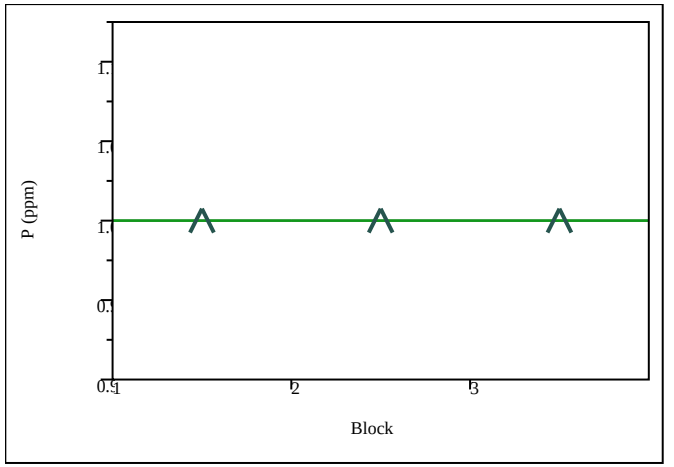
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	2	5.575556	2.78778	0.5634	0.5967
Error	6	29.686667	4.94778		
C. Total	8	35.262222			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	79.8667	1.2842	76.724	83.009
2	3	81.3000	1.2842	78.158	84.442
3	3	81.7000	1.2842	78.558	84.842

Std Error uses a pooled estimate of error variance

Oneway Analysis of P (ppm) By Block Glass ID=Std Soln, Set=1
Reference Value = 0



Oneway Anova
Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	1
Observations (or Sum Wgts)	9

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	2	0	0	.	.
Error	6	0	0		
C. Total	8	0			

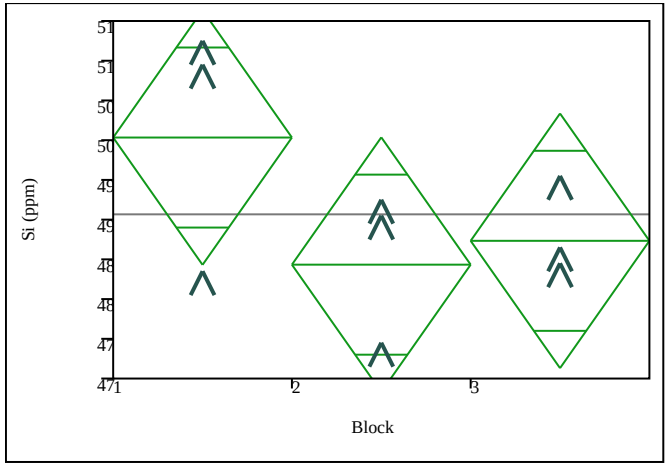
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	1.00000	0	1.0000	1.0000
2	3	1.00000	0	1.0000	1.0000
3	3	1.00000	0	1.0000	1.0000

Std Error uses a pooled estimate of error variance

Exhibit B-3. Measurements of the Solution Standard by Analytical Block (continued)

Oneway Analysis of Si (ppm) By Block Glass ID=Std Soln, Set=1
Reference Value = 50



Oneway Anova
Summary of Fit

Rsquare	0.359867
Adj Rsquare	0.14649
Root Mean Square Error	1.134313
Mean of Response	49.06667
Observations (or Sum Wgts)	9

Analysis of Variance

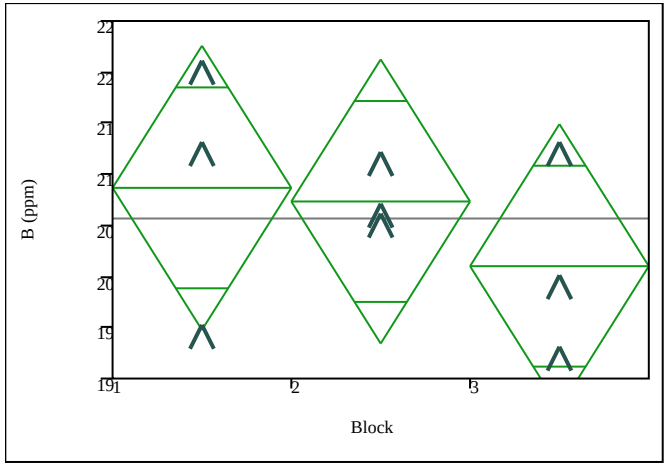
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	2	4.340000	2.17000	1.6865	0.2623
Error	6	7.720000	1.28667		
C. Total	8	12.060000			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	50.0333	0.65490	48.431	51.636
2	3	48.4333	0.65490	46.831	50.036
3	3	48.7333	0.65490	47.131	50.336

Std Error uses a pooled estimate of error variance

Oneway Analysis of B (ppm) By Block Glass ID=Std Soln, Set=2
Reference Value = 20



Oneway Anova
Summary of Fit

Rsquare	0.147605
Adj Rsquare	-0.13653
Root Mean Square Error	0.984322
Mean of Response	20.56667
Observations (or Sum Wgts)	9

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	2	1.0066667	0.503333	0.5195	0.6193
Error	6	5.8133333	0.968889		
C. Total	8	6.8200000			

