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Chemical Composition Analysis and Product Consistency Tests to Support Enhanced Hanford Waste Glass Models: Results for the Second Set of High Alumina Outer Layer Matrix Glasses

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EXECUTIVE SUMMARY

In this report, the Savannah River National Laboratory provides chemical analyses and Product Consistency Test (PCT) results for 16 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 regions 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. Some amount of undissolved material remained after the acid digestion preparation method. The undissolved material was analyzed and found to consist of spinels. The elements present in the material that was left undissolved by the acid digestion preparation method were reported using the peroxide fusion dissolution method, which provided complete dissolution of the glasses.

All of the measured sums of oxides for the study glasses fall within the interval of 99.5 to 103.5 wt %. Comparisons of the targeted and measured chemical compositions showed that, with one exception, the measured values for the glasses met the targeted concentrations within 10% for those components present at more than 5 wt %. The measured value for Na_2O in glass EWG-OL-33558 was 12.3% higher than the targeted value.

The PCT results were normalized to both the targeted and measured compositions of the study glasses. One of the quenched glasses (EWG-OL-3388) and four of the centerline canister cooled glasses (EWG-OL-3122, EWG-OL-3208, EWG-OL-3388, and EWG-OL-38081) had NL [B] values that were greater than that of the Environmental Assessment benchmark glass. These results can be combined with additional characterization, including X-ray diffraction, to determine the cause of the higher release rates.

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LIST OF ABBREVIATIONS

AD	Acid Dissolution
ANOVA	Analysis of Variance
ARM	Approved Reference Material
BDL	Below Detection Limit
CCC	Canister Centerline Cooled
DOE	U.S. Department of Energy
DWPF	Defense Waste Processing Facility
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
JHCM	Joule-Heated Ceramic Melter
LAW	Low Activity Waste
LRM	Low-level Reference Material
NL	Normalized Leachate
ORP	U.S. Department of Energy – Office of River Protection
PCT	Product Consistency Test
PF	Peroxide Fusion
PNNL	Pacific Northwest National Laboratory
RSD	Relative Standard Deviation
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 the ability to meet processing, regulatory compliance, and product quality requirements. DOE-ORP has requested that SRNL support the advancement of glass formulations and process control strategies in key technical areas, as defined in the Task Technical and Quality Assurance Plan (TTQAP).[1] One of these areas is enhanced HLW glass model applicability regions.

The current WTP glass composition-properties models were developed over a limited waste composition region for processing the initial feed.[2] The glass composition region is sufficient for start-up of the WTP with waste loadings at the minimum contract requirement, but does not extend to the 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 regions of the models.[4,5] New data will 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 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).[4,6] The results of these analyses will be used to revise or extend the validation regions of the current WTP glass property models and to develop new models to cover a broader span of waste compositions.

2.0 Experimental Procedure

2.1 Glasses Selected for Study

PNNL provided 16 glasses for this second set of analyses and the identifiers for these glasses are given in Table 2-1. Two versions of each glass were provided: rapidly cooled (quenched) versions of each glass, and Canister Centerline Cooled (CCC) versions of each glass, which were heat treated by PNNL to simulate slow cooling at the center of a WTP canister. The quenched glasses were used for chemical analyses. Both the quenched and the CCC glasses were used for the PCTs.

Table 2-1. Identifiers for PNNL Glasses Characterized in this Study

Glass Identifier
EWG-Centroid-2-R1
EWG-OL-33694
EWG-OL-3388
EWG-OL-32706
EWG-OL-23401
EWG-OL-3208
EWG-OL-35387
EWG-OL-4099
EWG-OL-33858
EWG-OL-38081
EWG-OL-12707
EWG-OL-33558
EWG-OL-16450
EWG-OL-3231
EWG-OL-3122
EWG-OL-5549

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.

2.2 Compositional Analysis

Chemical analysis was performed under the auspices of an analytical plan[7] 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)[8] 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 (0.3 wt % F and 0.02 wt % Ag_2O), 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.

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.[9-11] 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

[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.

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.

An AD method was used for those components that could not be measured via the PF preparation due to interferences or low (minor) concentrations. Some of the solutions resulting from the AD preparation method contained a small amount of undissolved solids.

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). A SEM micrograph of undissolved material from the AD preparation of glass EWG-OL-3388 is shown as Figure 2-1. The particulates exhibit spinel morphology. The white rectangle in Figure 2-1 indicates the area scanned to produce the EDS spectrum shown as Figure 2-2. Elements observed include Al, Cr, Fe, Mn, and Ni. Magnesium was observed during the analyses of some of the samples but is not indicated by the example in Figure 2-2.

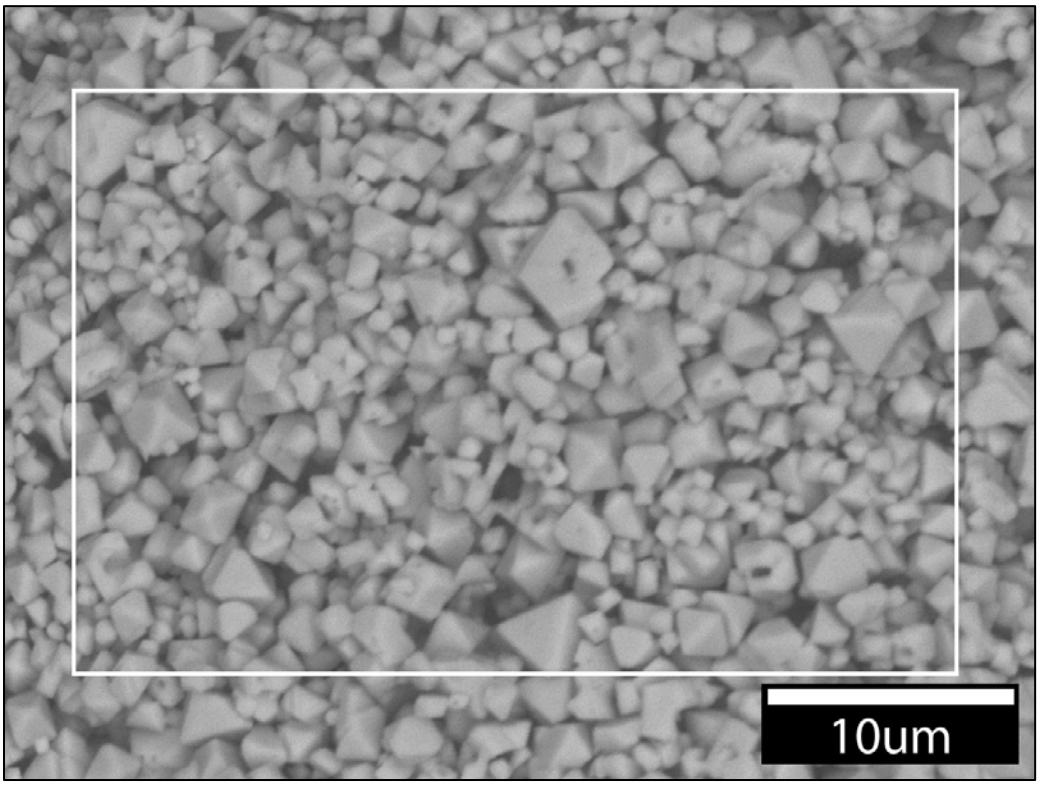

Figure 2-1. SEM Micrograph of Undissolved Material from the AD Preparation of Glass EWG-OL-3388.

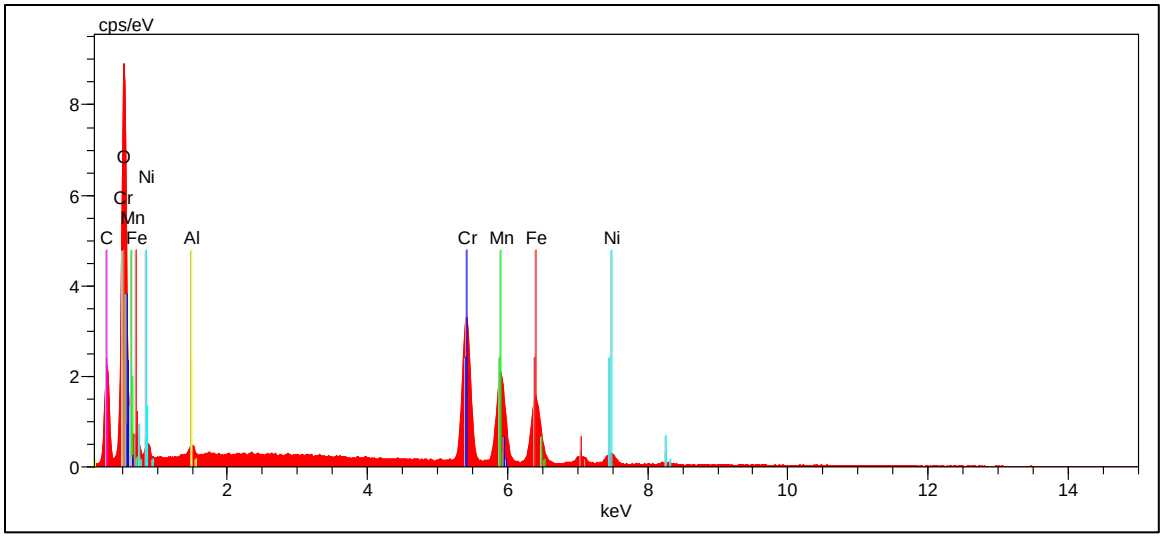

Figure 2-2. EDS Spectrum Corresponding to the White Rectangle Shown in Figure 2-1.

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 Cr and Mg, in addition to the other major components of the glasses. 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 2-2.

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

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

2.3 Product Consistency Test

The PCT Method-A[12] 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,[13] the Approved Reference Material (ARM) glass,[14] and blanks from the sample cleaning batch. Samples were ground, washed, and prepared according to the standard procedure.[12] 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.[15] Samples of a multi-element, standard solution were 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 by PNNL subsequent to the chemical composition analysis) and measured compositions using the average of the common logarithms of the leachate concentrations.

2.4 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 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 2 study glasses that were prepared by the AD method. Table A-3 and Table A-4 in Appendix A provide the elemental concentration measurements in wt % from these glasses as prepared by the PF method. Elemental measurements for samples of the LRM standard glass are also provided in the tables of Appendix A. These unprocessed data are provided as appendices to this report so that the values are readily available should they be of interest for future reviews.

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.)[16] was used to support these analyses.

3.1.1 Treatment of Detection Limits

The elemental concentrations in Table A-1 through Table A-4 were converted to oxide concentrations by multiplying the values for each element by the gravimetric factor for the corresponding oxide. 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 for the purposes of statistical review and calculating a sum of oxides for each glass. Those oxides with measured concentrations that were below the associated detection limit will be denoted with a less than symbol (<) as the measured compositions are reported.

3.1.2 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 through Table A-4, with each plotted point identified by its Lab ID. Plotting the data in this format provides an opportunity to identify gross trends in performance of the analytical instrument within and among calibration blocks. A review of these plots identified a slight, upward shift in the measurements of the second sub-block of the first block of NiO results. This shift is on the order of 0.05 wt % and may be the result of a minor difference in instrument calibrations. Similarly, there is a slight difference in CaO measurements between the first and second sub-blocks of the second block, which again may be the result of a minor difference in instrument calibrations. There do not appear to be any other gross patterns or trends in the analytical process over the course of these measurements.

3.1.3 Composition Measurements by Glass Identifier

Exhibit A-2 in Appendix A provides plots of the oxide concentration measurements by the PNNL Glass ID (including the LRM reference glass) 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. Plotting the data in this format provides an opportunity to review the values for each individual glass as a function of the duplicate preparations and duplicate

measurements. A review of the plots presented in these exhibits reveals the repeatability of the four individual values for each oxide for each glass and leads to the following observations:

- There is scatter for the Al_2O_3 measurements of glass EWG-OL-3122.
- The scatter seen in some of the CaO measurements reflects the slight shift between the first and second sub-blocks within the second measurement block as noted above.
- The Li_2O measurements for the second AD preparation of glass EWG-OL-38081 (Lab IDs Q03AD21 and Q03AD22) are slightly lower than the Li_2O measurements for the first AD preparation of this glass. However, this pattern does not hold for the other oxides whose measurements are derived via the AD preparation method. See for example the plot for ZrO_2.
- The scatter seen in some of the NiO measurements reflects the slight upper shift in the second sub-block within the first measurement block as noted above. Also, there appears to be a preparation effect for the second PF preparation of glass EWG-OL-3122 (Lab IDs Q16AD21 and Q16AD22) as indicated by an upward shift in the two measurements for this prepared sample.
- One SiO_2 measurement (Lab ID Q07PF12) for glass EWG-OL-5549 appears to be substantially higher than the other three SiO_2 measurements for this glass.

The SiO_2 issue for glass EWG-OL-5549 was addressed by excluding the substantially higher value from further consideration in these results. Thus, only the other three SiO_2 measurements for glass EWG-OL-5549 were averaged to determine a representative concentration for this oxide for this glass. None of the other observations noted above from Exhibit A-2 indicated an error in preparation or measurement that had to be addressed in treatment of the data. Therefore, the entire set of measurement data was used in determining representative, measured compositions for the other oxides of glass EWG-OL-5549 and all of the oxides for the other study glasses.

3.1.4 Results for the LRM Standard

Exhibit A-3 in Appendix A provides a review of the LRM results against acceptability limits utilized by SRNL. The review is in the form of a plot of the measurements arranged by preparation method and element, framed by upper and lower acceptability limits for the concentration of the element in question. The results show that all of the measurements for the elements present in the LRM standard glass were within the acceptability limits utilized by SRNL in conducting instrument and procedure assessments during the execution of these measurements.

3.1.5 Measured versus Targeted Compositions

From the discussion of Section 3.1.3, all of the measurements for each oxide for each glass (i.e., all of the measurements in Appendix A, Table A-1 through Table A-4), except for the one high SiO_2 measurement for glass EWG-OL-5549, 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 allow PNNL to draw comparisons between the measured and targeted values.

Table A-5 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 99.5 to 103.5 wt %, indicating excellent recovery of all components. Entries in Table A-5 show the relative differences between the

measured values and the targeted values for the oxides with targeted values above 5 wt %. The relative differences are shaded if they are 10% or more.[a]

3.2 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 for the dilution factors. The measurements for the study glasses, blanks, and the ARM glass were multiplied by 1.6667 to determine the values in parts per million (ppm) and the measurements for EA were multiplied by 16.6667 to determine the values in ppm.

Based on the masses of the PCT vessels before and after the 7-day procedures, there were three samples that had water-loss issues: two ARM samples and one EA sample in the second analytical set. These samples are shaded in Table B-1 and their measurements are not included in the results presented in the following sections. Per the ASTM procedure, the other replicates of these glasses were used to demonstrate that the PCT was in control. 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.[14]

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 11.1.1 (SAS Institute, Inc.)[16] was used to support these analyses.

3.2.1 Treatment of Detection Limits

Some of the "ar" measurements (Table B-1 in Appendix B) were below the detection limit of 1 ppm (prior to correction for dilution). These measurements (indicated by a "<" symbol in Table B-1) were replaced by their detection limits in subsequent analyses for the purposes of statistical review and calculating normalized leachate values. Those elements with measured concentrations that were below the associated detection limit will be denoted with a less than symbol (<) as the normalized leachate values are reported.

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

Table 3-1 provides a review of the measurements of the solution standard samples that were included in the analytical blocks for the PCT analyses. For each analytical block, the mean, standard deviation, and percent relative standard deviation (%RSD) are determined for each element present in the standard. Following the guidance in ASTM C 1285, there were two primary evaluations conducted for these summary statistics: the mean value for each analytical block was found to be less than 10% from the reference value (i.e., a percent relative bias less than 10%) for the element in question, and the %RSD was less than 10% for the element in question. The results in Table 3-1 satisfy these criteria, and thus, there are no significant issues with the analytical outcomes for the measurements of the PCT solutions.

[a] These criteria were selected arbitrarily for the purpose of highlighting differences from targeted concentrations that may be of practical concern.

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

Set	1			2			Reference values (ppm)
Block	1	2	3	1	2	3	
Mean (B (ppm))	20.8	20.6	20.4	20.0	20.7	20.9	20
Mean (Ca (ppm))	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0
Mean (K (ppm))	10.4	10.0	9.9	9.9	9.7	10.4	10
Mean (Li (ppm))	10.0	9.8	9.7	9.6	9.5	10.0	10
Mean (Na (ppm))	79.9	81.5	82.6	81.5	79.9	80.9	81
Mean (P (ppm))	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0
Mean (Si (ppm))	50.0	51.2	51.3	50.8	49.5	50.4	50
% relative bias, B	4.2%	2.8%	2.2%	0.0%	3.3%	4.7%	<10% per ASTM C 1285
% relative bias, K	3.7%	0.3%	-0.5%	-0.9%	-3.4%	4.0%	
% relative bias, Li	0.5%	-2.2%	-3.1%	-3.8%	-5.2%	-0.2%	
% relative bias, Na	-1.4%	0.7%	2.0%	0.6%	-1.4%	-0.1%	
% relative bias, Si	0.0%	2.3%	2.7%	1.6%	-1.1%	0.9%	
Std Dev (B (ppm))	1.457	1.436	1.150	1.453	1.358	0.737	
Std Dev (K (ppm))	0.058	0.145	0.134	0.095	0.090	0.200	
Std Dev (Li (ppm))	0.136	0.090	0.106	0.030	0.067	0.126	
Std Dev (Na (ppm))	1.041	0.896	0.929	0.200	0.503	1.572	
Std Dev (Si (ppm))	0.600	0.503	0.808	0.361	0.451	0.551	
%RSD (B (ppm))	6.99%	6.98%	5.63%	7.26%	6.57%	3.52%	<10% per ASTM C 1285
%RSD (K (ppm))	0.56%	1.44%	1.35%	0.96%	0.93%	1.92%	
%RSD (Li (ppm))	1.36%	0.92%	1.09%	0.31%	0.70%	1.26%	
%RSD (Na (ppm))	1.30%	1.10%	1.12%	0.25%	0.63%	1.94%	
%RSD (Si (ppm))	1.20%	0.98%	1.57%	0.71%	0.91%	1.09%	

3.2.3 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 second set of PNNL glasses. Plotting the data in this format provides an opportunity to identify gross trends in performance of the analytical instrument within and among calibration blocks. No issues were observed in these plots.

3.2.4 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. 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 in the following sections.

3.2.5 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. The common logarithm of the normalized PCT (normalized leachate, NL) for each element of interest was determined as described in ASTM C 1285 and used for comparison.

3.2.6 Effects of Heat Treatments

Exhibit B-3 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. Note that the normalized ARM results from the second analytical set relied on only one sample solution. The other two sample solutions had water-loss issues, as noted earlier. Also note that an indicator is provided as part of these plots to show results involving below detection limit (bdl) values.

The plots of Exhibit B-3 provide a graphical 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 g/L. In reading this table, note that bdl values are indicated and 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
- PCT results normalized to the targeted and measured compositions are not provided for those components with targeted concentrations of zero for a given glass composition.

A review of the PCT data shows that four of the study glasses have normalized leachate values for boron (NL [B]) that are higher than the benchmark EA glass NL [B] of 16.695 g/L.[13] For three of those four glasses (EWG-OL-3122, EWG-OL-3208, and EWG-OL-38081), the NL [B] values for the quenched versions were below that of the EA glass, while the NL [B] values for the CCC versions were above that of the EA glass. This is typically indicative of devitrification occurring during the CCC heat treatment, where the crystalline phase has a negative impact on the durability of the glass. The NL [B] values for both the quenched and CCC versions of the fourth glass (EWG-OL-3388) were above that of the EA glass. This may be indicative of phase separation or devitrification in the glass regardless of heat treatment, or it may be that this glass composition simply has poor durability relative to that of the EA glass. X-ray diffraction analysis can be used to aid in further interpretation of the PCT results.

Table 3-2. Normalized PCT Results

Glass ID	Heat Treatment	Comp View	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-1	ref	ref	0.450	< 0.123	.	0.530	0.463	< 0.595	0.258
ARM-1*	ref	ref	0.537	0.112	.	0.557	0.469	0.623	0.259
EA	ref	ref	10.597	< 2.082	< 50.192	6.488	8.446	.	2.967
EA	ref	ref	8.881	< 2.082	< 50.192	5.439	7.029	.	2.596
EWG-OL-12707	ccc	measured	6.030	0.083	.	< 11.991	5.969	< 0.134	0.073
EWG-OL-12707	ccc	targeted	6.155	0.085	.	5.867	6.002	< 0.127	0.078
EWG-OL-12707	quenched	measured	7.572	0.078	.	< 14.643	7.416	< 0.134	0.081
EWG-OL-12707	quenched	targeted	7.730	0.080	.	7.165	7.456	< 0.127	0.086
EWG-OL-16450	ccc	measured	5.895	2.265	.	.	5.374	.	< 0.027
EWG-OL-16450	ccc	targeted	6.208	2.347	.	.	5.351	.	< 0.029
EWG-OL-16450	quenched	measured	4.230	0.275	.	.	5.274	.	0.094
EWG-OL-16450	quenched	targeted	4.455	0.284	.	.	5.251	.	0.100
EWG-OL-23401	ccc	measured	0.372	0.104	.	.	0.393	.	0.090
EWG-OL-23401	ccc	targeted	0.376	0.108	.	.	0.388	.	0.091
EWG-OL-23401	quenched	measured	0.194	0.060	.	.	0.401	.	0.099
EWG-OL-23401	quenched	targeted	0.196	0.062	.	.	0.395	.	0.101
EWG-OL-3122	ccc	measured	20.037	0.544	2.606	.	12.119	.	0.025
EWG-OL-3122	ccc	targeted	20.101	0.549	2.273	.	12.002	.	0.026
EWG-OL-3122	quenched	measured	0.244	0.094	0.252	.	0.446	.	0.119
EWG-OL-3122	quenched	targeted	0.245	0.095	0.220	.	0.442	.	0.121
EWG-OL-3208	ccc	measured	87.043	.	12.511	15.774	45.003	1.547	1.652
EWG-OL-3208	ccc	targeted	93.014	.	12.333	16.145	43.560	1.497	1.652
EWG-OL-3208	quenched	measured	3.166	.	1.007	2.456	3.065	0.902	0.858
EWG-OL-3208	quenched	targeted	3.383	.	0.992	2.513	2.966	0.873	0.858
EWG-OL-3231	ccc	measured	1.554	< 0.023	0.825	1.706	1.396	< 0.137	0.266
EWG-OL-3231	ccc	targeted	1.610	< 0.024	0.805	1.682	1.500	< 0.127	0.266
EWG-OL-3231	quenched	measured	1.783	< 0.024	0.912	1.937	1.593	< 0.137	0.231
EWG-OL-3231	quenched	targeted	1.847	< 0.025	0.890	1.909	1.713	< 0.127	0.231
EWG-OL-32706	ccc	measured	0.405	.	0.206	0.709	0.316	.	0.162
EWG-OL-32706	ccc	targeted	0.410	.	0.199	0.626	0.340	.	0.162

*Two of the three vessels in this set had water loss issues.

Table 3-2. Normalized PCT Results (continued)

Glass ID	Heat Treatment	Comp. View	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-32706	quenched	measured	0.384	.	0.225	0.682	0.318	.	0.139
EWG-OL-32706	quenched	targeted	0.389	.	0.218	0.602	0.342	.	0.138
EWG-OL-33558	ccc	measured	0.310	< 0.023	0.206	< 1.667	0.297	< 0.131	0.110
EWG-OL-33558	ccc	targeted	0.333	< 0.024	0.207	< 1.380	0.333	< 0.127	0.110
EWG-OL-33558	quenched	measured	0.274	0.031	0.256	< 1.667	0.456	< 0.131	0.103
EWG-OL-33558	quenched	targeted	0.293	0.032	0.258	< 1.380	0.512	< 0.127	0.103
EWG-OL-33694	ccc	measured	0.506	.	0.256	< 1.667	0.433	.	0.159
EWG-OL-33694	ccc	targeted	0.515	.	0.249	< 17.941	0.449	.	0.159
EWG-OL-33694	quenched	measured	1.073	.	0.385	< 1.667	0.917	.	0.141
EWG-OL-33694	quenched	targeted	1.090	.	0.374	< 17.941	0.952	.	0.142
EWG-OL-33858	ccc	measured	3.324	.	1.427	1.388	1.082	.	0.207
EWG-OL-33858	ccc	targeted	3.445	.	1.374	1.367	1.155	.	0.211
EWG-OL-33858	quenched	measured	0.448	.	0.344	0.516	0.365	.	0.236
EWG-OL-33858	quenched	targeted	0.464	.	0.331	0.508	0.389	.	0.241
EWG-OL-3388	ccc	measured	20.603	.	9.270	.	17.810	0.541	0.180
EWG-OL-3388	ccc	targeted	21.334	.	9.212	.	17.806	0.511	0.185
EWG-OL-3388	quenched	measured	18.240	.	8.458	.	15.849	0.582	0.161
EWG-OL-3388	quenched	targeted	18.888	.	8.406	.	15.846	0.550	0.165
EWG-OL-35387	ccc	measured	1.484	.	0.443	< 1.667	1.109	.	0.309
EWG-OL-35387	ccc	targeted	1.559	.	0.419	< 17.941	1.084	.	0.306
EWG-OL-35387	quenched	measured	1.543	.	0.478	< 1.667	1.231	.	0.315
EWG-OL-35387	quenched	targeted	1.621	.	0.452	< 17.941	1.203	.	0.312
EWG-OL-38081	ccc	measured	78.250	.	6.266	45.232	8.734	.	0.242
EWG-OL-38081	ccc	targeted	80.469	.	6.183	42.157	9.144	.	0.247
EWG-OL-38081	quenched	measured	0.547	.	0.300	0.663	0.350	.	0.329
EWG-OL-38081	quenched	targeted	0.562	.	0.296	0.618	0.366	.	0.336
EWG-OL-4099	ccc	measured	1.318	0.043	.	1.346	1.184	< 0.131	0.168
EWG-OL-4099	ccc	targeted	1.339	0.044	.	1.361	1.281	< 0.127	0.169
EWG-OL-4099	quenched	measured	1.213	0.044	.	1.239	1.105	< 0.131	0.158
EWG-OL-4099	quenched	targeted	1.232	0.045	.	1.254	1.195	< 0.127	0.158

Table 3-2. Normalized PCT Results (continued)

Glass ID	Heat Treatment	Comp. View	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-5549	ccc	measured	4.766	0.320	4.866	.	5.512	.	0.083
EWG-OL-5549	ccc	targeted	4.895	0.325	4.689	.	5.284	.	0.085
EWG-OL-5549	quenched	measured	3.807	0.254	4.060	.	4.520	.	0.088
EWG-OL-5549	quenched	targeted	3.910	0.258	3.912	.	4.333	.	0.091

4.0 Summary

In this report, SRNL provides chemical analyses and PCT results for 16 simulated HLW glasses fabricated by PNNL. The results of these analyses will be used as part of efforts to revise or extend the validation regions of the current WTP glass property models (or develop new 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 amount of undissolved material remained after the acid digestion method. The undissolved material was analyzed and found to consistent with the composition and morphology of spinel crystals. The elements present in the material that was left undissolved by the AD preparation method were reported using the PF dissolution method, which provided complete dissolution of the glasses.

All of the measured sums of oxides for the study glasses fall within the interval of 99.5 to 103.5 wt %. Comparisons of the targeted and measured chemical compositions showed that, with one exception, the measured values for the glasses met the targeted concentrations within 10% for those components present at more than 5 wt %. The measured value for Na_2O in glass EWG-OL-33558 was 12.3% higher than the targeted value.

A review of the PCT data revealed that water loss occurred in one of the vessels containing EA glass and two of the vessels containing ARM glass in the second analytical set. Results from these vessels were therefore omitted from further analysis. Per the ASTM procedure, the other replicates of these glasses were used to demonstrate that the PCT was in control. The PCT results were normalized to both the targeted and measured compositions of the study glasses. One of the quenched glasses (EWG-OL-3388) and four of the CCC heat treated glasses (EWG-OL-3122, EWG-OL-3208, EWG-OL-3388, and EWG-OL-38081) had NL [B] values that were greater than that of the EA benchmark glass. These results can be combined with additional characterization, including X-ray diffraction, to determine the cause of the higher release rates.

5.0 References

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Appendix A Tables and Exhibits Supporting the Chemical Composition Measurements

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

ID	Block	Sub-Blk	Sequence	Lab ID	Cd (wt%)	K (wt%)	Li (wt%)	Na (wt%)	P (wt%)
LRM	1	1	1	LRMAD111	0.116	1.31	<0.100	15.0	0.241
EWG-OL-4099	1	1	2	Q02AD11	<0.100	<0.100	2.81	4.05	1.31
EWG-OL-3231	1	1	3	Q08AD11	<0.100	2.45	2.73	3.96	1.24
EWG-Centroid-2-R1	1	1	4	Q09AD11	<0.100	0.561	1.30	8.79	0.464
EWG-OL-38081	1	1	5	Q03AD21	<0.100	2.39	2.49	6.21	<0.100
EWG-OL-33694	1	1	6	Q12AD11	<0.100	2.52	<0.100	4.25	<0.100
EWG-OL-4099	1	1	7	Q02AD21	<0.100	<0.100	2.79	4.06	1.27
EWG-OL-35387	1	1	8	Q04AD11	<0.100	2.34	<0.100	13.0	<0.100
EWG-OL-33858	1	1	9	Q05AD21	<0.100	2.39	2.75	3.95	<0.100
LRM	1	1	10	LRMAD112	0.115	1.38	<0.100	15.1	0.259
EWG-OL-3231	1	1	11	Q08AD21	<0.100	2.55	2.70	4.14	1.20
EWG-OL-38081	1	1	12	Q03AD11	<0.100	2.48	2.73	6.22	<0.100
EWG-OL-23401	1	1	13	Q06AD21	<0.100	<0.100	<0.100	12.7	<0.100
EWG-OL-23401	1	1	14	Q06AD11	<0.100	<0.100	<0.100	12.9	<0.100
EWG-OL-35387	1	1	15	Q04AD21	<0.100	2.43	<0.100	13.1	<0.100
EWG-OL-33694	1	1	16	Q12AD21	<0.100	2.46	<0.100	4.28	<0.100
EWG-Centroid-2-R1	1	1	17	Q09AD21	<0.100	0.587	1.28	9.03	0.441
EWG-OL-33858	1	1	18	Q05AD11	<0.100	2.42	2.74	3.98	<0.100
LRM	1	1	19	LRMAD113	0.115	1.36	<0.100	14.9	0.253
LRM	1	2	1	LRMAD121	0.111	1.29	<0.100	14.6	0.246
EWG-OL-33858	1	2	2	Q05AD22	<0.100	2.42	2.72	3.91	<0.100
EWG-OL-38081	1	2	3	Q03AD22	<0.100	2.47	2.40	6.23	<0.100
EWG-OL-38081	1	2	4	Q03AD12	<0.100	2.49	2.77	6.07	<0.100
EWG-OL-23401	1	2	5	Q06AD22	<0.100	<0.100	<0.100	12.8	<0.100
EWG-Centroid-2-R1	1	2	6	Q09AD22	<0.100	0.531	1.30	8.82	0.433
EWG-OL-23401	1	2	7	Q06AD12	<0.100	<0.100	<0.100	12.9	<0.100
EWG-OL-3231	1	2	8	Q08AD12	<0.100	2.31	2.78	3.85	1.26
EWG-OL-4099	1	2	9	Q02AD22	<0.100	<0.100	2.80	3.93	1.25
LRM	1	2	10	LRMAD122	0.110	1.30	<0.100	14.2	0.241
EWG-OL-3231	1	2	11	Q08AD22	<0.100	2.41	2.78	4.00	1.15

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

ID	Block	Sub-Blk	Sequence	Lab ID	Cd (wt%)	K (wt%)	Li (wt%)	Na (wt%)	P (wt%)
EWG-Centroid-2-R1	1	2	12	Q09AD12	<0.100	0.542	1.35	8.94	0.446
EWG-OL-35387	1	2	13	Q04AD22	<0.100	2.37	<0.100	13.1	<0.100
EWG-OL-35387	1	2	14	Q04AD12	<0.100	2.28	<0.100	13.0	<0.100
EWG-OL-33858	1	2	15	Q05AD12	<0.100	2.36	2.77	3.99	<0.100
EWG-OL-33694	1	2	16	Q12AD22	<0.100	2.35	<0.100	4.07	<0.100
EWG-OL-4099	1	2	17	Q02AD12	<0.100	<0.100	2.88	4.01	1.26
EWG-OL-33694	1	2	18	Q12AD12	<0.100	2.36	<0.100	4.16	<0.100
LRM	1	2	19	LRMAD123	0.117	1.35	<0.100	14.9	0.225
LRM	2	1	1	LRMAD211	0.131	1.19	<0.100	14.6	0.267
EWG-OL-33558	2	1	2	Q11AD11	<0.100	2.52	<0.100	4.30	1.31
EWG-OL-3388	2	1	3	Q10AD11	<0.100	2.54	<0.100	13.2	1.20
EWG-OL-3122	2	1	4	Q16AD21	<0.100	2.31	<0.100	13.2	<0.100
EWG-OL-3208	2	1	5	Q14AD21	<0.100	2.50	2.79	12.9	1.24
EWG-OL-3122	2	1	6	Q16AD11	<0.100	2.06	<0.100	13.2	<0.100
EWG-OL-5549	2	1	7	Q07AD21	<0.100	2.35	<0.100	12.7	<0.100
EWG-OL-16450	2	1	8	Q15AD11	<0.100	<0.100	<0.100	13.1	<0.100
EWG-OL-12707	2	1	9	Q01AD21	<0.100	<0.100	<0.100	13.4	1.21
LRM	2	1	10	LRMAD212	0.131	1.29	<0.100	15.2	0.284
EWG-OL-32706	2	1	11	Q13AD11	<0.100	2.46	0.509	5.06	<0.100
EWG-OL-3208	2	1	12	Q14AD11	<0.100	2.59	2.80	13.0	1.29
EWG-OL-33558	2	1	13	Q11AD21	<0.100	2.54	<0.100	4.11	1.23
EWG-OL-3388	2	1	14	Q10AD21	<0.100	2.51	<0.100	13.6	1.26
EWG-OL-5549	2	1	15	Q07AD11	<0.100	2.52	<0.100	12.8	<0.100
EWG-OL-12707	2	1	16	Q01AD11	<0.100	<0.100	<0.100	13.4	1.26
EWG-OL-32706	2	1	17	Q13AD21	<0.100	2.43	0.502	5.02	<0.100
EWG-OL-16450	2	1	18	Q15AD21	<0.100	<0.100	<0.100	13.1	<0.100
LRM	2	1	19	LRMAD213	0.128	1.30	<0.100	15.1	0.291
LRM	2	2	1	LRMAD221	0.112	1.26	<0.100	14.8	0.236
EWG-OL-33558	2	2	2	Q11AD12	<0.100	2.52	<0.100	4.22	1.34
EWG-OL-3208	2	2	3	Q14AD12	<0.100	2.37	2.88	12.8	1.29
EWG-OL-5549	2	2	4	Q07AD12	<0.100	2.36	<0.100	12.9	<0.100

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

ID	Block	Sub-Blk	Sequence	Lab ID	Cd (wt%)	K (wt%)	Li (wt%)	Na (wt%)	P (wt%)
EWG-OL-32706	2	2	5	Q13AD22	<0.100	2.44	0.492	4.88	<0.100
EWG-OL-3388	2	2	6	Q10AD12	<0.100	2.41	<0.100	13.2	1.22
EWG-OL-3122	2	2	7	Q16AD22	<0.100	2.29	<0.100	13.4	<0.100
EWG-OL-16450	2	2	8	Q15AD22	<0.100	<0.100	<0.100	13.0	<0.100
EWG-OL-5549	2	2	9	Q07AD22	<0.100	2.37	<0.100	12.8	<0.100
LRM	2	2	10	LRMAD222	0.112	1.31	<0.100	14.8	0.232
EWG-OL-3208	2	2	11	Q14AD22	<0.100	2.36	2.94	13.0	1.25
EWG-OL-12707	2	2	12	Q01AD12	<0.100	<0.100	<0.100	13.7	1.23
EWG-OL-16450	2	2	13	Q15AD12	<0.100	<0.100	<0.100	13.3	<0.100
EWG-OL-33558	2	2	14	Q11AD22	<0.100	2.44	<0.100	4.03	1.19
EWG-OL-32706	2	2	15	Q13AD12	<0.100	2.31	0.512	4.94	<0.100
EWG-OL-12707	2	2	16	Q01AD22	<0.100	<0.100	<0.100	13.2	1.29
EWG-OL-3122	2	2	17	Q16AD12	<0.100	2.03	<0.100	13.1	<0.100
EWG-OL-3388	2	2	18	Q10AD22	<0.100	2.44	<0.100	13.4	1.27
LRM	2	2	19	LRMAD223	0.115	1.32	<0.100	15.2	0.226

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

ID	Block	Sub-Blk	Sequence	Lab ID	Pb (wt%)	Ru (wt%)	S (wt%)	Sr (wt%)	Zr (wt%)
LRM	1	1	1	LRMAD111	<0.100	<0.100	<0.100	<0.100	0.683
EWG-OL-4099	1	1	2	Q02AD11	0.254	<0.100	0.140	<0.100	<0.100
EWG-OL-3231	1	1	3	Q08AD11	0.255	<0.100	0.129	<0.100	<0.100
EWG-Centroid-2-R1	1	1	4	Q09AD11	0.250	<0.100	0.110	<0.100	0.676
EWG-OL-38081	1	1	5	Q03AD21	0.249	<0.100	<0.100	<0.100	2.81
EWG-OL-33694	1	1	6	Q12AD11	0.265	<0.100	<0.100	<0.100	<0.100
EWG-OL-4099	1	1	7	Q02AD21	0.253	<0.100	0.138	<0.100	<0.100
EWG-OL-35387	1	1	8	Q04AD11	0.254	<0.100	<0.100	<0.100	<0.100
EWG-OL-33858	1	1	9	Q05AD21	0.252	<0.100	<0.100	<0.100	<0.100
LRM	1	1	10	LRMAD112	<0.100	<0.100	<0.100	<0.100	0.690
EWG-OL-3231	1	1	11	Q08AD21	0.255	<0.100	0.124	<0.100	<0.100
EWG-OL-38081	1	1	12	Q03AD11	0.256	<0.100	<0.100	<0.100	2.86
EWG-OL-23401	1	1	13	Q06AD21	0.248	<0.100	<0.100	<0.100	2.85
EWG-OL-23401	1	1	14	Q06AD11	0.244	<0.100	<0.100	<0.100	2.89
EWG-OL-35387	1	1	15	Q04AD21	0.258	<0.100	<0.100	<0.100	<0.100
EWG-OL-33694	1	1	16	Q12AD21	0.262	<0.100	<0.100	<0.100	<0.100
EWG-Centroid-2-R1	1	1	17	Q09AD21	0.252	<0.100	0.114	<0.100	0.690
EWG-OL-33858	1	1	18	Q05AD11	0.251	<0.100	<0.100	<0.100	<0.100
LRM	1	1	19	LRMAD113	<0.100	<0.100	0.107	<0.100	0.686
LRM	1	2	1	LRMAD121	<0.100	<0.100	0.103	<0.100	0.665
EWG-OL-33858	1	2	2	Q05AD22	0.250	<0.100	<0.100	<0.100	<0.100
EWG-OL-38081	1	2	3	Q03AD22	0.244	<0.100	<0.100	<0.100	2.82
EWG-OL-38081	1	2	4	Q03AD12	0.259	<0.100	<0.100	<0.100	2.78
EWG-OL-23401	1	2	5	Q06AD22	0.248	<0.100	<0.100	<0.100	2.78
EWG-Centroid-2-R1	1	2	6	Q09AD22	0.254	<0.100	0.110	<0.100	0.666
EWG-OL-23401	1	2	7	Q06AD12	0.244	<0.100	<0.100	<0.100	2.84
EWG-OL-3231	1	2	8	Q08AD12	0.257	<0.100	0.127	<0.100	<0.100
EWG-OL-4099	1	2	9	Q02AD22	0.252	<0.100	0.141	<0.100	<0.100

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

ID	Block	Sub-Blk	Sequence	Lab ID	Pb (wt%)	Ru (wt%)	S (wt%)	Sr (wt%)	Zr (wt%)
LRM	1	2	10	LRMAD122	<0.100	<0.100	<0.100	<0.100	0.644
EWG-OL-3231	1	2	11	Q08AD22	0.262	<0.100	0.130	<0.100	<0.100
EWG-Centroid-2-R1	1	2	12	Q09AD12	0.258	<0.100	0.109	<0.100	0.677
EWG-OL-35387	1	2	13	Q04AD22	0.259	<0.100	<0.100	<0.100	<0.100
EWG-OL-35387	1	2	14	Q04AD12	0.256	<0.100	<0.100	<0.100	<0.100
EWG-OL-33858	1	2	15	Q05AD12	0.252	<0.100	<0.100	<0.100	<0.100
EWG-OL-33694	1	2	16	Q12AD22	0.262	<0.100	<0.100	<0.100	<0.100
EWG-OL-4099	1	2	17	Q02AD12	0.262	<0.100	0.142	<0.100	<0.100
EWG-OL-33694	1	2	18	Q12AD12	0.272	<0.100	<0.100	<0.100	<0.100
LRM	1	2	19	LRMAD123	<0.100	<0.100	<0.100	<0.100	0.673
LRM	2	1	1	LRMAD211	<0.100	<0.100	0.124	<0.100	0.667
EWG-OL-33558	2	1	2	Q11AD11	0.262	<0.100	<0.100	<0.100	<0.100
EWG-OL-3388	2	1	3	Q10AD11	0.267	<0.100	<0.100	<0.100	<0.100
EWG-OL-3122	2	1	4	Q16AD21	0.194	<0.100	<0.100	<0.100	<0.100
EWG-OL-3208	2	1	5	Q14AD21	0.263	<0.100	0.127	<0.100	<0.100
EWG-OL-3122	2	1	6	Q16AD11	0.207	<0.100	<0.100	<0.100	<0.100
EWG-OL-5549	2	1	7	Q07AD21	0.229	<0.100	0.121	<0.100	2.74
EWG-OL-16450	2	1	8	Q15AD11	0.255	<0.100	0.142	<0.100	<0.100
EWG-OL-12707	2	1	9	Q01AD21	0.231	<0.100	0.157	<0.100	2.89
LRM	2	1	10	LRMAD212	<0.100	<0.100	<0.100	<0.100	0.697
EWG-OL-32706	2	1	11	Q13AD11	0.266	<0.100	<0.100	<0.100	2.96
EWG-OL-3208	2	1	12	Q14AD11	0.264	<0.100	0.126	<0.100	<0.100
EWG-OL-33558	2	1	13	Q11AD21	0.259	<0.100	<0.100	<0.100	<0.100
EWG-OL-3388	2	1	14	Q10AD21	0.256	<0.100	<0.100	<0.100	<0.100
EWG-OL-5549	2	1	15	Q07AD11	0.247	<0.100	0.126	<0.100	2.80
EWG-OL-12707	2	1	16	Q01AD11	0.235	<0.100	0.130	<0.100	2.91
EWG-OL-32706	2	1	17	Q13AD21	0.265	<0.100	<0.100	<0.100	2.96

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

ID	Block	Sub-Blk	Sequence	Lab ID	Pb (wt%)	Ru (wt%)	S (wt%)	Sr (wt%)	Zr (wt%)
EWG-OL-16450	2	1	18	Q15AD21	0.252	<0.100	0.135	<0.100	<0.100
LRM	2	1	19	LRMAD213	<0.100	<0.100	<0.100	<0.100	0.694
LRM	2	2	1	LRMAD221	<0.100	<0.100	<0.100	<0.100	0.677
EWG-OL-33558	2	2	2	Q11AD12	0.267	<0.100	<0.100	<0.100	<0.100
EWG-OL-3208	2	2	3	Q14AD12	0.267	<0.100	0.131	<0.100	<0.100
EWG-OL-5549	2	2	4	Q07AD12	0.253	<0.100	0.131	<0.100	2.77
EWG-OL-32706	2	2	5	Q13AD22	0.266	<0.100	<0.100	<0.100	2.88
EWG-OL-3388	2	2	6	Q10AD12	0.266	<0.100	<0.100	<0.100	<0.100
EWG-OL-3122	2	2	7	Q16AD22	0.196	<0.100	<0.100	<0.100	<0.100
EWG-OL-16450	2	2	8	Q15AD22	0.254	<0.100	0.137	<0.100	<0.100
EWG-OL-5549	2	2	9	Q07AD22	0.229	<0.100	0.117	<0.100	2.76
LRM	2	2	10	LRMAD222	<0.100	<0.100	<0.100	<0.100	0.67
EWG-OL-3208	2	2	11	Q14AD22	0.270	<0.100	0.134	<0.100	<0.100
EWG-OL-12707	2	2	12	Q01AD12	0.237	<0.100	0.131	<0.100	2.93
EWG-OL-16450	2	2	13	Q15AD12	0.256	<0.100	0.142	<0.100	<0.100
EWG-OL-33558	2	2	14	Q11AD22	0.257	<0.100	<0.100	<0.100	<0.100
EWG-OL-32706	2	2	15	Q13AD12	0.265	<0.100	<0.100	<0.100	2.90
EWG-OL-12707	2	2	16	Q01AD22	0.234	<0.100	0.158	<0.100	2.84
EWG-OL-3122	2	2	17	Q16AD12	0.210	<0.100	<0.100	<0.100	<0.100
EWG-OL-3388	2	2	18	Q10AD22	0.252	<0.100	<0.100	<0.100	<0.100
LRM	2	2	19	LRMAD223	<0.100	<0.100	0.115	<0.100	0.682

Table A-3. PF Measurements of Set 2 Study Glasses – Part 1

ID	Block	Sub-Blk	Sequence	Lab ID	Al (wt%)	B (wt%)	Bi (wt%)	Ca (wt%)	Cr (wt%)
LRM	1	1	1	LRMPF111	5.07	2.63	<0.100	0.541	0.150
EWG-OL-33558	1	1	2	Q11PF11	7.87	2.68	<0.100	7.17	<0.100
EWG-Centroid-2-R1	1	1	3	Q09PF11	11.1	4.81	0.930	2.59	0.521
EWG-OL-5549	1	1	4	Q07PF21	7.62	6.84	2.67	6.81	<0.100
EWG-OL-32706	1	1	5	Q13PF21	7.77	6.84	<0.100	<0.100	<0.100
EWG-OL-3208	1	1	6	Q14PF21	7.87	2.70	<0.100	<0.100	1.07
EWG-OL-33694	1	1	7	Q12PF11	8.06	7.16	2.62	<0.100	<0.100
EWG-OL-32706	1	1	8	Q13PF11	7.97	7.13	<0.100	<0.100	<0.100
EWG-OL-3208	1	1	9	Q14PF11	8.08	2.80	<0.100	<0.100	1.07
LRM	1	1	10	LRMPF112	5.21	2.59	<0.100	0.548	0.150
EWG-OL-3231	1	1	11	Q08PF11	7.87	7.10	<0.100	7.28	1.06
EWG-Centroid-2-R1	1	1	12	Q09PF21	11.4	4.96	0.906	2.65	0.500
EWG-OL-33694	1	1	13	Q12PF21	7.99	6.96	2.59	0.108	<0.100
EWG-OL-33558	1	1	14	Q11PF21	8.01	2.71	<0.100	7.40	<0.100
EWG-OL-3388	1	1	15	Q10PF21	7.85	7.13	2.63	<0.100	1.04
EWG-OL-5549	1	1	16	Q07PF11	7.99	7.24	2.63	6.86	<0.100
EWG-OL-3231	1	1	17	Q08PF21	7.94	7.26	<0.100	7.32	1.04
EWG-OL-3388	1	1	18	Q10PF11	7.90	7.18	2.61	<0.100	1.04
LRM	1	1	19	LRMPF113	5.21	2.62	<0.100	0.587	0.145
LRM	1	2	1	LRMPF121	5.13	2.57	<0.100	0.613	0.091
EWG-Centroid-2-R1	1	2	2	Q09PF22	11.3	4.95	0.866	2.62	0.474
EWG-OL-33694	1	2	3	Q12PF12	7.74	6.85	2.62	<0.100	<0.100
EWG-OL-33694	1	2	4	Q12PF22	7.77	6.81	2.62	0.135	<0.100
EWG-OL-3231	1	2	5	Q08PF12	7.59	6.92	<0.100	7.27	1.06
EWG-OL-33558	1	2	6	Q11PF22	7.87	2.64	<0.100	7.36	<0.100
EWG-OL-5549	1	2	7	Q07PF22	7.70	6.98	2.60	6.84	<0.100
EWG-OL-32706	1	2	8	Q13PF12	7.71	6.77	<0.100	<0.100	<0.100

Table A-3. PF Measurements of Set 2 Study Glasses – Part 1 (continued)

ID	Block	Sub-Blk	Sequence	Lab ID	Al (wt%)	B (wt%)	Bi (wt%)	Ca (wt%)	Cr (wt%)
EWG-OL-3208	1	2	9	Q14PF12	7.76	2.56	<0.100	<0.100	1.05
LRM	1	2	10	LRMPF122	5.18	2.50	<0.100	0.625	0.096
EWG-OL-3388	1	2	11	Q10PF22	7.74	7.02	2.62	<0.100	1.04
EWG-Centroid-2-R1	1	2	12	Q09PF12	11.5	5.02	0.869	2.81	0.472
EWG-OL-3231	1	2	13	Q08PF22	7.75	7.03	<0.100	7.50	1.03
EWG-OL-32706	1	2	14	Q13PF22	7.90	6.95	<0.100	0.132	<0.100
EWG-OL-3388	1	2	15	Q10PF12	7.68	6.97	2.63	0.118	1.05
EWG-OL-5549	1	2	16	Q07PF12	7.71	7.01	2.57	6.96	<0.100
EWG-OL-3208	1	2	17	Q14PF22	7.67	2.56	<0.100	<0.100	1.06
EWG-OL-33558	1	2	18	Q11PF12	7.94	2.62	<0.100	7.48	<0.100
LRM	1	2	19	LRMPF123	5.23	2.54	<0.100	0.636	0.096
LRM	2	1	1	LRMPF211	5.07	2.49	<0.100	0.709	0.116
EWG-OL-23401	2	1	2	Q06PF21	8.05	2.57	<0.100	7.78	1.04
EWG-OL-12707	2	1	3	Q01PF11	7.83	7.06	2.70	7.62	<0.100
EWG-OL-38081	2	1	4	Q03PF11	13.7	2.52	2.63	0.278	<0.100
EWG-OL-23401	2	1	5	Q06PF11	7.88	2.43	<0.100	7.75	1.06
EWG-OL-12707	2	1	6	Q01PF21	8.04	7.21	2.70	7.68	<0.100
EWG-OL-35387	2	1	7	Q04PF11	8.00	2.61	2.62	0.164	1.05
EWG-OL-33858	2	1	8	Q05PF21	15.8	3.17	2.60	0.191	<0.100
EWG-OL-3122	2	1	9	Q16PF11	15.2	2.46	<0.100	7.30	0.963
LRM	2	1	10	LRMPF212	5.30	2.54	<0.100	0.719	0.118
EWG-OL-16450	2	1	11	Q15PF11	8.05	7.27	2.67	7.70	1.06
EWG-OL-33858	2	1	12	Q05PF11	16.2	3.25	2.60	0.203	<0.100
EWG-OL-3122	2	1	13	Q16PF21	16.4	2.53	<0.100	7.77	1.03
EWG-OL-4099	2	1	14	Q02PF11	7.75	6.94	<0.100	7.72	<0.100
EWG-OL-4099	2	1	15	Q02PF21	7.81	7.08	<0.100	7.72	<0.100
EWG-OL-38081	2	1	16	Q03PF21	13.8	2.56	2.61	0.180	<0.100

Table A-3. PF Measurements of Set 2 Study Glasses – Part 1 (continued)

ID	Block	Sub-Blk	Sequence	Lab ID	Al (wt%)	B (wt%)	Bi (wt%)	Ca (wt%)	Cr (wt%)
EWG-OL-16450	2	1	17	Q15PF21	8.07	7.31	2.66	7.82	1.05
EWG-OL-35387	2	1	18	Q04PF21	8.15	2.66	2.57	0.219	1.04
LRM	2	1	19	LRMPF213	5.33	2.54	<0.100	0.731	0.113
LRM	2	2	1	LRMPF221	5.03	2.52	<0.100	0.508	0.097
EWG-OL-12707	2	2	2	Q01PF22	7.60	6.80	2.62	6.95	<0.100
EWG-OL-4099	2	2	3	Q02PF12	7.41	6.66	<0.100	6.97	<0.100
EWG-OL-23401	2	2	4	Q06PF22	7.81	2.52	<0.100	7.00	1.06
EWG-OL-3122	2	2	5	Q16PF12	14.7	2.44	<0.100	6.61	0.990
EWG-OL-33858	2	2	6	Q05PF22	15.5	3.17	2.60	<0.100	<0.100
EWG-OL-23401	2	2	7	Q06PF12	7.83	2.53	<0.100	7.10	1.04
EWG-OL-16450	2	2	8	Q15PF12	7.79	7.03	2.63	7.06	1.05
EWG-OL-35387	2	2	9	Q04PF12	7.70	2.56	2.52	<0.100	1.03
LRM	2	2	10	LRMPF222	5.18	2.51	<0.100	0.522	0.09
EWG-OL-33858	2	2	11	Q05PF12	15.5	3.17	2.60	<0.100	<0.100
EWG-OL-35387	2	2	12	Q04PF22	7.92	2.61	2.59	<0.100	1.05
EWG-OL-3122	2	2	13	Q16PF22	15.9	2.54	<0.100	7.20	1.02
EWG-OL-38081	2	2	14	Q03PF12	13.4	2.52	2.57	0.103	<0.100
EWG-OL-12707	2	2	15	Q01PF12	7.61	6.83	2.62	7.10	<0.100
EWG-OL-38081	2	2	16	Q03PF22	13.8	2.62	2.60	<0.100	<0.100
EWG-OL-4099	2	2	17	Q02PF22	7.87	7.09	<0.100	7.07	<0.100
EWG-OL-16450	2	2	18	Q15PF22	7.97	7.17	2.67	7.04	1.10
LRM	2	2	19	LRMPF223	5.16	2.53	<0.100	0.492	0.102

Table A-4. PF Measurements of Set 2 Study Glasses – Part 2

ID	Block	Sub-Blk	Sequence	Lab ID	Fe (wt%)	Mg (wt%)	Mn (wt%)	Ni (wt%)	Si (wt%)
LRM	1	1	1	LRMPF111	1.05	<0.100	<0.100	0.103	23.1
EWG-OL-33558	1	1	2	Q11PF11	6.92	2.27	2.38	0.269	17.1
EWG-Centroid-2-R1	1	1	3	Q09PF11	3.79	0.214	0.803	0.272	14.8
EWG-OL-5549	1	1	4	Q07PF21	<0.100	2.10	<0.100	0.273	9.68
EWG-OL-32706	1	1	5	Q13PF21	<0.100	2.28	<0.100	0.279	19.9
EWG-OL-3208	1	1	6	Q14PF21	<0.100	<0.100	2.38	0.281	18.5
EWG-OL-33694	1	1	7	Q12PF11	<0.100	2.34	2.41	0.290	19.8
EWG-OL-32706	1	1	8	Q13PF11	<0.100	2.33	<0.100	0.281	19.2
EWG-OL-3208	1	1	9	Q14PF11	<0.100	<0.100	2.40	0.285	18.7
LRM	1	1	10	LRMPF112	1.04	<0.100	<0.100	0.097	23.4
EWG-OL-3231	1	1	11	Q08PF11	<0.100	<0.100	2.37	0.274	13.8
EWG-Centroid-2-R1	1	1	12	Q09PF21	3.87	0.222	0.781	0.286	14.2
EWG-OL-33694	1	1	13	Q12PF21	<0.100	2.33	2.37	0.286	19.3
EWG-OL-33558	1	1	14	Q11PF21	7.11	2.34	2.39	0.284	16.9
EWG-OL-3388	1	1	15	Q10PF21	6.86	<0.100	2.34	0.273	9.31
EWG-OL-5549	1	1	16	Q07PF11	<0.100	2.19	<0.100	0.277	9.31
EWG-OL-3231	1	1	17	Q08PF21	<0.100	<0.100	2.33	0.276	13.5
EWG-OL-3388	1	1	18	Q10PF11	6.93	<0.100	2.32	0.275	9.27
LRM	1	1	19	LRMPF113	1.16	<0.100	<0.100	0.100	22.9
LRM	1	2	1	LRMPF121	1.01	<0.100	<0.100	0.150	23.8
EWG-Centroid-2-R1	1	2	2	Q09PF22	3.85	0.171	0.750	0.321	15.2
EWG-OL-33694	1	2	3	Q12PF12	<0.100	2.24	2.41	0.311	20.8
EWG-OL-33694	1	2	4	Q12PF22	<0.100	2.24	2.43	0.319	20.9
EWG-OL-3231	1	2	5	Q08PF12	<0.100	<0.100	2.36	0.315	14.4
EWG-OL-33558	1	2	6	Q11PF22	7.05	2.28	2.37	0.325	17.5
EWG-OL-5549	1	2	7	Q07PF22	<0.100	2.09	<0.100	0.317	9.85
EWG-OL-32706	1	2	8	Q13PF12	<0.100	2.24	<0.100	0.327	20.2

Table A-4. PF Measurements of Set 2 Study Glasses – Part 2 (continued)

ID	Block	Sub-Blk	Sequence	Lab ID	Fe (wt%)	Mg (wt%)	Mn (wt%)	Ni (wt%)	Si (wt%)
EWG-OL-3208	1	2	9	Q14PF12	<0.100	<0.100	2.39	0.328	19.6
LRM	1	2	10	LRMPF122	1.03	<0.100	<0.100	0.149	24.8
EWG-OL-3388	1	2	11	Q10PF22	6.80	<0.100	2.34	0.318	9.86
EWG-Centroid-2-R1	1	2	12	Q09PF12	3.89	0.173	0.75	0.326	15.1
EWG-OL-3231	1	2	13	Q08PF22	<0.100	<0.100	2.32	0.320	14.2
EWG-OL-32706	1	2	14	Q13PF22	<0.100	2.28	<0.100	0.330	21.0
EWG-OL-3388	1	2	15	Q10PF12	6.76	<0.100	2.36	0.324	10.0
EWG-OL-5549	1	2	16	Q07PF12	<0.100	2.08	<0.100	0.318	12.9
EWG-OL-3208	1	2	17	Q14PF22	<0.100	<0.100	2.39	0.318	19.6
EWG-OL-33558	1	2	18	Q11PF12	6.98	2.25	2.38	0.323	17.9
LRM	1	2	19	LRMPF123	1.03	<0.100	<0.100	0.150	24.6
LRM	2	1	1	LRMPF211	0.935	<0.100	<0.100	0.100	24.7
EWG-OL-23401	2	1	2	Q06PF21	<0.100	<0.100	<0.100	0.272	19.6
EWG-OL-12707	2	1	3	Q01PF11	<0.100	<0.100	2.41	0.274	10.1
EWG-OL-38081	2	1	4	Q03PF11	<0.100	<0.100	2.38	0.270	18.0
EWG-OL-23401	2	1	5	Q06PF11	<0.100	<0.100	<0.100	0.266	20.2
EWG-OL-12707	2	1	6	Q01PF21	<0.100	<0.100	2.41	0.275	10.1
EWG-OL-35387	2	1	7	Q04PF11	<0.100	2.27	2.36	0.280	19.1
EWG-OL-33858	2	1	8	Q05PF21	<0.100	2.24	2.63	0.278	15.9
EWG-OL-3122	2	1	9	Q16PF11	<0.100	<0.100	2.17	0.244	11.4
LRM	2	1	10	LRMPF212	0.968	<0.100	<0.100	0.097	25.0
EWG-OL-16450	2	1	11	Q15PF11	<0.100	2.24	2.38	0.275	10.9
EWG-OL-33858	2	1	12	Q05PF11	<0.100	2.31	2.38	0.269	16.6
EWG-OL-3122	2	1	13	Q16PF21	<0.100	<0.100	2.37	0.423	12.1
EWG-OL-4099	2	1	14	Q02PF11	<0.100	2.20	2.32	0.269	14.2
EWG-OL-4099	2	1	15	Q02PF21	<0.100	2.21	2.35	0.274	14.4
EWG-OL-38081	2	1	16	Q03PF21	<0.100	<0.100	2.38	0.275	17.8

Table A-4. PF Measurements of Set 2 Study Glasses – Part 2 (continued)

ID	Block	Sub-Blk	Sequence	Lab ID	Fe (wt%)	Mg (wt%)	Mn (wt%)	Ni (wt%)	Si (wt%)
EWG-OL-16450	2	1	17	Q15PF21	<0.100	2.24	2.37	0.284	10.9
EWG-OL-35387	2	1	18	Q04PF21	<0.100	2.31	2.36	0.283	20.0
LRM	2	1	19	LRMPF213	0.969	<0.100	<0.100	0.096	24.2
LRM	2	2	1	LRMPF221	0.980	<0.100	<0.100	0.098	25.0
EWG-OL-12707	2	2	2	Q01PF22	<0.100	<0.100	2.38	0.265	9.9
EWG-OL-4099	2	2	3	Q02PF12	<0.100	2.17	2.33	0.261	14.2
EWG-OL-23401	2	2	4	Q06PF22	<0.100	<0.100	<0.100	0.262	20.3
EWG-OL-3122	2	2	5	Q16PF12	<0.100	<0.100	2.24	0.236	11.9
EWG-OL-33858	2	2	6	Q05PF22	<0.100	2.26	2.41	0.269	16.8
EWG-OL-23401	2	2	7	Q06PF12	<0.100	<0.100	<0.100	0.261	19.9
EWG-OL-16450	2	2	8	Q15PF12	<0.100	2.20	2.38	0.265	10.9
EWG-OL-35387	2	2	9	Q04PF12	<0.100	2.25	2.35	0.280	19.8
LRM	2	2	10	LRMPF222	1.00	<0.100	<0.100	0.099	23.3
EWG-OL-33858	2	2	11	Q05PF12	<0.100	2.27	2.39	0.266	16.7
EWG-OL-35387	2	2	12	Q04PF22	<0.100	2.31	2.40	0.273	20.3
EWG-OL-3122	2	2	13	Q16PF22	<0.100	<0.100	2.38	0.412	12.1
EWG-OL-38081	2	2	14	Q03PF12	<0.100	<0.100	2.36	0.275	17.7
EWG-OL-12707	2	2	15	Q01PF12	<0.100	<0.100	2.40	0.267	9.92
EWG-OL-38081	2	2	16	Q03PF22	<0.100	<0.100	2.43	0.273	18.1
EWG-OL-4099	2	2	17	Q02PF22	<0.100	2.27	2.36	0.263	14.3
EWG-OL-16450	2	2	18	Q15PF22	<0.100	2.27	2.46	0.270	11.2
LRM	2	2	19	LRMPF223	1.02	<0.100	<0.100	0.097	24.3

