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Chemical Composition Analysis and Product Consistency Tests to Support Enhanced Hanford Waste Glass Models: Results for the January, March, and April 2015 LAW Glasses

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September 2015

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EXECUTIVE SUMMARY

In this report, the Savannah River National Laboratory provides chemical analyses and Product Consistency Test (PCT) results for several simulated low activity waste (LAW) glasses (designated as the January, March, and April 2015 LAW 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. All of the measured sums of oxides for the study glasses fall within the interval of 97.9 to 100.7 wt %, indicating recovery of all components. The Al_2O_3 concentration of glass EWG-LAW-ORP-LD1-3 is about 45% higher than the targeted value. The concentrations of other major oxides in this glass are below their targeted values, indicating that excess Al_2O_3 may have been added to the batch for EWG-LAW-ORP-LD1-3.

The PCT results were normalized to both the targeted and measured compositions of the study glasses. Several of the study glasses have normalized concentration values that are higher than the WTP contract limit of 4.0 g/L for both the quenched and CCC heat treatments. These results can be combined with additional characterization, including X-ray diffraction, to determine the cause of the higher releases. It is recommended that a more complete review of the influence of composition and heat treatment on the PCT responses of the glasses described in this report, as well as those described in a previous report,[1] be performed in order to draw further conclusions.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ABBREVIATIONS

ar	As Received
ARM	Approved Reference Material
bdl	Below Detection Limit
CCC	Canister Centerline Cooled
DOE	U.S. Department of Energy
EA	Environmental Assessment benchmark glass
EDS	Energy Dispersive Spectroscopy
HLW	High Level Waste
IC	Ion Chromatography
ICP-AES	Inductively Coupled Plasma – Atomic Emission Spectroscopy
JHCM	Joule-Heated Ceramic Melter
KH	Potassium hydroxide digestion
LAW	Low Activity Waste
LM	Lithium Metaborate fusion
LRM	Low-level Reference Material
NC_i	Normalized Concentration of element *i*
ORP	Office of River Protection
PCT	Product Consistency Test
PF	Peroxide Fusion
PNNL	Pacific Northwest National Laboratory
ppm	Parts Per Million
RSD	Relative Standard Deviation
SEM	Scanning Electron Microscopy
SRNL	Savannah River National Laboratory
TTQAP	Task Technical and Quality Assurance Plan
WTP	Hanford Tank 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 the Hanford Tank 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 into borosilicate glass using Joule-heated ceramic melters (JHCM).

Efforts are being made to increase the loading of Hanford tank wastes in the glass while conforming to processing requirements and product quality regulations. 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).[2] One of these areas is enhancing waste glass composition/property models and broadening the compositional regions over which those models are applicable.

In this report, SRNL provides chemical analyses and Product Consistency Test (PCT) results for select simulated LAW glasses (designated by SRNL as the January, March, and April 2015 LAW glasses) fabricated by Pacific Northwest National Laboratory (PNNL).[3] The results of these analyses will be used to revise or extend the validation regions of the current WTP glass property models or to develop new models to cover a broader span of waste compositions.

2.0 Experimental Procedure

2.1 Glasses Selected for Study

Multiple glasses fabricated at PNNL are included in the analyses described in this report. Chemical composition measurements were completed for the glasses listed in Table 2-1. PCTs were completed for the glasses listed in Table 2-2. Both quenched (Q) and canister centerline cooled (CCC) glasses were included in the PCTs. Chemical compositions of some of the study glasses were measured earlier and these data are available in a previous report.[1] Where appropriate, these data were used in calculating the normalized PCT results for the glasses presented in this report.

Table 2-1. Identifiers for the Glasses Included in the Chemical Composition Analyses

Glass ID
EWG-LAW-New-OL-108249-SO4Mod
EWG-LAW-New-OL-116208-SO4Mod
EWG-LAW-ORP-LD1-3
EWG-LAW-New-OL-8788-Mod
EWG-LAW-New-OL-45748
EWG-LAW-New-OL-54017
EWG-LAW-New-OL-62909-Mod
EWG-LAW-New-OL-65959-Mod
EWG-LAW-New-OL-80309
EWG-LAW-New-OL-127708-Mod
EWG-LAW-ORP-LD1-2

Table 2-2. Identifiers for the Glasses Included in the PCT Analyses

Glass ID		Glass ID
EWG-LAW-ORP-LD1-2-Q		EWG-LAW-New-IL-93907-CCC
EWG-LAW-New-OL-8788-Mod-Q		EWG-LAW-New-IL-151542-CCC-1225
EWG-LAW-New-OL-45748-Q		EWG-LAW-New-OL-8788-Mod-CCC-1300
EWG-LAW-New-OL-54017-Q		EWG-LAW-New-OL-14844-CCC-1250
EWG-LAW-New-OL-80309-Q		EWG-LAW-New-OL-15493-CCC-1225
EWG-LAW-Centroid-1-CCC		EWG-LAW-New-OL-17130-CCC-1150
EWG-LAW-New-OL-15493-CCC		W-New-OL-57284-CCC-1200
EWG-LAW-New-OL-62380-CCC		EWG-LAW-New-OL-100210-CCC-1250
EWG-LAW-New-OL-90780-CCC		EWG-LAW-New-OL-108249-(SO4 Mod)-CCC-1300
EWG-LAW-New-IL-1721-CCC		EWG-LAW-New-OL-108249-(SO4 Mod)-Q
EWG-LAW-NEW-OL-45748-Sn-CCC-1300		EWG-LAW-New-OL-116208-(SO4 Mod)-CCC-1300
EWG-LAW-Centroid-2-CCC-1150		EWG-LAW-New-OL-116208-(SO4 Mod)-Q
EWG-LAW-NEW-IL-70316-CCC		EWG-LAW-New-OL-122817-CCC-1200
EWG-LAW-NEW-OL-540175-Sn-CCC-1225		EWG-LAW-New-OL-127708-Mod-CCC-1300
EWG-LAW-NEW-OL-8445-CCC-1200		EWG-LAW-New-OL-65959-Mod-CCC-1250
EWG-LAW-NEW-IL-103151-CCC-1250		EWG-LAW-ORP-LD1-1-CCC-1300
EWG-LAW-NEW-IL-94020-CCC-1300		EWG-LAW-ORP-LD1-3-Q
EWG-LAW-NEW-OL-62909-Mod-Q		EWG-LAW-New-IL-87749-CCC-1225
EWG-LAW-NEW-OL-65959-Mod-Q		EWG-LAW-New-IL-166697-CCC-1250
EWG-LAW-NEW-OL-127708-Mod-Q		EWG-LAW-New-IL-166731-CCC-1225
EWG-LAW-New-IL-456-CCC-1200		EWG-LAW-New-OL-62909-Mod-CCC-1300
EWG-LAW-New-IL-5253-CCC		EWG-LAW-New-OL-80309-CCC-1300
EWG-LAW-New-IL-5255-CCC-1200		EWG-LAW-ORP-LD1-2-CCC-1300
EWG-LAW-New-IL-42295-CCC-1150		EWG-LAW-ORP-LD1-3-CCC-1300

In the sections that follow, the methods used for measuring chemical composition and PCT performance are described and reviews of the resulting data are provided. Detailed data from these analyses are included as appendices.

2.2 Compositional Analysis

Chemical analysis was performed under the auspices of an analytical plan[4] on a representative sample from the quenched version of each of the glasses listed in Table 2-1 to allow for comparisons among the targeted and measured (or as-batched) compositions. Three preparation techniques, including sodium peroxide fusion (PF), lithium metaborate fusion (LM), and potassium hydroxide digestion (KH) were used to prepare each of the glass samples, in duplicate, for analysis. Each of the duplicate samples was analyzed twice for each element of interest by Inductively Coupled Plasma – Atomic Emission Spectroscopy (ICP-AES) or ion chromatography (IC), for a total of four measurements per element per glass. Glass standards were also intermittently measured to assess the performance of the ICP-AES and IC instruments over the course of these analyses. Specifically, several samples of the low-level reference material (LRM)[5] were included as part of the analytical plan. The LRM composition reported as the "Consensus Average" is used as the reference composition of this glass for the purposes of this study.[5] The preparation and measurement methods used for each of the reported glass components are listed in Table 2-3.

Table 2-3. Preparation and Measurement Methods Used in Reporting the Concentrations of Each of the Components of the Study Glasses

Analyte	Preparation Method	Measurement Method
Al	PF	ICP-AES
B	PF	ICP-AES
Ca	LM	ICP-AES
Cl	KH	IC
Cr	LM	ICP-AES
F	KH	IC
Fe	PF	ICP-AES
K	LM	ICP-AES
Li	PF	ICP-AES
Mg	LM	ICP-AES
Na	LM	ICP-AES
P	LM	ICP-AES
Si	PF	ICP-AES
Sn	PF	ICP-AES
S	LM	ICP-AES
V	LM	ICP-AES
Zn	LM	ICP-AES
Zr	LM	ICP-AES

2.3 Product Consistency Test

The PCT Method-A was performed on each of the study glasses to assess chemical durability.[6] Also included in the experimental test matrix was the Environmental Assessment (EA) benchmark glass,[7] the Approved Reference Material (ARM) glass,[8] and blanks from the sample cleaning batch.[a] Samples were ground, washed, and prepared according to the standard procedure.[6] Fifteen milliliters of Type-I ASTM water (as defined in the procedure) 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 to ambient temperature, the resulting solutions were sampled (filtered and acidified), then labeled and analyzed by ICP-AES under the auspices of three analytical plans.[9-11] Aliquots of the cooled, unfiltered leachates were also measured for pH. Samples of a multi-element, standard solution were included in the analytical plans as a check of the accuracy of the ICP-AES instrument used for these measurements. Normalized concentrations were calculated based on both the targeted (provided by PNNL) and measured compositions using the average of the common logarithms of the triplicate leachate concentrations.

2.4 Quality Assurance

Requirements for performing reviews of technical reports and the extent of review are established in Savannah River Site Manual E7, Procedure 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.

[a] The EA glass was included in the PCT for reference but will not be discussed further in this report. WTP contractual requirements dictate the required performance of Hanford LAW glass rather than a comparison to the EA glass.

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 % for the study glasses as prepared by the LM method. Table A-3 in Appendix A provides the elemental concentration measurements in wt % for the study glasses as prepared by the PF method. Table A-4 in Appendix A provides the elemental concentration measurements in wt % for the study glasses as prepared by the KH 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.

For the LM digestion, a dilute 4% HNO_3 solution and 2 ml of concentrated HCl are typically used to digest the glass monolith that forms in the fusion. However, during a previous study of similar glasses, it was found that the addition of HCl may be linked to the formation of a precipitate affecting the measurement of P and Zr in the resulting solutions.[1] Therefore, HCl was omitted from the LM preparation of the glasses described in this report.

An early review of the composition measurements revealed that one of the study glasses, EWG-LAW-New-OL-45748, had measurement issues with the samples prepared by LM. Additional samples of this glass were prepared again by LM, with the solutions analyzed as a third analytical block of measurements. The resulting measurements were significantly improved (closer to targeted values), thus the values from the third block will be used in place of the original measurements for EWG-LAW-New-OL-45748 for the following discussions.

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 of the glasses. JMP™ Pro Version 11.2.1 (SAS Institute, Inc.)[12] was used to support these analyses.

3.1.1 Treatment of Detection Limits

The elemental concentrations in Table A-1 through Table A-4 of Appendix A 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 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 each sample 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 in Appendix A, 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 instruments within and among calibration blocks. A review of these plots did not identify any 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:

- The Al_2O_3 concentration of glass EWG-LAW-ORP-LD1-3 is higher than the targeted value. The concentrations of other major oxides in this glass, including B_2O_3, CaO, Na_2O, SiO_2, ZnO, and ZrO_2, are below their targeted values, indicating that excess Al_2O_3 may have been added to the batch for EWG-LAW-ORP-LD1-3.
- There is scatter among the B_2O_3 and Na_2O measurements for some of the study glasses.
- There is scatter seen in some of the Cl and F measurements, although the concentrations of these components are low.
- Glass EWG-LAW-New-OL-108249-SO4Mod contained a small but measureable amount of MgO, while the targeted MgO concentration for this glass was zero. This measurement was confirmed via an additional preparation and measurement.
- The measured values for P_2O_5 for glass EWG-LAW-New-OL-45748 were improved after the second preparation.
- There is scatter among the SiO_2 and SnO_2 measurements for some of the study glasses.

None of the observations noted above were considered to indicate 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 study glasses.

3.1.4 Results for the LRM Standard

Exhibit A-3 in Appendix A provides a comparison of the LRM results to their acceptability limits utilized by SRNL.[13] 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 analyses.

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), were averaged to determine a representative chemical composition for each glass. A sum of oxides was also computed for each glass based upon the averaged, 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. For example, note that some measured Cl, F, and SO_3 concentrations are somewhat below the targeted values for some of the study glasses. This may be due to volatility during fabrication of the glasses.

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 97.9 to 100.7 wt %, indicating 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, in five sets, 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 dilutions. The "ar" 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 "ar" 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 no samples that had water-loss issues. The ratio of leachant volume to the mass of ground glass was confirmed to be correct for each vessel. The measured concentrations of B, Li, Na, and Si in the leachates from the ARM glasses all fell within the limits of the control charts, demonstrating proper performance of the PCTs.[8] The measured pH values for each of the PCT leachates are provided in Table B-2 through Table B-6 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 concentrations for each glass are determined, and comparisons are made between the PCTs for the two heat treatments of each glass (when available). JMP Pro Version 11.2.1 (SAS Institute, Inc.)[12] was used to support these analyses.

3.2.1 Treatment of Detection Limits

Some of the as-received 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 review and calculating normalized concentration values. Those elements with measured concentrations that were below the associated detection limit will be denoted with a less than symbol (<) as the normalized concentration 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	Jan 1			Jan 2			Mar 1			Mar 2			Apr			Reference values (ppm)
Block	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	
Mean(B (ppm))	19.30	21.13	20.57	19.03	20.07	20.03	19.87	20.43	20.80	20.17	21.63	20.97	19.60	19.40	20.70	20
Mean(Li (ppm))	9.84	9.88	9.70	9.63	9.55	9.77	9.87	9.84	9.83	9.72	10.50	10.01	9.29	9.61	10.10	10
Mean(Na (ppm))	80.93	83.47	84.23	83.13	81.97	82.37	82.47	80.17	83.53	83.47	82.00	83.07	84.90	78.07	81.80	81
Mean(Si (ppm))	47.33	49.00	49.33	48.37	48.10	48.63	50.50	49.50	50.93	49.30	50.80	50.20	48.27	45.70	47.27	50
% relative bias B	-3.5%	5.7%	2.8%	-4.8%	0.3%	0.2%	-0.7%	2.2%	4.0%	0.8%	8.2%	4.8%	-2.0%	-3.0%	3.5%	
% relative bias Li	-1.6%	-1.2%	-3.0%	-3.7%	-4.5%	-2.3%	-1.3%	-1.6%	-1.7%	-2.8%	5.0%	0.1%	-7.1%	-3.9%	1.0%	<10% per ASTM C 1285
% relative bias Na	-0.1%	3.0%	4.0%	2.6%	1.2%	1.7%	1.8%	-1.0%	3.1%	3.0%	1.2%	2.6%	4.8%	-3.6%	1.0%	
% relative bias Si	-5.3%	-2.0%	-1.3%	-3.3%	-3.8%	-2.7%	1.0%	-1.0%	1.9%	-1.4%	1.6%	0.4%	-3.5%	-8.6%	-5.5%	
Std Dev (B (ppm))	0.819	0.751	0.666	0.451	0.306	0.208	0.404	0.651	1.100	1.201	0.289	0.231	0.866	0.361	0.800	
Std Dev (Li (ppm))	0.281	0.040	0.044	0.050	0.081	0.010	0.046	0.060	0.153	0.334	0.100	0.081	0.246	0.163	0.400	
Std Dev (Na (ppm))	2.272	0.651	0.666	0.666	0.814	0.379	1.210	0.709	1.301	3.166	1.212	0.666	2.265	1.097	3.764	
Std Dev (Si (ppm))	1.301	0.100	0.379	0.252	0.400	0.289	0.200	0.458	1.124	1.670	0.557	0.436	1.172	0.100	1.856	
%RSD (B (ppm))	4.24	3.55	3.24	2.37	1.52	1.04	2.03	3.18	5.29	5.96	1.33	1.10	4.42	1.86	3.86	
%RSD (Li (ppm))	2.86	0.41	0.45	0.52	0.85	0.10	0.46	0.61	1.55	3.44	0.95	0.81	2.65	1.70	3.96	<10% per ASTM C 1285
%RSD (Na (ppm))	2.81	0.78	0.79	0.80	0.99	0.46	1.47	0.88	1.56	3.79	1.48	0.80	2.67	1.41	4.60	
%RSD (Si (ppm))	2.75	0.20	0.77	0.52	0.83	0.59	0.40	0.93	2.21	3.39	1.10	0.87	2.43	0.22	3.93	

3.2.3 Measurements in Analytical Sequence

Exhibit B-1 in Appendix B provides plots of the common logarithms of the leachate concentrations (ppm) in analytical sequence by analytical block by analytical set. Each of the analytical sets corresponds to an oven run that was used to conduct the PCT measurements needed to support the study of the LAW glasses. Heat treatment is indicated by a suffix to the glass identifiers in these plots. 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 versions (when available) of each of the study glasses and for the standards for each analytical set. Heat treatment is indicated by a suffix to the glass identifiers in these plots. 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 when available. 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. These differences will be further discussed below.

3.2.5 Normalization of the PCT Results

The PCT leachate data were normalized using both the targeted and measured compositions of the glasses to obtain grams of waste form per liter of leachant ($g_{glass}/L_{leachant}$) concentrations for each element of interest. The common logarithm of the normalized concentration (NC_i) for each element (i) of interest was determined as described in ASTM C 1285 and used for comparison.[a] The following equation was used to calculate the NC_i values using the triplicate PCT analyses:

$$\log(NC_i) = \overline{\log C_\iota} - [1 + \log f_i]$$

where $\log(NC_i)$ is the logarithm of the normalized glass concentration based on element i, $\overline{\log C_\iota}$ is the average of the logarithms of the measured concentrations of element i in the triplicate leachates, and $\log f_i$ is either the logarithm of the targeted concentration of element i in the glass, or the logarithm of the average measured concentration of element i in the glass (from Table A-5 in Appendix A).

3.2.6 Review of the PCT Results

Exhibit B-3 in Appendix B provides plots of the normalized PCT responses for each of the study glasses with the heat treatment of each glass indicated, as well as for the responses of the ARM and EA glasses. The results are grouped by compositional view. Heat treatment is indicated by a suffix to the glass identifiers in these plots. 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 heat treatments of each study glass where more than one heat treatment was available. Table 3-2 provides a listing of the normalized PCT responses. In reading this table, note that bdl values are

[a] Note that the waste forms in this study were assumed to be of similar density, the PCT-A reference volume of leachant to sample mass ratio was used, and the 100 to 200 mesh reference particle size was used. Thus, no adjustment for the density of the glasses was made in normalizing the PCT results. Data provided in the appendices of this report allow for the calculation of normalized elemental mass loss (NL_i) if glass densities are measured at a later date.

indicated and that results are omitted for those elements with targeted concentrations of zero for a given glass composition. The data are normalized to both the targeted and the measured compositions of the glasses. The following discussion will focus only on the values normalized to the measured compositions since the choice of compositional view has little practical effect on the outcome of the PCTs for these glasses.

A review of the PCT results (normalized to measured compositions) shows that several of the study glasses have normalized concentration values that are higher than the WTP contract[a] limit of 4.0 g/L.[b] Glasses with normalized release values for B, Li, and Na that were greater than 4.0 g/L are:

- EWG-LAW-New-IL-42295-CCC-1150
- EWG-LAW-New-IL-5255-CCC-1200
- EWG-LAW-New-OL-108249-(SO4 Mod)-CCC-1300
- EWG-LAW-New-OL-116208-(SO4 Mod)-CCC-1300
- EWG-LAW-New-OL-116208-(SO4 Mod)-Q
- EWG-LAW-New-OL-14844-CCC-1250
- EWG-LAW-New-OL-65959-Mod-CCC-1250
- EWG-LAW-New-OL-80309-CCC-1300
- EWG-LAW-New-OL-80309-Q
- EWG-LAW-New-OL-90780-CCC

Glasses with normalized releases for B and Na that were greater than 4.0 g/L are:

- EWG-LAW-New-OL-15493-CCC
- EWG-LAW-New-OL-15493-CCC-1225

Glass EWG-LAW-New-IL-166731-CCC-1225 had normalized release values for B and Li that were greater than 4.0 g/L. Glass EWG-LAW-New-OL-17130-CCC-1150 had normalized release values for B, Li, Na, and Si that were greater than 4.0 g/L. This is the only glass of the group described in this report with a normalized release for Si that was greater than 4.0 g/L.

The group of glasses described in this report contains several pairs of glasses that differ only in heat treatment. This provides an opportunity to observe the impacts of heat treatment on the PCT results for glasses of the same composition. There were no differences that appeared to be of practical significance between the PCT responses of the following pairs of glasses:

- EWG-LAW-Centroid-1-CCC and EWG-LAW-Centroid-2-CCC-1150
- EWG-LAW-NEW-OL-127708-Mod-Q and
  EWG-LAW-New-OL-127708-Mod-CCC-1300
- EWG-LAW-New-OL-45748-Q and EWG-LAW-NEW-OL-45748-Sn-CCC-1300
- EWG-LAW-New-OL-54017-Q and EWG-LAW-NEW-OL-54017-Sn-CCC-1225
- EWG-LAW-NEW-OL-62909-Mod-Q and EWG-LAW-New-OL-62909-Mod-CCC-1300
- EWG-LAW-New-OL-8788-Mod-Q and EWG-LAW-New-OL-8788-Mod-CCC-1300
- All versions of the EWG-LAW-ORP-LD1 glass in this group

There was also no difference of practical significance between the PCT responses of glasses EWG-LAW-New-OL-15493-CCC and EWG-LAW-New-OL-15493-CCC-1225, although the normalized release values for these glasses were quite high (NC_B values of 96.018 g/L and

[a] WTP Contract, U.S. DOE Contract Number DE-AC27-01RV14136, Section C, Specification 2.2.2.17.2.
[b] A glass density of 2.67 g/cm^3 was assumed in converting the WTP contract limit of 2.0 g/m^2 to 4.0 g/L.

90.476 g/L, respectively) relative to the limit of 4.0 g/L. In fact, these values represent leaching of almost all of the boron from the glass (an NC_i value of 100 g/L is equivalent to complete leaching).

There are three pairs of glasses that showed increases in normalized release values after the CCC heat treatment:

- EWG-LAW-New-OL-108249-(SO4 Mod)-Q and
  EWG-LAW-New-OL-108249-(SO4 Mod)-CCC-1300
- EWG-LAW-New-OL-116208-(SO4 Mod)-Q and
  EWG-LAW-New-OL-116208-(SO4 Mod)-CCC-1300
- EWG-LAW-NEW-OL-65959-Mod-Q and EWG-LAW-New-OL-65959-Mod-CCC-1250

The PCT responses of glasses EWG-LAW-New-OL-80309-Q and EWG-LAW-New-OL-80309-CCC-1300 were unusual in that the normalized release values for the quenched version of this glass were generally higher than those of the CCC version (e.g., NC_B values of 22.921 g/L for the quenched version and 11.117 g/L for the CCC version).

It is recommended that a more complete review of the influence of composition and heat treatment on the PCT responses of the glasses described in this report, as well as those described in a previous report,[1] be performed in order to draw further conclusions. Additional characterization, such as X-ray diffraction analysis to identify possible crystalline phases, would be beneficial for further interpretation of the PCT results. One could also examine the glasses for amorphous phase separation using transmission electron microscopy or test for the potential of amorphous phase separation using a model.[14]

Table 3-2. Normalized PCT Results

Set	Glass ID w Heat Treatment	Comp View	NC_B (g/L)	NC_{Li} (g/L)	NC_{Na} (g/L)	NC_{Si} (g/L)
January Set 1	ARM-1	ref	0.470	0.575	0.509	0.274
January Set 1	EA	ref	10.394	6.043	7.907	2.705
January Set 1	EWG-LAW-Centroid-1-CCC	measured	0.916	0.837	1.013	0.322
January Set 1	EWG-LAW-Centroid-1-CCC	targeted	0.888	0.782	1.041	0.320
January Set 1	EWG-LAW-New-IL-1721-CCC	measured	1.617	1.418	1.377	0.489
January Set 1	EWG-LAW-New-IL-1721-CCC	targeted	1.600	1.370	1.402	0.496
January Set 1	EWG-LAW-New-OL-15493-CCC	measured	96.018	-	39.102	2.158
January Set 1	EWG-LAW-New-OL-15493-CCC	targeted	95.074	-	40.601	2.158
January Set 1	EWG-LAW-New-OL-45748-Q	measured	0.218	0.404	0.393	0.111
January Set 1	EWG-LAW-New-OL-45748-Q	targeted	0.225	0.401	0.401	0.115
January Set 1	EWG-LAW-New-OL-54017-Q	measured	0.349	-	0.525	0.178
January Set 1	EWG-LAW-New-OL-54017-Q	targeted	0.361	-	0.516	0.183
January Set 1	EWG-LAW-New-OL-62380-CCC	measured	0.274	-	0.462	0.106
January Set 1	EWG-LAW-New-OL-62380-CCC	targeted	0.251	-	0.454	0.106
January Set 1	EWG-LAW-New-OL-80309-Q	measured	22.921	17.571	15.797	1.021
January Set 1	EWG-LAW-New-OL-80309-Q	targeted	23.040	17.003	15.125	1.032
January Set 1	EWG-LAW-New-OL-8788-Mod-Q	measured	0.301	0.487	0.418	0.212
January Set 1	EWG-LAW-New-OL-8788-Mod-Q	targeted	0.311	0.476	0.404	0.219
January Set 1	EWG-LAW-New-OL-90780-CCC	measured	29.009	20.085	12.069	0.586
January Set 1	EWG-LAW-New-OL-90780-CCC	targeted	28.140	19.350	11.984	0.592
January Set 1	EWG-LAW-ORP-LD1-2-Q	measured	0.841	-	1.070	0.236
January Set 1	EWG-LAW-ORP-LD1-2-Q	targeted	0.847	-	1.033	0.241
January Set 2	ARM-1	ref	0.455	0.548	0.499	0.266
January Set 2	EA	ref	11.645	6.948	9.256	3.065
January Set 2	EWG-LAW-Centroid-2-CCC-1150	measured	0.918	0.795	1.007	0.315
January Set 2	EWG-LAW-Centroid-2-CCC-1150	targeted	0.891	0.752	1.052	0.319
January Set 2	EWG-LAW-NEW-IL-103151-CCC-1250	measured	1.822	1.169	1.823	0.689
January Set 2	EWG-LAW-NEW-IL-103151-CCC-1250	targeted	1.688	1.060	1.888	0.665
January Set 2	EWG-LAW-NEW-IL-70316-CCC	measured	0.628	0.866	1.282	0.316
January Set 2	EWG-LAW-NEW-IL-70316-CCC	targeted	0.602	0.808	1.266	0.315
January Set 2	EWG-LAW-NEW-IL-94020-CCC-1300	measured	0.427	0.547	0.552	0.252
January Set 2	EWG-LAW-NEW-IL-94020-CCC-1300	targeted	0.408	0.511	0.563	0.246
January Set 2	EWG-LAW-NEW-OL-127708-Mod-Q	measured	0.546	0.555	0.537	0.257
January Set 2	EWG-LAW-NEW-OL-127708-Mod-Q	targeted	0.552	0.676	0.537	0.261

Table 3-2. Normalized PCT Results (continued)

Set	Glass ID w Heat Treatment	Comp View	NC_B (g/L)	NC_{Li} (g/L)	NC_{Na} (g/L)	NC_{Si} (g/L)
January Set 2	EWG-LAW-NEW-OL-45748-Sn-CCC-1300	measured	0.929	1.540	0.359	0.299
January Set 2	EWG-LAW-NEW-OL-45748-Sn-CCC-1300	targeted	0.961	1.528	0.367	0.308
January Set 2	EWG-LAW-NEW-OL-54017-Sn-CCC-1225	measured	0.195	-	0.460	0.167
January Set 2	EWG-LAW-NEW-OL-54017-Sn-CCC-1225	targeted	0.202	-	0.452	0.172
January Set 2	EWG-LAW-NEW-OL-62909-Mod-Q	measured	0.416	0.580	0.589	0.115
January Set 2	EWG-LAW-NEW-OL-62909-Mod-Q	targeted	0.421	0.557	0.610	0.118
January Set 2	EWG-LAW-NEW-OL-65959-Mod-Q	measured	3.331	2.773	2.510	0.670
January Set 2	EWG-LAW-NEW-OL-65959-Mod-Q	targeted	3.340	2.710	2.436	0.680
January Set 2	EWG-LAW-NEW-OL-8445-CCC-1200	measured	0.420	0.494	0.515	0.077
January Set 2	EWG-LAW-NEW-OL-8445-CCC-1200	targeted	0.415	0.468	0.496	0.079
March Set 1	ARM-1	ref	0.528	0.611	0.535	0.294
March Set 1	EA	ref	9.750	6.092	7.559	2.762
March Set 1	EWG-LAW-New-IL-151542-CCC-1225	measured	0.717	0.871	0.892	0.291
March Set 1	EWG-LAW-New-IL-151542-CCC-1225	targeted	0.671	0.794	0.938	0.290
March Set 1	EWG-LAW-New-IL-42295-CCC-1150	measured	16.603	13.622	11.403	2.191
March Set 1	EWG-LAW-New-IL-42295-CCC-1150	targeted	16.300	13.050	11.629	2.219
March Set 1	EWG-LAW-New-IL-456-CCC-1200	measured	0.510	0.764	0.761	0.245
March Set 1	EWG-LAW-New-IL-456-CCC-1200	targeted	0.508	0.739	0.764	0.248
March Set 1	EWG-LAW-New-IL-5253-CCC	measured	2.331	2.125	1.850	0.511
March Set 1	EWG-LAW-New-IL-5253-CCC	targeted	2.209	2.003	1.808	0.511
March Set 1	EWG-LAW-New-IL-5255-CCC-1200	measured	13.212	11.154	9.288	1.556
March Set 1	EWG-LAW-New-IL-5255-CCC-1200	targeted	12.572	10.361	9.008	1.549
March Set 1	EWG-LAW-New-IL-93907-CCC	measured	0.484	0.496	0.484	0.254
March Set 1	EWG-LAW-New-IL-93907-CCC	targeted	0.445	0.455	0.466	0.248
March Set 1	EWG-LAW-New-OL-14844-CCC-1250	measured	7.487	7.438	6.689	1.097
March Set 1	EWG-LAW-New-OL-14844-CCC-1250	targeted	6.997	6.958	6.787	1.132
March Set 1	EWG-LAW-New-OL-15493-CCC-1225	measured	90.476	-	39.830	2.114
March Set 1	EWG-LAW-New-OL-15493-CCC-1225	targeted	89.586	-	41.357	2.114
March Set 1	EWG-LAW-New-OL-17130-CCC-1150	measured	22.562	19.538	16.771	5.024
March Set 1	EWG-LAW-New-OL-17130-CCC-1150	targeted	21.438	18.467	16.339	4.974
March Set 1	EWG-LAW-New-OL-57284-CCC-1200	measured	2.288	-	1.800	0.444
March Set 1	EWG-LAW-New-OL-57284-CCC-1200	targeted	2.225	-	1.807	0.443
March Set 1	EWG-LAW-New-OL-8788-Mod-CCC-1300	measured	0.507	0.518	0.436	0.240
March Set 1	EWG-LAW-New-OL-8788-Mod-CCC-1300	targeted	0.522	0.506	0.422	0.248

Table 3-2. Normalized PCT Results (continued)

Set	Glass ID w Heat Treatment	Comp View	NC_B (g/L)	NC_{Li} (g/L)	NC_{Na} (g/L)	NC_{Si} (g/L)
March Set 2	ARM-1	ref	0.503	0.581	0.449	0.279
March Set 2	EA	ref	12.147	7.12	9.069	3.109
March Set 2	EWG-LAW-New-OL-100210-CCC-1250	measured	2.046	-	2.334	1.198
March Set 2	EWG-LAW-New-OL-100210-CCC-1250	targeted	1.960	-	2.463	1.187
March Set 2	EWG-LAW-New-OL-108249-(SO4 Mod)-CCC-1300	measured	15.658	4.953	4.690	0.126
March Set 2	EWG-LAW-New-OL-108249-(SO4 Mod)-CCC-1300	targeted	16.110	4.913	4.557	0.131
March Set 2	EWG-LAW-New-OL-108249-(SO4 Mod)-Q	measured	0.318	0.609	0.865	0.178
March Set 2	EWG-LAW-New-OL-108249-(SO4 Mod)-Q	targeted	0.328	0.604	0.840	0.186
March Set 2	EWG-LAW-New-OL-116208-(SO4 Mod)-CCC-1300	measured	17.888	7.692	11.881	1.019
March Set 2	EWG-LAW-New-OL-116208-(SO4 Mod)-CCC-1300	targeted	18.065	7.444	11.443	1.060
March Set 2	EWG-LAW-New-OL-116208-(SO4 Mod)-Q	measured	8.521	7.77	8.170	1.228
March Set 2	EWG-LAW-New-OL-116208-(SO4 Mod)-Q	targeted	8.605	7.519	7.869	1.277
March Set 2	EWG-LAW-New-OL-122817-CCC-1200	measured	0.443	-	0.899	0.218
March Set 2	EWG-LAW-New-OL-122817-CCC-1200	targeted	0.440	-	0.932	0.213
March Set 2	EWG-LAW-New-OL-127708-Mod-CCC-1300	measured	0.513	0.563	0.436	0.266
March Set 2	EWG-LAW-New-OL-127708-Mod-CCC-1300	targeted	0.519	0.686	0.437	0.271
March Set 2	EWG-LAW-New-OL-65959-Mod-CCC-1250	measured	46.330	18.428	18.947	0.506
March Set 2	EWG-LAW-New-OL-65959-Mod-CCC-1250	targeted	46.468	18.012	18.382	0.514
March Set 2	EWG-LAW-ORP-LD1-1-CCC-1300	measured	0.594	-	0.747	0.300
March Set 2	EWG-LAW-ORP-LD1-1-CCC-1300	targeted	0.569	-	0.736	0.300
March Set 2	EWG-LAW-ORP-LD1-3-Q	measured	0.629	-	0.769	0.182
March Set 2	EWG-LAW-ORP-LD1-3-Q	targeted	0.606	-	0.707	0.177
April	ARM-1	ref	0.508	0.599	0.529	0.277
April	EA	ref	12.856	7.463	10.429	3.117
April	EWG-LAW-New-IL-166697-CCC-1250	measured	0.788	0.697	0.842	0.337
April	EWG-LAW-New-IL-166697-CCC-1250	targeted	0.754	0.659	0.860	0.344
April	EWG-LAW-New-IL-166731-CCC-1225	measured	4.863	4.392	2.832	0.702
April	EWG-LAW-New-IL-166731-CCC-1225	targeted	4.701	4.099	2.913	0.712
April	EWG-LAW-New-IL-87749-CCC-1225	measured	0.321	0.713	0.857	0.213
April	EWG-LAW-New-IL-87749-CCC-1225	targeted	0.311	0.674	0.867	0.213
April	EWG-LAW-New-OL-62909-Mod-CCC-1300	measured	0.261	0.45	0.431	0.142
April	EWG-LAW-New-OL-62909-Mod-CCC-1300	targeted	0.264	0.432	0.447	0.146
April	EWG-LAW-New-OL-80309-CCC-1300	measured	11.117	8.969	7.441	1.209
April	EWG-LAW-New-OL-80309-CCC-1300	targeted	11.174	8.68	7.124	1.223

Table 3-2. Normalized PCT Results (continued)

Set	Glass ID w Heat Treatment	Comp View	NC_B (g/L)	NC_{Li} (g/L)	NC_{Na} (g/L)	NC_{Si} (g/L)
April	EWG-LAW-ORP-LD1-2-CCC-1300	measured	0.639	-	0.856	0.266
April	EWG-LAW-ORP-LD1-2-CCC-1300	targeted	0.644	-	0.827	0.271
April	EWG-LAW-ORP-LD1-3-CCC-1300	measured	0.480	-	0.649	0.155
April	EWG-LAW-ORP-LD1-3-CCC-1300	targeted	0.462	-	0.597	0.151

4.0 Summary

In this report, SRNL provides chemical analyses and PCT results for several simulated LAW glasses (designated as the January, March, and April 2015 LAW glasses) fabricated by PNNL. The measured chemical composition data are reported and compared with the targeted values for each component for each glass. Measurements for one of the glasses were repeated in order to correct unexpected results. All of the measured sums of oxides for the study glasses fall within the interval of 97.9 to 100.7 wt %, indicating recovery of all components. The Al_2O_3 concentration of glass EWG-LAW-ORP-LD1-3 is about 45% higher than the targeted value. The concentrations of other major oxides in this glass are below their targeted values, indicating that excess Al_2O_3 may have been added to the batch for EWG-LAW-ORP-LD1-3.