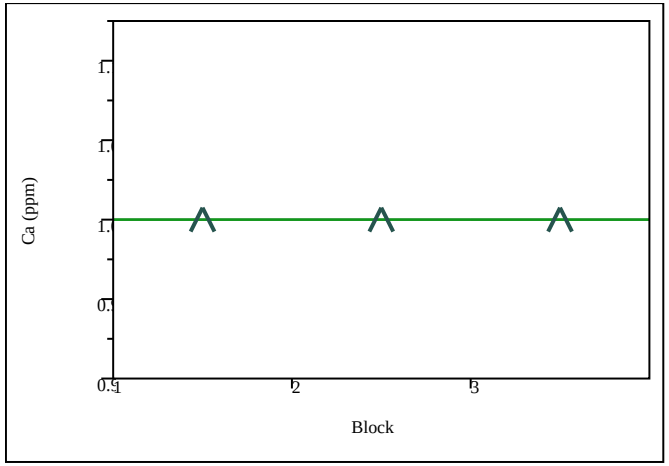
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	20.8667	0.56830	19.476	22.257
2	3	20.7333	0.56830	19.343	22.124
3	3	20.1000	0.56830	18.709	21.491

Std Error uses a pooled estimate of error variance

Exhibit B-3. Measurements of the Solution Standard by Analytical Block (continued)

Oneway Analysis of Ca (ppm) By Block Glass ID=Std Soln, Set=2
Reference Value = 0



Oneway Anova
Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	1
Observations (or Sum Wgts)	9

Analysis of Variance

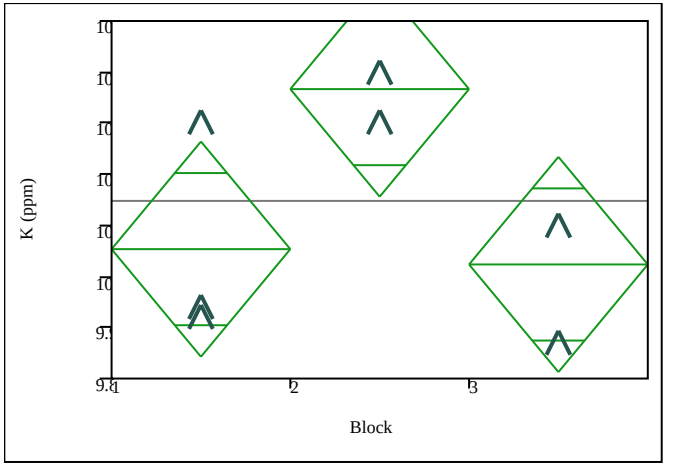
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	2	0	0	.	.
Error	6	0	0		
C. Total	8	0			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	1.00000	0	1.0000	1.0000
2	3	1.00000	0	1.0000	1.0000
3	3	1.00000	0	1.0000	1.0000

Std Error uses a pooled estimate of error variance

Oneway Analysis of K (ppm) By Block Glass ID=Std Soln, Set=2
Reference Value = 10



Oneway Anova
Summary of Fit

Rsquare	0.619244
Adj Rsquare	0.492325
Root Mean Square Error	0.149108
Mean of Response	10.14778
Observations (or Sum Wgts)	9

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	2	0.21695556	0.108478	4.8791	0.0552
Error	6	0.13340000	0.022233		
C. Total	8	0.35035556			

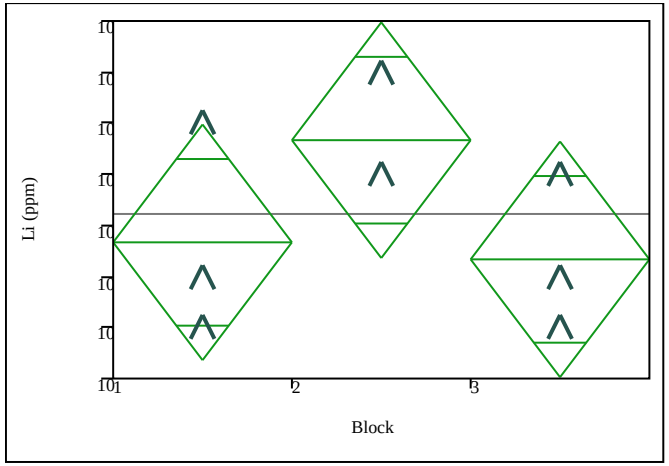
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	10.0533	0.08609	9.843	10.264
2	3	10.3667	0.08609	10.156	10.577
3	3	10.0233	0.08609	9.813	10.234

Std Error uses a pooled estimate of error variance

Exhibit B-3. Measurements of the Solution Standard by Analytical Block (continued)

Oneway Analysis of Li (ppm) By Block Glass ID=Std Soln, Set=2
Reference Value = 10



Oneway Anova
Summary of Fit

Rsquare	0.373913
Adj Rsquare	0.165217
Root Mean Square Error	0.163299
Mean of Response	10.32222
Observations (or Sum Wgts)	9