Table A-5. Comparison of Measured and Targeted Compositions for Set 2 Study Glasses

Glass ID	Oxide	Measured (wt %)		Targeted (wt %)	Difference of Measured versus Targeted	% Difference of Measured versus Targeted
EWG-Centroid-2-R1	Al_2O_3		21.40	22.00	-0.60	-2.7%
EWG-Centroid-2-R1	B_2O_3		15.89	15.50	0.39	2.5%
EWG-Centroid-2-R1	Bi_2O_3		1.00	1.00	-0.01	
EWG-Centroid-2-R1	CaO		3.73	3.50	0.23	
EWG-Centroid-2-R1	CdO	<	0.11	0.10	0.01	
EWG-Centroid-2-R1	Cr_2O_3		0.72	0.75	-0.03	
EWG-Centroid-2-R1	Fe_2O_3		5.50	5.50	0.00	0.1%
EWG-Centroid-2-R1	K_2O		0.67	0.70	-0.03	
EWG-Centroid-2-R1	Li_2O		2.82	3.00	-0.19	
EWG-Centroid-2-R1	MgO		0.32	0.50	-0.18	
EWG-Centroid-2-R1	MnO		1.00	1.00	0.00	
EWG-Centroid-2-R1	Na_2O		11.99	11.50	0.49	4.3%
EWG-Centroid-2-R1	NiO		0.38	0.40	-0.02	
EWG-Centroid-2-R1	P_2O_5		1.02	1.00	0.02	
EWG-Centroid-2-R1	PbO		0.27	0.30	-0.03	
EWG-Centroid-2-R1	RuO_2	<	0.13	0.01	0.12	
EWG-Centroid-2-R1	SiO_2		31.72	31.50	0.22	0.7%
EWG-Centroid-2-R1	SO_3		0.28	0.30	-0.02	
EWG-Centroid-2-R1	SrO	<	0.12	0.12	0.00	
EWG-Centroid-2-R1	ZrO_2		0.92	1.00	-0.09	
EWG-Centroid-2-R1	Sum		99.98	99.68	0.30	0.3%
EWG-OL-12707	Al_2O_3		14.68	15.00	-0.32	-2.1%
EWG-OL-12707	B_2O_3		22.46	22.00	0.46	2.1%
EWG-OL-12707	Bi_2O_3		2.97	3.00	-0.04	
EWG-OL-12707	CaO		10.27	10.00	0.27	2.7%
EWG-OL-12707	CdO	<	0.11	0.10	0.01	
EWG-OL-12707	Cr_2O_3	<	0.15	0.00	0.15	
EWG-OL-12707	Fe_2O_3	<	0.14	0.00	0.14	
EWG-OL-12707	K_2O	<	0.12	0.00	0.12	
EWG-OL-12707	Li_2O	<	0.22	0.44	-0.23	
EWG-OL-12707	MgO	<	0.17	0.00	0.17	
EWG-OL-12707	MnO		3.10	3.00	0.10	
EWG-OL-12707	Na_2O		18.10	18.00	0.10	0.5%
EWG-OL-12707	NiO		0.34	0.40	-0.06	
EWG-OL-12707	P_2O_5		2.86	3.00	-0.14	
EWG-OL-12707	PbO		0.25	0.30	-0.05	
EWG-OL-12707	RuO_2	<	0.13	0.01	0.12	
EWG-OL-12707	SiO_2		21.40	20.02	1.38	6.9%
EWG-OL-12707	SO_3		0.36	0.30	0.06	
EWG-OL-12707	SrO	<	0.12	0.12	0.00	
EWG-OL-12707	ZrO_2		3.91	4.00	-0.09	
EWG-OL-12707	Sum		101.85	99.69	2.16	2.2%
EWG-OL-16450	Al_2O_3		15.06	15.00	0.06	0.4%
EWG-OL-16450	B_2O_3		23.17	22.00	1.17	5.3%
EWG-OL-16450	Bi_2O_3		2.96	3.00	-0.04	
EWG-OL-16450	CaO		10.36	10.00	0.36	3.6%
EWG-OL-16450	CdO	<	0.11	0.10	0.01	
EWG-OL-16450	Cr_2O_3		1.56	1.60	-0.04	
EWG-OL-16450	Fe_2O_3	<	0.14	0.00	0.14	
EWG-OL-16450	K_2O	<	0.12	0.00	0.12	
EWG-OL-16450	Li_2O	<	0.22	0.00	0.22	
EWG-OL-16450	MgO		3.71	4.00	-0.29	
EWG-OL-16450	MnO		3.10	3.00	0.10	
EWG-OL-16450	Na_2O		17.69	17.77	-0.08	-0.4%
EWG-OL-16450	NiO		0.35	0.40	-0.05	
EWG-OL-16450	P_2O_5	<	0.23	0.00	0.23	
EWG-OL-16450	PbO		0.27	0.30	-0.03	

Table A-5. Comparison of Measured and Targeted Compositions for Set 2 Study Glasses (continued)

Glass ID	Oxide	Measured (wt %)		Targeted (wt %)	Difference of Measured versus Targeted	% Difference of Measured versus Targeted
EWG-OL-16450	RuO_2	<	0.13	0.01	0.12	
EWG-OL-16450	SiO_2		23.48	22.08	1.40	6.3%
EWG-OL-16450	SO_3		0.35	0.30	0.05	
EWG-OL-16450	SrO	<	0.12	0.12	0.00	
EWG-OL-16450	ZrO_2	<	0.14	0.00	0.14	
EWG-OL-16450	Sum		103.26	99.68	3.58	3.6%
EWG-OL-23401	Al_2O_3		14.91	15.00	-0.09	-0.6%
EWG-OL-23401	B_2O_3		8.09	8.00	0.09	1.1%
EWG-OL-23401	Bi_2O_3	<	0.11	0.00	0.11	
EWG-OL-23401	CaO		10.37	10.00	0.37	3.7%
EWG-OL-23401	CdO	<	0.11	0.10	0.01	
EWG-OL-23401	Cr_2O_3		1.54	1.60	-0.07	
EWG-OL-23401	Fe_2O_3	<	0.14	0.00	0.14	
EWG-OL-23401	K_2O	<	0.12	0.00	0.12	
EWG-OL-23401	Li_2O	<	0.22	0.00	0.22	
EWG-OL-23401	MgO	<	0.17	0.00	0.17	
EWG-OL-23401	MnO	<	0.13	0.00	0.13	
EWG-OL-23401	Na_2O		17.29	17.54	-0.25	-1.4%
EWG-OL-23401	NiO		0.34	0.40	-0.06	
EWG-OL-23401	P_2O_5	<	0.23	0.00	0.23	
EWG-OL-23401	PbO		0.27	0.30	-0.04	
EWG-OL-23401	RuO_2	<	0.13	0.01	0.12	
EWG-OL-23401	SiO_2		42.79	42.32	0.47	1.1%
EWG-OL-23401	SO_3	<	0.25	0.30	-0.05	
EWG-OL-23401	SrO	<	0.12	0.12	0.00	
EWG-OL-23401	ZrO_2		3.84	4.00	-0.16	
EWG-OL-23401	Sum		101.14	99.69	1.45	1.5%
EWG-OL-3122	Al_2O_3		29.38	30.00	-0.62	-2.1%
EWG-OL-3122	B_2O_3		8.03	8.00	0.03	0.3%
EWG-OL-3122	Bi_2O_3	<	0.11	0.00	0.11	
EWG-OL-3122	CaO		10.10	10.00	0.10	1.0%
EWG-OL-3122	CdO	<	0.11	0.10	0.01	
EWG-OL-3122	Cr_2O_3		1.46	1.60	-0.14	
EWG-OL-3122	Fe_2O_3	<	0.14	0.00	0.14	
EWG-OL-3122	K_2O		2.62	3.00	-0.38	
EWG-OL-3122	Li_2O	<	0.22	0.00	0.22	
EWG-OL-3122	MgO	<	0.17	0.00	0.17	
EWG-OL-3122	MnO		2.96	3.00	-0.04	
EWG-OL-3122	Na_2O		17.83	18.00	-0.17	-1.0%
EWG-OL-3122	NiO		0.42	0.40	0.02	
EWG-OL-3122	P_2O_5	<	0.23	0.00	0.23	
EWG-OL-3122	PbO		0.22	0.30	-0.08	
EWG-OL-3122	RuO_2	<	0.13	0.01	0.12	
EWG-OL-3122	SiO_2		25.40	24.86	0.54	2.2%
EWG-OL-3122	SO_3	<	0.25	0.30	-0.05	
EWG-OL-3122	SrO	<	0.12	0.12	0.00	
EWG-OL-3122	ZrO_2	<	0.14	0.00	0.14	
EWG-OL-3122	Sum		100.03	99.69	0.34	0.3%
EWG-OL-3208	Al_2O_3		14.82	15.00	-0.18	-1.2%
EWG-OL-3208	B_2O_3		8.55	8.00	0.55	6.9%
EWG-OL-3208	Bi_2O_3	<	0.11	0.00	0.11	
EWG-OL-3208	CaO	<	0.14	0.00	0.14	
EWG-OL-3208	CdO	<	0.11	0.10	0.01	
EWG-OL-3208	Cr_2O_3		1.55	1.60	-0.05	
EWG-OL-3208	Fe_2O_3	<	0.14	0.00	0.14	
EWG-OL-3208	K_2O		2.96	3.00	-0.04	

Table A-5. Comparison of Measured and Targeted Compositions for Set 2 Study Glasses (continued)

Glass ID	Oxide	Measured (wt %)		Targeted (wt %)	Difference of Measured versus Targeted	% Difference of Measured versus Targeted
EWG-OL-3208	Li_2O		6.14	6.00	0.14	2.4%
EWG-OL-3208	MgO	<	0.17	0.00	0.17	
EWG-OL-3208	MnO		3.09	3.00	0.09	
EWG-OL-3208	Na_2O		17.42	18.00	-0.58	-3.2%
EWG-OL-3208	NiO		0.39	0.40	-0.01	
EWG-OL-3208	P_2O_5		2.90	3.00	-0.10	
EWG-OL-3208	PbO		0.29	0.30	-0.01	
EWG-OL-3208	RuO_2	<	0.13	0.01	0.12	
EWG-OL-3208	SiO_2		40.86	40.86	0.00	0.0%
EWG-OL-3208	SO_3		0.32	0.30	0.02	
EWG-OL-3208	SrO	<	0.12	0.12	0.00	
EWG-OL-3208	ZrO_2	<	0.14	0.00	0.14	
EWG-OL-3208	Sum		100.35	99.69	0.66	0.7%
EWG-OL-3231	Al_2O_3		14.71	15.00	-0.29	-1.9%
EWG-OL-3231	B_2O_3		22.79	22.00	0.79	3.6%
EWG-OL-3231	Bi_2O_3	<	0.11	0.00	0.11	
EWG-OL-3231	CaO		10.27	10.00	0.27	2.7%
EWG-OL-3231	CdO	<	0.11	0.10	0.01	
EWG-OL-3231	Cr_2O_3		1.53	1.60	-0.07	
EWG-OL-3231	Fe_2O_3	<	0.14	0.00	0.14	
EWG-OL-3231	K_2O		2.93	3.00	-0.07	
EWG-OL-3231	Li_2O		5.92	6.00	-0.09	-1.4%
EWG-OL-3231	MgO	<	0.17	0.00	0.17	
EWG-OL-3231	MnO		3.03	3.00	0.03	
EWG-OL-3231	Na_2O		5.38	5.00	0.38	7.5%
EWG-OL-3231	NiO		0.38	0.40	-0.02	
EWG-OL-3231	P_2O_5		2.78	3.00	-0.22	
EWG-OL-3231	PbO		0.28	0.30	-0.02	
EWG-OL-3231	RuO_2	<	0.13	0.01	0.12	
EWG-OL-3231	SiO_2		29.90	29.86	0.04	0.1%
EWG-OL-3231	SO_3		0.32	0.30	0.02	
EWG-OL-3231	SrO	<	0.12	0.12	0.00	
EWG-OL-3231	ZrO_2	<	0.14	0.00	0.14	
EWG-OL-3231	Sum		101.12	99.69	1.43	1.4%
EWG-OL-32706	Al_2O_3		14.81	15.00	-0.19	-1.3%
EWG-OL-32706	B_2O_3		22.29	22.00	0.29	1.3%
EWG-OL-32706	Bi_2O_3	<	0.11	0.00	0.11	
EWG-OL-32706	CaO	<	0.15	0.00	0.15	
EWG-OL-32706	CdO	<	0.11	0.10	0.01	
EWG-OL-32706	Cr_2O_3	<	0.15	0.00	0.15	
EWG-OL-32706	Fe_2O_3	<	0.14	0.00	0.14	
EWG-OL-32706	K_2O		2.90	3.00	-0.10	
EWG-OL-32706	Li_2O		1.09	1.23	-0.15	
EWG-OL-32706	MgO		3.79	4.00	-0.22	
EWG-OL-32706	MnO	<	0.13	0.00	0.13	
EWG-OL-32706	Na_2O		6.71	6.23	0.48	7.6%
EWG-OL-32706	NiO		0.39	0.40	-0.01	
EWG-OL-32706	P_2O_5	<	0.23	0.00	0.23	
EWG-OL-32706	PbO		0.29	0.30	-0.01	
EWG-OL-32706	RuO_2	<	0.13	0.01	0.12	
EWG-OL-32706	SiO_2		42.95	43.00	-0.05	-0.1%
EWG-OL-32706	SO_3	<	0.25	0.30	-0.05	
EWG-OL-32706	SrO	<	0.12	0.12	0.00	
EWG-OL-32706	ZrO_2		3.95	4.00	-0.05	
EWG-OL-32706	Sum		100.67	99.69	0.98	1.0%
EWG-OL-33558	Al_2O_3		14.97	15.00	-0.03	-0.2%

Table A-5. Comparison of Measured and Targeted Compositions for Set 2 Study Glasses (continued)

Glass ID	Oxide	Measured (wt %)		Targeted (wt %)	Difference of Measured versus Targeted	% Difference of Measured versus Targeted
EWG-OL-33558	B_2O_3		8.57	8.00	0.57	7.2%
EWG-OL-33558	Bi_2O_3	<	0.11	0.00	0.11	
EWG-OL-33558	CaO		10.29	10.00	0.29	2.9%
EWG-OL-33558	CdO	<	0.11	0.10	0.01	
EWG-OL-33558	Cr_2O_3	<	0.15	0.00	0.15	
EWG-OL-33558	Fe_2O_3		10.03	10.00	0.03	0.3%
EWG-OL-33558	K_2O		3.02	3.00	0.02	
EWG-OL-33558	Li_2O	<	0.22	0.26	-0.05	
EWG-OL-33558	MgO		3.79	4.00	-0.21	
EWG-OL-33558	MnO		3.07	3.00	0.07	
EWG-OL-33558	Na_2O		5.61	5.00	0.61	12.3%
EWG-OL-33558	NiO		0.38	0.40	-0.02	
EWG-OL-33558	P_2O_5		2.90	3.00	-0.10	
EWG-OL-33558	PbO		0.28	0.30	-0.02	
EWG-OL-33558	RuO_2	<	0.13	0.01	0.12	
EWG-OL-33558	SiO_2		37.12	37.19	-0.07	-0.2%
EWG-OL-33558	SO_3	<	0.25	0.30	-0.05	
EWG-OL-33558	SrO	<	0.12	0.12	0.00	
EWG-OL-33558	ZrO_2	<	0.14	0.00	0.14	
EWG-OL-33558	Sum		101.26	99.68	1.58	1.6%
EWG-OL-33694	Al_2O_3		14.91	15.00	-0.09	-0.6%
EWG-OL-33694	B_2O_3		22.36	22.00	0.36	1.6%
EWG-OL-33694	Bi_2O_3		2.91	3.00	-0.09	
EWG-OL-33694	CaO	<	0.16	0.00	0.16	
EWG-OL-33694	CdO	<	0.11	0.10	0.01	
EWG-OL-33694	Cr_2O_3	<	0.15	0.00	0.15	
EWG-OL-33694	Fe_2O_3	<	0.14	0.00	0.14	
EWG-OL-33694	K_2O		2.92	3.00	-0.08	
EWG-OL-33694	Li_2O	<	0.22	0.02	0.20	
EWG-OL-33694	MgO		3.79	4.00	-0.21	
EWG-OL-33694	MnO		3.11	3.00	0.11	
EWG-OL-33694	Na_2O		5.65	5.44	0.21	3.8%
EWG-OL-33694	NiO		0.38	0.40	-0.02	
EWG-OL-33694	P_2O_5	<	0.23	0.00	0.23	
EWG-OL-33694	PbO		0.29	0.30	-0.01	
EWG-OL-33694	RuO_2	<	0.13	0.01	0.12	
EWG-OL-33694	SiO_2		43.21	43.00	0.21	0.5%
EWG-OL-33694	SO_3	<	0.25	0.30	-0.05	
EWG-OL-33694	SrO	<	0.12	0.12	0.00	
EWG-OL-33694	ZrO_2	<	0.14	0.00	0.14	
EWG-OL-33694	Sum		101.17	99.69	1.48	1.5%
EWG-OL-33858	Al_2O_3		29.76	30.00	-0.24	-0.8%
EWG-OL-33858	B_2O_3		10.27	9.91	0.36	3.6%
EWG-OL-33858	Bi_2O_3		2.90	3.00	-0.10	
EWG-OL-33858	CaO	<	0.21	0.00	0.21	
EWG-OL-33858	CdO	<	0.11	0.10	0.01	
EWG-OL-33858	Cr_2O_3	<	0.15	0.00	0.15	
EWG-OL-33858	Fe_2O_3	<	0.14	0.00	0.14	
EWG-OL-33858	K_2O		2.89	3.00	-0.11	
EWG-OL-33858	Li_2O		5.91	6.00	-0.09	-1.5%
EWG-OL-33858	MgO		3.76	4.00	-0.24	
EWG-OL-33858	MnO		3.17	3.00	0.17	
EWG-OL-33858	Na_2O		5.34	5.00	0.34	6.7%
EWG-OL-33858	NiO		0.34	0.40	-0.06	
EWG-OL-33858	P_2O_5	<	0.23	0.00	0.23	
EWG-OL-33858	PbO		0.27	0.30	-0.03	

Table A-5. Comparison of Measured and Targeted Compositions for Set 2 Study Glasses (continued)

Glass ID	Oxide	Measured (wt %)		Targeted (wt %)	Difference of Measured versus Targeted	% Difference of Measured versus Targeted
EWG-OL-33858	RuO_2	<	0.13	0.01	0.12	
EWG-OL-33858	SiO_2		35.30	34.55	0.75	2.2%
EWG-OL-33858	SO_3	<	0.25	0.30	-0.05	
EWG-OL-33858	SrO	<	0.12	0.12	0.00	
EWG-OL-33858	ZrO_2	<	0.14	0.00	0.14	
EWG-OL-33858	Sum		101.38	99.69	1.69	1.7%
EWG-OL-3388	Al_2O_3		14.72	15.00	-0.28	-1.8%
EWG-OL-3388	B_2O_3		22.78	22.00	0.78	3.5%
EWG-OL-3388	Bi_2O_3		2.92	3.00	-0.08	
EWG-OL-3388	CaO	<	0.15	0.00	0.15	
EWG-OL-3388	CdO	<	0.11	0.10	0.01	
EWG-OL-3388	Cr_2O_3		1.52	1.60	-0.08	
EWG-OL-3388	Fe_2O_3		9.78	9.86	-0.08	-0.9%
EWG-OL-3388	K_2O		2.98	3.00	-0.02	
EWG-OL-3388	Li_2O	<	0.22	0.00	0.22	
EWG-OL-3388	MgO	<	0.17	0.00	0.17	
EWG-OL-3388	MnO		3.02	3.00	0.02	
EWG-OL-3388	Na_2O		18.00	18.00	0.00	0.0%
EWG-OL-3388	NiO		0.38	0.40	-0.02	
EWG-OL-3388	P_2O_5		2.84	3.00	-0.16	
EWG-OL-3388	PbO		0.28	0.30	-0.02	
EWG-OL-3388	RuO_2	<	0.13	0.01	0.12	
EWG-OL-3388	SiO_2		20.56	20.00	0.56	2.8%
EWG-OL-3388	SO_3	<	0.25	0.30	-0.05	
EWG-OL-3388	SrO	<	0.12	0.12	0.00	
EWG-OL-3388	ZrO_2	<	0.14	0.00	0.14	
EWG-OL-3388	Sum		101.06	99.69	1.37	1.4%
EWG-OL-35387	Al_2O_3		15.01	15.00	0.01	0.0%
EWG-OL-35387	B_2O_3		8.40	8.00	0.40	5.1%
EWG-OL-35387	Bi_2O_3		2.87	3.00	-0.13	
EWG-OL-35387	CaO	<	0.20	0.00	0.20	
EWG-OL-35387	CdO	<	0.11	0.10	0.01	
EWG-OL-35387	Cr_2O_3		1.52	1.60	-0.08	
EWG-OL-35387	Fe_2O_3	<	0.14	0.00	0.14	
EWG-OL-35387	K_2O		2.84	3.00	-0.16	
EWG-OL-35387	Li_2O	<	0.22	0.02	0.20	
EWG-OL-35387	MgO		3.79	4.00	-0.21	
EWG-OL-35387	MnO		3.06	3.00	0.06	
EWG-OL-35387	Na_2O		17.59	18.00	-0.41	-2.3%
EWG-OL-35387	NiO		0.36	0.40	-0.05	
EWG-OL-35387	P_2O_5	<	0.23	0.00	0.23	
EWG-OL-35387	PbO		0.28	0.30	-0.02	
EWG-OL-35387	RuO_2	<	0.13	0.01	0.12	
EWG-OL-35387	SiO_2		42.36	42.83	-0.47	-1.1%
EWG-OL-35387	SO_3	<	0.25	0.30	-0.05	
EWG-OL-35387	SrO	<	0.12	0.12	0.00	
EWG-OL-35387	ZrO_2	<	0.14	0.00	0.14	
EWG-OL-35387	Sum		99.61	99.68	-0.07	-0.1%
EWG-OL-38081	Al_2O_3		25.84	26.00	-0.16	-0.6%
EWG-OL-38081	B_2O_3		8.23	8.00	0.23	2.8%
EWG-OL-38081	Bi_2O_3		2.90	3.00	-0.10	
EWG-OL-38081	CaO	<	0.23	0.00	0.23	
EWG-OL-38081	CdO	<	0.11	0.10	0.01	
EWG-OL-38081	Cr_2O_3	<	0.15	0.00	0.15	
EWG-OL-38081	Fe_2O_3	<	0.14	0.00	0.14	
EWG-OL-38081	K_2O		2.96	3.00	-0.04	

Table A-5. Comparison of Measured and Targeted Compositions for Set 2 Study Glasses (continued)

Glass ID	Oxide	Measured (wt %)		Targeted (wt %)	Difference of Measured versus Targeted	% Difference of Measured versus Targeted
EWG-OL-38081	Li_2O		5.59	6.00	-0.41	-6.8%
EWG-OL-38081	MgO	<	0.17	0.00	0.17	
EWG-OL-38081	MnO		3.08	3.00	0.08	
EWG-OL-38081	Na_2O		8.33	7.96	0.37	4.7%
EWG-OL-38081	NiO		0.35	0.40	-0.05	
EWG-OL-38081	P_2O_5	<	0.23	0.00	0.23	
EWG-OL-38081	PbO		0.27	0.30	-0.03	
EWG-OL-38081	RuO_2	<	0.13	0.01	0.12	
EWG-OL-38081	SiO_2		38.29	37.49	0.80	2.1%
EWG-OL-38081	SO_3	<	0.25	0.30	-0.05	
EWG-OL-38081	SrO	<	0.12	0.12	0.00	
EWG-OL-38081	ZrO_2		3.81	4.00	-0.19	
EWG-OL-38081	Sum		101.18	99.68	1.50	1.5%
EWG-OL-4099	Al_2O_3		14.57	15.00	-0.43	-2.9%
EWG-OL-4099	B_2O_3		22.35	22.00	0.35	1.6%
EWG-OL-4099	Bi_2O_3	<	0.11	0.00	0.11	
EWG-OL-4099	CaO		10.31	10.00	0.31	3.1%
EWG-OL-4099	CdO	<	0.11	0.10	0.01	
EWG-OL-4099	Cr_2O_3	<	0.15	0.00	0.15	
EWG-OL-4099	Fe_2O_3	<	0.14	0.00	0.14	
EWG-OL-4099	K_2O	<	0.12	0.00	0.12	
EWG-OL-4099	Li_2O		6.07	6.00	0.07	1.2%
EWG-OL-4099	MgO		3.67	4.00	-0.33	
EWG-OL-4099	MnO		3.02	3.00	0.02	
EWG-OL-4099	Na_2O		5.41	5.00	0.41	8.2%
EWG-OL-4099	NiO		0.34	0.40	-0.06	
EWG-OL-4099	P_2O_5		2.92	3.00	-0.08	
EWG-OL-4099	PbO		0.28	0.30	-0.03	
EWG-OL-4099	RuO_2	<	0.13	0.01	0.12	
EWG-OL-4099	SiO_2		30.54	30.46	0.08	0.3%
EWG-OL-4099	SO_3		0.35	0.30	0.05	
EWG-OL-4099	SrO	<	0.12	0.12	0.00	
EWG-OL-4099	ZrO_2	<	0.14	0.00	0.14	
EWG-OL-4099	Sum		100.84	99.69	1.15	1.2%
EWG-OL-5549	Al_2O_3		14.65	15.00	-0.35	-2.3%
EWG-OL-5549	B_2O_3		22.60	22.00	0.60	2.7%
EWG-OL-5549	Bi_2O_3		2.92	3.00	-0.08	
EWG-OL-5549	CaO		9.61	9.46	0.15	1.6%
EWG-OL-5549	CdO	<	0.11	0.10	0.01	
EWG-OL-5549	Cr_2O_3	<	0.15	0.00	0.15	
EWG-OL-5549	Fe_2O_3	<	0.14	0.00	0.14	
EWG-OL-5549	K_2O		2.89	3.00	-0.11	
EWG-OL-5549	Li_2O	<	0.22	0.00	0.22	
EWG-OL-5549	MgO		3.51	4.00	-0.49	
EWG-OL-5549	MnO	<	0.13	0.00	0.13	
EWG-OL-5549	Na_2O		17.25	18.00	-0.75	-4.1%
EWG-OL-5549	NiO		0.38	0.40	-0.02	
EWG-OL-5549	P_2O_5	<	0.23	0.00	0.23	
EWG-OL-5549	PbO		0.26	0.30	-0.04	
EWG-OL-5549	RuO_2	<	0.13	0.01	0.12	
EWG-OL-5549	SiO_2		20.57	20.00	0.57	2.8%
EWG-OL-5549	SO_3		0.31	0.30	0.01	
EWG-OL-5549	SrO	<	0.12	0.12	0.00	
EWG-OL-5549	ZrO_2		3.74	4.00	-0.26	
EWG-OL-5549	Sum		99.90	99.69	0.21	0.2%

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

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

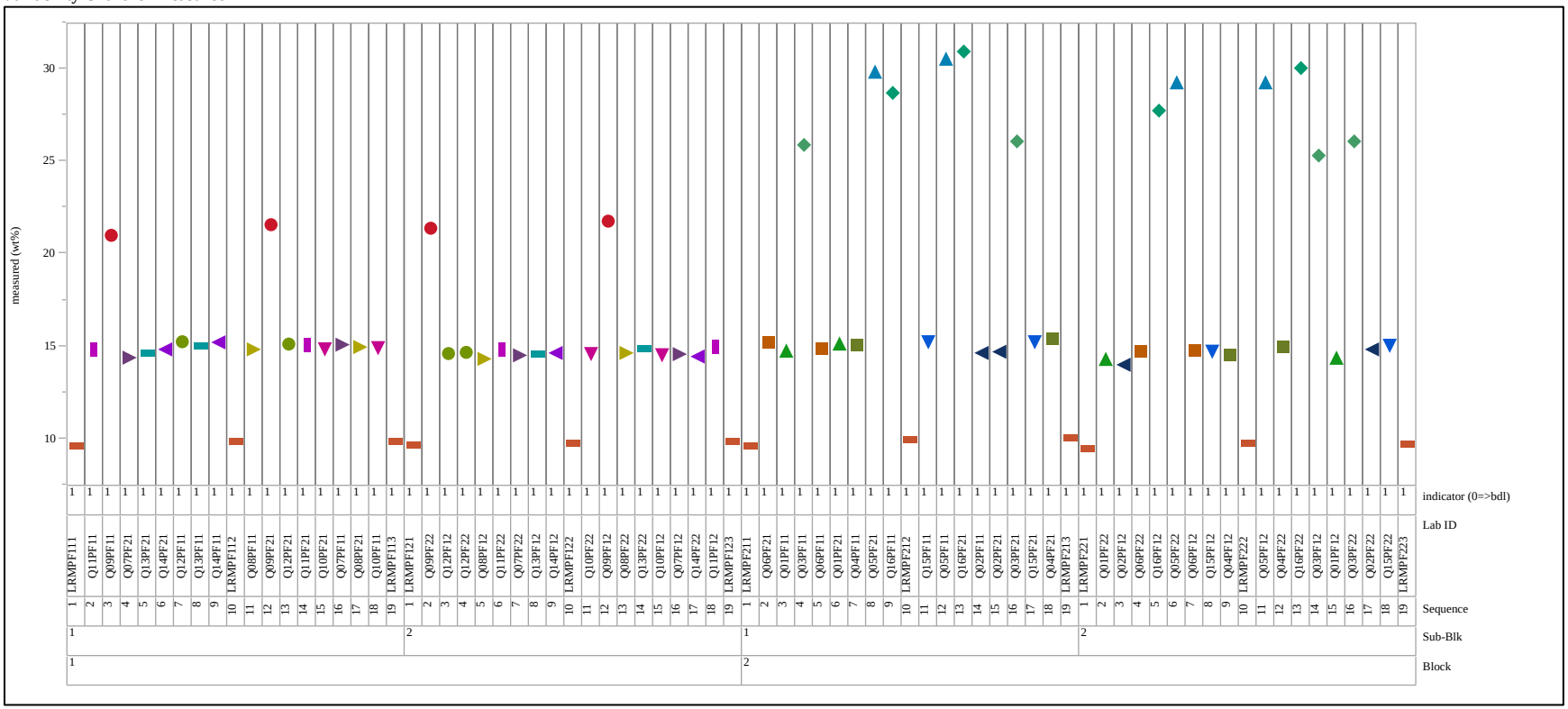


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence Grouped by Analytical Block (continued)

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

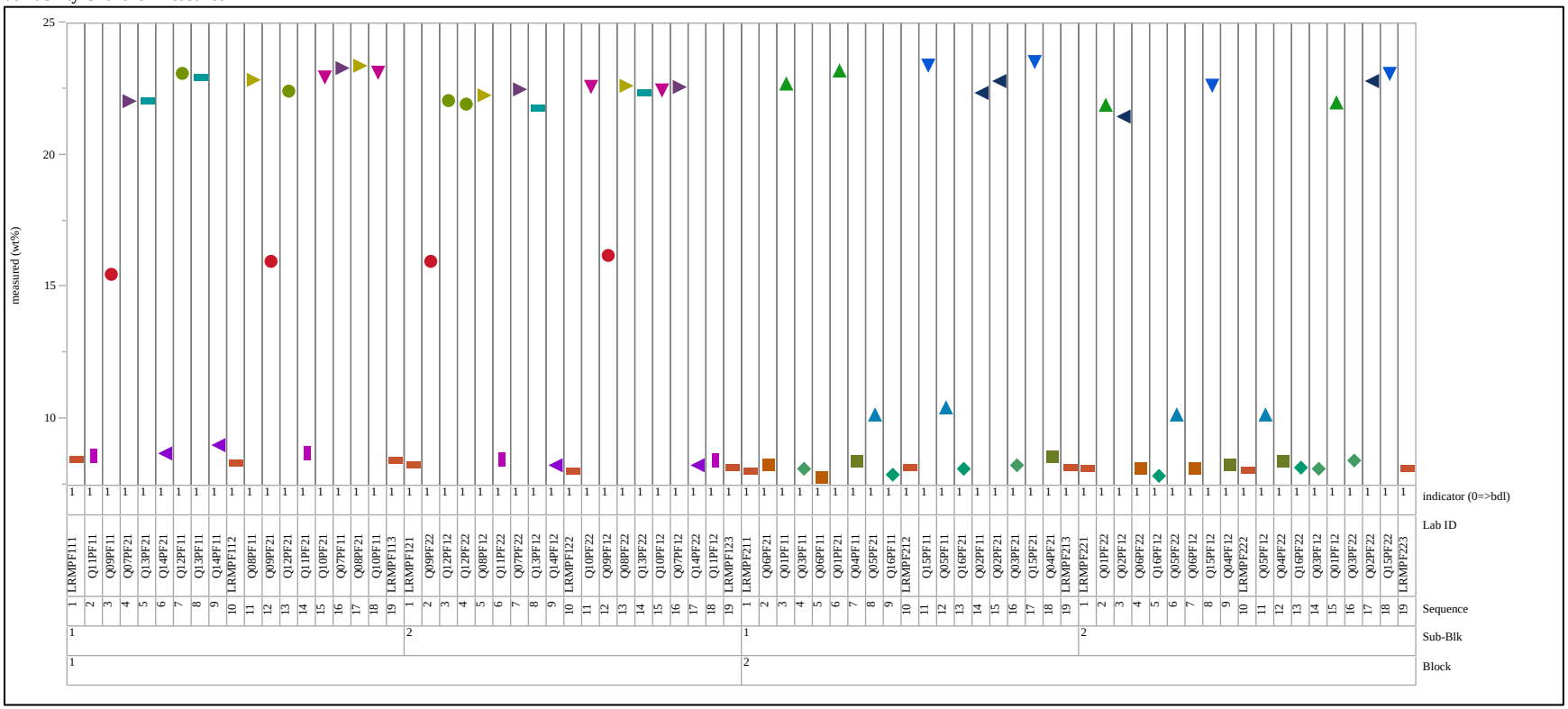


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence Grouped by Analytical Block (continued)

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

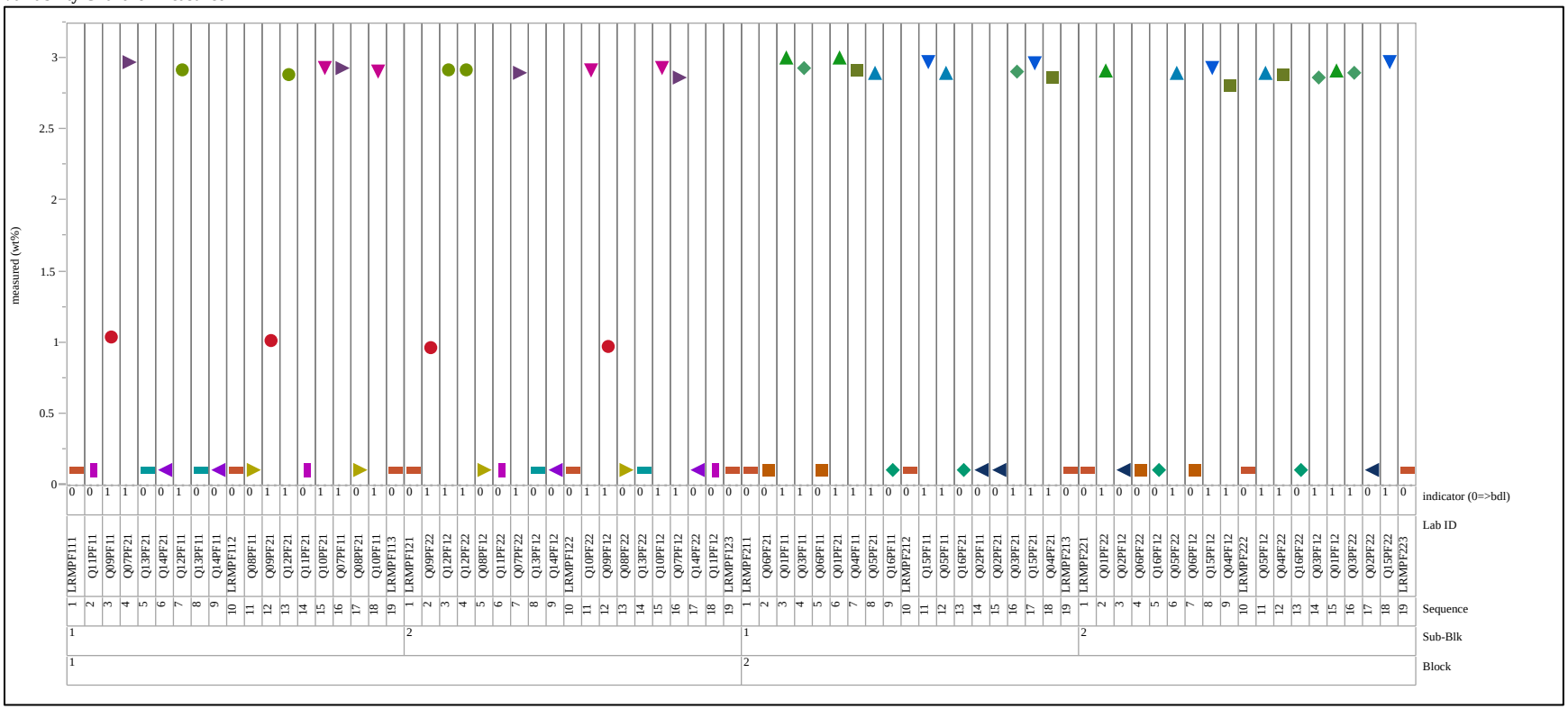


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence Grouped by Analytical Block (continued)

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

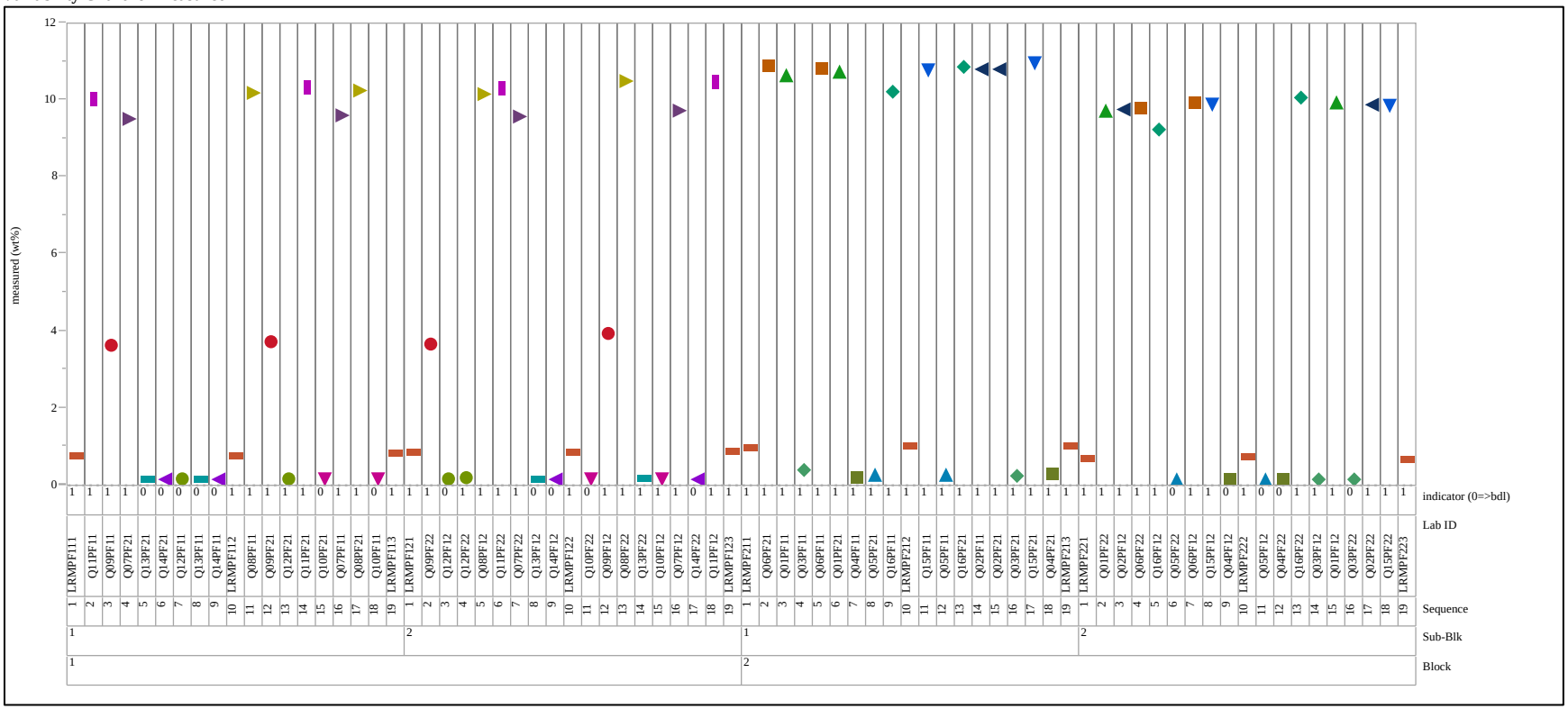


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence Grouped by Analytical Block (continued)

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

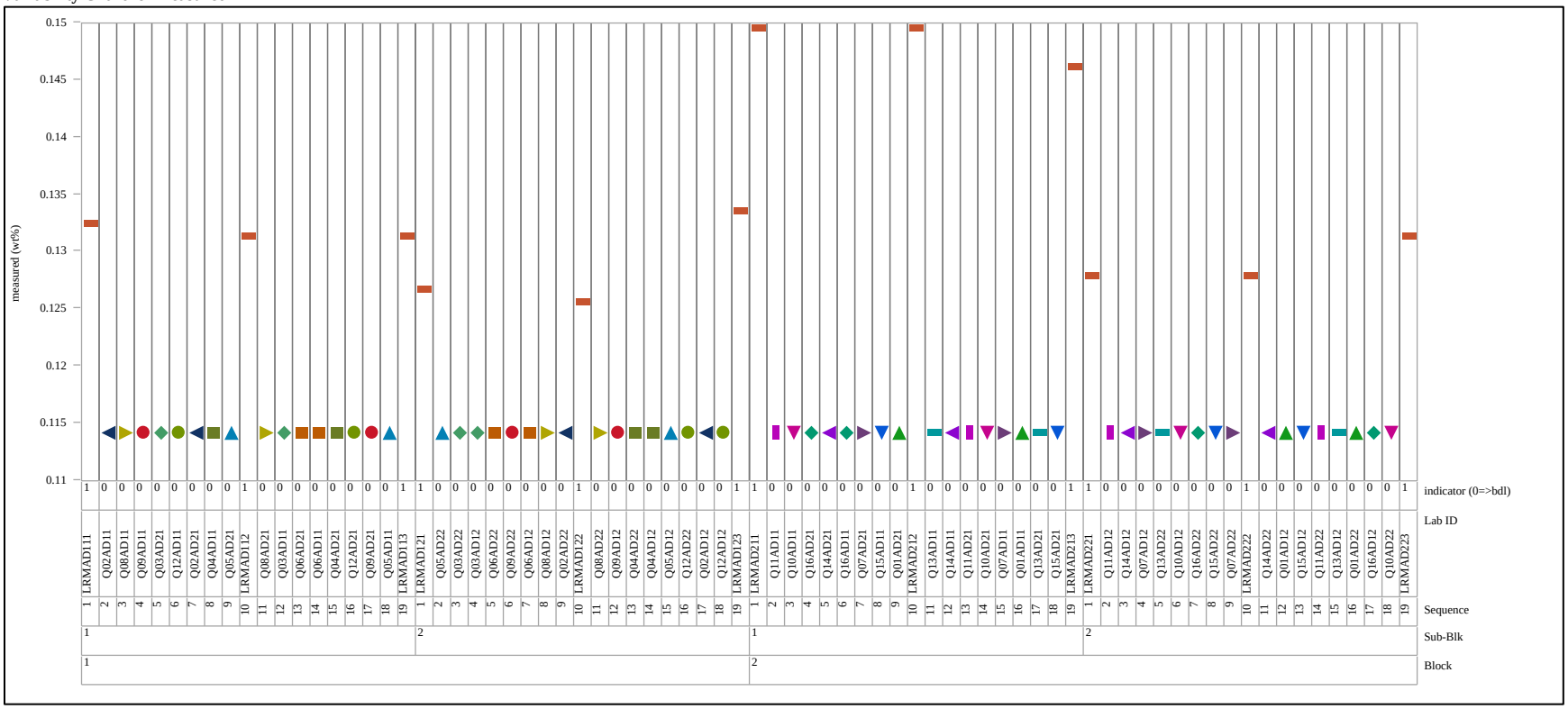


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence Grouped by Analytical Block (continued)

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

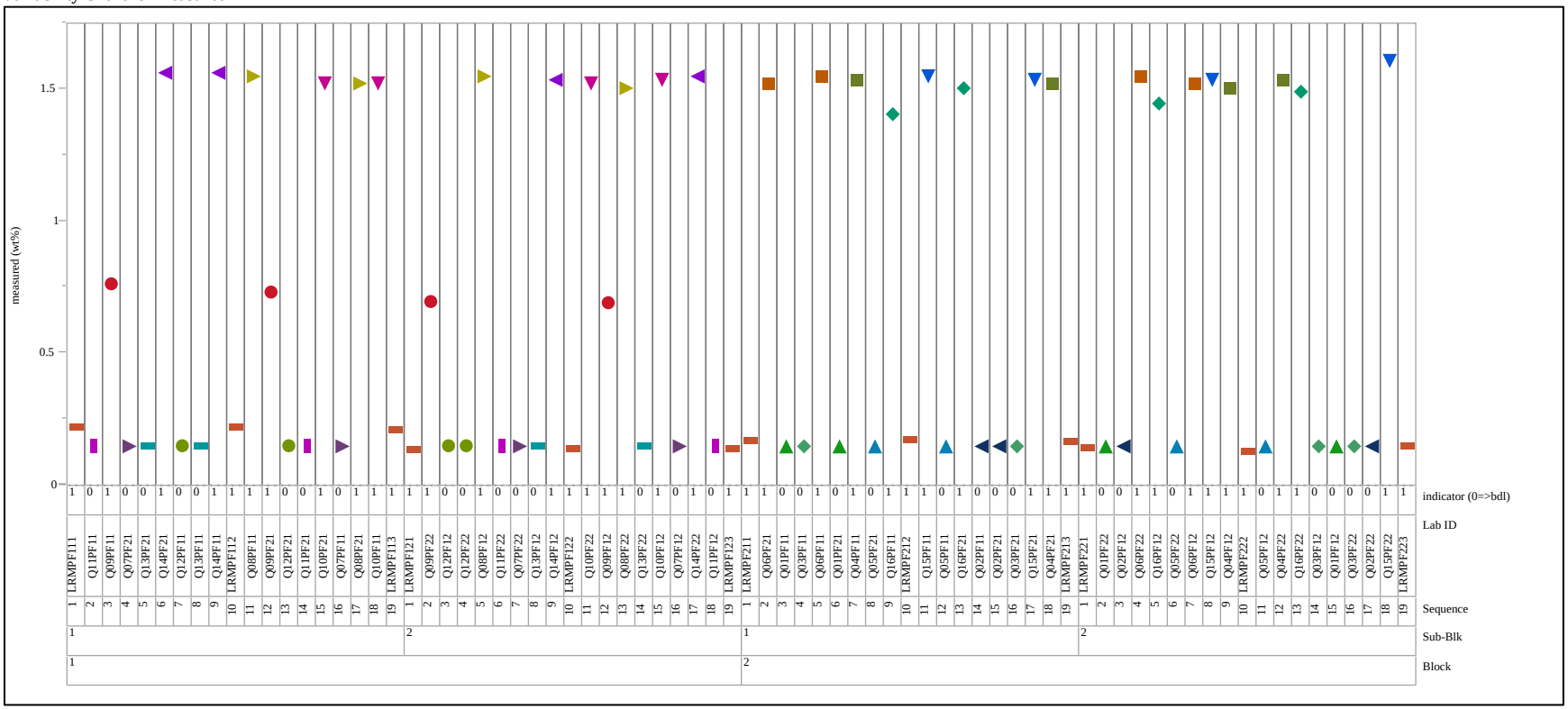


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence Grouped by Analytical Block (continued)

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

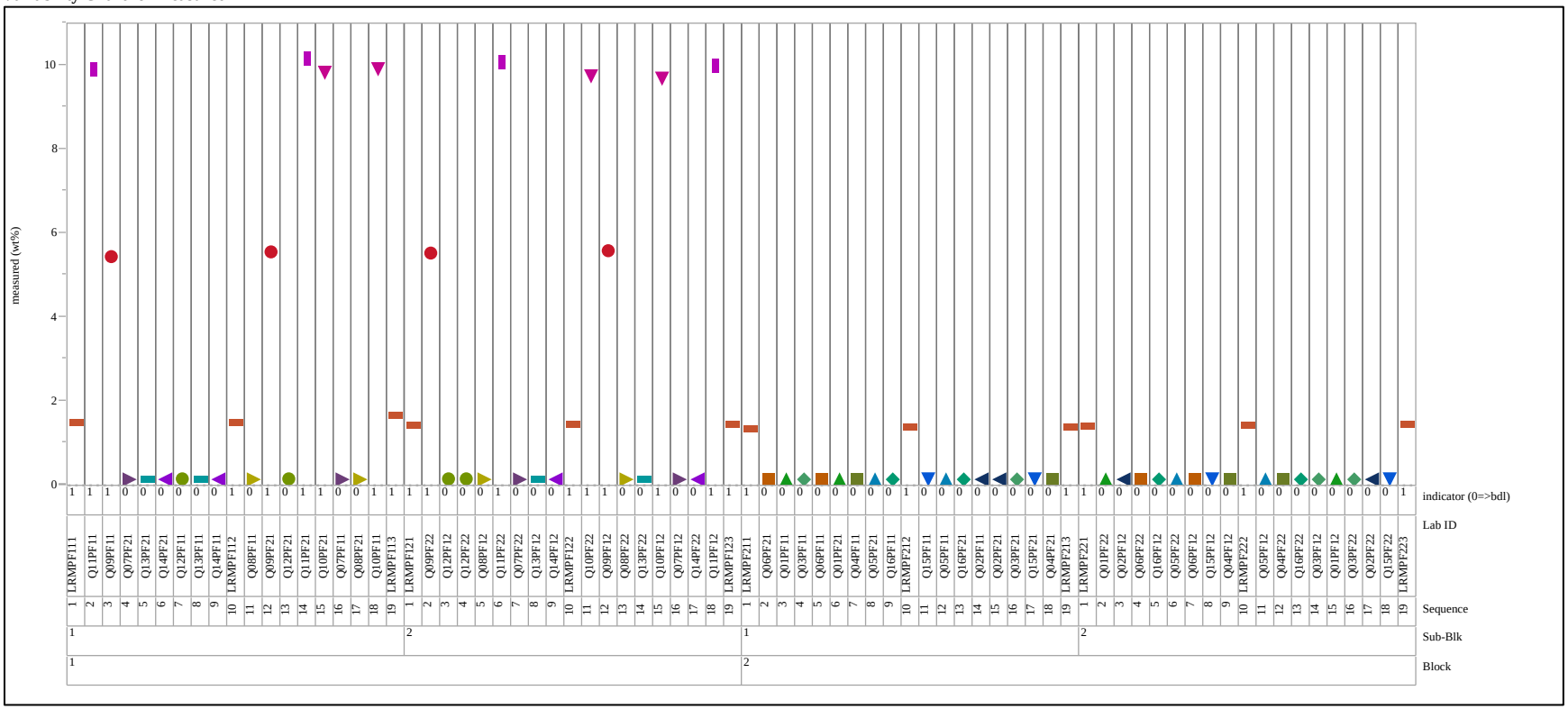


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence Grouped by Analytical Block (continued)

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

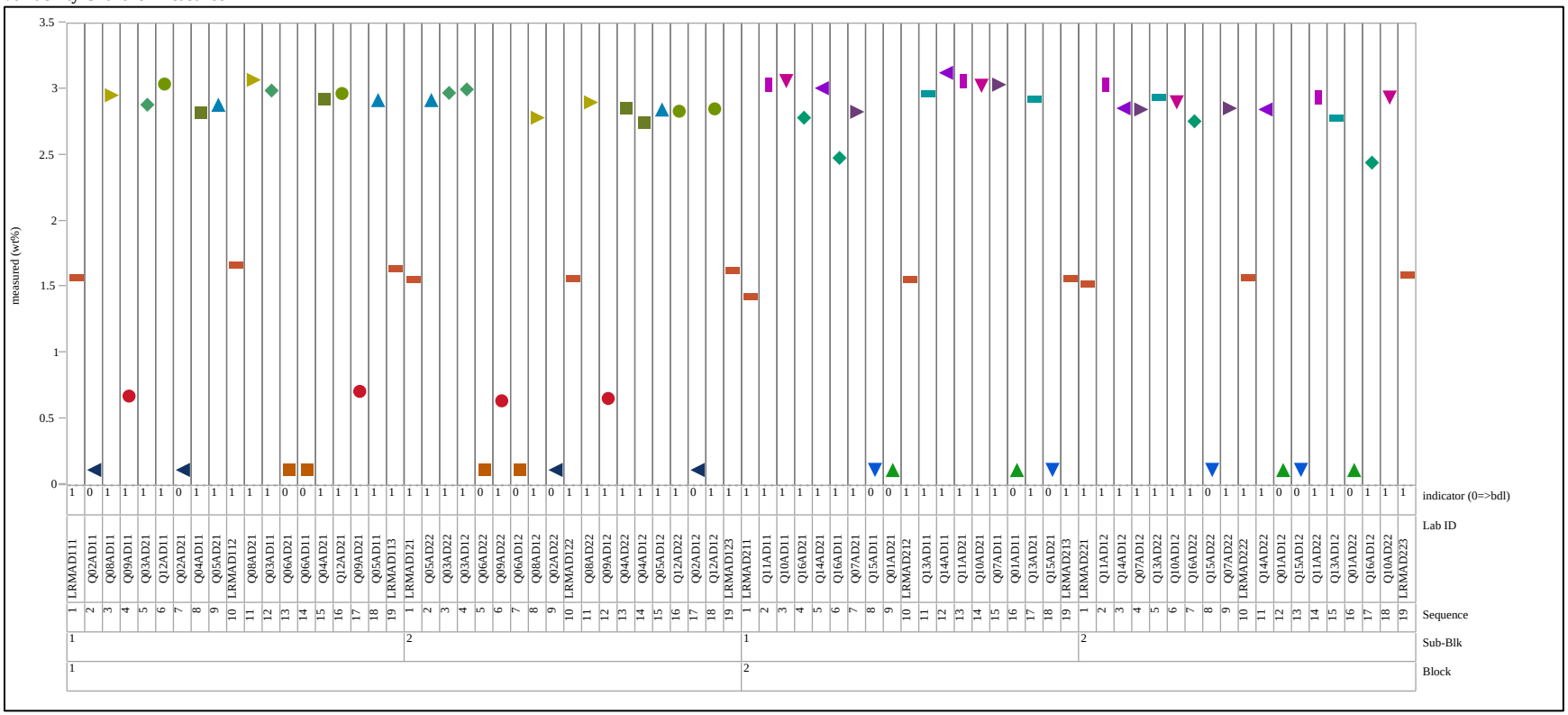


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence Grouped by Analytical Block (continued)

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

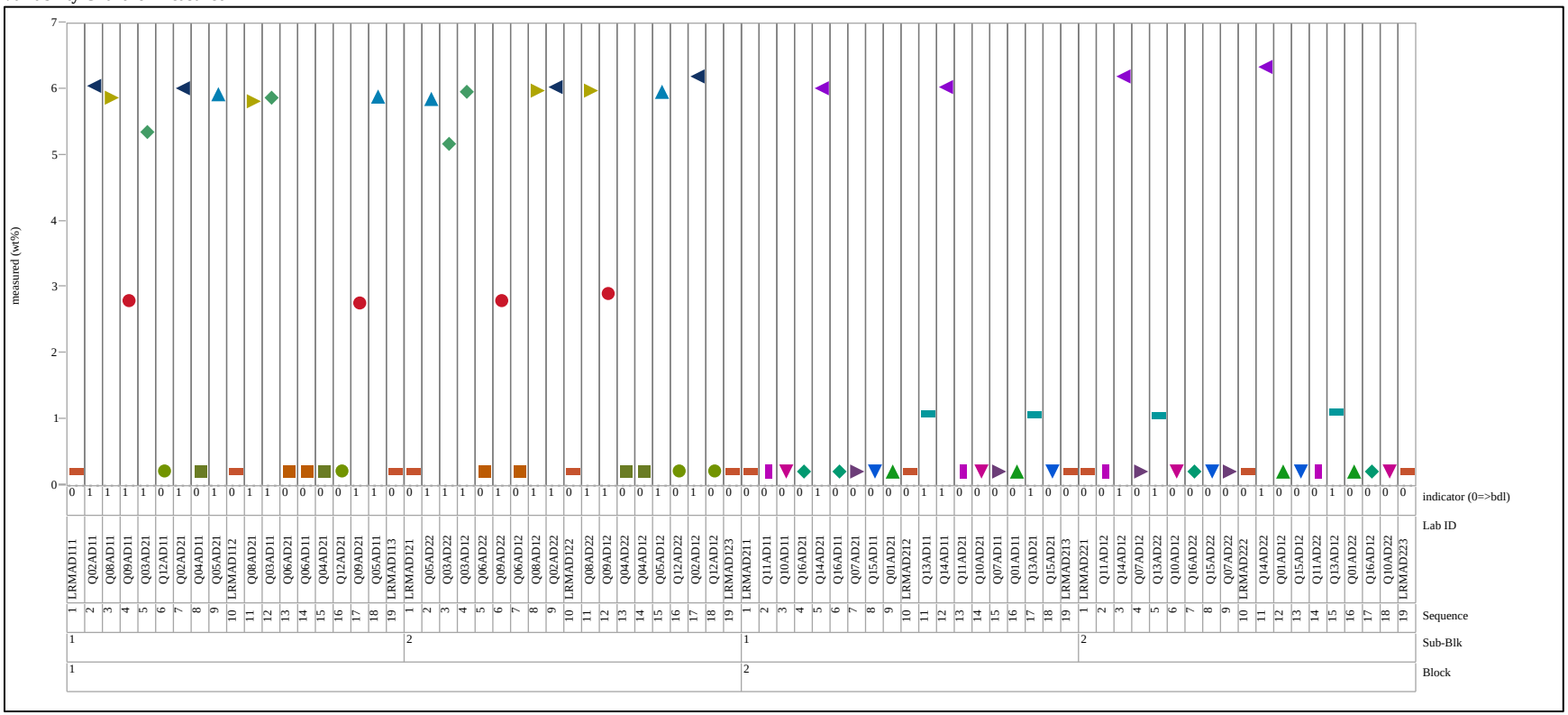


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence Grouped by Analytical Block (continued)

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

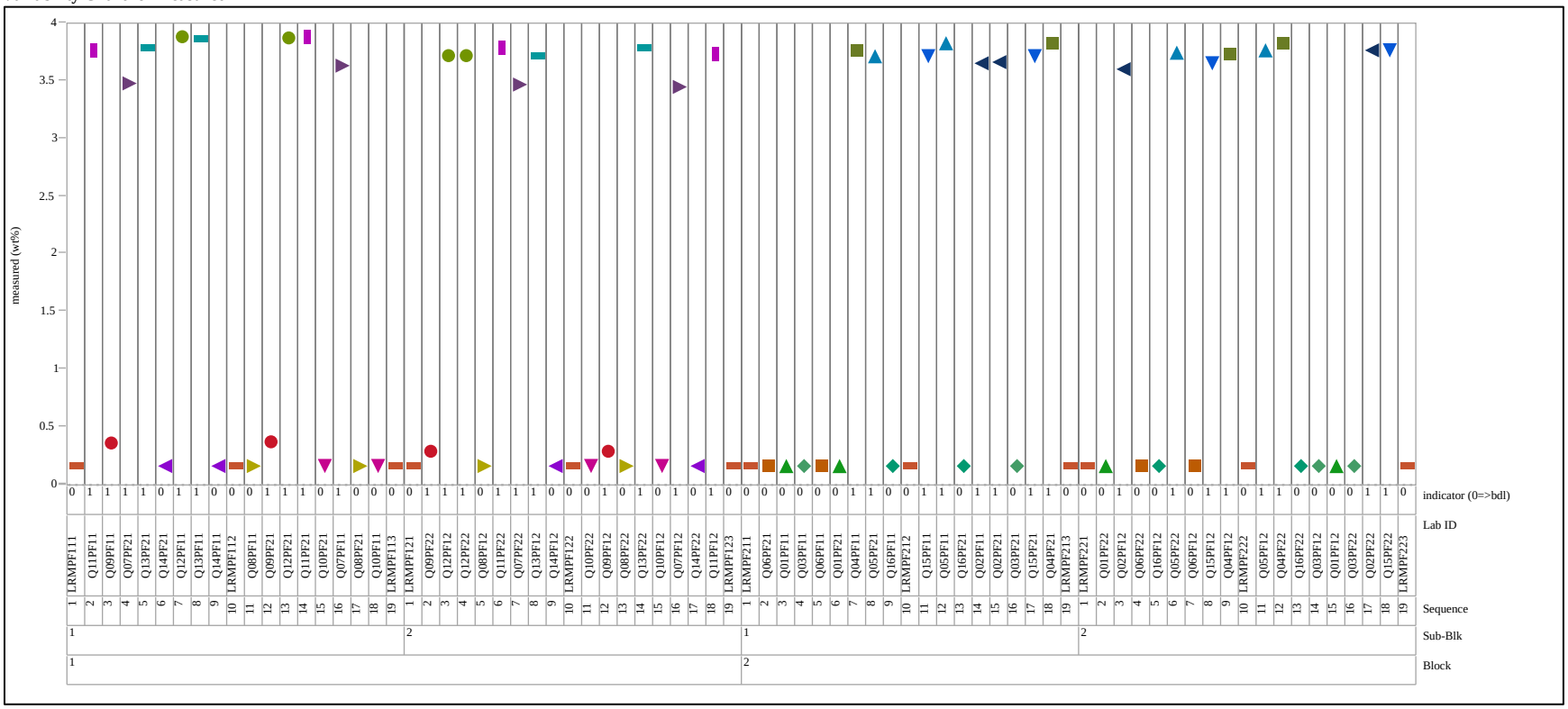


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence Grouped by Analytical Block (continued)