The PCT results were normalized to both the targeted and measured compositions of the study glasses. Several of the study glasses have normalized concentration values that are higher than the WTP contract limit of 4.0 g/L for both the quenched and CCC heat treatments. These results can be combined with additional characterization, including X-ray diffraction, to determine the cause of the higher releases. It is recommended that a more complete review of the influence of composition and heat treatment on the PCT responses of the glasses described in this report, as well as those described in a previous report,[1] be performed in order to draw further conclusions.

5.0 References

1. Fox, K. M., T. B. Edwards, and D. R. Best, "Chemical Composition Analysis and Product Consistency Tests to Support Enhanced Hanford Waste Glass Models: Results for the August and October 2014 LAW Glasses," *U.S. Department of Energy Report SRNL-STI-2015-00226, Revision 0,* Savannah River National Laboratory, Aiken, SC (2015).

2. Fox, K. M. and D. K. Peeler, "Task Technical and Quality Assurance Plan for Hanford HLW Glass Development and Characterization," *U.S. Department of Energy Report SRNL-RP-2013-00692, Revision 0,* Savannah River National Laboratory, Aiken, SC (2013).

3. Vienna, J. D., D. S. Kim, M. J. Schweiger, J. S. McCloy, J. Matyáš, G. F. Piepel, and S. K. Cooley, "Test Plan: Enhanced Hanford Waste Glass Models," *U.S. Department of Energy Report TP-EWG-00001, Revision 0,* Pacific Northwest National Laboratory, Richland, WA (2013).

4. Edwards, T. B., "An Analytical Plan for Measuring the Chemical Compositions of the January 2015 and March 2015 Hanford Enhanced Waste Glass LAW Studies," *U.S. Department of Energy Memorandum SRNL-L3100-2015-00066,* Savannah River National Laboratory, Aiken, SC (2015).

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

6. ASTM, "Standard Test Methods for Determining Chemical Durability of Nuclear Waste Glasses: The Product Consistency Test (PCT)," *ASTM C-1285,* (2014).

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

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

9. Peeler, D. K. and T. B. Edwards, "An Analytical Plan for Measuring the PCT Solutions from the January 2015 Hanford Enhanced Waste Glass LAW Studies," *U.S. Department of Energy Memorandum SRNL-L3100-2015-00010,* Savannah River National Laboratory, Aiken, SC (2015).

10. Edwards, T. B., "An Analytical Plan for Measuring the PCT Solutions from the March 2015 Hanford Enhanced Waste Glass LAW Studies," *U.S. Department of Energy Memorandum SRNL-L3100-2015-00052,* Savannah River National Laboratory, Aiken, SC (2015).

11. Edwards, T. B., "An Analytical Plan for Measuring the PCT Solutions from the April 2015 Hanford Enhanced Waste Glass LAW Studies," *U.S. Department of Energy Memorandum SRNL-L3100-2015-00080,* Savannah River National Laboratory, Aiken, SC (2015).

12. **JMP™ Pro, Ver. 11.2.1,** [Computer Software] SAS Institute Inc., Cary, NC (2014).

13. Best, D. R., "Inductively Coupled Plasma-Atomic Emission Spectrometer, Agilent 730 ES," *Manual L29, Procedure ITS-0079,* Savannah River National Laboratory, Aiken, SC (2014).

14. Jantzen, C. M., K. G. Brown, and T. B. Edwards, "Impact of Phase Separation on Waste Glass Durability"; pp. 289-300 in Ceramic Transactions, Vol. 107, *Environmental Issues and Waste Management Technologies in the Ceramic and Nuclear Industries V*. Edited by G. T. Chandler. The American Ceramic Society, Westerville, OH, 2000.

Appendix A Tables and Exhibits Supporting the Chemical Composition Measurements

Table A-1. LM Measurements of the LAW Study Glasses – Part 1

ID	Block	Sub-Blk	Sequence	Lab ID	Ca (wt%)	Cr (wt%)	K (wt%)	Mg (wt%)	Na (wt%)
LRM	1	1	1	LRMLM111	0.355	0.141	1.29	0.066	14.7
EWG-LAW-New-OL-8788-Mod	1	1	2	A08LM21	0.085	0.217	1.23	1.91	9.49
EWG-LAW-New-OL-54017	1	1	3	A02LM21	7.72	0.036	<0.100	1.94	11.1
EWG-LAW-New-OL-116208-SO4Mod	1	1	4	A07LM21	8.30	0.208	<0.100	2.08	11.5
EWG-LAW-New-OL-45748	1	1	5	A11LM11	8.78	0.204	<0.100	<0.010	8.40
EWG-LAW-New-OL-116208-SO4Mod	1	1	6	A07LM11	8.53	0.216	<0.100	2.09	12.0
EWG-LAW-New-OL-45748	1	1	7	A11LM21	8.77	0.211	<0.100	<0.010	8.37
LRM	1	1	8	LRMLM112	0.374	0.144	1.35	0.068	15.2
EWG-LAW-ORP-LD1-3	1	1	9	A06LM11	5.18	0.328	0.154	0.610	14.5
EWG-LAW-New-OL-108249-SO4Mod	1	1	10	A03LM11	6.81	0.219	1.24	0.040	11.3
EWG-LAW-New-OL-8788-Mod	1	1	11	A08LM11	0.079	0.221	1.32	1.89	9.31
EWG-LAW-New-OL-108249-SO4Mod	1	1	12	A03LM21	6.72	0.223	1.33	0.041	11.1
EWG-LAW-New-OL-54017	1	1	13	A02LM11	7.48	0.039	<0.100	1.90	10.9
EWG-LAW-ORP-LD1-3	1	1	14	A06LM21	5.09	0.337	0.163	0.620	14.4
LRM	1	1	15	LRMLM113	0.361	0.147	1.43	0.070	15.0
LRM	1	2	1	LRMLM121	0.356	0.141	1.28	0.066	14.6
EWG-LAW-New-OL-8788-Mod	1	2	2	A08LM12	0.077	0.218	1.25	1.89	9.30
EWG-LAW-New-OL-45748	1	2	3	A11LM22	8.50	0.212	<0.100	<0.010	8.18
EWG-LAW-New-OL-108249-SO4Mod	1	2	4	A03LM12	6.89	0.220	1.18	0.039	11.4
EWG-LAW-New-OL-54017	1	2	5	A02LM12	7.55	0.038	<0.100	1.92	10.9
EWG-LAW-New-OL-45748	1	2	6	A11LM12	8.53	0.213	<0.100	<0.010	8.17
EWG-LAW-New-OL-116208-SO4Mod	1	2	7	A07LM22	8.37	0.224	<0.100	2.08	11.8
LRM	1	2	8	LRMLM122	0.355	0.146	1.31	0.068	14.5
EWG-LAW-New-OL-108249-SO4Mod	1	2	9	A03LM22	6.82	0.225	1.24	0.040	11.2
EWG-LAW-New-OL-8788-Mod	1	2	10	A08LM22	0.082	0.227	1.27	1.88	9.25
EWG-LAW-ORP-LD1-3	1	2	11	A06LM22	5.12	0.340	0.153	0.611	14.2
EWG-LAW-New-OL-54017	1	2	12	A02LM22	7.55	0.038	<0.100	1.91	10.8
EWG-LAW-ORP-LD1-3	1	2	13	A06LM12	5.11	0.339	0.154	0.613	14.2
EWG-LAW-New-OL-116208-SO4Mod	1	2	14	A07LM12	8.18	0.227	<0.100	2.04	11.4
LRM	1	2	15	LRMLM123	0.363	0.149	1.36	0.069	14.8
LRM	2	1	1	LRMLM211	0.348	0.136	1.25	0.062	14.9
EWG-LAW-New-OL-80309	2	1	2	A09LM11	0.016	0.032	1.21	1.83	10.6
EWG-LAW-New-OL-127708-Mod	2	1	3	A04LM21	0.231	0.035	1.25	1.88	9.31
EWG-LAW-New-OL-65959-Mod	2	1	4	A05LM11	0.035	0.032	<0.100	1.86	11.9

Table A-1. LM Measurements of the LAW Study Glasses – Part 1 (continued)

ID	Block	Sub-Blk	Sequence	Lab ID	Ca (wt%)	Cr (wt%)	K (wt%)	Mg (wt%)	Na (wt%)
EWG-LAW-ORP-LD1-2	2	1	5	A10LM11	5.36	0.331	0.139	0.582	15.0
EWG-LAW-New-OL-80309	2	1	6	A09LM21	0.017	0.032	1.23	1.81	10.4
EWG-LAW-New-OL-62909-Mod	2	1	7	A01LM21	8.91	0.203	<0.100	2.12	10.1
LRM	2	1	8	LRMLM212	0.342	0.136	1.26	0.062	14.7
EWG-LAW-New-OL-65959-Mod	2	1	9	A05LM21	0.033	0.032	<0.100	1.85	11.8
EWG-LAW-New-OL-127708-Mod	2	1	10	A04LM11	0.220	0.034	1.27	1.88	9.25
EWG-LAW-New-OL-62909-Mod	2	1	11	A01LM11	8.62	0.205	<0.100	2.09	9.78
EWG-LAW-ORP-LD1-2	2	1	12	A10LM21	5.29	0.323	0.146	0.568	14.8
LRM	2	1	13	LRMLM213	0.346	0.136	1.26	0.062	14.7
LRM	2	2	1	LRMLM221	0.328	0.137	1.29	0.062	15.3
EWG-LAW-New-OL-80309	2	2	2	A09LM22	0.028	0.032	1.27	1.89	11.0
EWG-LAW-New-OL-62909-Mod	2	2	3	A01LM22	8.96	0.206	<0.100	2.13	10.1
EWG-LAW-New-OL-127708-Mod	2	2	4	A04LM22	0.215	0.035	1.26	1.92	9.31
EWG-LAW-ORP-LD1-2	2	2	5	A10LM22	5.45	0.319	0.150	0.577	15.1
EWG-LAW-New-OL-62909-Mod	2	2	6	A01LM12	8.86	0.207	<0.100	2.12	10.0
EWG-LAW-New-OL-127708-Mod	2	2	7	A04LM12	0.208	0.035	1.30	1.93	9.26
LRM	2	2	8	LRMLM222	0.326	0.138	1.29	0.062	15.1
EWG-LAW-New-OL-65959-Mod	2	2	9	A05LM22	0.039	0.033	<0.100	1.93	12.0
EWG-LAW-New-OL-80309	2	2	10	A09LM12	0.025	0.033	1.23	1.88	10.9
EWG-LAW-ORP-LD1-2	2	2	11	A10LM12	5.49	0.328	0.142	0.590	15.2
EWG-LAW-New-OL-65959-Mod	2	2	12	A05LM12	0.037	0.033	<0.100	1.91	11.8
LRM	2	2	13	LRMLM223	0.328	0.138	1.30	0.062	15.1
LRM	3	1	1	LRMLM311	0.416	0.138	1.22	0.06	16.0
EWG-LAW-New-OL-45748	3	1	2	A11LM11	9.01	0.211	<0.100	<0.100	8.65
EWG-LAW-New-OL-45748	3	1	3	A11LM12	9.05	0.216	<0.100	<0.100	8.67
LRM	3	2	1	LRMLM321	0.353757	0.120	1.13	0.06	15.7
EWG-LAW-New-OL-45748	3	2	2	A11LM21	8.96	0.210	<0.100	<0.100	8.63
EWG-LAW-New-OL-45748	3	2	3	A11LM22	8.93	0.215	<0.100	<0.100	8.61

Table A-2. LM Measurements of LAW Study Glasses – Part 2

ID	Block	Sub-Blk	Sequence	Lab ID	P (wt%)	S (wt%)	V (wt%)	Zn (wt%)	Zr (wt%)
LRM	1	1	1	LRMLM111	0.192	<0.100	<0.100	<0.100	0.610
EWG-LAW-New-OL-8788-Mod	1	1	2	A08LM21	0.613	<0.100	<0.100	3.97	3.89
EWG-LAW-New-OL-54017	1	1	3	A02LM21	0.085	<0.100	0.983	4.01	<0.100
EWG-LAW-New-OL-116208-SO4Mod	1	1	4	A07LM21	0.601	0.367	0.686	0.782	4.53
EWG-LAW-New-OL-45748	1	1	5	A11LM11	0.260	<0.100	1.50	3.99	<0.100
EWG-LAW-New-OL-116208-SO4Mod	1	1	6	A07LM11	0.616	0.388	0.701	0.780	4.56
EWG-LAW-New-OL-45748	1	1	7	A11LM21	0.205	<0.100	1.57	4.00	<0.100
LRM	1	1	8	LRMLM112	0.200	<0.100	<0.100	<0.100	0.632
EWG-LAW-ORP-LD1-3	1	1	9	A06LM11	0.119	0.349	0.532	2.22	2.06
EWG-LAW-New-OL-108249-SO4Mod	1	1	10	A03LM11	0.641	0.357	<0.100	3.91	<0.100
EWG-LAW-New-OL-8788-Mod	1	1	11	A08LM11	0.654	<0.100	<0.100	3.94	4.03
EWG-LAW-New-OL-108249-SO4Mod	1	1	12	A03LM21	0.647	0.367	<0.100	3.90	<0.100
EWG-LAW-New-OL-54017	1	1	13	A02LM11	0.091	<0.100	1.04	3.87	<0.100
EWG-LAW-ORP-LD1-3	1	1	14	A06LM21	0.124	0.366	0.545	2.18	2.11
LRM	1	1	15	LRMLM113	0.207	<0.100	<0.100	<0.100	0.650
LRM	1	2	1	LRMLM121	0.193	<0.100	<0.100	<0.100	0.608
EWG-LAW-New-OL-8788-Mod	1	2	2	A08LM12	0.647	<0.100	<0.100	3.98	3.91
EWG-LAW-New-OL-45748	1	2	3	A11LM22	0.206	<0.100	1.55	3.99	<0.100
EWG-LAW-New-OL-108249-SO4Mod	1	2	4	A03LM12	0.643	0.354	<0.100	3.99	<0.100
EWG-LAW-New-OL-54017	1	2	5	A02LM12	0.088	<0.100	1.01	3.95	<0.100
EWG-LAW-New-OL-45748	1	2	6	A11LM12	0.254	<0.100	1.57	3.99	<0.100
EWG-LAW-New-OL-116208-SO4Mod	1	2	7	A07LM22	0.638	0.403	0.715	0.793	4.38
LRM	1	2	8	LRMLM122	0.201	<0.100	<0.100	<0.100	0.633
EWG-LAW-New-OL-108249-SO4Mod	1	2	9	A03LM22	0.639	0.365	<0.100	3.97	<0.100
EWG-LAW-New-OL-8788-Mod	1	2	10	A08LM22	0.654	<0.100	<0.100	3.97	4.03
EWG-LAW-ORP-LD1-3	1	2	11	A06LM22	0.121	0.359	0.542	2.22	2.08
EWG-LAW-New-OL-54017	1	2	12	A02LM22	0.090	<0.100	1.03	3.97	<0.100
EWG-LAW-ORP-LD1-3	1	2	13	A06LM12	0.122	0.361	0.545	2.22	2.09
EWG-LAW-New-OL-116208-SO4Mod	1	2	14	A07LM12	0.655	0.409	0.730	0.775	4.48
LRM	1	2	15	LRMLM123	0.204	<0.100	<0.100	<0.100	0.640
LRM	2	1	1	LRMLM211	0.186	<0.100	<0.100	<0.100	0.596
EWG-LAW-New-OL-80309	2	1	2	A09LM11	0.083	0.656	2.16	3.82	4.33
EWG-LAW-New-OL-127708-Mod	2	1	3	A04LM21	0.080	<0.100	<0.100	0.756	<0.100
EWG-LAW-New-OL-65959-Mod	2	1	4	A05LM11	0.084	<0.100	1.97	3.90	<0.100
EWG-LAW-ORP-LD1-2	2	1	5	A10LM11	0.115	0.335	0.540	2.32	2.11

Table A-2. LM Measurements of LAW Study Glasses – Part 2 (continued)

ID	Block	Sub-Blk	Sequence	Lab ID	P (wt%)	S (wt%)	V (wt%)	Zn (wt%)	Zr (wt%)
EWG-LAW-New-OL-80309	2	1	6	A09LM21	0.083	0.664	2.13	3.78	4.25
EWG-LAW-New-OL-62909-Mod	2	1	7	A01LM21	0.624	<0.100	<0.100	0.772	3.730
LRM	2	1	8	LRMLM212	0.186	<0.100	<0.100	<0.100	0.598
EWG-LAW-New-OL-65959-Mod	2	1	9	A05LM21	0.084	<0.100	1.94	3.85	<0.100
EWG-LAW-New-OL-127708-Mod	2	1	10	A04LM11	0.079	<0.100	<0.100	0.768	<0.100
EWG-LAW-New-OL-62909-Mod	2	1	11	A01LM11	0.635	<0.100	<0.100	0.77	3.78
EWG-LAW-ORP-LD1-2	2	1	12	A10LM21	0.118	0.327	0.526	2.29	2.05
LRM	2	1	13	LRMLM213	0.187	<0.100	<0.100	<0.100	0.598
LRM	2	2	1	LRMLM221	0.188	<0.100	<0.100	<0.100	0.606
EWG-LAW-New-OL-80309	2	2	2	A09LM22	0.084	0.641	2.19	3.94	4.37
EWG-LAW-New-OL-62909-Mod	2	2	3	A01LM22	0.634	<0.100	<0.100	0.773	3.48
EWG-LAW-New-OL-127708-Mod	2	2	4	A04LM22	0.081	<0.100	<0.100	0.781	<0.100
EWG-LAW-ORP-LD1-2	2	2	5	A10LM22	0.118	0.323	0.537	2.38	2.09
EWG-LAW-New-OL-62909-Mod	2	2	6	A01LM12	0.642	<0.100	<0.100	0.763	3.47
EWG-LAW-New-OL-127708-Mod	2	2	7	A04LM12	0.079	<0.100	<0.100	0.783	<0.100
LRM	2	2	8	LRMLM222	0.187	<0.100	<0.100	<0.100	0.610
EWG-LAW-New-OL-65959-Mod	2	2	9	A05LM22	0.083	<0.100	2.00	4.01	<0.100
EWG-LAW-New-OL-80309	2	2	10	A09LM12	0.080	0.648	2.19	3.92	4.36
EWG-LAW-ORP-LD1-2	2	2	11	A10LM12	0.114	0.320	0.551	2.39	2.16
EWG-LAW-New-OL-65959-Mod	2	2	12	A05LM12	0.083	<0.100	2.00	3.95	<0.100
LRM	2	2	13	LRMLM223	0.188	<0.100	<0.100	<0.100	0.613
LRM	3	1	1	LRMPF311	0.214	<0.100	<0.100	<0.100	0.658
EWG-LAW-New-OL-45748	3	1	2	A11LM11	0.637	<0.100	1.67	4.06	<0.100
EWG-LAW-New-OL-45748	3	1	3	A11LM12	0.623	<0.100	1.68	4.08	<0.100
LRM	3	2	1	LRMPF321	0.272	<0.100	<0.100	<0.100	0.595
EWG-LAW-New-OL-45748	3	2	2	A11LM21	0.615	<0.100	1.66	4.08	<0.100
EWG-LAW-New-OL-45748	3	2	3	A11LM22	0.620	<0.100	1.66	4.07	<0.100

Table A-3. PF Measurements of the LAW Study Glasses

ID	Block	Sub-Blk	Sequence	Lab ID	Al (wt%)	B (wt%)	Fe (wt%)	Li (wt%)	Si (wt%)	Sn (wt%)
LRM	1	1	1	LRMPF111	5.18	2.55	1.04	<0.100	25.8	<0.500
EWG-LAW-New-OL-108249-SO4Mod	1	1	2	A03PF21	6.42	1.92	1.10	2.32	16.7	3.69
EWG-LAW-ORP-LD1-3	1	1	3	A06PF11	7.78	3.55	0.688	<0.100	16.7	<0.500
EWG-LAW-New-OL-8788-Mod	1	1	4	A08PF21	6.58	1.90	1.07	1.14	22.1	<0.500
EWG-LAW-New-OL-116208-SO4Mod	1	1	5	A07PF21	1.89	1.85	1.05	2.23	16.7	3.51
EWG-LAW-New-OL-116208-SO4Mod	1	1	6	A07PF11	1.95	1.91	1.08	2.31	16.4	3.35
EWG-LAW-New-OL-54017	1	1	7	A02PF21	1.94	1.91	1.09	<0.100	22.6	3.43
LRM	1	1	8	LRMPF112	5.21	2.45	1.04	<0.100	25.9	<0.500
EWG-LAW-New-OL-45748	1	1	9	A11PF21	7.30	1.95	1.05	2.31	16.3	3.68
EWG-LAW-New-OL-8788-Mod	1	1	10	A08PF11	6.56	1.91	1.07	1.13	22.0	<0.500
EWG-LAW-ORP-LD1-3	1	1	11	A06PF21	7.74	3.59	0.672	<0.100	16.8	<0.500
EWG-LAW-New-OL-54017	1	1	12	A02PF11	1.94	1.93	1.06	<0.100	22.1	3.31
EWG-LAW-New-OL-108249-SO4Mod	1	1	13	A03PF11	6.38	1.93	1.10	2.30	16.5	3.50
EWG-LAW-New-OL-45748	1	1	14	A11PF11	7.22	1.92	1.07	2.29	16.3	3.53
LRM	1	1	15	LRMPF113	5.07	2.41	1.02	<0.100	25.4	<0.500
LRM	1	2	1	LRMPF121	5.15	2.51	1.04	<0.100	25.8	<0.500
EWG-LAW-New-OL-8788-Mod	1	2	2	A08PF12	6.60	1.98	1.10	1.14	22.6	<0.500
EWG-LAW-New-OL-45748	1	2	3	A11PF12	7.31	1.96	1.09	2.33	16.6	3.82
EWG-LAW-New-OL-8788-Mod	1	2	4	A08PF22	6.55	1.89	1.07	1.13	22.1	<0.500
EWG-LAW-New-OL-108249-SO4Mod	1	2	5	A03PF22	6.36	1.91	1.10	2.29	16.5	3.61
EWG-LAW-New-OL-54017	1	2	6	A02PF22	1.91	1.90	1.08	<0.100	22.6	3.72
EWG-LAW-New-OL-45748	1	2	7	A11PF22	7.21	1.88	1.05	2.29	16.2	3.70
LRM	1	2	8	LRMPF122	5.29	2.50	1.06	<0.100	26.3	<0.500
EWG-LAW-New-OL-116208-SO4Mod	1	2	9	A07PF12	1.99	2.02	1.12	2.36	16.9	3.76
EWG-LAW-ORP-LD1-3	1	2	10	A06PF12	7.78	3.60	0.694	<0.100	17.0	<0.500
EWG-LAW-ORP-LD1-3	1	2	11	A06PF22	7.88	3.66	0.682	<0.100	17.1	<0.500
EWG-LAW-New-OL-116208-SO4Mod	1	2	12	A07PF22	1.84	1.81	1.04	2.18	16.7	3.52
EWG-LAW-New-OL-54017	1	2	13	A02PF12	1.99	1.98	1.10	<0.100	23.0	3.49
EWG-LAW-New-OL-108249-SO4Mod	1	2	14	A03PF12	6.51	1.96	1.13	2.36	17.0	3.66
LRM	1	2	15	LRMPF123	5.31	2.50	1.07	<0.100	26.6	<0.500
LRM	2	1	1	LRMPF211	5.30	2.52	1.02	<0.100	26.3	<0.500
EWG-LAW-New-OL-80309	2	1	2	A09PF11	1.88	4.34	1.03	2.25	16.2	3.43
EWG-LAW-ORP-LD1-2	2	1	3	A10PF21	5.36	3.77	0.683	<0.100	17.8	<0.500
EWG-LAW-New-OL-65959-Mod	2	1	4	A05PF21	7.27	4.08	<0.100	2.28	16.6	3.18
EWG-LAW-New-OL-127708-Mod	2	1	5	A04PF21	5.75	4.30	1.03	1.11	22.4	3.29

Table A-3. PF Measurements of the LAW Study Glasses (continued)

ID	Block	Sub-Blk	Sequence	Lab ID	Al (wt%)	B (wt%)	Fe (wt%)	Li (wt%)	Si (wt%)	Sn (wt%)
EWG-LAW-New-OL-62909-Mod	2	1	6	A01PF11	6.54	2.82	<0.100	1.10	16.3	3.27
EWG-LAW-New-OL-80309	2	1	7	A09PF21	1.85	4.28	1.02	2.23	16.1	3.14
LRM	2	1	8	LRMPF212	5.26	2.45	1.03	<0.100	26.3	<0.500
EWG-LAW-New-OL-65959-Mod	2	1	9	A05PF11	7.12	3.97	<0.100	2.24	16.3	3.36
EWG-LAW-ORP-LD1-2	2	1	10	A10PF11	5.25	3.70	0.692	<0.100	17.5	<0.500
EWG-LAW-New-OL-62909-Mod	2	1	11	A01PF21	6.32	2.68	<0.100	1.06	15.7	3.23
EWG-LAW-New-OL-127708-Mod	2	1	12	A04PF11	5.77	4.28	1.03	1.11	22.3	3.33
LRM	2	1	13	LRMPF213	5.21	2.46	1.03	<0.100	26.3	<0.500
LRM	2	2	1	LRMPF221	5.34	2.63	1.08	<0.100	26.5	<0.500
EWG-LAW-New-OL-65959-Mod	2	2	2	A05PF12	7.27	4.20	<0.100	2.31	16.6	3.41
EWG-LAW-New-OL-80309	2	2	3	A09PF22	1.92	4.32	1.07	2.28	16.1	3.46
EWG-LAW-New-OL-65959-Mod	2	2	4	A05PF22	7.04	4.01	<0.100	2.25	16.0	3.43
EWG-LAW-New-OL-62909-Mod	2	2	5	A01PF22	6.54	2.86	<0.100	1.15	16.2	3.43
EWG-LAW-ORP-LD1-2	2	2	6	A10PF22	5.29	3.78	0.724	<0.100	17.6	<0.500
EWG-LAW-New-OL-127708-Mod	2	2	7	A04PF12	5.82	4.39	1.08	1.17	22.5	3.46
LRM	2	2	8	LRMPF222	5.17	2.50	1.06	<0.100	26.0	<0.500
EWG-LAW-ORP-LD1-2	2	2	9	A10PF12	5.36	3.82	0.766	<0.100	17.9	<0.500
EWG-LAW-New-OL-80309	2	2	10	A09PF12	1.88	4.23	1.06	2.23	15.9	3.45
EWG-LAW-New-OL-127708-Mod	2	2	11	A04PF22	5.76	4.31	1.08	1.16	22.3	3.38
EWG-LAW-New-OL-62909-Mod	2	2	12	A01PF12	6.51	2.83	<0.100	1.15	16.1	3.37
LRM	2	2	13	LRMPF223	5.10	2.41	1.03	<0.100	25.3	<0.500

Table A-4. KH Measurements of the LAW Study Glasses

ID	Block	Sub-Blk	Sequence	Lab ID	Cl (wt%)	F (wt%)
LRM	1	1	1	LRMKH111	<0.010	0.854
EWG-LAW-New-OL-45748	1	1	2	A11KH21	0.241	0.510
EWG-LAW-New-OL-116208-SO4Mod	1	1	3	A07KH11	0.277	0.570
EWG-LAW-New-OL-108249-SO4Mod	1	1	4	A03KH11	0.300	0.557
EWG-LAW-New-OL-45748	1	1	5	A11KH11	0.236	0.505
EWG-LAW-New-OL-54017	1	1	6	A02KH21	0.040	0.057
EWG-LAW-ORP-LD1-3	1	1	7	A06KH21	0.152	0.109
LRM	1	1	8	LRMKH112	<0.010	0.844
EWG-LAW-New-OL-8788-Mod	1	1	9	A08KH21	0.320	0.528
EWG-LAW-New-OL-108249-SO4Mod	1	1	10	A03KH21	0.287	0.559
EWG-LAW-New-OL-54017	1	1	11	A02KH11	0.041	0.056
EWG-LAW-New-OL-8788-Mod	1	1	12	A08KH11	0.322	0.530
EWG-LAW-New-OL-116208-SO4Mod	1	1	13	A07KH21	0.291	0.593
EWG-LAW-ORP-LD1-3	1	1	14	A06KH11	0.163	0.117
LRM	1	1	15	LRMKH113	<0.010	0.852
LRM	1	2	1	LRMKH121	<0.010	0.845
EWG-LAW-New-OL-54017	1	2	2	A02KH12	0.042	0.057
EWG-LAW-New-OL-116208-SO4Mod	1	2	3	A07KH22	0.290	0.592
EWG-LAW-New-OL-108249-SO4Mod	1	2	4	A03KH12	0.287	0.554
EWG-LAW-ORP-LD1-3	1	2	5	A06KH12	0.163	0.119
EWG-LAW-New-OL-45748	1	2	6	A11KH12	0.234	0.499
EWG-LAW-New-OL-8788-Mod	1	2	7	A08KH22	0.322	0.532
LRM	1	2	8	LRMKH122	<0.010	0.846
EWG-LAW-New-OL-108249-SO4Mod	1	2	9	A03KH22	0.298	0.655
EWG-LAW-New-OL-45748	1	2	10	A11KH22	0.239	0.515
EWG-LAW-New-OL-54017	1	2	11	A02KH22	0.042	0.058
EWG-LAW-New-OL-116208-SO4Mod	1	2	12	A07KH12	0.283	0.594
EWG-LAW-New-OL-8788-Mod	1	2	13	A08KH12	0.320	0.528
EWG-LAW-ORP-LD1-3	1	2	14	A06KH22	0.168	0.118
LRM	1	2	15	LRMKH123	<0.010	0.850
LRM	2	1	1	LRMKH211	<0.010	0.848
EWG-LAW-New-OL-80309	2	1	2	A09KH21	0.044	0.069
EWG-LAW-New-OL-127708-Mod	2	1	3	A04KH21	0.030	0.052
EWG-LAW-New-OL-62909-Mod	2	1	4	A01KH21	0.223	0.538
EWG-LAW-New-OL-80309	2	1	5	A09KH11	0.040	0.064
EWG-LAW-ORP-LD1-2	2	1	6	A10KH21	0.174	0.123
EWG-LAW-New-OL-65959-Mod	2	1	7	A05KH11	0.034	0.063
LRM	2	1	8	LRMKH212	<0.010	0.851
EWG-LAW-ORP-LD1-2	2	1	9	A10KH11	0.175	0.124
EWG-LAW-New-OL-65959-Mod	2	1	10	A05KH21	0.032	0.064
EWG-LAW-New-OL-62909-Mod	2	1	11	A01KH11	0.224	0.551
EWG-LAW-New-OL-127708-Mod	2	1	12	A04KH11	0.028	0.053
LRM	2	1	13	LRMKH213	<0.010	0.853
LRM	2	2	1	LRMKH221	<0.010	0.880
EWG-LAW-New-OL-62909-Mod	2	2	2	A01KH22	0.218	0.558
EWG-LAW-New-OL-80309	2	2	3	A09KH22	0.043	0.067
EWG-LAW-ORP-LD1-2	2	2	4	A10KH12	0.172	0.124
EWG-LAW-New-OL-65959-Mod	2	2	5	A05KH22	0.033	0.064
EWG-LAW-ORP-LD1-2	2	2	6	A10KH22	0.172	0.126
EWG-LAW-New-OL-65959-Mod	2	2	7	A05KH12	0.038	0.064
LRM	2	2	8	LRMKH222	<0.010	0.873
EWG-LAW-New-OL-80309	2	2	9	A09KH12	0.043	0.068
EWG-LAW-New-OL-62909-Mod	2	2	10	A01KH12	0.222	0.562
EWG-LAW-New-OL-127708-Mod	2	2	11	A04KH22	0.028	0.052
EWG-LAW-New-OL-127708-Mod	2	2	12	A04KH12	0.028	0.053
LRM	2	2	13	LRMKH223	<0.010	0.887