Analysis of Variance

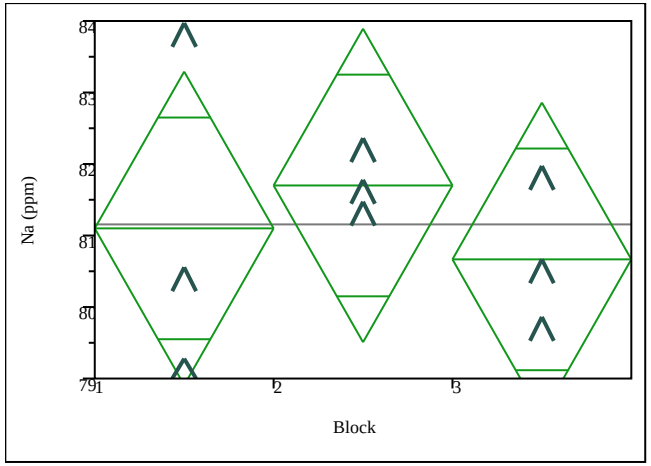
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	2	0.09555556	0.047778	1.7917	0.2454
Error	6	0.16000000	0.026667		
C. Total	8	0.25555556			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	10.2667	0.09428	10.036	10.497
2	3	10.4667	0.09428	10.236	10.697
3	3	10.2333	0.09428	10.003	10.464

Std Error uses a pooled estimate of error variance

Oneway Analysis of Na (ppm) By Block Glass ID=Std Soln, Set=2
Reference Value = 81



Oneway Anova
Summary of Fit

Rsquare	0.100581
Adj Rsquare	-0.19923
Root Mean Square Error	1.551702
Mean of Response	81.15556
Observations (or Sum Wgts)	9

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	2	1.615556	0.80778	0.3355	0.7276
Error	6	14.446667	2.40778		
C. Total	8	16.062222			

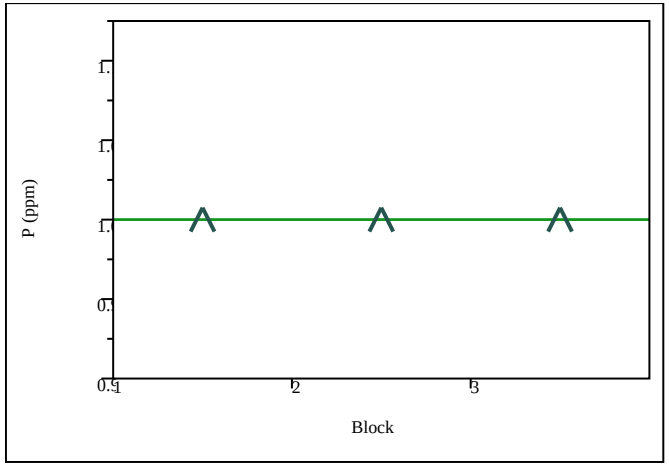
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	81.1000	0.89588	78.908	83.292
2	3	81.7000	0.89588	79.508	83.892
3	3	80.6667	0.89588	78.475	82.859

Std Error uses a pooled estimate of error variance

Exhibit B-3. Measurements of the Solution Standard by Analytical Block (continued)

Oneway Analysis of P (ppm) By Block Glass ID=Std Soln, Set=2
Reference Value = 0



Oneway Anova
Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	1
Observations (or Sum Wgts)	9

Analysis of Variance

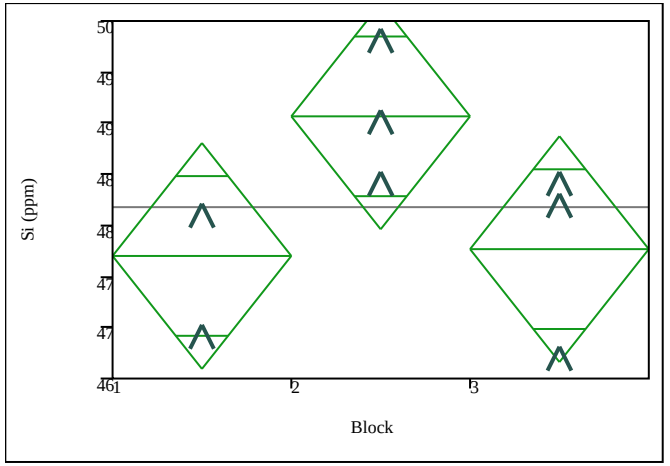
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	2	0	0	.	.
Error	6	0	0		
C. Total	8	0			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	1.00000	0	1.0000	1.0000
2	3	1.00000	0	1.0000	1.0000
3	3	1.00000	0	1.0000	1.0000

Std Error uses a pooled estimate of error variance

Oneway Analysis of Si (ppm) By Block Glass ID=Std Soln, Set=2
Reference Value = 50



Oneway Anova
Summary of Fit

Rsquare	0.492322
Adj Rsquare	0.323096
Root Mean Square Error	0.782446
Mean of Response	48.17778
Observations (or Sum Wgts)	9

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	2	3.5622222	1.78111	2.9093	0.1308
Error	6	3.6733333	0.61222		
C. Total	8	7.2355556			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	47.7000	0.45175	46.595	48.805
2	3	49.0667	0.45175	47.961	50.172
3	3	47.7667	0.45175	46.661	48.872