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

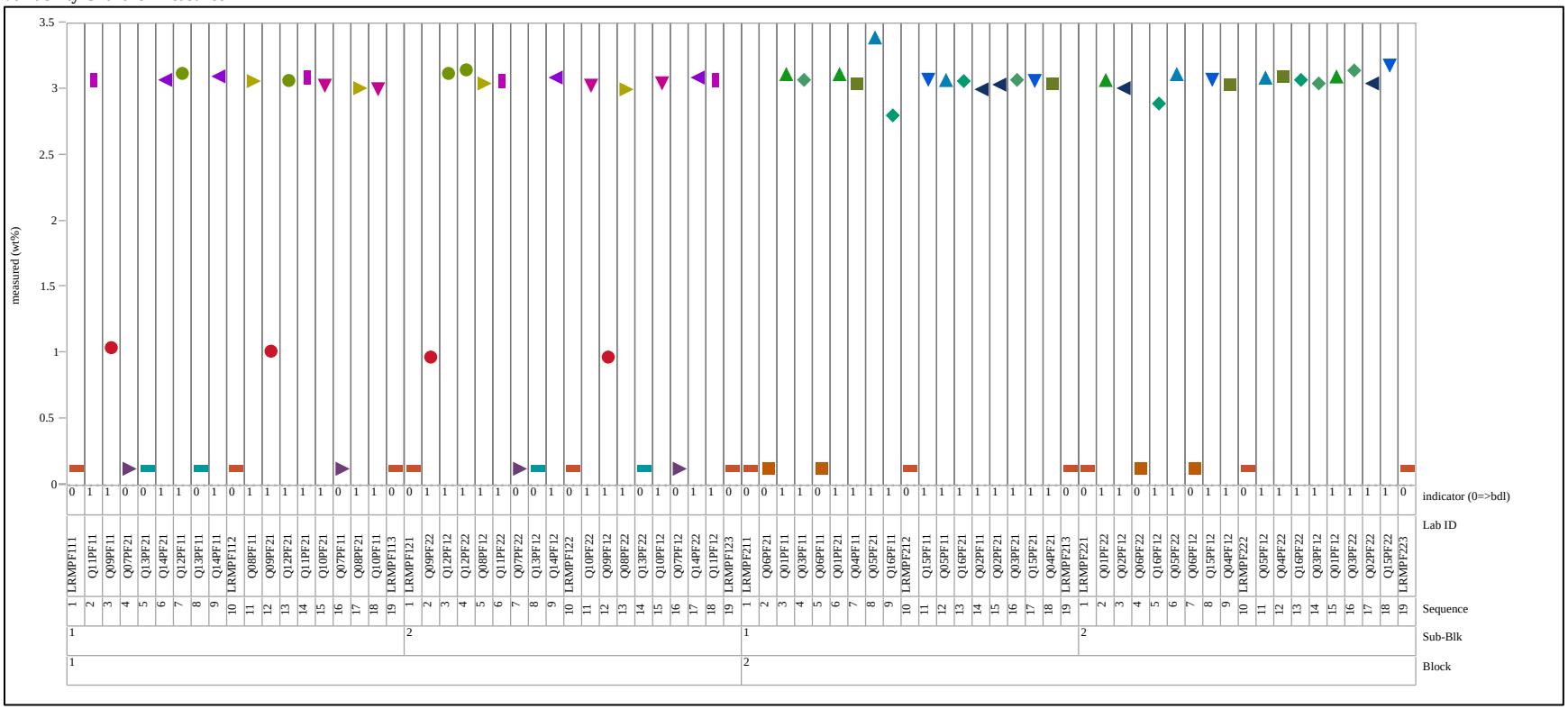


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence Grouped by Analytical Block (continued)

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

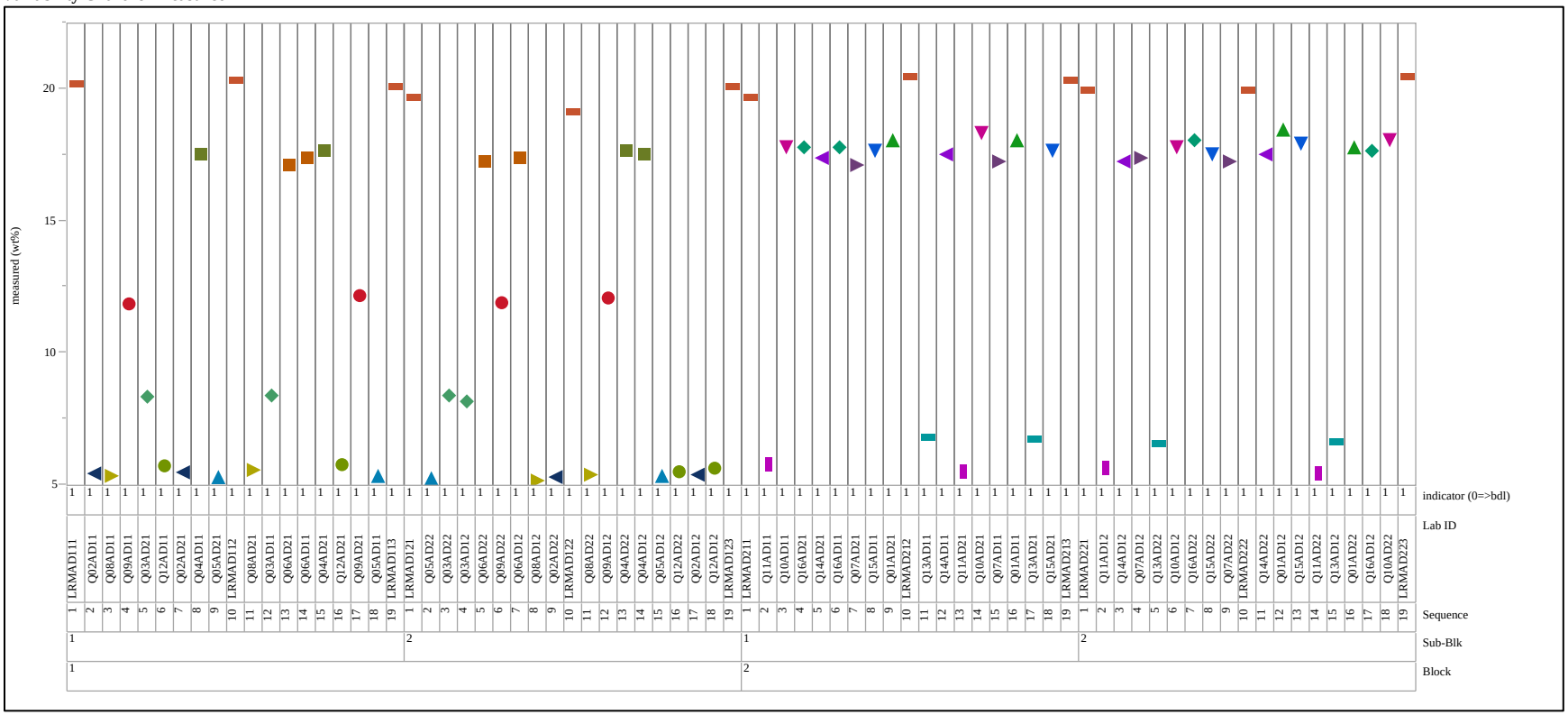


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence Grouped by Analytical Block (continued)

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

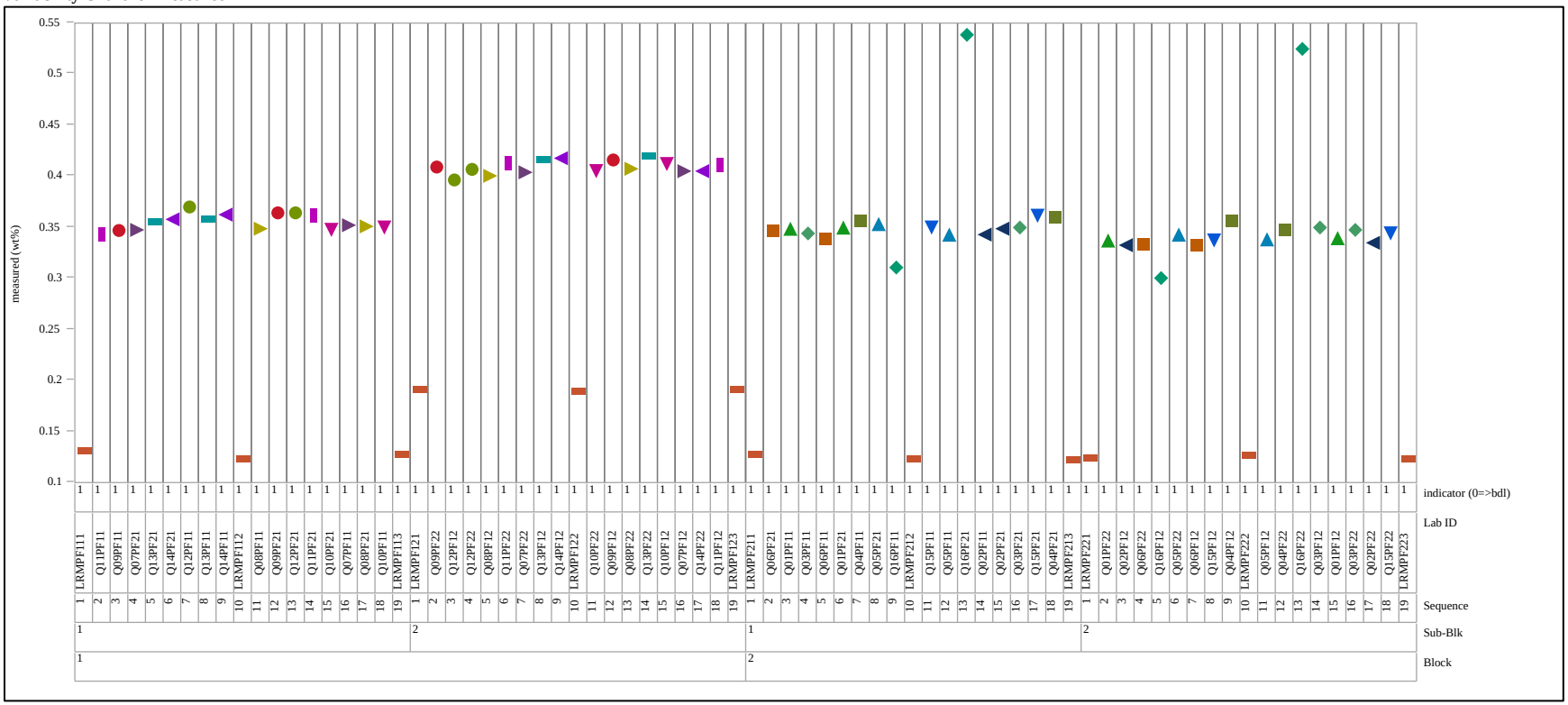


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence Grouped by Analytical Block (continued)

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

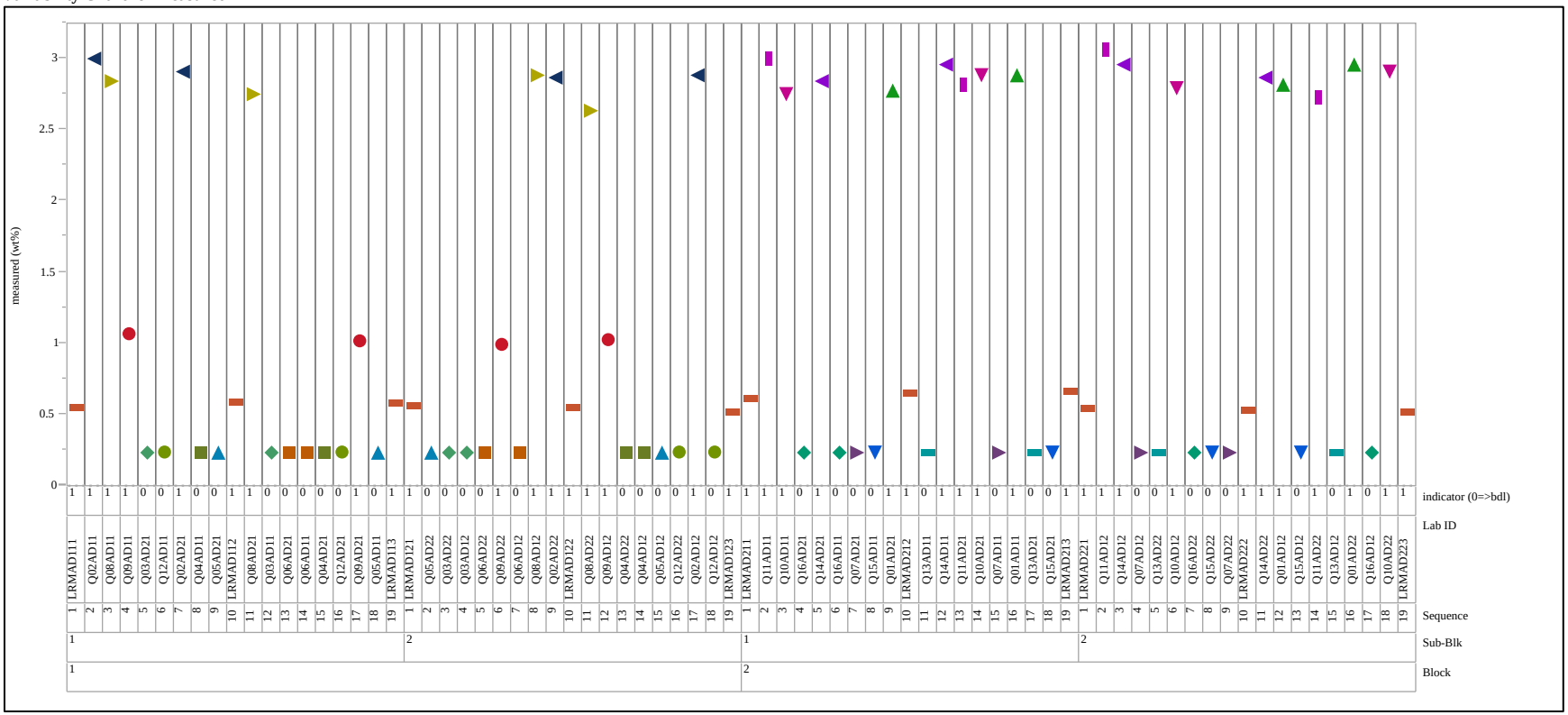


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence Grouped by Analytical Block (continued)

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

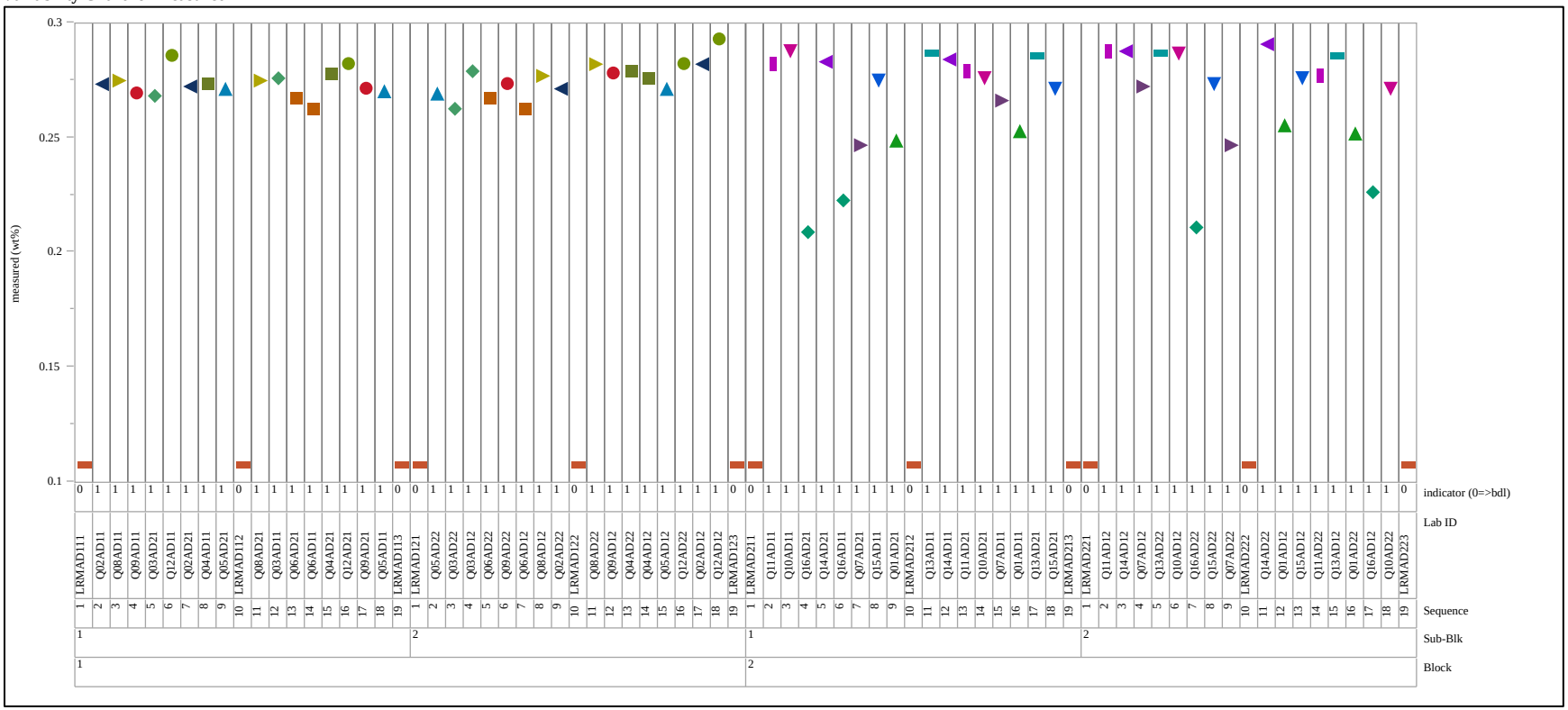


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence Grouped by Analytical Block (continued)

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

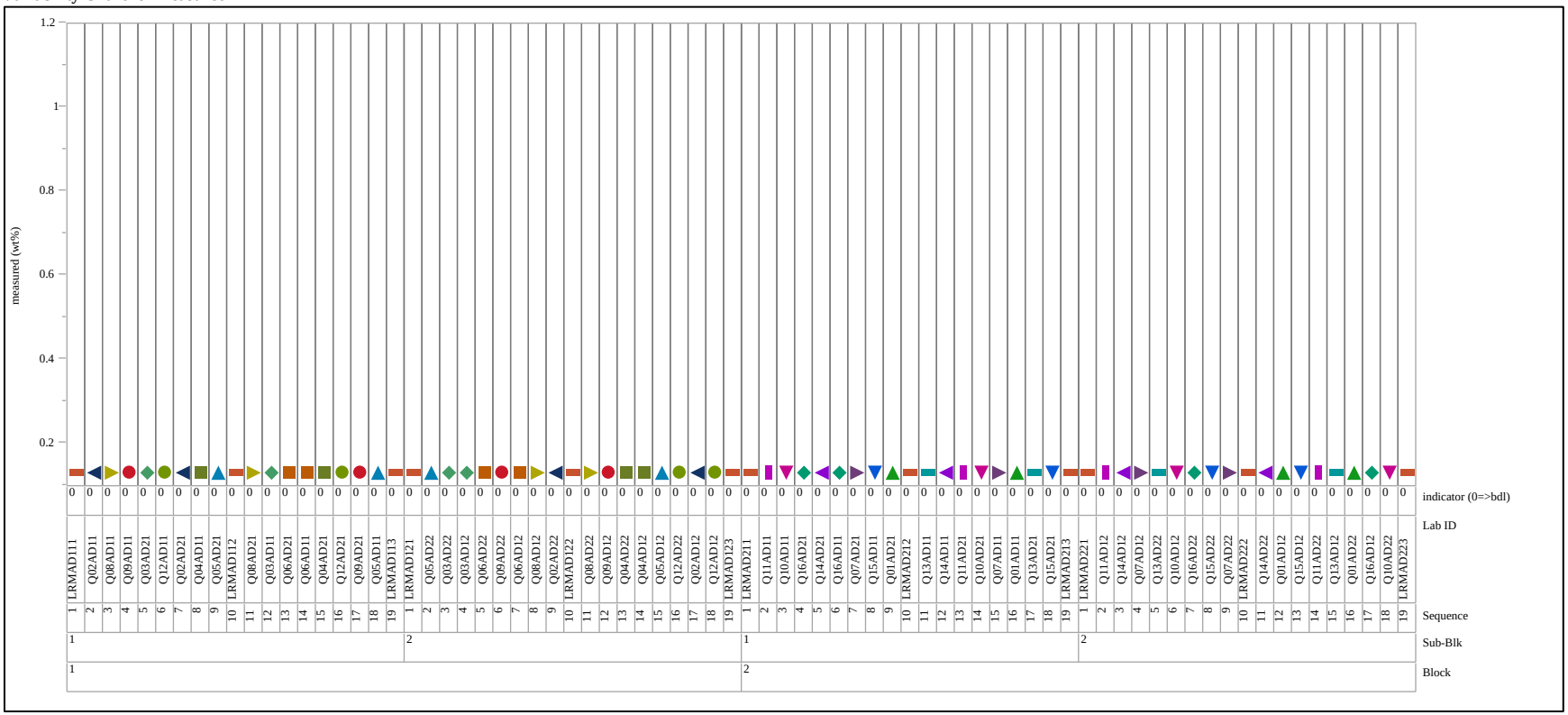


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence Grouped by Analytical Block (continued)

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

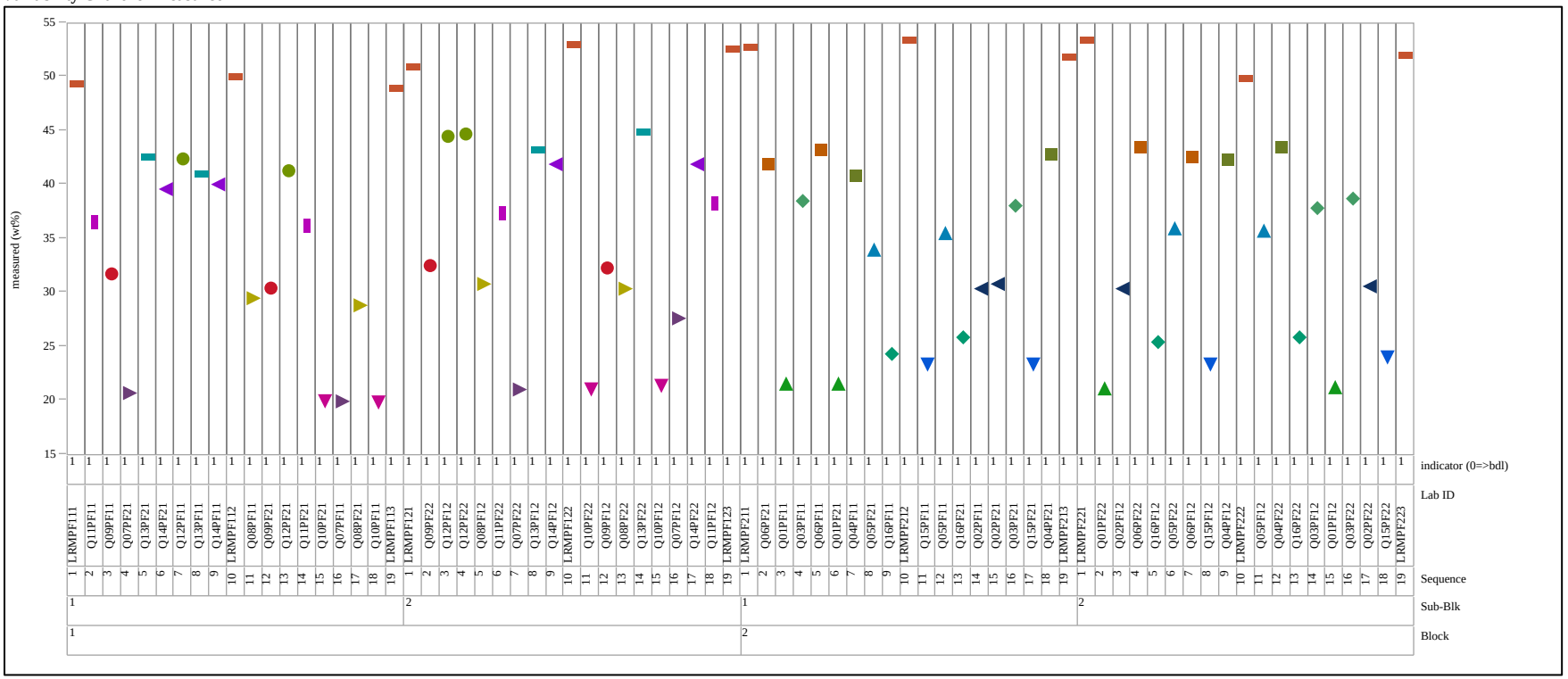


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence Grouped by Analytical Block (continued)

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

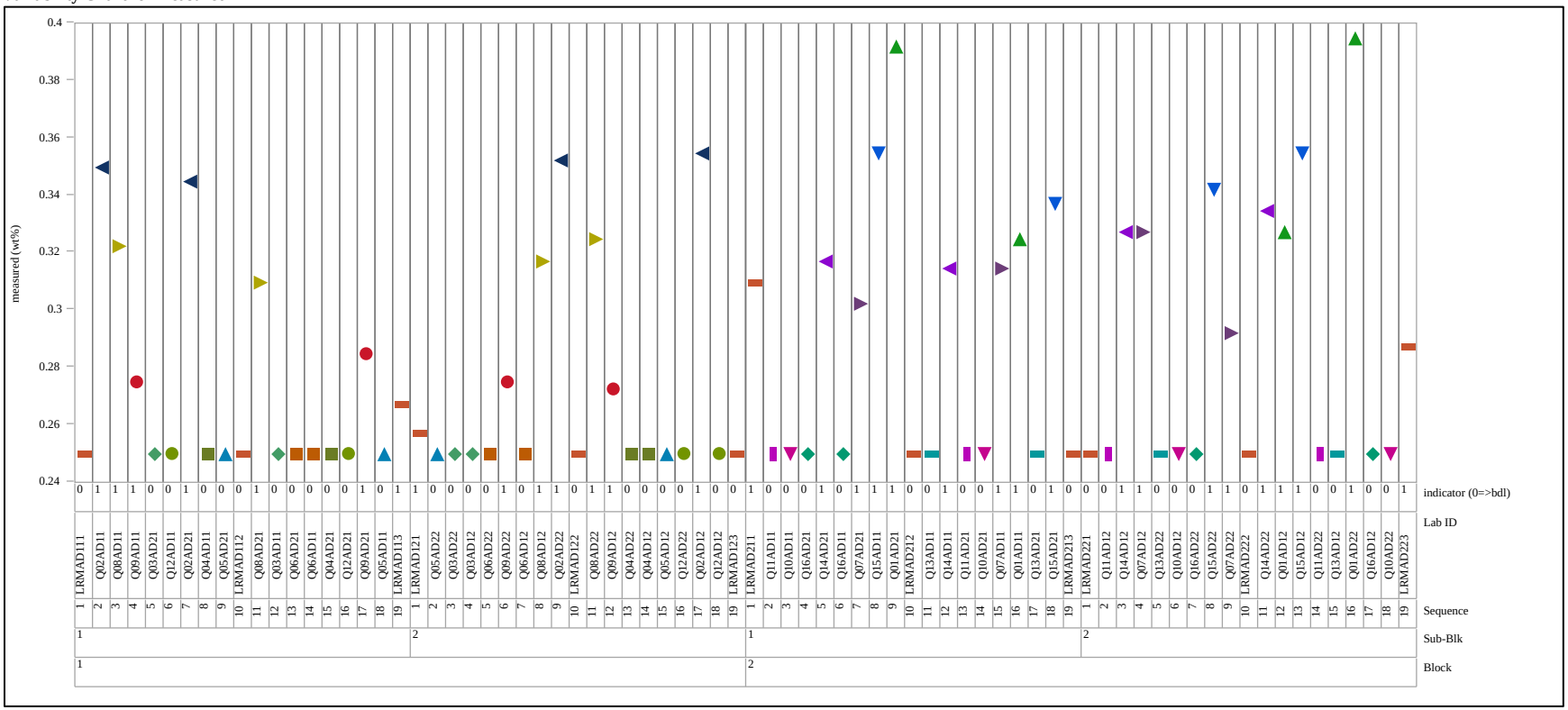


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence Grouped by Analytical Block (continued)

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

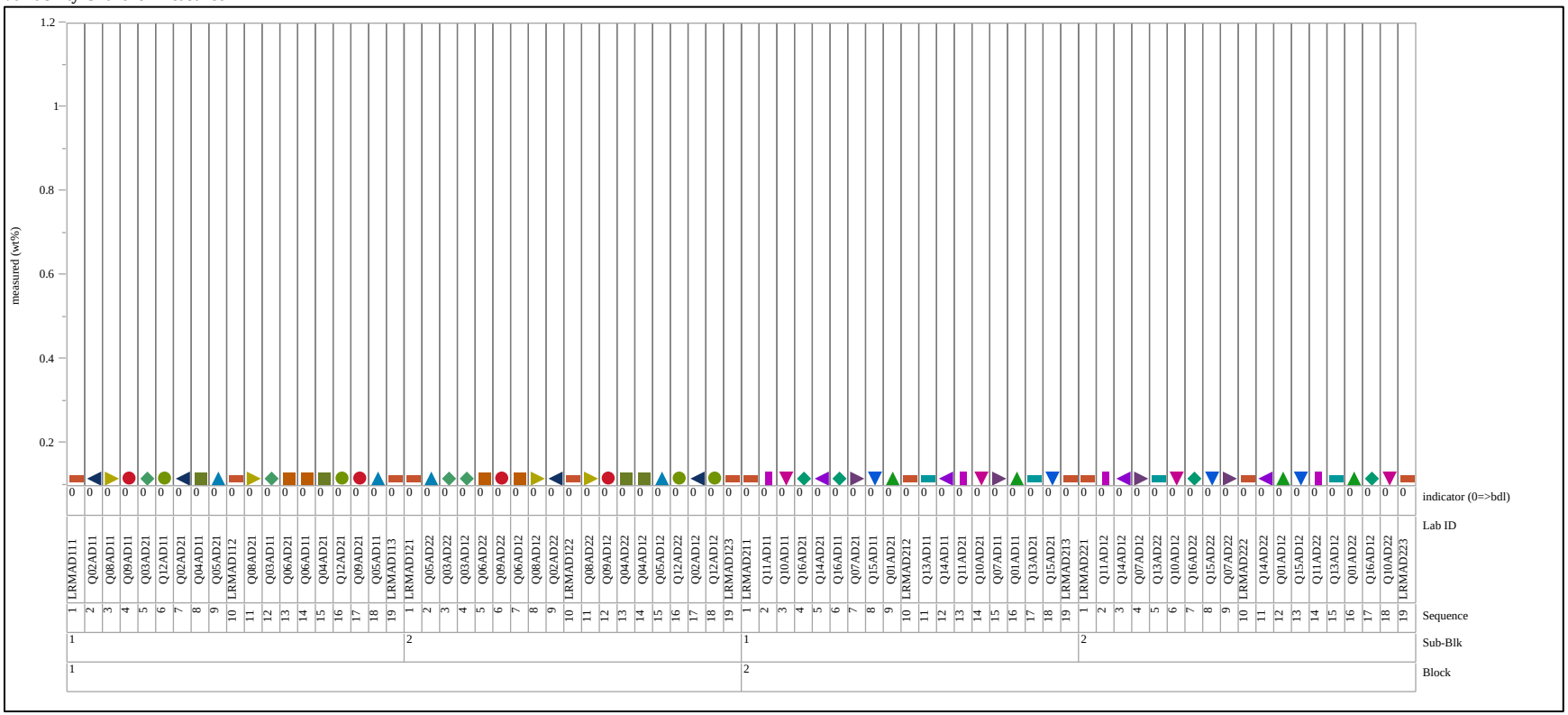


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence Grouped by Analytical Block (continued)

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

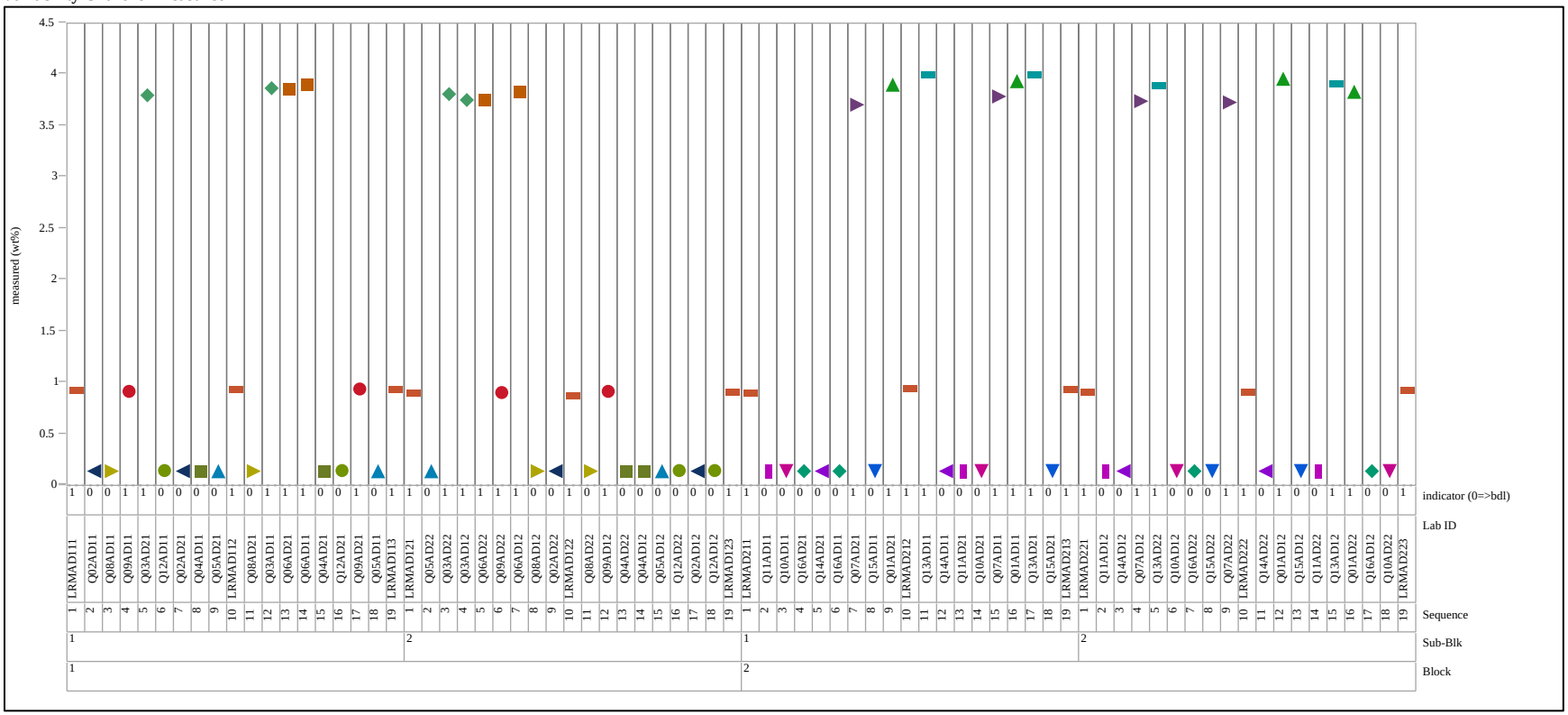


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations

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

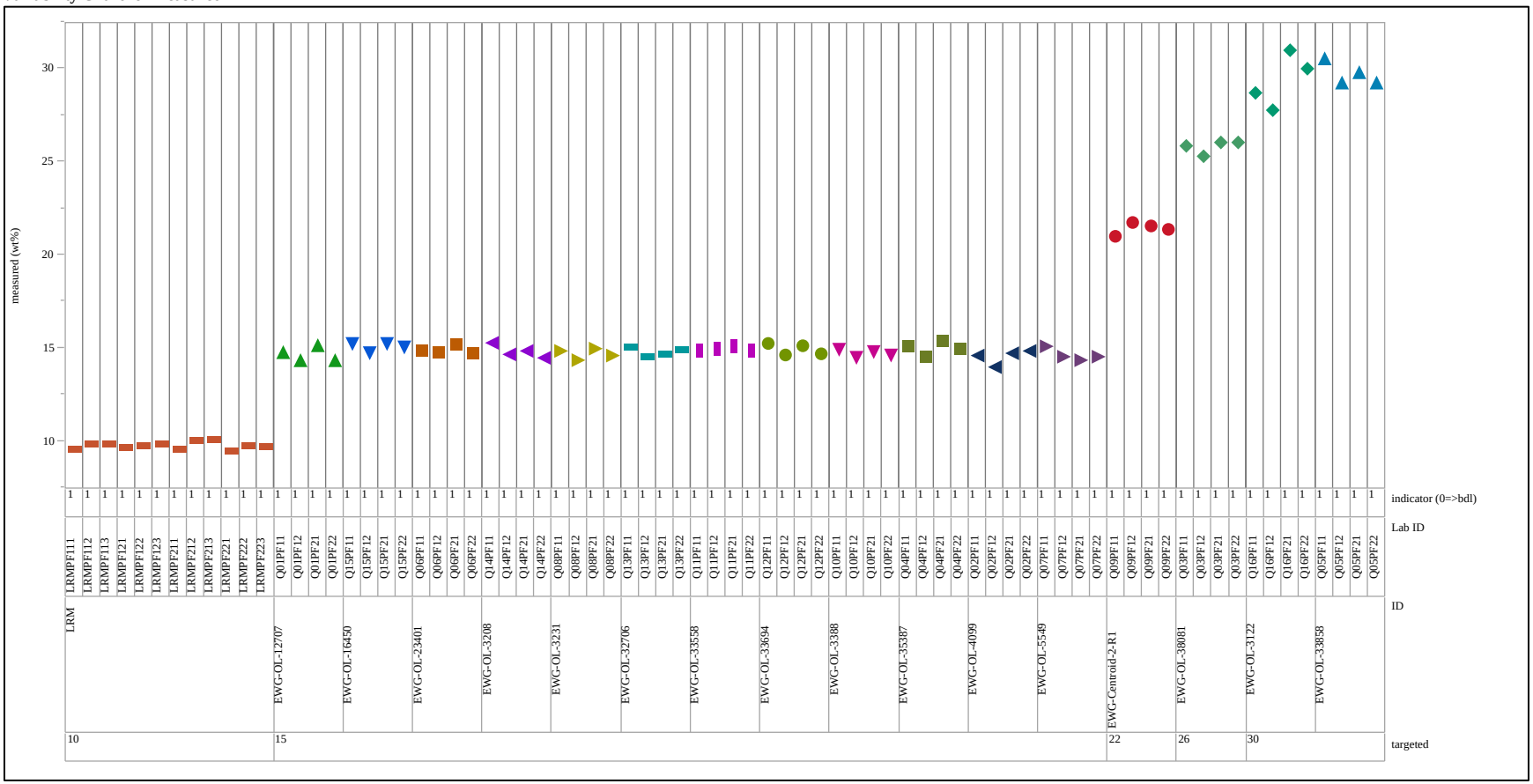


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations (continued)

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

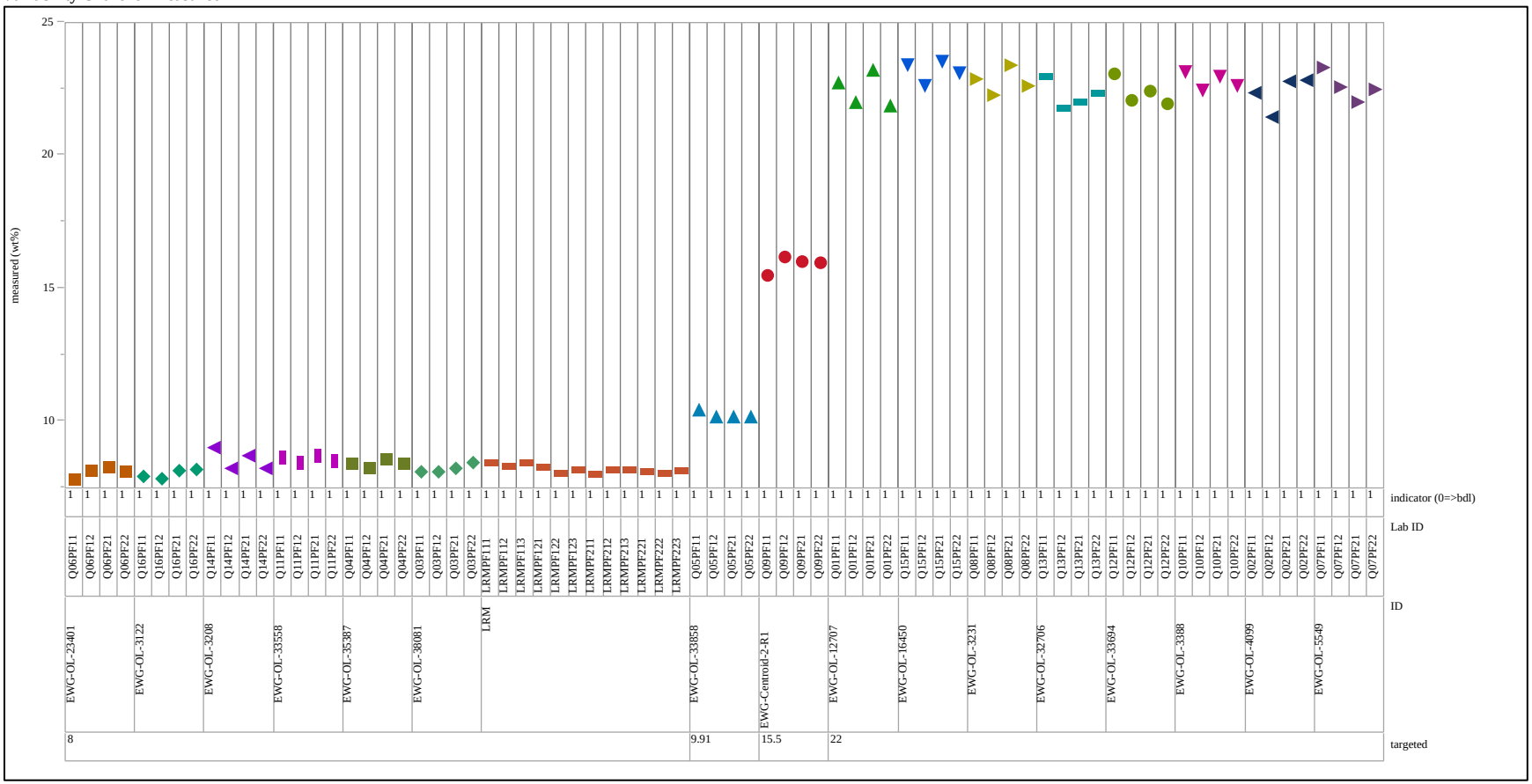


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations (continued)

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

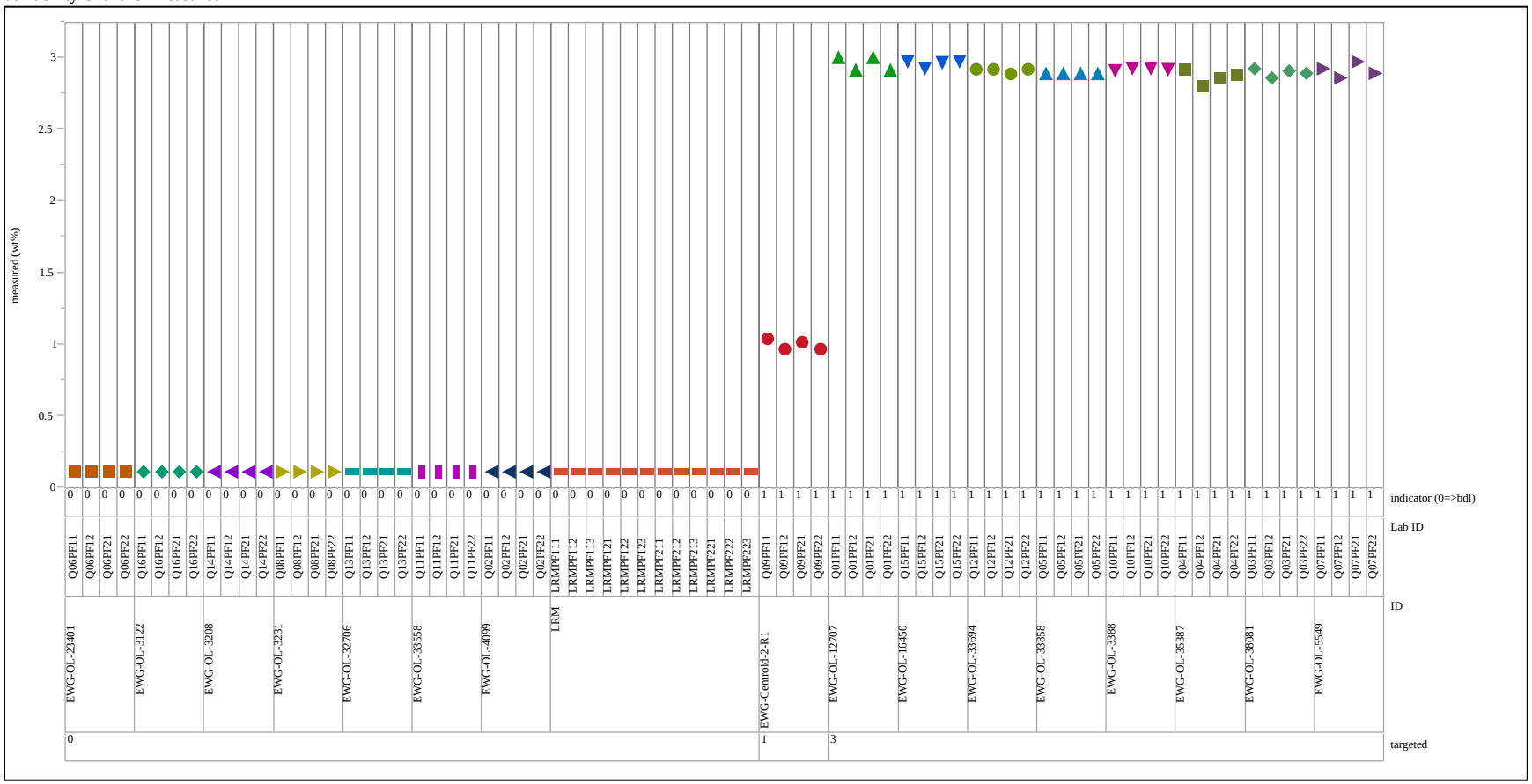


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations (continued)

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

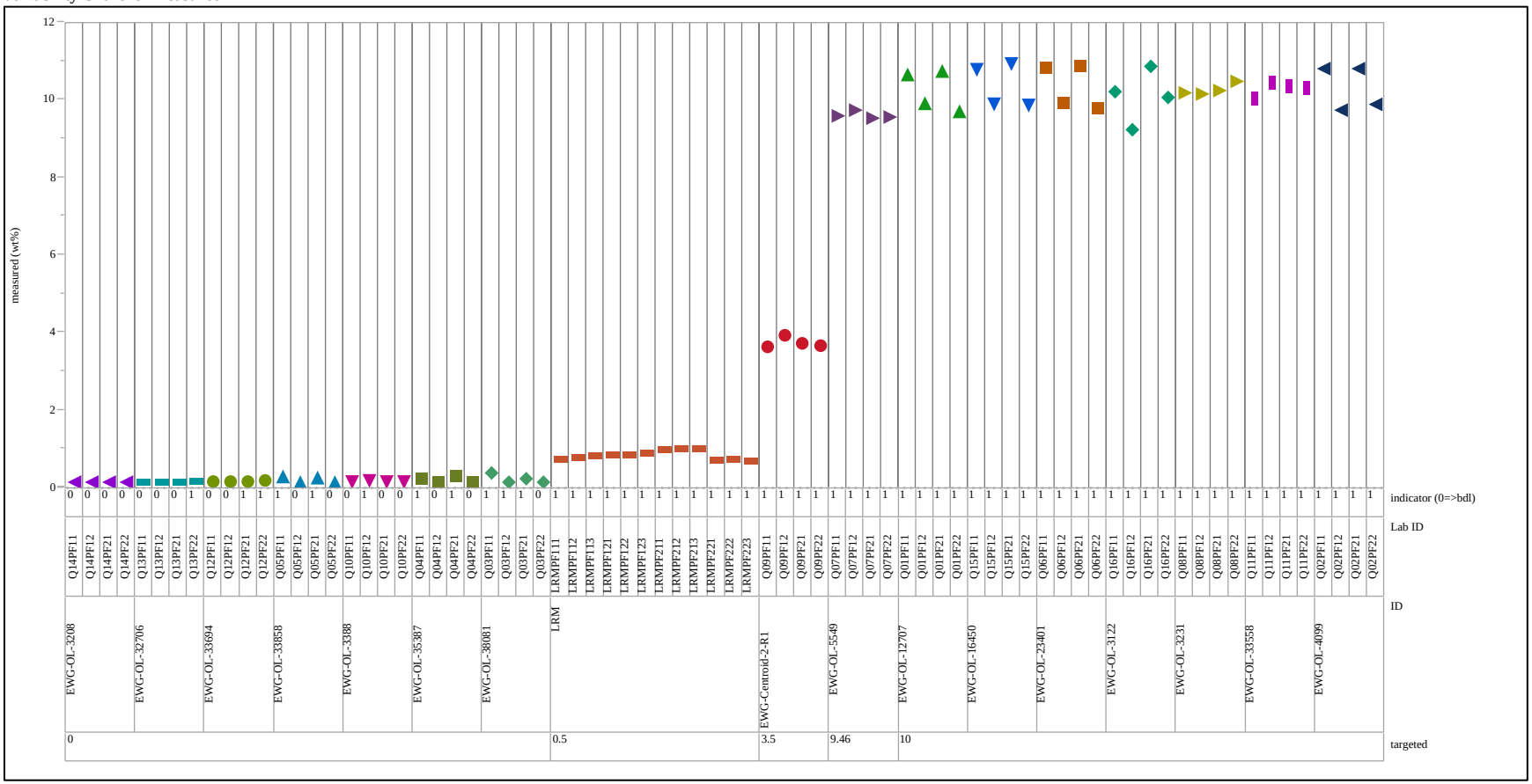


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations (continued)

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

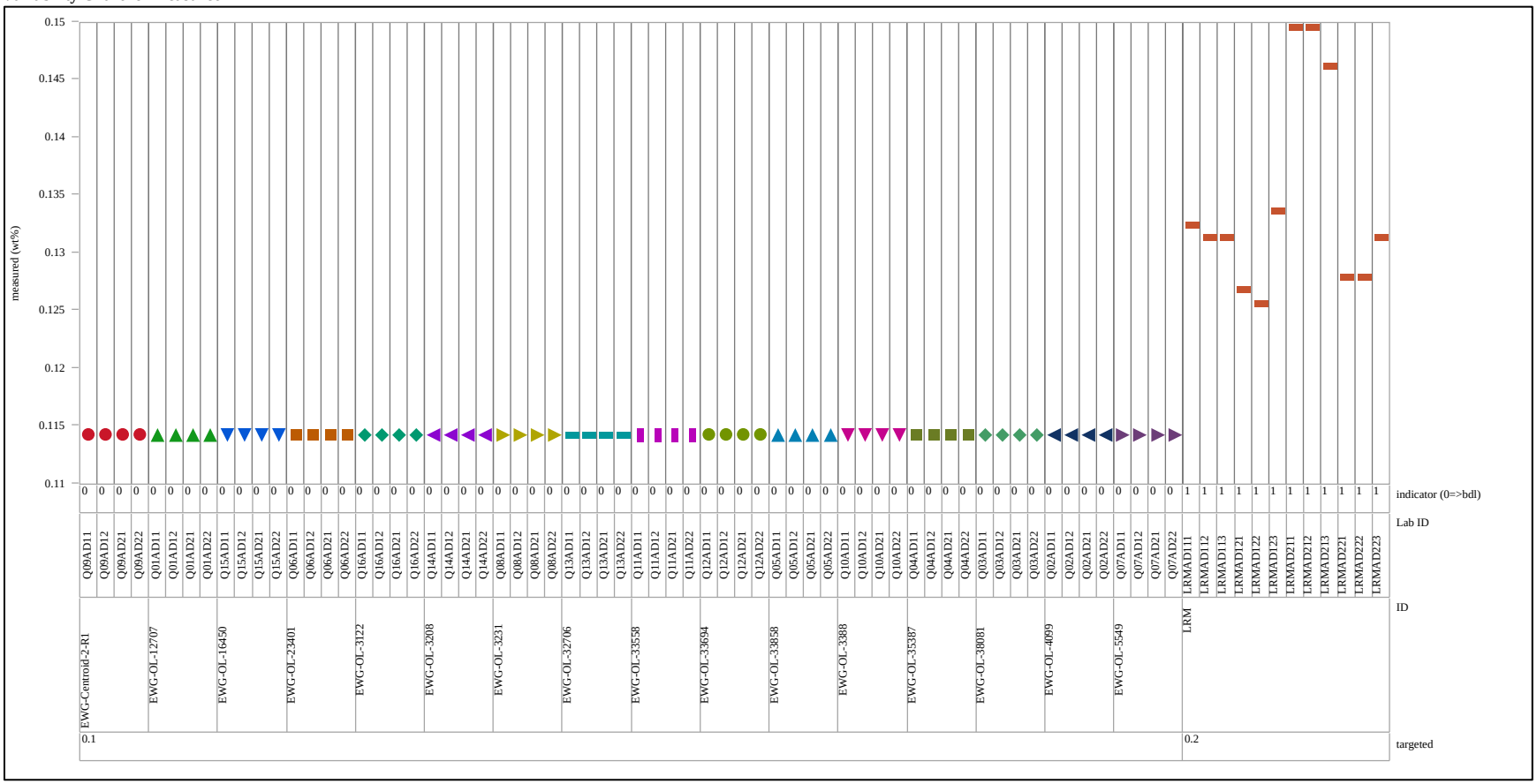


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations (continued)

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

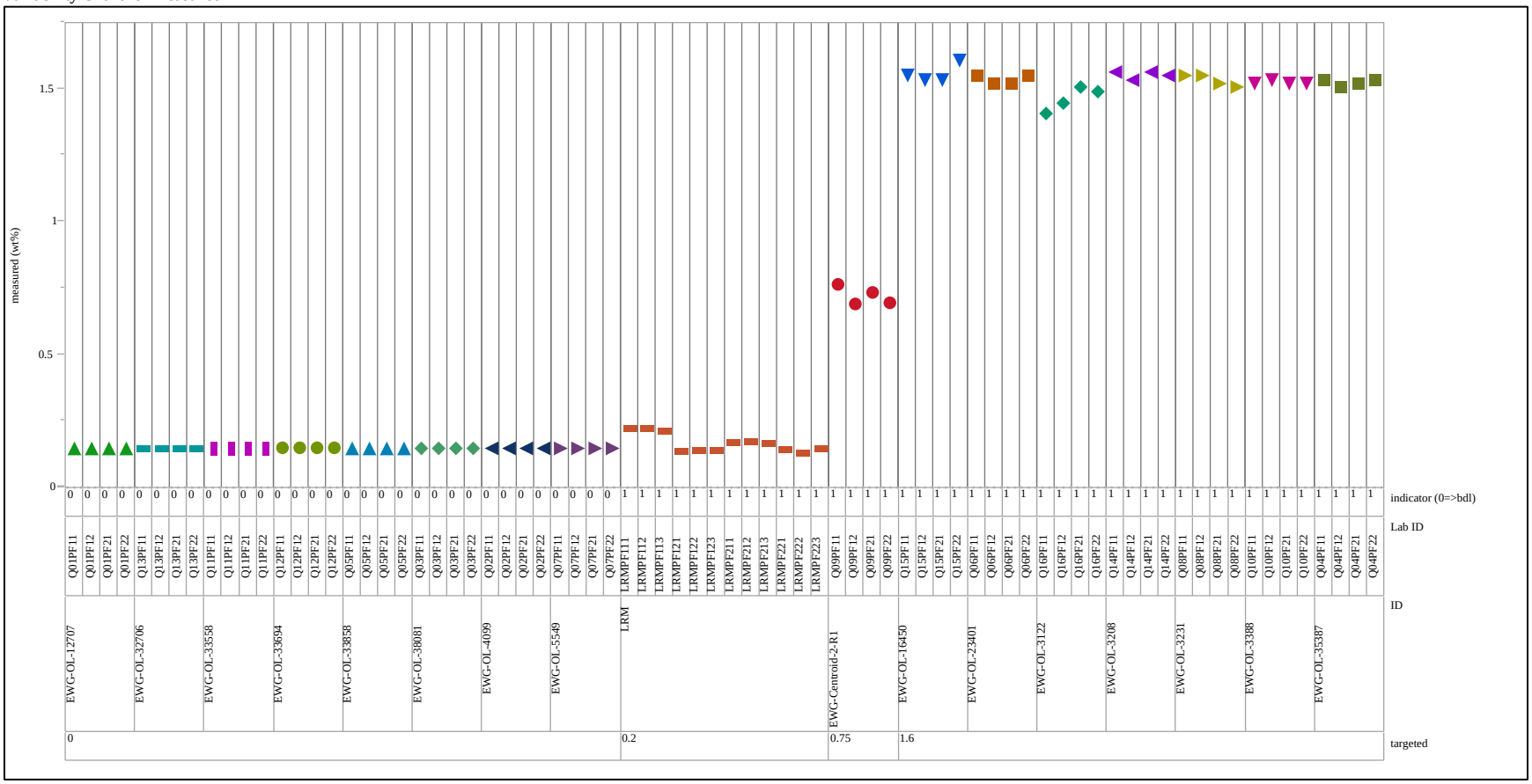


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations (continued)

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

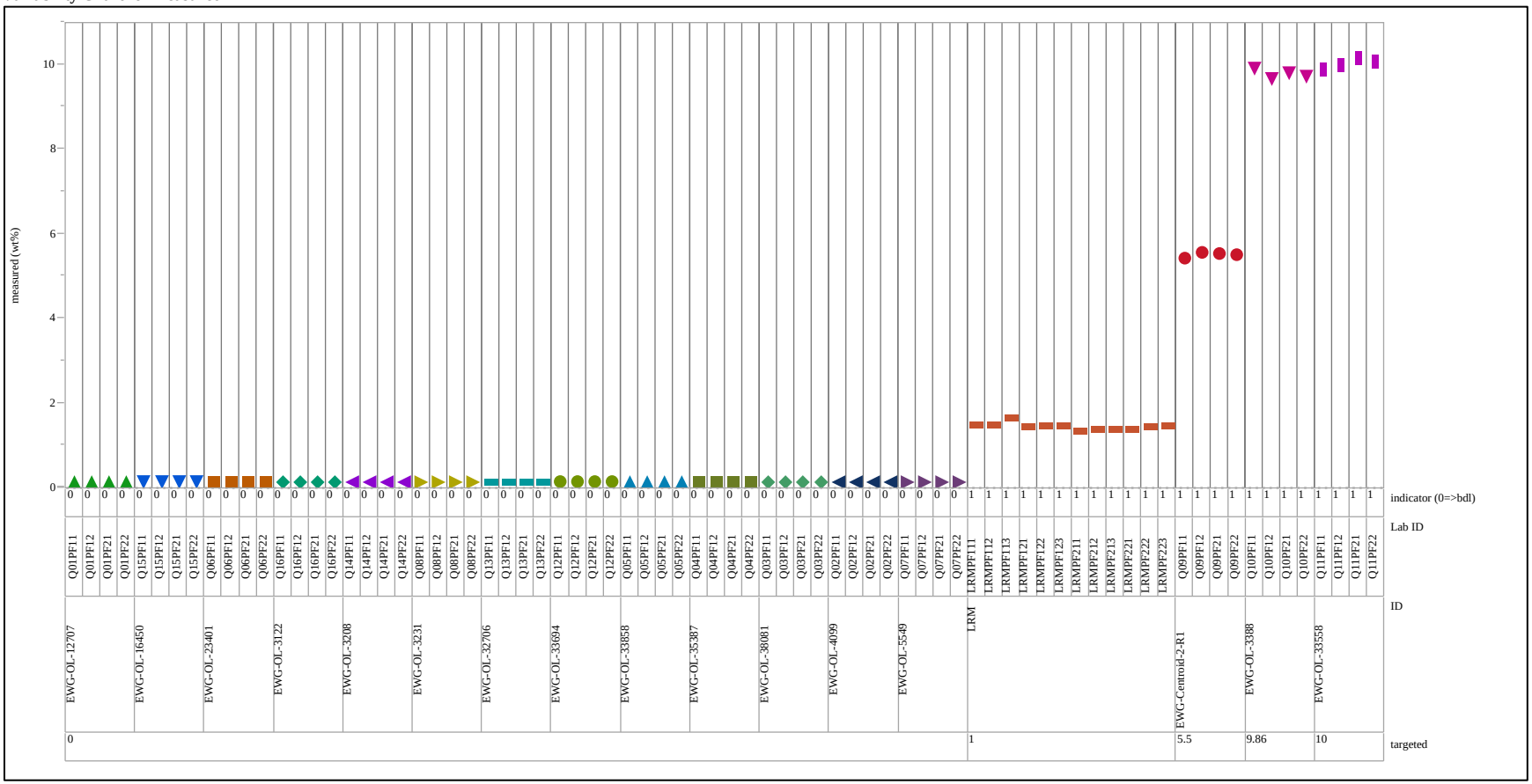


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations (continued)