Table A-5. Comparison of Targeted and Measured Glass Compositions

Glass ID	Oxide	BDL (<)	Measured (wt %)	Targeted (wt %)	Measured versus Targeted	% Difference of Measured versus Targeted
EWG-LAW-New-OL-108249-SO4Mod	Al_2O_3		12.126	12.030	0.096	0.8%
EWG-LAW-New-OL-108249-SO4Mod	B_2O_3		6.214	6.040	0.174	2.9%
EWG-LAW-New-OL-108249-SO4Mod	CaO		9.529	10.070	-0.541	-5.4%
EWG-LAW-New-OL-108249-SO4Mod	Cl		0.293	0.470	-0.177	
EWG-LAW-New-OL-108249-SO4Mod	Cr_2O_3		0.324	0.310	0.014	
EWG-LAW-New-OL-108249-SO4Mod	F		0.581	0.710	-0.129	
EWG-LAW-New-OL-108249-SO4Mod	Fe_2O_3		1.583	1.510	0.073	
EWG-LAW-New-OL-108249-SO4Mod	K_2O		1.503	1.510	-0.007	
EWG-LAW-New-OL-108249-SO4Mod	Li_2O		4.989	5.030	-0.041	-0.8%
EWG-LAW-New-OL-108249-SO4Mod	MgO		0.066	0.000	0.066	
EWG-LAW-New-OL-108249-SO4Mod	Na_2O		15.165	15.610	-0.445	-2.9%
EWG-LAW-New-OL-108249-SO4Mod	P_2O_5		1.472	1.520	-0.048	
EWG-LAW-New-OL-108249-SO4Mod	SiO_2		35.673	34.230	1.443	4.2%
EWG-LAW-New-OL-108249-SO4Mod	SnO_2		4.590	5.030	-0.440	-8.8%
EWG-LAW-New-OL-108249-SO4Mod	SO_3		0.901	0.890	0.011	
EWG-LAW-New-OL-108249-SO4Mod	V_2O_5	<	0.179	0.000	0.179	
EWG-LAW-New-OL-108249-SO4Mod	ZnO		4.908	5.030	-0.122	-2.4%
EWG-LAW-New-OL-108249-SO4Mod	ZrO_2	<	0.135	0.000	0.135	
EWG-LAW-New-OL-108249-SO4Mod	Sum		100.231	99.990	0.241	0.2%
EWG-LAW-New-OL-116208-SO4Mod	Al_2O_3		3.623	3.530	0.093	
EWG-LAW-New-OL-116208-SO4Mod	B_2O_3		6.110	6.050	0.060	1.0%
EWG-LAW-New-OL-116208-SO4Mod	CaO		11.676	12.350	-0.674	-5.5%
EWG-LAW-New-OL-116208-SO4Mod	Cl		0.285	0.470	-0.185	
EWG-LAW-New-OL-116208-SO4Mod	Cr_2O_3		0.320	0.310	0.010	
EWG-LAW-New-OL-116208-SO4Mod	F		0.587	0.720	-0.133	
EWG-LAW-New-OL-116208-SO4Mod	Fe_2O_3		1.533	1.510	0.023	
EWG-LAW-New-OL-116208-SO4Mod	K_2O	<	0.121	0.000	0.121	
EWG-LAW-New-OL-116208-SO4Mod	Li_2O		4.887	5.050	-0.163	-3.2%
EWG-LAW-New-OL-116208-SO4Mod	MgO		3.437	3.530	-0.093	
EWG-LAW-New-OL-116208-SO4Mod	Na_2O		15.738	16.340	-0.602	-3.7%
EWG-LAW-New-OL-116208-SO4Mod	P_2O_5		1.438	1.520	-0.082	
EWG-LAW-New-OL-116208-SO4Mod	SiO_2		35.673	34.310	1.363	4.0%
EWG-LAW-New-OL-116208-SO4Mod	SnO_2		4.488	4.540	-0.052	
EWG-LAW-New-OL-116208-SO4Mod	SO_3		0.978	0.930	0.048	
EWG-LAW-New-OL-116208-SO4Mod	V_2O_5		1.264	1.260	0.004	
EWG-LAW-New-OL-116208-SO4Mod	ZnO		0.974	1.010	-0.036	
EWG-LAW-New-OL-116208-SO4Mod	ZrO_2		6.062	6.560	-0.498	-7.6%
EWG-LAW-New-OL-116208-SO4Mod	Sum		99.194	99.990	-0.796	-0.8%
EWG-LAW-New-OL-127708-Mod	Al_2O_3		10.912	10.940	-0.028	-0.3%
EWG-LAW-New-OL-127708-Mod	B_2O_3		13.910	13.750	0.160	1.2%
EWG-LAW-New-OL-127708-Mod	CaO		0.306	0.300	0.006	
EWG-LAW-New-OL-127708-Mod	Cl		0.029	0.060	-0.032	
EWG-LAW-New-OL-127708-Mod	Cr_2O_3		0.051	0.040	0.011	
EWG-LAW-New-OL-127708-Mod	F		0.053	0.090	-0.038	
EWG-LAW-New-OL-127708-Mod	Fe_2O_3		1.508	1.500	0.008	
EWG-LAW-New-OL-127708-Mod	K_2O		1.530	1.500	0.030	
EWG-LAW-New-OL-127708-Mod	Li_2O		2.449	2.010	0.439	
EWG-LAW-New-OL-127708-Mod	MgO		3.155	3.500	-0.345	
EWG-LAW-New-OL-127708-Mod	Na_2O		12.513	12.500	0.013	0.1%
EWG-LAW-New-OL-127708-Mod	P_2O_5		0.183	0.200	-0.017	
EWG-LAW-New-OL-127708-Mod	SiO_2		47.867	47.000	0.867	1.8%
EWG-LAW-New-OL-127708-Mod	SnO_2		4.272	5.000	-0.728	-14.6%
EWG-LAW-New-OL-127708-Mod	SO_3	<	0.250	0.610	-0.360	
EWG-LAW-New-OL-127708-Mod	V_2O_5	<	0.179	0.000	0.179	
EWG-LAW-New-OL-127708-Mod	ZnO		0.961	1.000	-0.039	
EWG-LAW-New-OL-127708-Mod	ZrO_2	<	0.135	0.000	0.135	
EWG-LAW-New-OL-127708-Mod	Sum		100.260	100.000	0.260	0.3%
EWG-LAW-New-OL-45748	Al_2O_3		13.718	13.850	-0.132	-1.0%
EWG-LAW-New-OL-45748	B_2O_3		6.206	6.000	0.206	3.4%

Table A-5. Comparison of Targeted and Measured Glass Compositions (continued)

Glass ID	Oxide	BDL (<)	Measured (wt %)	Targeted (wt %)	Measured versus Targeted	% Difference of Measured versus Targeted
EWG-LAW-New-OL-45748	CaO		12.575	12.240	0.335	2.7%
EWG-LAW-New-OL-45748	Cl		0.238	0.470	-0.233	
EWG-LAW-New-OL-45748	Cr_2O_3		0.311	0.310	0.001	
EWG-LAW-New-OL-45748	F		0.507	0.710	-0.203	
EWG-LAW-New-OL-45748	Fe_2O_3		1.523	1.500	0.023	
EWG-LAW-New-OL-45748	K_2O	<	0.121	0.000	0.121	
EWG-LAW-New-OL-45748	Li_2O		4.962	5.000	-0.038	-0.8%
EWG-LAW-New-OL-45748	MgO	<	0.166	0.000	0.166	
EWG-LAW-New-OL-45748	Na_2O		11.647	11.400	0.247	2.2%
EWG-LAW-New-OL-45748	P_2O_5		1.429	1.510	-0.081	
EWG-LAW-New-OL-45748	SiO_2		34.978	34.000	0.978	2.9%
EWG-LAW-New-OL-45748	SnO_2		4.675	5.000	-0.325	-6.5%
EWG-LAW-New-OL-45748	SO_3	<	0.250	0.100	0.150	
EWG-LAW-New-OL-45748	V_2O_5		2.977	2.910	0.067	
EWG-LAW-New-OL-45748	ZnO		5.069	5.000	0.069	1.4%
EWG-LAW-New-OL-45748	ZrO_2	<	0.135	0.000	0.135	
EWG-LAW-New-OL-45748	Sum		101.487	100.000	1.487	1.5%
EWG-LAW-New-OL-54017	Al_2O_3		3.675	3.500	0.175	
EWG-LAW-New-OL-54017	B_2O_3		6.214	6.000	0.214	3.6%
EWG-LAW-New-OL-54017	CaO		10.599	11.170	-0.571	-5.1%
EWG-LAW-New-OL-54017	Cl		0.041	0.060	-0.019	
EWG-LAW-New-OL-54017	Cr_2O_3		0.055	0.040	0.015	
EWG-LAW-New-OL-54017	F		0.057	0.090	-0.033	
EWG-LAW-New-OL-54017	Fe_2O_3		1.548	1.500	0.048	
EWG-LAW-New-OL-54017	K_2O	<	0.121	0.000	0.121	
EWG-LAW-New-OL-54017	Li_2O	<	0.215	0.000	0.215	
EWG-LAW-New-OL-54017	MgO		3.180	3.500	-0.320	
EWG-LAW-New-OL-54017	Na_2O		14.727	15.000	-0.273	-1.8%
EWG-LAW-New-OL-54017	P_2O_5		0.203	0.200	0.003	
EWG-LAW-New-OL-54017	SiO_2		48.295	47.000	1.295	2.8%
EWG-LAW-New-OL-54017	SnO_2		4.428	5.000	-0.572	-11.4%
EWG-LAW-New-OL-54017	SO_3	<	0.250	0.100	0.150	
EWG-LAW-New-OL-54017	V_2O_5		1.813	1.830	-0.017	
EWG-LAW-New-OL-54017	ZnO		4.917	5.000	-0.083	-1.7%
EWG-LAW-New-OL-54017	ZrO_2	<	0.135	0.000	0.135	
EWG-LAW-New-OL-54017	Sum		100.472	99.990	0.482	0.5%
EWG-LAW-New-OL-62909-Mod	Al_2O_3		12.239	12.350	-0.111	-0.9%
EWG-LAW-New-OL-62909-Mod	B_2O_3		9.008	8.900	0.108	1.2%
EWG-LAW-New-OL-62909-Mod	CaO		12.365	12.240	0.125	1.0%
EWG-LAW-New-OL-62909-Mod	Cl		0.222	0.470	-0.248	
EWG-LAW-New-OL-62909-Mod	Cr_2O_3		0.300	0.310	-0.010	
EWG-LAW-New-OL-62909-Mod	F		0.552	0.710	-0.158	
EWG-LAW-New-OL-62909-Mod	Fe_2O_3	<	0.143	0.000	0.143	
EWG-LAW-New-OL-62909-Mod	K_2O	<	0.121	0.000	0.121	
EWG-LAW-New-OL-62909-Mod	Li_2O		2.401	2.500	-0.099	
EWG-LAW-New-OL-62909-Mod	MgO		3.507	3.500	0.007	
EWG-LAW-New-OL-62909-Mod	Na_2O		13.473	13.000	0.473	3.6%
EWG-LAW-New-OL-62909-Mod	P_2O_5		1.452	1.510	-0.058	
EWG-LAW-New-OL-62909-Mod	SiO_2		34.389	33.500	0.889	2.7%
EWG-LAW-New-OL-62909-Mod	SnO_2		4.221	4.410	-0.189	
EWG-LAW-New-OL-62909-Mod	SO_3	<	0.250	0.100	0.150	
EWG-LAW-New-OL-62909-Mod	V_2O_5	<	0.179	0.000	0.179	
EWG-LAW-New-OL-62909-Mod	ZnO		0.958	1.000	-0.042	
EWG-LAW-New-OL-62909-Mod	ZrO_2		4.883	5.500	-0.617	-11.2%
EWG-LAW-New-OL-62909-Mod	Sum		100.663	100.000	0.663	0.7%
EWG-LAW-New-OL-65959-Mod	Al_2O_3		13.557	13.850	-0.293	-2.1%
EWG-LAW-New-OL-65959-Mod	B_2O_3		13.089	13.050	0.039	0.3%
EWG-LAW-New-OL-65959-Mod	CaO		0.050	0.000	0.050	
EWG-LAW-New-OL-65959-Mod	Cl		0.034	0.060	-0.026	

Table A-5. Comparison of Targeted and Measured Glass Compositions (continued)

Glass ID	Oxide	BDL (<)	Measured (wt %)	Targeted (wt %)	Measured versus Targeted	% Difference of Measured versus Targeted
EWG-LAW-New-OL-65959-Mod	Cr_2O_3		0.048	0.040	0.008	
EWG-LAW-New-OL-65959-Mod	F		0.064	0.090	-0.026	
EWG-LAW-New-OL-65959-Mod	Fe_2O_3	<	0.143	0.000	0.143	
EWG-LAW-New-OL-65959-Mod	K_2O	<	0.121	0.000	0.121	
EWG-LAW-New-OL-65959-Mod	Li_2O		4.887	5.000	-0.113	-2.3%
EWG-LAW-New-OL-65959-Mod	MgO		3.130	3.500	-0.370	
EWG-LAW-New-OL-65959-Mod	Na_2O		16.008	16.500	-0.493	-3.0%
EWG-LAW-New-OL-65959-Mod	P_2O_5		0.191	0.200	-0.009	
EWG-LAW-New-OL-65959-Mod	SiO_2		35.031	34.500	0.531	1.5%
EWG-LAW-New-OL-65959-Mod	SnO_2		4.247	4.500	-0.253	
EWG-LAW-New-OL-65959-Mod	SO_3	<	0.250	0.100	0.150	
EWG-LAW-New-OL-65959-Mod	V_2O_5		3.530	3.600	-0.070	
EWG-LAW-New-OL-65959-Mod	ZnO		4.889	5.000	-0.111	-2.2%
EWG-LAW-New-OL-65959-Mod	ZrO_2	<	0.135	0.000	0.135	
EWG-LAW-New-OL-65959-Mod	Sum		99.403	99.990	-0.587	-0.6%
EWG-LAW-New-OL-80309	Al_2O_3		3.557	3.500	0.057	
EWG-LAW-New-OL-80309	B_2O_3		13.821	13.750	0.071	0.5%
EWG-LAW-New-OL-80309	CaO		0.030	0.000	0.030	
EWG-LAW-New-OL-80309	Cl		0.043	0.060	-0.018	
EWG-LAW-New-OL-80309	Cr_2O_3		0.047	0.040	0.007	
EWG-LAW-New-OL-80309	F		0.067	0.090	-0.023	
EWG-LAW-New-OL-80309	Fe_2O_3		1.494	1.500	-0.006	
EWG-LAW-New-OL-80309	K_2O		1.488	1.500	-0.012	
EWG-LAW-New-OL-80309	Li_2O		4.839	5.000	-0.161	-3.2%
EWG-LAW-New-OL-80309	MgO		3.072	3.500	-0.428	
EWG-LAW-New-OL-80309	Na_2O		14.457	15.100	-0.643	-4.3%
EWG-LAW-New-OL-80309	P_2O_5		0.189	0.200	-0.011	
EWG-LAW-New-OL-80309	SiO_2		34.389	34.000	0.389	1.1%
EWG-LAW-New-OL-80309	SnO_2		4.279	4.500	-0.221	
EWG-LAW-New-OL-80309	SO_3		1.629	1.750	-0.121	
EWG-LAW-New-OL-80309	V_2O_5		3.869	4.000	-0.131	
EWG-LAW-New-OL-80309	ZnO		4.811	5.000	-0.189	-3.8%
EWG-LAW-New-OL-80309	ZrO_2		5.846	6.500	-0.654	-10.1%
EWG-LAW-New-OL-80309	Sum		97.926	99.990	-2.064	-2.1%
EWG-LAW-New-OL-8788-Mod	Al_2O_3		12.419	12.350	0.069	0.6%
EWG-LAW-New-OL-8788-Mod	B_2O_3		6.182	6.000	0.182	3.0%
EWG-LAW-New-OL-8788-Mod	CaO		0.113	0.050	0.063	
EWG-LAW-New-OL-8788-Mod	Cl		0.321	0.470	-0.149	
EWG-LAW-New-OL-8788-Mod	Cr_2O_3		0.323	0.310	0.013	
EWG-LAW-New-OL-8788-Mod	F		0.530	0.710	-0.181	
EWG-LAW-New-OL-8788-Mod	Fe_2O_3		1.541	1.500	0.041	
EWG-LAW-New-OL-8788-Mod	K_2O		1.527	1.500	0.027	
EWG-LAW-New-OL-8788-Mod	Li_2O		2.444	2.500	-0.057	
EWG-LAW-New-OL-8788-Mod	MgO		3.138	3.500	-0.362	
EWG-LAW-New-OL-8788-Mod	Na_2O		12.587	13.000	-0.413	-3.2%
EWG-LAW-New-OL-8788-Mod	P_2O_5		1.471	1.510	-0.039	
EWG-LAW-New-OL-8788-Mod	SiO_2		47.493	46.000	1.493	3.2%
EWG-LAW-New-OL-8788-Mod	SnO_2	<	0.635	0.000	0.635	
EWG-LAW-New-OL-8788-Mod	SO_3	<	0.250	0.100	0.150	
EWG-LAW-New-OL-8788-Mod	V_2O_5	<	0.179	0.000	0.179	
EWG-LAW-New-OL-8788-Mod	ZnO		4.936	5.000	-0.064	-1.3%
EWG-LAW-New-OL-8788-Mod	ZrO_2		5.356	5.500	-0.144	-2.6%
EWG-LAW-New-OL-8788-Mod	Sum		101.441	100.000	1.441	1.4%
EWG-LAW-ORP-LD1-2	Al_2O_3		10.043	10.150	-0.107	-1.1%
EWG-LAW-ORP-LD1-2	B_2O_3		12.131	12.040	0.091	0.8%
EWG-LAW-ORP-LD1-2	CaO		7.552	8.010	-0.458	-5.7%
EWG-LAW-ORP-LD1-2	Cl		0.173	0.330	-0.157	
EWG-LAW-ORP-LD1-2	Cr_2O_3		0.475	0.500	-0.025	
EWG-LAW-ORP-LD1-2	F		0.124	0.170	-0.046	

Table A-5. Comparison of Targeted and Measured Glass Compositions (continued)

Glass ID	Oxide	BDL (<)	Measured (wt %)	Targeted (wt %)	Measured versus Targeted	% Difference of Measured versus Targeted
EWG-LAW-ORP-LD1-2	Fe_2O_3		1.024	1.000	0.024	
EWG-LAW-ORP-LD1-2	K_2O		0.174	0.160	0.014	
EWG-LAW-ORP-LD1-2	Li_2O	<	0.215	0.000	0.215	
EWG-LAW-ORP-LD1-2	MgO		0.961	1.000	-0.039	
EWG-LAW-ORP-LD1-2	Na_2O		20.254	20.980	-0.726	-3.5%
EWG-LAW-ORP-LD1-2	P_2O_5		0.266	0.290	-0.024	
EWG-LAW-ORP-LD1-2	SiO_2		37.866	37.140	0.726	2.0%
EWG-LAW-ORP-LD1-2	SnO_2	<	0.635	0.000	0.635	
EWG-LAW-ORP-LD1-2	SO_3		0.815	1.060	-0.245	
EWG-LAW-ORP-LD1-2	V_2O_5		0.961	1.000	-0.039	
EWG-LAW-ORP-LD1-2	ZnO		2.919	3.000	-0.081	
EWG-LAW-ORP-LD1-2	ZrO_2		2.840	3.000	-0.160	
EWG-LAW-ORP-LD1-2	Sum		99.428	99.830	-0.402	-0.4%
EWG-LAW-ORP-LD1-3	Al_2O_3		14.729	10.150	4.579	45.1%
EWG-LAW-ORP-LD1-3	B_2O_3		11.592	12.040	-0.448	-3.7%
EWG-LAW-ORP-LD1-3	CaO		7.171	8.010	-0.839	-10.5%
EWG-LAW-ORP-LD1-3	Cl		0.162	0.330	-0.169	
EWG-LAW-ORP-LD1-3	Cr_2O_3		0.491	0.500	-0.009	
EWG-LAW-ORP-LD1-3	F		0.116	0.170	-0.054	
EWG-LAW-ORP-LD1-3	Fe_2O_3		0.978	1.000	-0.022	
EWG-LAW-ORP-LD1-3	K_2O		0.188	0.160	0.028	
EWG-LAW-ORP-LD1-3	Li_2O	<	0.215	0.000	0.215	
EWG-LAW-ORP-LD1-3	MgO		1.017	1.000	0.017	
EWG-LAW-ORP-LD1-3	Na_2O		19.310	20.980	-1.670	-8.0%
EWG-LAW-ORP-LD1-3	P_2O_5		0.278	0.290	-0.012	
EWG-LAW-ORP-LD1-3	SiO_2		36.154	37.140	-0.986	-2.7%
EWG-LAW-ORP-LD1-3	SnO_2	<	0.635	0.000	0.635	
EWG-LAW-ORP-LD1-3	SO_3		0.896	1.060	-0.164	
EWG-LAW-ORP-LD1-3	V_2O_5		0.966	1.000	-0.034	
EWG-LAW-ORP-LD1-3	ZnO		2.751	3.000	-0.249	
EWG-LAW-ORP-LD1-3	ZrO_2		2.816	3.000	-0.184	
EWG-LAW-ORP-LD1-3	Sum		100.465	99.830	0.635	0.6%
LRM	Al_2O_3		9.855	9.510	0.345	3.6%
LRM	B_2O_3		8.020	7.850	0.170	2.2%
LRM	CaO		0.495	0.540	-0.045	
LRM	Cl	<	0.010	0.000	0.010	
LRM	Cr_2O_3		0.203	0.190	0.013	
LRM	F		0.857	0.860	-0.003	
LRM	Fe_2O_3		1.492	1.380	0.112	
LRM	K_2O		1.551	1.480	0.071	
LRM	Li_2O	<	0.215	0.110	0.105	
LRM	MgO		0.107	0.100	0.006	
LRM	Na_2O		20.249	20.030	0.219	1.1%
LRM	P_2O_5		0.459	0.540	-0.081	
LRM	SiO_2		55.711	54.200	1.511	2.8%
LRM	SnO_2	<	0.635	0.000	0.635	
LRM	SO_3	<	0.250	0.300	-0.050	
LRM	V_2O_5	<	0.179	0.000	0.179	
LRM	ZnO	<	0.125	0.000	0.125	
LRM	ZrO_2		0.834	0.930	-0.096	
LRM	Sum		101.245	98.020	3.225	3.3%

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

Analyte=Al2O3 (wt%), Prep=PF
Variability Chart for Measured

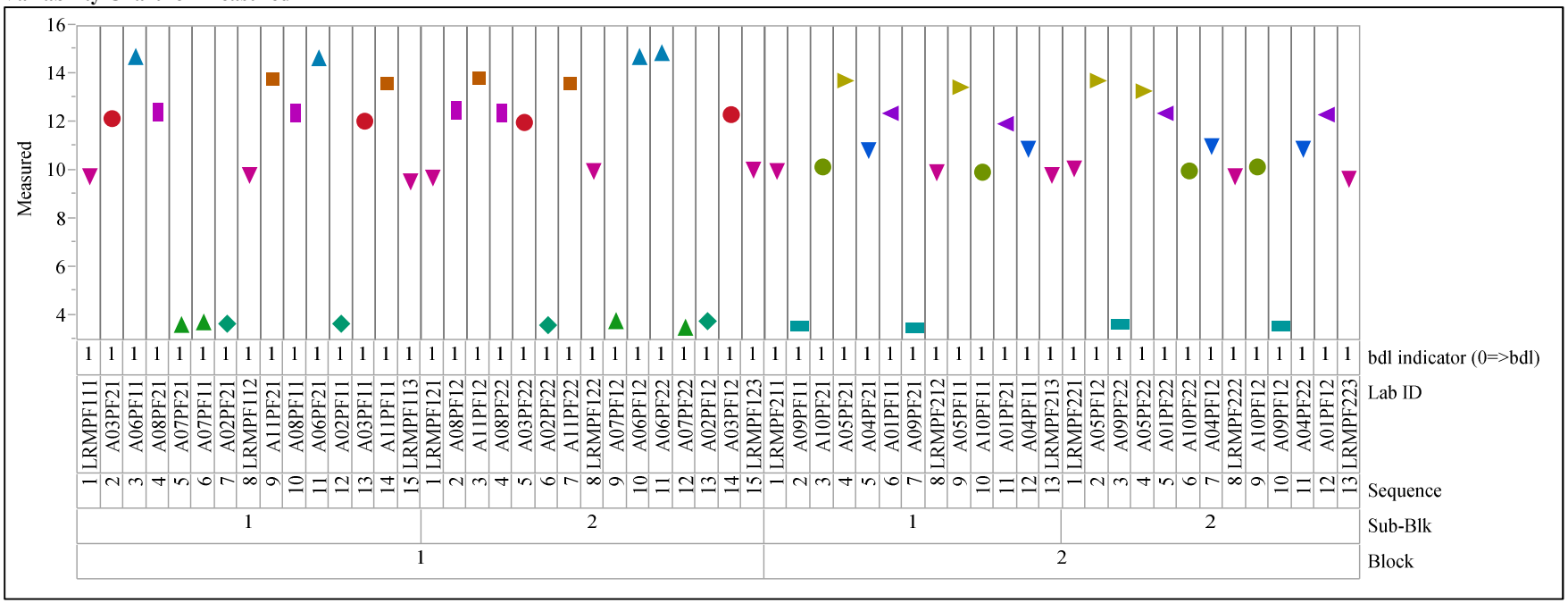


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence (continued)

Analyte=B2O3 (wt%), Prep=PF
Variability Chart for Measured

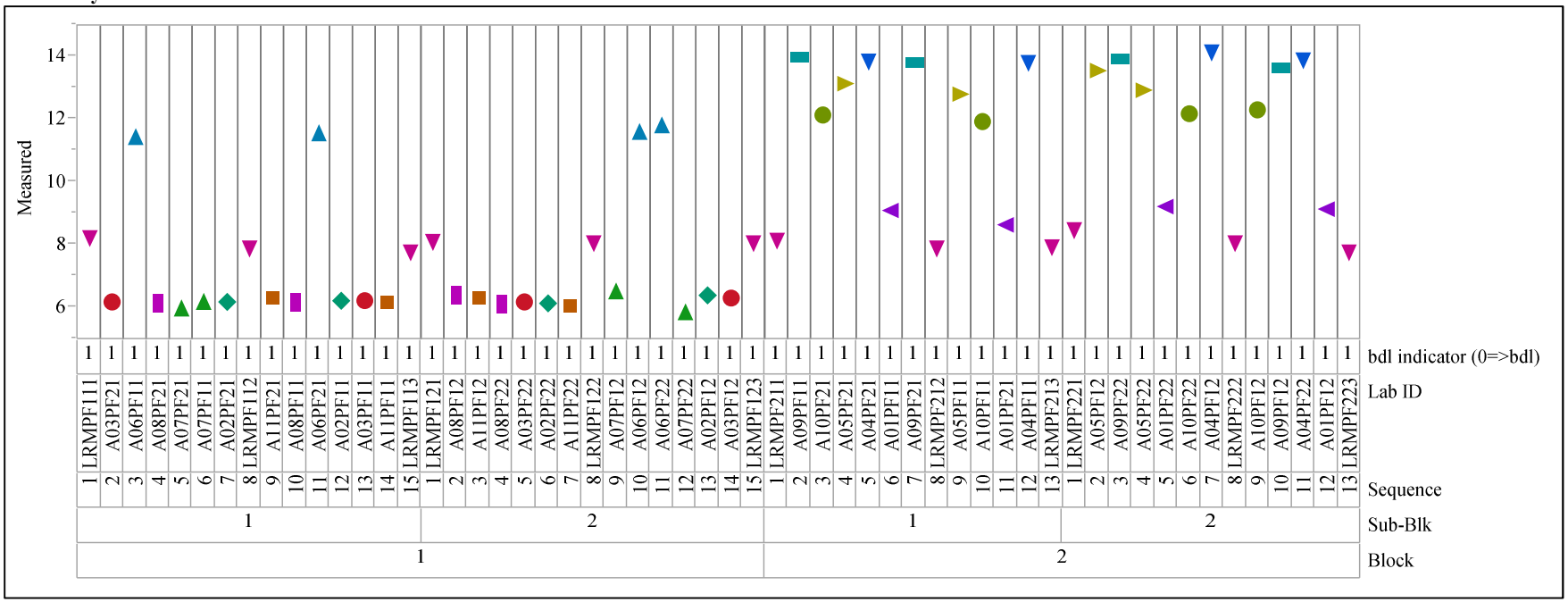


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence (continued)

Analyte=CaO (wt%), Prep=LM
Variability Chart for Measured

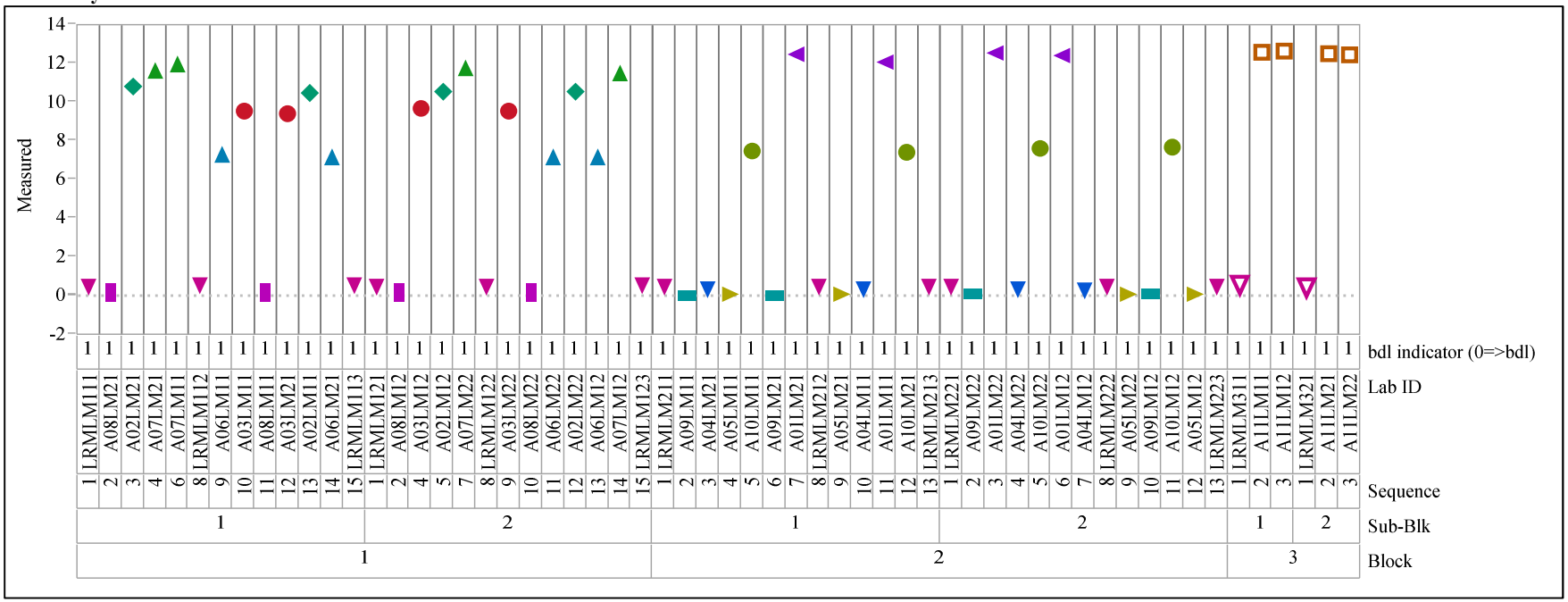


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence (continued)

Analyte=Cl (wt%), Prep=KH
Variability Chart for Measured

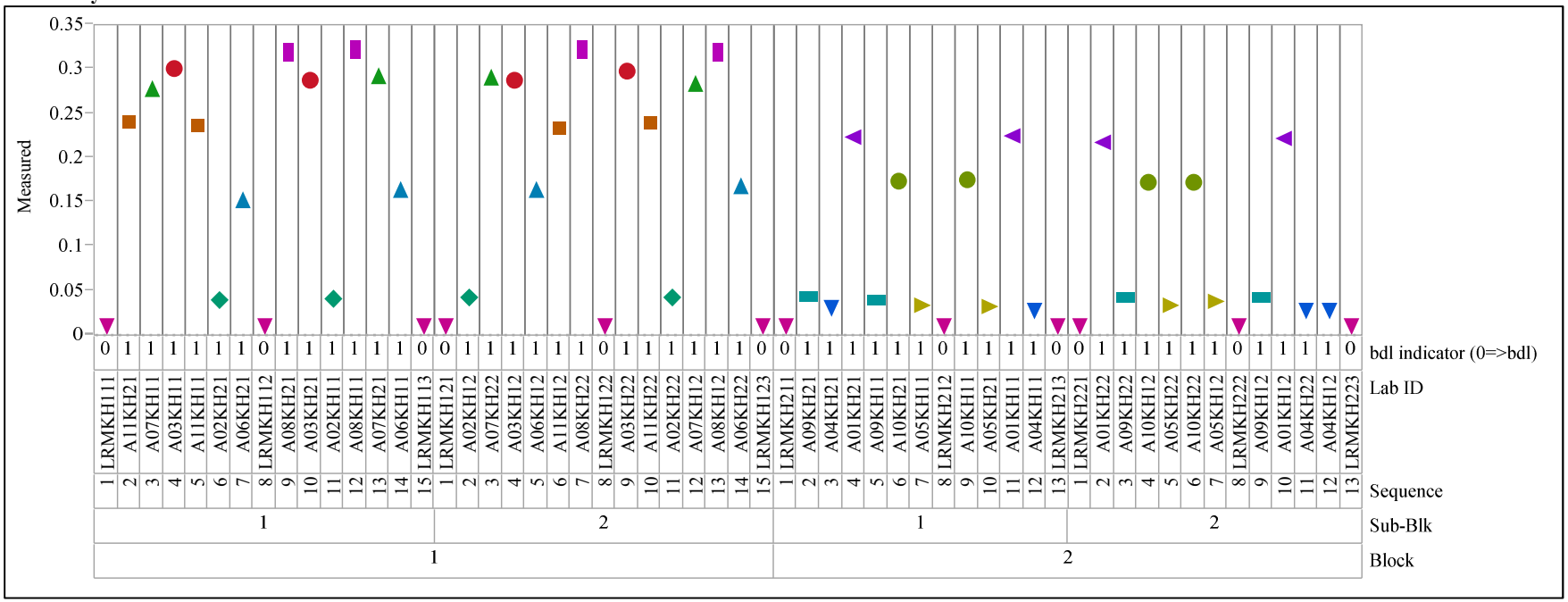


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence (continued)

Analyte=Cr2O3 (wt%), Prep=LM
Variability Chart for Measured

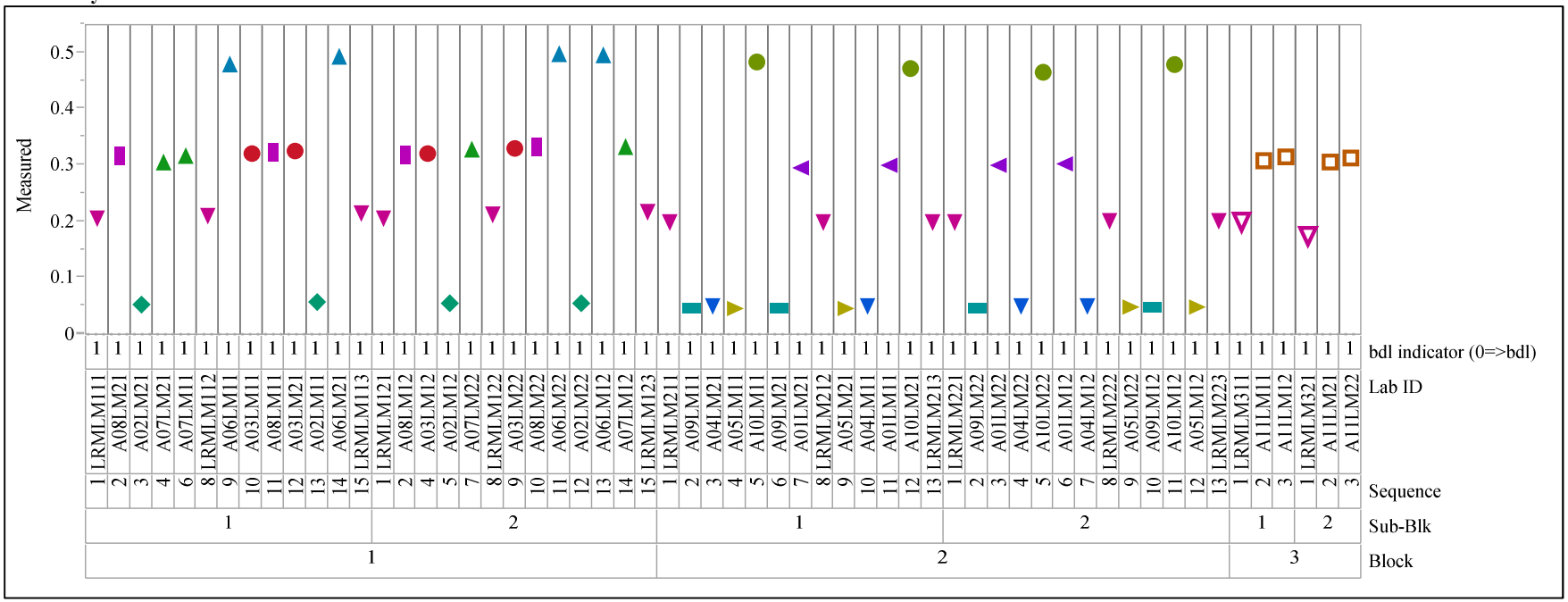


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence (continued)