Std Error uses a pooled estimate of error variance

Exhibit B-4. Normalized PCT Results by Heat Treatment by Compositional View for Glass

Variability Chart for log NL[B (g/L)]

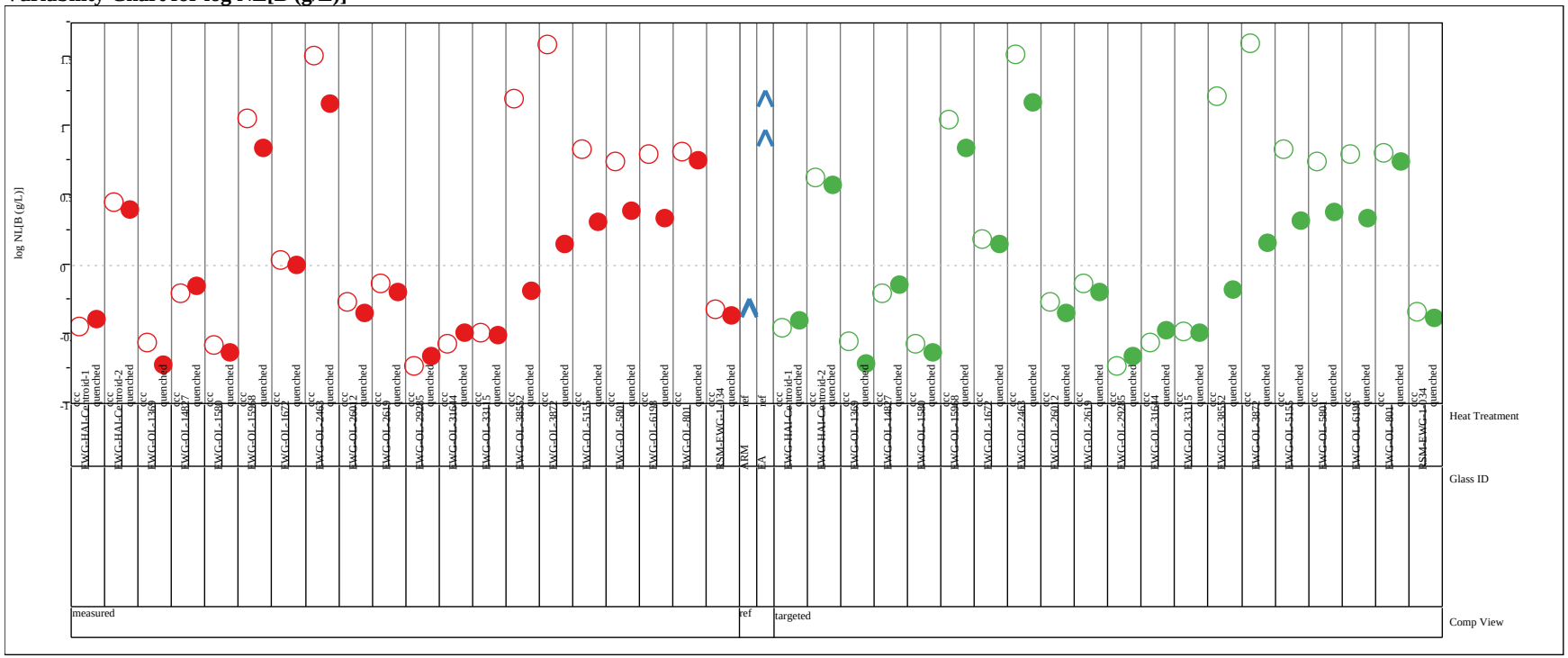


Exhibit B-4. Normalized PCT Results by Heat Treatment by Compositional View for Glass (continued)

Variability Chart for log NL[Ca (g/L)]