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

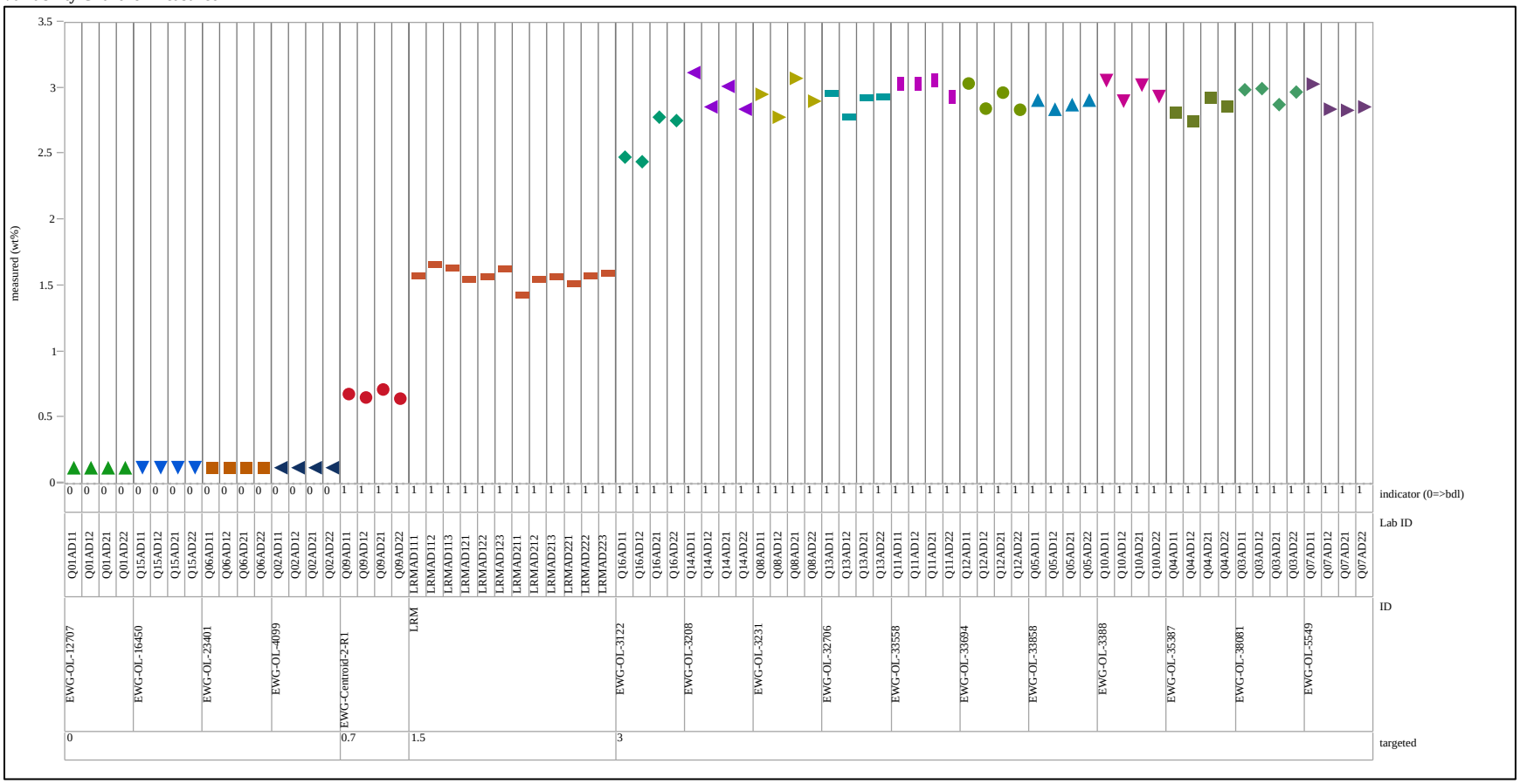


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations (continued)

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

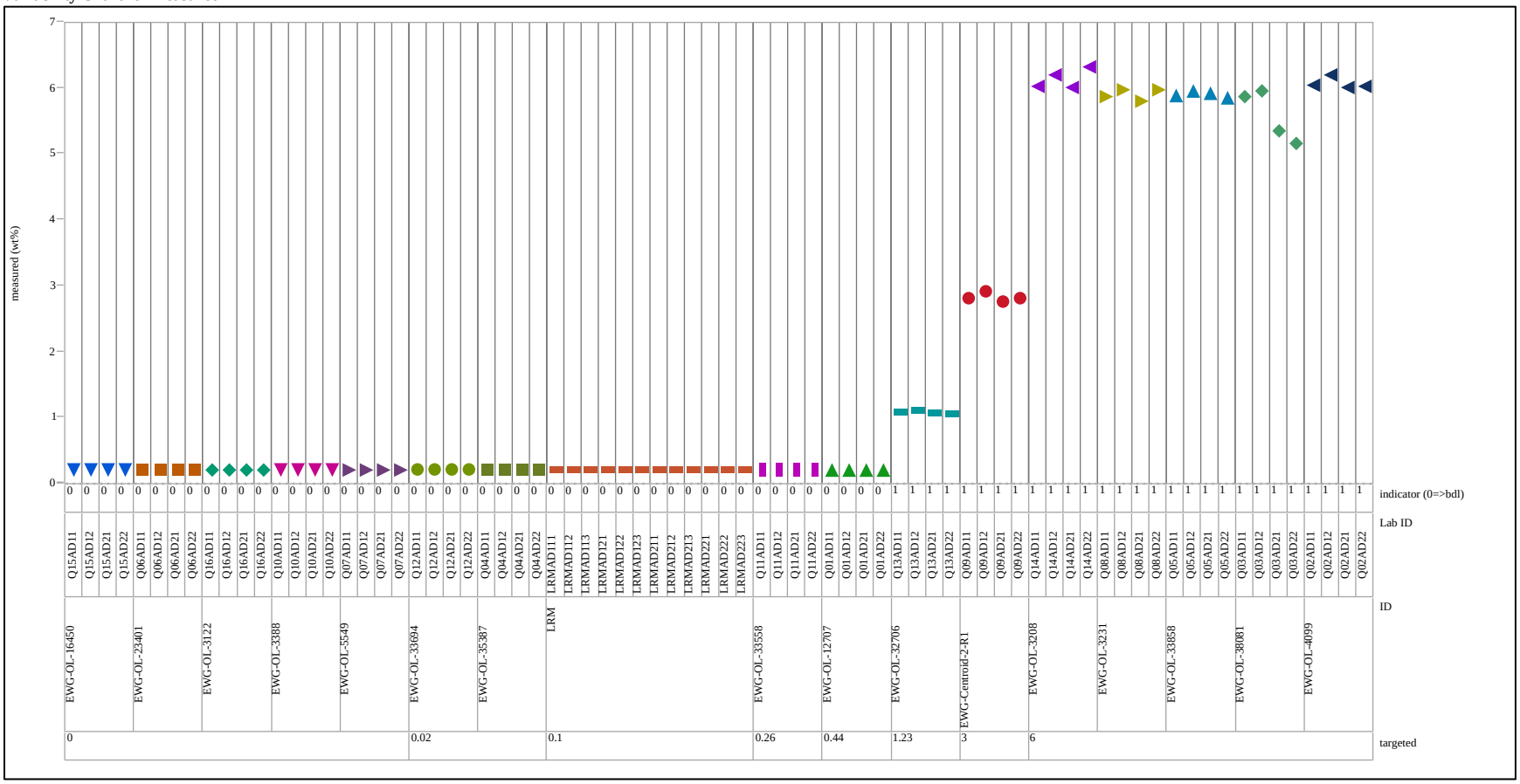


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations (continued)

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

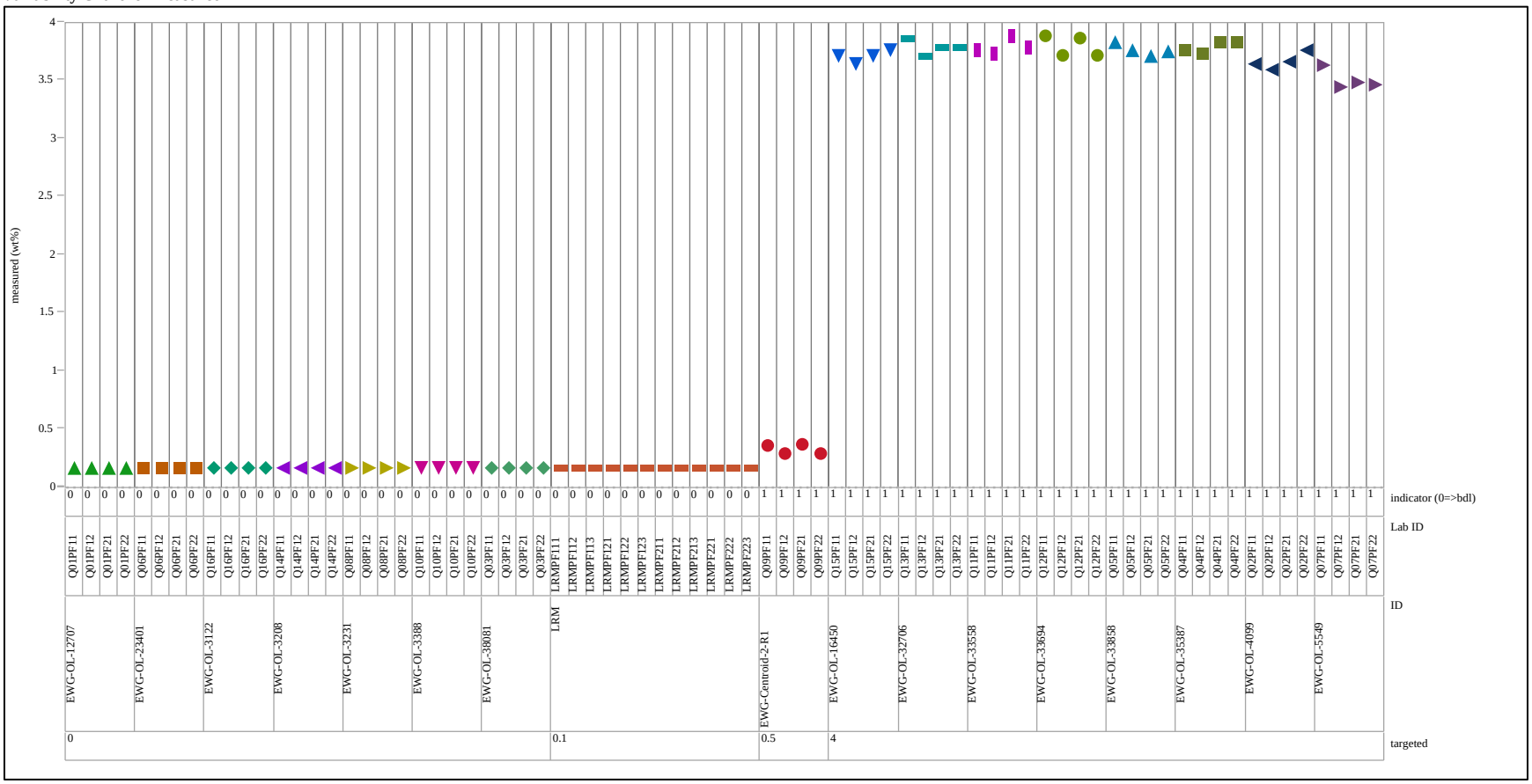


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations (continued)

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

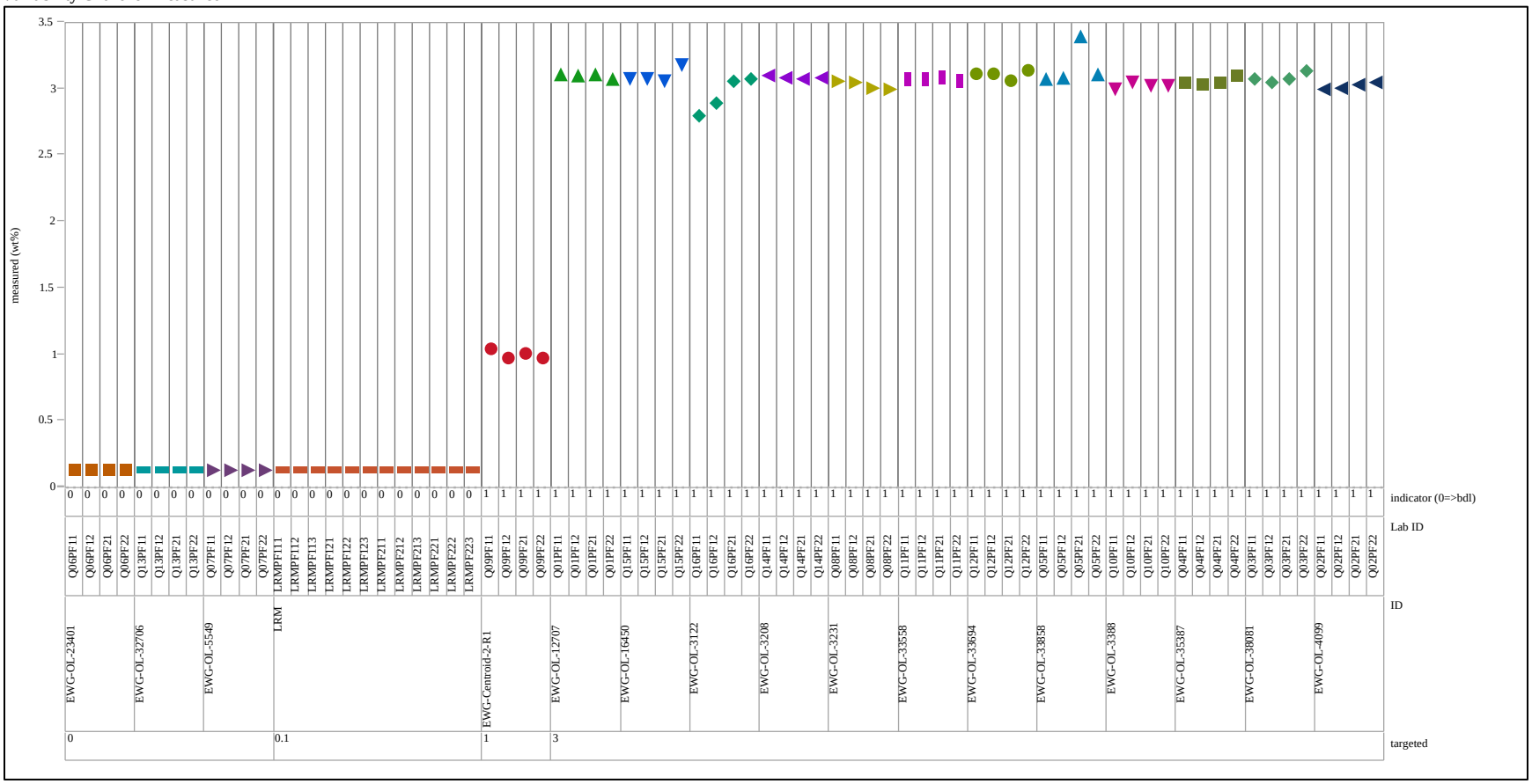


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations (continued)

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

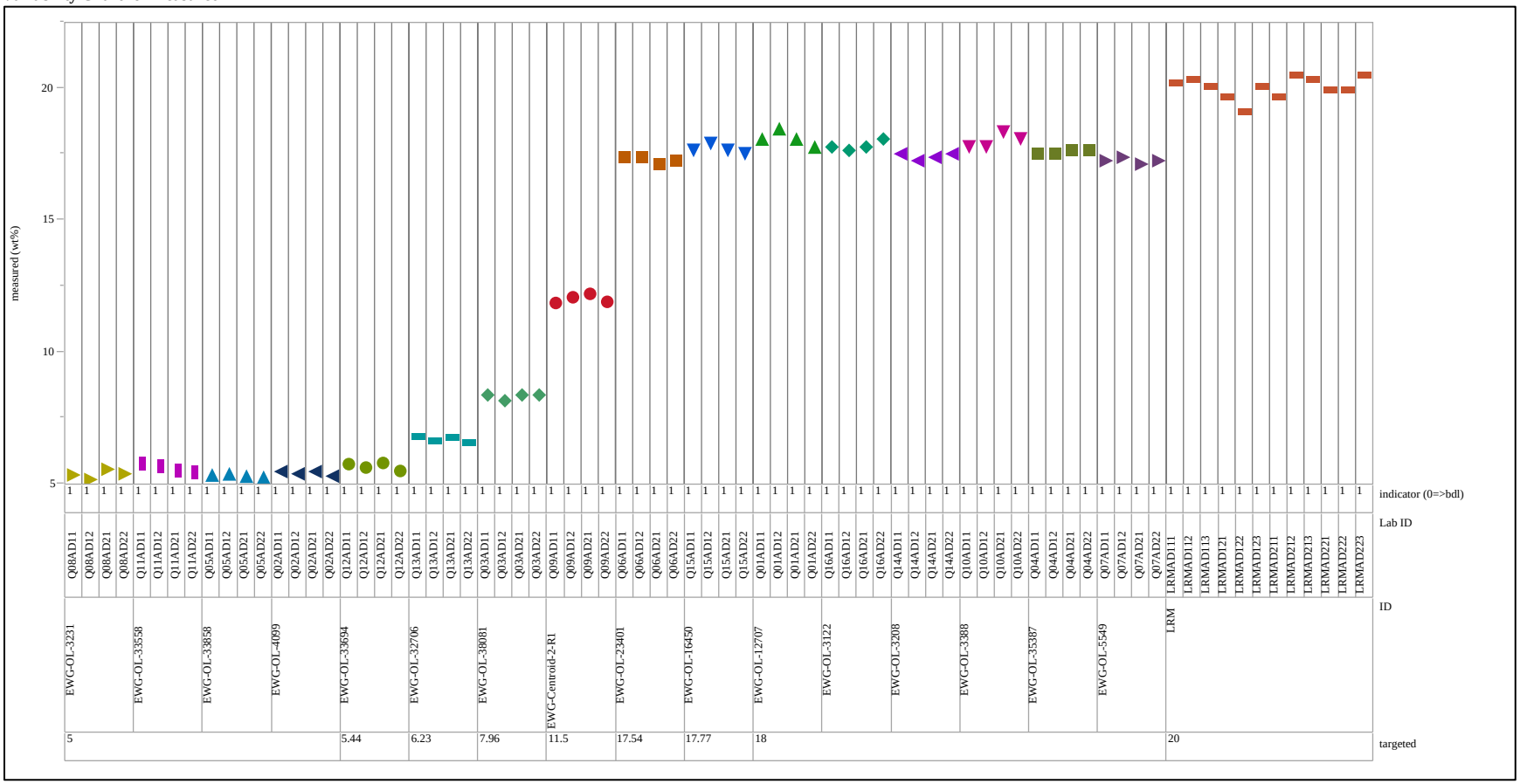


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations (continued)

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

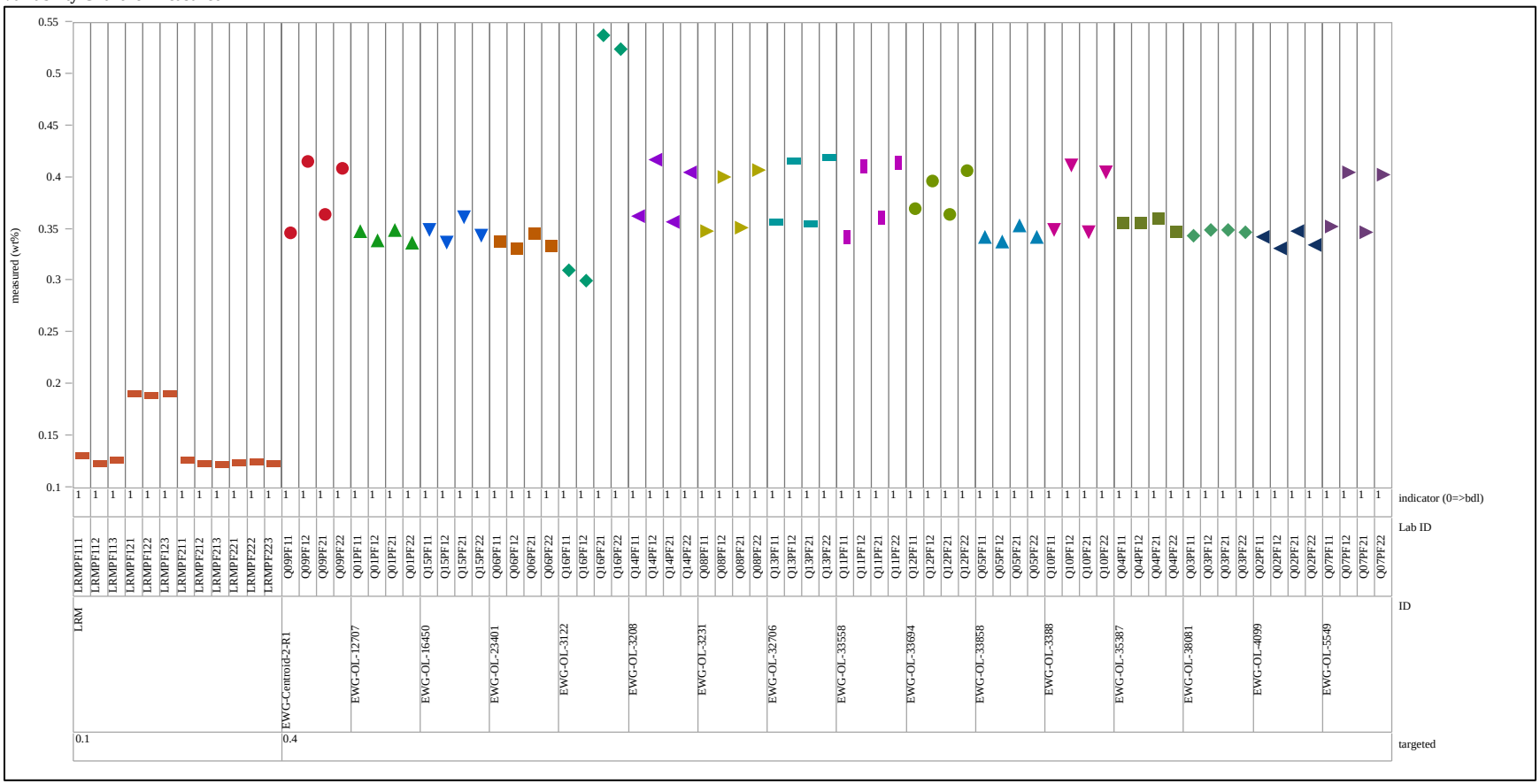


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations (continued)

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

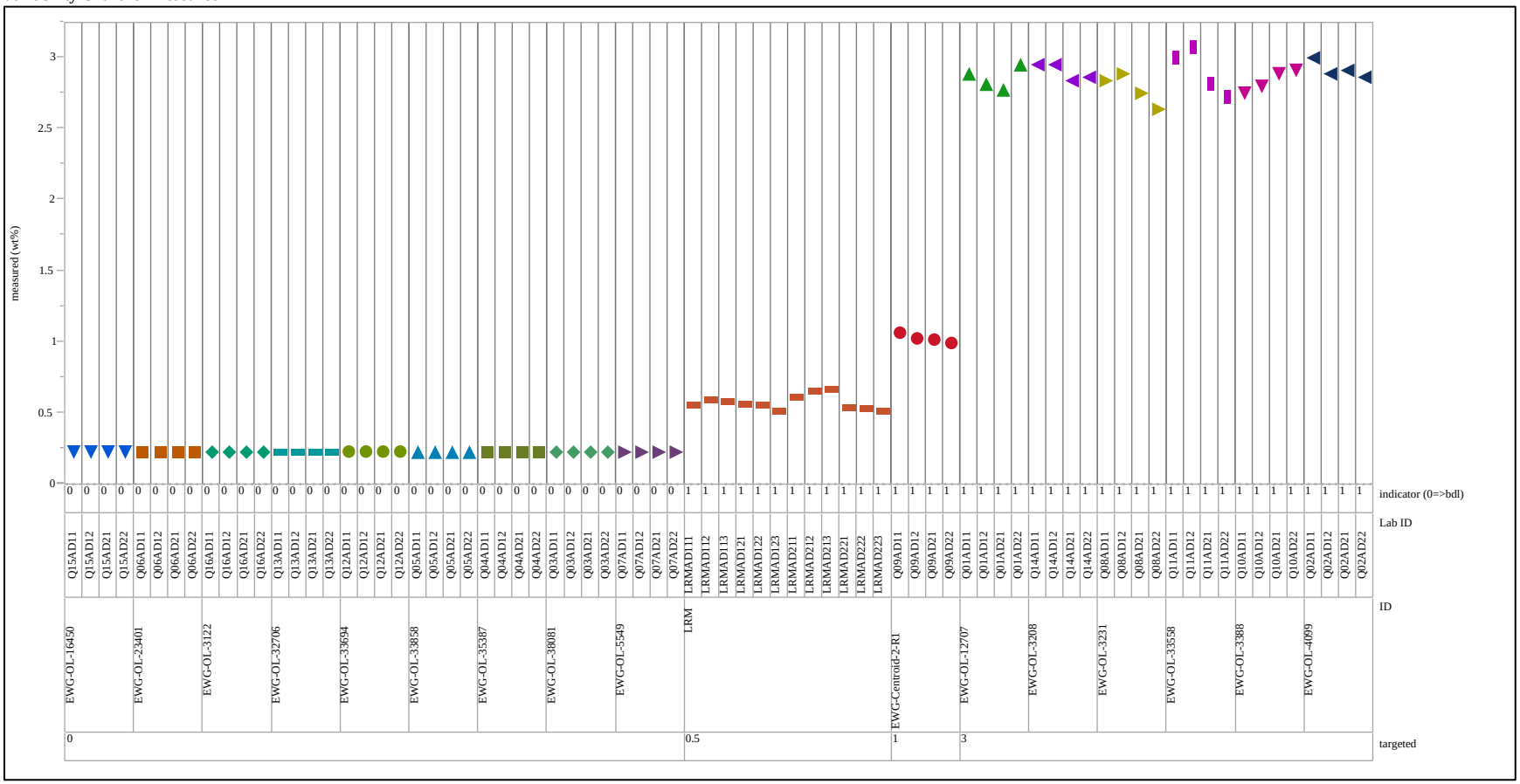


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations (continued)

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

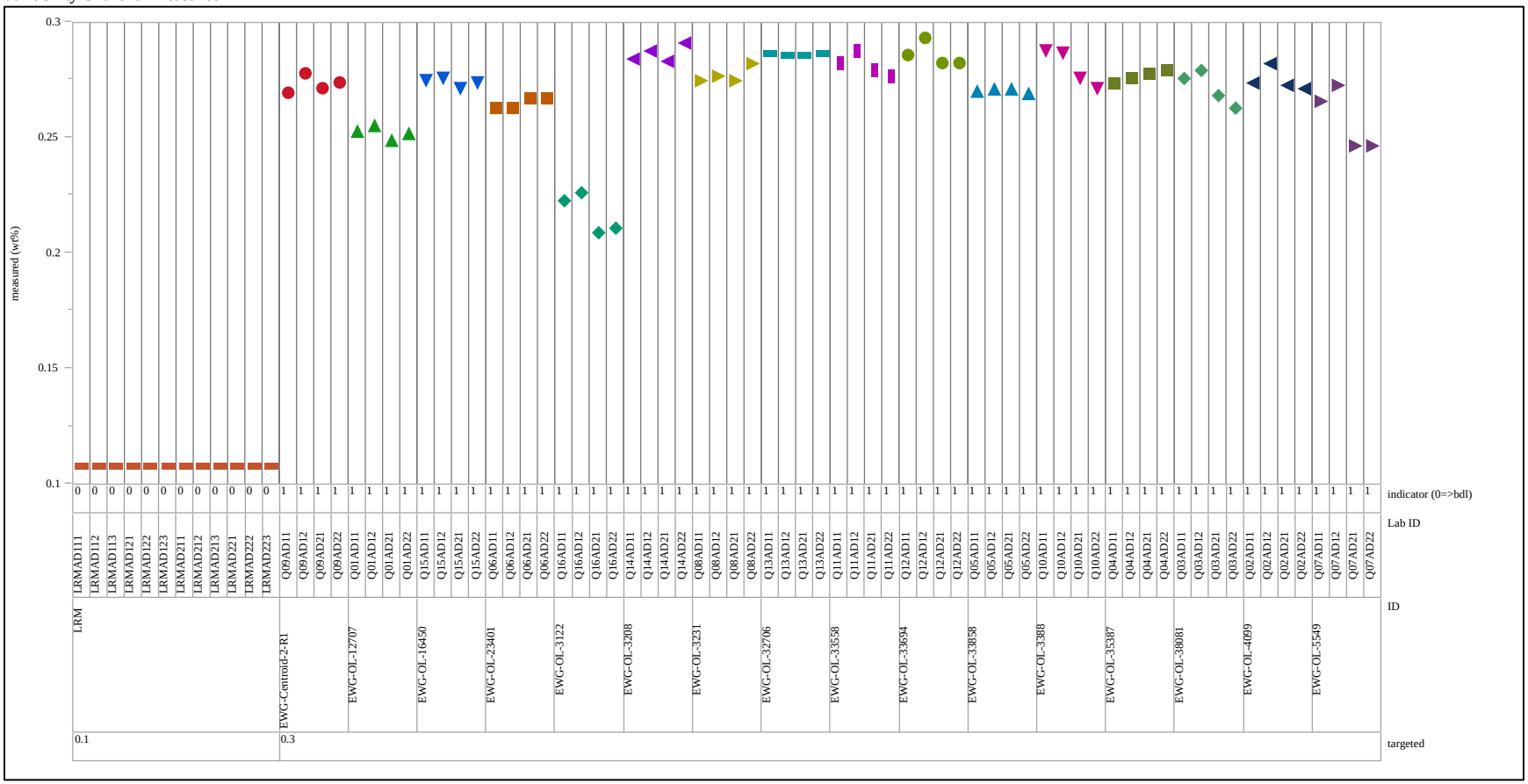


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations (continued)

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

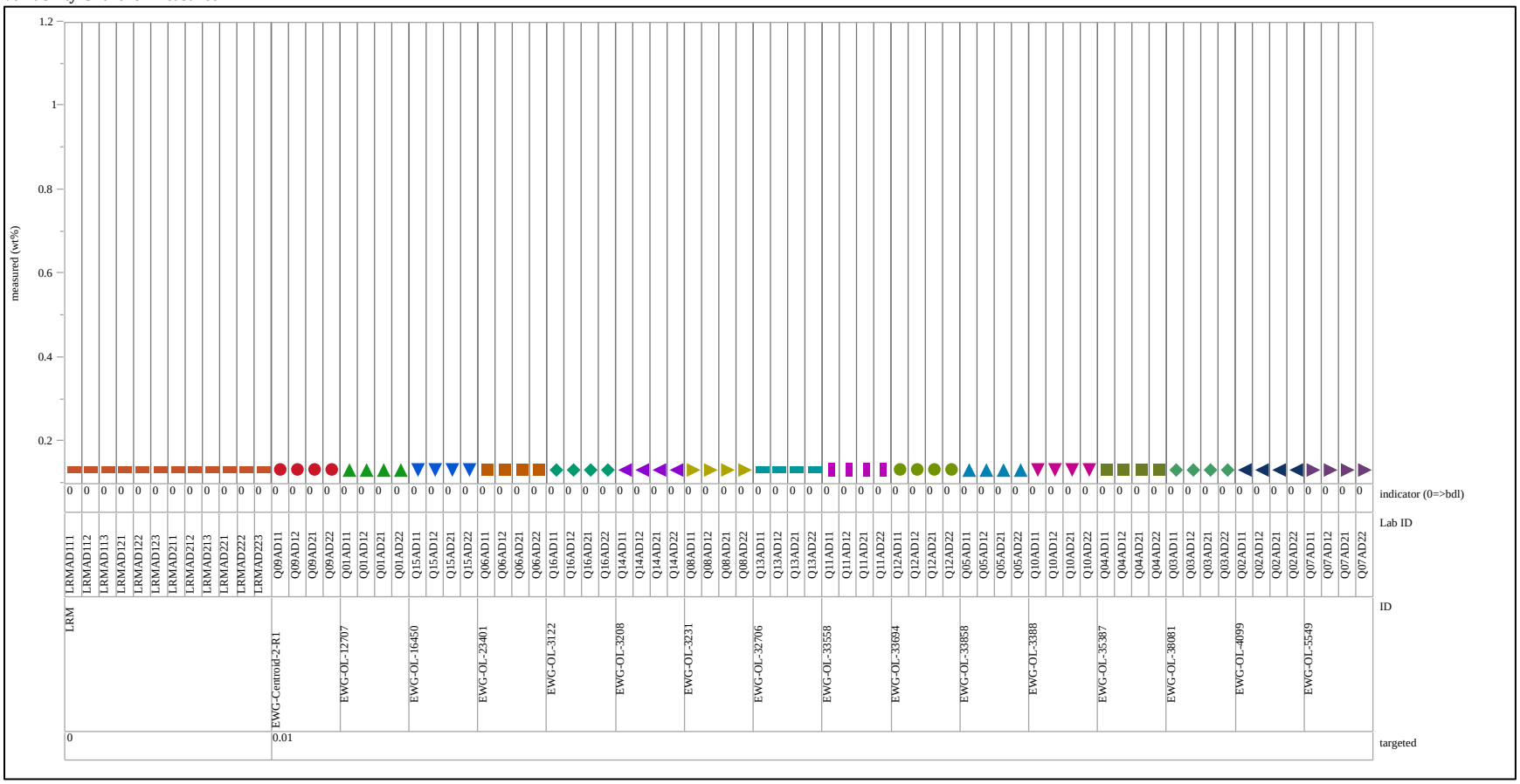
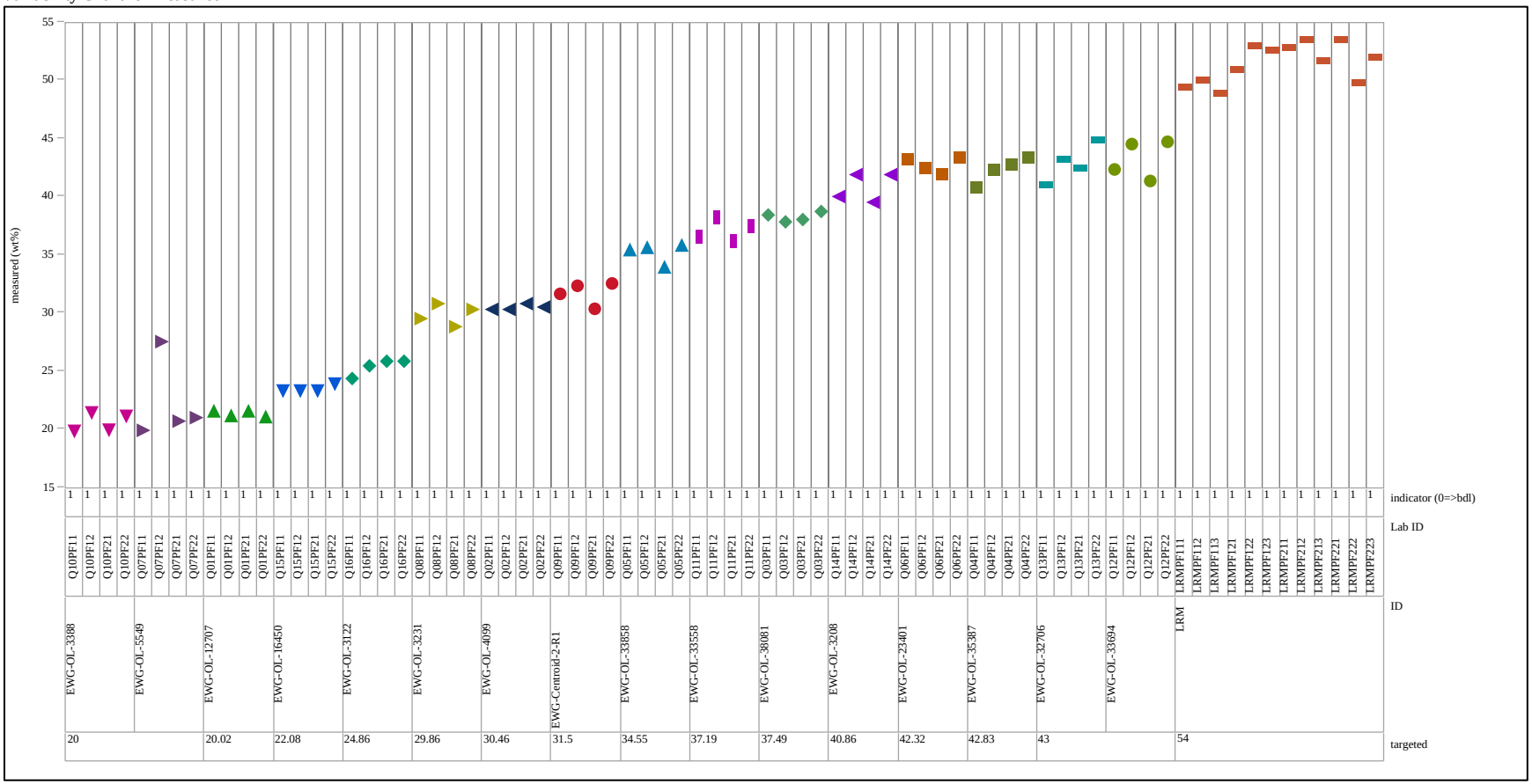


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations (continued)



Note the high value for the Q07PF12 measurement of glass EWG-OL-5549. This value is deemed an outlier and will be excluded as the representative composition of glass EWG-OL-5549 is determined.

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

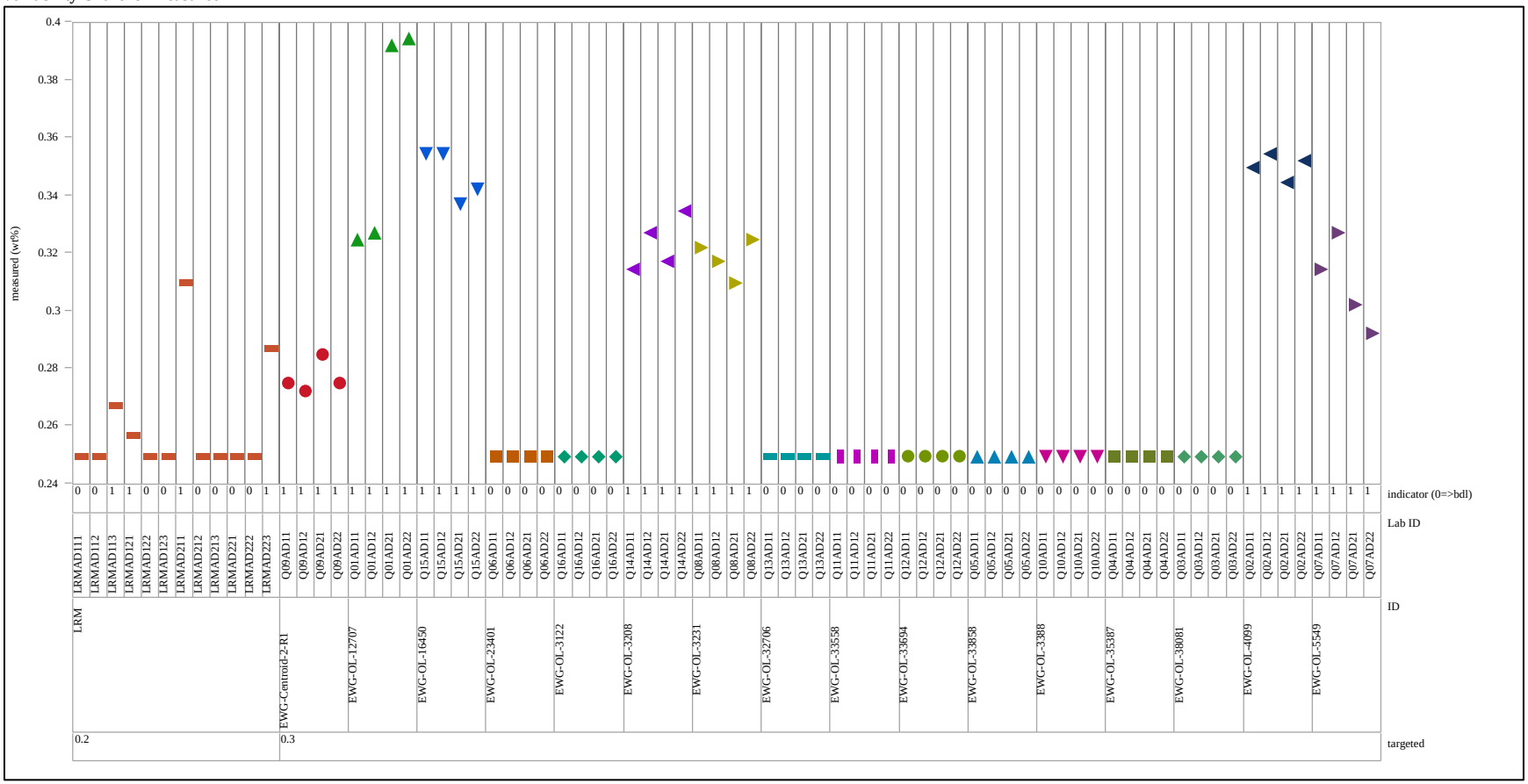


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations (continued)

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

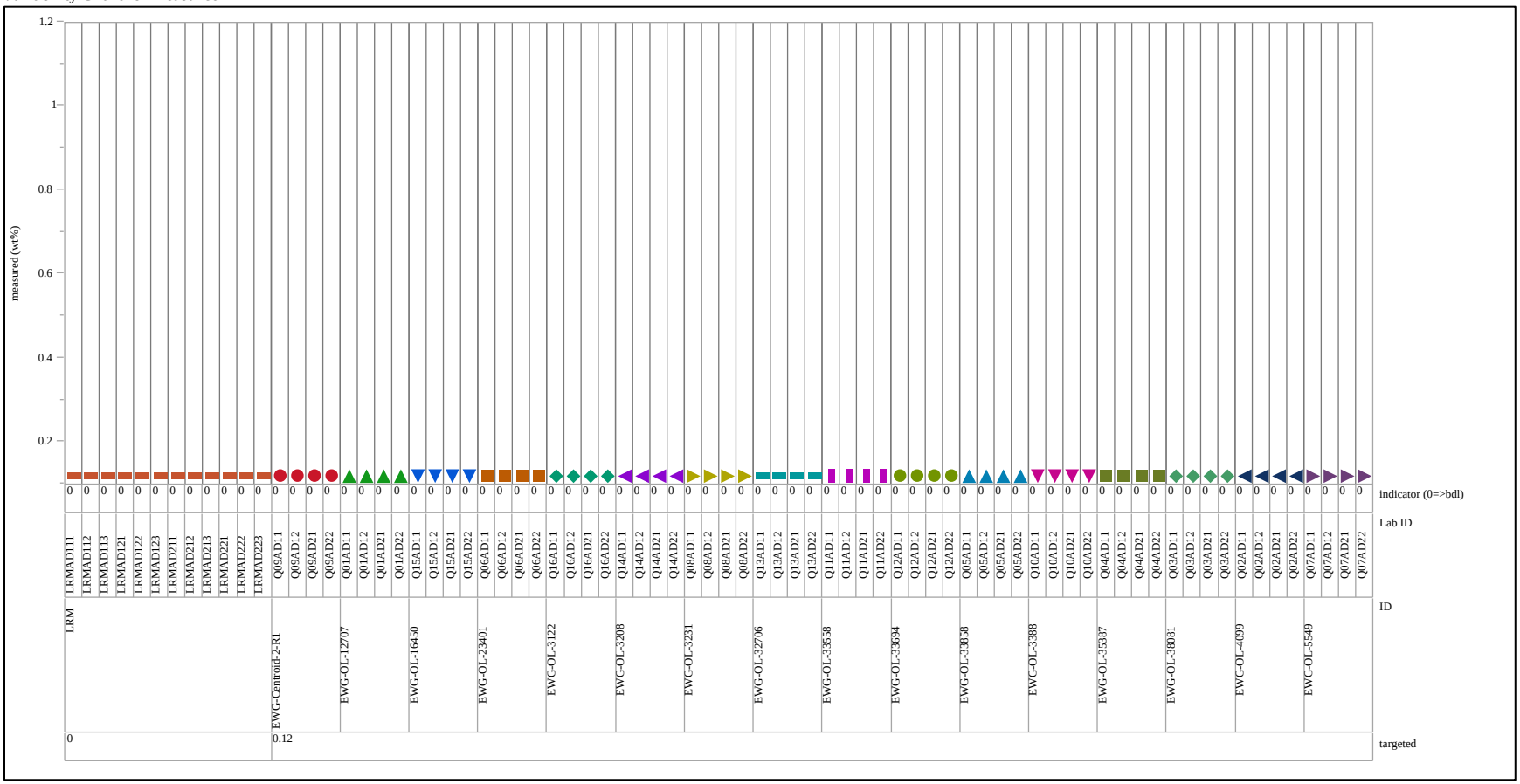


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations (continued)

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

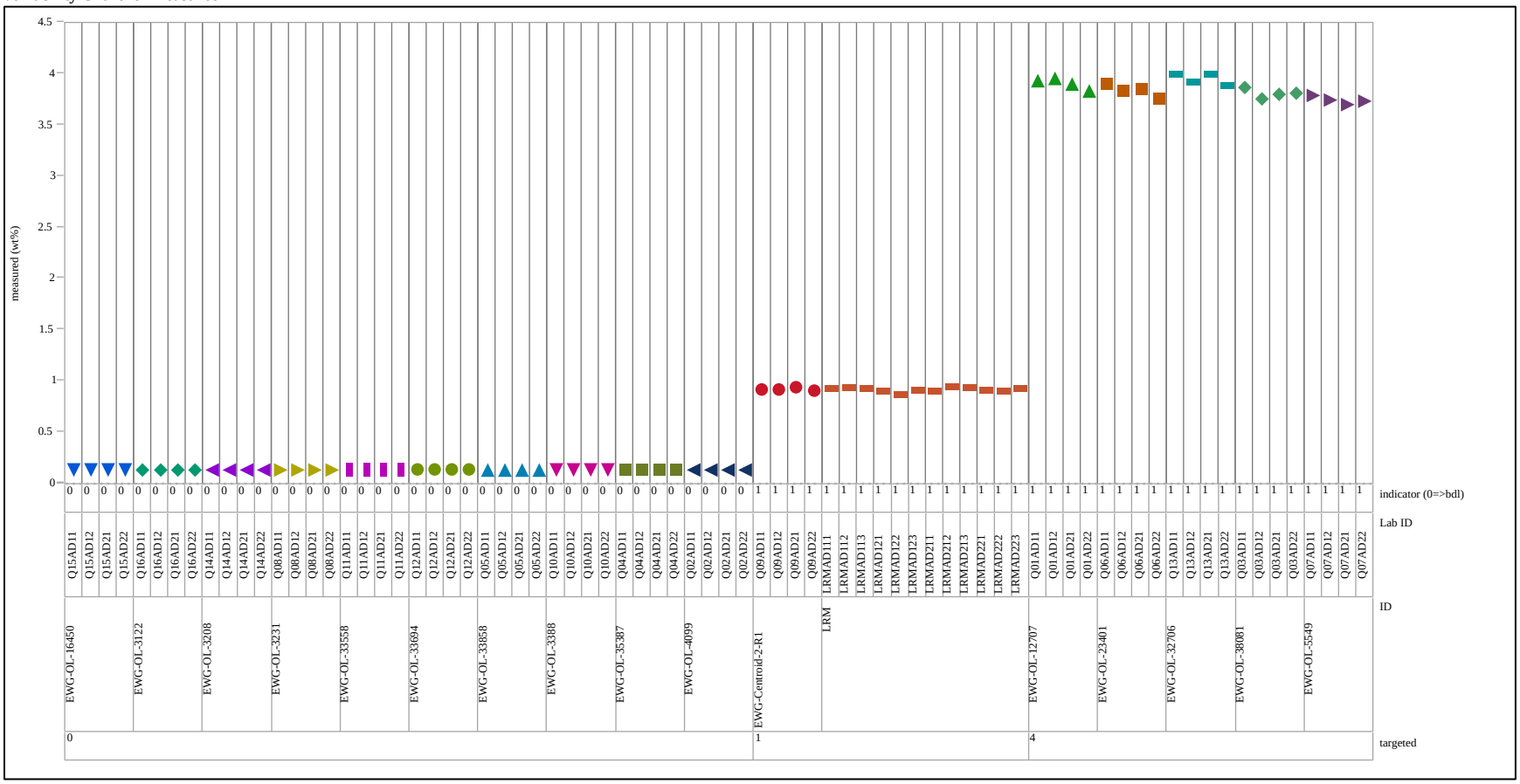


Exhibit A-3. Measurements of the LRM Standard Glass by Preparation Method by Element

Glass ID=LRM, Prep Method=AD, Element=K (wt%)

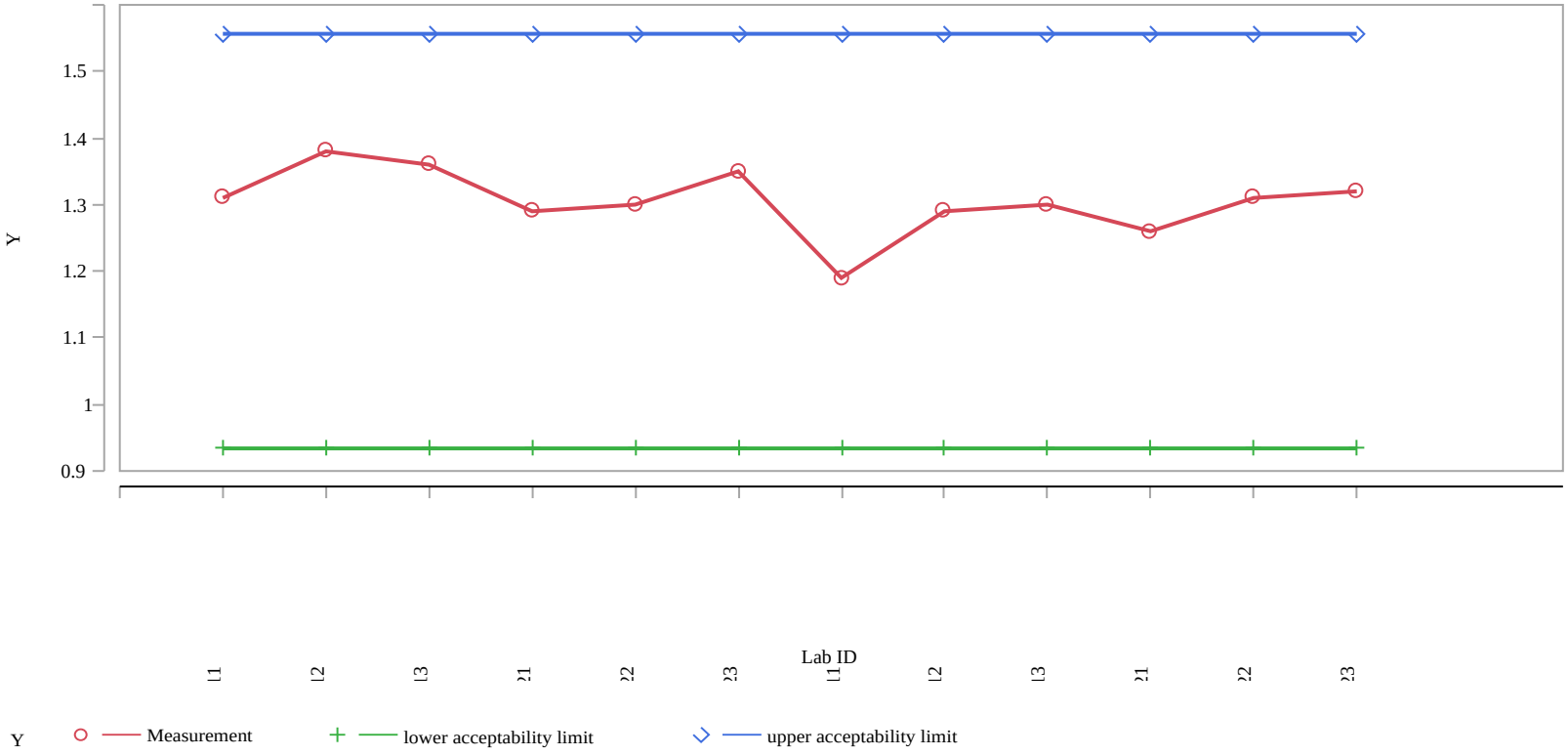


Exhibit A-3. Measurements of the LRM Standard Glass by Preparation Method by Element (continued)

Glass ID=LRM, Prep Method=AD, Element=Na (wt%)

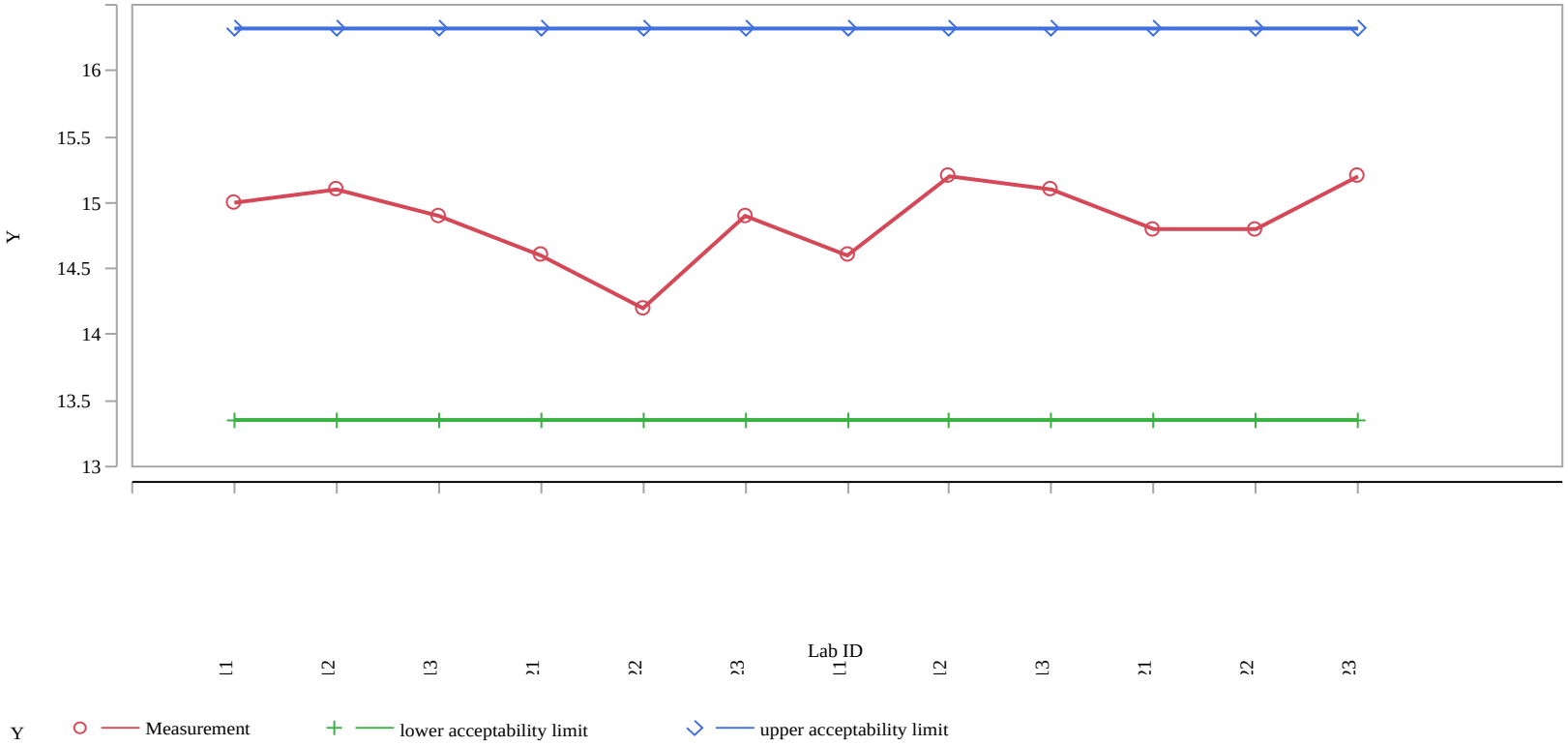


Exhibit A-3. Measurements of the LRM Standard Glass by Preparation Method by Element (continued)

Glass ID=LRM, Prep Method=AD, Element=Zr (wt%)

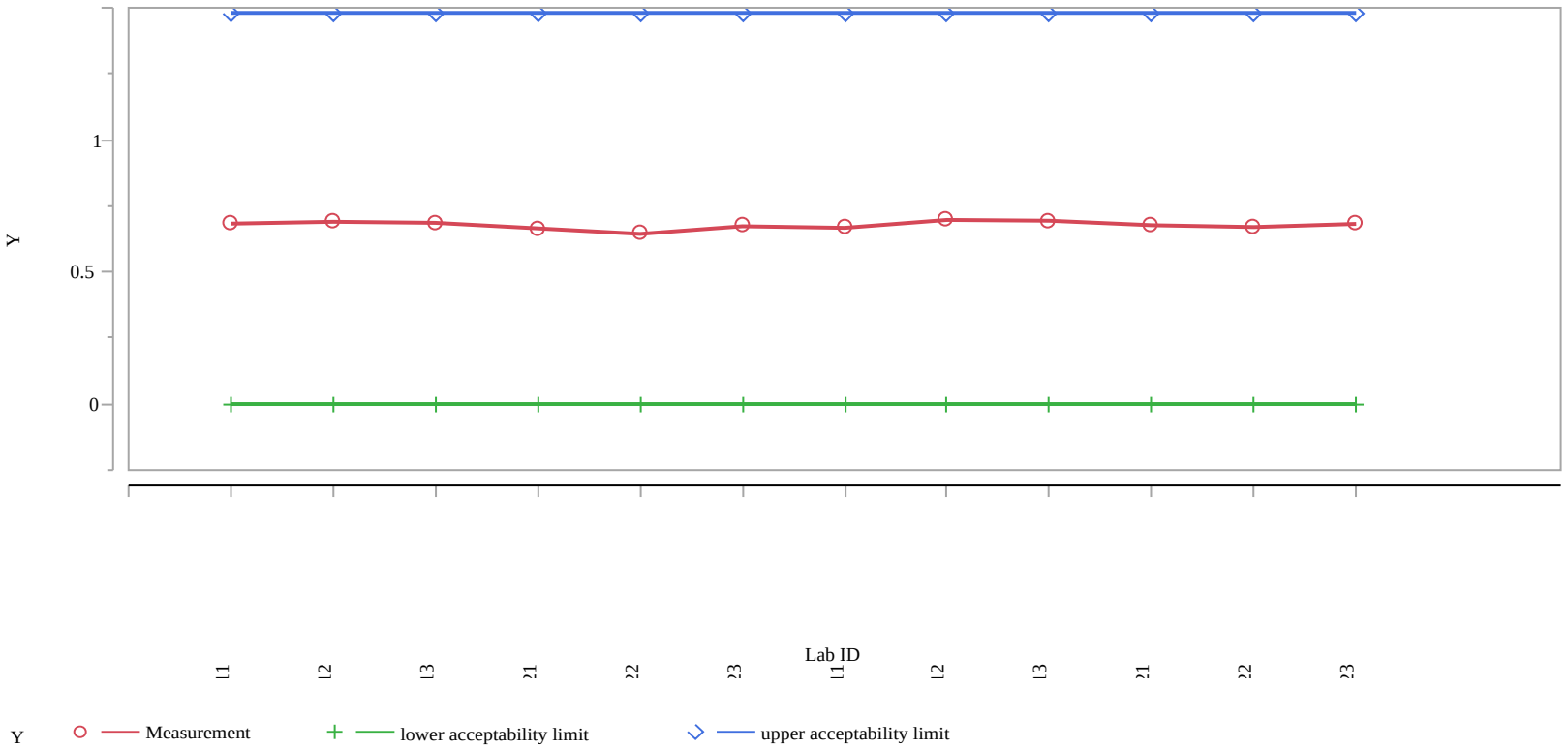


Exhibit A-3. Measurements of the LRM Standard Glass by Preparation Method by Element (continued)

Glass ID=LRM, Prep Method=PF, Element=Al (wt%)

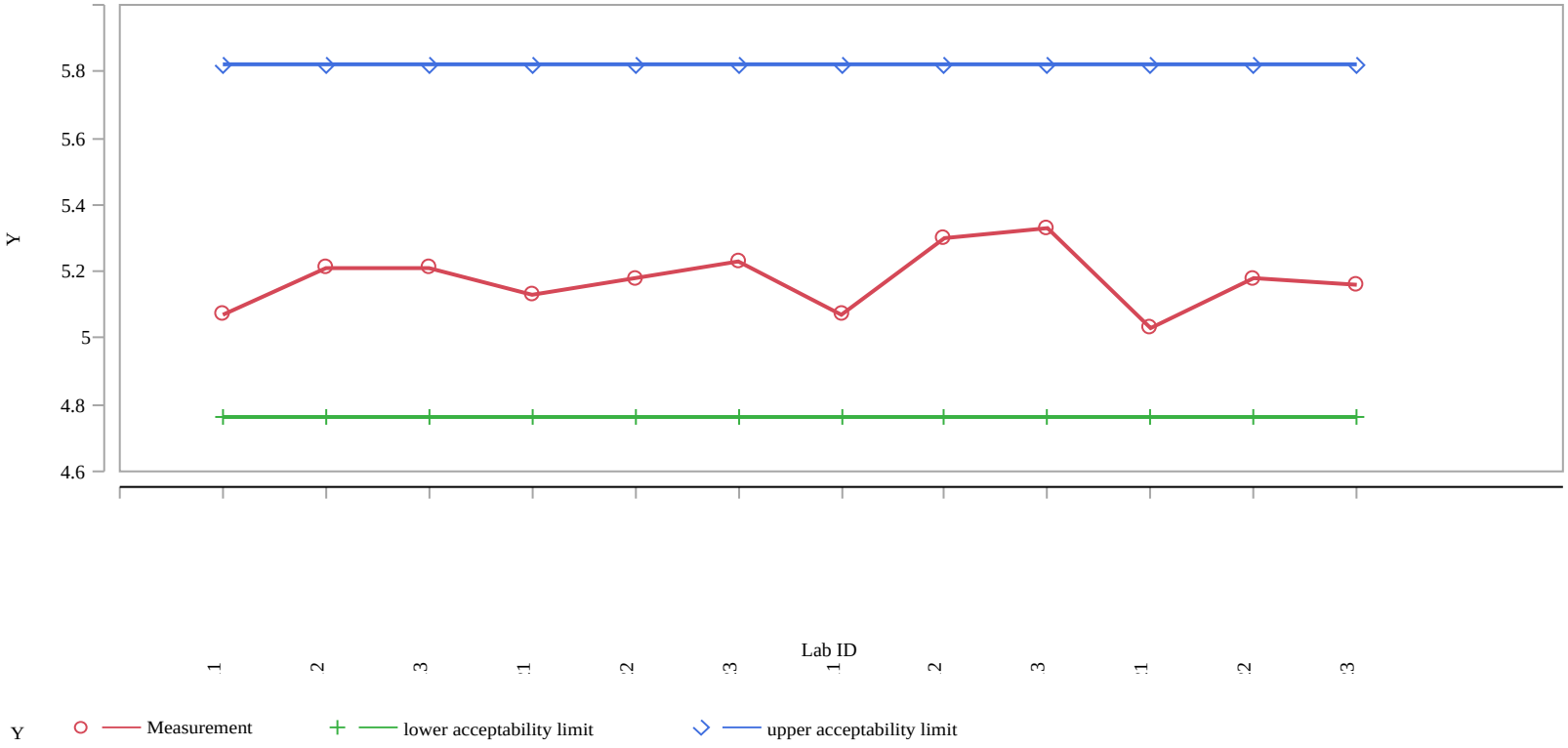


Exhibit A-3. Measurements of the LRM Standard Glass by Preparation Method by Element (continued)

Glass ID=LRM, Prep Method=PF, Element=B (wt%)