Analyte=F (wt%), Prep=KH
Variability Chart for Measured

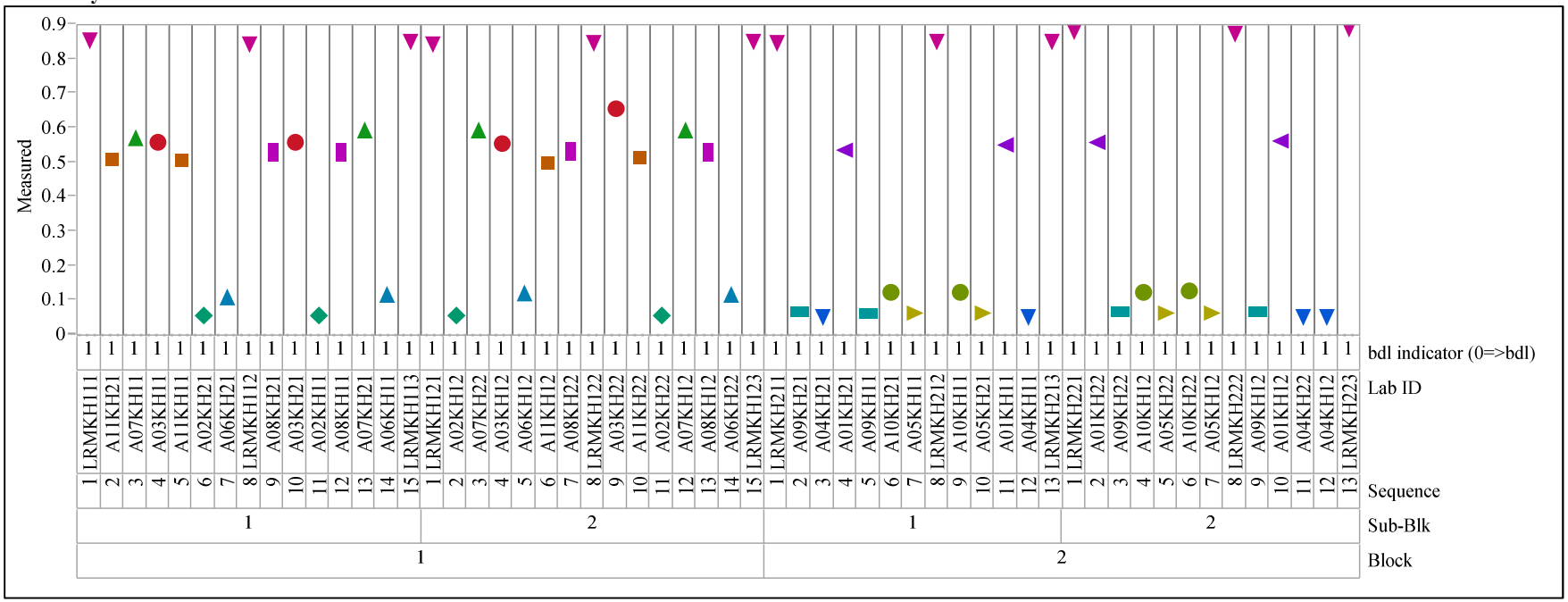


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence (continued)

Analyte=Fe2O3 (wt%), Prep=PF
Variability Chart for Measured

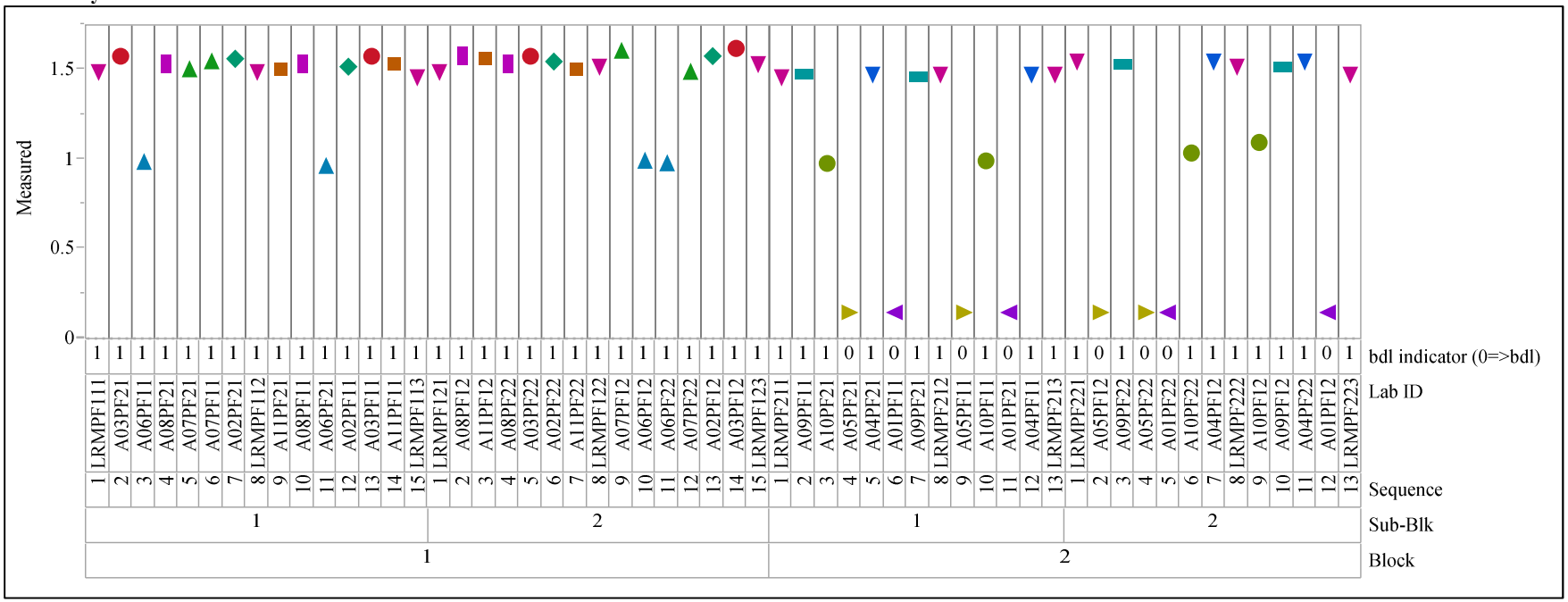


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence (continued)

Analyte=K2O (wt%), Prep=LM
Variability Chart for Measured

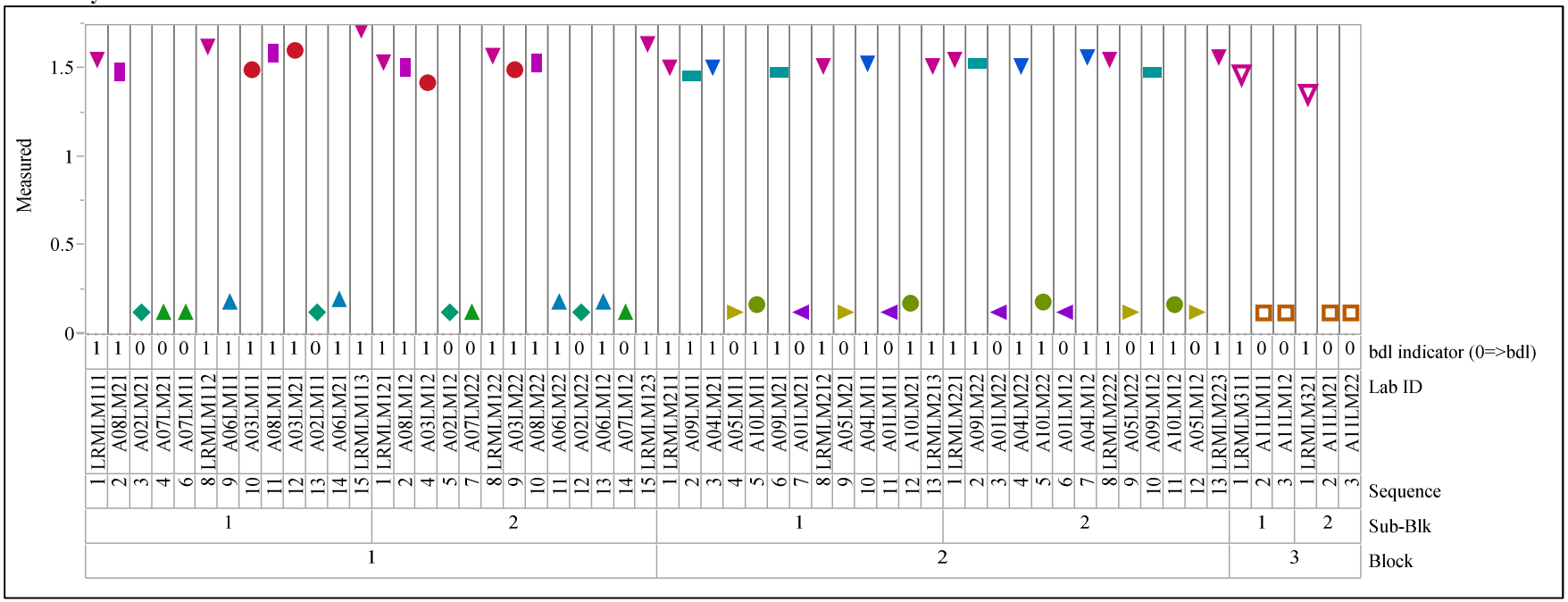


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence (continued)

Analyte=Li2O (wt%), Prep=PF
Variability Chart for Measured

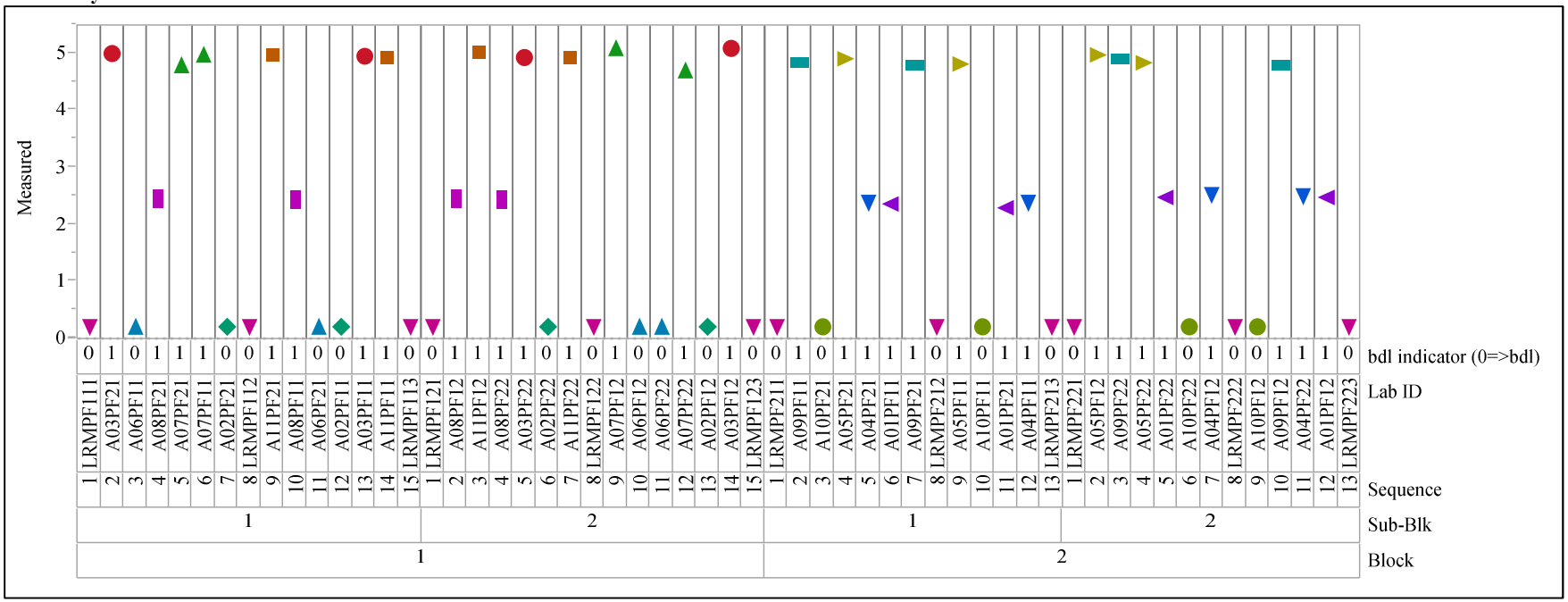


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence (continued)

Analyte=MgO (wt%), Prep=LM
Variability Chart for Measured

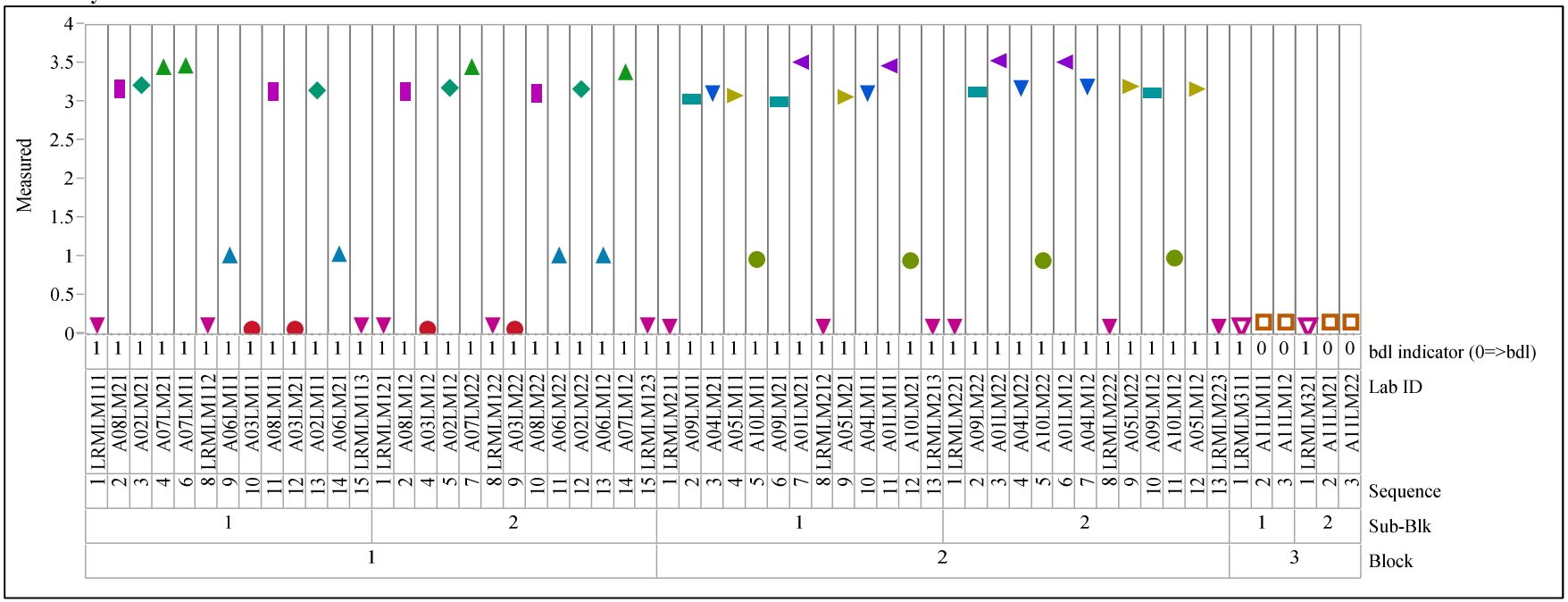


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence (continued)

Analyte=Na2O (wt%), Prep=LM
Variability Chart for Measured

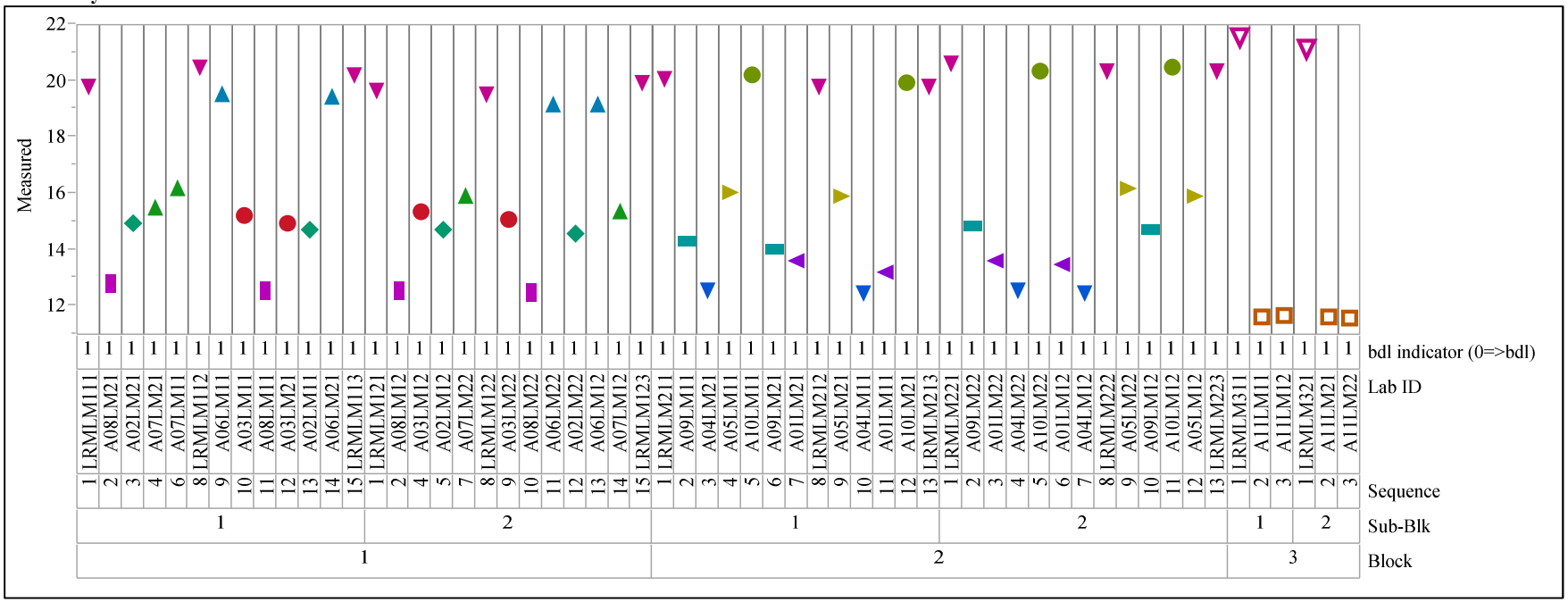


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence (continued)

Analyte=P2O5 (wt%), Prep=LM
Variability Chart for Measured

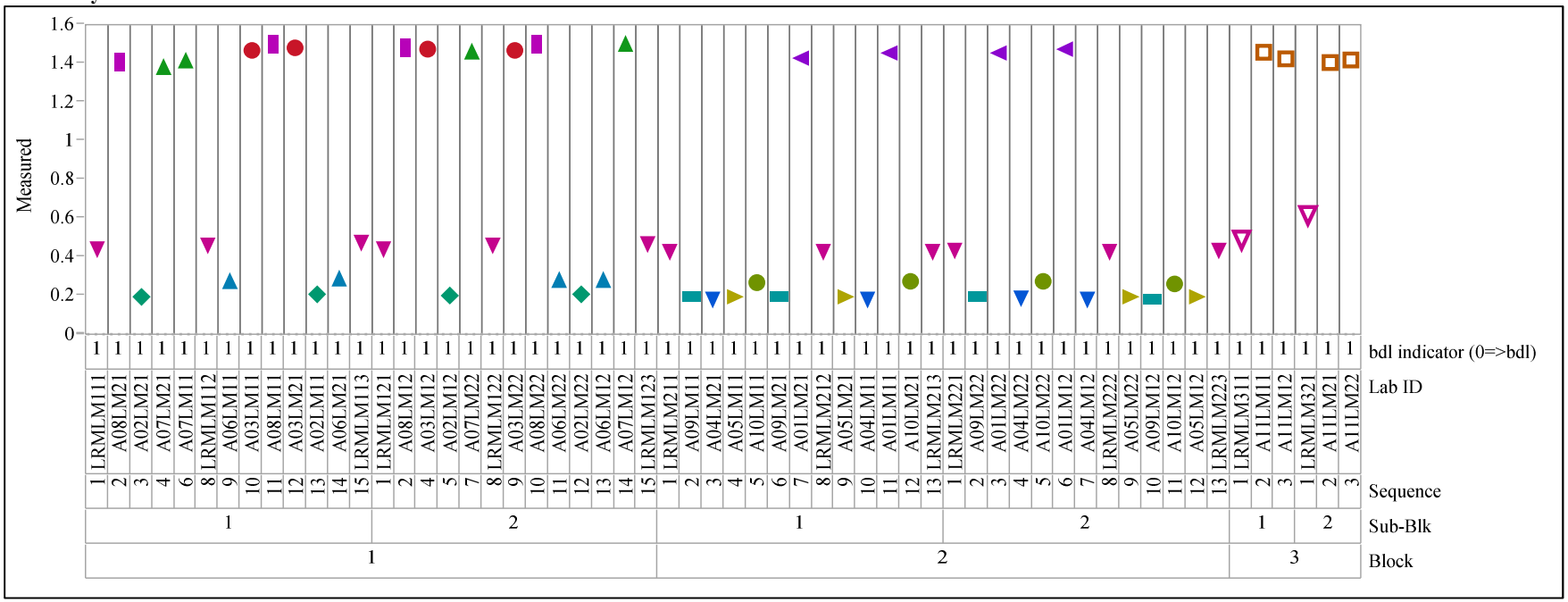


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence (continued)

Analyte=SiO2 (wt%), Prep=PF
Variability Chart for Measured

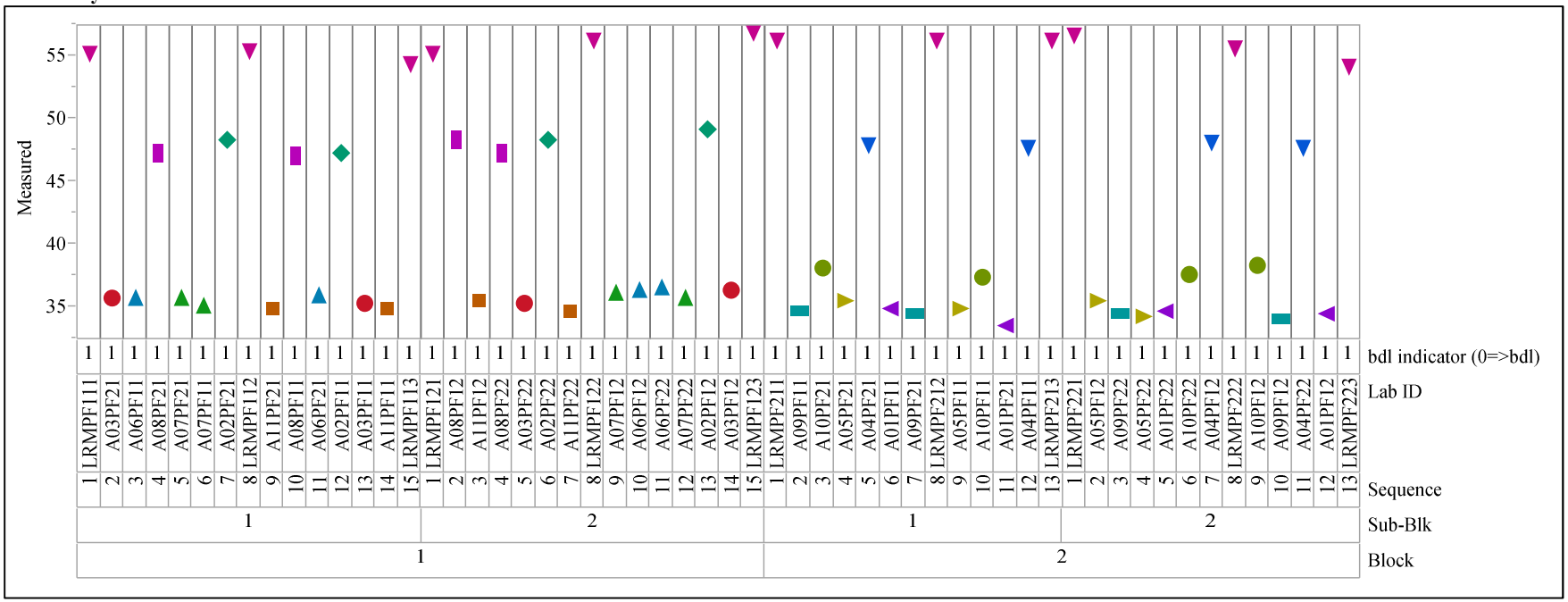


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence (continued)

Analyte=SnO2 (wt%), Prep=PF
Variability Chart for Measured

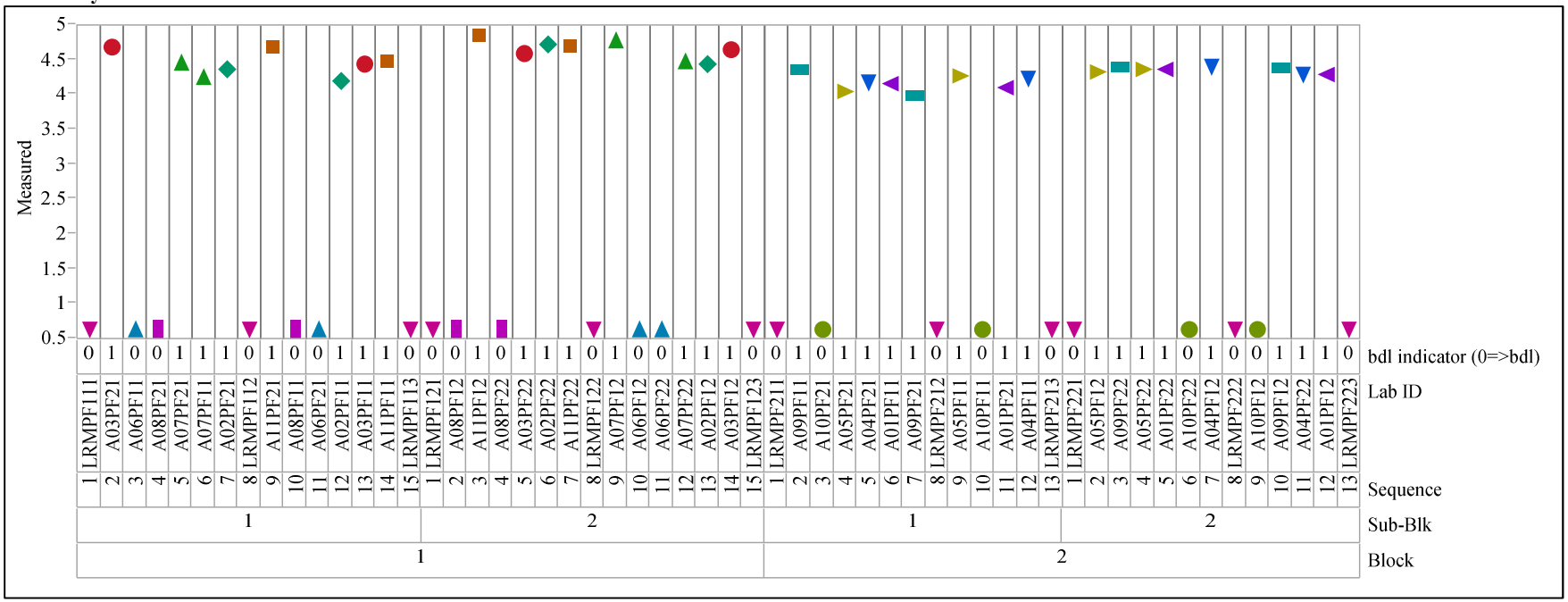


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence (continued)

Analyte=SO3 (wt%), Prep=LM
Variability Chart for Measured

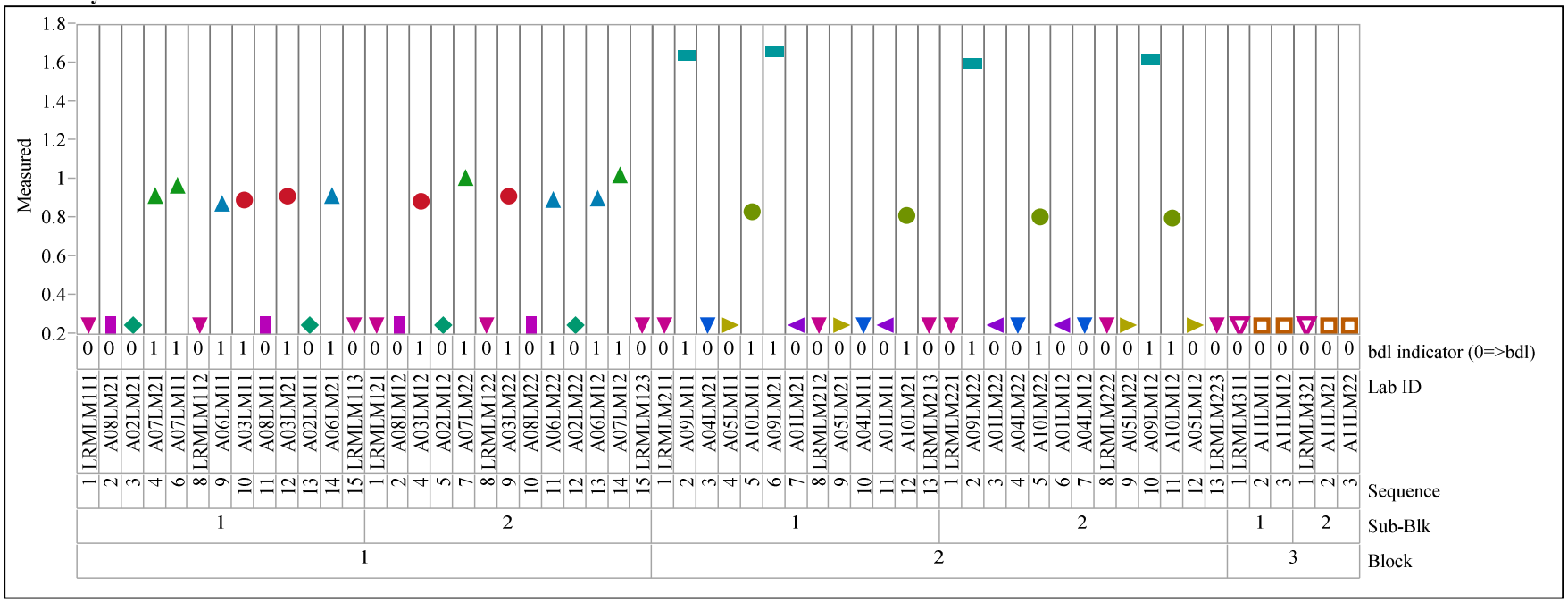


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence (continued)

Analyte=V2O5 (wt%), Prep=LM
Variability Chart for Measured

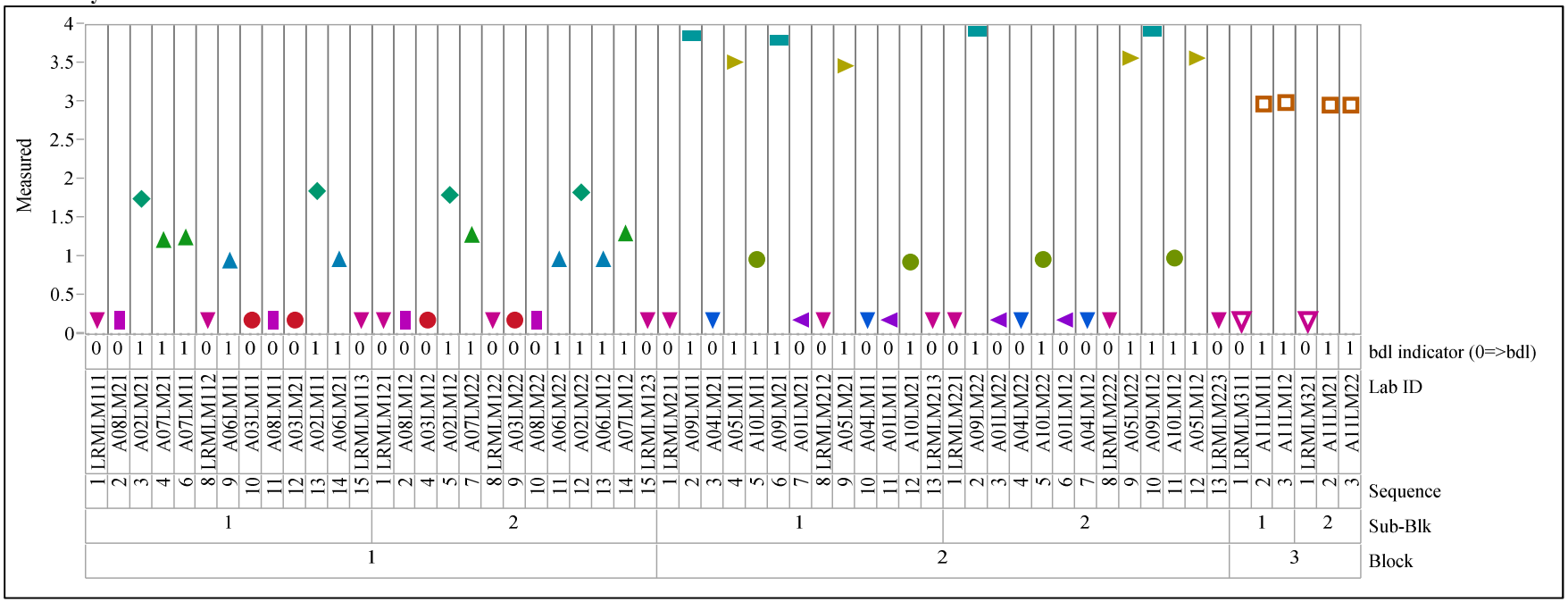


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence (continued)

Analyte=ZnO (wt%), Prep=LM
Variability Chart for Measured

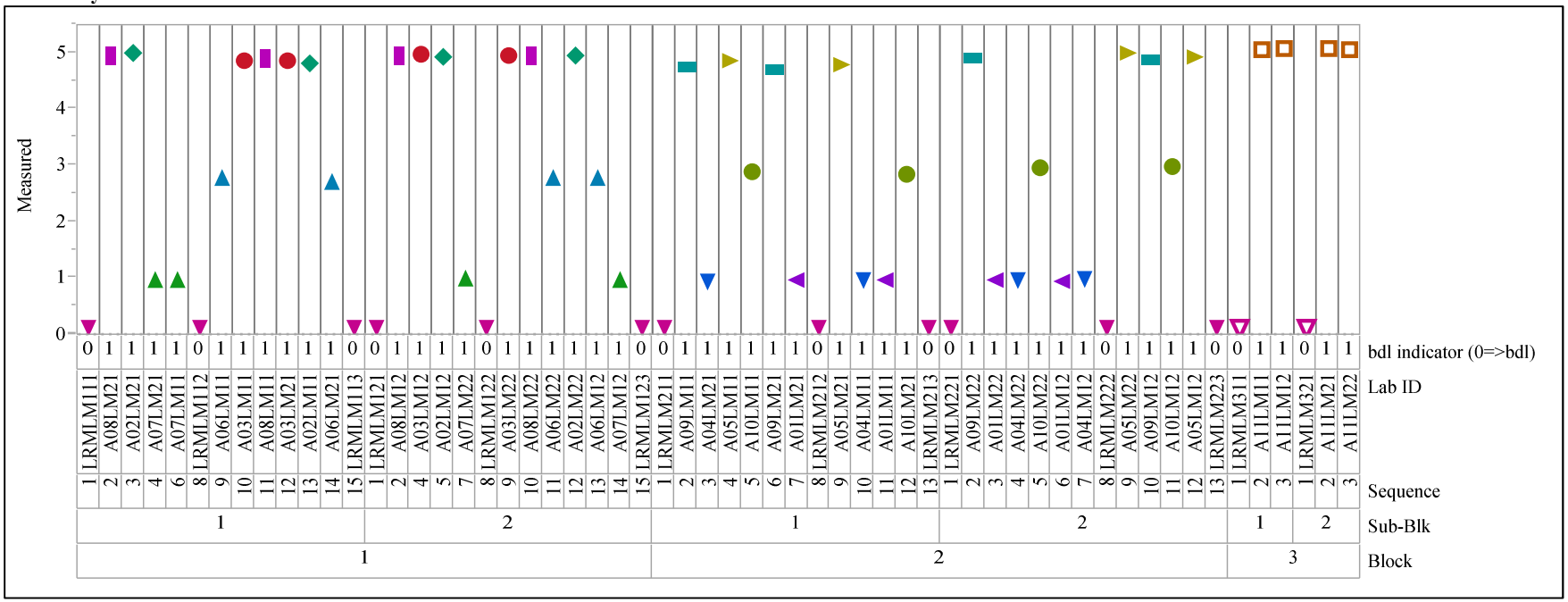


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence (continued)