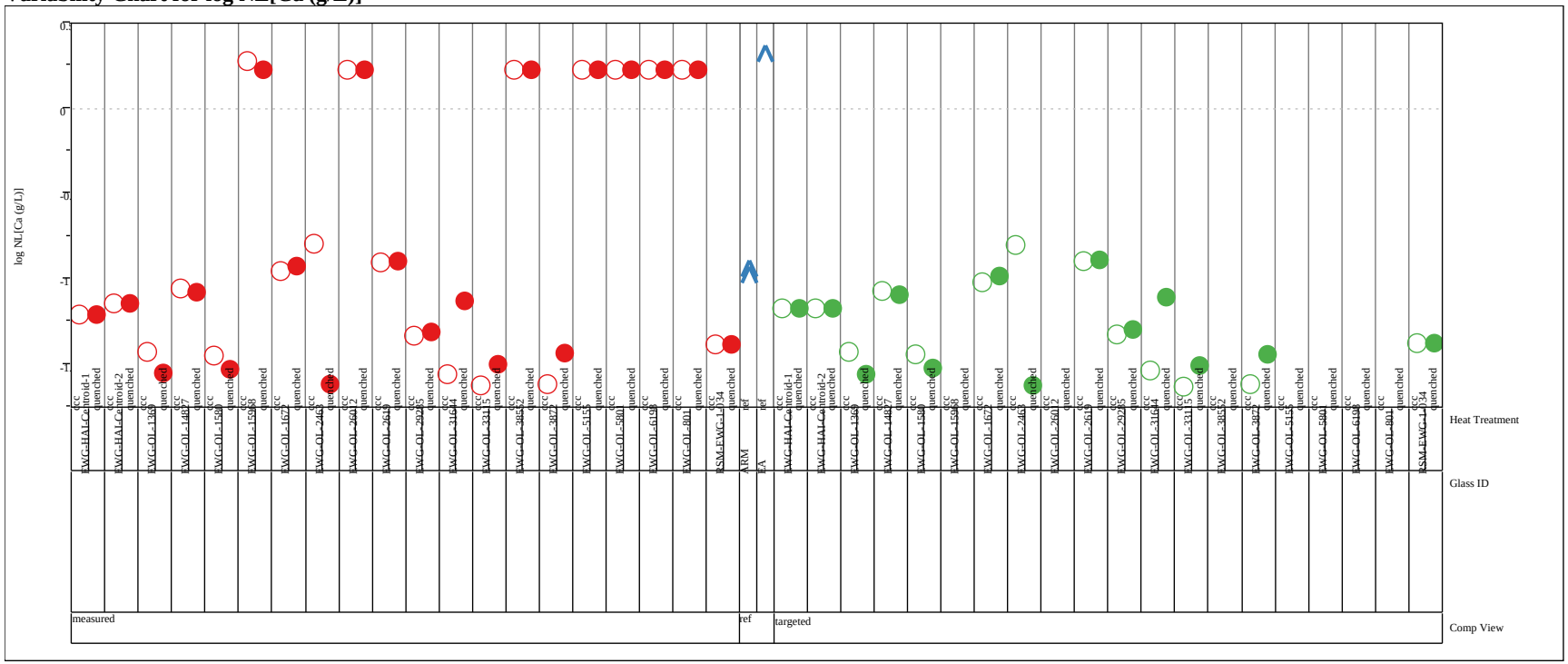


Exhibit B-4. Normalized PCT Results by Heat Treatment by Compositional View for Glass (continued)

Variability Chart for log NL[K (g/L)]

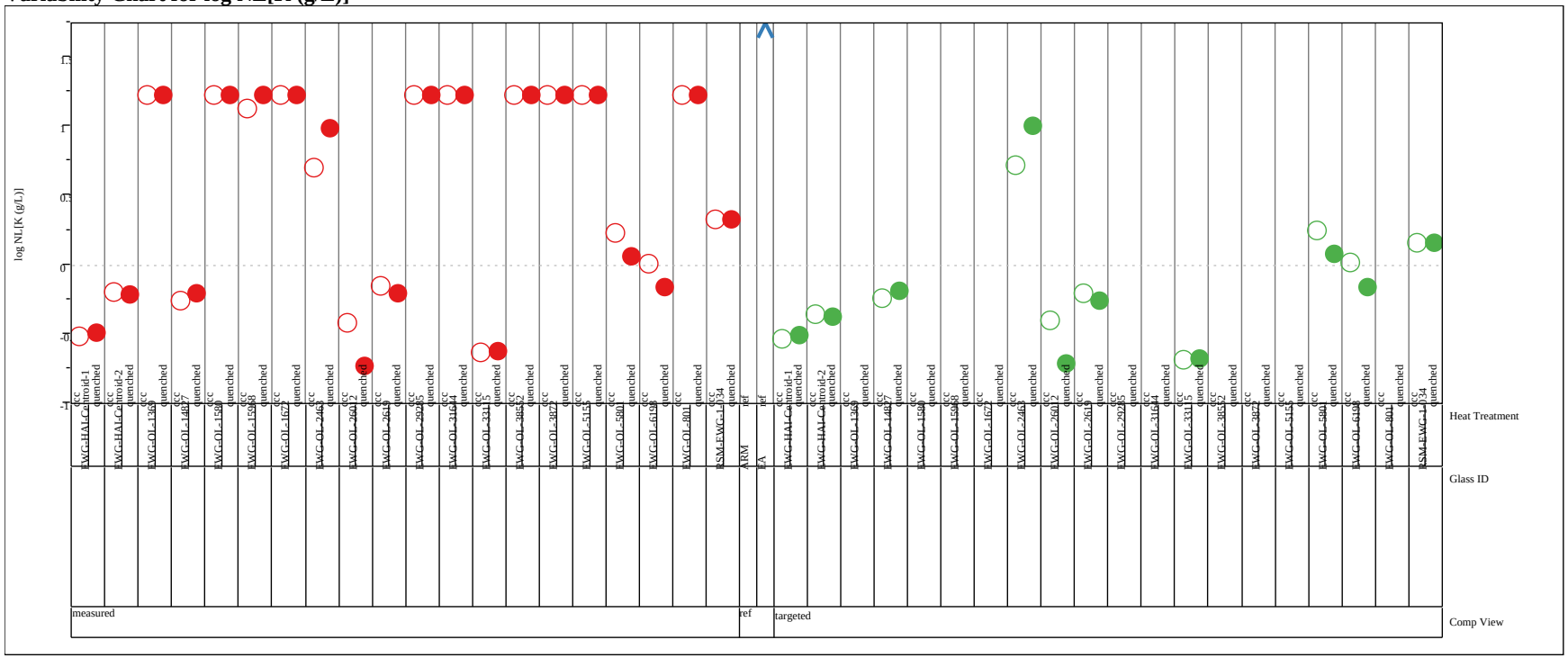


Exhibit B-4. Normalized PCT Results by Heat Treatment by Compositional View for Glass (continued)