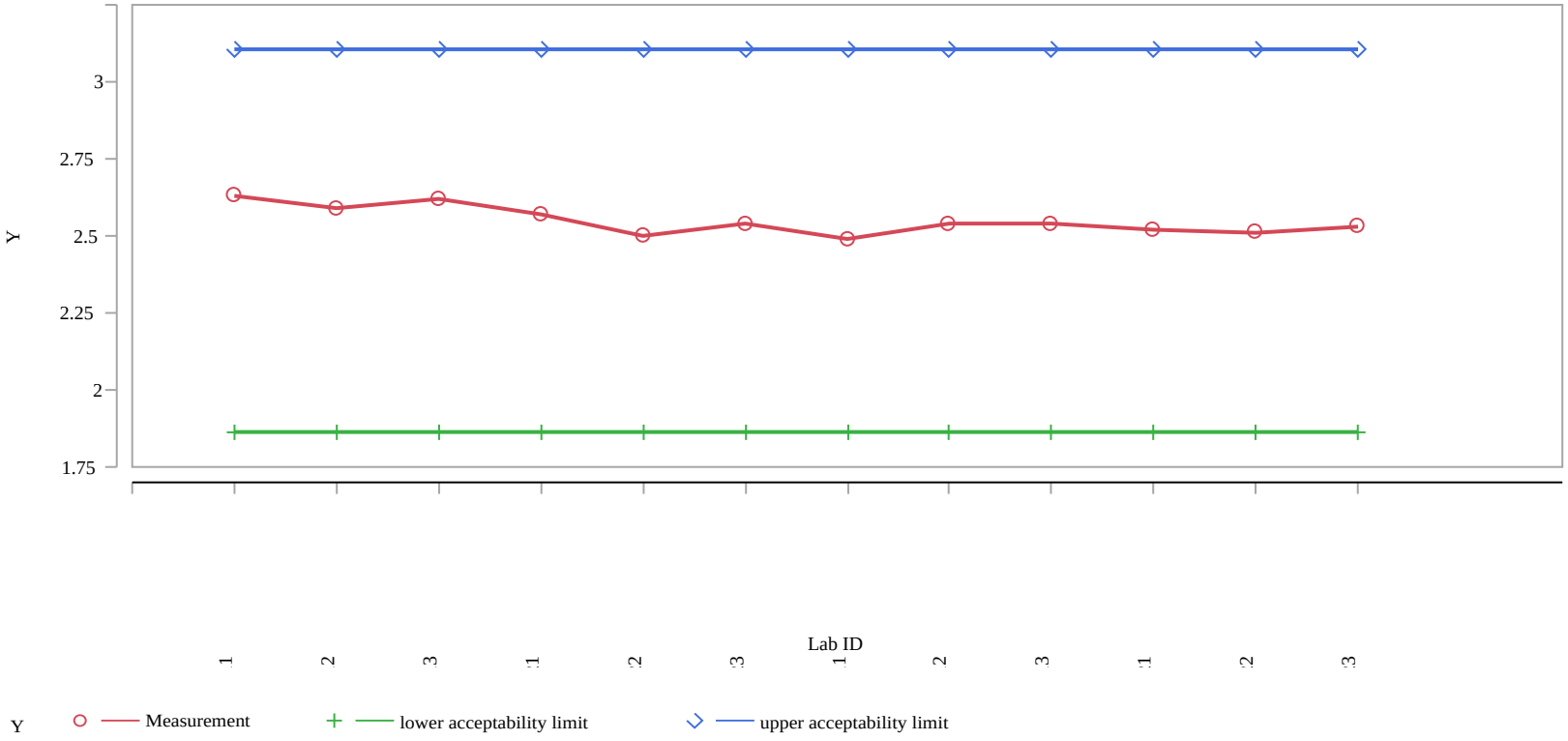


Exhibit A-3. Measurements of the LRM Standard Glass by Preparation Method by Element (continued)

Glass ID=LRM, Prep Method=PF, Element=Fe (wt%)

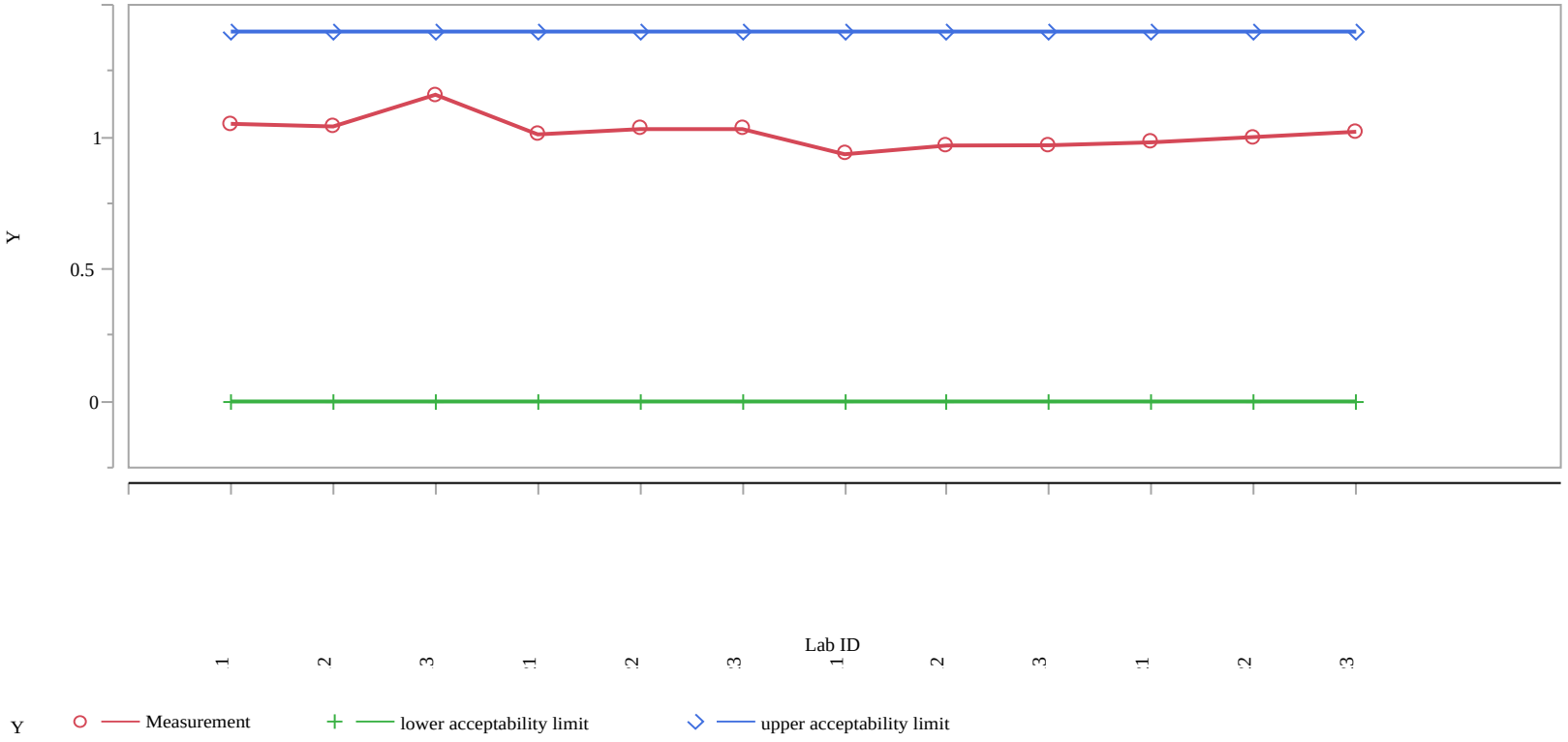


Exhibit A-3. Measurements of the LRM Standard Glass by Preparation Method by Element (continued)

Glass ID=LRM, Prep Method=PF, Element=Si (wt%)

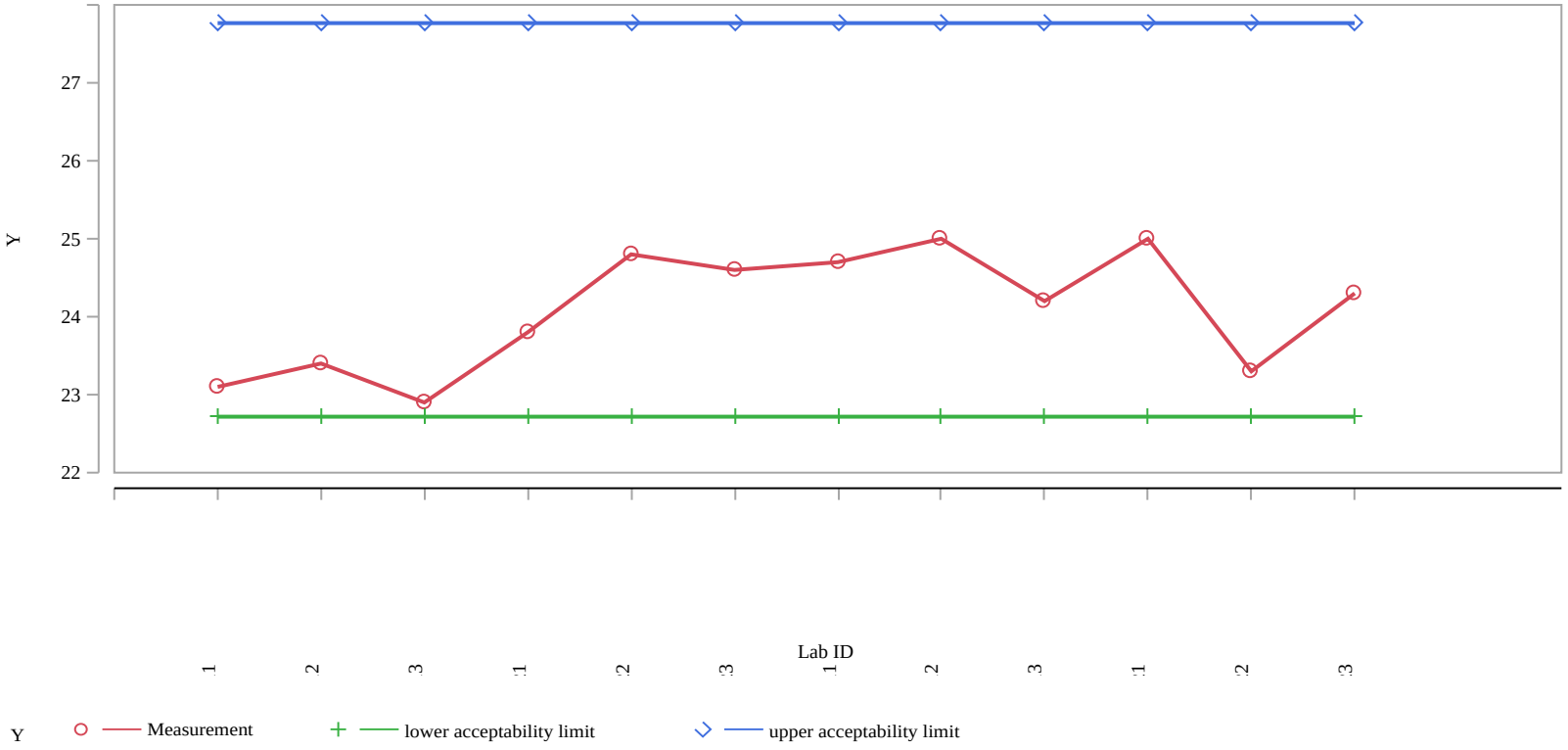


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide

Overlay Plot Oxide=Al2O3 (wt%)

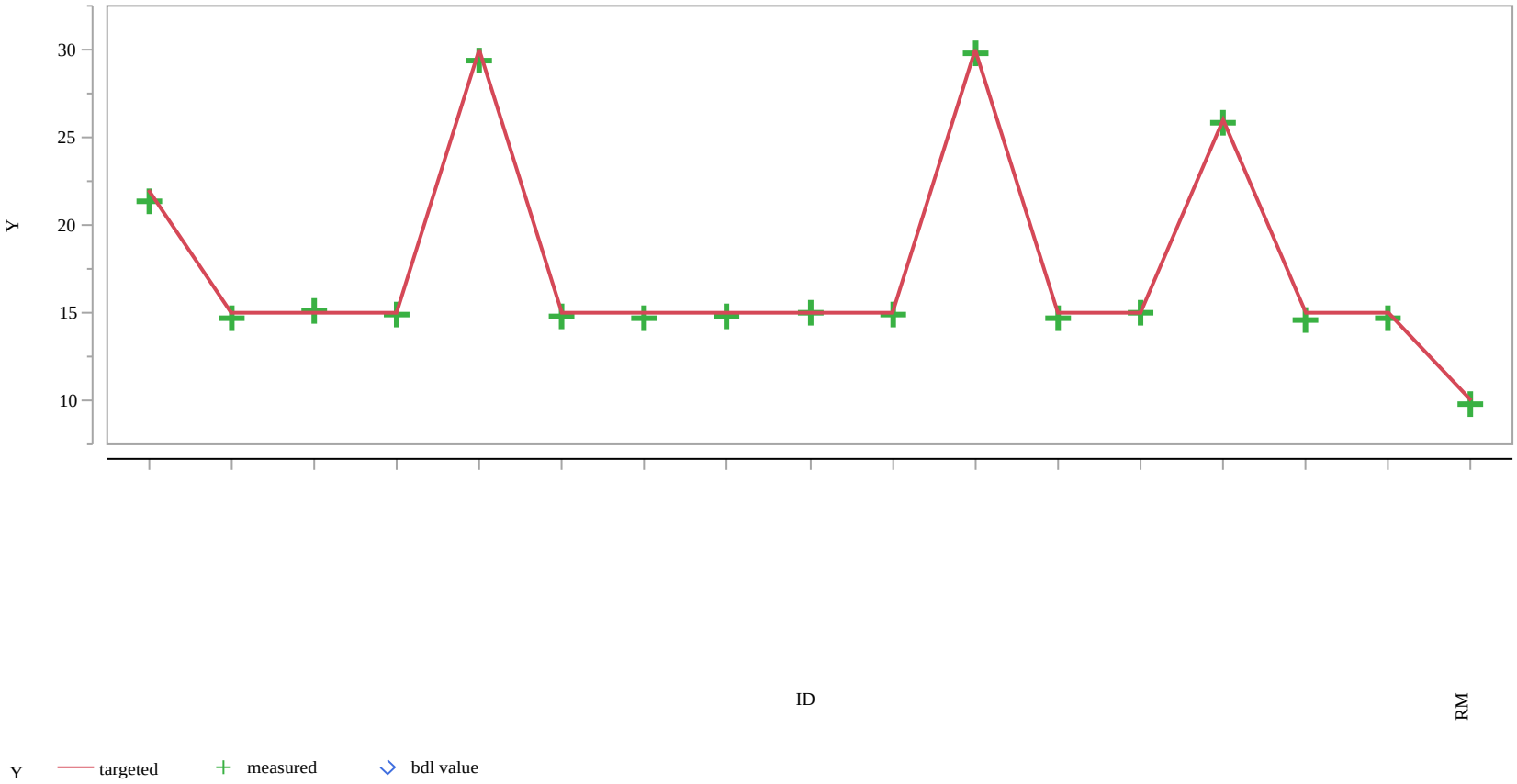


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

Overlay Plot Oxide=B2O3 (wt%)

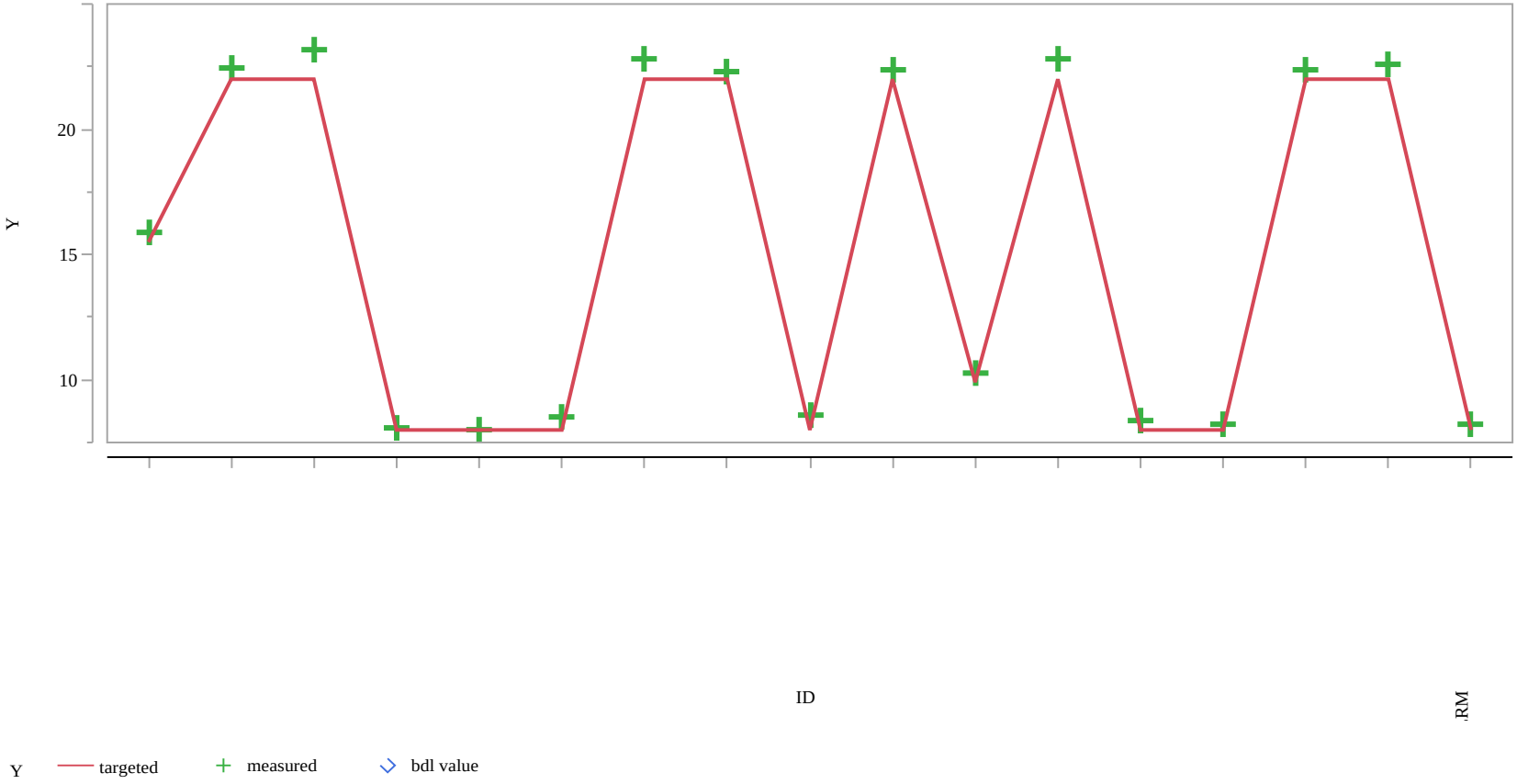


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

Overlay Plot Oxide=Bi2O3 (wt%)

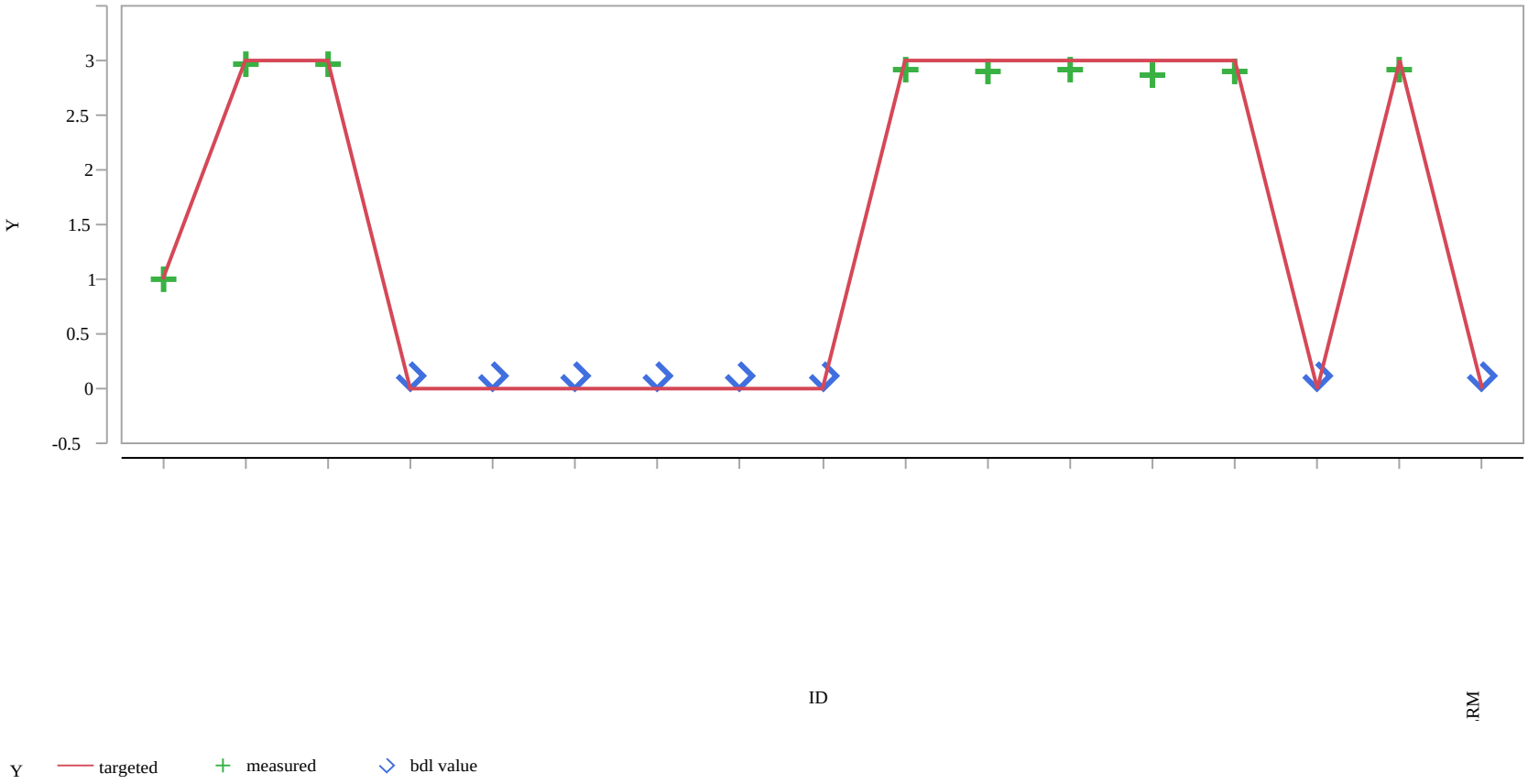


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

Overlay Plot Oxide=CaO (wt%)

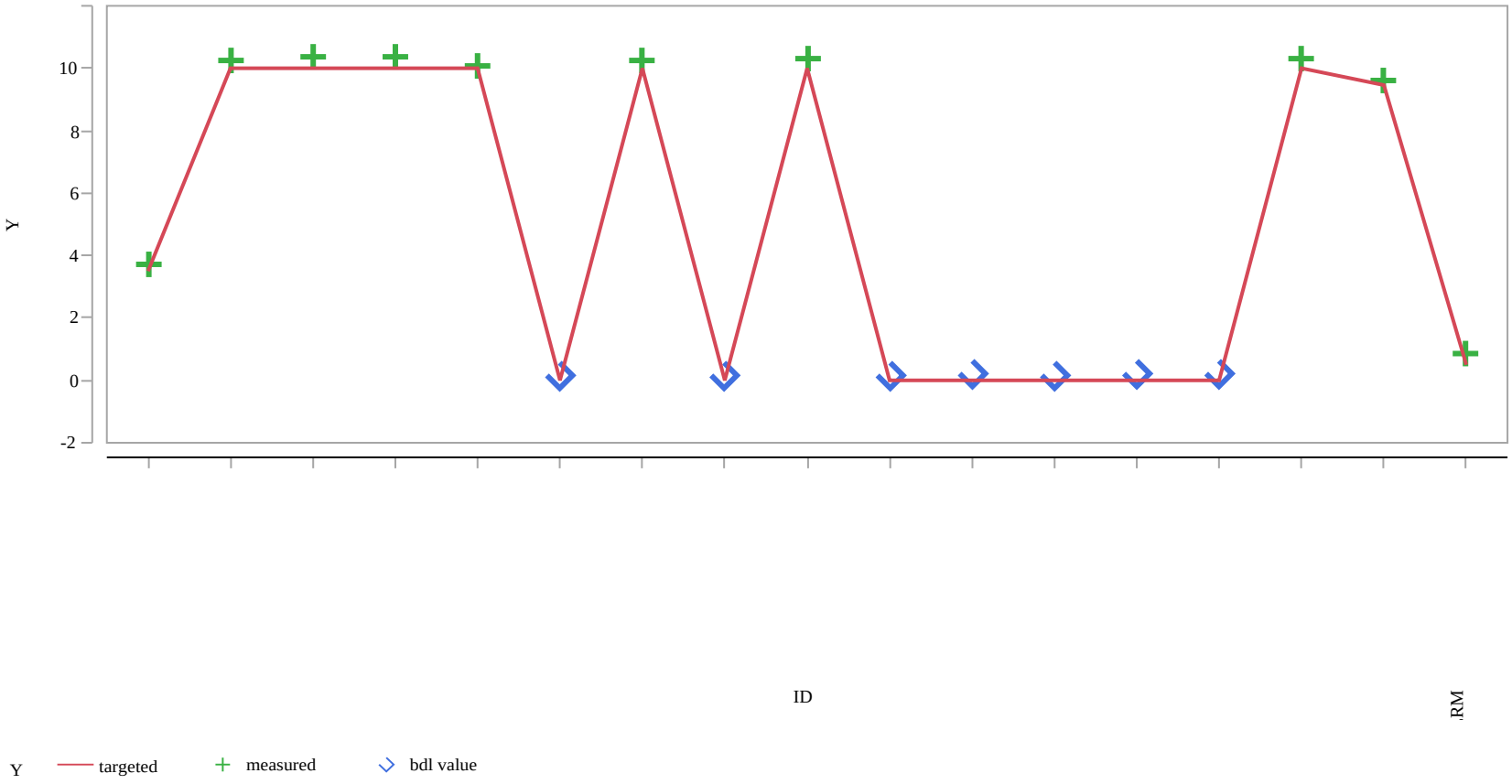


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

Overlay Plot Oxide=CdO (wt%)

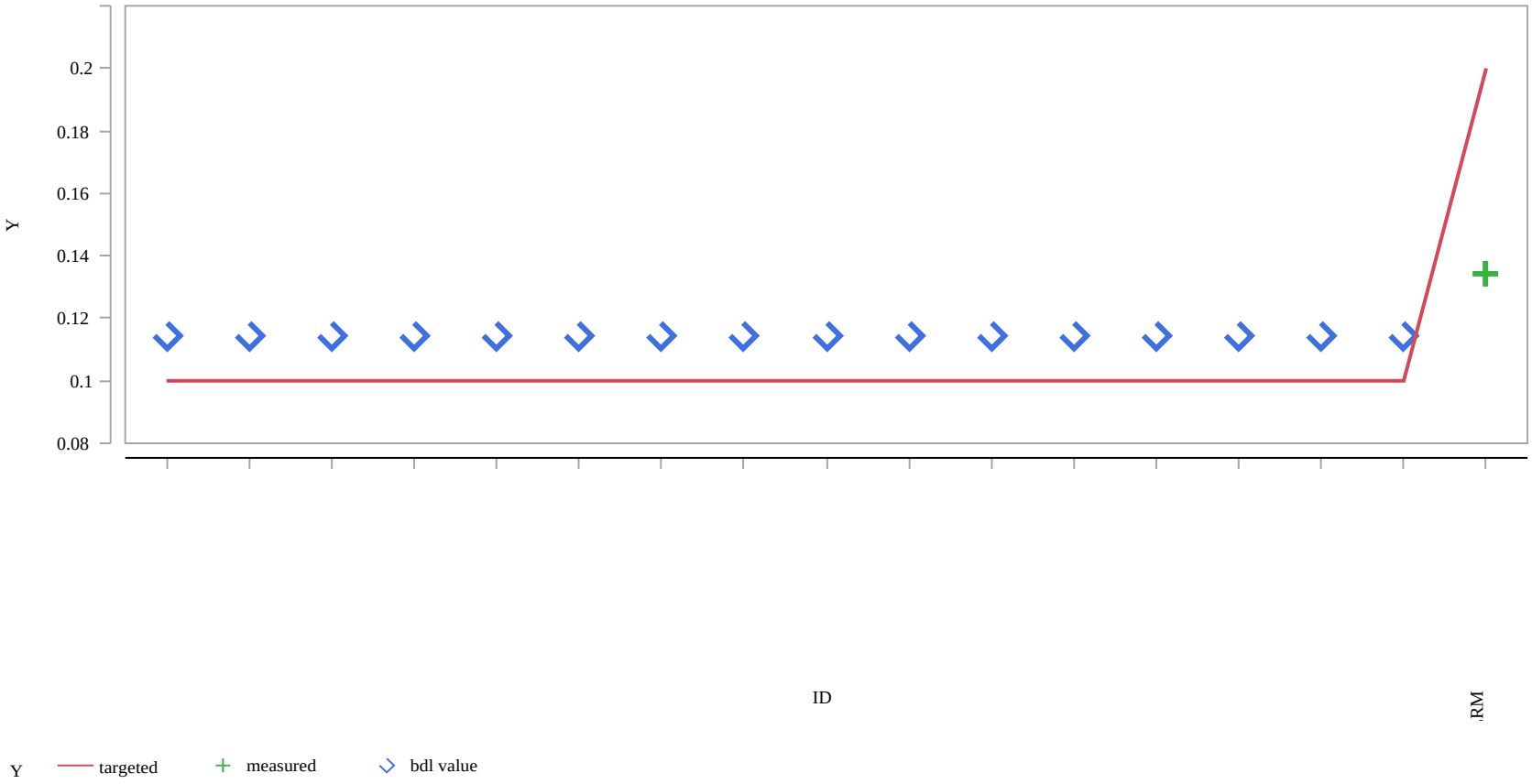


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

Overlay Plot Oxide=Cr2O3 (wt%)

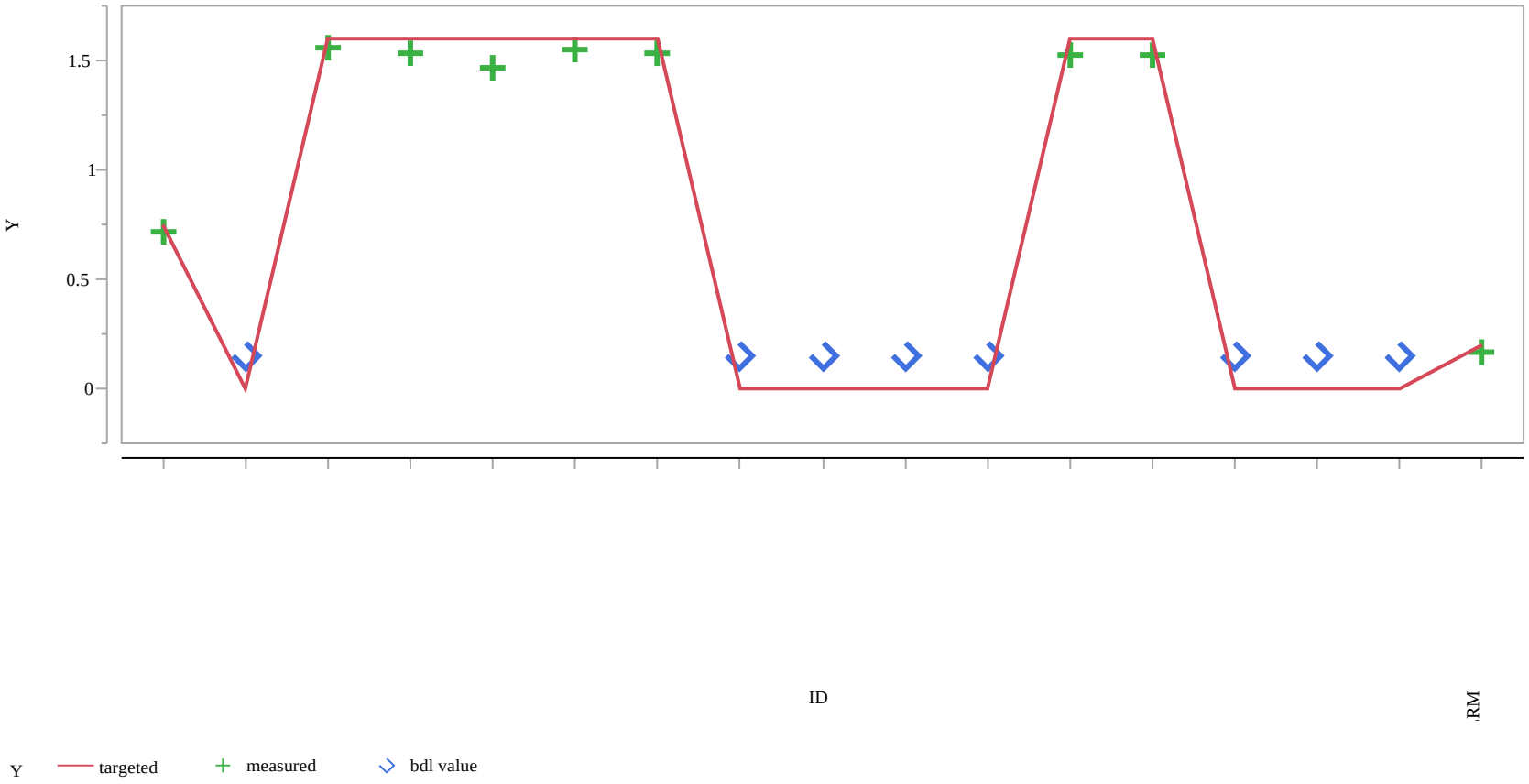


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

Overlay Plot Oxide=Fe2O3 (wt%)

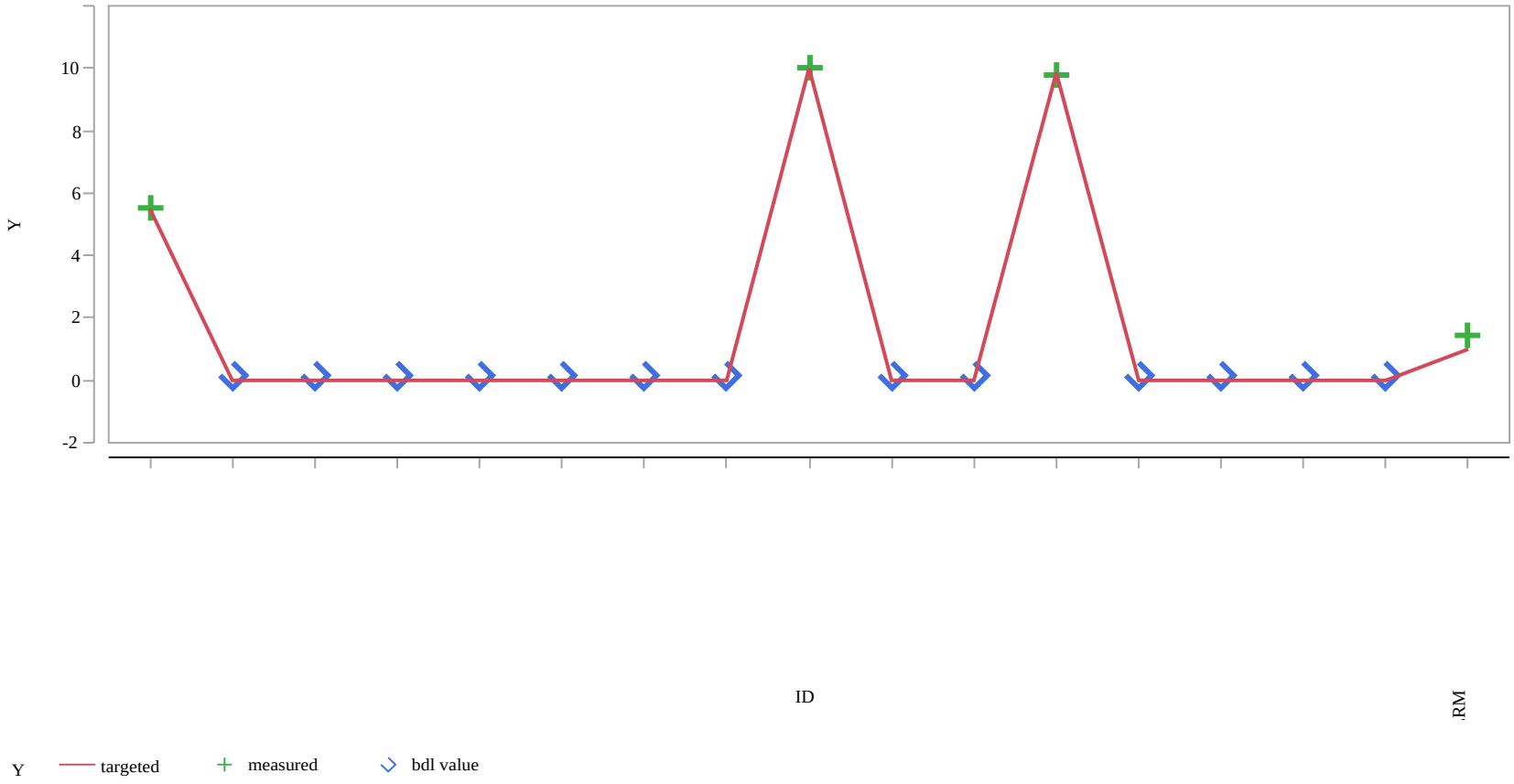


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

Overlay Plot Oxide=K2O (wt%)

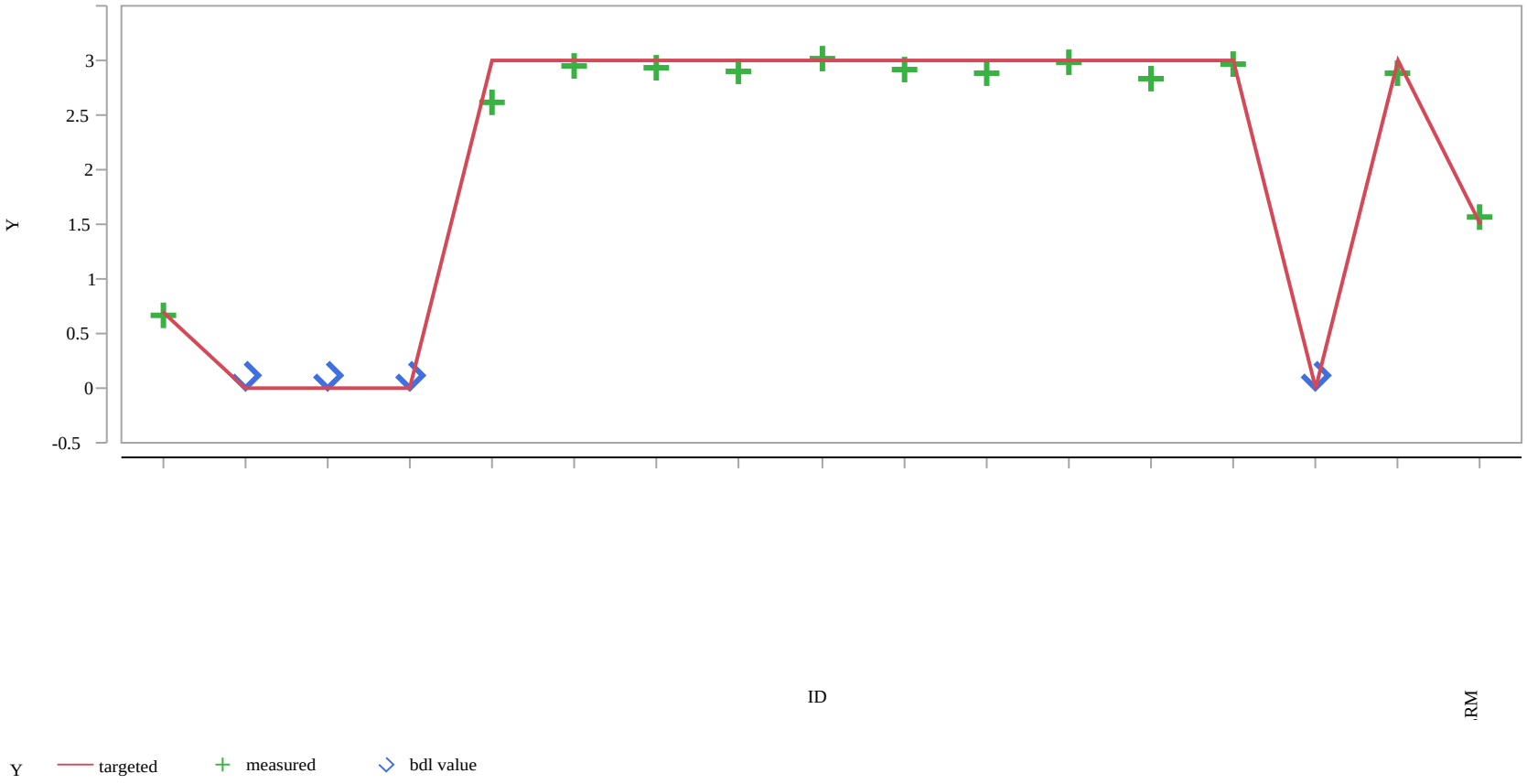


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

Overlay Plot Oxide=Li2O (wt%)

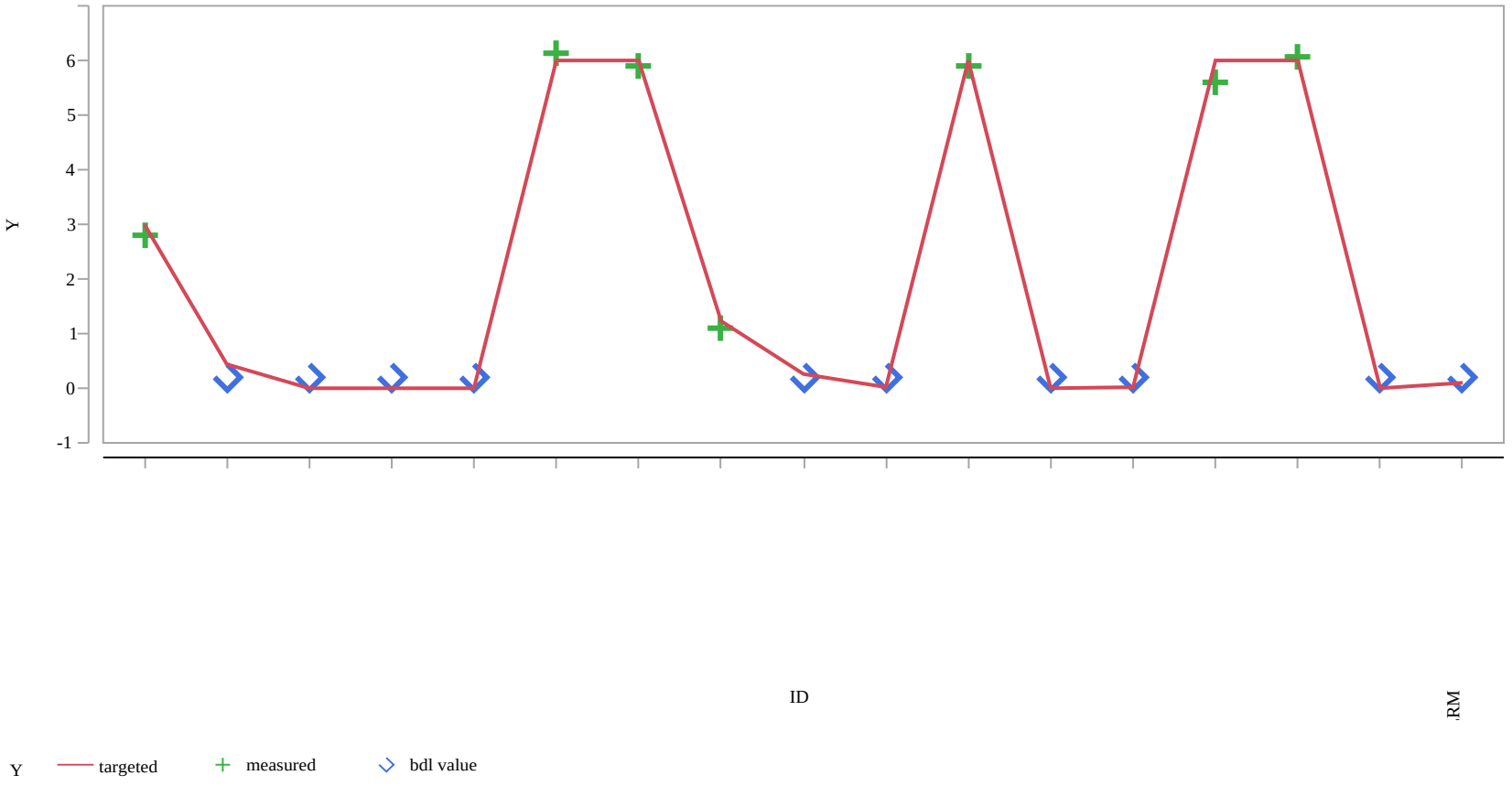


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

Overlay Plot Oxide=MgO (wt%)

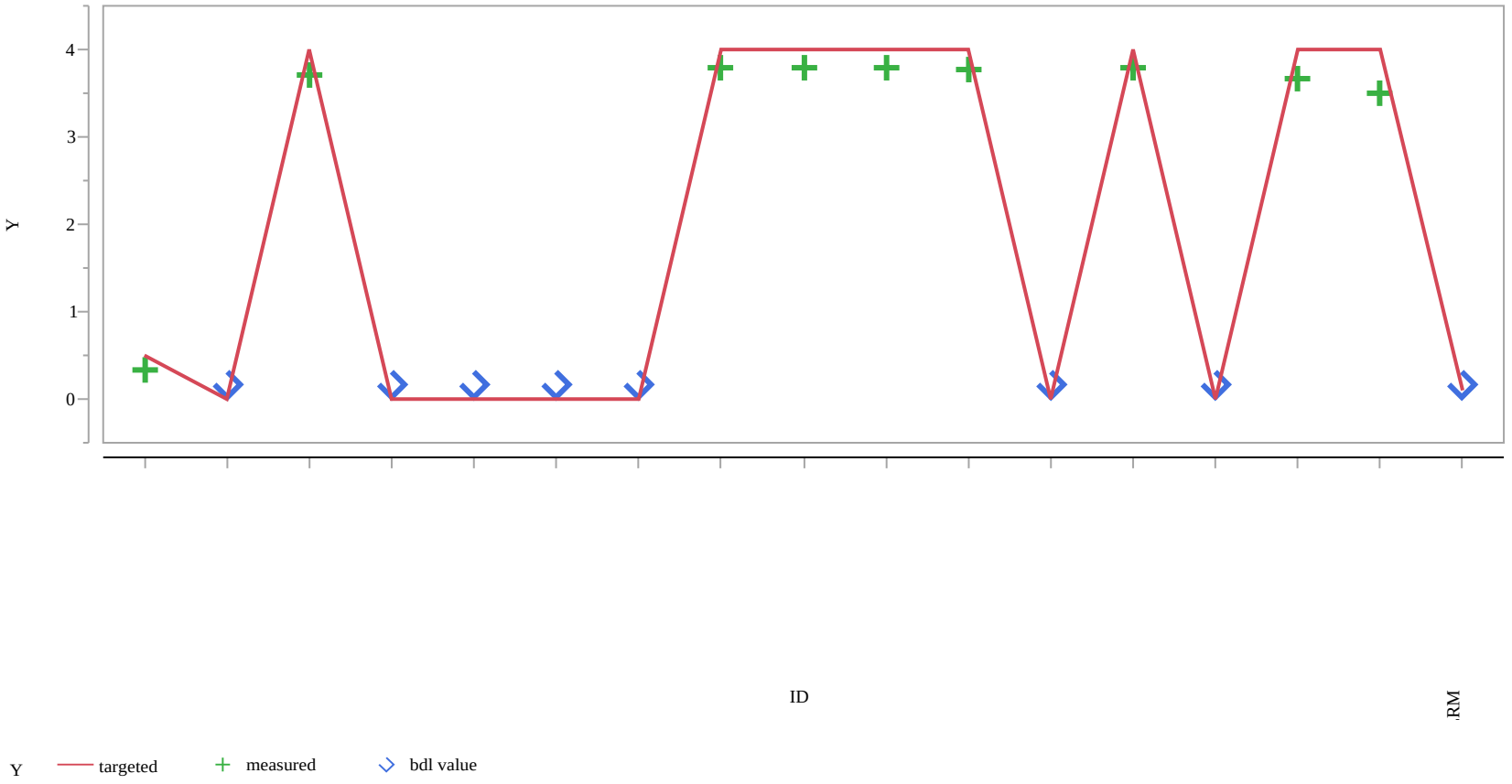


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

Overlay Plot Oxide=MnO (wt%)

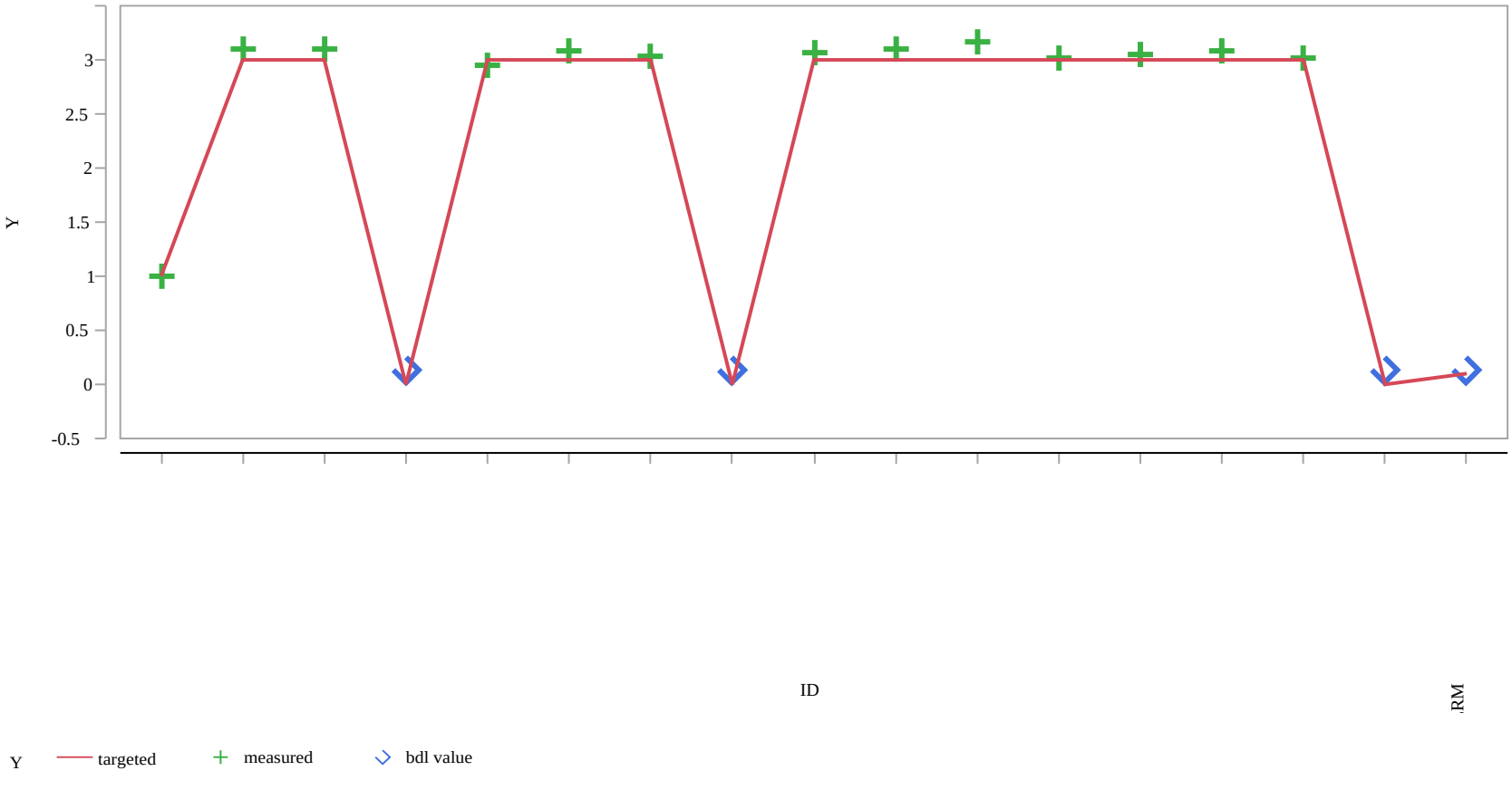


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

Overlay Plot Oxide=Na2O (wt%)

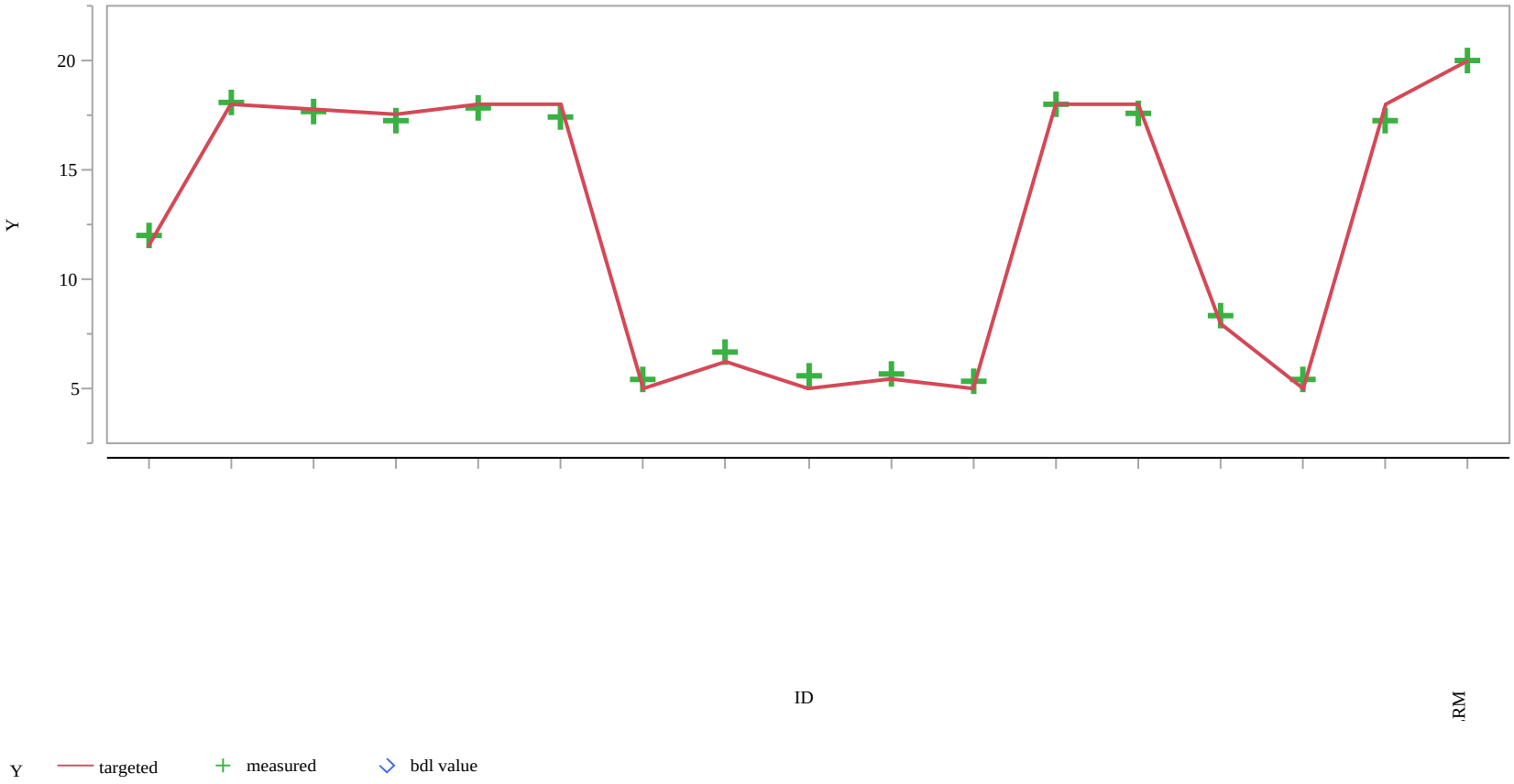


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

Overlay Plot Oxide=NiO (wt%)

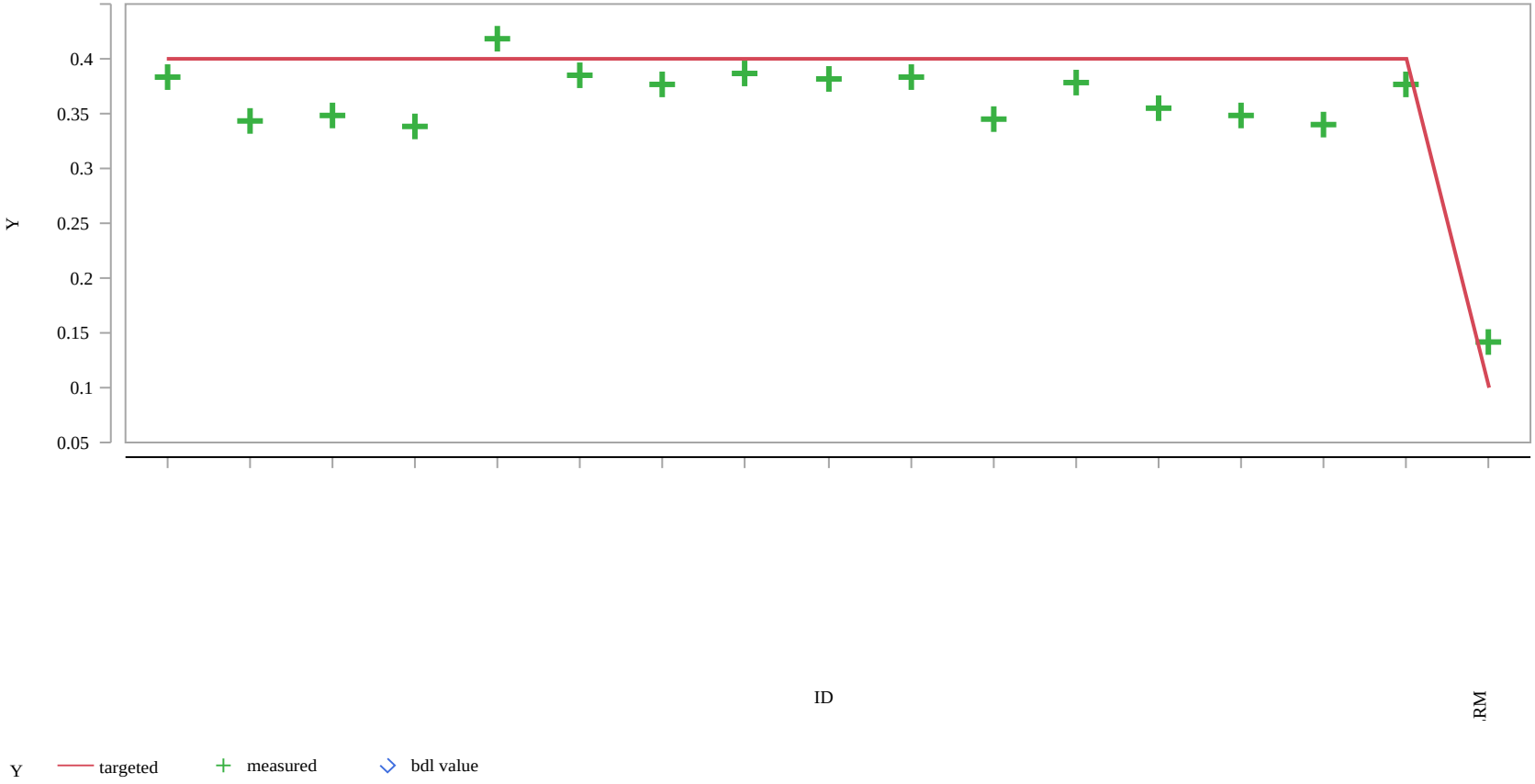


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

Overlay Plot Oxide=P2O5 (wt%)

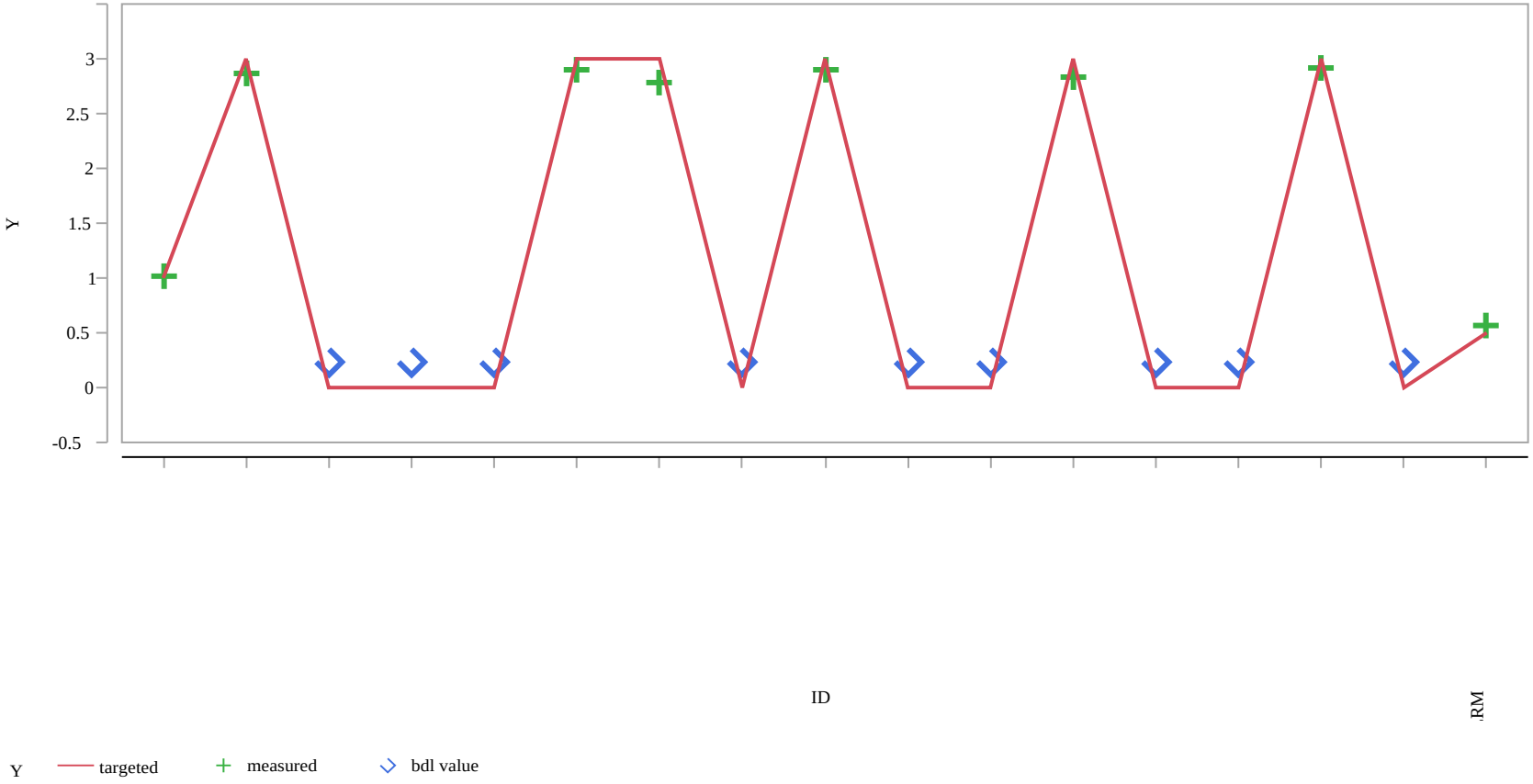


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

Overlay Plot Oxide=PbO (wt%)