Analyte=ZrO2 (wt%), Prep=LM
Variability Chart for Measured

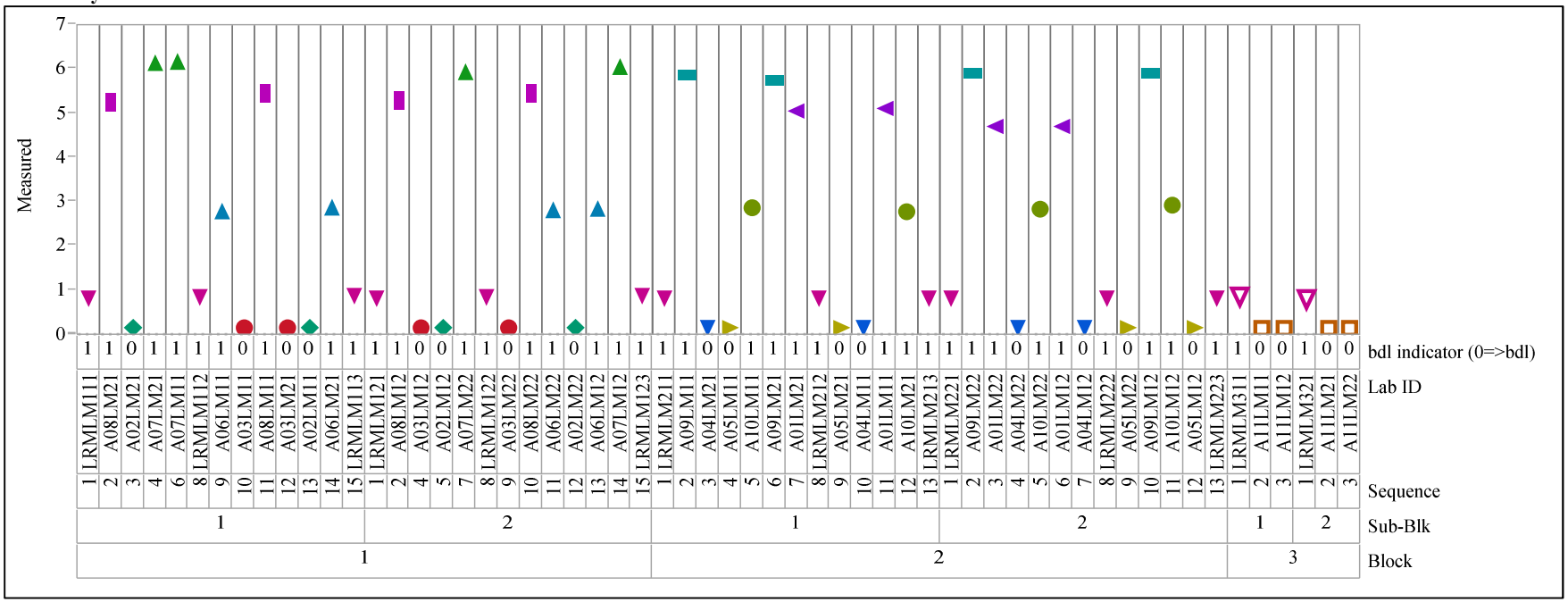


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations

Analyte=Al2O3 (wt%), Prep=PF
Variability Chart for Measured

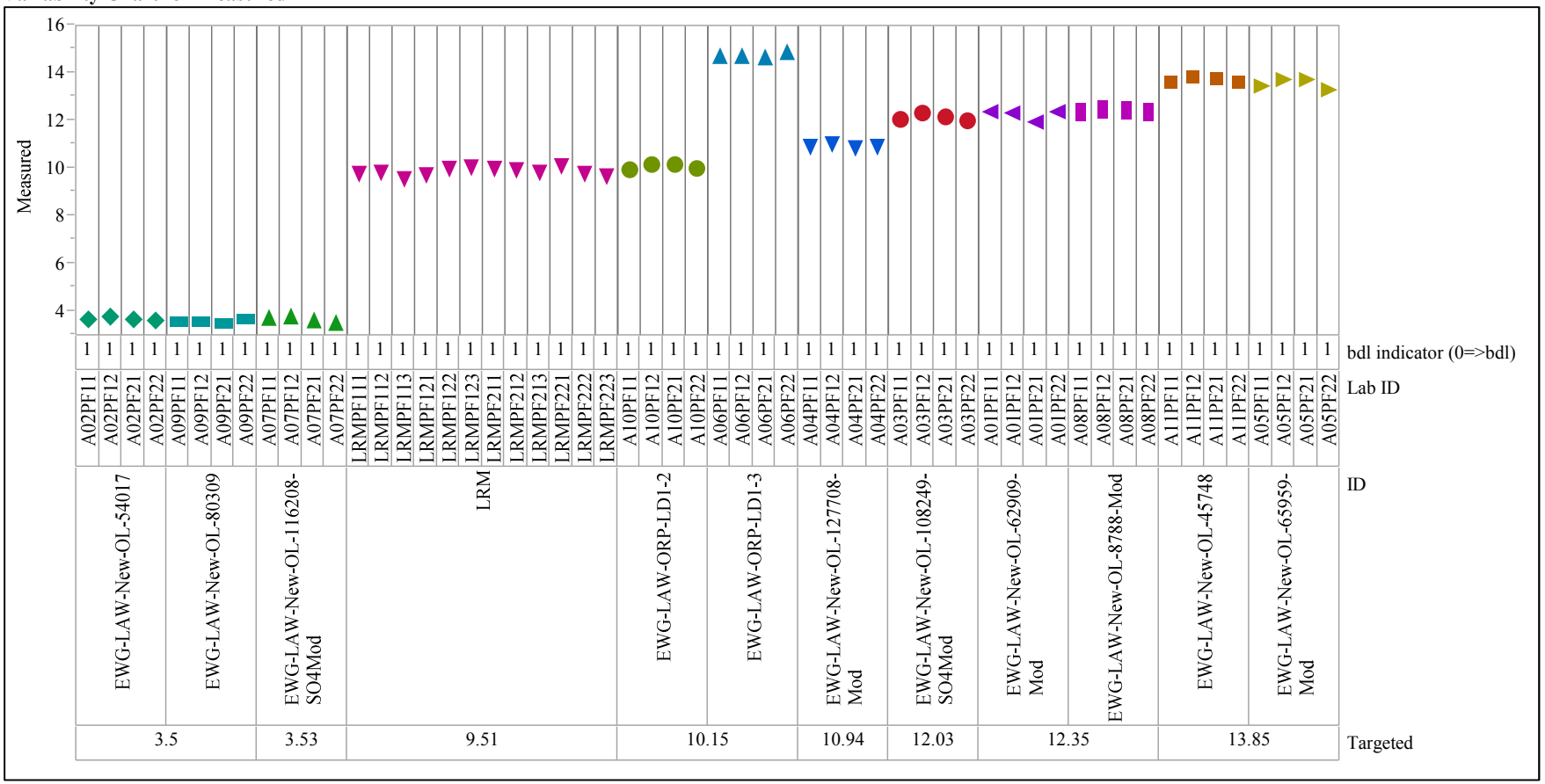


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations (continued)

Analyte=B2O3 (wt%), Prep=PF
Variability Chart for Measured

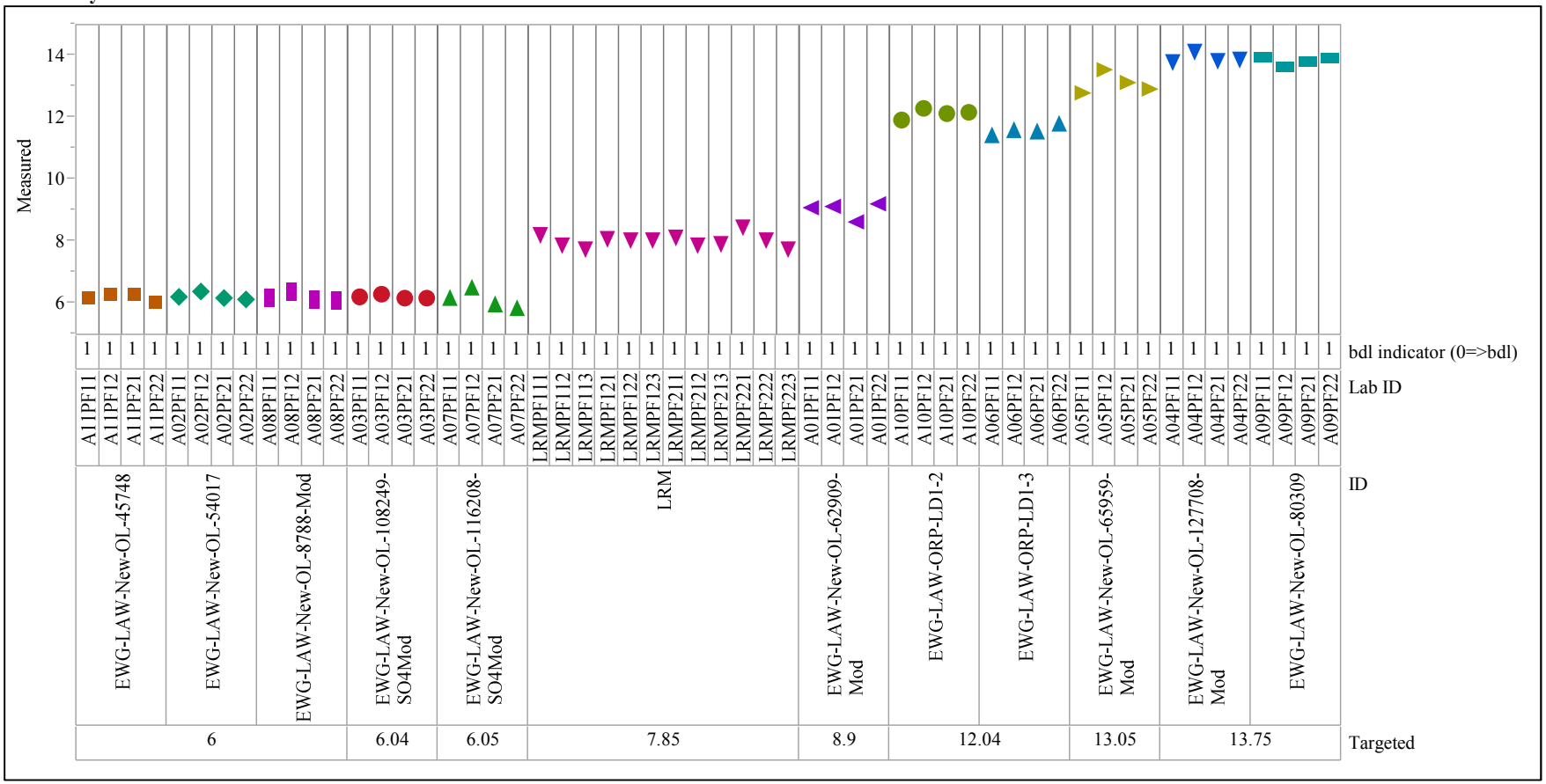


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations (continued)

Analyte=CaO (wt%), Prep=LM
Variability Chart for Measured

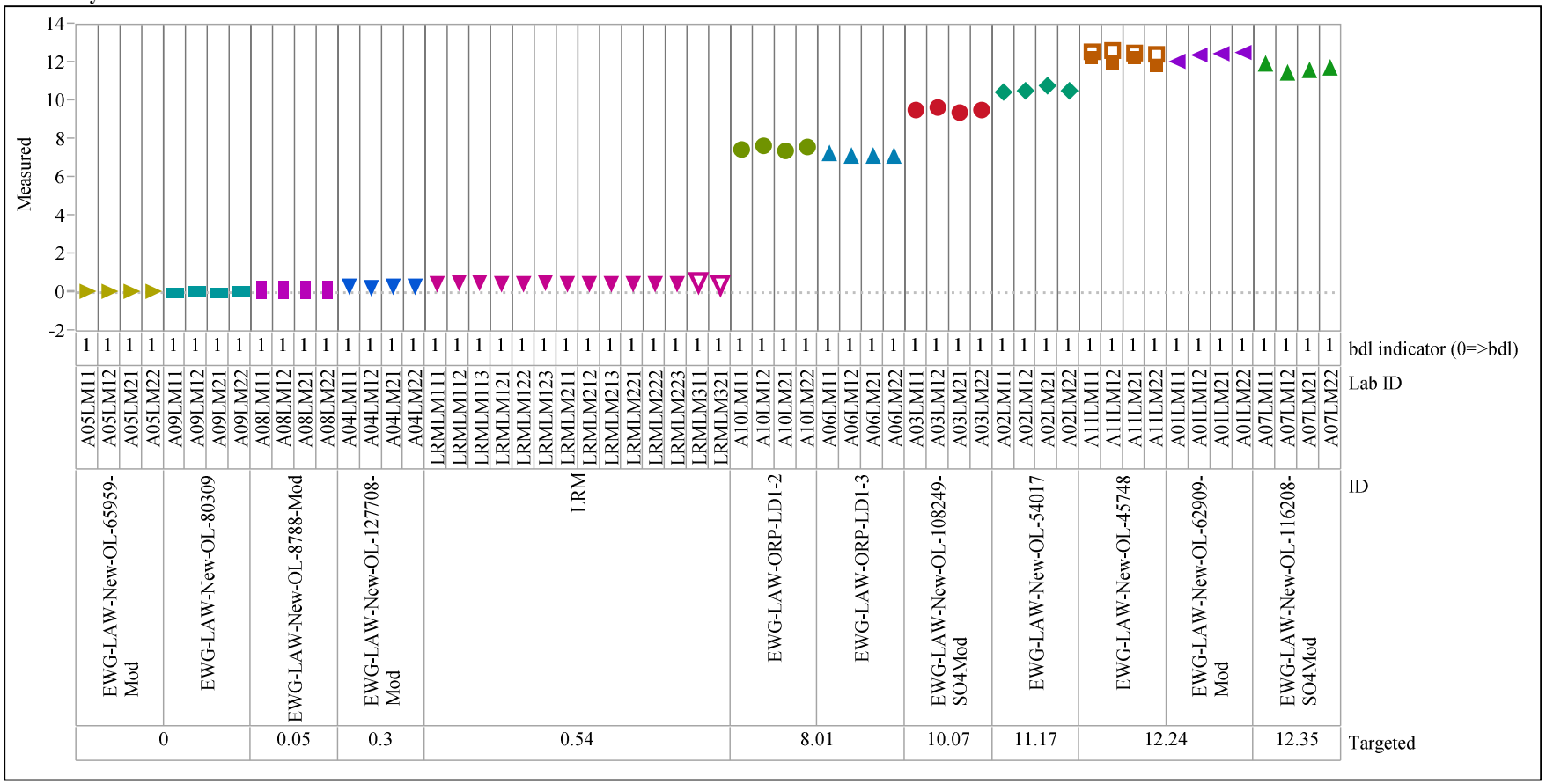


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations (continued)

Analyte=Cl (wt%), Prep=KH
Variability Chart for Measured

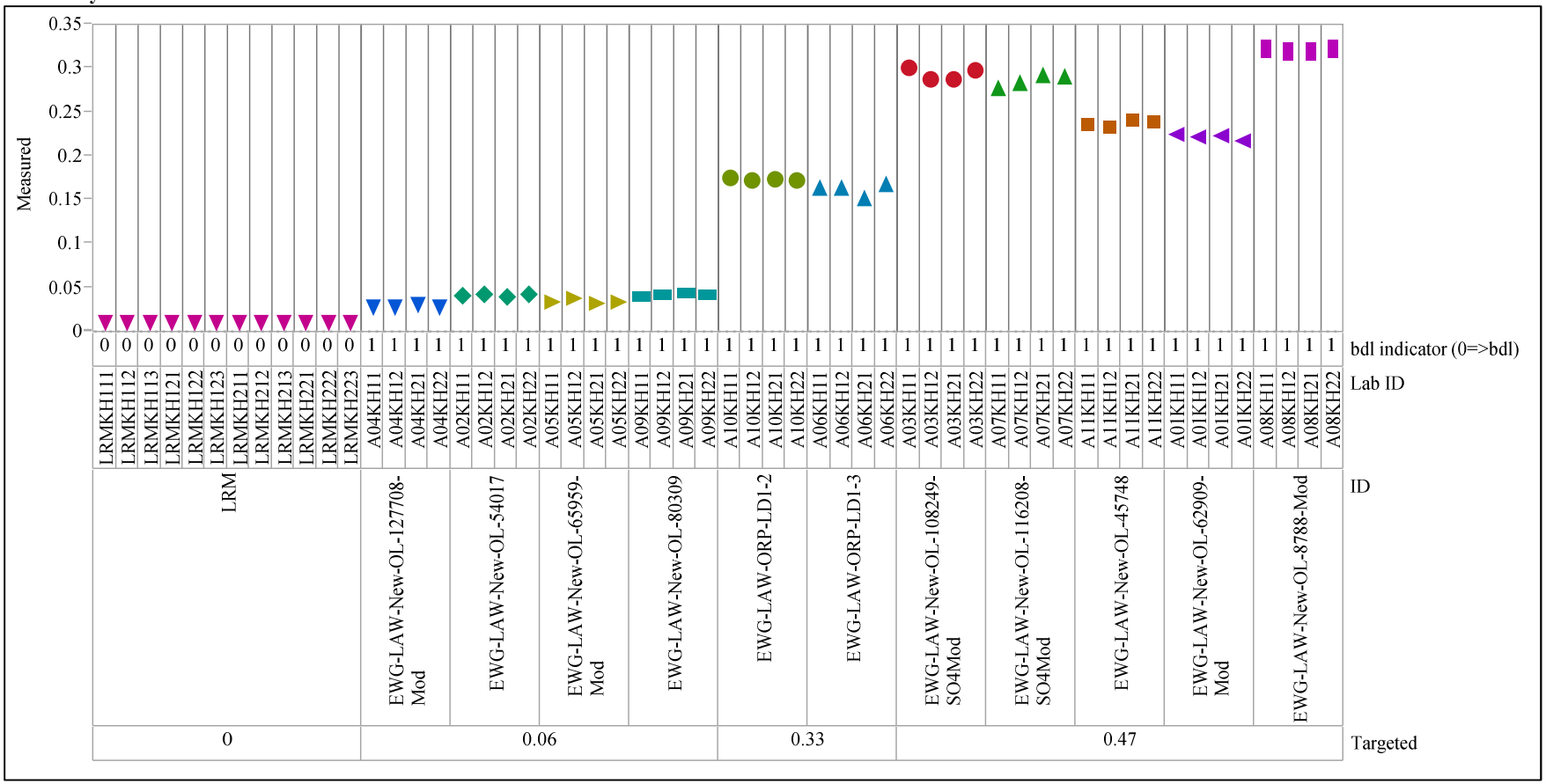


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations (continued)

Analyte=Cr2O3 (wt%), Prep=LM
Variability Chart for Measured

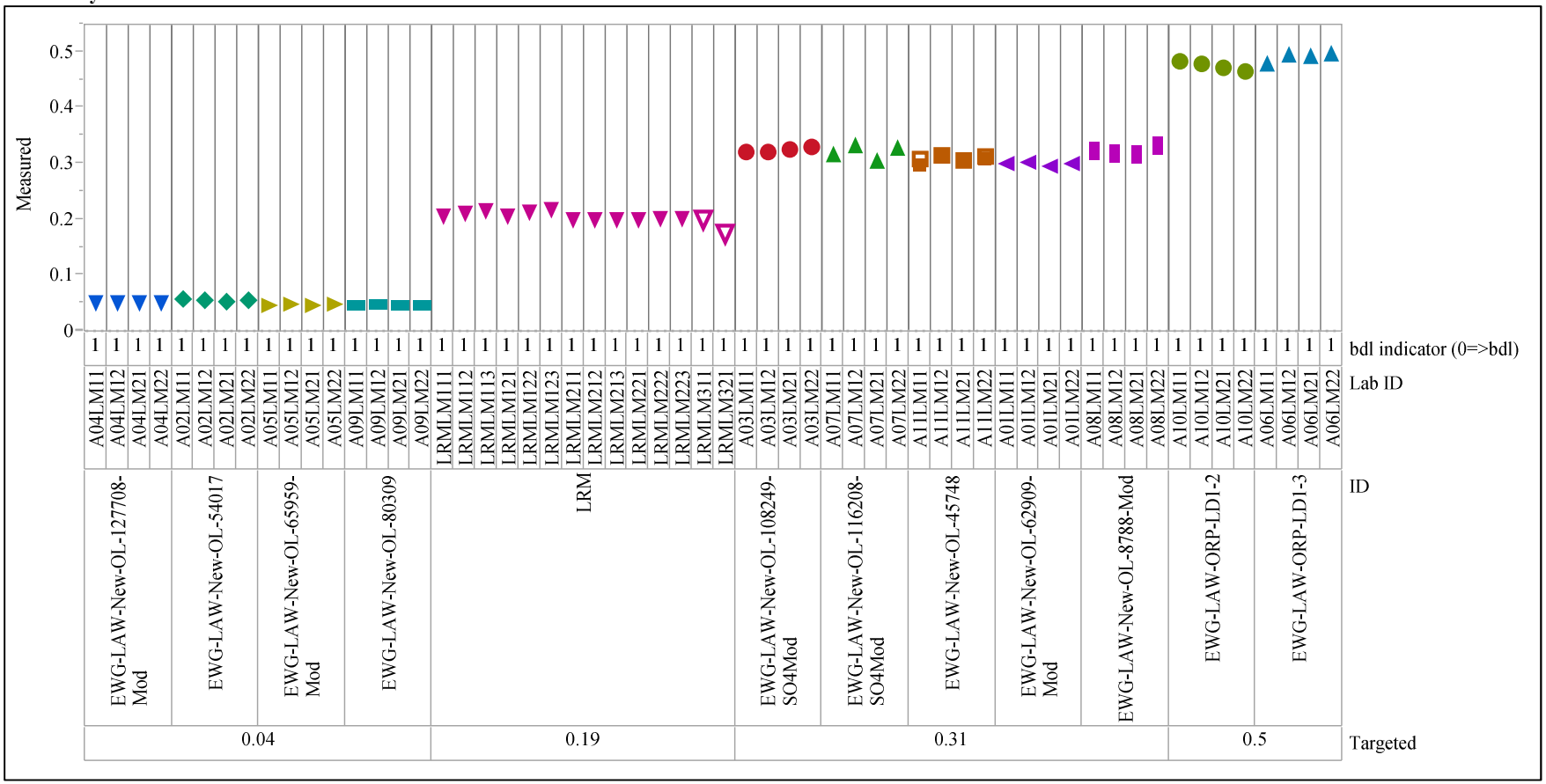


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations (continued)

Analyte=F (wt%), Prep=KH
Variability Chart for Measured

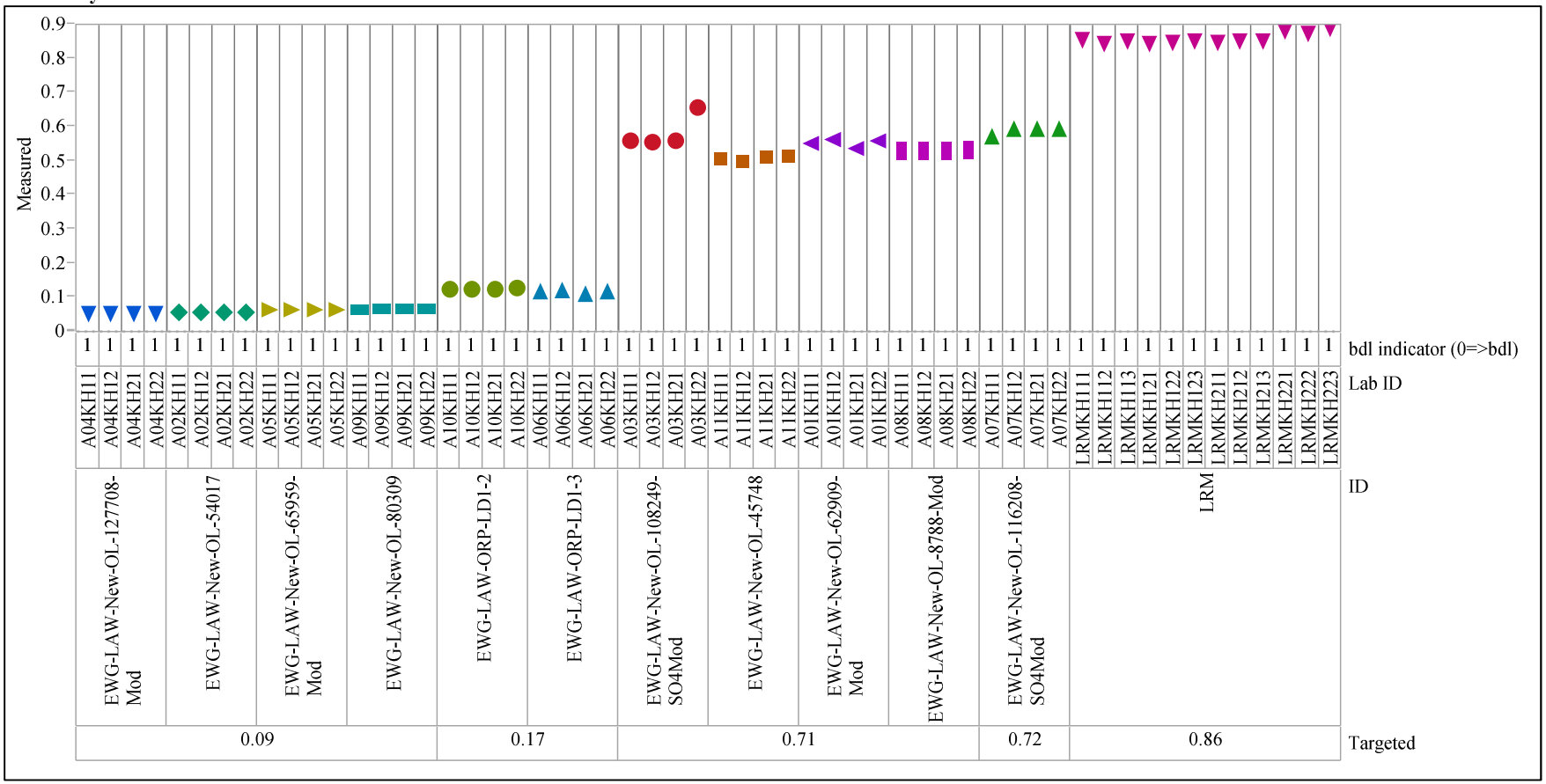


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations (continued)

Analyte=Fe2O3 (wt%), Prep=PF
Variability Chart for Measured

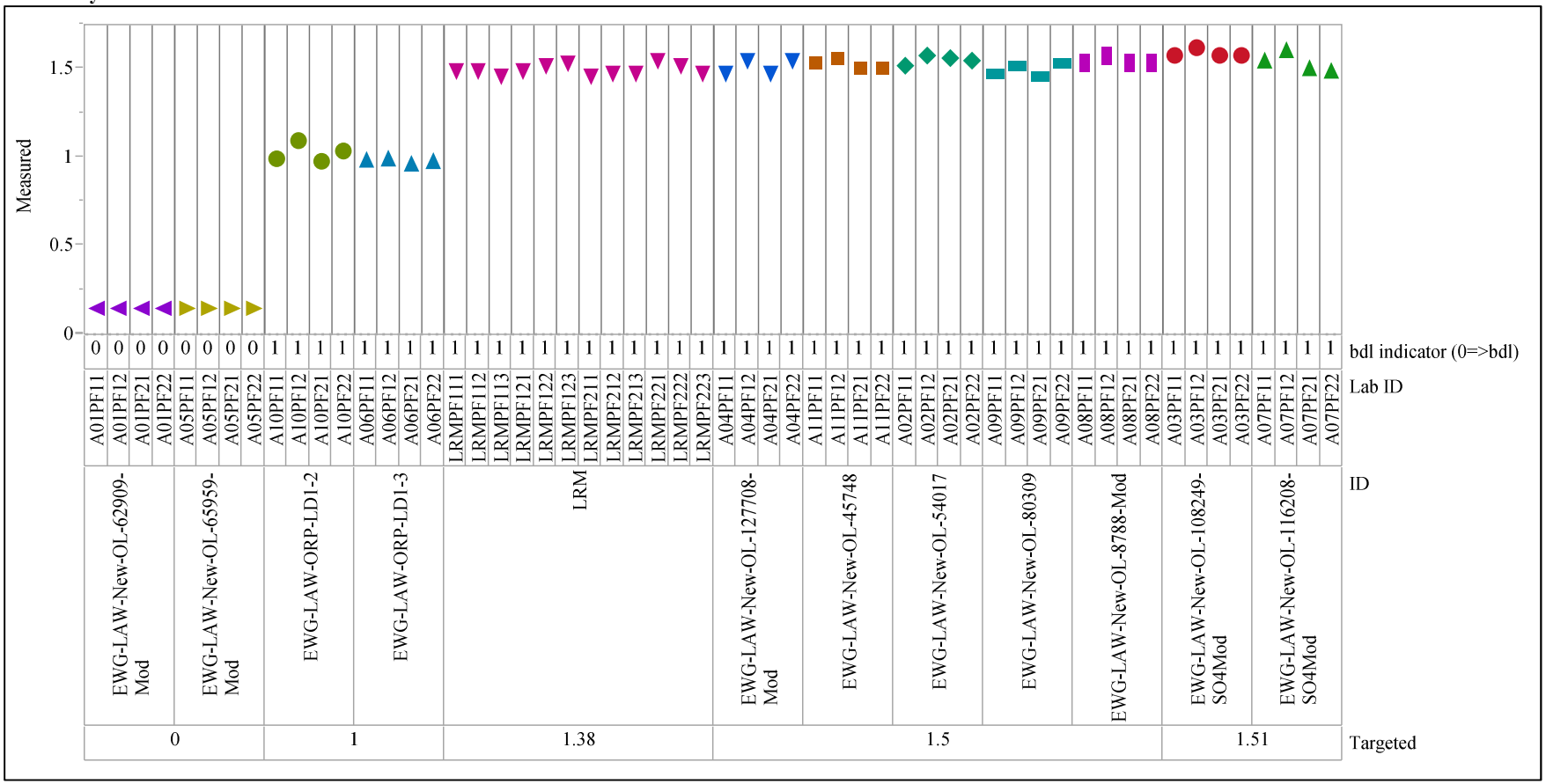


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations (continued)

Analyte=K2O (wt%), Prep=LM
Variability Chart for Measured

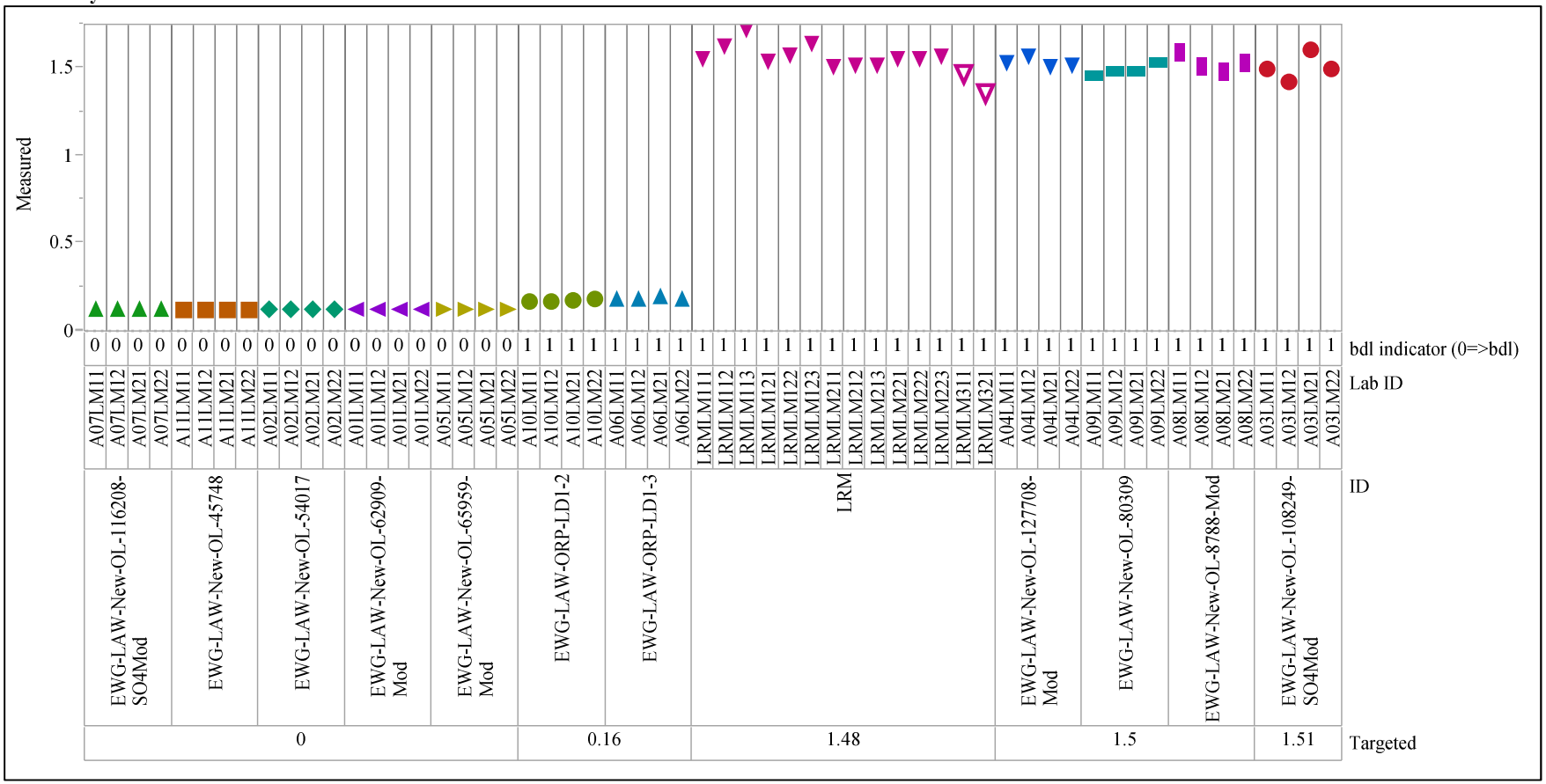


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations (continued)

Analyte=Li2O (wt%), Prep=PF
Variability Chart for Measured

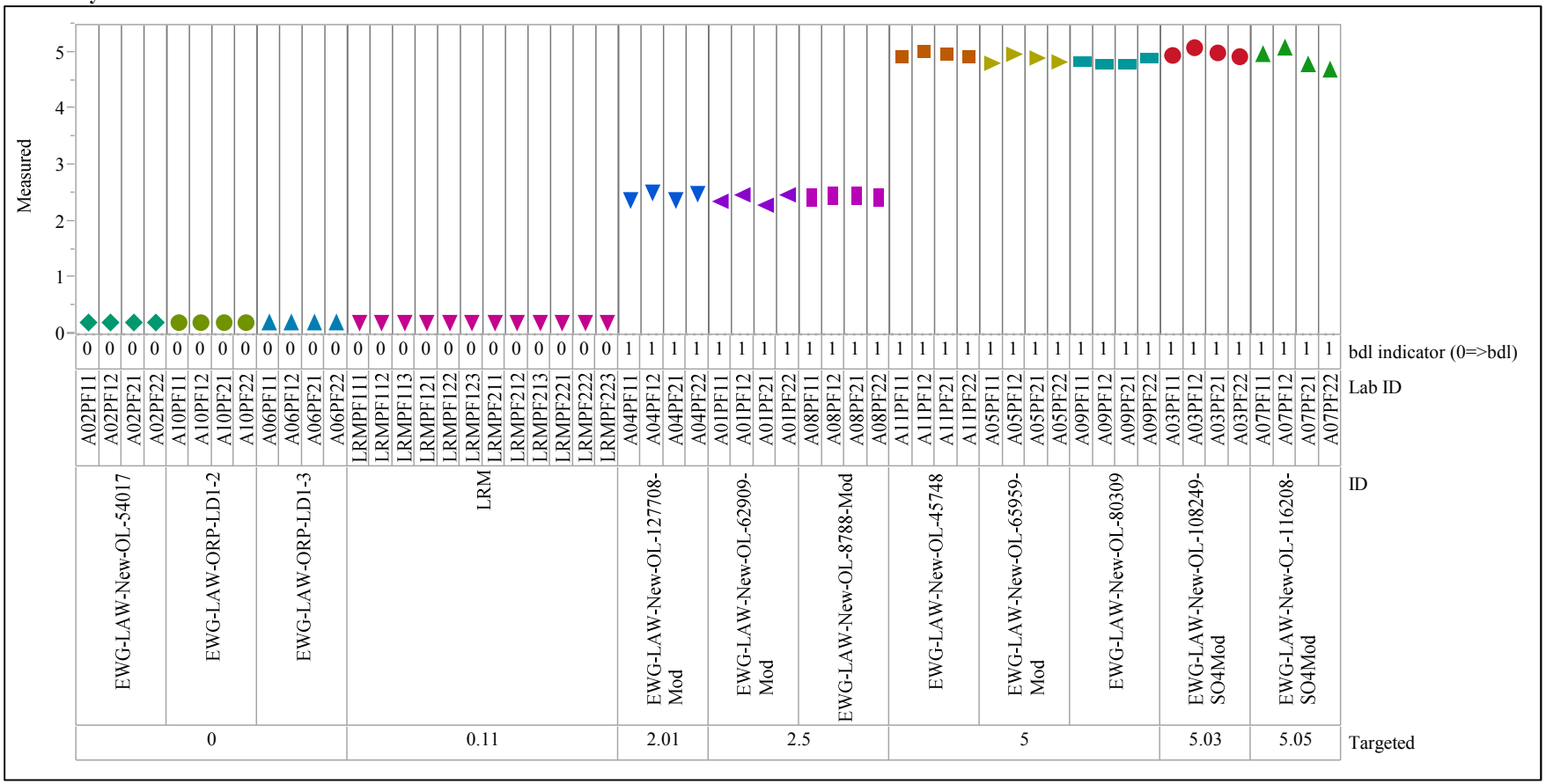


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations (continued)