Variability Chart for log NL[Li(g/L)]

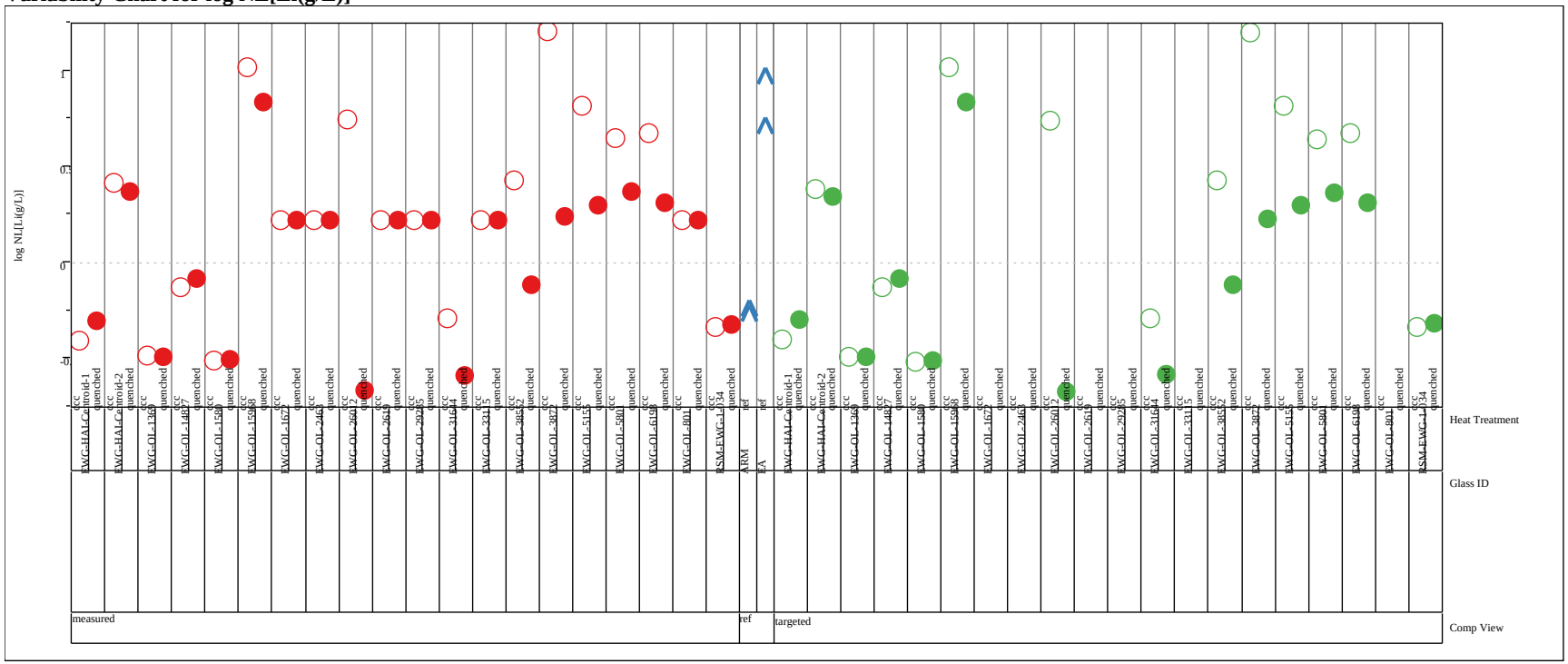


Exhibit B-4. Normalized PCT Results by Heat Treatment by Compositional View for Glass (continued)

Variability Chart for log NL[Na (g/L)]