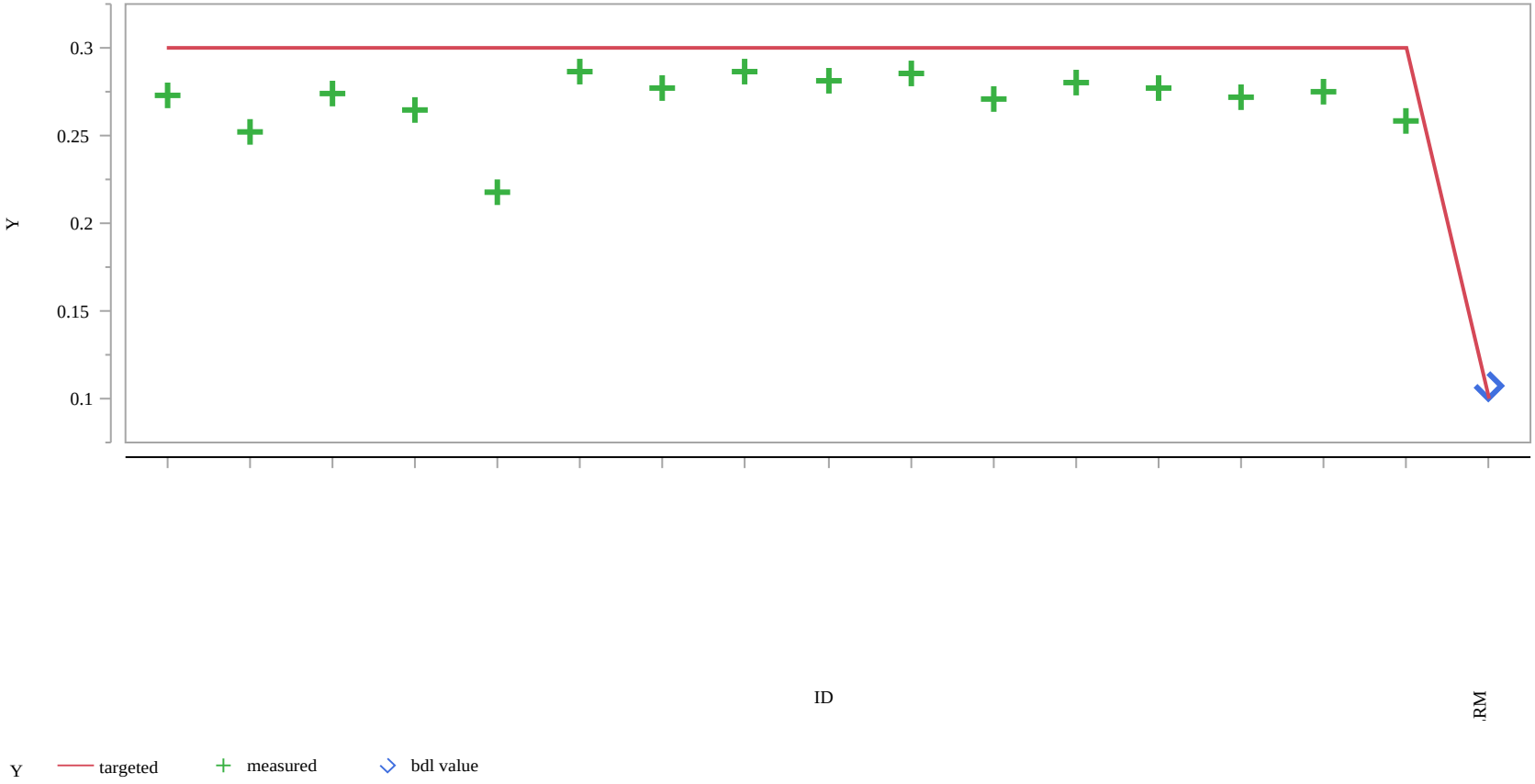


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

Overlay Plot Oxide=RuO2 (wt%)

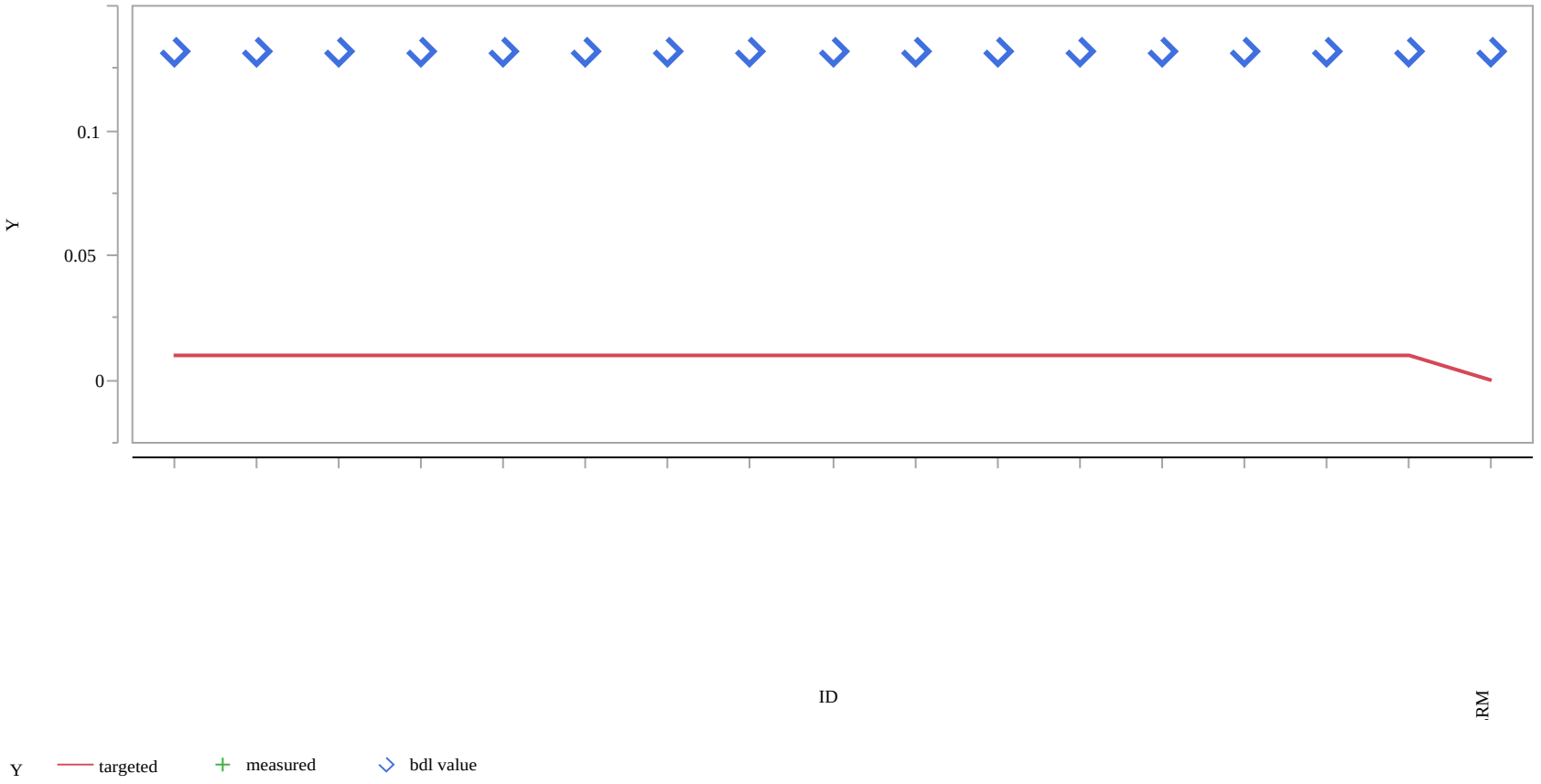


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

Overlay Plot Oxide=SiO2 (wt%)

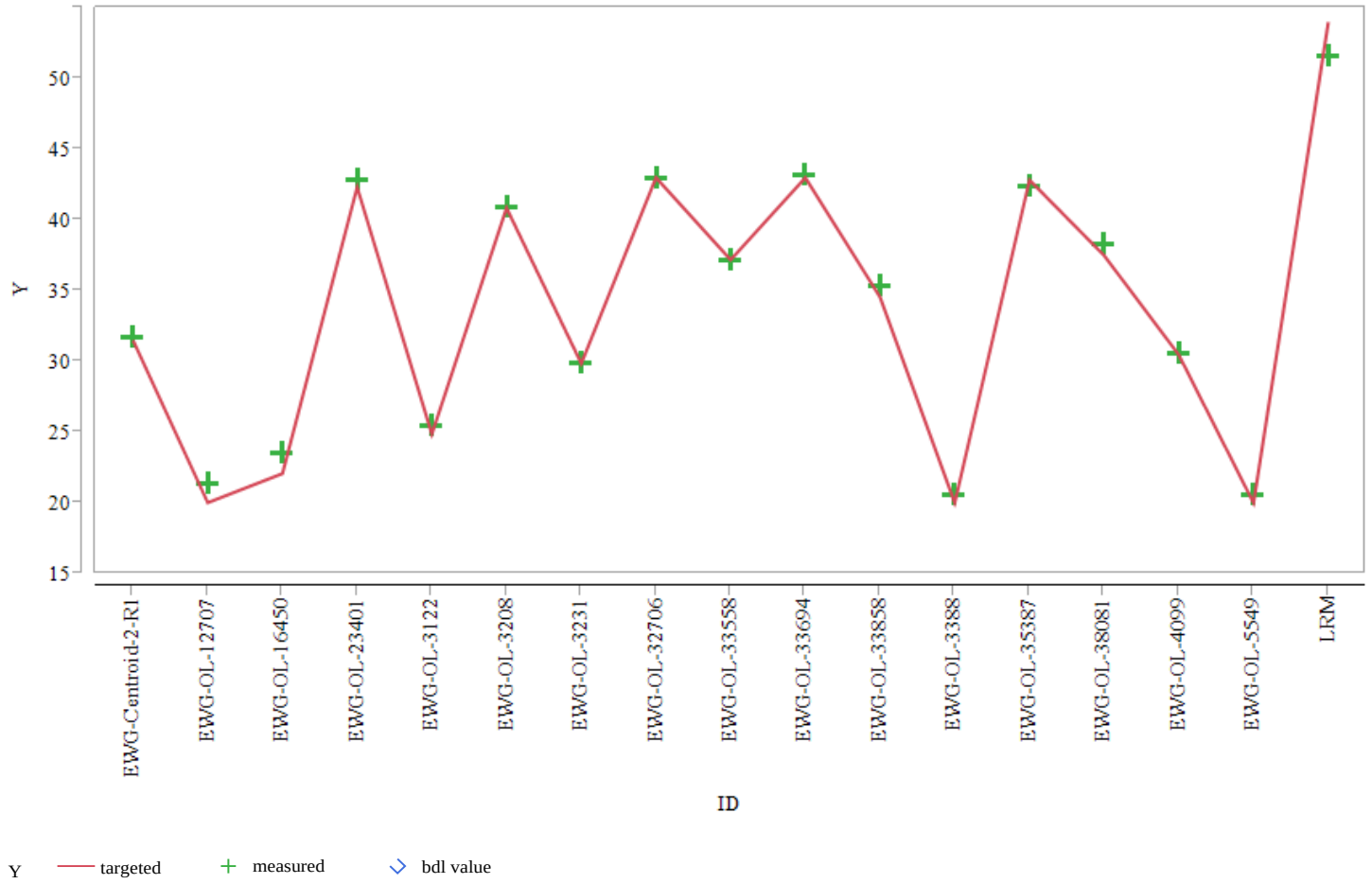


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

Overlay Plot Oxide=SO3 (wt%)

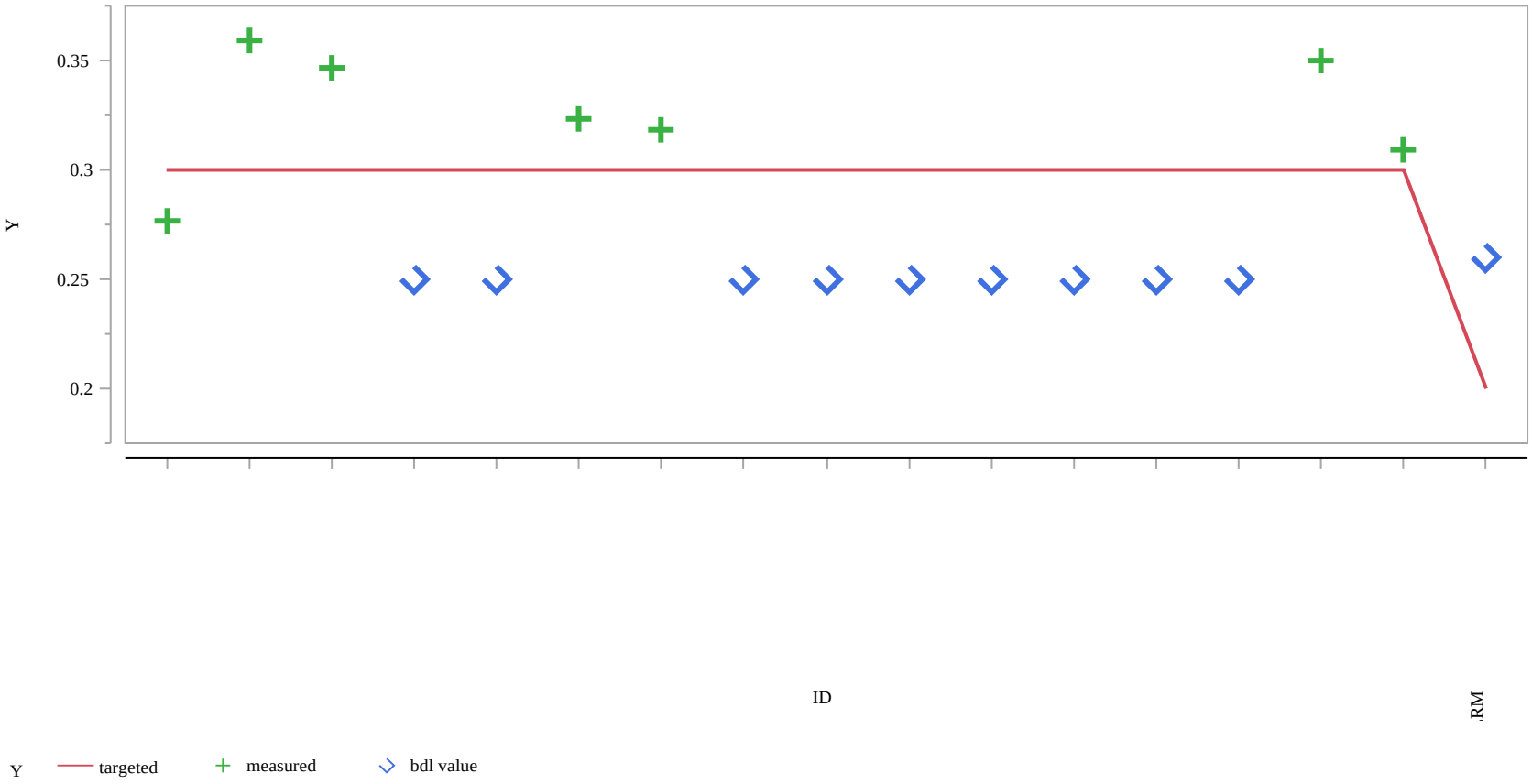


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

Overlay Plot Oxide=SrO (wt%)

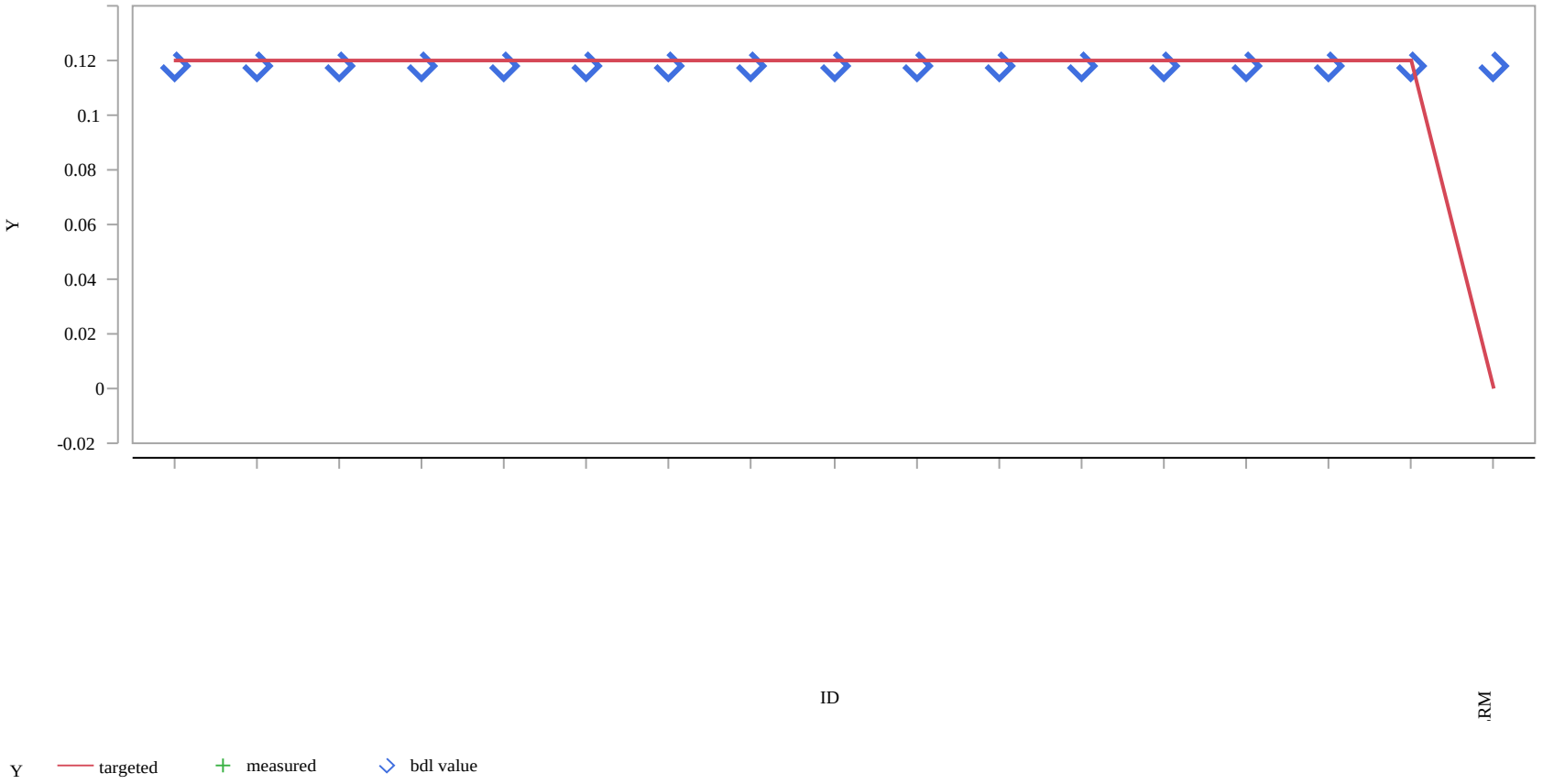


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

Overlay Plot Oxide=ZrO2 (wt%)

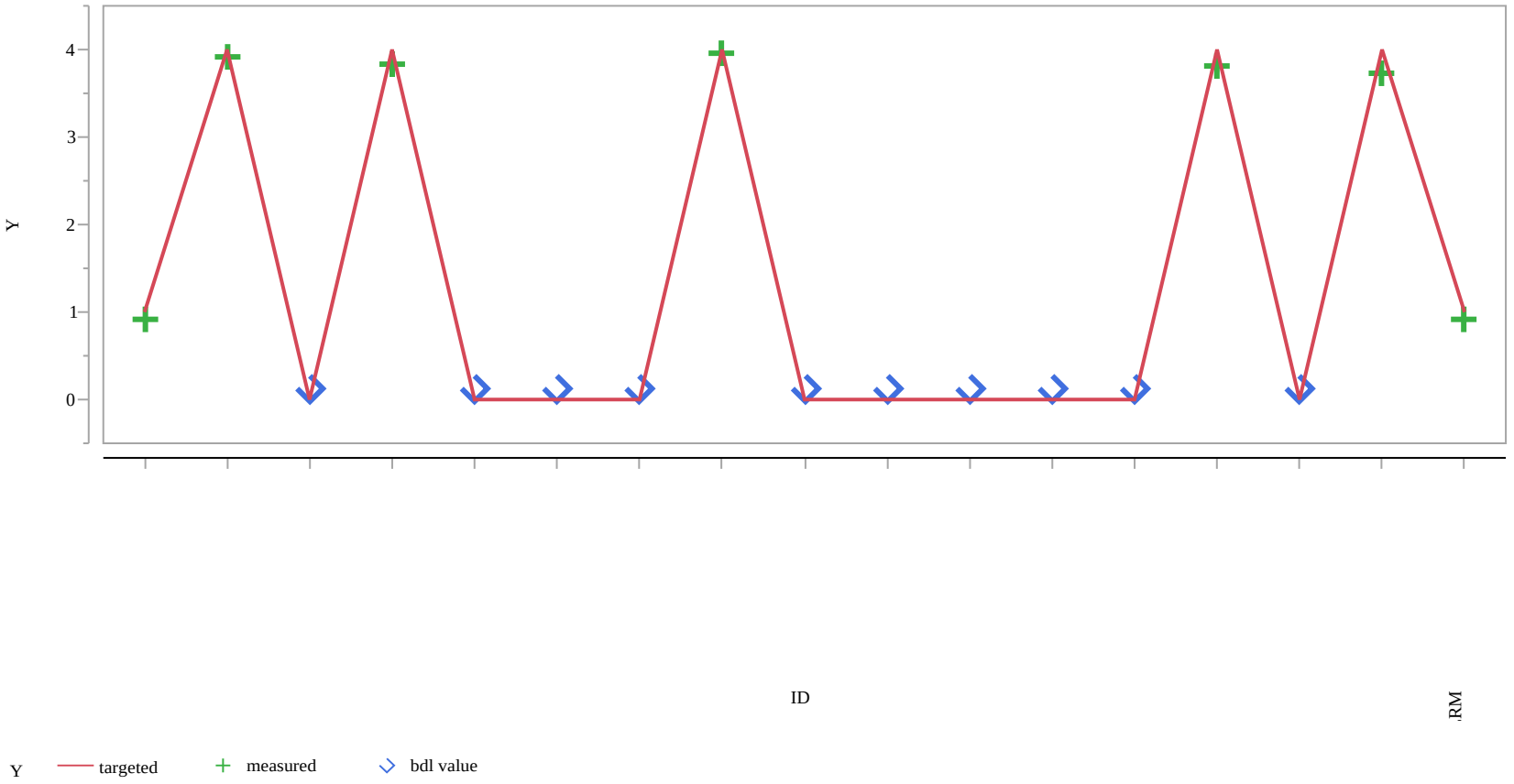
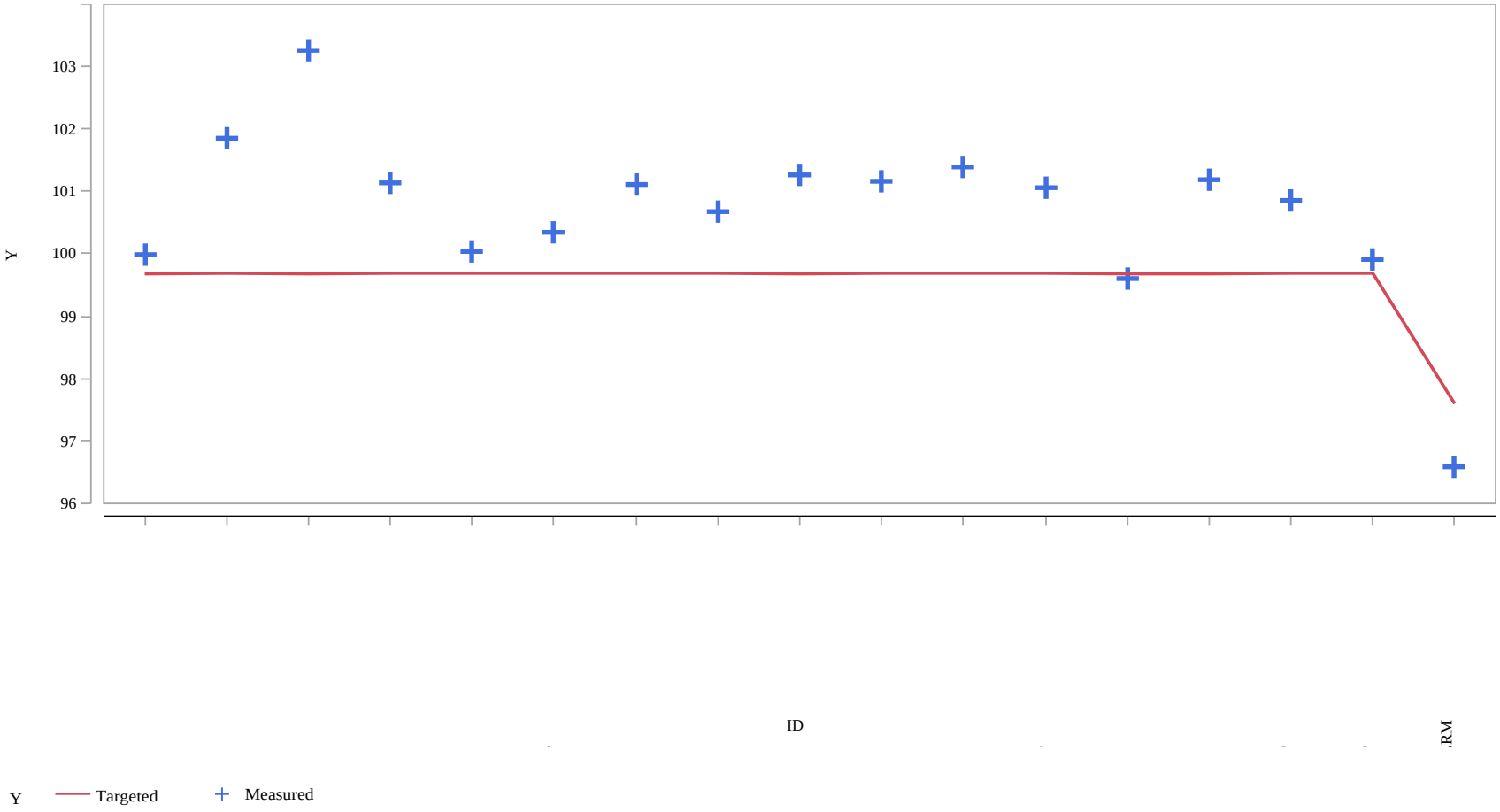


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

Overlay Plot Oxide=Sum of Oxides



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-e1-1	20.2	<1.00	10.4	10.0	80.7	<1.00	50.6	20.200	<1.000	10.400	10.000	80.700	<1.000	50.600
EWG-OL-3208	quenched	1	1	2	E03	46.2	<1.00	14.3	39.6	220	6.88	93.9	77.002	<1.667	23.834	66.001	366.674	11.467	156.503
EWG-OL-32706	quenched	1	1	3	E09	15.1	<1.00	3.591	2.36	9.36	<1.00	16.2	25.167	<1.667	5.985	3.933	15.600	<1.667	27.001
EWG-OL-12707	quenched	1	1	4	E42	324	3.94	<1.00	9.48	615	<1.00	4.95	540.011	6.567	<1.667	15.800	1025.02	<1.667	8.250
EWG-OL-3122	quenched	1	1	5	E08	3.84	4.24	3.65	<1.00	35.0	<1.00	8.36	6.400	7.067	6.083	<1.667	58.335	<1.667	13.934
ARM-1	ref	1	1	6	E25	9.60	<1.00	<1.00	7.76	20.0	1.04	33.7	16.000	<1.667	<1.667	12.934	33.334	1.733	56.168
EWG-OL-3231	ccc	1	1	7	E49	62.8	1.07	12.2	27.4	32.4	<1.00	21.9	104.669	1.783	20.334	45.668	54.001	<1.667	36.501
EWG-OL-3231	quenched	1	1	8	E31	71.2	1.23	13.2	30.9	36.7	<1.00	18.9	118.669	2.050	22.000	51.501	61.168	<1.667	31.501
EWG-OL-23401	quenched	1	1	9	E17	2.99	2.94	<1.00	<1.00	30.4	<1.00	11.9	4.983	4.900	<1.667	<1.667	50.668	<1.667	19.834
EWG-OL-16450	ccc	1	1	10	E16	260	103	<1.00	<1.00	427	<1.00	2.49	433.342	171.670	<1.667	<1.667	711.681	<1.667	4.150
EWG-OL-16450	quenched	1	1	11	E55	177	12.3	<1.00	<1.00	416	<1.00	6.34	295.006	20.500	<1.667	<1.667	693.347	<1.667	10.567
std soln	ref	1	1	12	std-e1-2	19.8	<1.00	10.3	10.2	78.7	<1.00	49.4	19.800	<1.000	10.300	10.200	78.700	<1.000	49.400
EWG-OL-23401	ccc	1	1	13	E05	5.44	4.82	<1.00	<1.00	29.9	<1.00	10.6	9.067	8.033	<1.667	<1.667	49.834	<1.667	17.667
EWG-OL-33558	quenched	1	1	14	E33	3.46	1.65	4.11	<1.00	11.0	<1.00	10.4	5.767	2.750	6.850	<1.667	18.334	<1.667	17.334
EA	ref	1	1	15	E24	20.5	<1.00	<1.00	7.69	60.0	<1.00	39.0	341.667	<16.667	<16.667	128.167	1000.00	<16.667	650.001
EWG-OL-12707	ccc	1	1	16	E26	226	3.69	<1.00	6.98	454	<1.00	4.63	376.674	6.150	<1.667	11.634	756.682	<1.667	7.717
EWG-OL-32706	ccc	1	1	17	E32	14.7	<1.00	3.28	2.39	9.04	<1.00	18.6	24.500	<1.667	5.467	3.983	15.067	<1.667	31.001
EWG-OL-33558	ccc	1	1	18	E52	3.90	1.09	3.53	<1.00	7.63	<1.00	11.4	6.500	1.817	5.883	<1.667	12.717	<1.667	19.000
EWG-OL-3208	ccc	1	1	19	E37	1380	<1.00	178	264	3470	12.0	176	2300.05	<1.667	296.673	440.009	5783.45	20.000	293.339
blank	ref	1	1	20	E51	4.93	<1.00	<1.00	<1.00	1.04	<1.00	<1.00	8.217	<1.667	<1.667	<1.667	1.733	<1.667	<1.667
EWG-OL-3122	ccc	1	1	21	E23	295	22.2	34.1	<1.00	1000	<1.00	2.17	491.677	37.001	56.834	<1.667	1666.70	<1.667	3.617
std soln	ref	1	1	22	std-e1-3	22.5	<1.00	10.4	9.94	80.2	<1.00	50.0	22.500	<1.000	10.400	9.940	80.200	<1.000	50.000
std soln	ref	1	2	1	std-e2-1	20.0	<1.00	9.94	9.69	82.1	<1.00	50.7	20.000	<1.000	9.940	9.690	82.100	<1.000	50.700
EWG-OL-12707	quenched	1	2	2	E07	321	3.39	<1.00	8.81	607	<1.00	4.82	535.011	5.650	<1.667	14.684	1011.69	<1.667	8.033
EWG-OL-3122	ccc	1	2	3	E53	303	24.2	34.0	<1.00	932	<1.00	1.70	505.010	40.334	56.668	<1.667	1553.36	<1.667	2.833
EA	ref	1	2	4	E50	24.3	<1.00	<1.00	7.85	65.5	<1.00	42.0	405.001	<16.667	<16.667	130.834	1091.67	<16.667	700.001
EWG-OL-3208	ccc	1	2	5	E41	1370	<1.00	187	272	3480	11.591	189	2283.38	<1.667	311.673	453.342	5800.12	19.319	315.006
EWG-OL-33558	ccc	1	2	6	E13	8.56	<1.00	2.89	<1.00	7.28	<1.00	11.5	14.267	<1.667	4.817	<1.667	12.134	<1.667	19.167
EWG-OL-33558	quenched	1	2	7	E30	6.68	1.26	3.70	<1.00	11.5	<1.00	10.9	11.134	2.100	6.167	<1.667	19.167	<1.667	18.167
EWG-OL-16450	quenched	1	2	8	E46	186	11.9	<1.00	<1.00	408	<1.00	6.19	310.006	19.834	<1.667	<1.667	680.014	<1.667	10.317
EWG-OL-12707	ccc	1	2	9	E21	289	3.84	<1.00	7.95	530	<1.00	4.10	481.676	6.400	<1.667	13.250	883.351	<1.667	6.833
EWG-OL-32706	ccc	1	2	10	E38	20.6	<1.00	2.92	2.23	10.4	<1.00	21.0	34.334	<1.667	4.867	3.717	17.334	<1.667	35.001
EWG-OL-3231	quenched	1	2	11	E35	78.8	<1.00	13.5	32.6	39.1	<1.00	19.9	131.336	<1.667	22.500	54.334	65.168	<1.667	33.167
std soln	ref	1	2	12	std-e2-2	22.2	<1.00	10.2	9.87	82.0	<1.00	51.7	22.200	<1.000	10.200	9.870	82.000	<1.000	51.700
EWG-OL-23401	ccc	1	2	13	E54	6.14	4.78	<1.00	<1.00	30.9	<1.00	11.4	10.234	7.967	<1.667	<1.667	51.501	<1.667	19.000
EWG-OL-32706	quenched	1	2	14	E22	16.9	<1.00	3.11	2.01	9.70	<1.00	17.1	28.167	<1.667	5.183	3.350	16.167	<1.667	28.501
EWG-OL-3231	ccc	1	2	15	E14	66.5	<1.00	12.0	28.5	33.8	<1.00	22.5	110.836	<1.667	20.000	47.501	56.334	<1.667	37.501
ARM-1	ref	1	2	16	E20	9.86	<1.00	<1.00	7.47	19.7	<1.00	33.6	16.434	<1.667	<1.667	12.450	32.834	<1.667	56.001

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-16450	ccc	1	2	17	E47	241	96.1	<1.00	<1.00	409	<1.00	2.23	401.675	160.170	<1.667	<1.667	681.680	<1.667	3.717
EWG-OL-3208	quenched	1	2	18	E45	53.7	<1.00	15.4	43.8	248	7.02	102	89.502	<1.667	25.667	73.001	413.342	11.700	170.003
EWG-OL-3122	quenched	1	2	19	E40	3.83	4.13	3.17	<1.00	35.5	<1.00	8.73	6.383	6.883	5.283	<1.667	59.168	<1.667	14.550
EWG-OL-23401	quenched	1	2	20	E19	3.16	2.56	<1.00	<1.00	30.9	<1.00	12.0	5.267	4.267	<1.667	<1.667	51.501	<1.667	20.000
std soln	ref	1	2	21	std-e2-3	19.5	<1.00	9.96	9.77	80.5	<1.00	51.1	19.500	<1.000	9.960	9.770	80.500	<1.000	51.100
std soln	ref	1	3	1	std-e3-1	20.4	<1.00	10.1	9.81	83.7	<1.00	52.2	20.400	<1.000	10.100	9.810	83.700	<1.000	52.200
ARM-1	ref	1	3	2	E56	9.00	1.63	<1.00	7.30	20.1	<1.00	33.5	15.000	2.717	<1.667	12.167	33.501	<1.667	55.834
EWG-OL-16450	quenched	1	3	3	E11	185	12.4	<1.00	<1.00	422	<1.00	6.09	308.340	20.667	<1.667	<1.667	703.347	<1.667	10.150
EWG-OL-12707	quenched	1	3	4	E02	306	3.05	<1.00	8.12	571	<1.00	4.77	510.010	5.083	<1.667	13.534	951.686	<1.667	7.950
EWG-OL-23401	ccc	1	3	5	E36	5.29	4.30	<1.00	<1.00	30.0	<1.00	10.5	8.817	7.167	<1.667	<1.667	50.001	<1.667	17.500
EWG-OL-33558	quenched	1	3	6	E29	3.61	1.20	3.75	<1.00	11.7	<1.00	10.9	6.017	2.000	6.250	<1.667	19.500	<1.667	18.167
EWG-OL-3208	quenched	1	3	7	E01	51.7	<1.00	14.8	42.8	246	6.68	99.2	86.168	<1.667	24.667	71.335	410.008	11.134	165.337
EWG-OL-33558	ccc	1	3	8	E18	3.65	<1.00	2.92	<1.00	7.36	<1.00	11.5	6.083	<1.667	4.867	<1.667	12.267	<1.667	19.167
EWG-OL-23401	quenched	1	3	9	E06	2.66	2.52	<1.00	<1.00	31.3	<1.00	11.9	4.433	4.200	<1.667	<1.667	52.168	<1.667	19.834
EA	ref	1	3	10	E15	22.3	<1.00	<1.00	7.57	64.1	<1.00	40.7	371.667	<16.667	<16.667	126.167	1068.34	<16.667	678.335
EWG-OL-32706	quenched	1	3	11	E48	15.9	<1.00	3.09	1.85	9.40	<1.00	16.8	26.501	<1.667	5.150	3.083	15.667	<1.667	28.001
std soln	ref	1	3	12	std-e3-2	19.3	<1.00	9.85	9.61	82.0	<1.00	51.2	19.300	<1.000	9.850	9.610	82.000	<1.000	51.200
EWG-OL-3122	ccc	1	3	13	E43	301	24.3	33.8	<1.00	954	<1.00	1.59	501.677	40.501	56.334	<1.667	1590.03	<1.667	2.650
EWG-OL-12707	ccc	1	3	14	E04	246	3.47	<1.00	6.71	462	<1.00	4.42	410.008	5.783	<1.667	11.184	770.015	<1.667	7.367
EWG-OL-32706	ccc	1	3	15	E28	15.7	<1.00	2.75	1.85	8.90	<1.00	19.1	26.167	<1.667	4.583	3.083	14.834	<1.667	31.834
EWG-OL-3122	quenched	1	3	16	E44	3.32	3.90	3.07	<1.00	35.7	<1.00	8.27	5.533	6.500	5.117	<1.667	59.501	<1.667	13.784
EWG-OL-3231	ccc	1	3	17	E34	68.8	<1.00	11.9	28.5	34.0	<1.00	22.5	114.669	<1.667	19.834	47.501	56.668	<1.667	37.501
EWG-OL-3208	ccc	1	3	18	E12	1410	<1.00	188	274	3520	11.7	204	2350.05	<1.667	313.340	456.676	5866.78	19.500	340.007
blank	ref	1	3	19	E27	2.66	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	4.433	<1.667	<1.667	<1.667	<1.667	<1.667	<1.667
EWG-OL-3231	quenched	1	3	20	E10	77.40	<1.00	13.20	32.30	38.60	<1.00	19.30	129.003	<1.667	22.000	53.834	64.335	<1.667	32.167
EWG-OL-16450	ccc	1	3	21	E39	263	103	<1.00	<1.00	434	<1.00	<1.00	438.342	171.670	<1.667	<1.667	723.348	<1.667	<1.667
std soln	ref	1	3	22	std-e3-3	21.6	<1.00	9.89	9.65	82.2	<1.00	50.6	21.600	<1.000	9.890	9.650	82.200	<1.000	50.600
std soln	ref	2	1	1	std-f1-1	18.5	<1.00	9.81	9.59	81.3	<1.00	50.5	18.500	<1.000	9.810	9.590	81.300	<1.000	50.500
EWG-OL-33694	quenched	2	1	2	F13	42.9	<1.00	5.39	<1.00	22.4	<1.00	17.0	71.501	<1.667	8.984	<1.667	37.334	<1.667	28.334
EWG-OL-5549	quenched	2	1	3	F48	159	10.5	60.1	<1.00	352	<1.00	4.91	265.005	17.500	100.169	<1.667	586.678	<1.667	8.183
EWG-OL-5549	ccc	2	1	4	F12	200	13.6	70.1	<1.00	423	<1.00	4.47	333.340	22.667	116.836	<1.667	705.014	<1.667	7.450
EWG-OL-38081	quenched	2	1	5	F34	7.10	<1.00	4.24	10.2	12.8	<1.00	35.6	11.834	<1.667	7.067	17.000	21.334	<1.667	59.335
EWG-OL-38081	ccc	2	1	6	F35	1240	<1.00	94.0	719	328	<1.00	26.5	2066.71	<1.667	156.670	1198.36	546.678	<1.667	44.168
ARM-1	ref	2	1	7	F39	<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-35387	ccc	2	1	8	F19	25.2	<1.00	6.61	<1.00	97.3	<1.00	39.4	42.001	<1.667	11.017	<1.667	162.170	<1.667	65.668
EWG-OL-4099	ccc	2	1	9	F22	55.7	1.73	<1.00	23.0	28.7	<1.00	14.4	92.835	2.883	<1.667	38.334	47.834	<1.667	24.000
blank	ref	2	1	10	F49	<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
std soln	ref	2	1	11	std-f1-2	20.1	<1.00	9.92	9.62	81.7	<1.00	50.7	20.100	<1.000	9.920	9.620	81.700	<1.000	50.700

Shaded rows indicate PCT vessels with water loss issues.

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	2	1	12	F44	18.7	<1.00	<1.00	6.63	54.6	<1.00	36.6	311.667	<16.667	<16.667	110.500	910.002	<16.667	610.001
EWG-OL-3388	quenched	2	1	13	F36	780	<1.00	131	<1.00	1320	4.20	9.21	1300.03	<1.667	218.338	<1.667	2200.04	7.000	15.350
EWG-OL-33694	ccc	2	1	14	F24	20.1	<1.00	3.50	<1.00	10.3	<1.00	18.8	33.501	<1.667	5.833	<1.667	17.167	<1.667	31.334
EWG-OL-33858	quenched	2	1	15	F40	8.18	<1.00	4.67	8.15	8.24	<1.00	22.7	13.634	<1.667	7.783	13.584	13.734	<1.667	37.834
EWG-OL-4099	quenched	2	1	16	F50	49.7	1.72	<1.00	20.8	26.4	<1.00	13.5	82.835	2.867	<1.667	34.667	44.001	<1.667	22.500
EWG-OL-33858	ccc	2	1	17	F28	63.4	<1.00	20.5	23.1	25.7	<1.00	20.7	105.669	<1.667	34.167	38.501	42.834	<1.667	34.501
EWG-OL-3388	ccc	2	1	18	F20	868	<1.00	140	<1.00	1410	3.85	9.97	1446.70	<1.667	233.338	<1.667	2350.05	6.417	16.617
EWG-OL-35387	quenched	2	1	19	F16	25.7	<1.00	6.69	<1.00	98.7	<1.00	38.3	42.834	<1.667	11.150	<1.667	164.503	<1.667	63.835
std soln	ref	2	1	20	std-f1-3	21.4	<1.00	10.0	9.65	81.5	<1.00	51.2	21.400	<1.000	10.000	9.650	81.500	<1.000	51.200
std soln	ref	2	2	1	std-f2-1	19.4	<1.00	9.75	9.52	79.8	<1.00	49.9	19.400	<1.000	9.750	9.520	79.800	<1.000	49.900
EWG-OL-4099	quenched	2	2	2	F45	50.0	1.75	<1.00	20.8	26.2	<1.00	13.3	83.335	2.917	<1.667	34.667	43.668	<1.667	22.167
EWG-OL-3388	quenched	2	2	3	F02	763	<1.00	121	<1.00	1240	4.07	9.10	1271.69	<1.667	201.671	<1.667	2066.71	6.783	15.167
EWG-OL-5549	quenched	2	2	4	F32	156	10.1	55.4	<1.00	332	<1.00	4.73	260.005	16.834	92.335	<1.667	553.344	<1.667	7.883
EWG-OL-33694	ccc	2	2	5	F03	19.7	<1.00	3.48	<1.00	10.4	<1.00	18.6	32.834	<1.667	5.800	<1.667	17.334	<1.667	31.001
EWG-OL-38081	quenched	2	2	6	F11	7.68	<1.00	4.22	10.3	12.9	<1.00	35.4	12.800	<1.667	7.033	17.167	21.500	<1.667	59.001
EWG-OL-35387	ccc	2	2	7	F17	23.5	<1.00	6.22	<1.00	90.8	<1.00	36.7	39.167	<1.667	10.367	<1.667	151.336	<1.667	61.168
EWG-OL-38081	ccc	2	2	8	F15	1160	<1.00	91.2	695	320	<1.00	25.3	1933.37	<1.667	152.003	1158.36	533.344	<1.667	42.168
ARM-1	ref	2	2	9	F07	<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
EA	ref	2	2	10	F30	18.7	<1.00	<1.00	6.29	50.6	<1.00	34.4	311.667	<16.667	<16.667	104.834	843.335	<16.667	573.334
std soln	ref	2	2	11	std-f2-2	20.5	<1.00	9.57	9.40	79.4	<1.00	49.0	20.500	<1.000	9.570	9.400	79.400	<1.000	49.000
EWG-OL-4099	ccc	2	2	12	F31	55.1	1.80	<1.00	22.5	28.4	<1.00	14.1	91.835	3.000	<1.667	37.501	47.334	<1.667	23.500
EWG-OL-33858	quenched	2	2	13	F04	8.83	<1.00	4.86	8.69	8.83	<1.00	24.0	14.717	<1.667	8.100	14.484	14.717	<1.667	40.001
EWG-OL-5549	ccc	2	2	14	F42	202	13.0	70.3	<1.00	427	<1.00	4.56	336.673	21.667	117.169	<1.667	711.681	<1.667	7.600
EWG-OL-33694	quenched	2	2	15	F23	47.2	<1.00	5.46	<1.00	23.5	<1.00	16.9	78.668	<1.667	9.100	<1.667	39.167	<1.667	28.167
EWG-OL-33858	ccc	2	2	16	F43	61.7	<1.00	20.2	22.5	25.4	<1.00	20.1	102.835	<1.667	33.667	37.501	42.334	<1.667	33.501
EWG-OL-35387	quenched	2	2	17	F14	22.4	<1.00	6.22	<1.00	92.9	<1.00	35.5	37.334	<1.667	10.367	<1.667	154.836	<1.667	59.168
EWG-OL-3388	ccc	2	2	18	F25	912	<1.00	137	<1.00	1450	3.83	10.3	1520.03	<1.667	228.338	<1.667	2416.72	6.383	17.167
std soln	ref	2	2	19	std-f2-3	22.1	<1.00	9.65	9.51	80.4	<1.00	49.5	22.100	<1.000	9.650	9.510	80.400	<1.000	49.500
std soln	ref	2	3	1	std-f3-1	20.1	<1.00	10.4	10.0	81.6	<1.00	50.7	20.100	<1.000	10.400	10.000	81.600	<1.000	50.700
EWG-OL-33858	quenched	2	3	2	F33	8.72	1.02	5.32	8.65	8.92	<1.00	23.4	14.534	1.700	8.867	14.417	14.867	<1.667	39.001
EWG-OL-5549	ccc	2	3	3	F41	200	13.0	69.8	<1.00	420	<1.00	5.35	333.340	21.667	116.336	<1.667	700.014	<1.667	8.917
EWG-OL-3388	ccc	2	3	4	F08	845	1.00	136	<1.00	1420	4.39	10.8	1408.36	1.667	226.671	<1.667	2366.71	7.317	18.000
EWG-OL-4099	quenched	2	3	5	F47	51.9	2.39	<1.00	21.3	27.2	<1.00	13.7	86.502	3.983	<1.667	35.501	45.334	<1.667	22.834
EWG-OL-33694	quenched	2	3	6	F26	44.1	1.03	5.95	<1.00	23.3	<1.00	17.3	73.501	1.717	9.917	<1.667	38.834	<1.667	28.834
EWG-OL-38081	ccc	2	3	7	F37	1200	<1.00	92.0	701	324	<1.00	26.1	2000.04	<1.667	153.336	1168.36	540.011	<1.667	43.501
EWG-OL-38081	quenched	2	3	8	F27	10.8	<1.00	4.82	10.5	13.2	<1.00	34.9	18.000	<1.667	8.033	17.500	22.000	<1.667	58.168
EWG-OL-33694	ccc	2	3	9	F29	23.7	<1.00	4.25	<1.00	12.0	<1.00	20.3	39.501	<1.667	7.083	<1.667	20.000	<1.667	33.834
EWG-OL-35387	ccc	2	3	10	F09	21.2	<1.00	5.96	<1.00	74.2	<1.00	34.3	35.334	<1.667	9.934	<1.667	123.669	<1.667	57.168

Shaded rows indicate PCT vessels with water loss issues.

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	2	3	11	std-f3-2	21.2	<1.00	10.2	9.85	79.1	<1.00	49.8	21.200	<1.000	10.200	9.850	79.100	<1.000	49.800
EWG-OL-4099	ccc	2	3	12	F21	53.9	2.20	<1.00	22.8	28.4	<1.00	14.7	89.835	3.667	<1.667	38.001	47.334	<1.667	24.500
EWG-OL-5549	quenched	2	3	13	F06	166	10.8	60.0	<1.00	358	<1.00	5.72	276.672	18.000	100.002	<1.667	596.679	<1.667	9.534
EA	ref	2	3	14	F38	36.1	<1.00	<1.00	11.6	98.8	<1.00	55.7	601.668	<16.667	<16.667	193.334	1646.67	<16.667	928.335
EWG-OL-35387	quenched	2	3	15	F46	24.5	<1.00	7.41	<1.00	97.7	<1.00	38.6	40.834	<1.667	12.350	<1.667	162.837	<1.667	64.335
blank	ref	2	3	16	F05	1.52	<1.00	<1.00	<1.00	1.24	<1.00	<1.00	2.533	<1.667	<1.667	<1.667	2.067	<1.667	<1.667
EWG-OL-3388	quenched	2	3	17	F01	780	<1.00	125	<1.00	1250	4.72	9.52	1300.03	<1.667	208.338	<1.667	2083.38	7.867	15.867
EWG-OL-33858	ccc	2	3	18	F18	65.8	1.12	20.9	23.0	26.0	<1.00	20.6	109.669	1.867	34.834	38.334	43.334	<1.667	34.334
ARM-1	ref	2	3	19	F10	11.3	1.07	<1.00	7.89	20.2	1.06	33.8	18.834	1.783	<1.667	13.150	33.667	1.767	56.334
std soln	ref	2	3	20	std-f3-3	21.5	<1.00	10.6	10.1	82.0	<1.00	50.8	21.500	<1.000	10.600	10.100	82.000	<1.000	50.800

Shaded rows indicate PCT vessels with water loss issues.

Table B-2. PCT Leachate pH Values

Set 1				Set 2			
Identifier	**pH**	**Identifier**	**pH**	**Identifier**	**pH**	**Identifier**	**pH**
Blank-1	6.91	EWG-OL-3122-ccc-3	11.42	Blank-1	6.81	EWG-OL-35387-ccc-3	11.05
Blank-2	6.77	EWG-OL-3122-Q-1	10.78	Blank-2	6.94	EWG-OL-35387-Q-1	11.25
ARM-1-1	10.06	EWG-OL-3122-Q-2	10.75	ARM-1-1	n/a	EWG-OL-35387-Q-2	11.22
ARM-1-2	10.06	EWG-OL-3122-Q-3	10.74	ARM-1-2	10.2	EWG-OL-35387-Q-3	11.14
ARM-1-3	10.07	EWG-OL-3208-ccc-1	12.25	ARM-1-3	n/a	EWG-OL-38081-ccc-1	10.02
EA-1	11.69	EWG-OL-3208-ccc-2	12.21	EA-1	n/a	EWG-OL-38081-ccc-2	10.08
EA-2	11.63	EWG-OL-3208-ccc-3	12.2	EA-2	11.53	EWG-OL-38081-ccc-3	10.05
EA-3	11.63	EWG-OL-3208-Q-1	11.76	EA-3	11.5	EWG-OL-38081-Q-1	10.33
EWG-OL-12707-ccc-1	9.91	EWG-OL-3208-Q-2	11.78	EWG-OL-33694-ccc-1	8.36	EWG-OL-38081-Q-2	10.26
EWG-OL-12707-ccc-2	9.86	EWG-OL-3208-Q-3	11.76	EWG-OL-33694-ccc-2	8.23	EWG-OL-38081-Q-3	10.22
EWG-OL-12707-ccc-3	9.86	EWG-OL-3231-ccc-1	9.76	EWG-OL-33694-ccc-3	8.35	EWG-OL-4099-ccc-1	9.81
EWG-OL-12707-Q-1	9.87	EWG-OL-3231-ccc-2	9.72	EWG-OL-33694-Q-1	8.72	EWG-OL-4099-ccc-2	9.76
EWG-OL-12707-Q-2	9.88	EWG-OL-3231-ccc-3	9.77	EWG-OL-33694-Q-2	8.67	EWG-OL-4099-ccc-3	9.72
EWG-OL-12707-Q-3	9.83	EWG-OL-3231-Q-1	9.82	EWG-OL-33694-Q-3	8.6	EWG-OL-4099-Q-1	9.71
EWG-OL-16450-ccc-1	10.05	EWG-OL-3231-Q-2	9.8	EWG-OL-33858-ccc-1	9.28	EWG-OL-4099-Q-2	9.73
EWG-OL-16450-ccc-2	10.08	EWG-OL-3231-Q-3	9.81	EWG-OL-33858-ccc-2	9.29	EWG-OL-4099-Q-3	9.75
EWG-OL-16450-ccc-3	10.09	EWG-OL-32706-ccc-1	8.72	EWG-OL-33858-ccc-3	9.26	EWG-OL-5549-ccc-1	11.23
EWG-OL-16450-Q-1	10.79	EWG-OL-32706-ccc-2	8.7	EWG-OL-33858-Q-1	9.51	EWG-OL-5549-ccc-2	11.22
EWG-OL-16450-Q-2	10.78	EWG-OL-32706-ccc-3	8.72	EWG-OL-33858-Q-2	9.52	EWG-OL-5549-ccc-3	11.15
EWG-OL-16450-Q-3	10.75	EWG-OL-32706-Q-1	8.75	EWG-OL-33858-Q-3	9.55	EWG-OL-5549-Q-1	11.26
EWG-OL-23401-ccc-1	10.57	EWG-OL-32706-Q-2	8.76	EWG-OL-3388-ccc-1	9.73	EWG-OL-5549-Q-2	11.24
EWG-OL-23401-ccc-2	10.57	EWG-OL-32706-Q-3	8.76	EWG-OL-3388-ccc-2	9.73	EWG-OL-5549-Q-3	11.15
EWG-OL-23401-ccc-3	10.55	EWG-OL-33558-ccc-1	9.09	EWG-OL-3388-ccc-3	9.67		
EWG-OL-23401-Q-1	10.77	EWG-OL-33558-ccc-2	9.1	EWG-OL-3388-Q-1	9.77		
EWG-OL-23401-Q-2	10.73	EWG-OL-33558-ccc-3	9.08	EWG-OL-3388-Q-2	9.74		
EWG-OL-23401-Q-3	10.77	EWG-OL-33558-Q-1	10.11	EWG-OL-3388-Q-3	9.7		
EWG-OL-3122-ccc-1	11.48	EWG-OL-33558-Q-2	10.05	EWG-OL-35387-ccc-1	10.9		
EWG-OL-3122-ccc-2	11.45	EWG-OL-33558-Q-3	10.01	EWG-OL-35387-ccc-2	11.12		