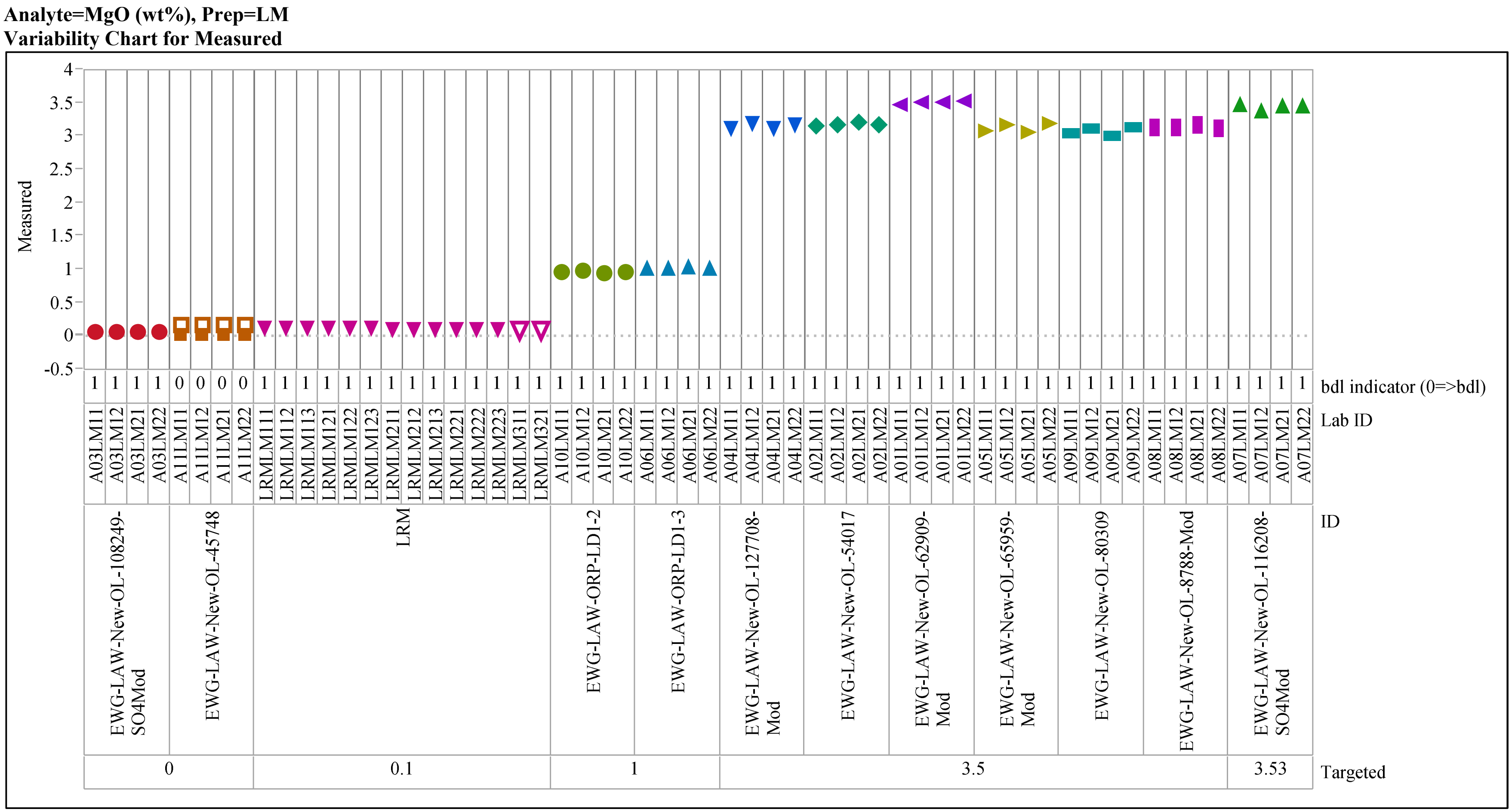


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations (continued)

Analyte=Na2O (wt%), Prep=LM
Variability Chart for Measured

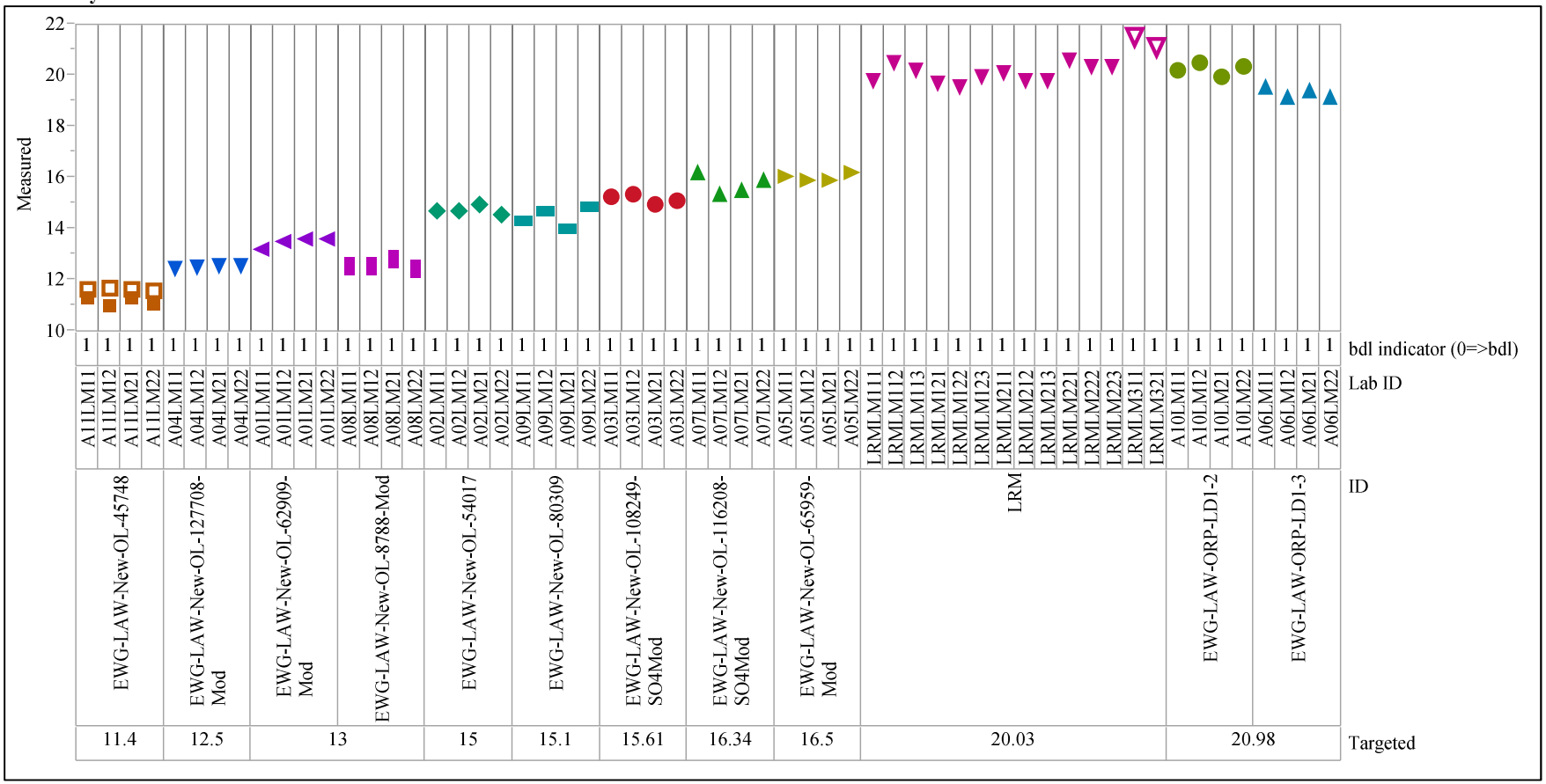


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations (continued)

Analyte=P2O5 (wt%), Prep=LM
Variability Chart for Measured

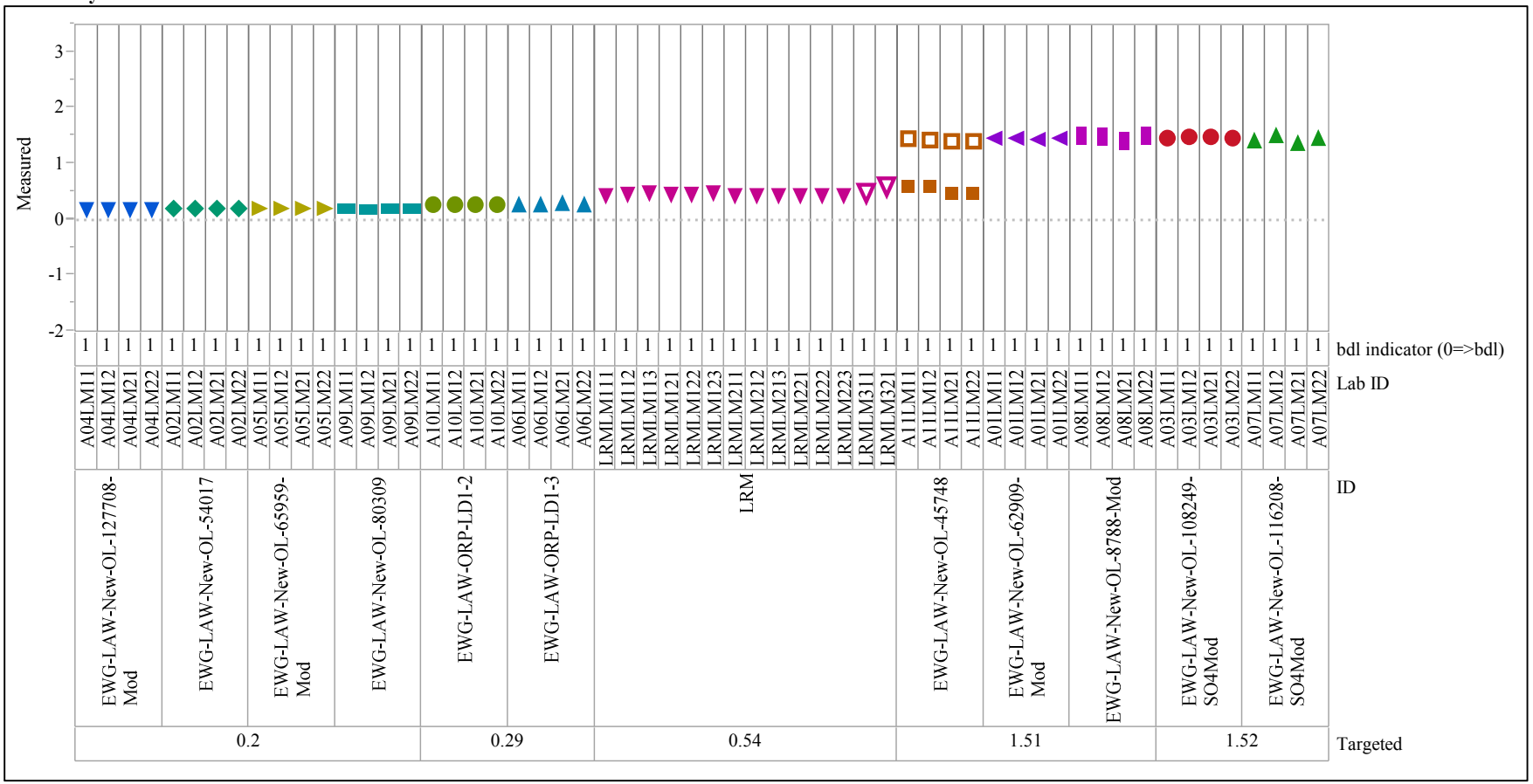


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations (continued)

Analyte=SiO2 (wt%), Prep=PF
Variability Chart for Measured

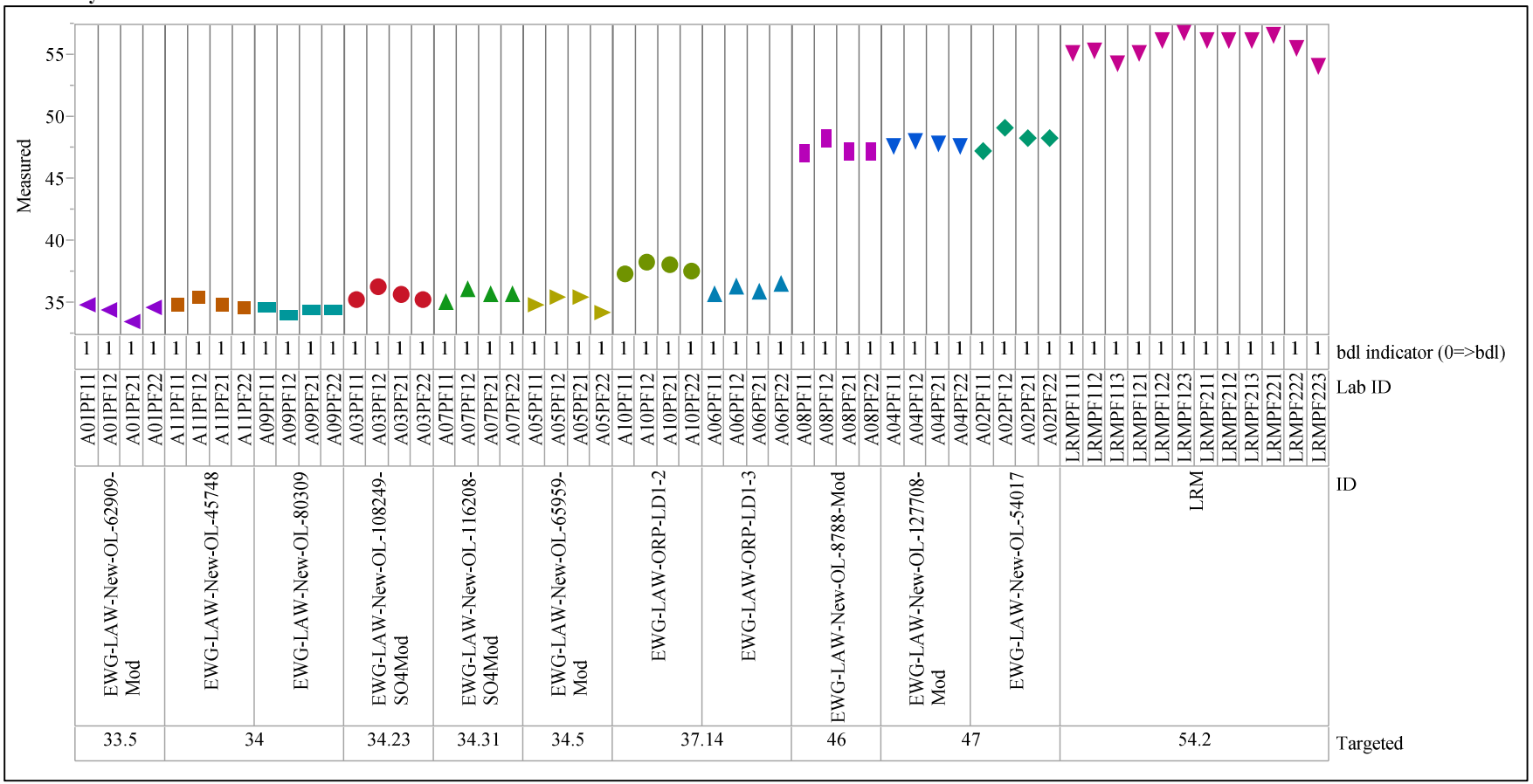


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations (continued)

Analyte=SnO2 (wt%), Prep=PF
Variability Chart for Measured

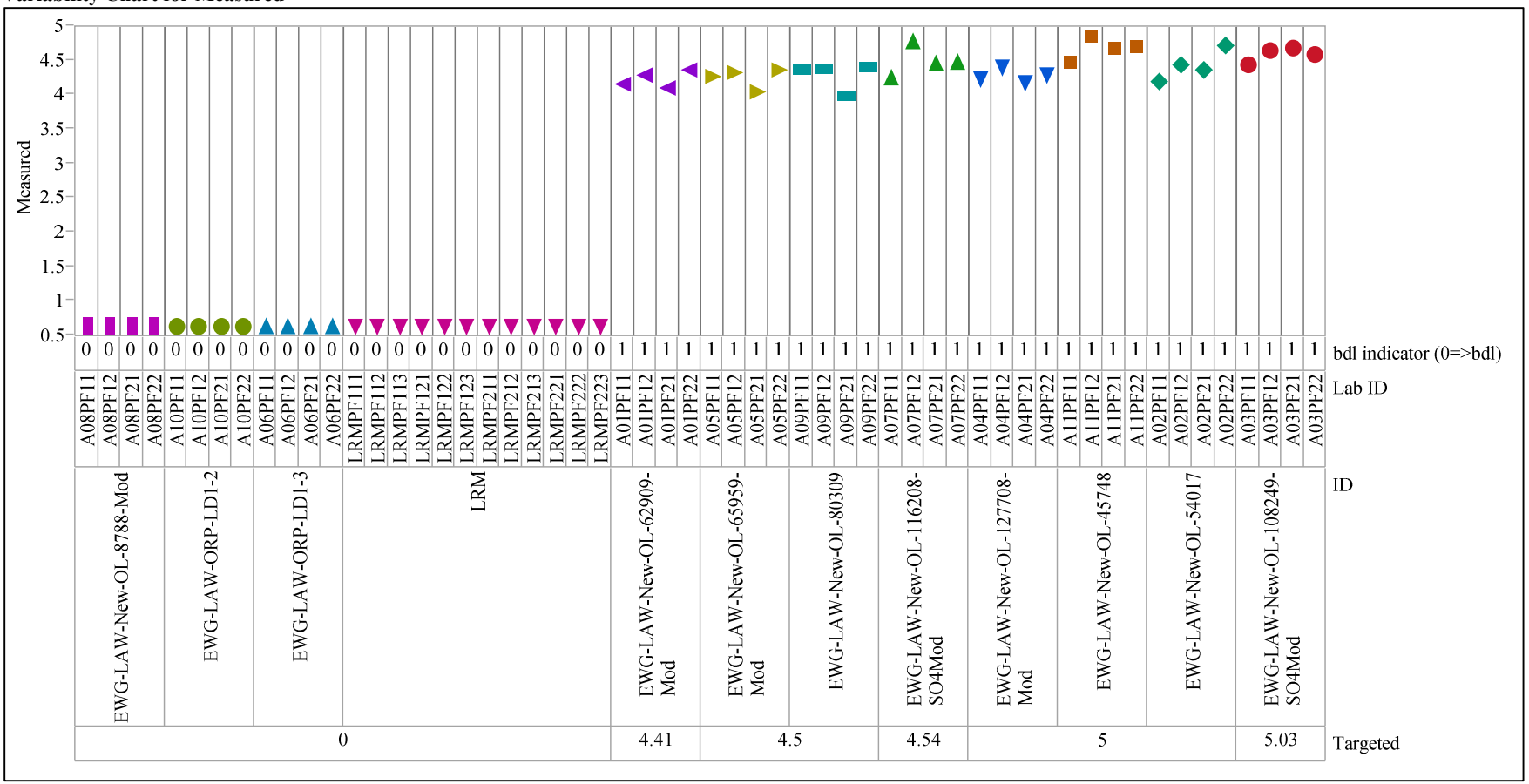


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations (continued)

Analyte=SO3 (wt%), Prep=LM
Variability Chart for Measured

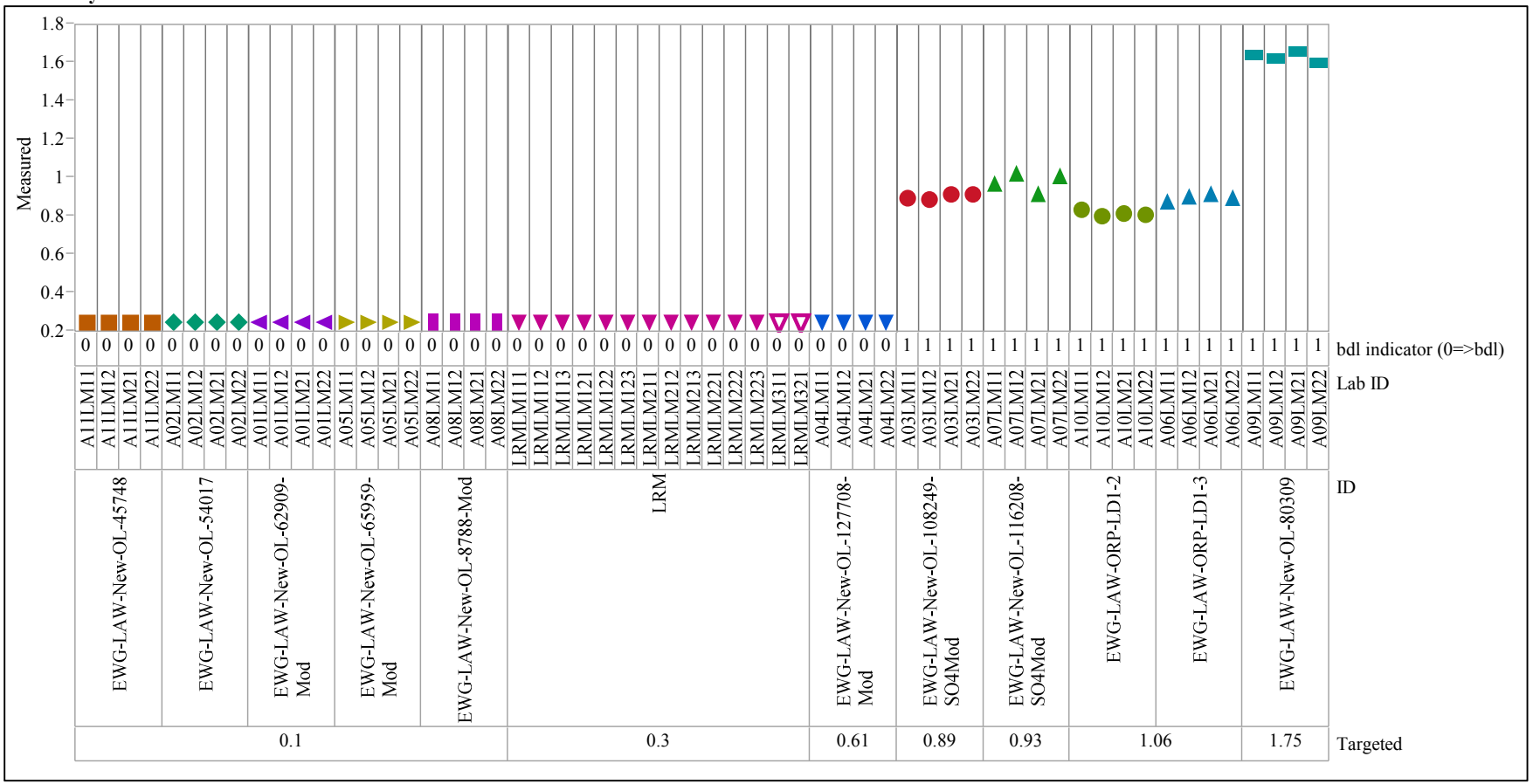


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations (continued)

Analyte=V2O5 (wt%), Prep=LM
Variability Chart for Measured

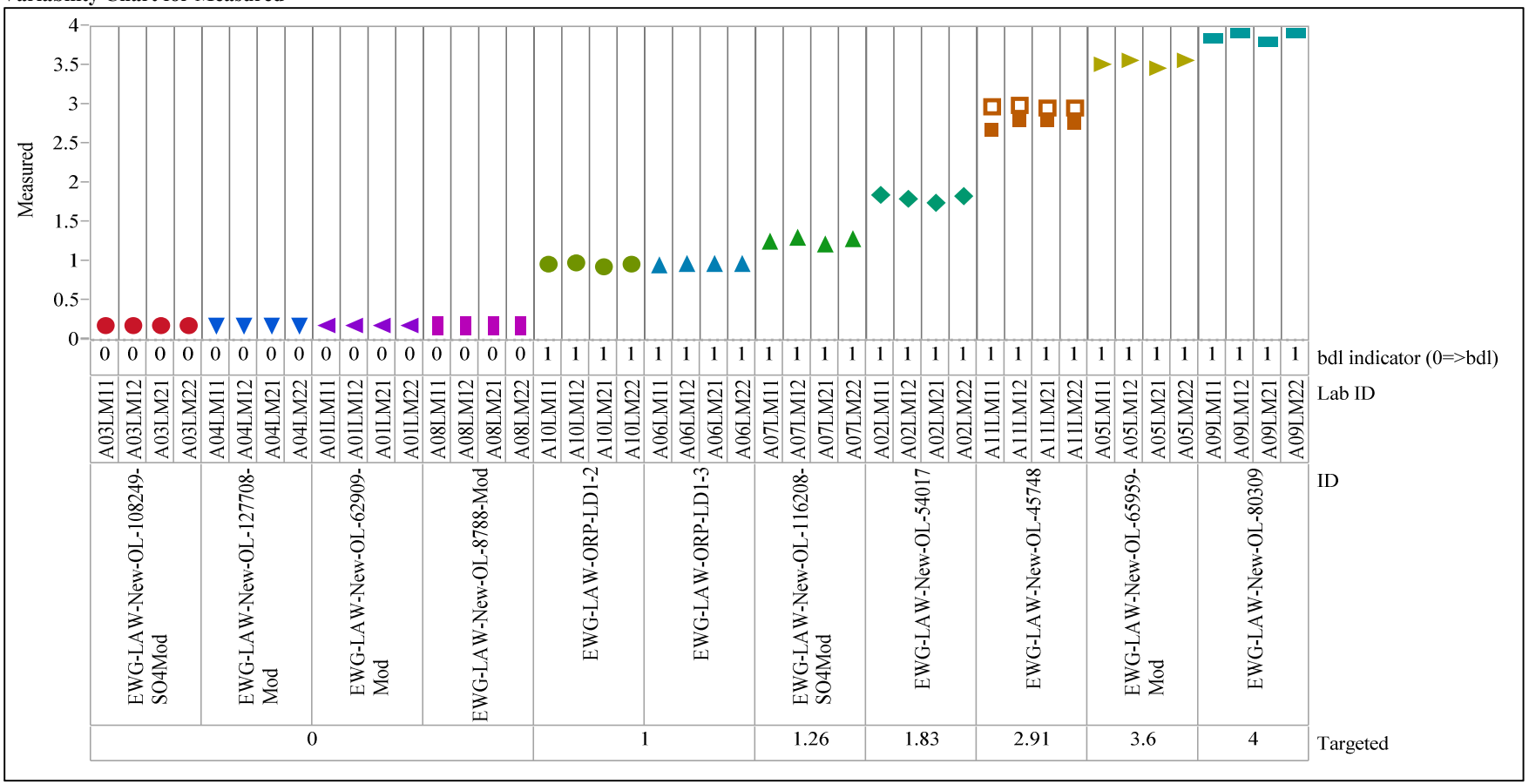


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations (continued)

Analyte=ZnO (wt%), Prep=LM
Variability Chart for Measured

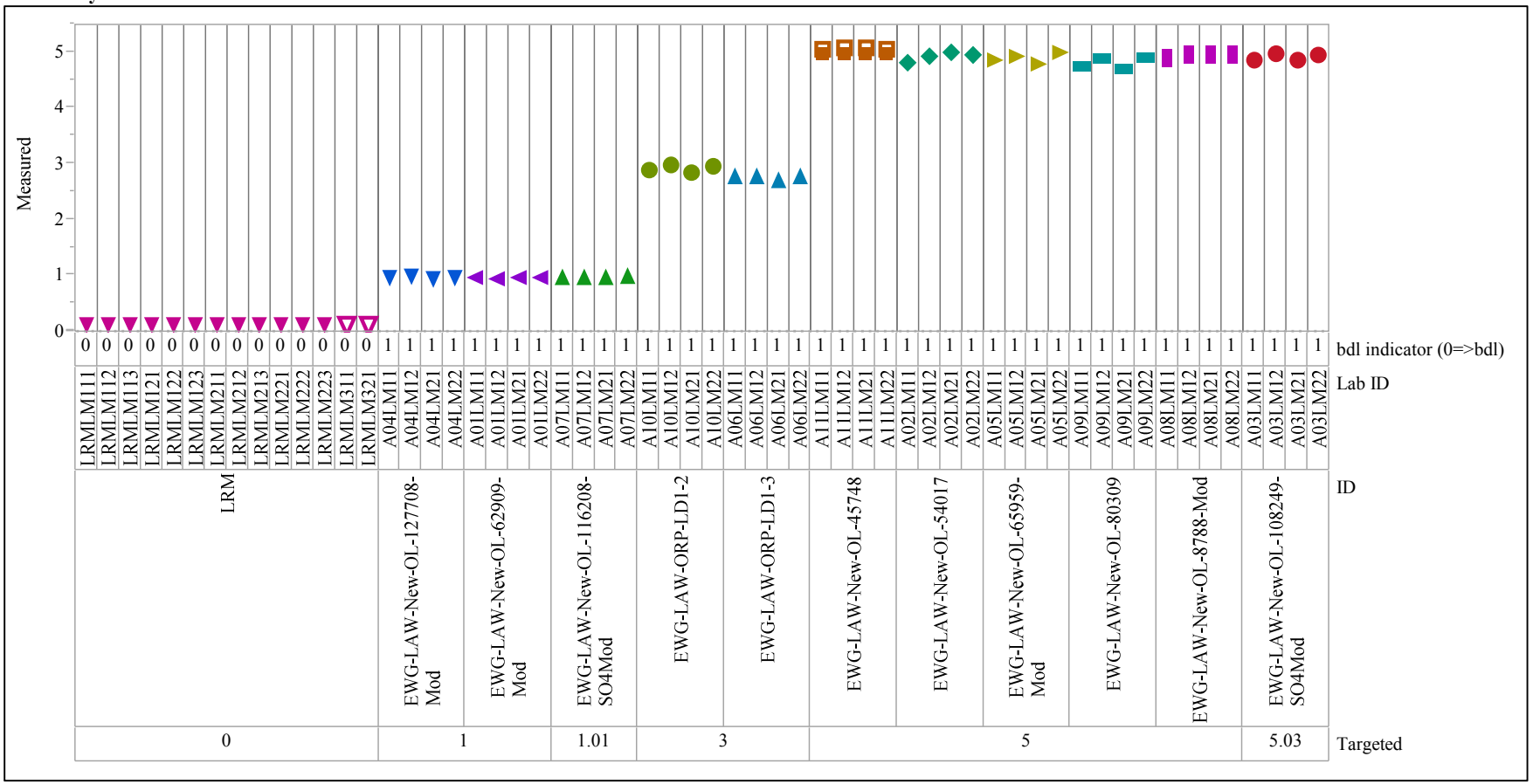


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations (continued)

Analyte=ZrO2 (wt%), Prep=LM
Variability Chart for Measured

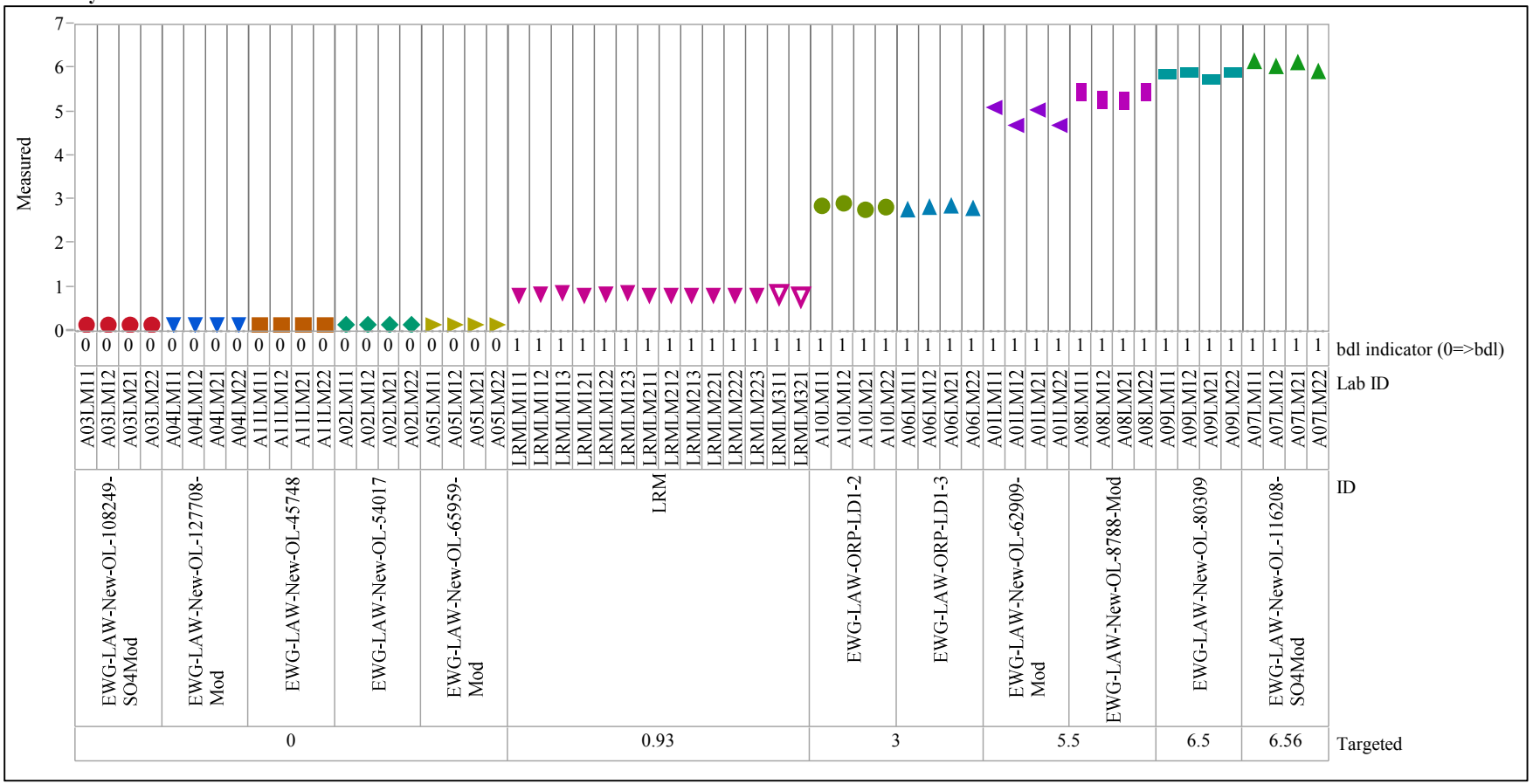


Exhibit A-3. Acceptability Evaluation for Measurements of the LRM Standard Glass

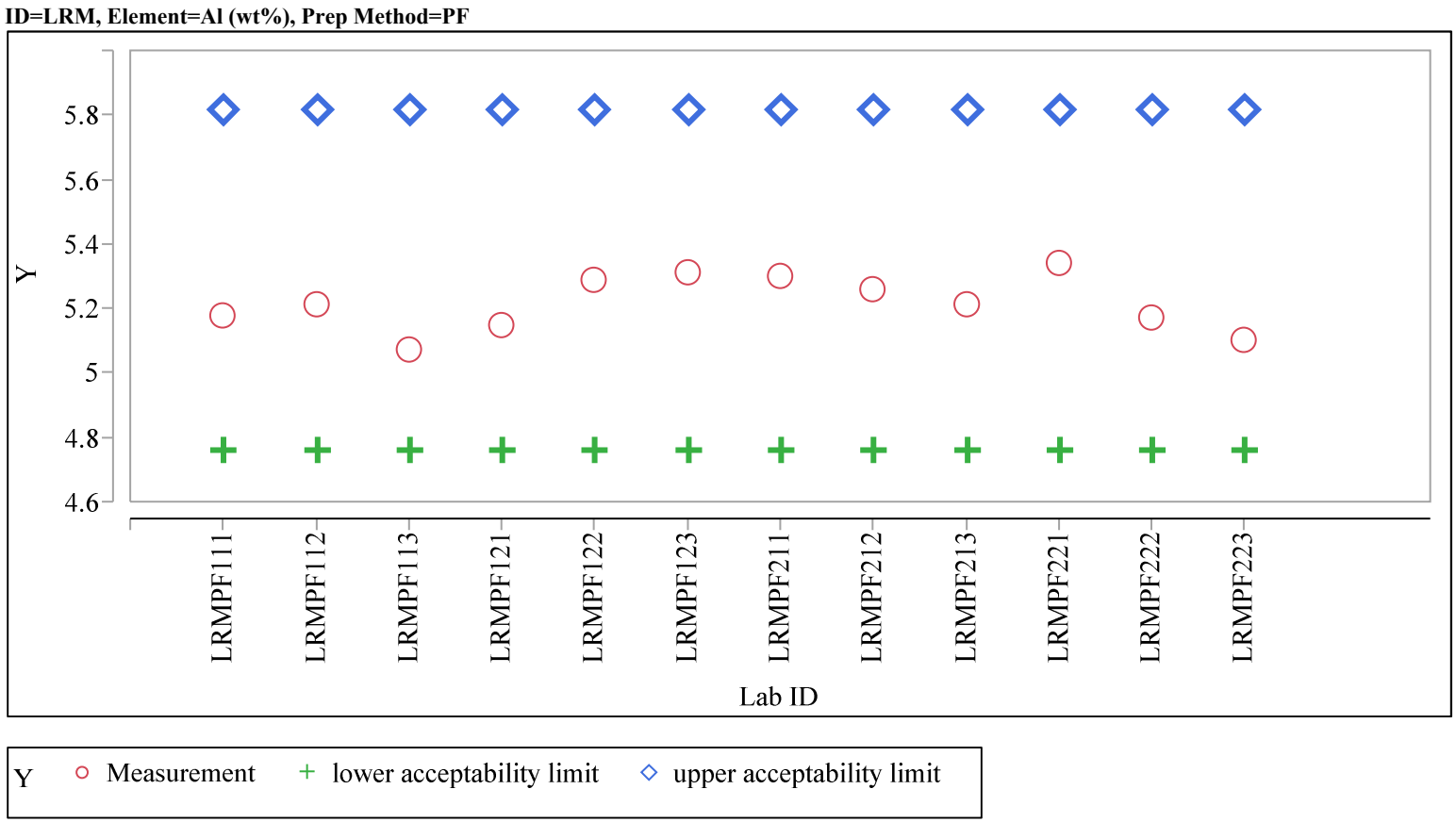


Exhibit A-3. Acceptability Evaluation for Measurements of the LRM Standard Glass (continued)