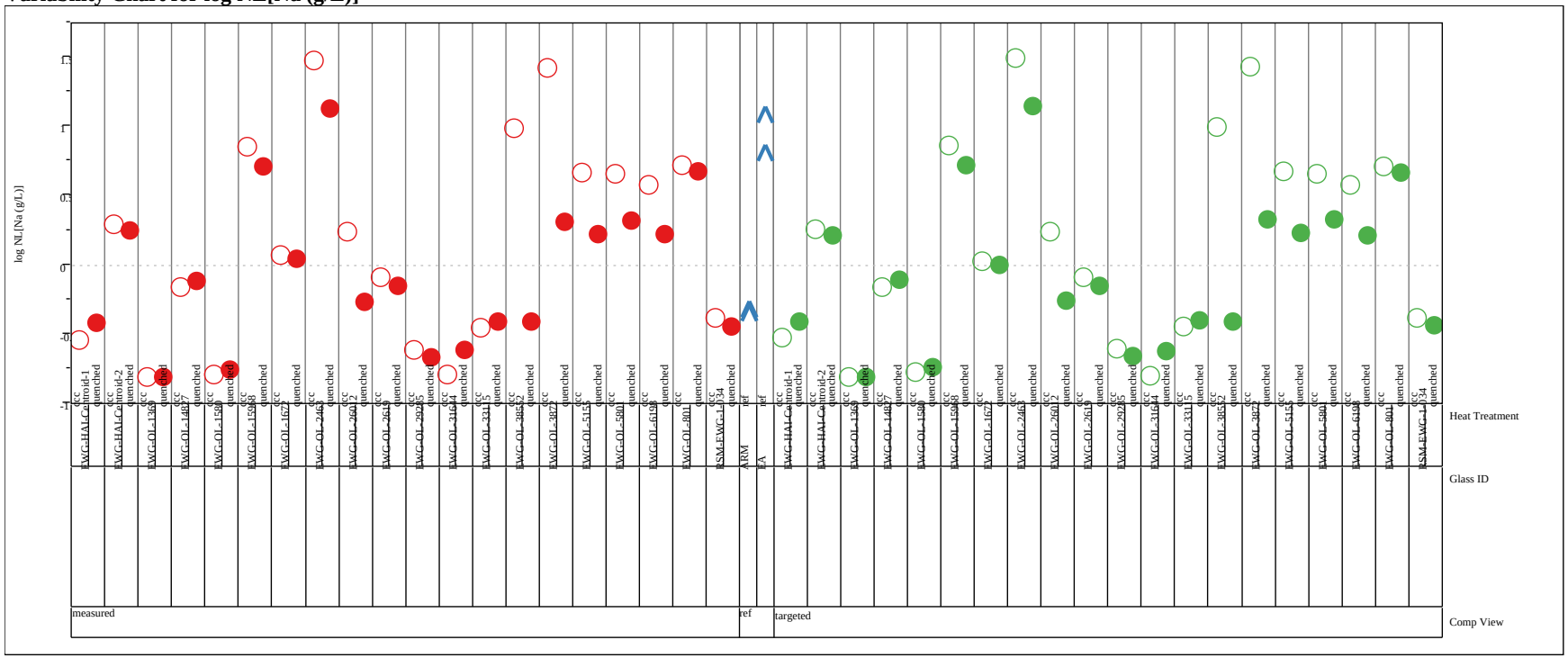


Exhibit B-4. Normalized PCT Results by Heat Treatment by Compositional View for Glass (continued)

Variability Chart for log NL[P (g/L)]