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

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

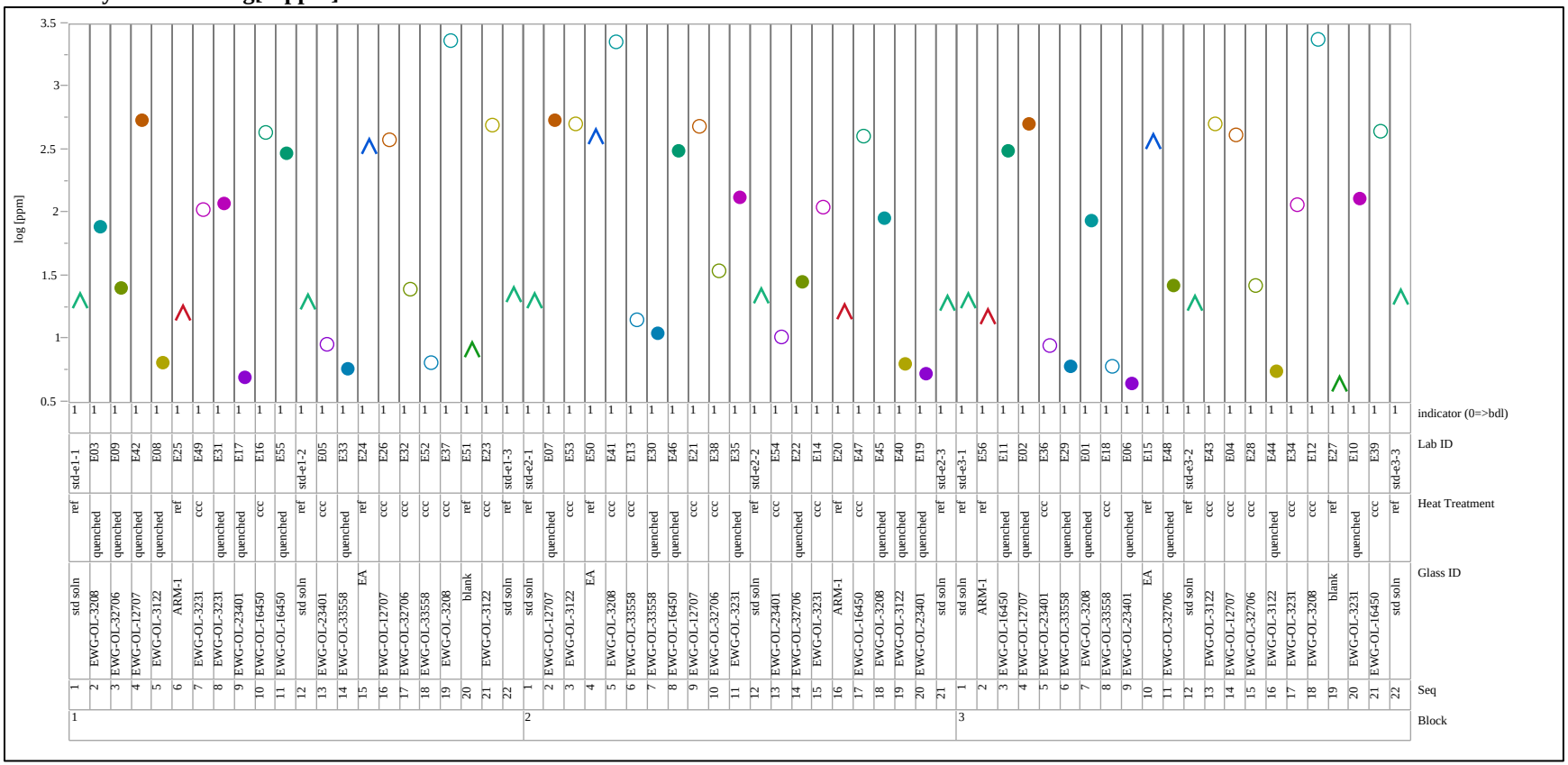


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

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

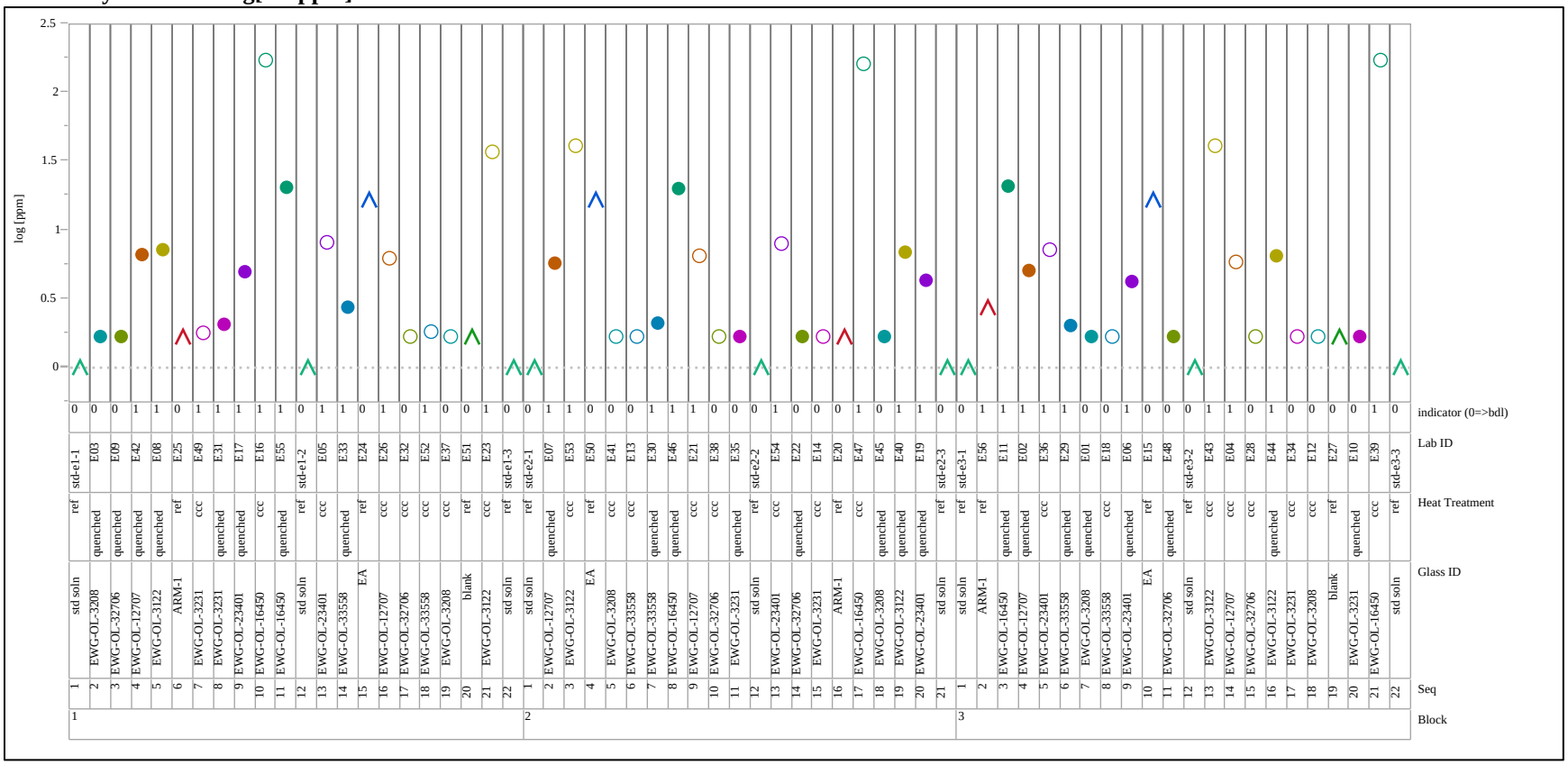


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

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

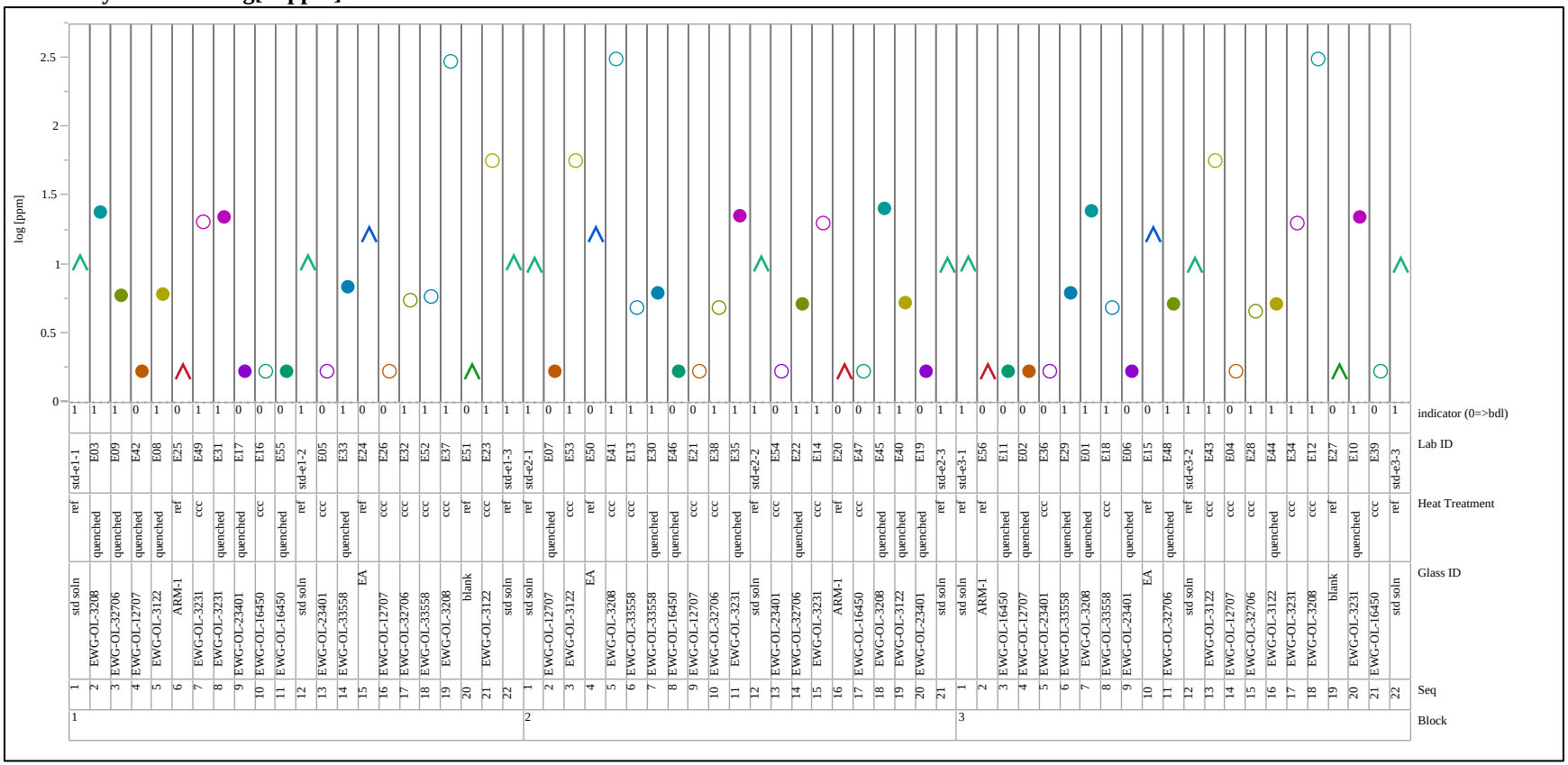


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

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

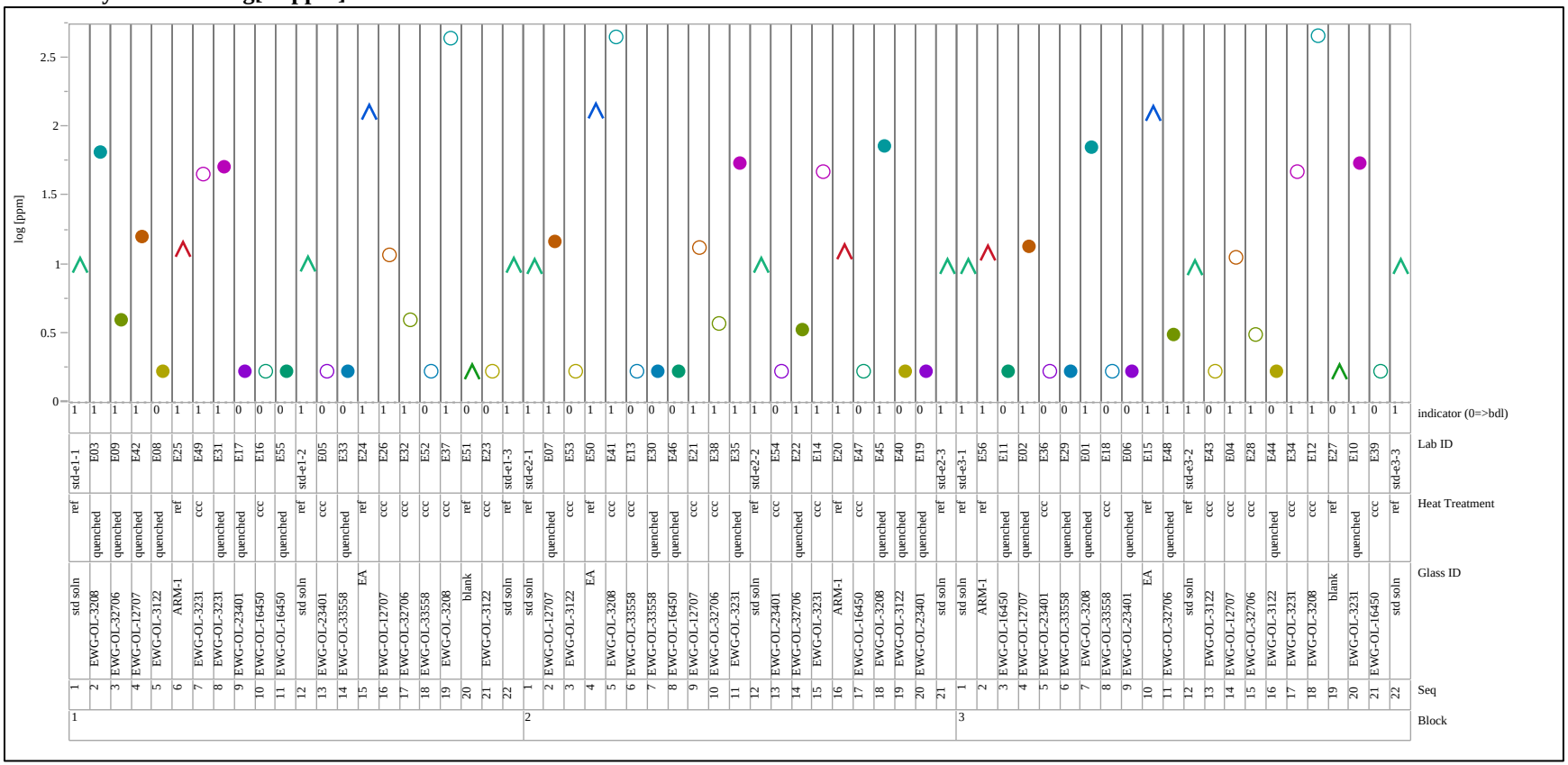


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

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

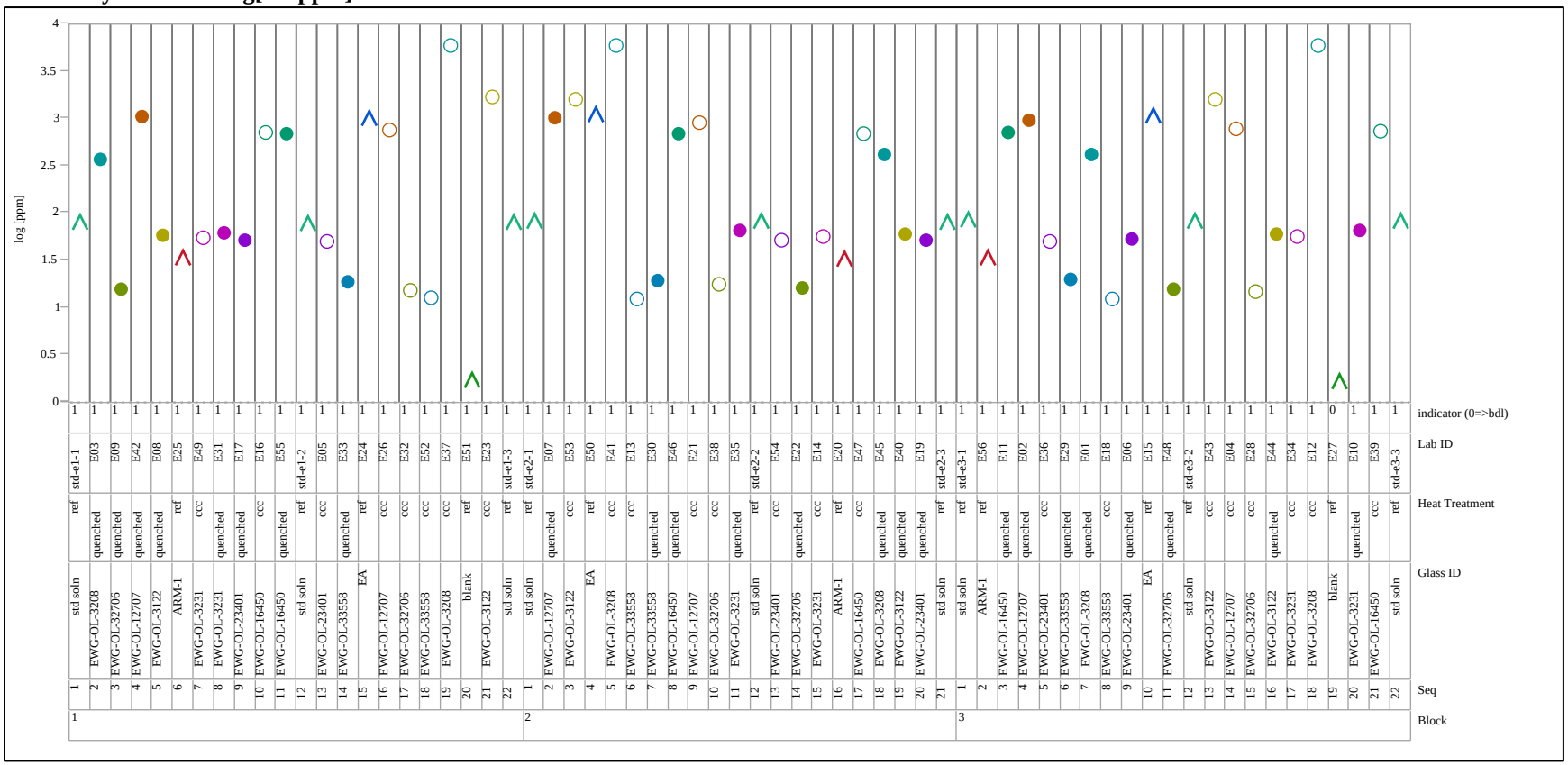


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

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

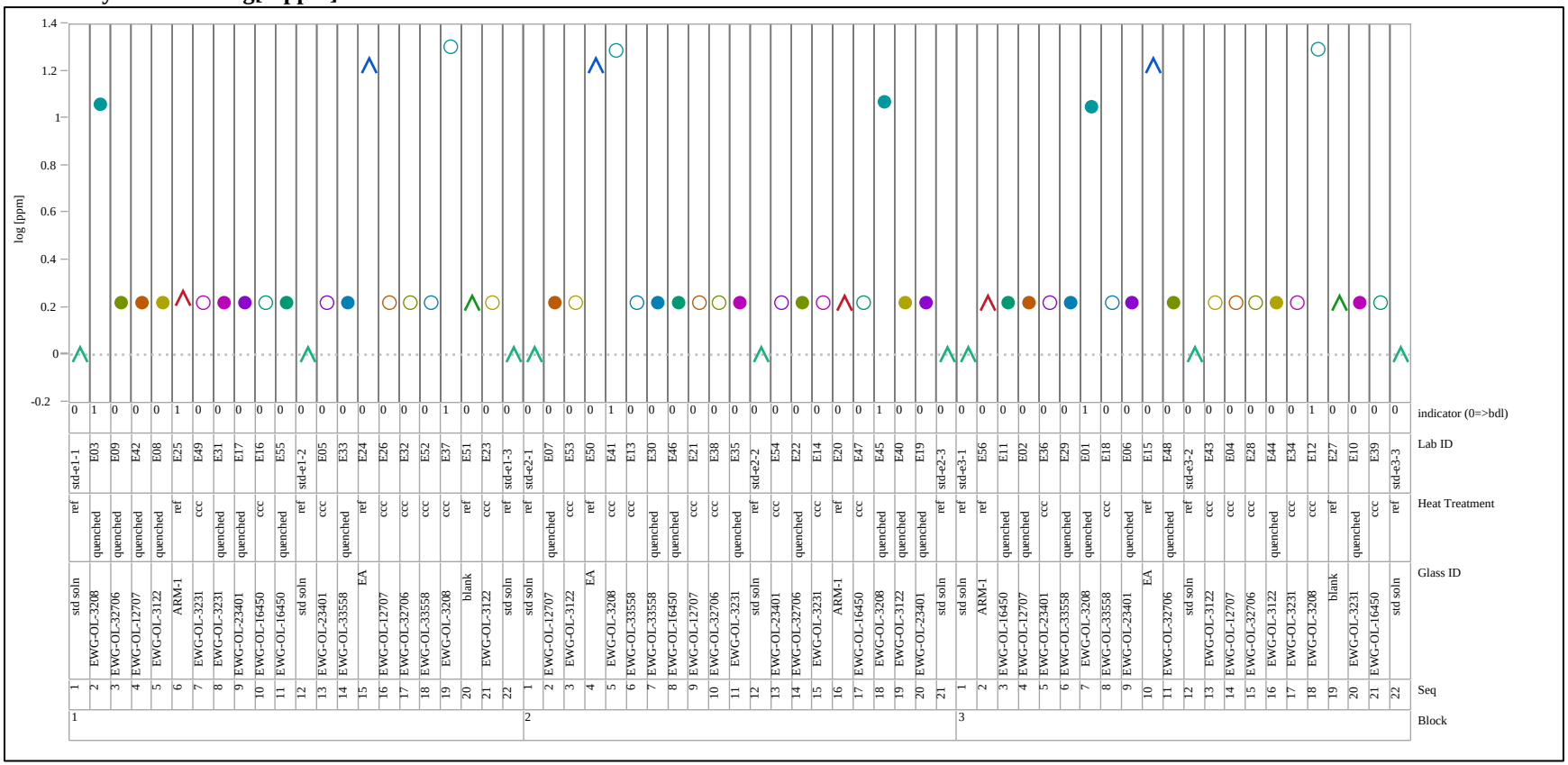


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

Analytical Set=1

Variability Chart for log[Si ppm]

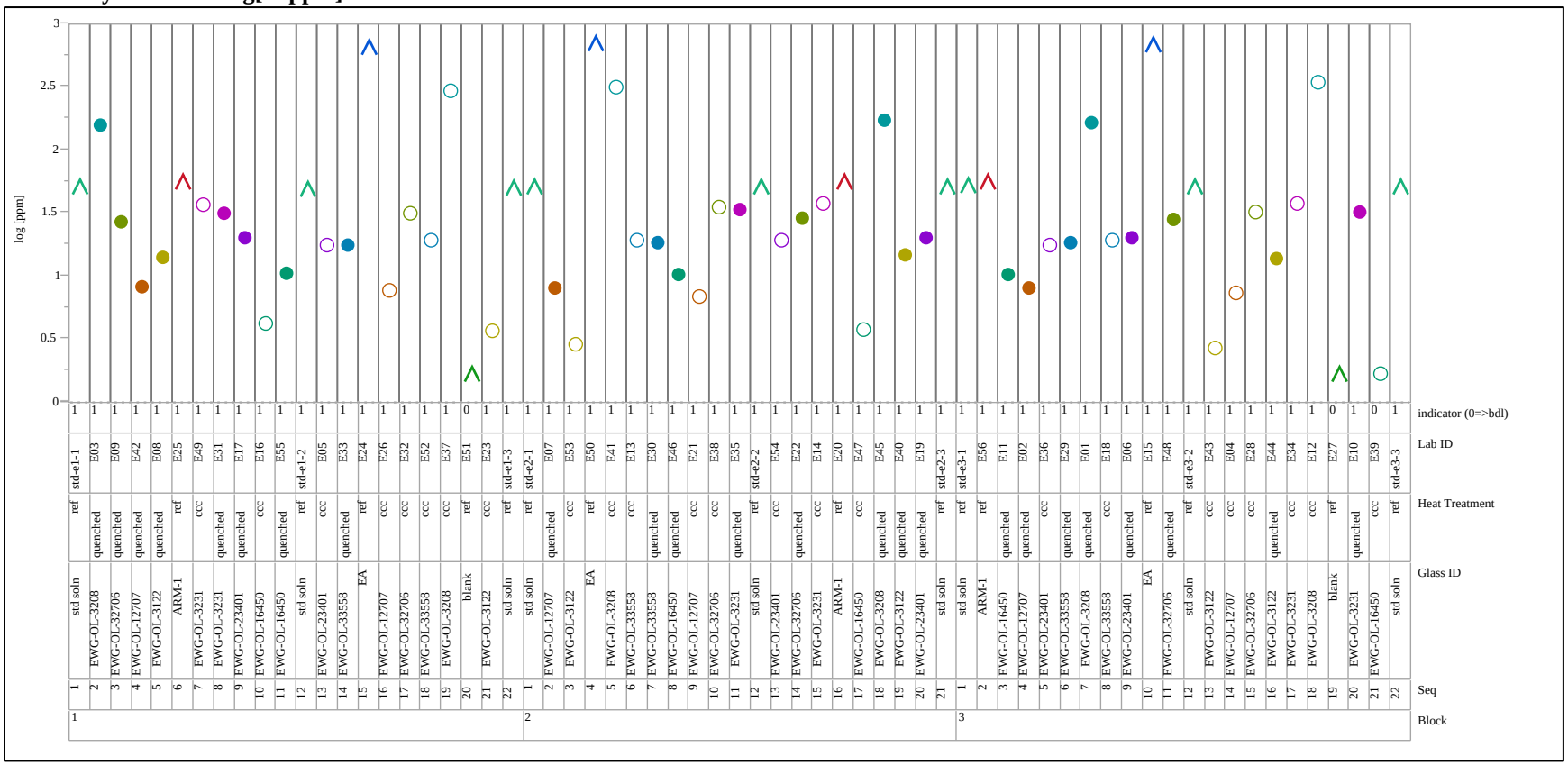


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

Analytical Set=2

Variability Chart for log[B ppm]

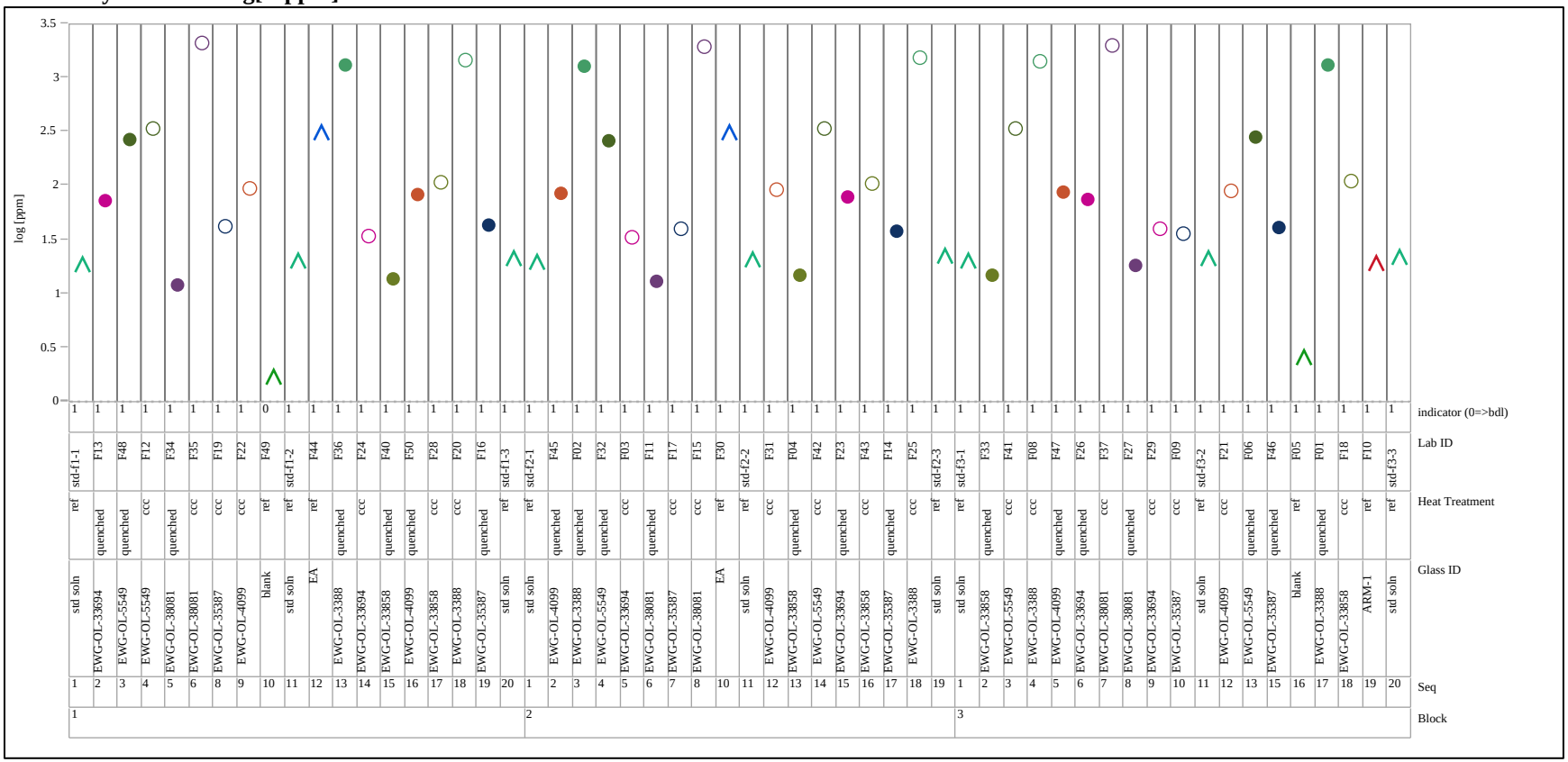


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

Analytical Set=2

Variability Chart for log[Ca ppm]

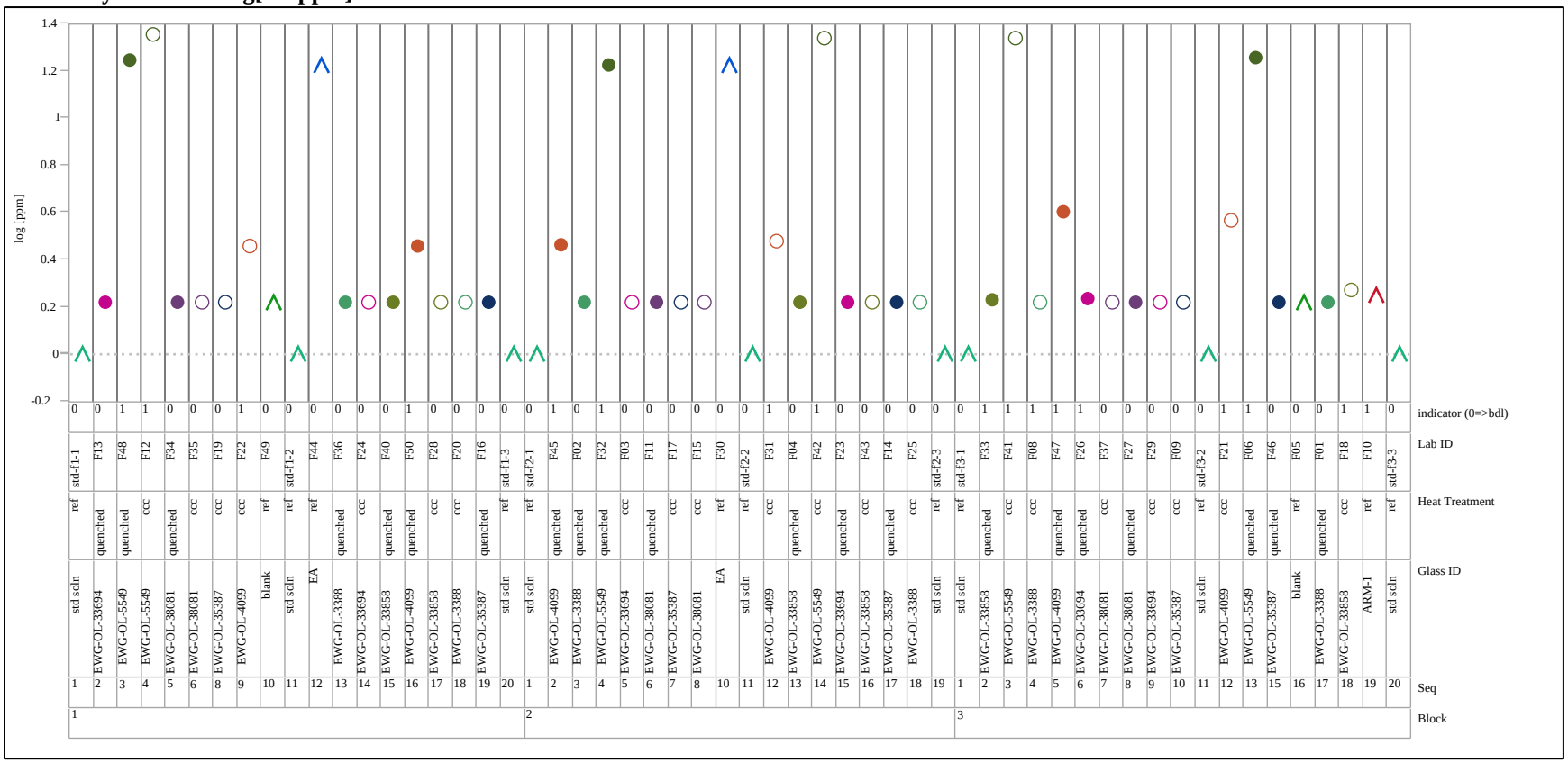


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

Analytical Set=2

Variability Chart for log[K ppm]

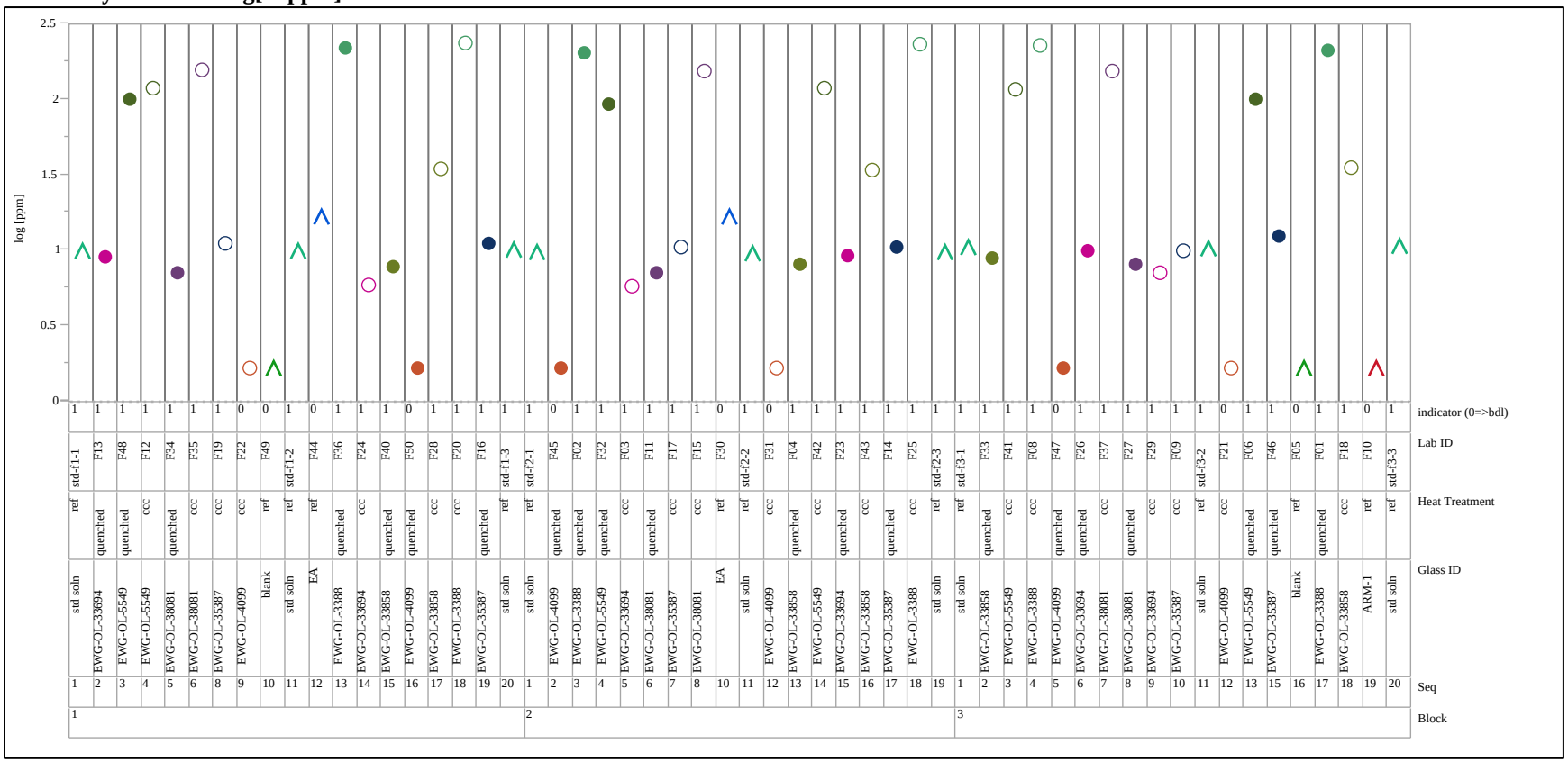


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

Analytical Set=2

Variability Chart for log[Li ppm]

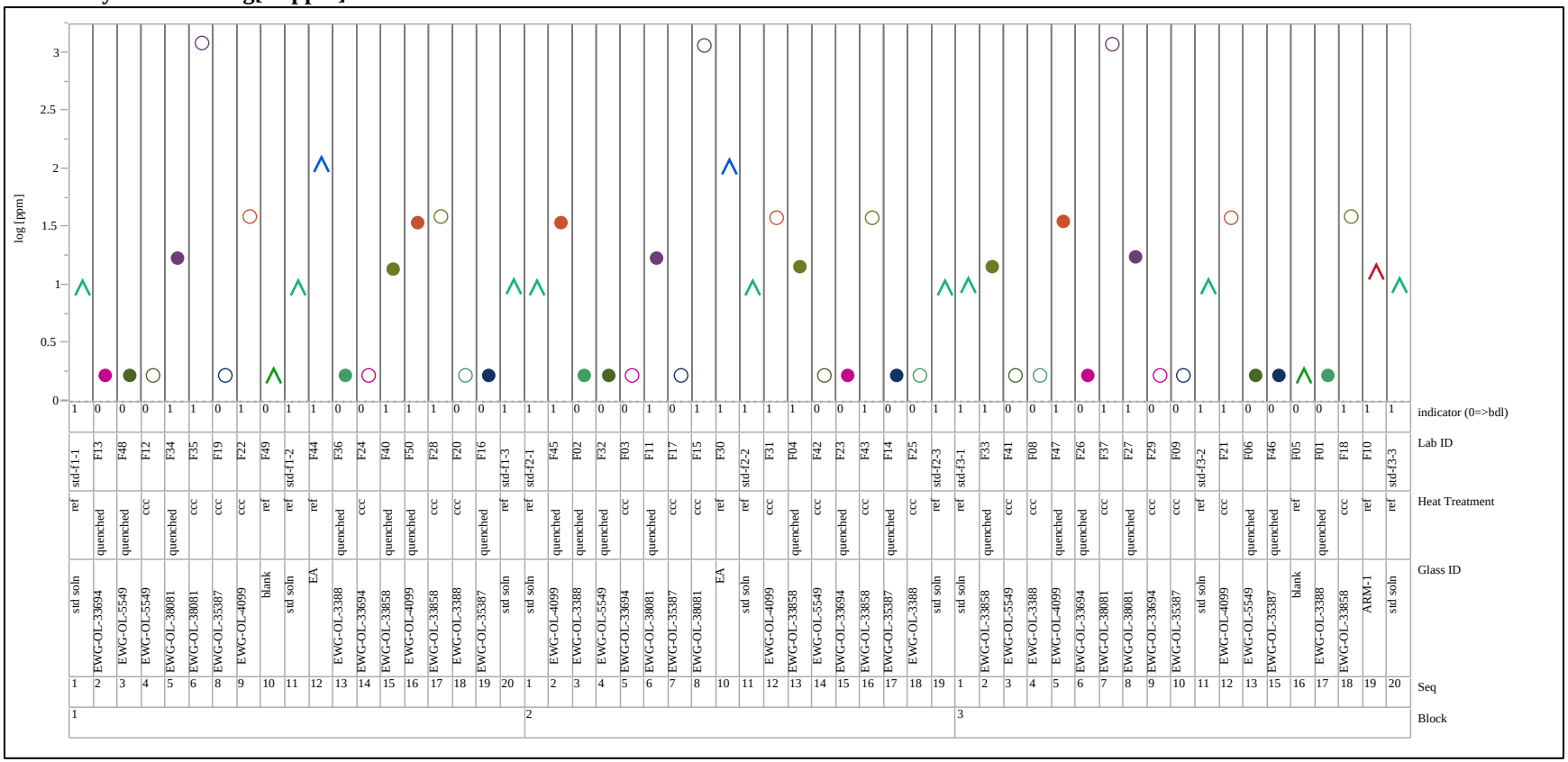


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

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

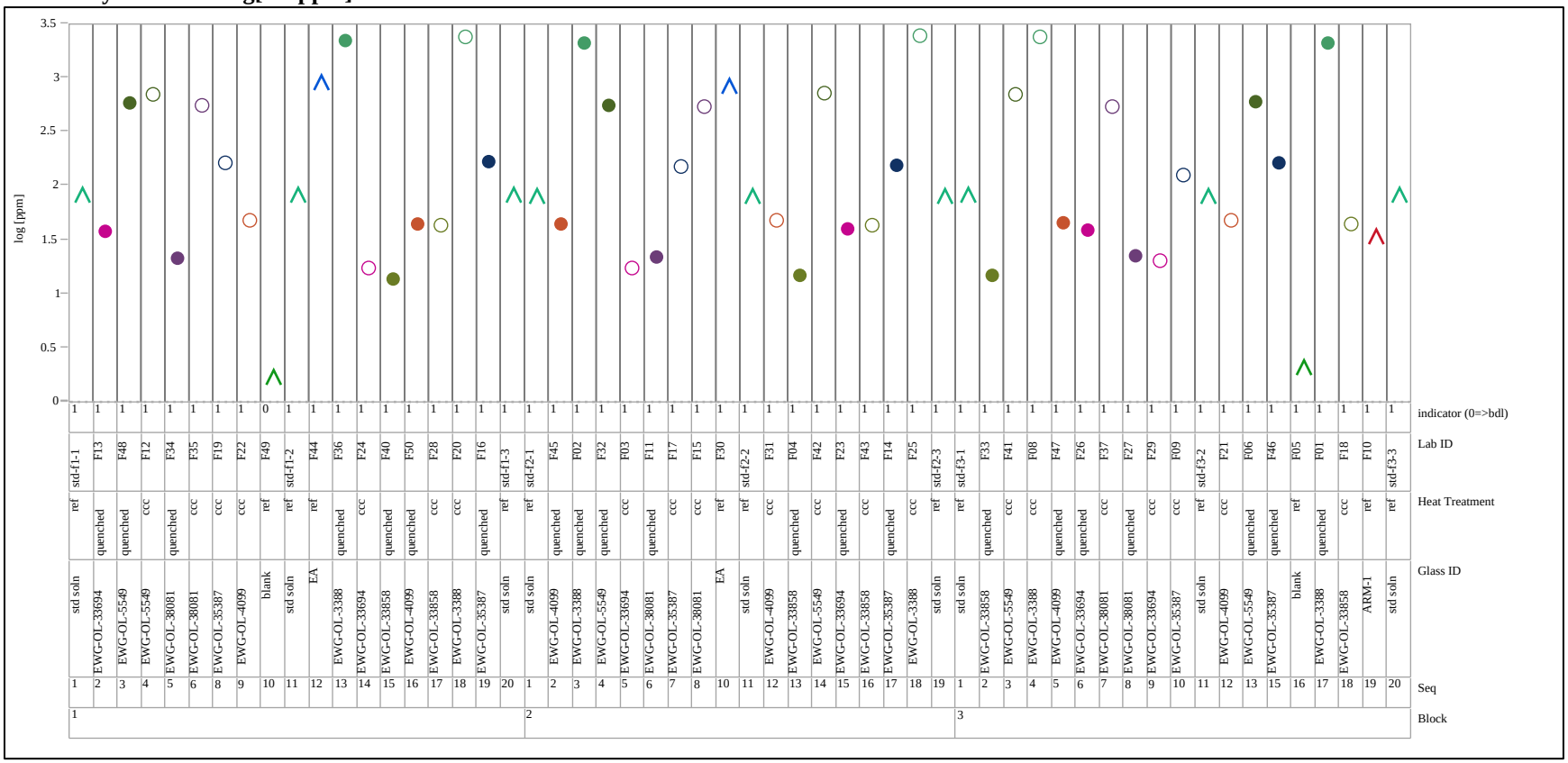


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

Analytical Set=2

Variability Chart for log[P ppm]

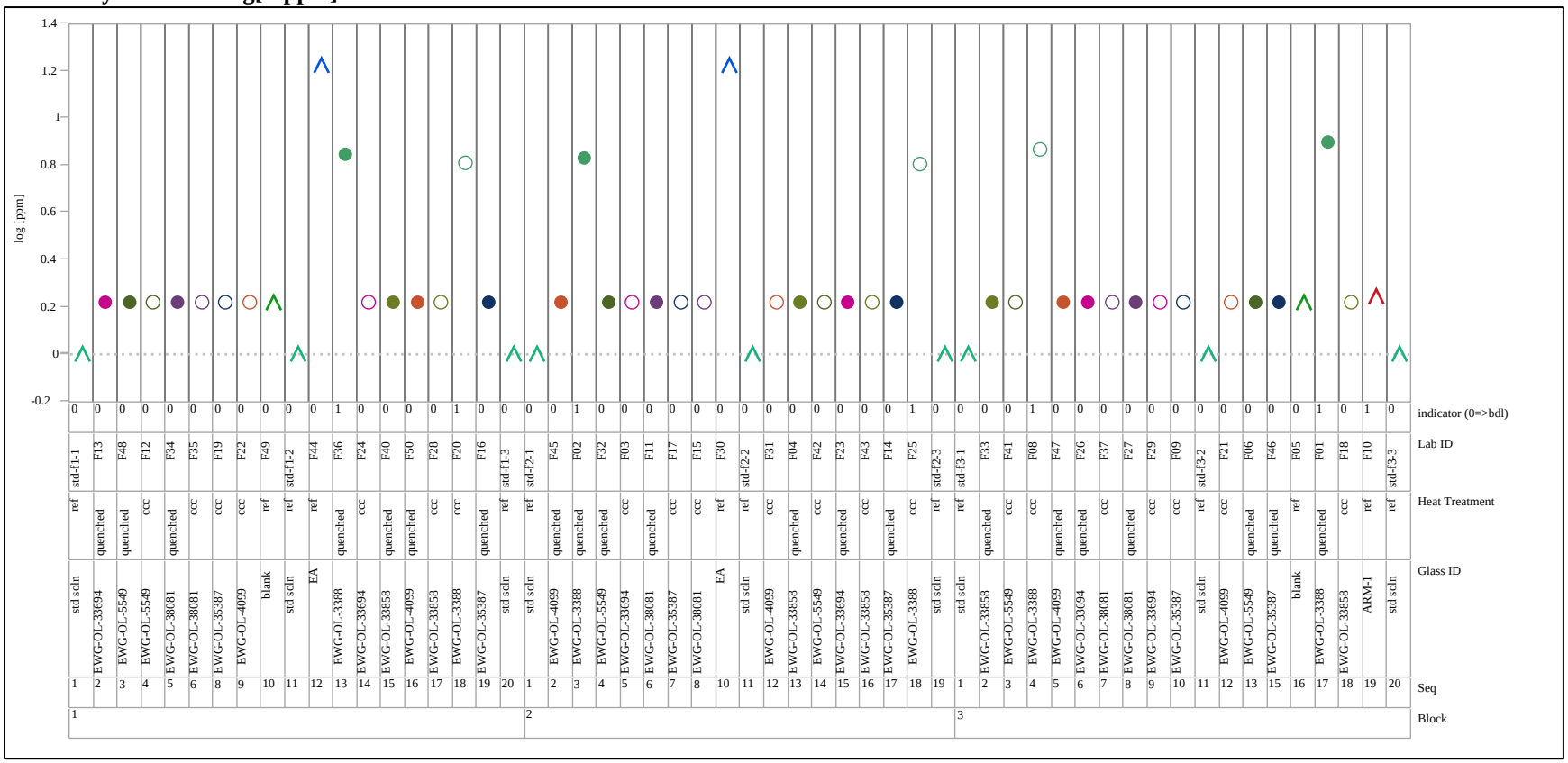


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

Analytical Set=2

Variability Chart for log[Si ppm]

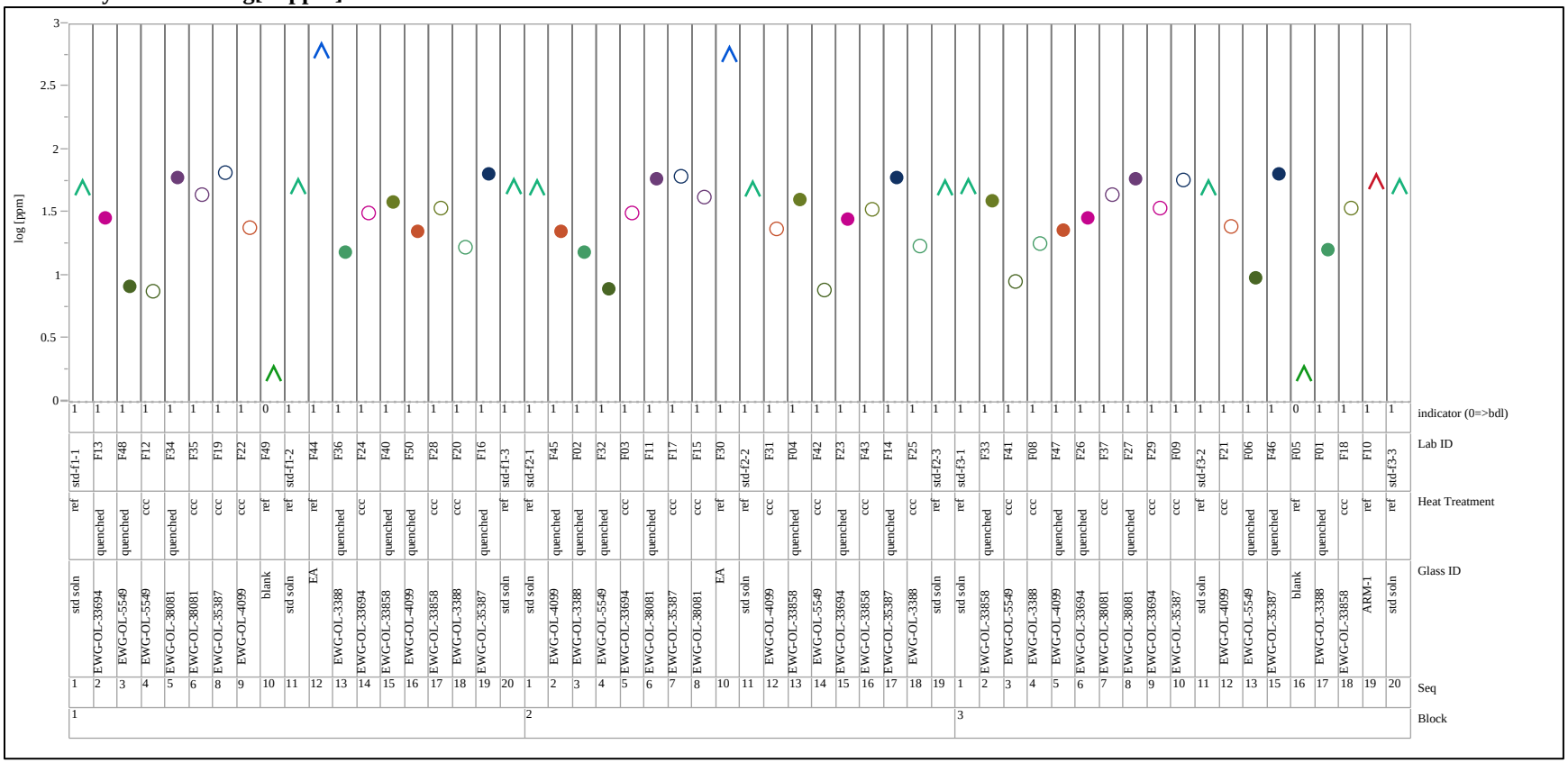


Exhibit B-2. PCT Measurements for Each Glass Grouped by Heat Treatment

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

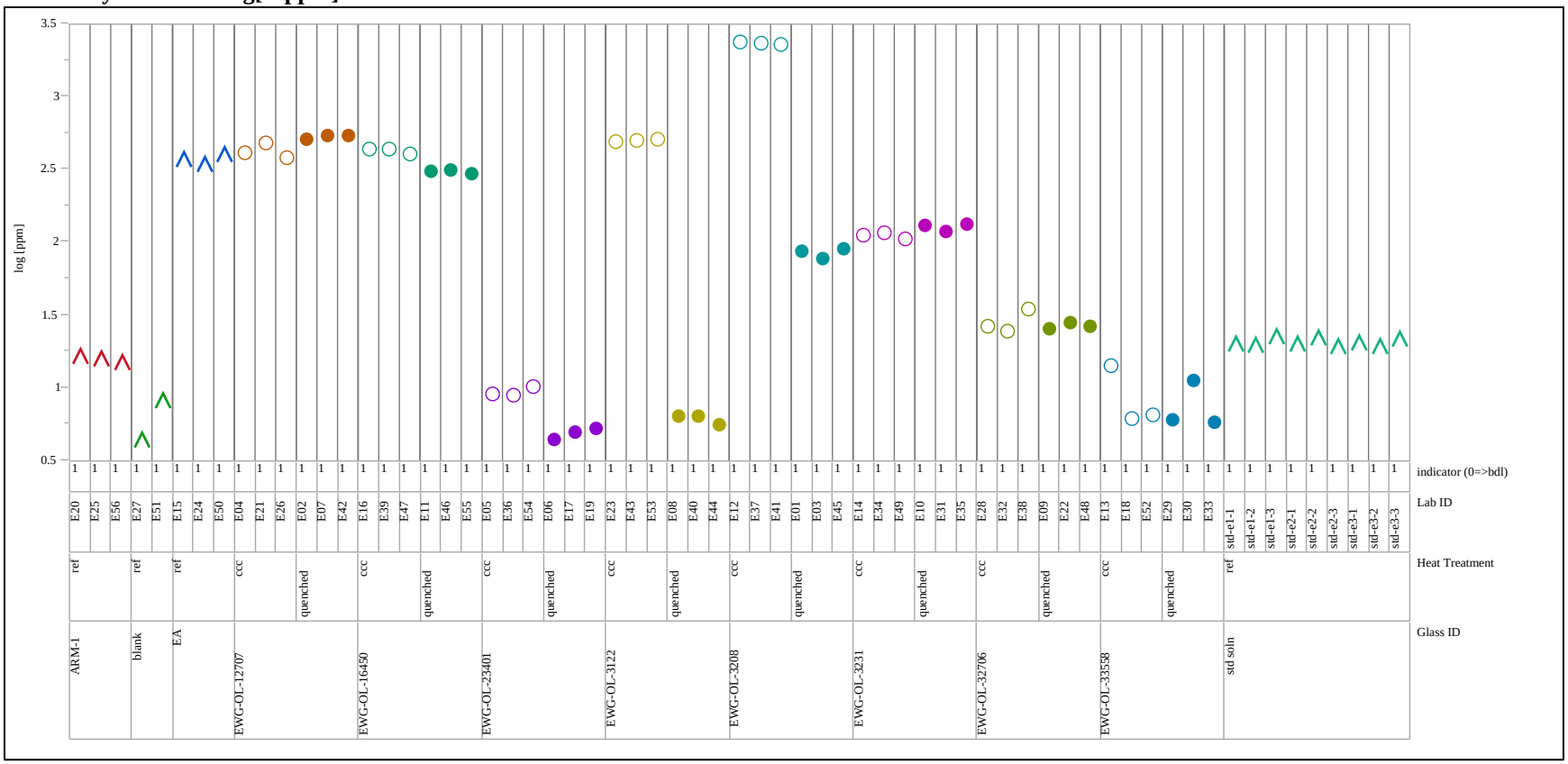


Exhibit B-2. PCT Measurements for Each Glass Grouped by Heat Treatment (continued)

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

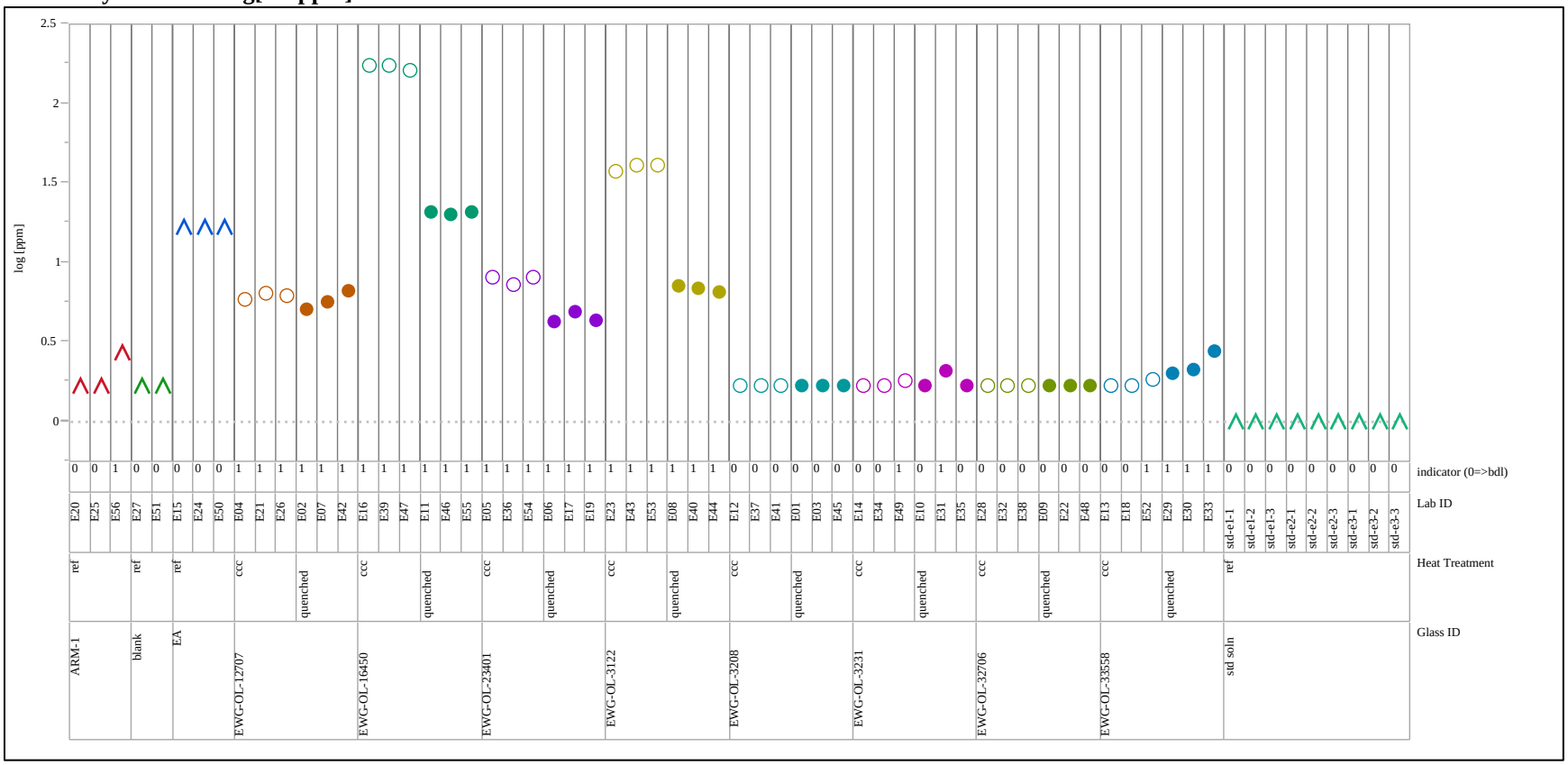


Exhibit B-2. PCT Measurements for Each Glass Grouped by Heat Treatment (continued)

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

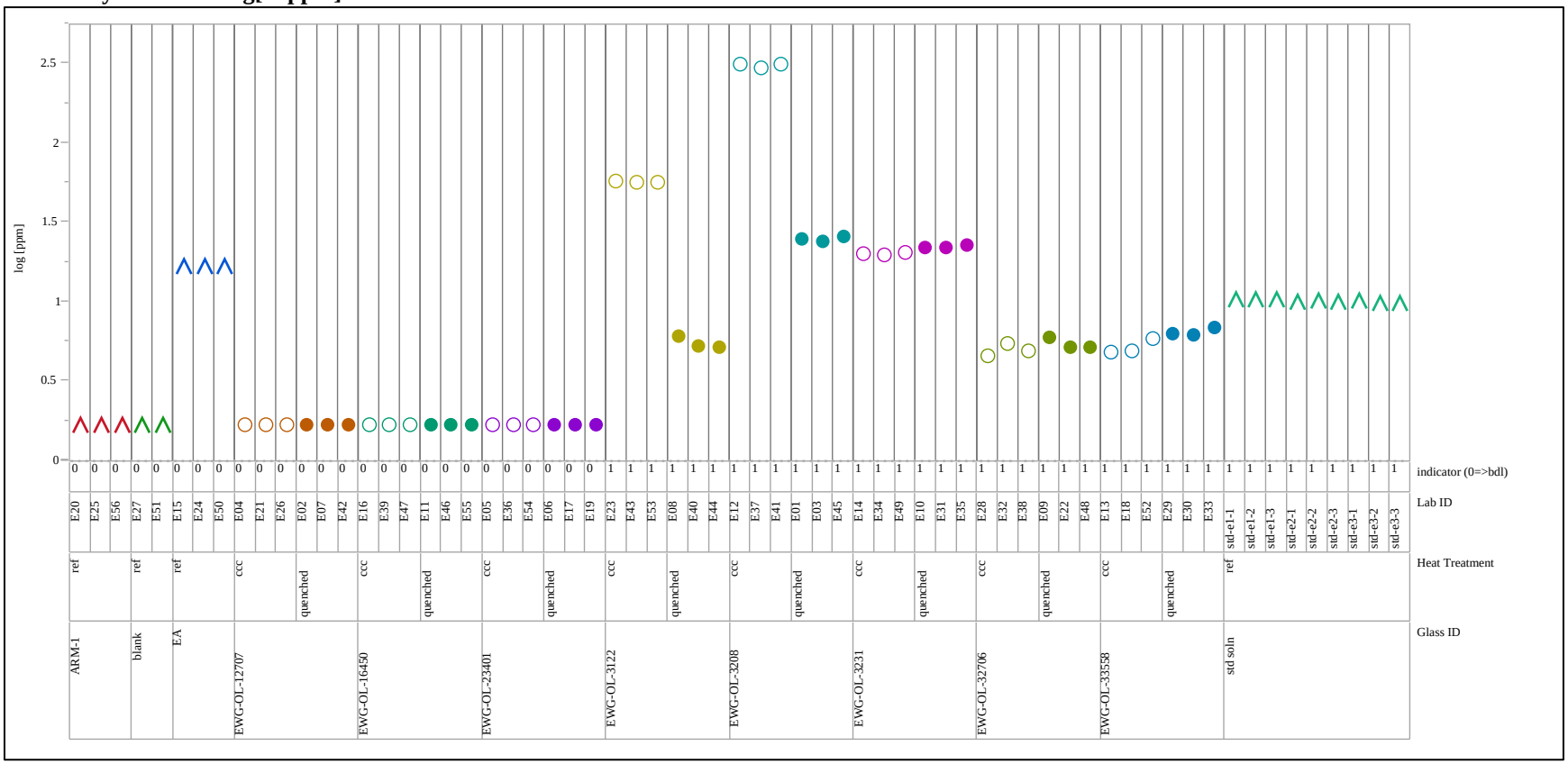


Exhibit B-2. PCT Measurements for Each Glass Grouped by Heat Treatment (continued)

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

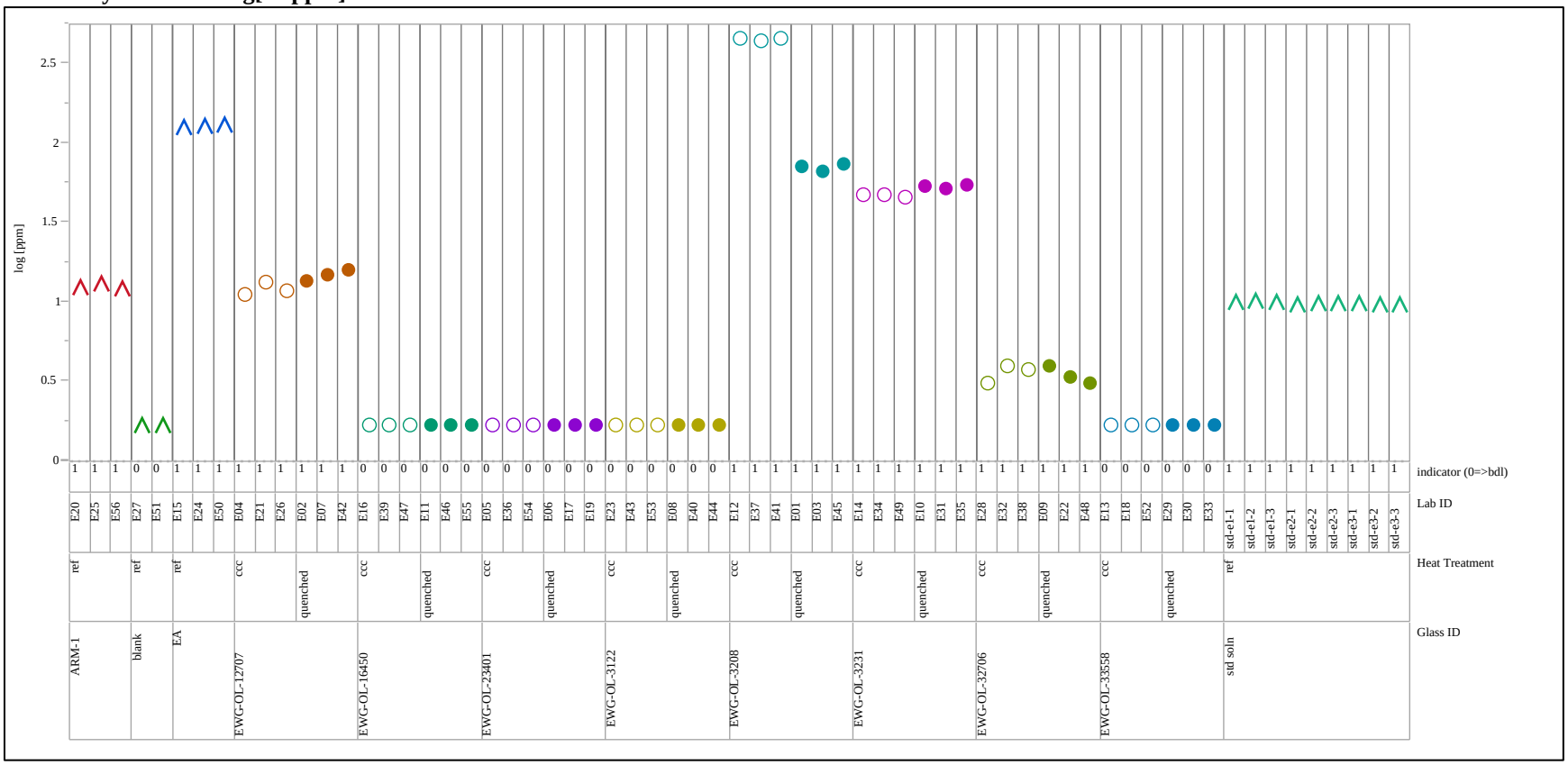


Exhibit B-2. PCT Measurements for Each Glass Grouped by Heat Treatment (continued)