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

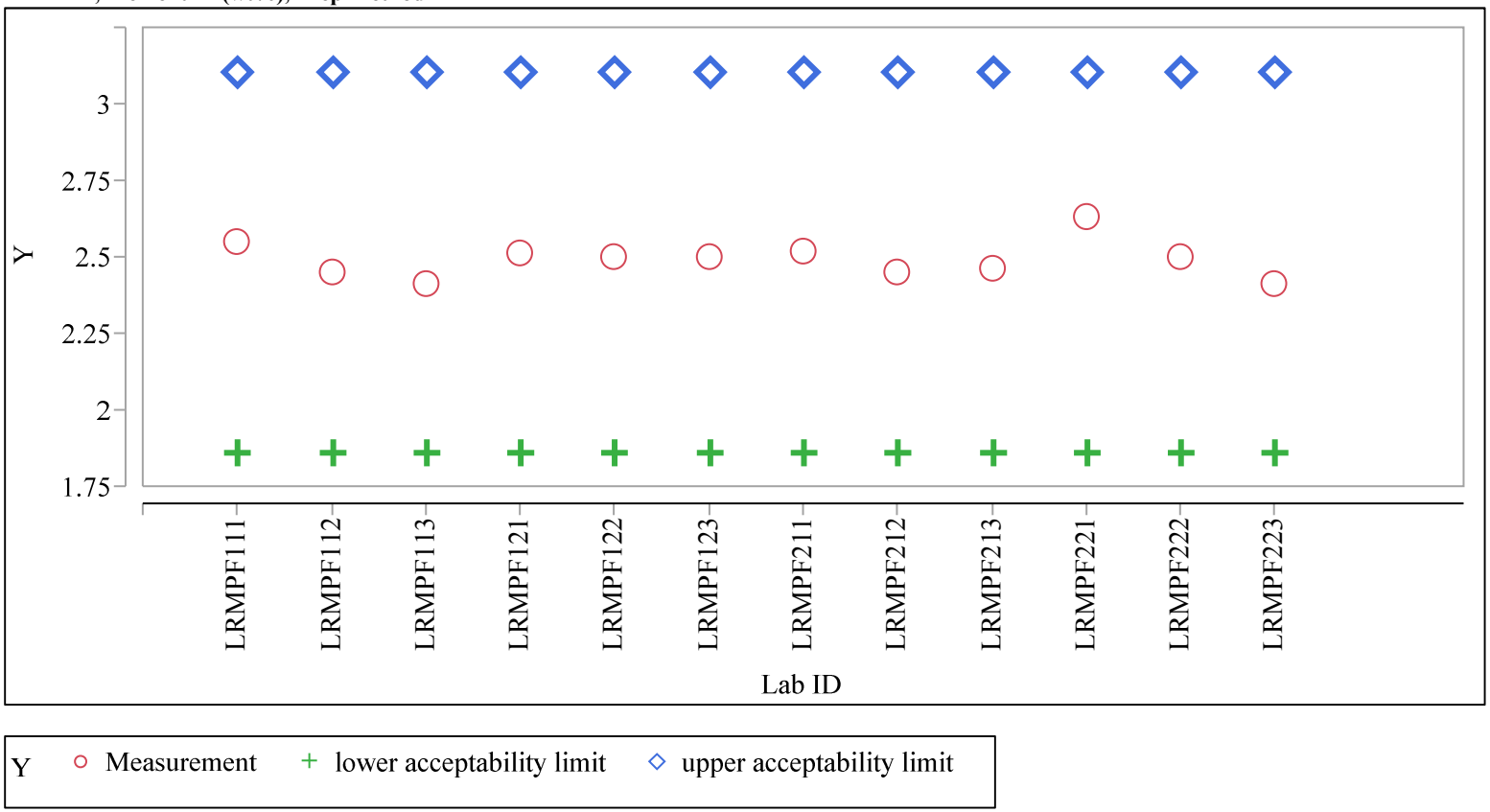


Exhibit A-3. Acceptability Evaluation for Measurements of the LRM Standard Glass (continued)

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

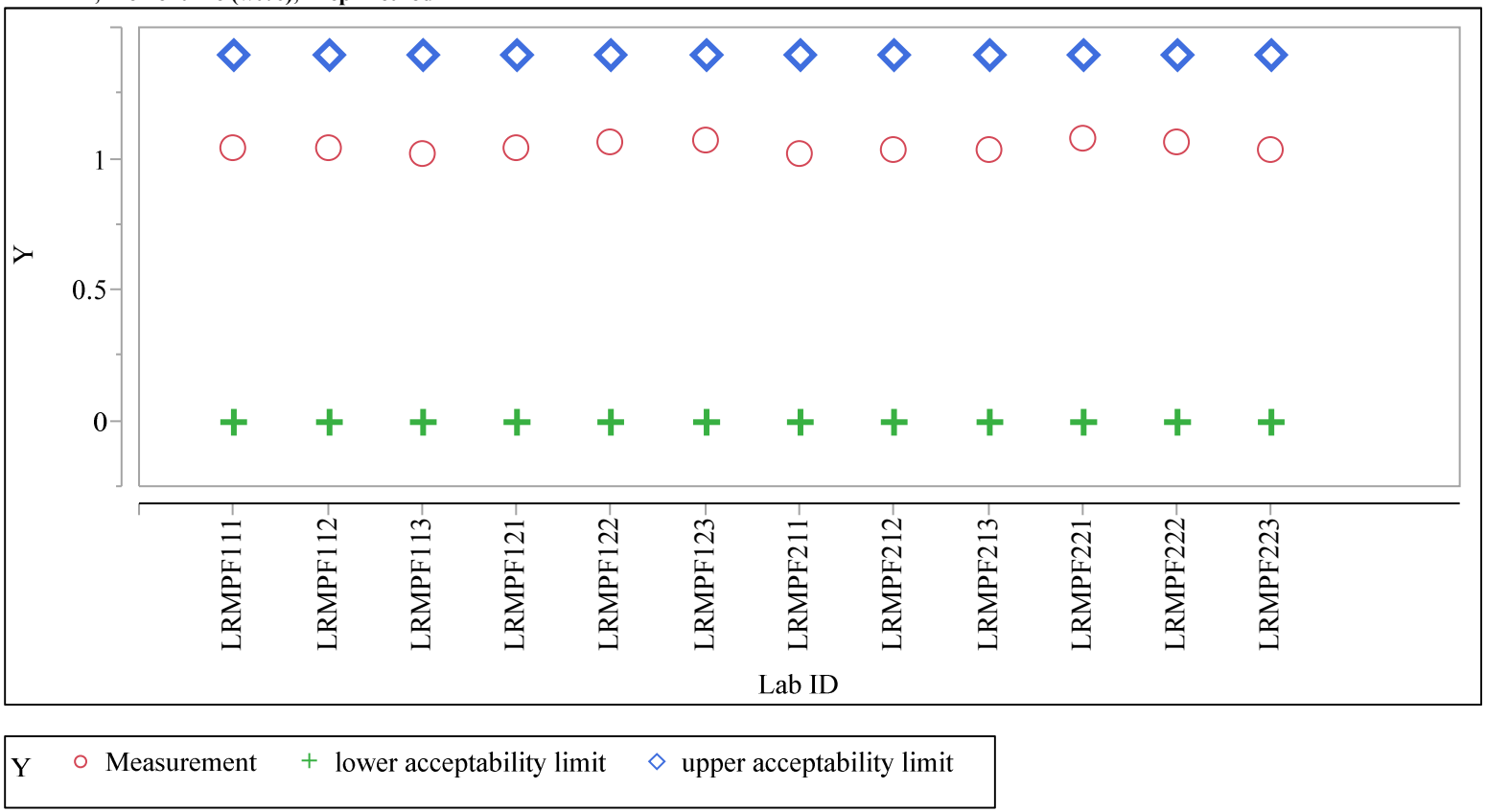


Exhibit A-3. Acceptability Evaluation for Measurements of the LRM Standard Glass (continued)

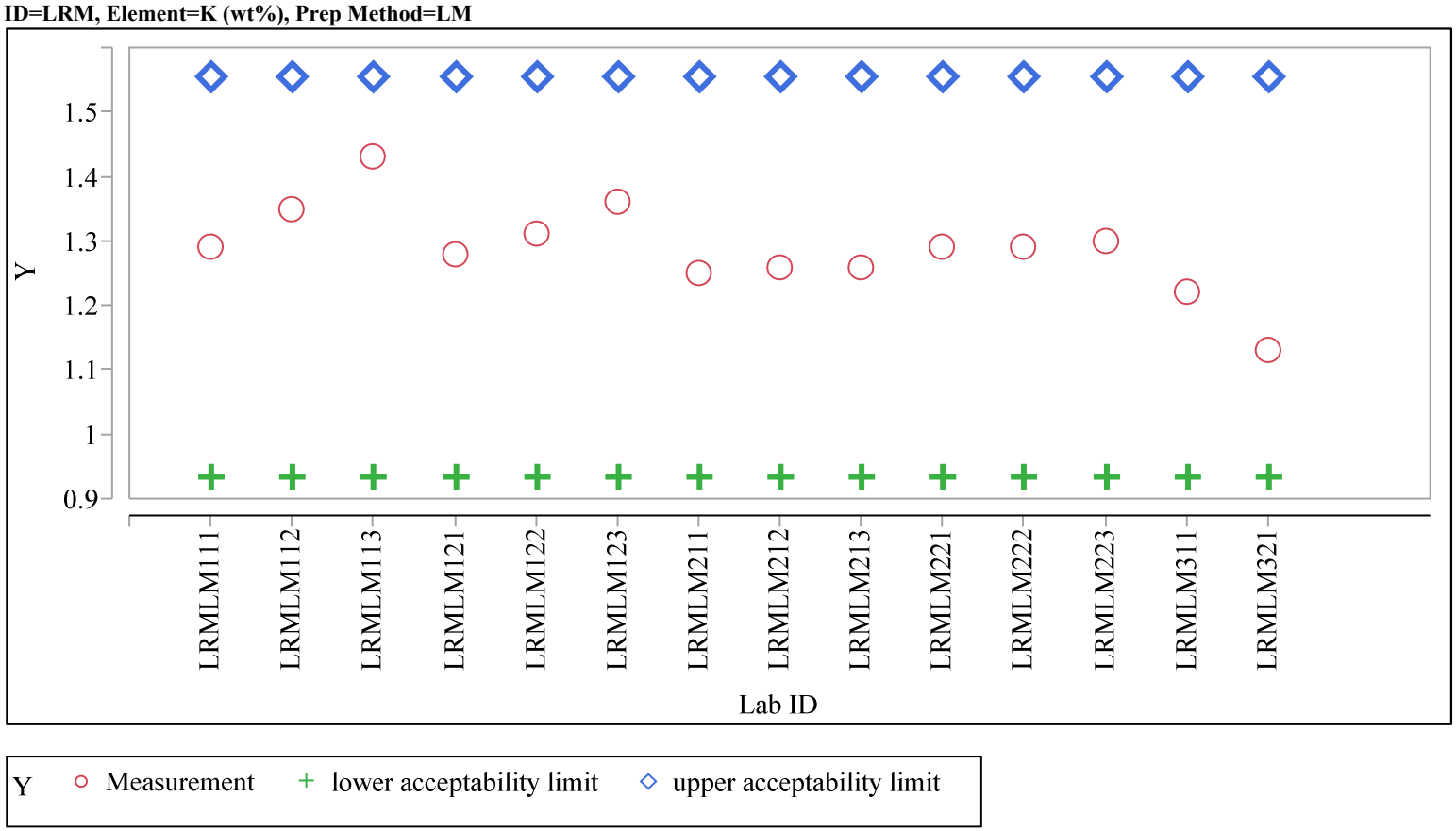


Exhibit A-3. Acceptability Evaluation for Measurements of the LRM Standard Glass (continued)

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

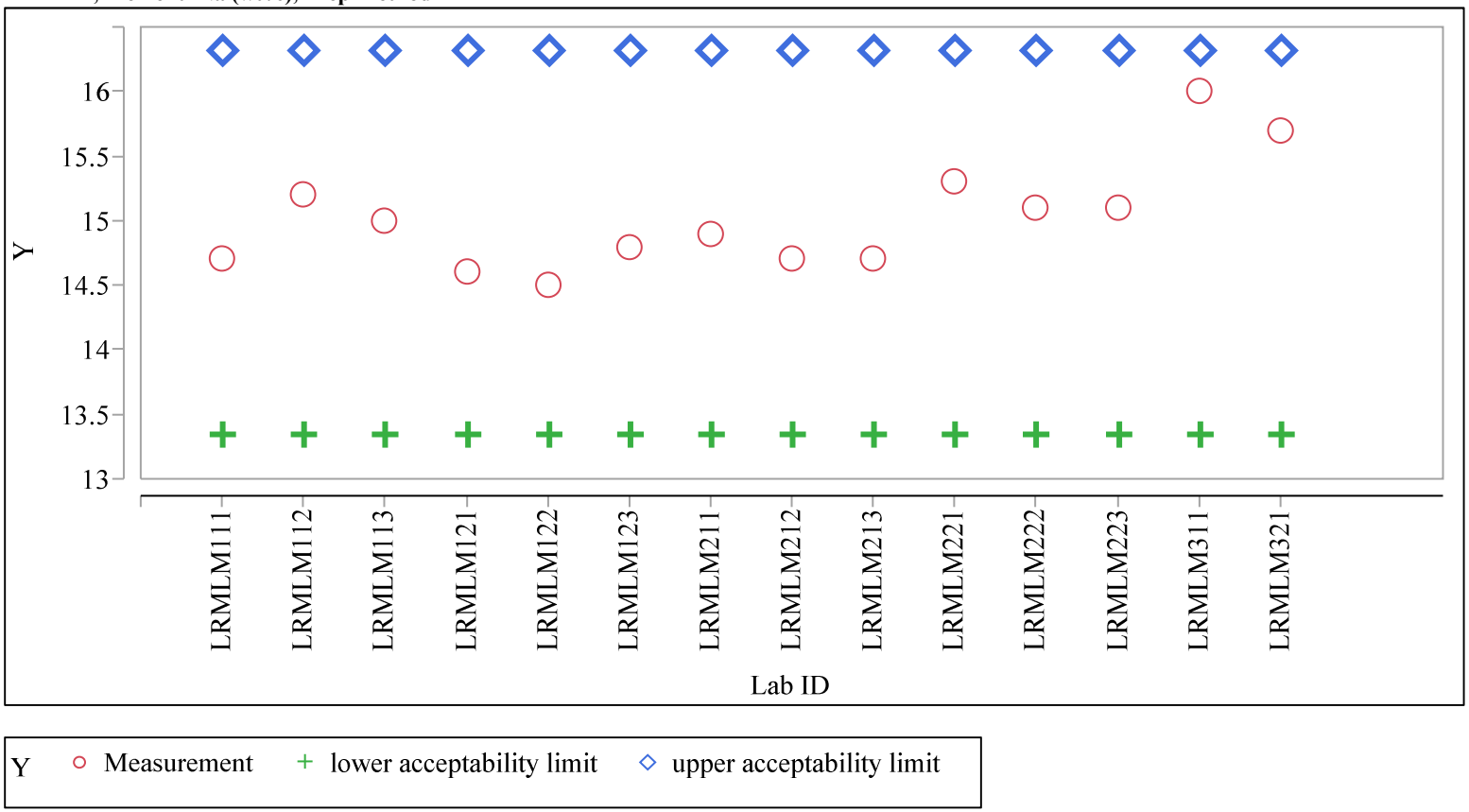


Exhibit A-3. Acceptability Evaluation for Measurements of the LRM Standard Glass (continued)

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

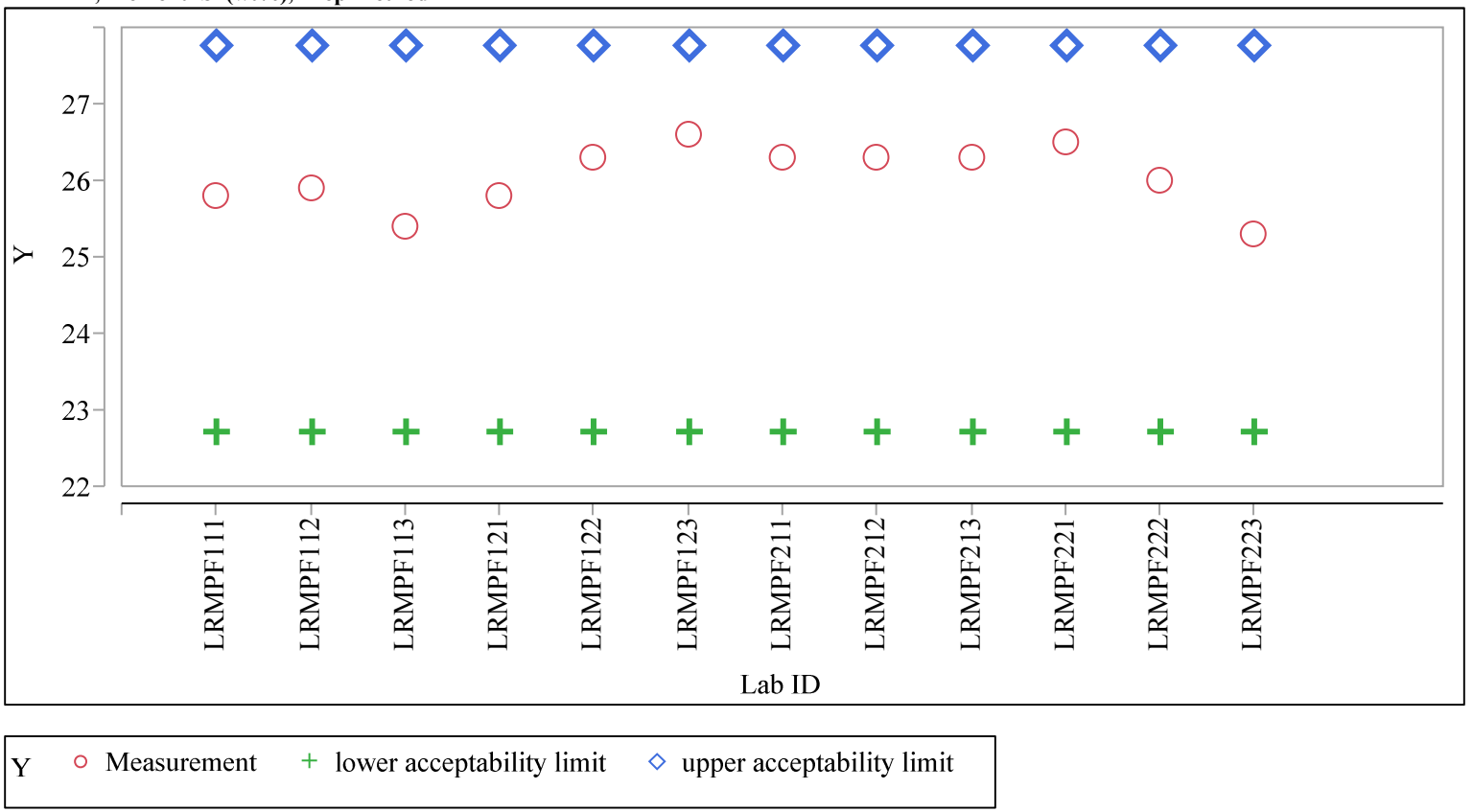


Exhibit A-3. Acceptability Evaluation for Measurements of the LRM Standard Glass (continued)