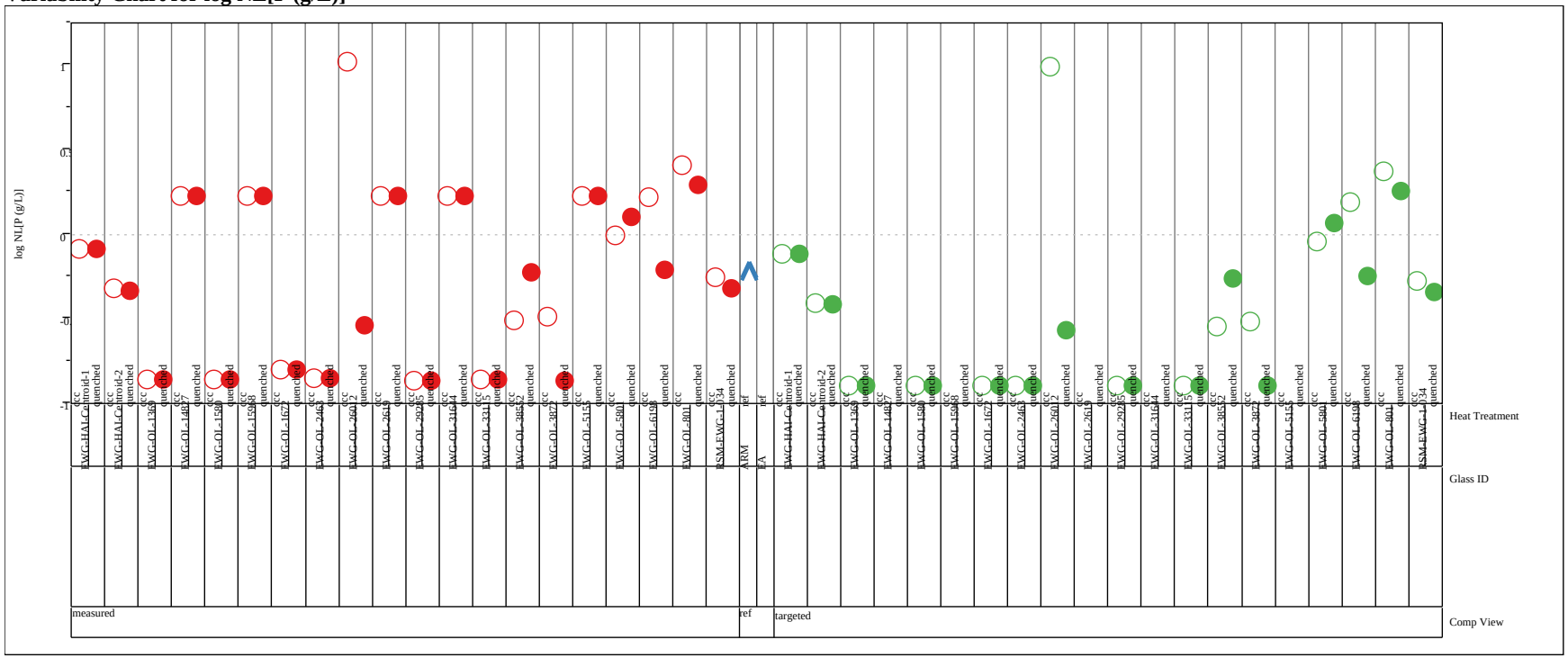
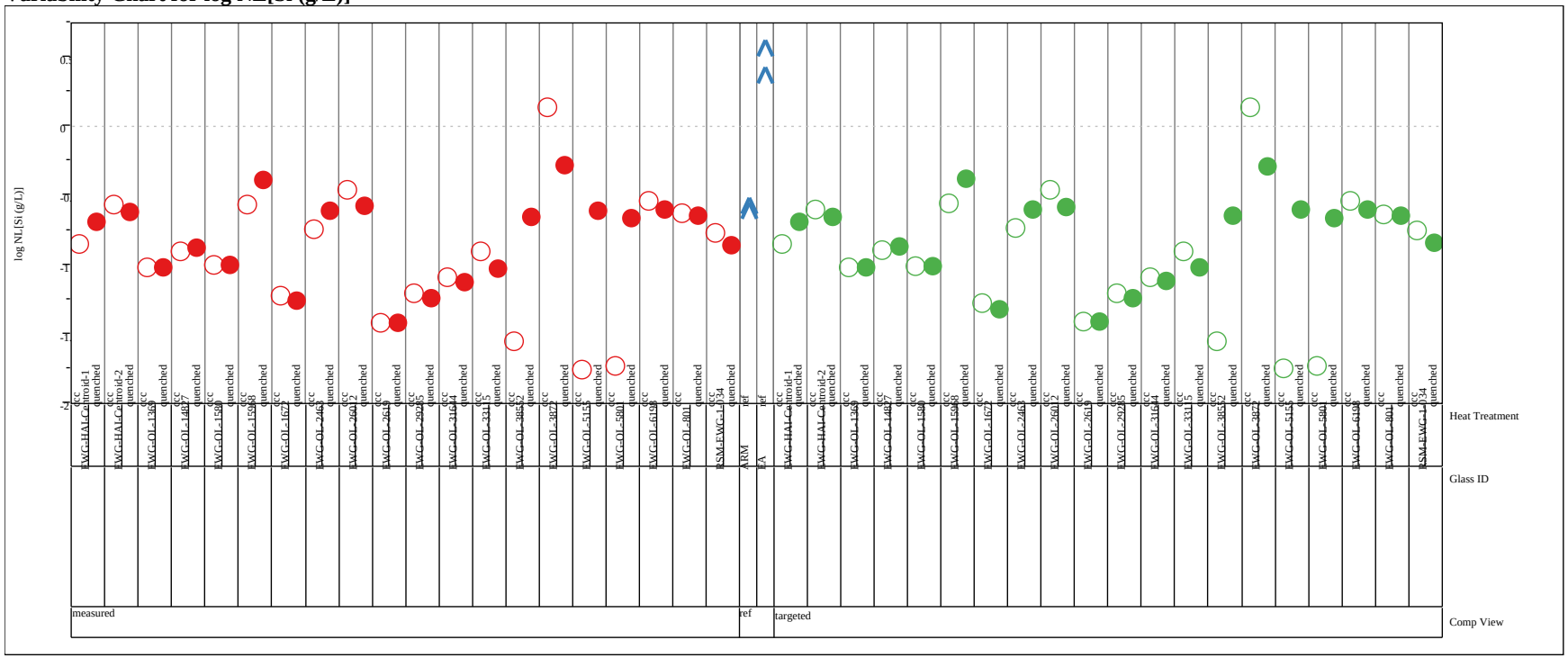


Exhibit B-4. Normalized PCT Results by Heat Treatment by Compositional View for Glass (continued)

Variability Chart for log NL[Si (g/L)]



Distribution:

J. W. Amoroso, 999-W
T. B. Brown, 773-A
J. V. Crum, PNNL
W. A. Drown, 773-41
T. B. Edwards, 999-W
S. D. Fink, 773-A
K. M. Fox, 999-W
C. C. Herman, 773-A
E. N. Hoffman, 999-W
F. C. Johnson, 999-W
A. A. Kruger, DOE-ORP
S. L. Marra, 773-A
D. H. McGuire, 999-W
D. K. Peeler, 999-W
F. M. Pennebaker, 773-42A
J. Matyáš, PNNL
M. J. Schweiger, PNNL
J. D. Vienna, PNNL
W. R. Wilmarth, 773-A
Records Administration (EDWS)