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

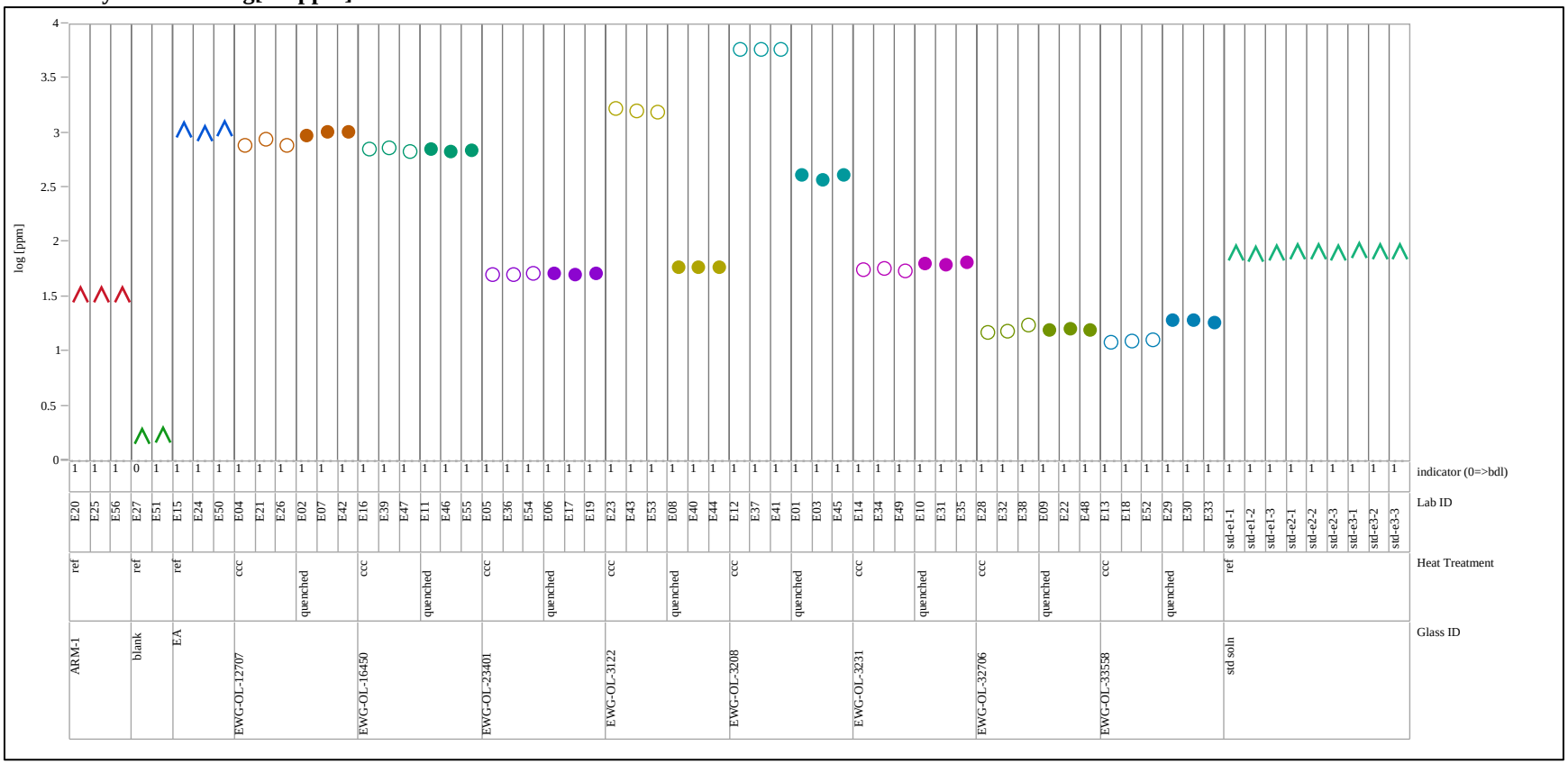


Exhibit B-2. PCT Measurements for Each Glass Grouped by Heat Treatment (continued)

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

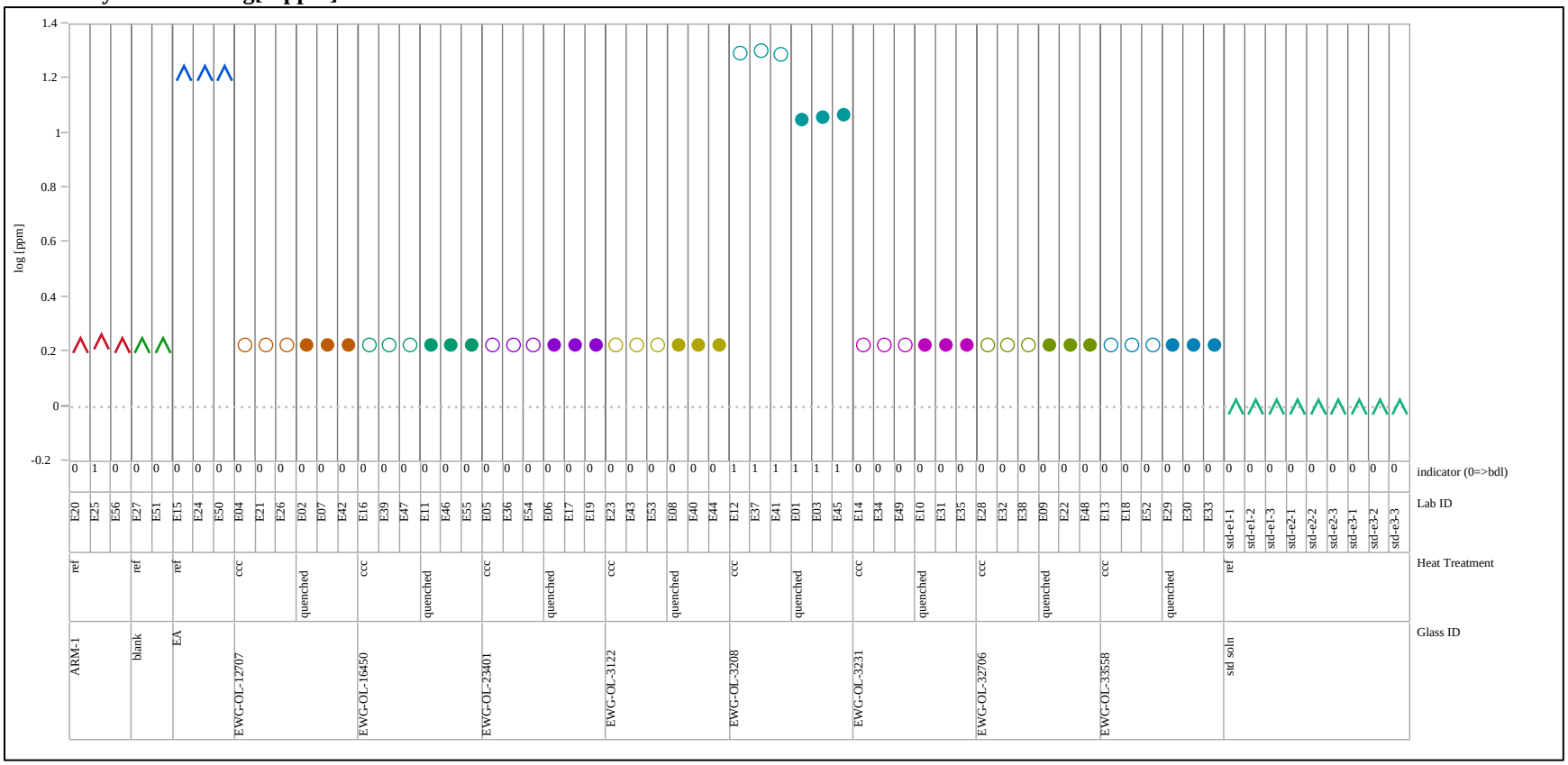


Exhibit B-2. PCT Measurements for Each Glass Grouped by Heat Treatment (continued)

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

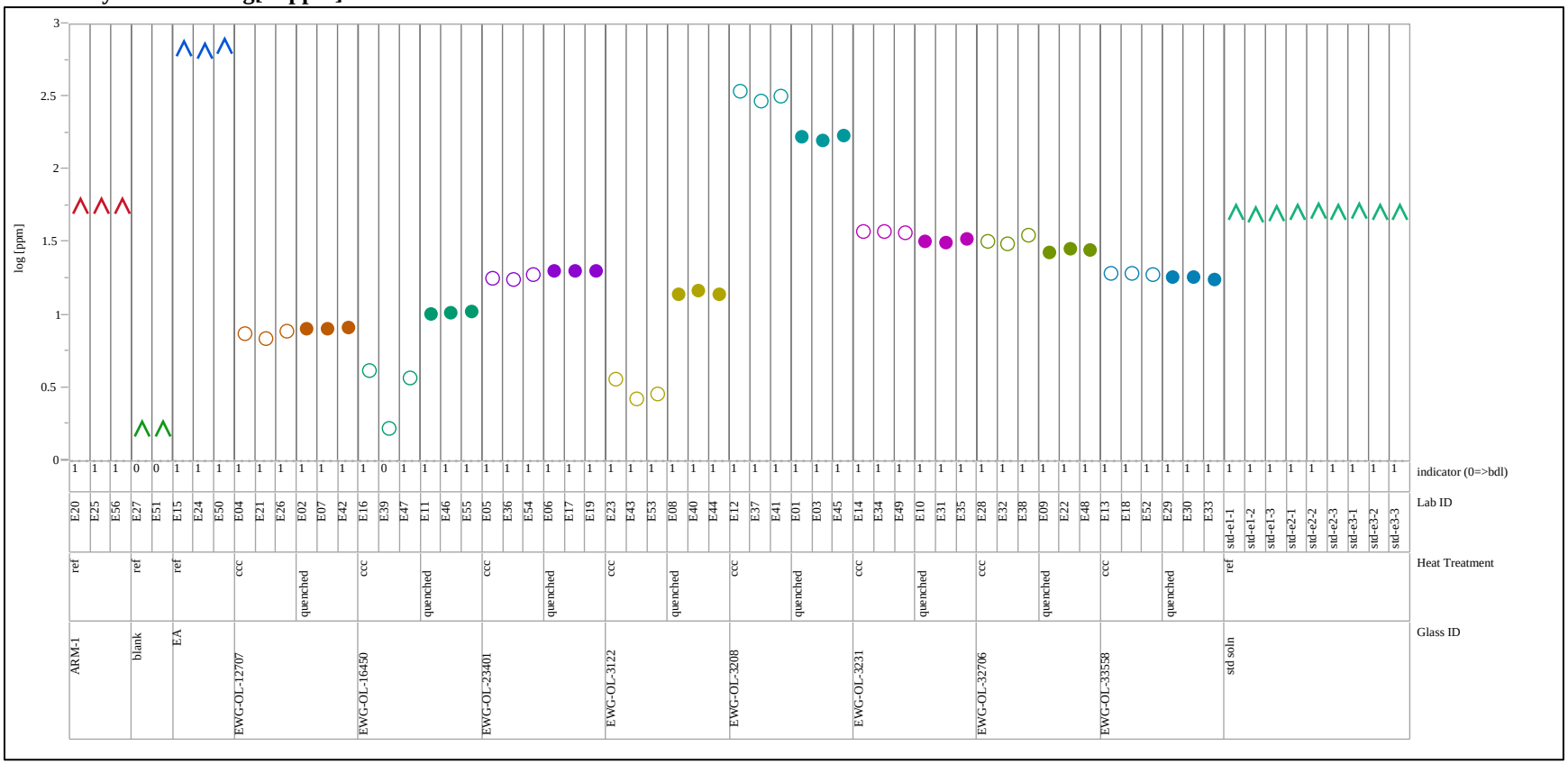


Exhibit B-2. PCT Measurements for Each Glass Grouped by Heat Treatment (continued)

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

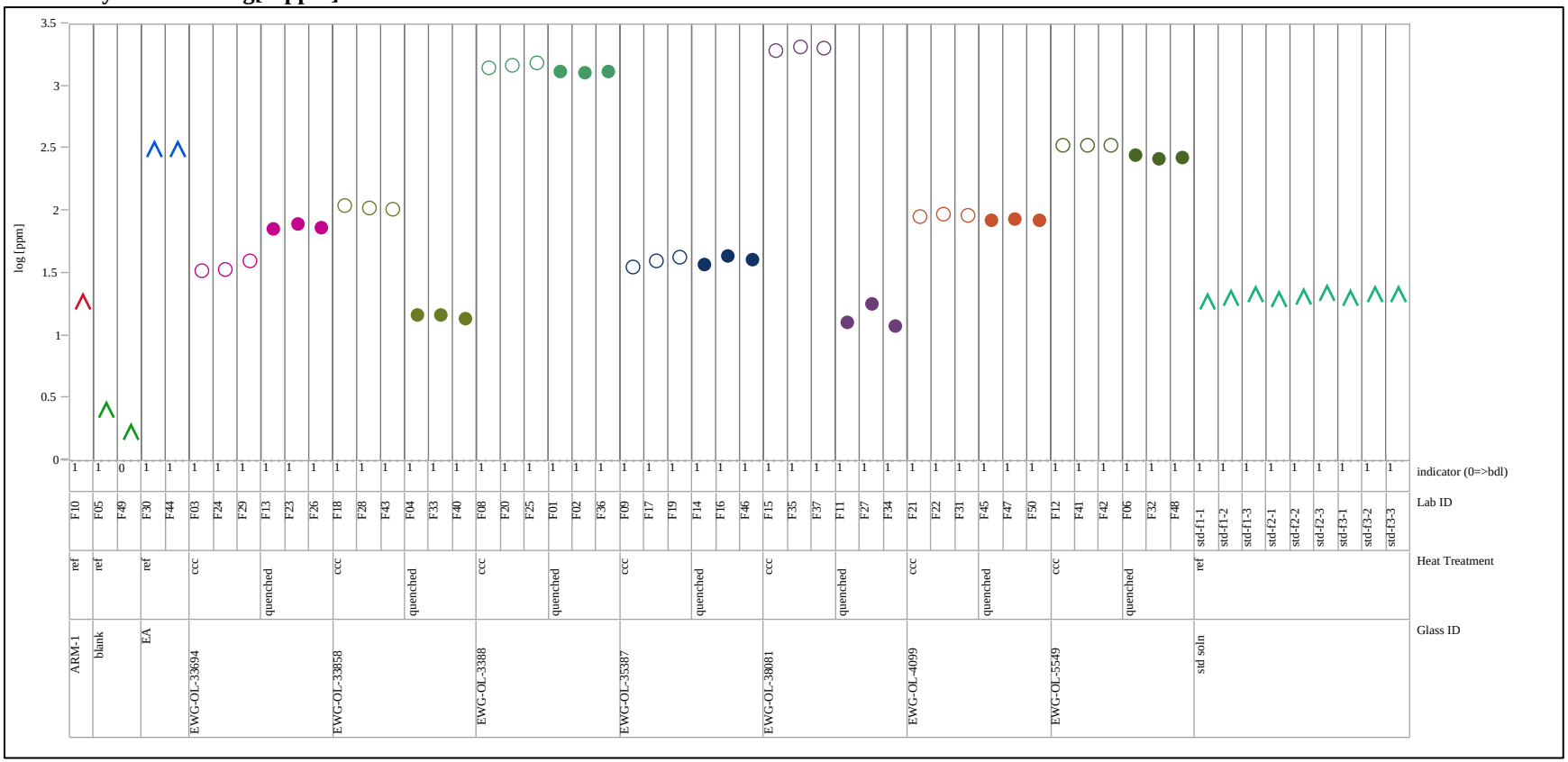


Exhibit B-2. PCT Measurements for Each Glass Grouped by Heat Treatment (continued)

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

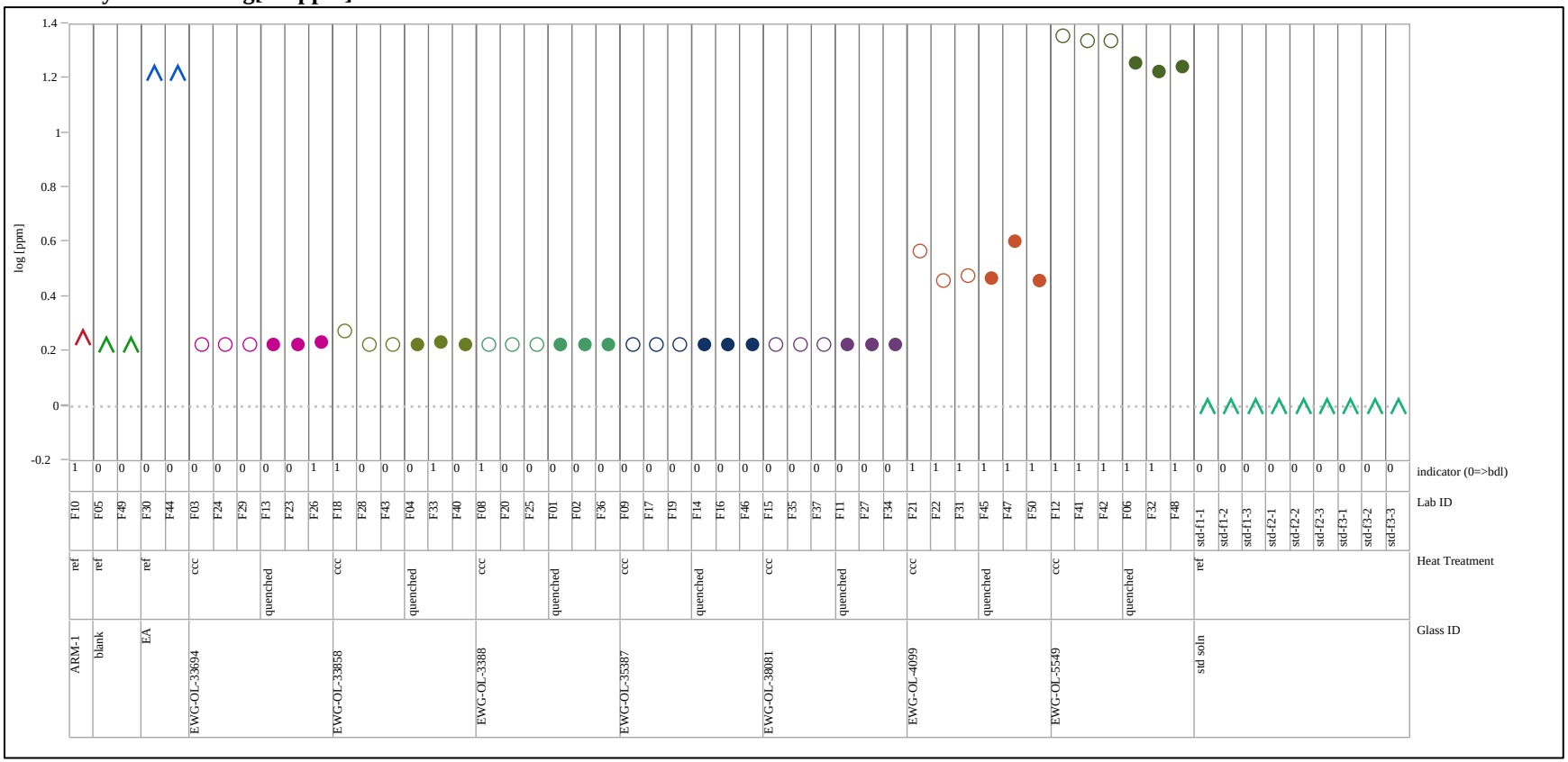


Exhibit B-2. PCT Measurements for Each Glass Grouped by Heat Treatment (continued)

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

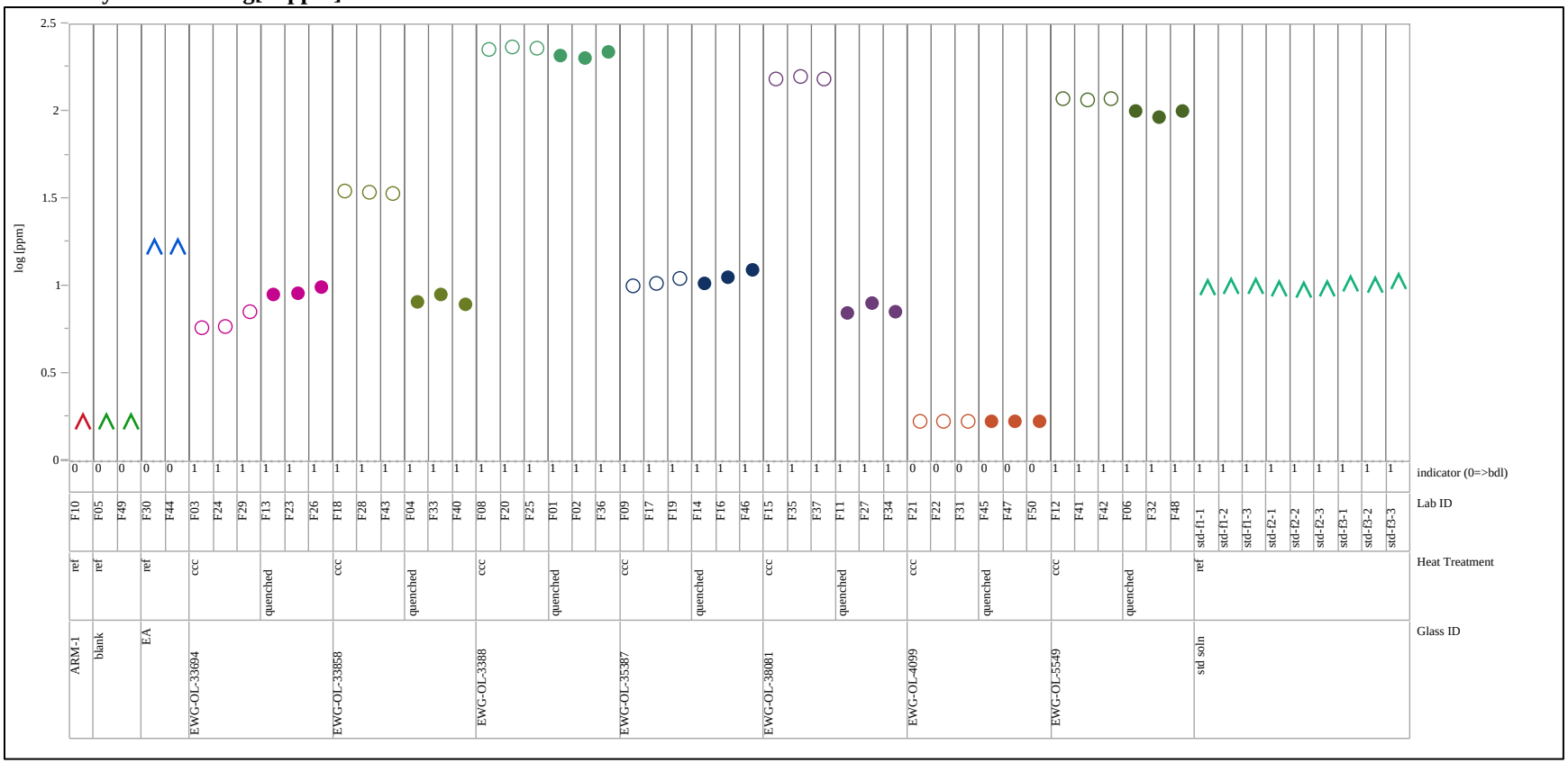


Exhibit B-2. PCT Measurements for Each Glass Grouped by Heat Treatment (continued)

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

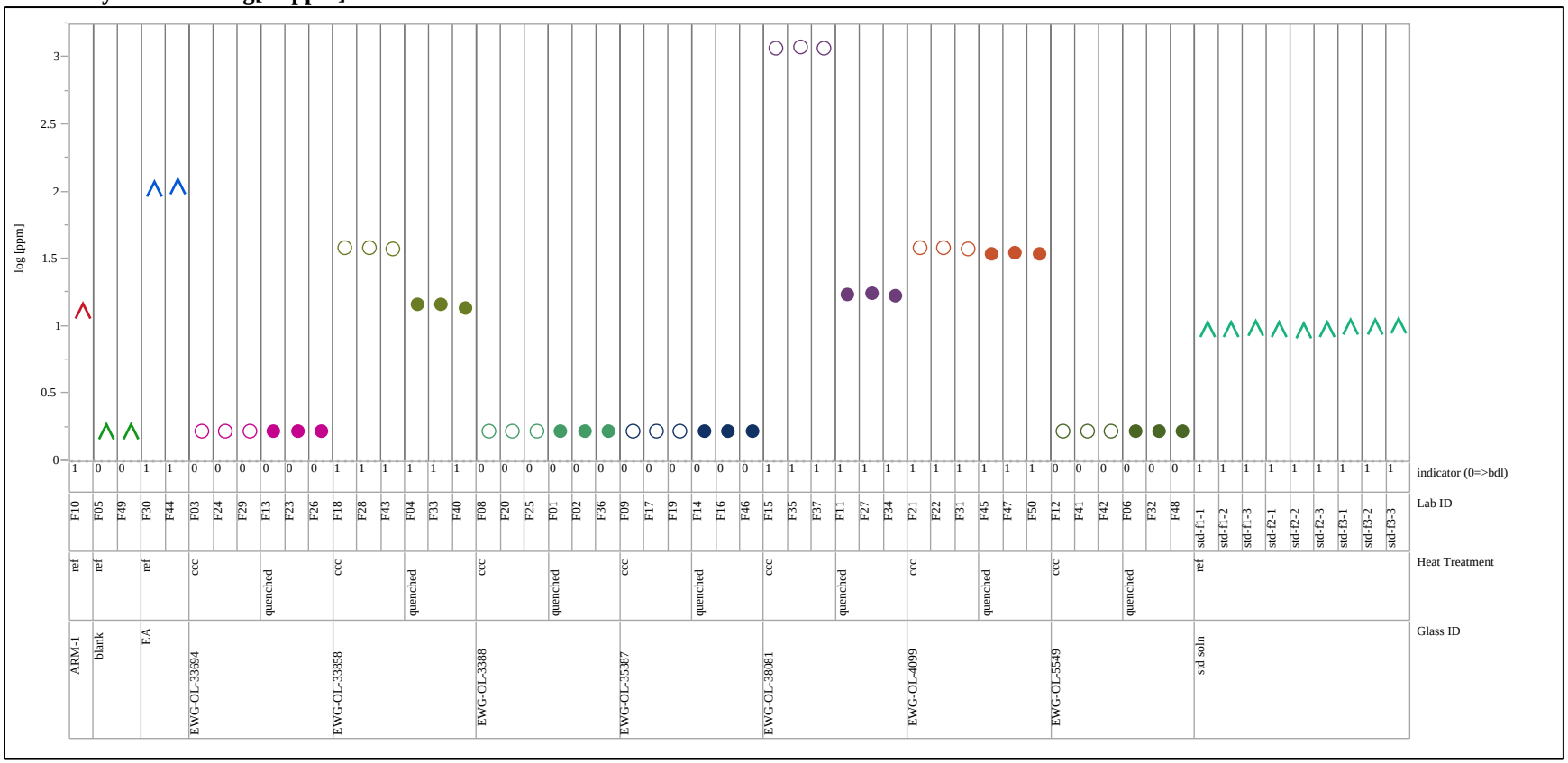


Exhibit B-2. PCT Measurements for Each Glass Grouped by Heat Treatment (continued)

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

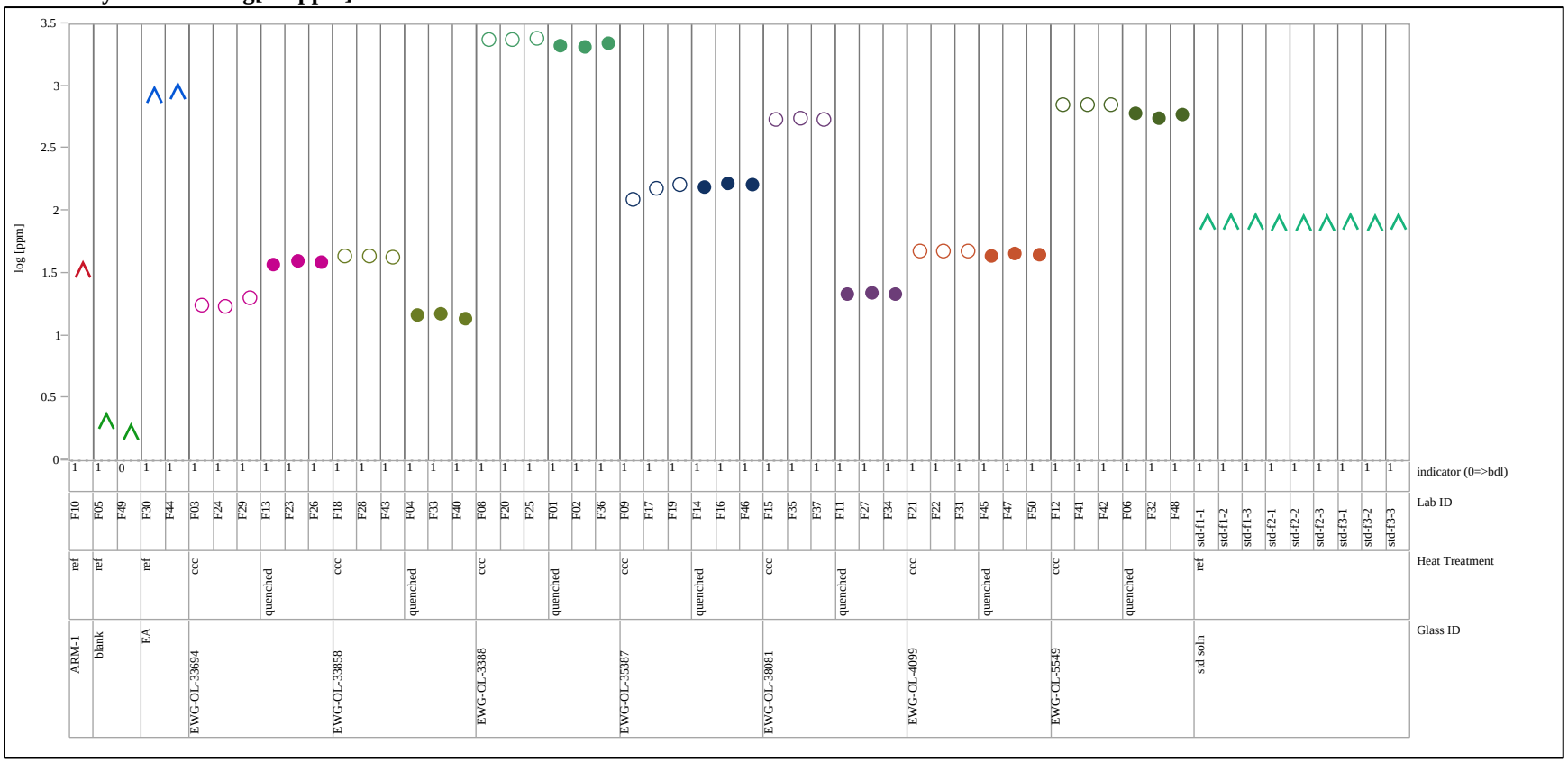


Exhibit B-2. PCT Measurements for Each Glass Grouped by Heat Treatment (continued)

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

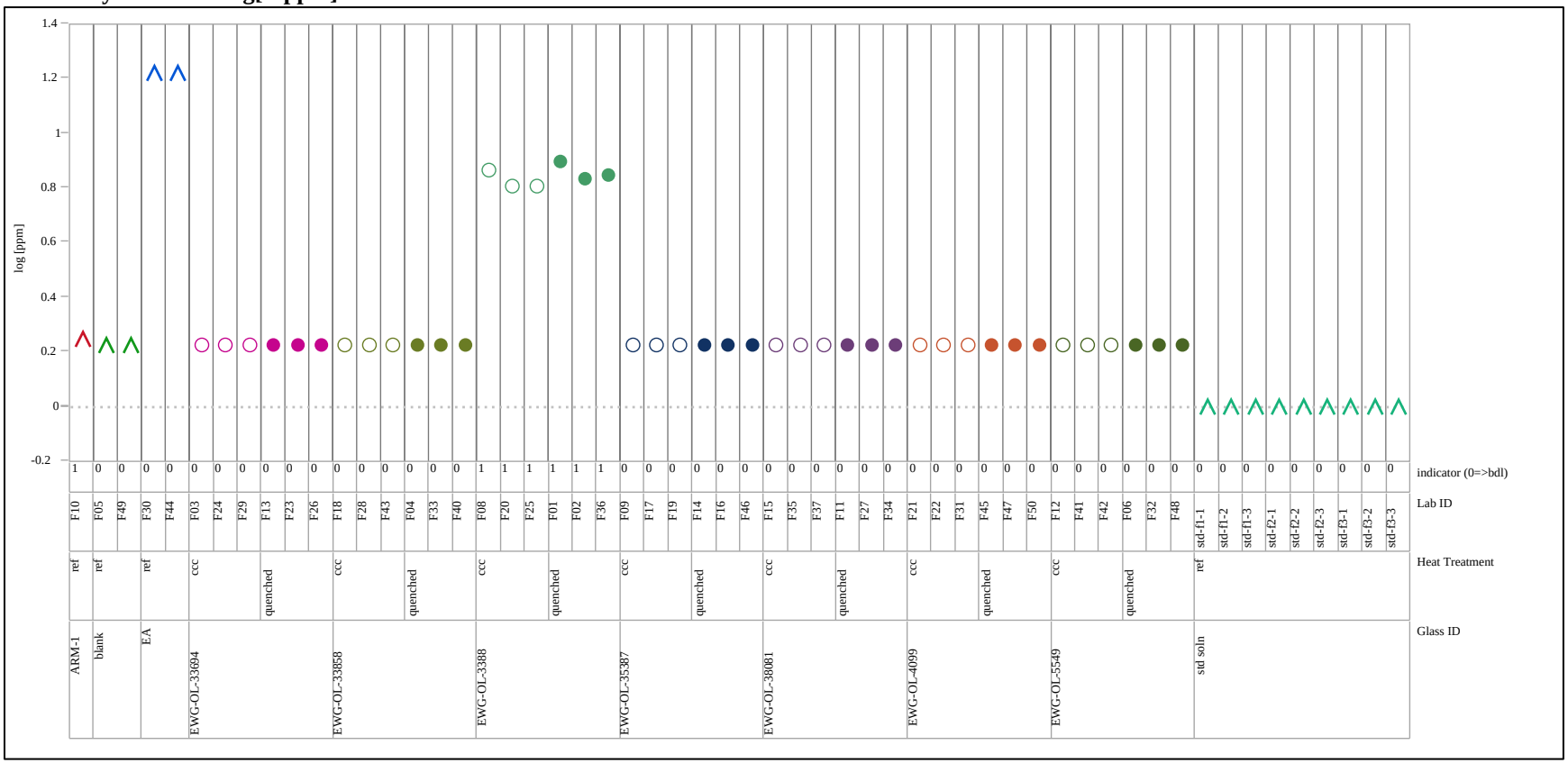


Exhibit B-2. PCT Measurements for Each Glass Grouped by Heat Treatment (continued)

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

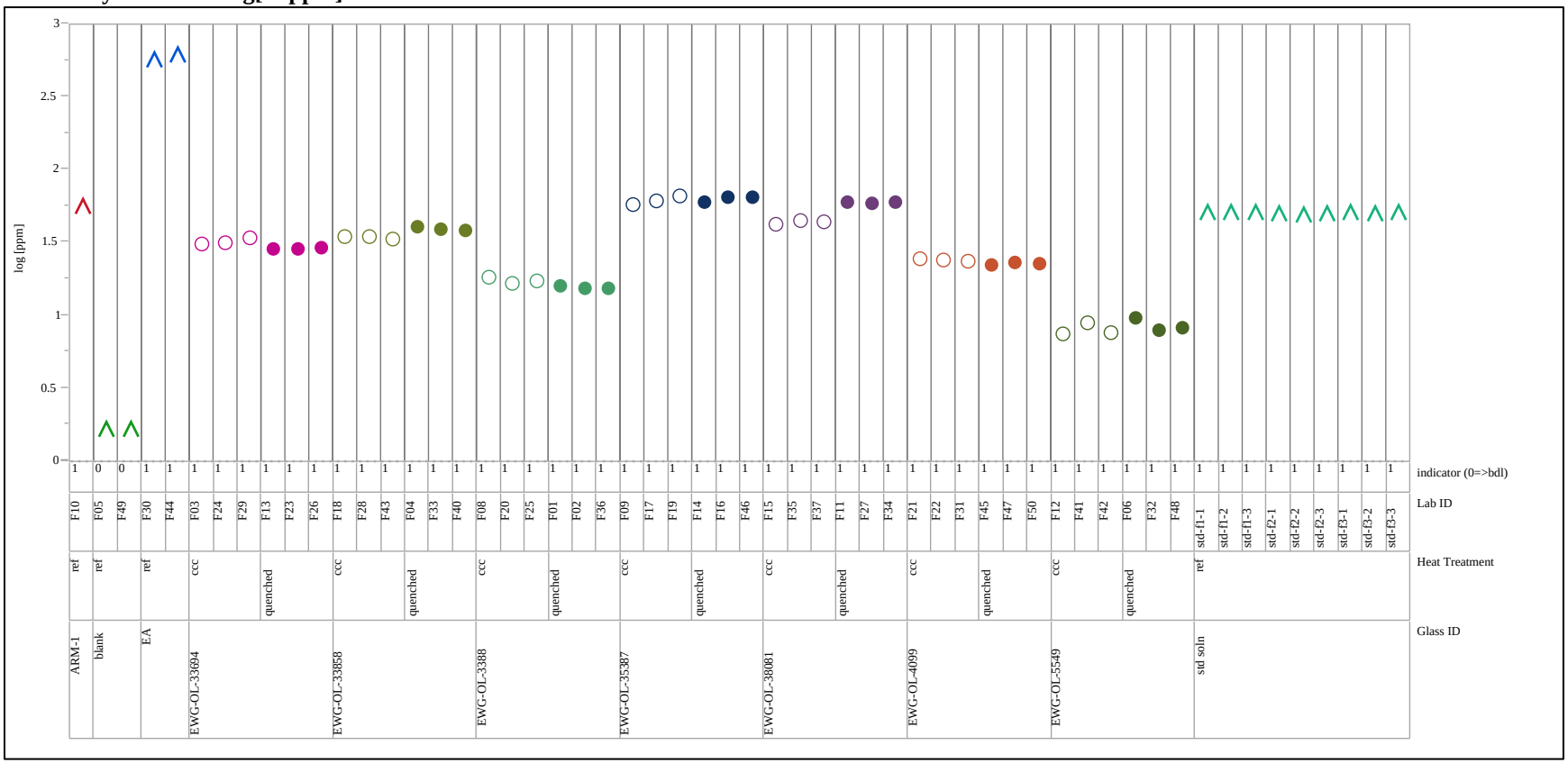
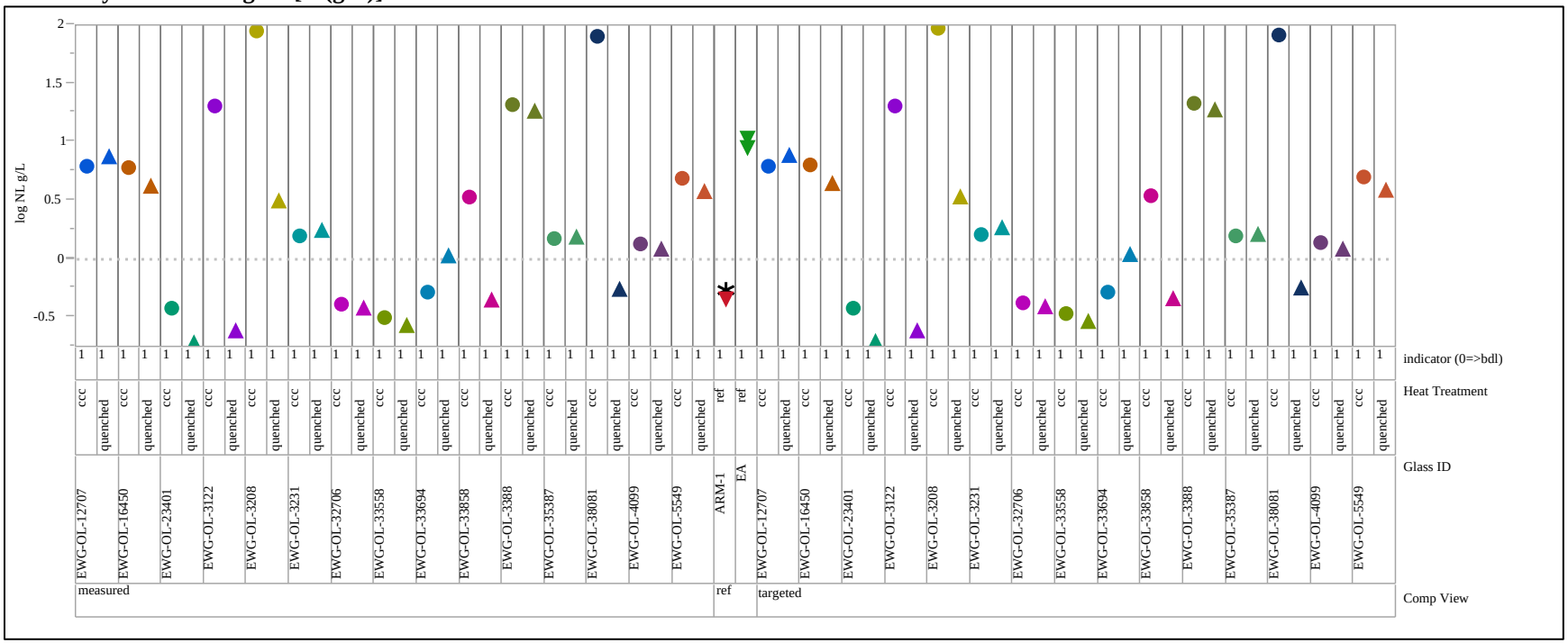


Exhibit B-3. Normalized PCT Results by Heat Treatment by Compositional View for Each Glass

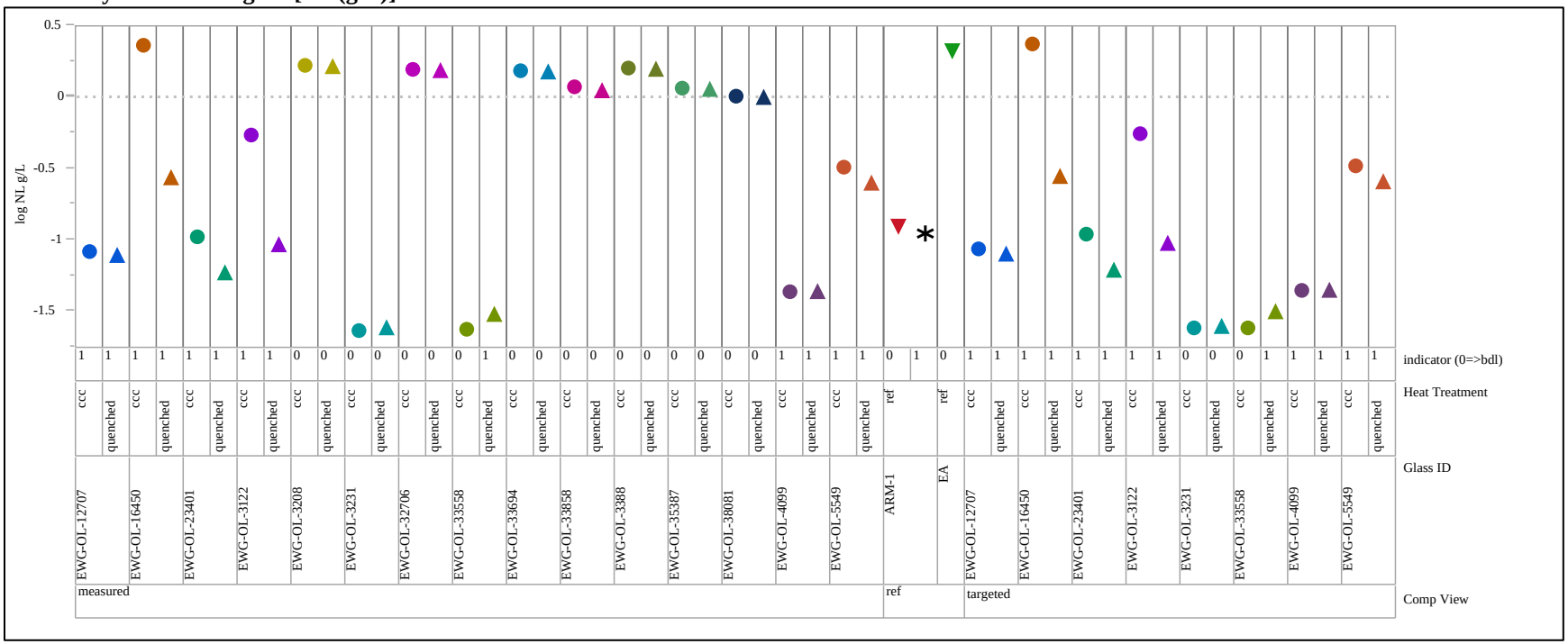
Variability Chart for log NL[B (g/L)]



Note that the ARM-1 value plotted with a ∗ symbol represents the outcome from a single solution. The other two ARM-1 replicate solutions had water-loss issues during the PCT.

Exhibit B-3. Normalized PCT Results by Heat Treatment by Compositional View for Each Glass (continued)

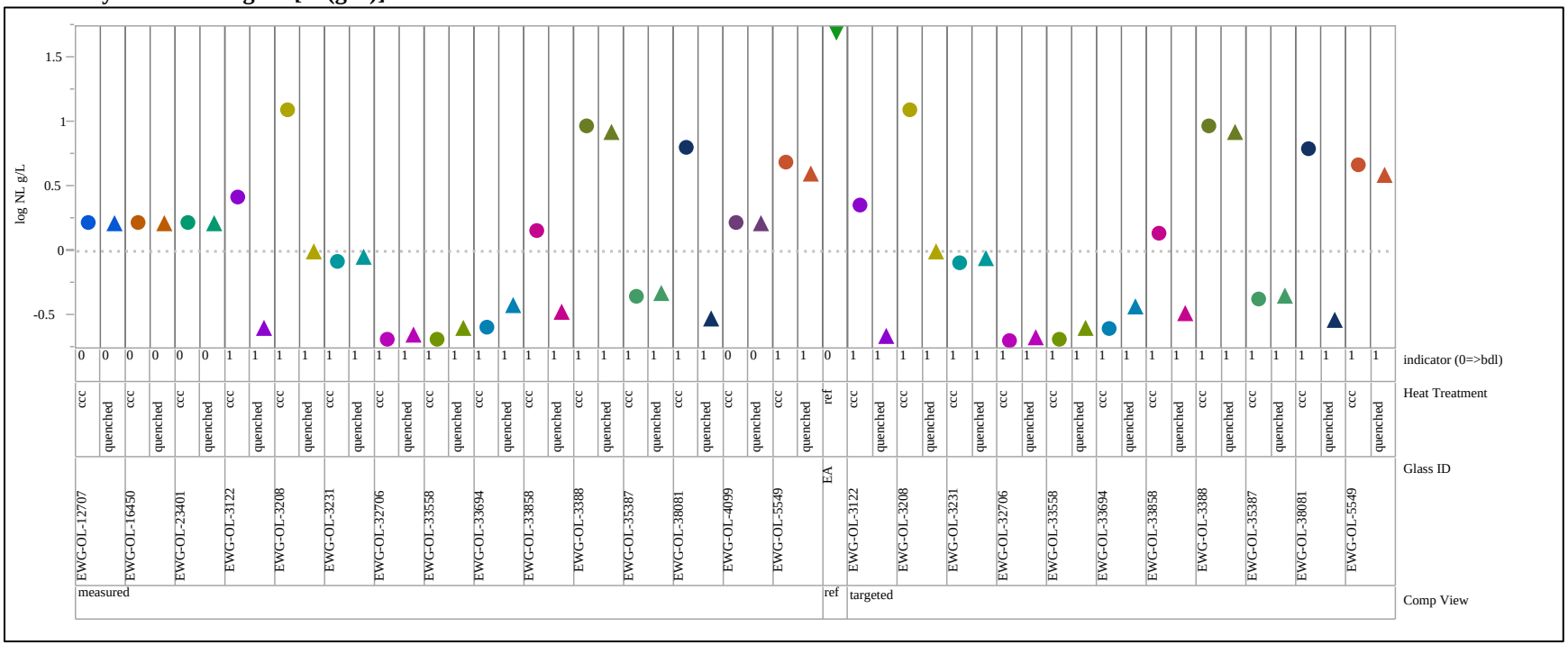
Variability Chart for log NL[Ca (g/L)]



Note that the ARM-1 value plotted with a ∗ symbol represents the outcome from a single solution. The other two ARM-1 replicate solutions had water-loss issues during the PCT.

Exhibit B-3. Normalized PCT Results by Heat Treatment by Compositional View for Each Glass (continued)

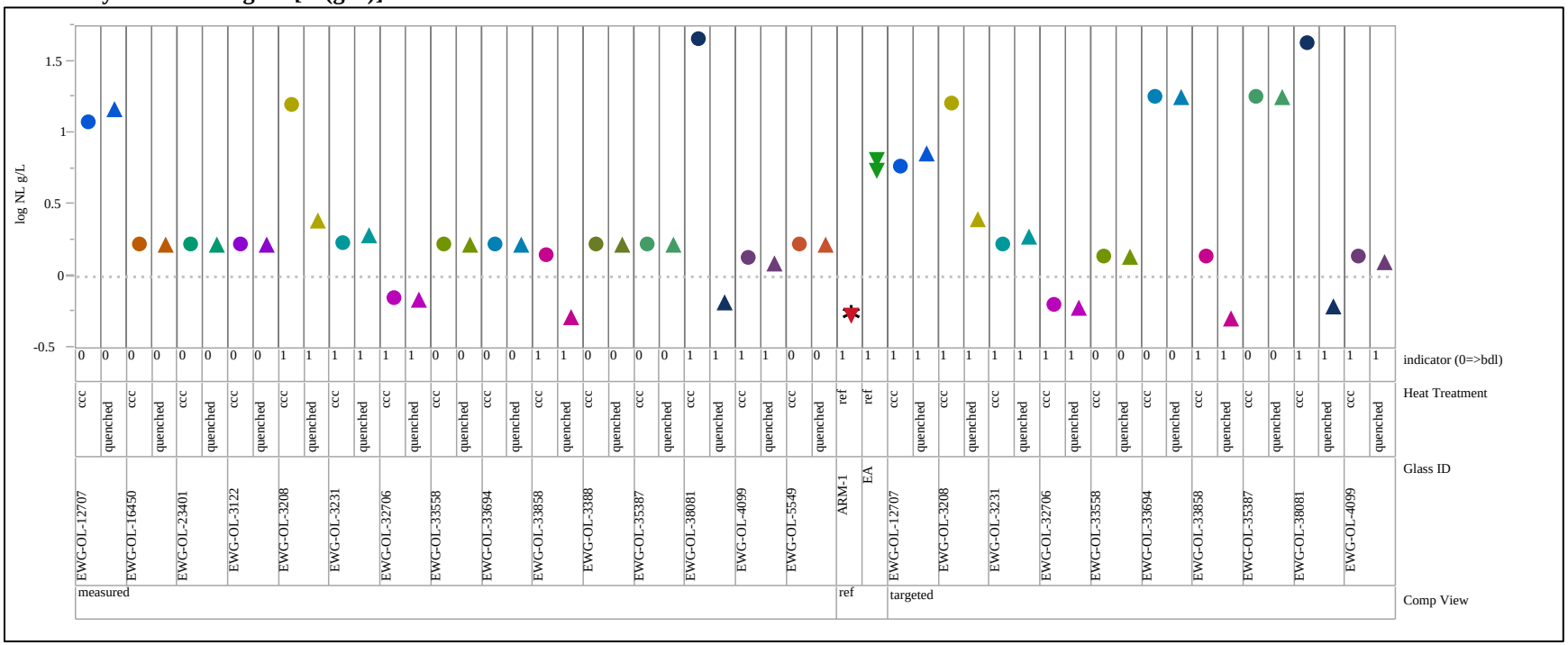
Variability Chart for log NL[K (g/L)]



Note that the ARM-1 value plotted with a ∗ symbol represents the outcome from a single solution. The other two ARM-1 replicate solutions had water-loss issues during the PCT.

Exhibit B-3. Normalized PCT Results by Heat Treatment by Compositional View for Each Glass (continued)

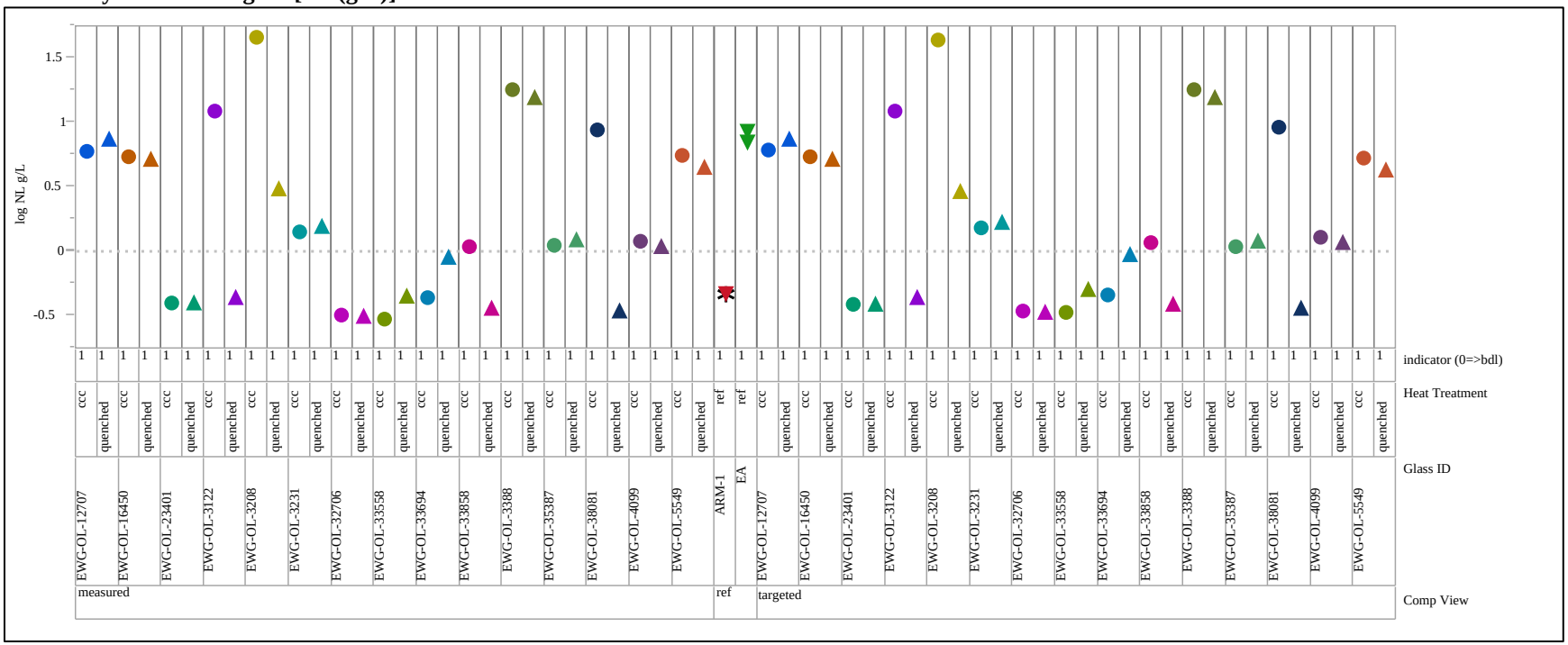
Variability Chart for log NL[Li(g/L)]



Note that the ARM-1 value plotted with a ∗ symbol represents the outcome from a single solution. The other two ARM-1 replicate solutions had water-loss issues during the PCT.

Exhibit B-3. Normalized PCT Results by Heat Treatment by Compositional View for Each Glass (continued)

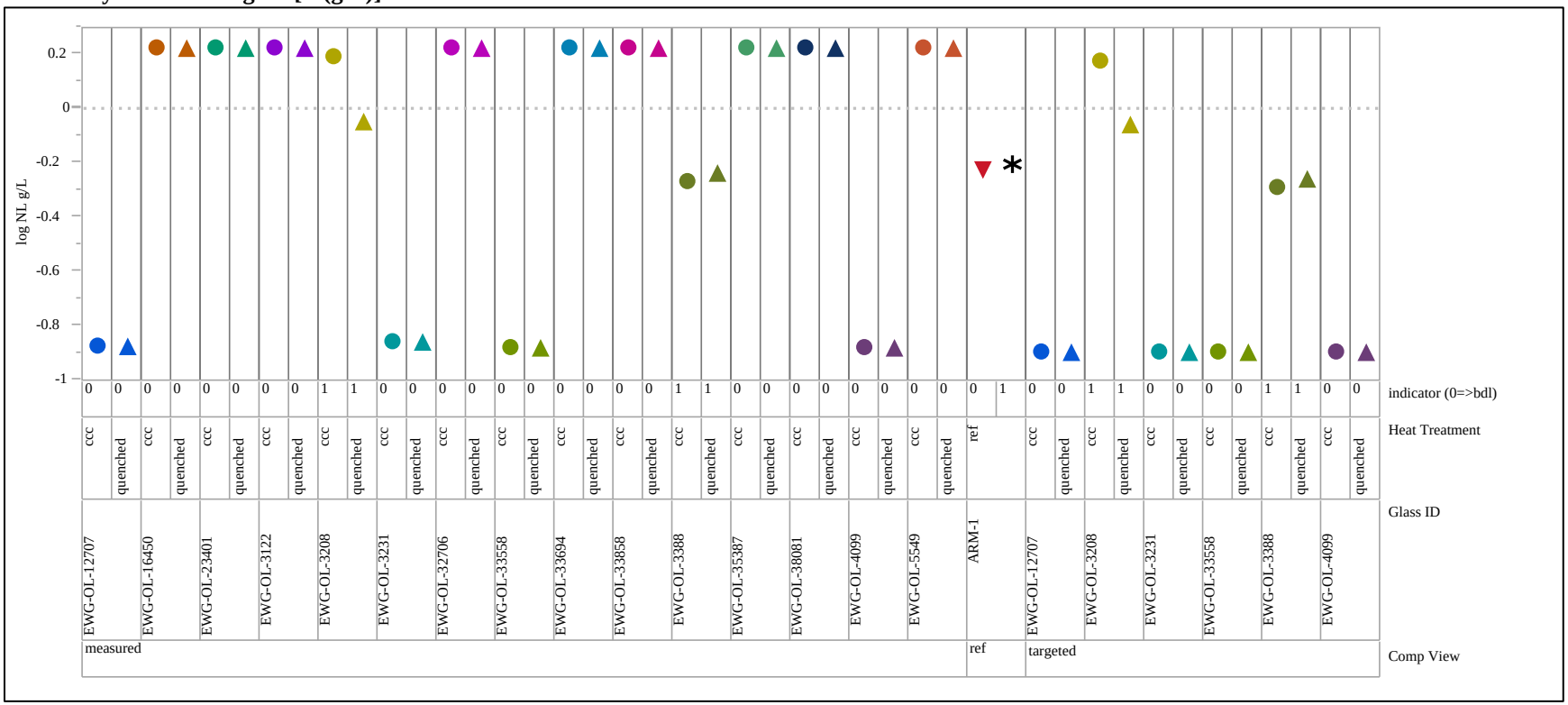
Variability Chart for log NL[Na (g/L)]



Note that the ARM-1 value plotted with a ∗ symbol represents the outcome from a single solution. The other two ARM-1 replicate solutions had water-loss issues during the PCT.

Exhibit B-3. Normalized PCT Results by Heat Treatment by Compositional View for Each Glass (continued)

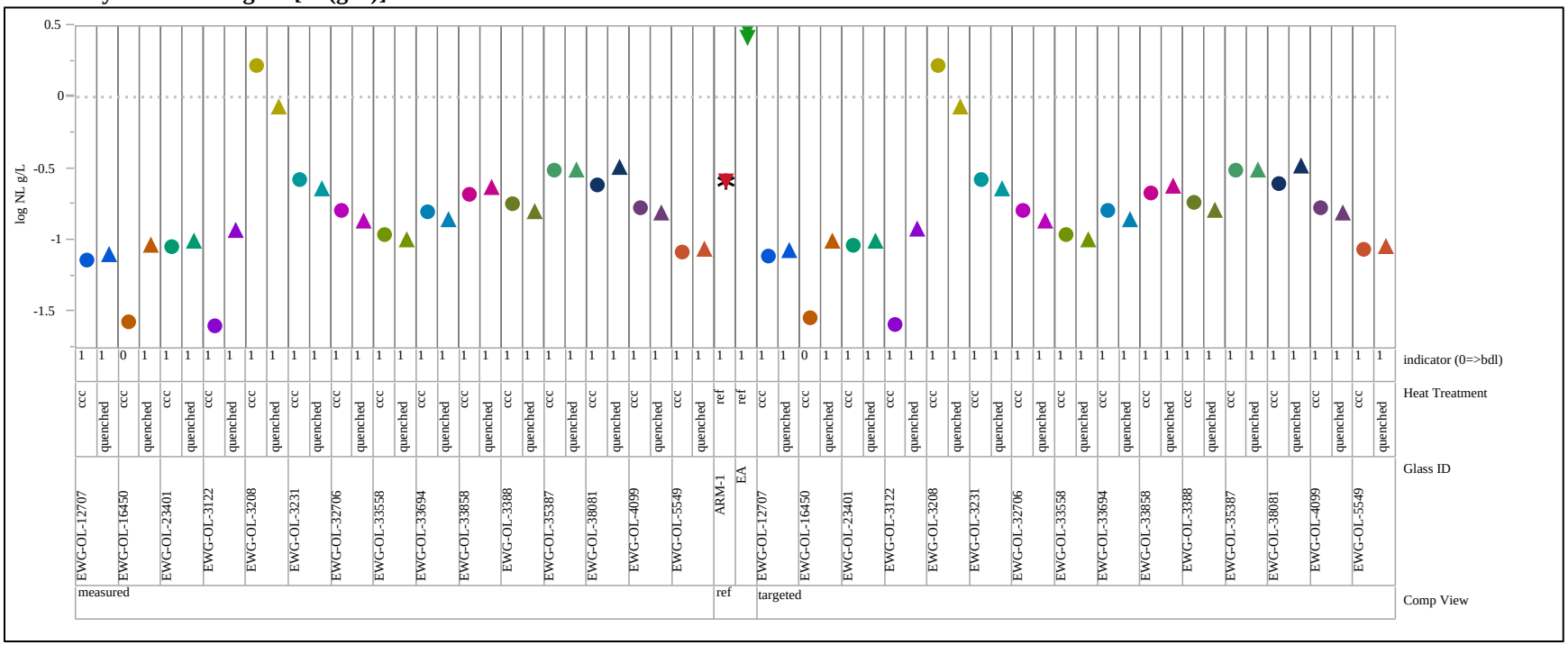
Variability Chart for log NL[P (g/L)]



Note that the ARM-1 value plotted with a ∗ symbol represents the outcome from a single solution. The other two ARM-1 replicate solutions had water-loss issues during the PCT.

Exhibit B-3. Normalized PCT Results by Heat Treatment by Compositional View for Each Glass (continued)

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



Note that the ARM-1 value plotted with a ∗ symbol represents the outcome from a single solution. The other two ARM-1 replicate solutions had water-loss issues during the PCT.

Distribution:

J. W. Amoroso, 999-W
T. B. Brown, 773-A
J. H. Christian, 999-W
Y-S. Chou, PNNL
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
D. S. Kim, PNNL
A. A. Kruger, DOE-ORP
S. L. Marra, 773-A
J. Matyáš, PNNL
D. H. McGuire, 999-W
D. K. Peeler, PNNL
F. M. Pennebaker, 773-42A
R. L. Russell, PNNL
M. J. Schweiger, PNNL
J. D. Vienna, PNNL
W. R. Wilmarth, 773-A
Records Administration (EDWS)