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

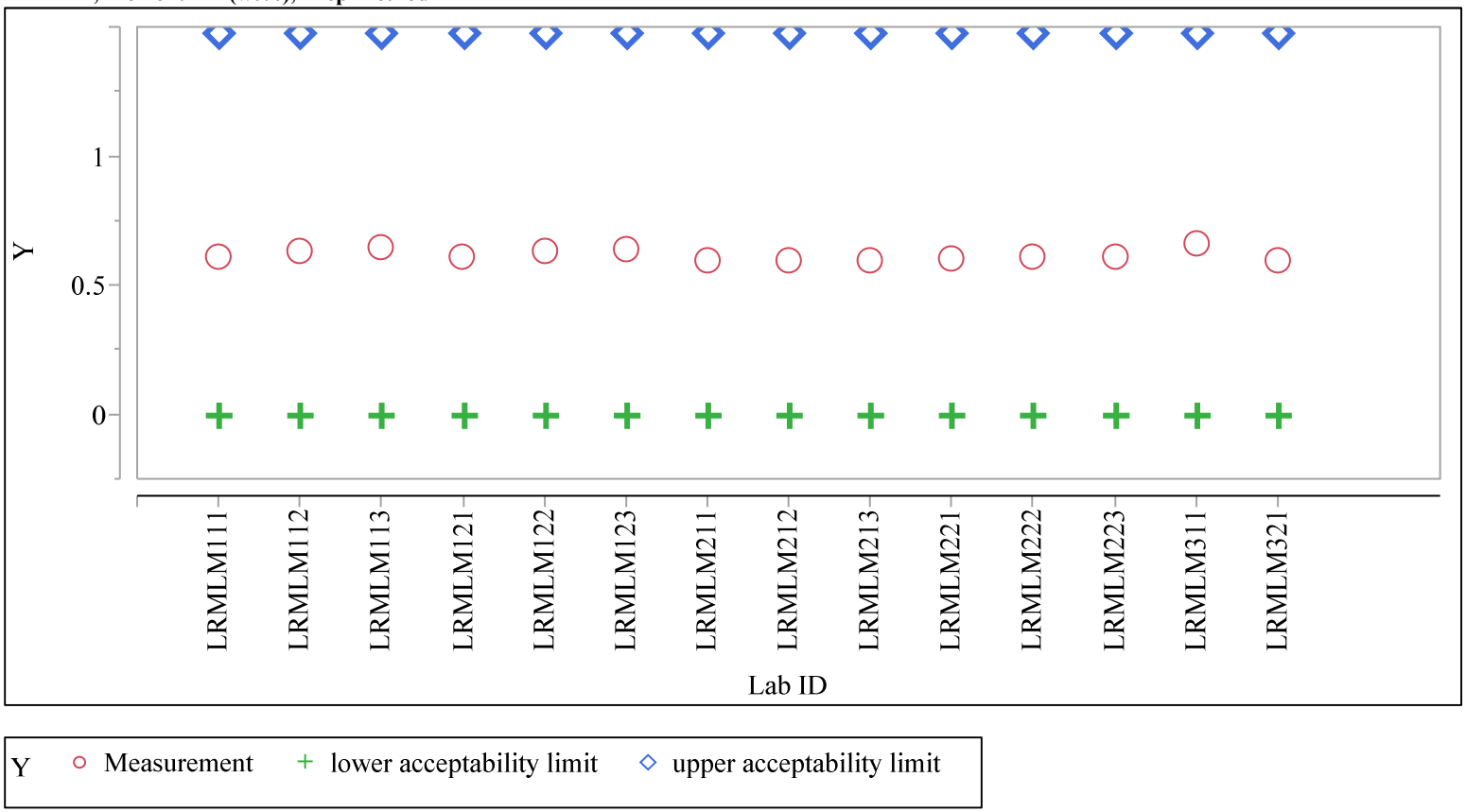


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide

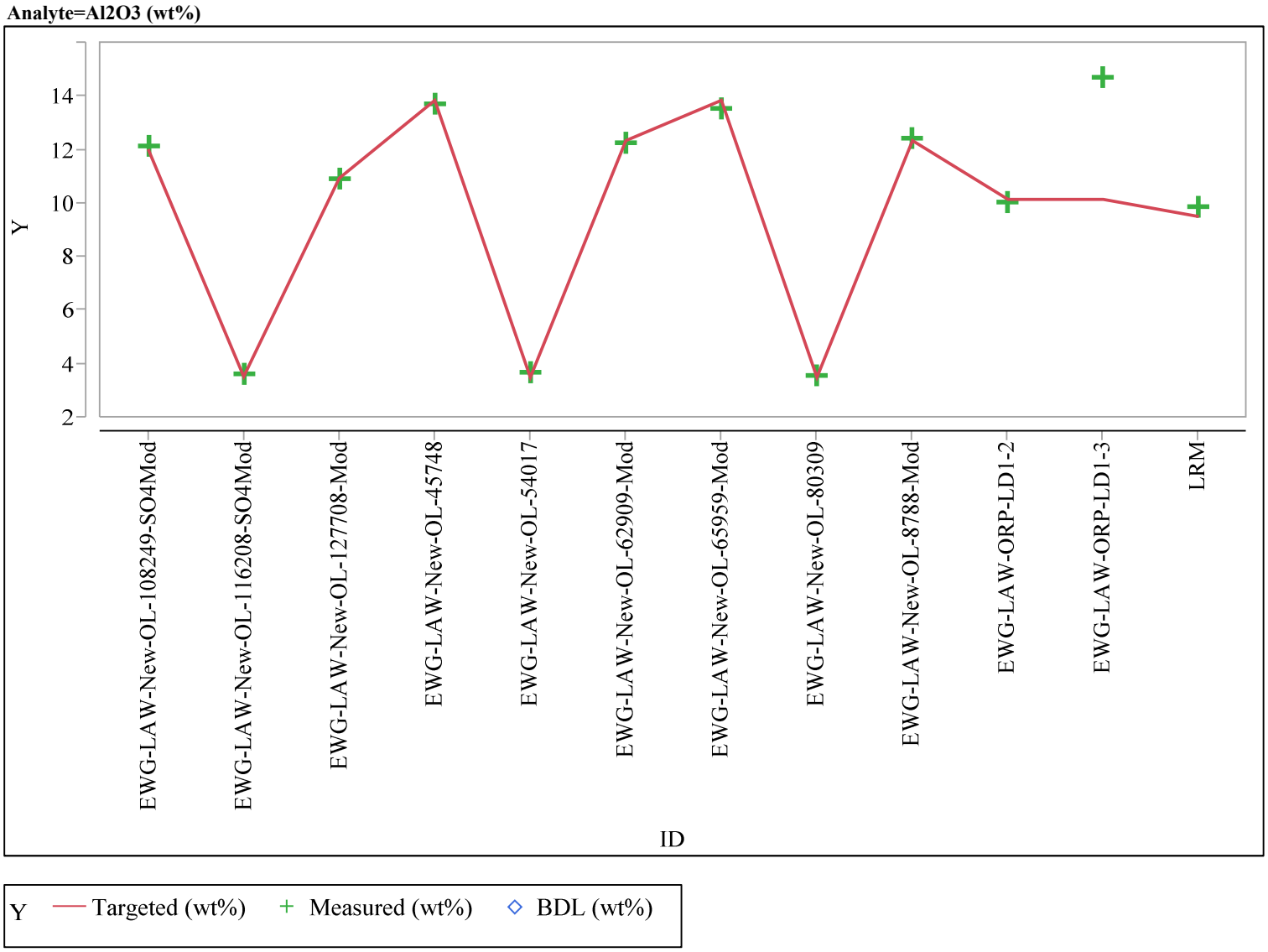


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

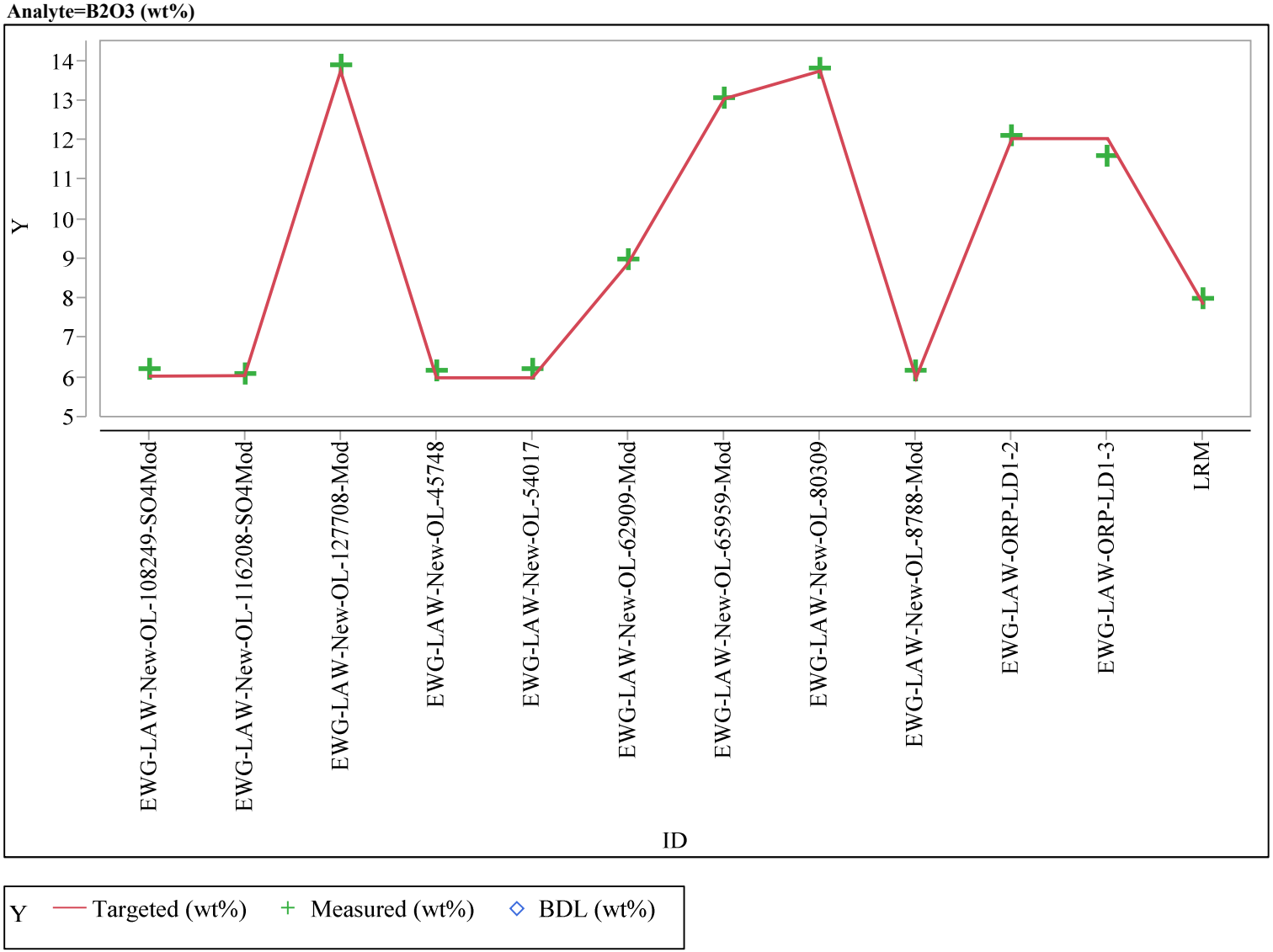


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

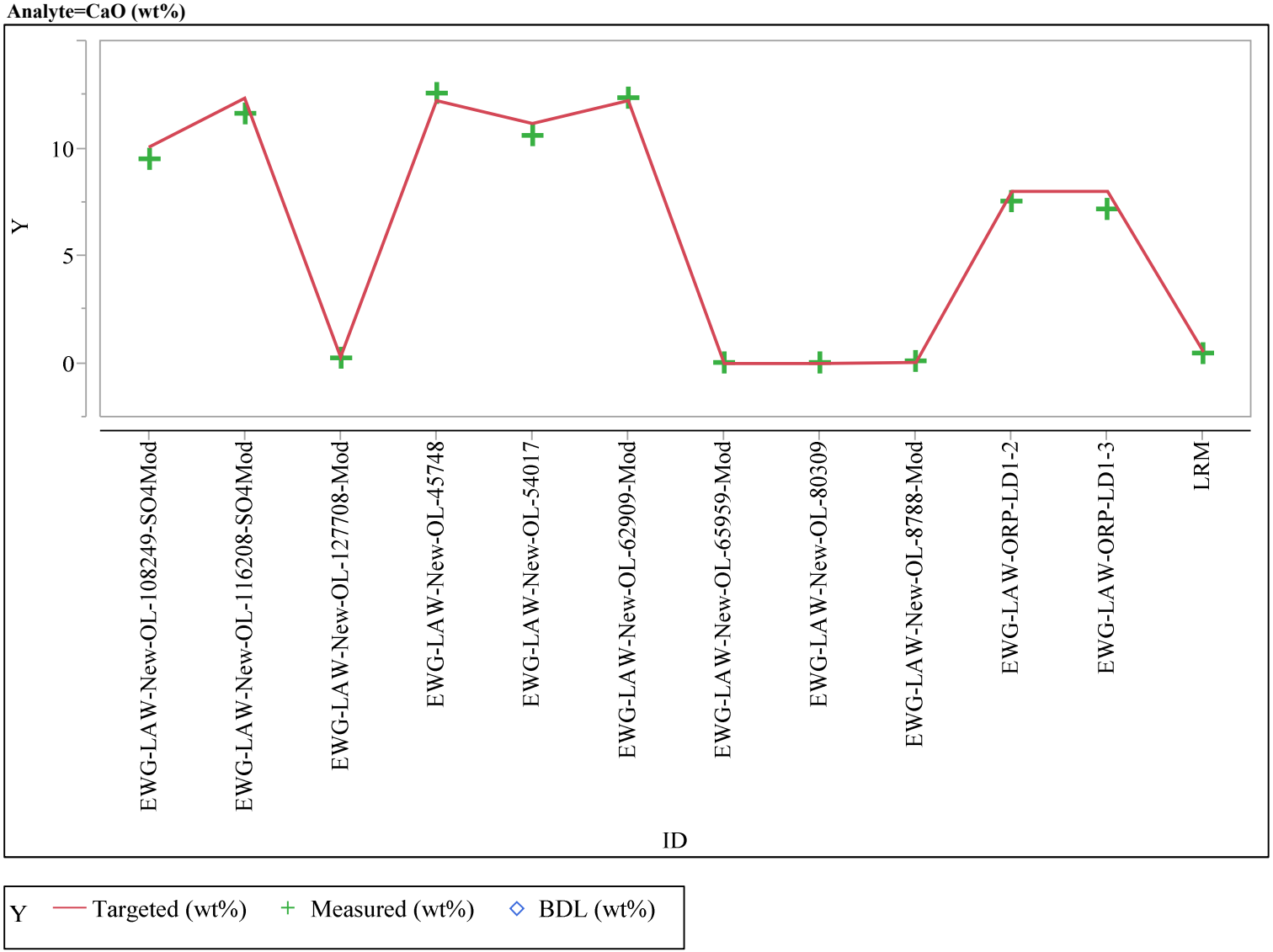


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

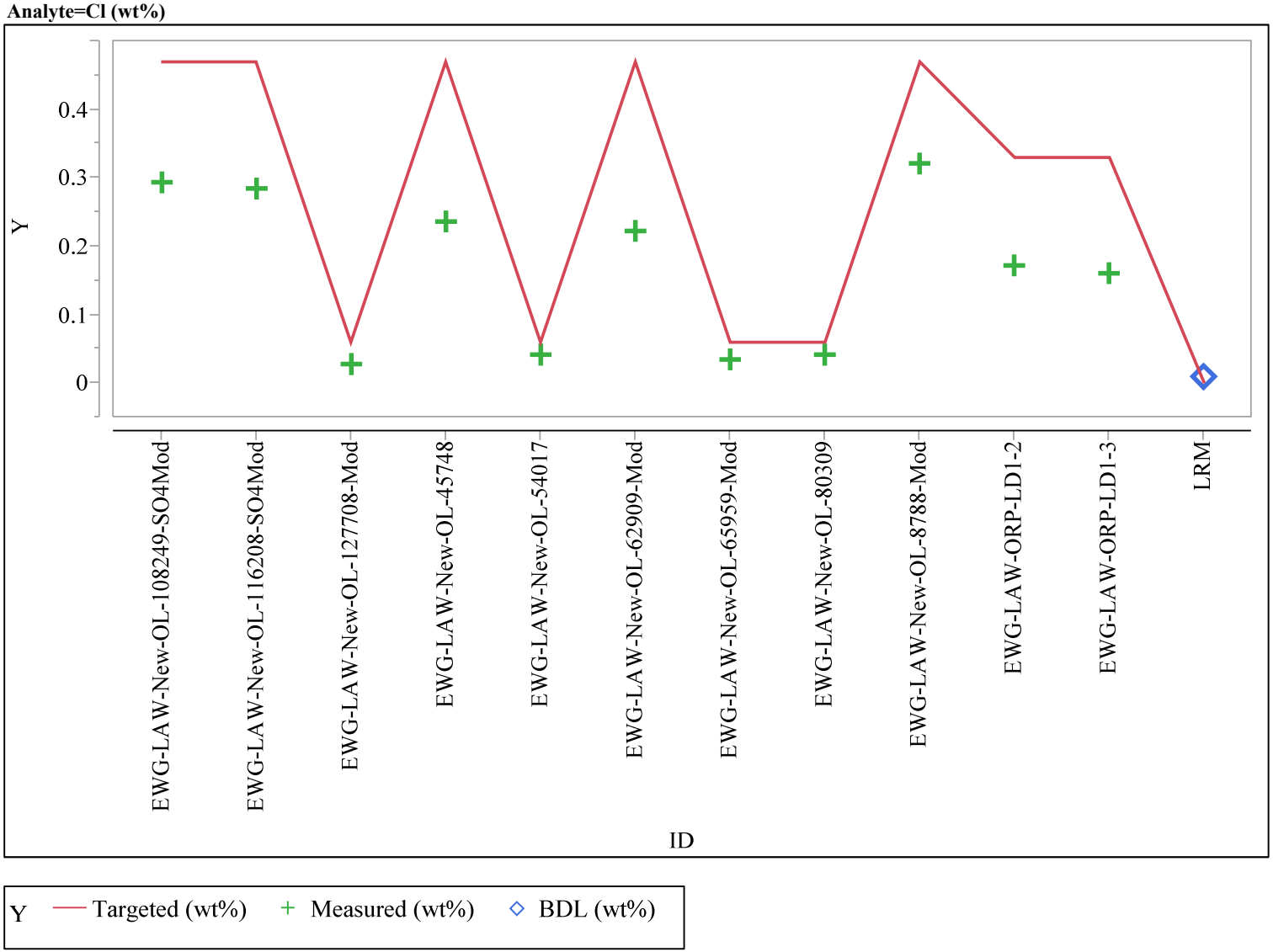


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

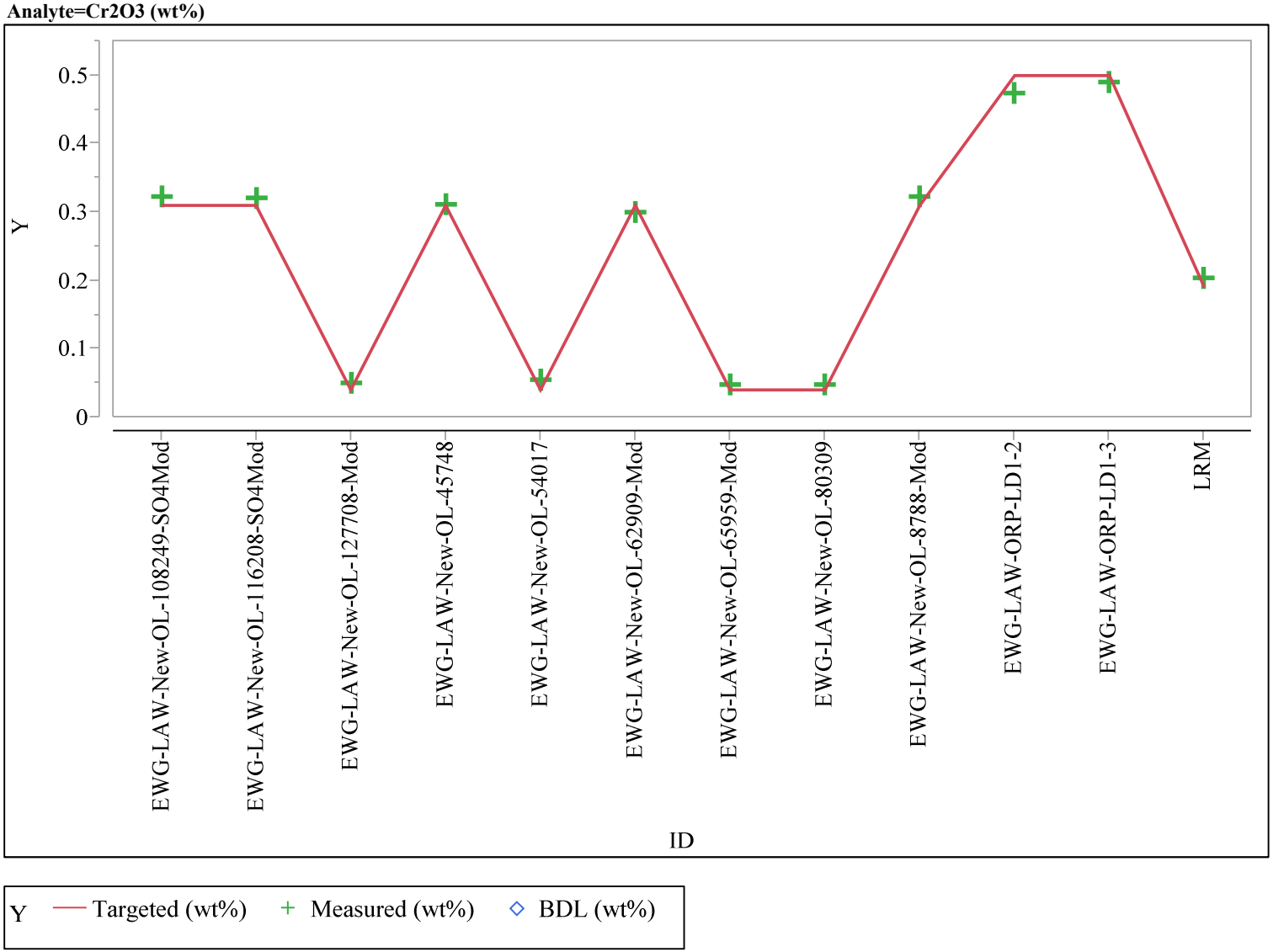


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

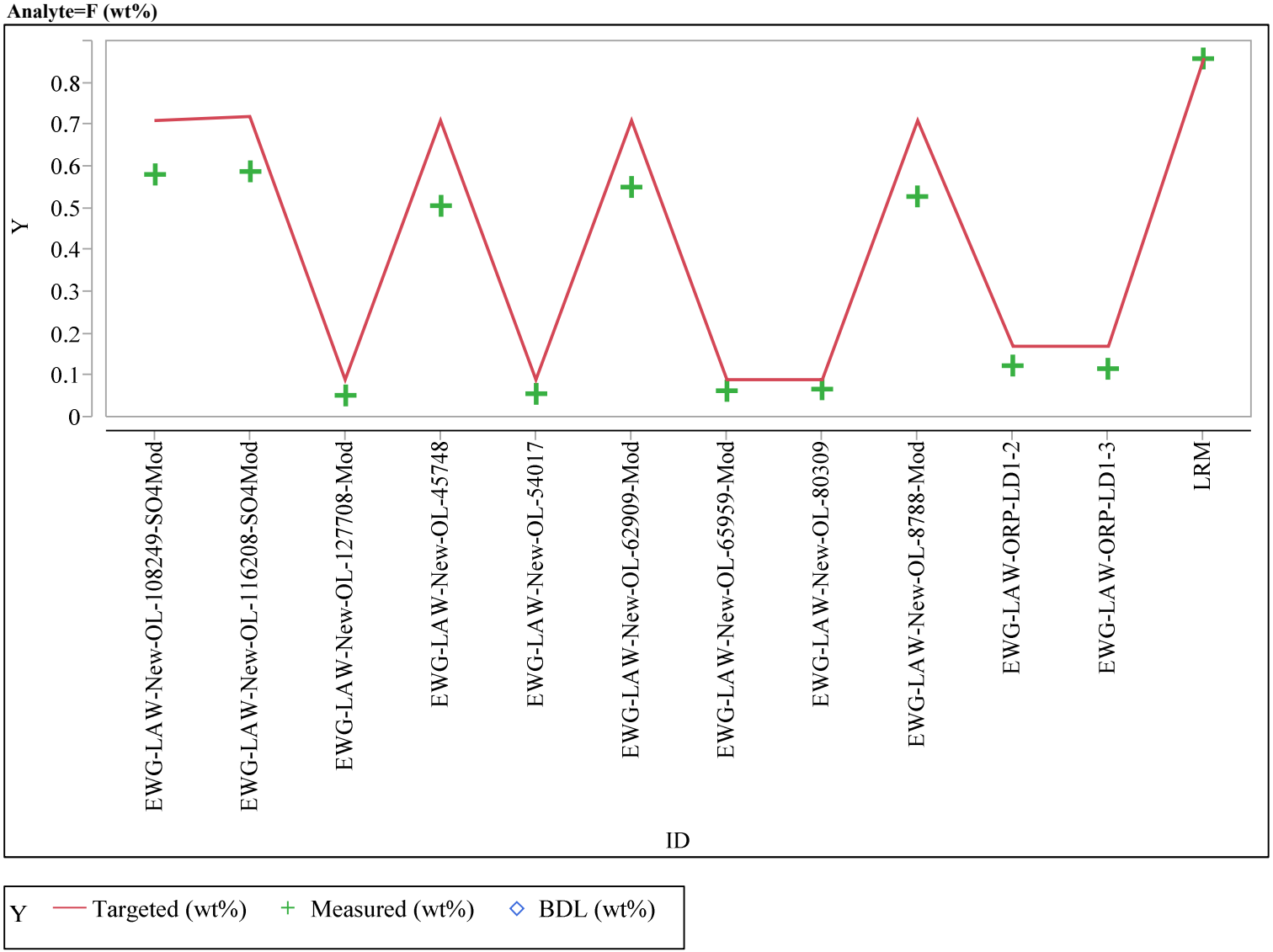


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

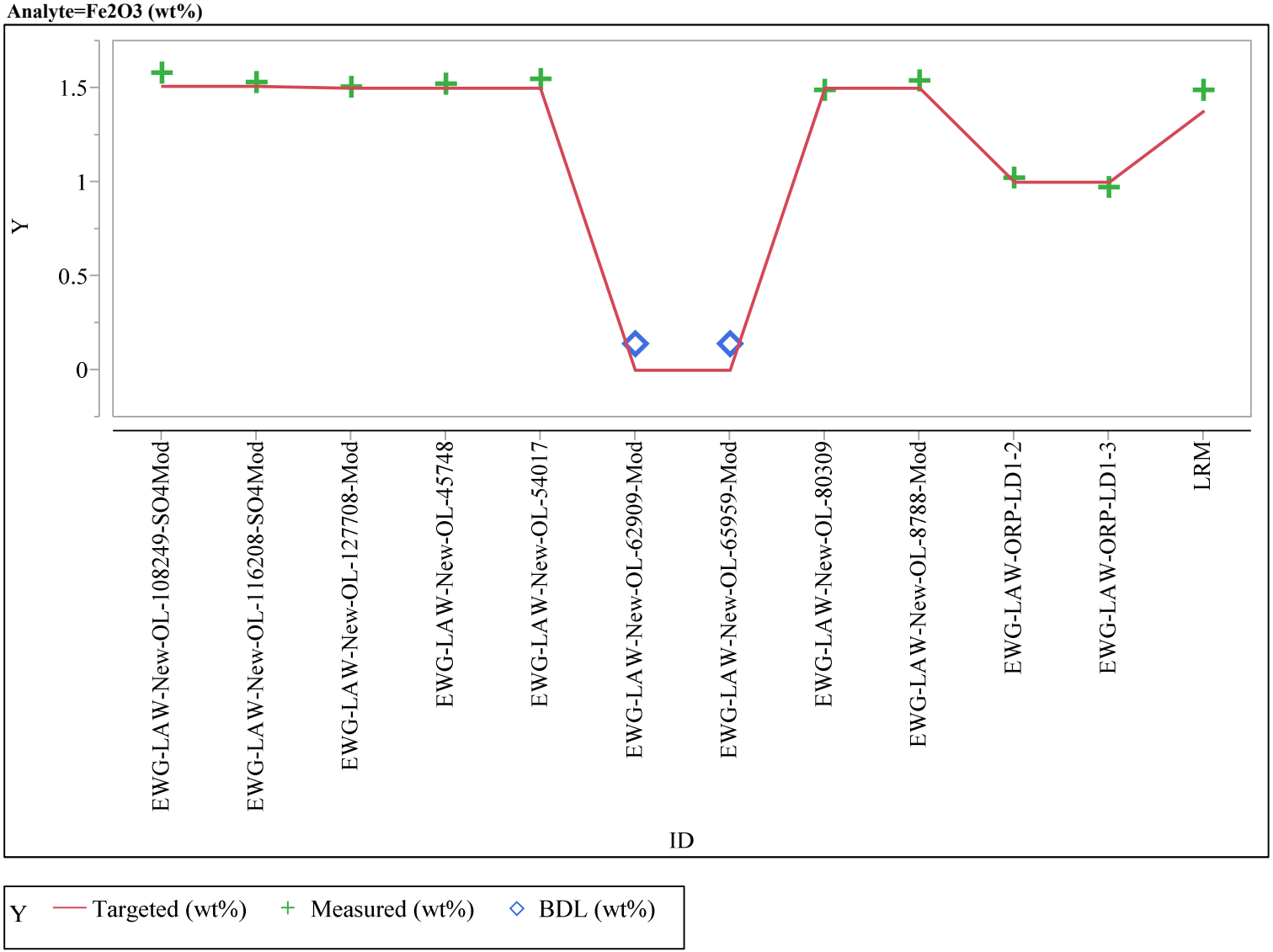


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

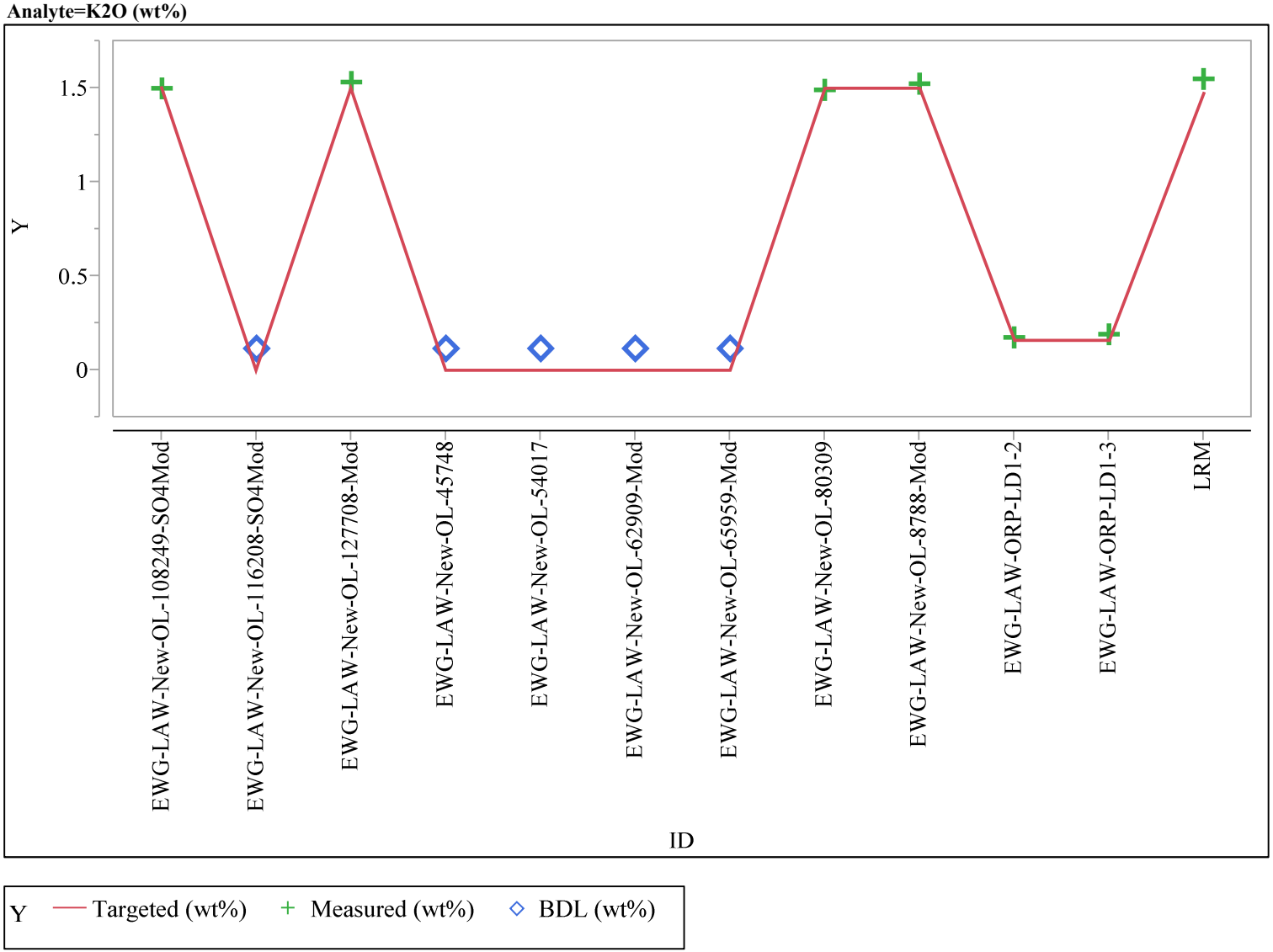


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

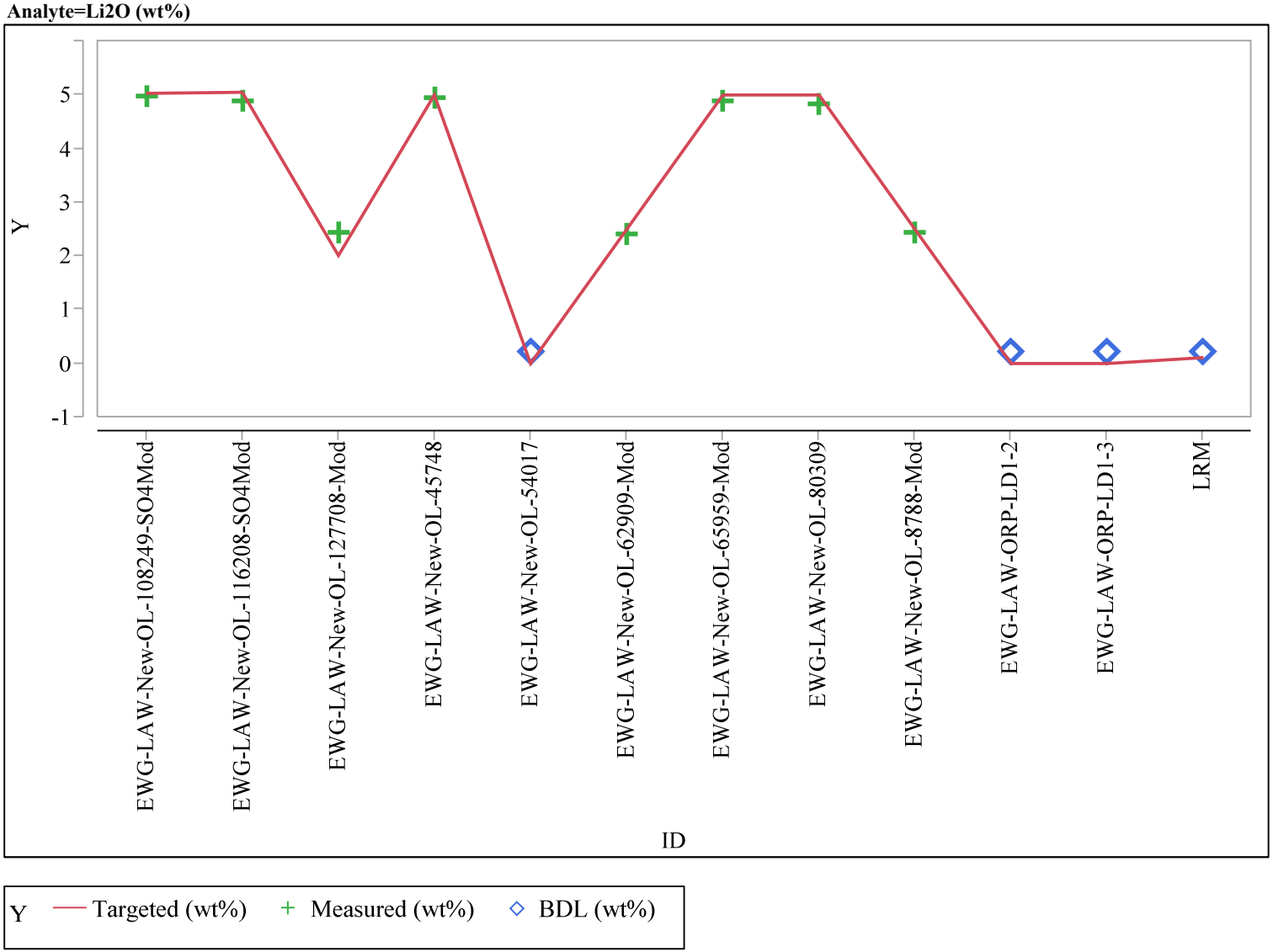


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

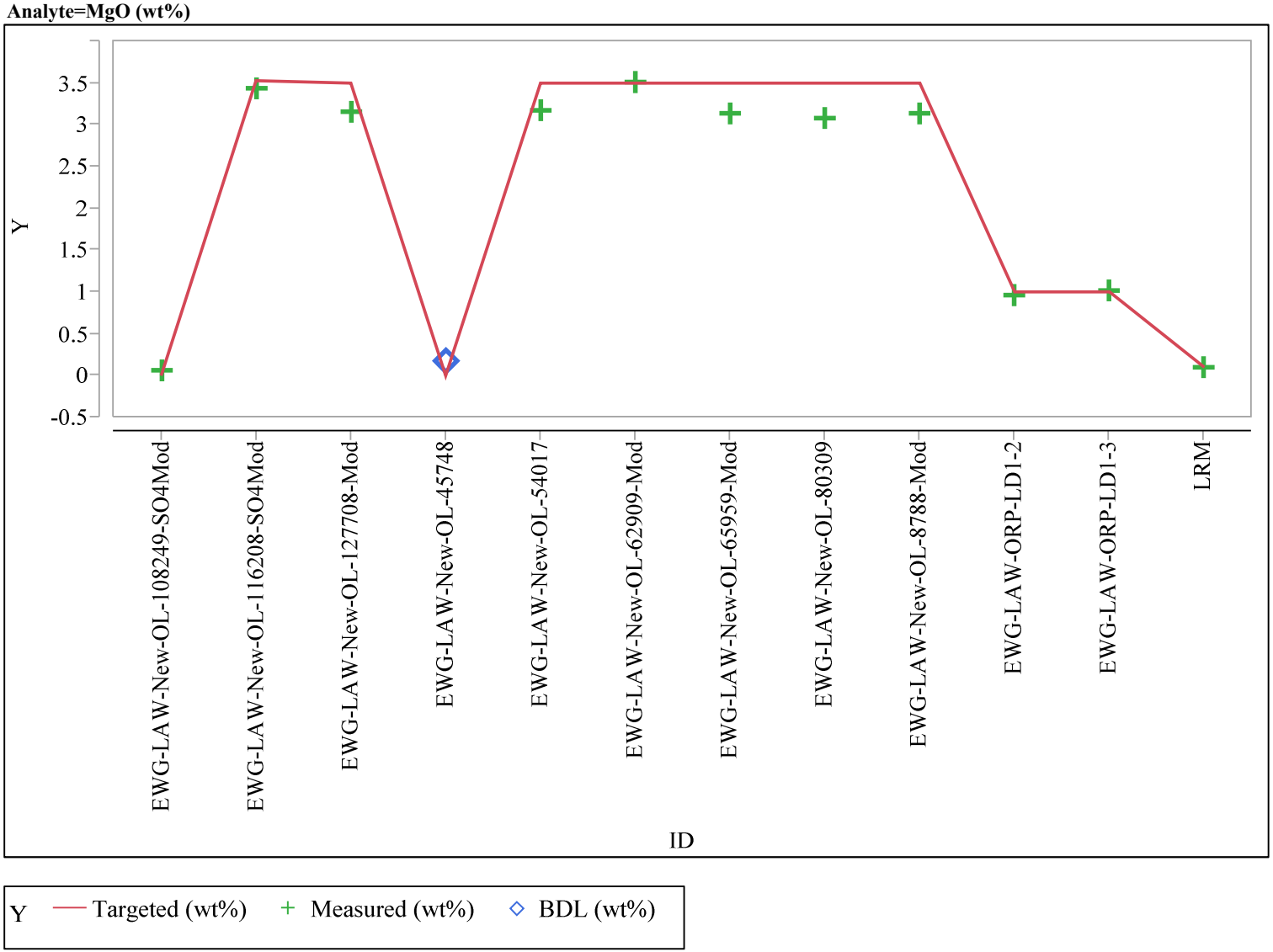


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

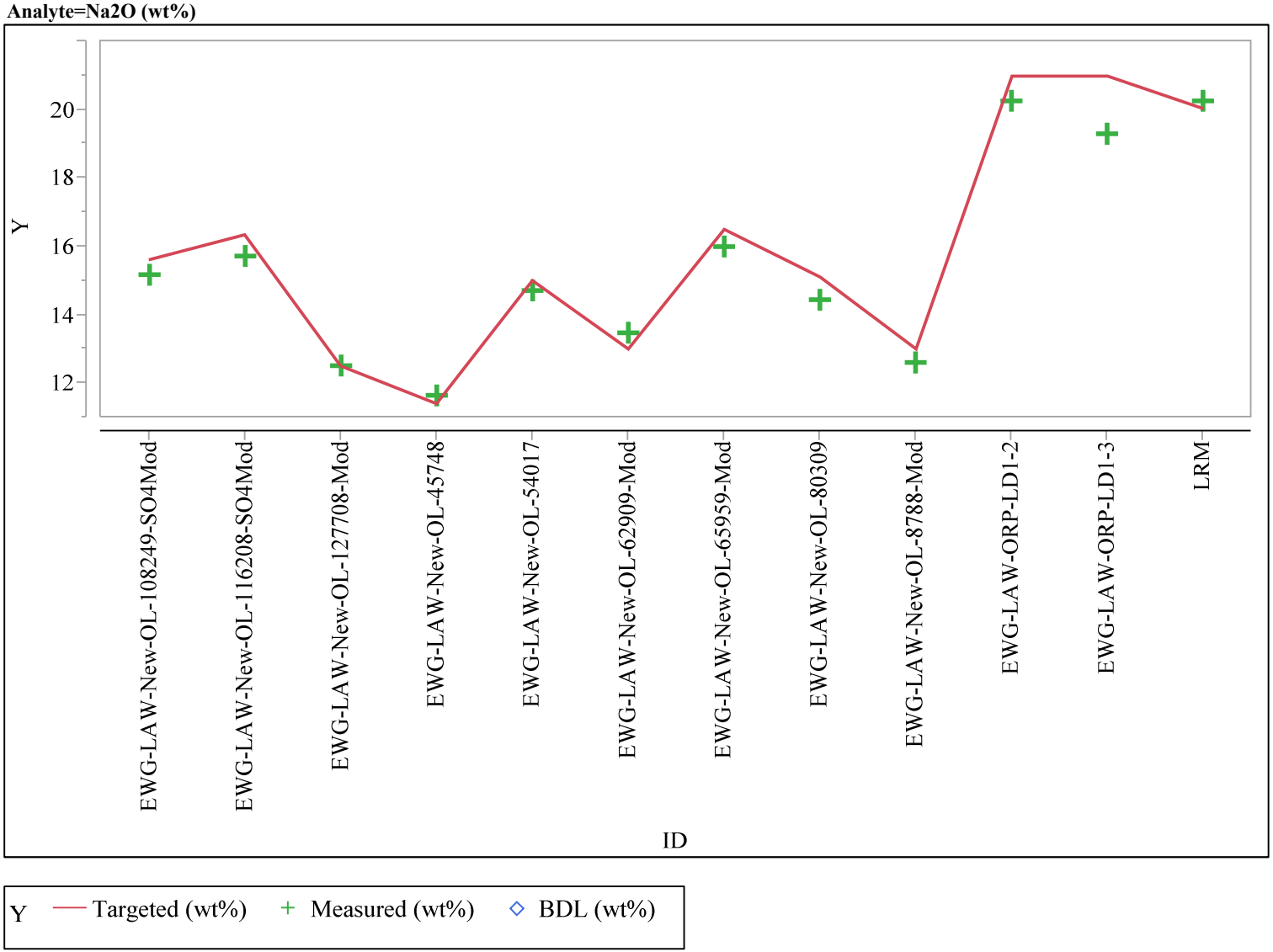


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

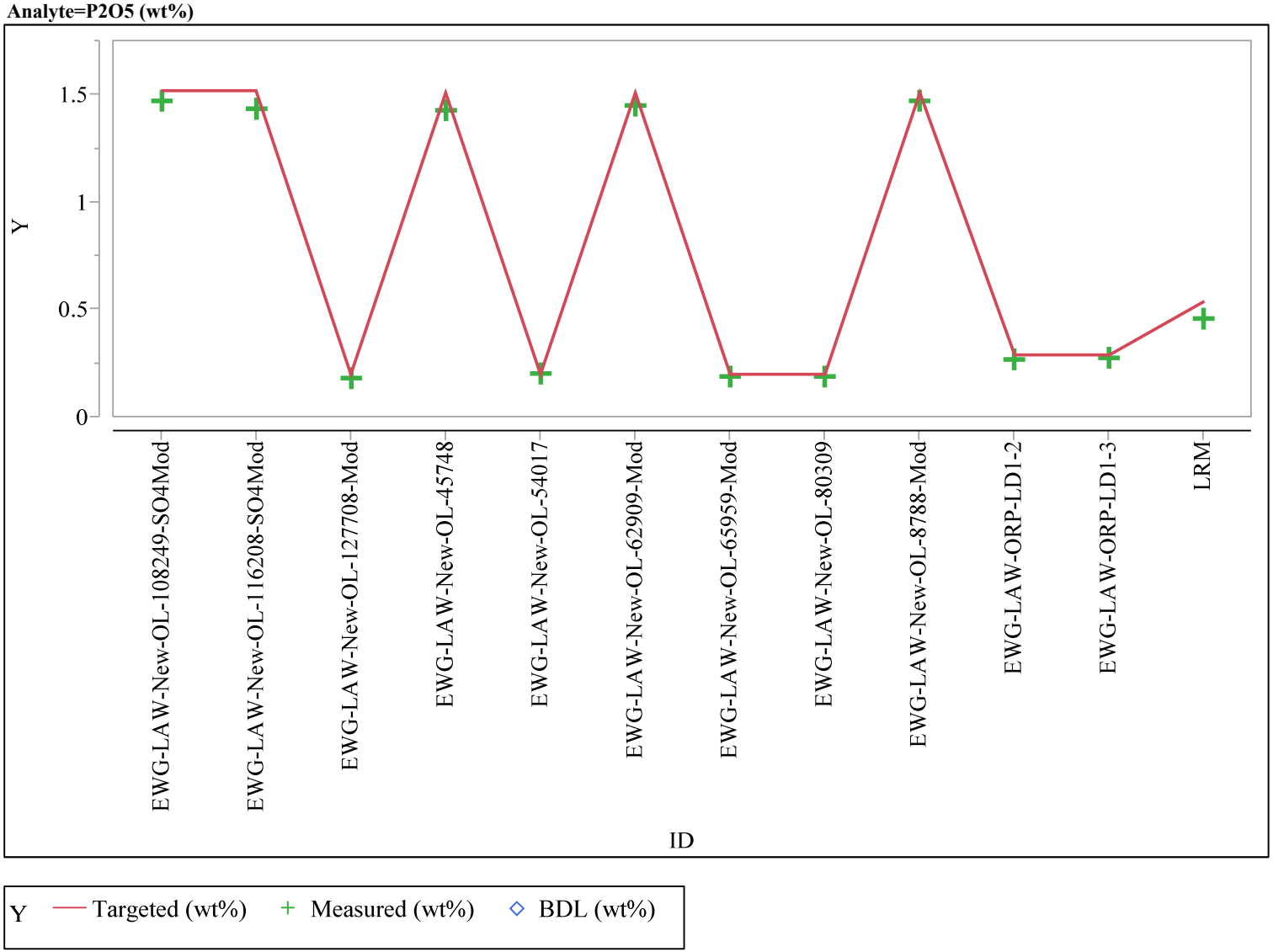


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

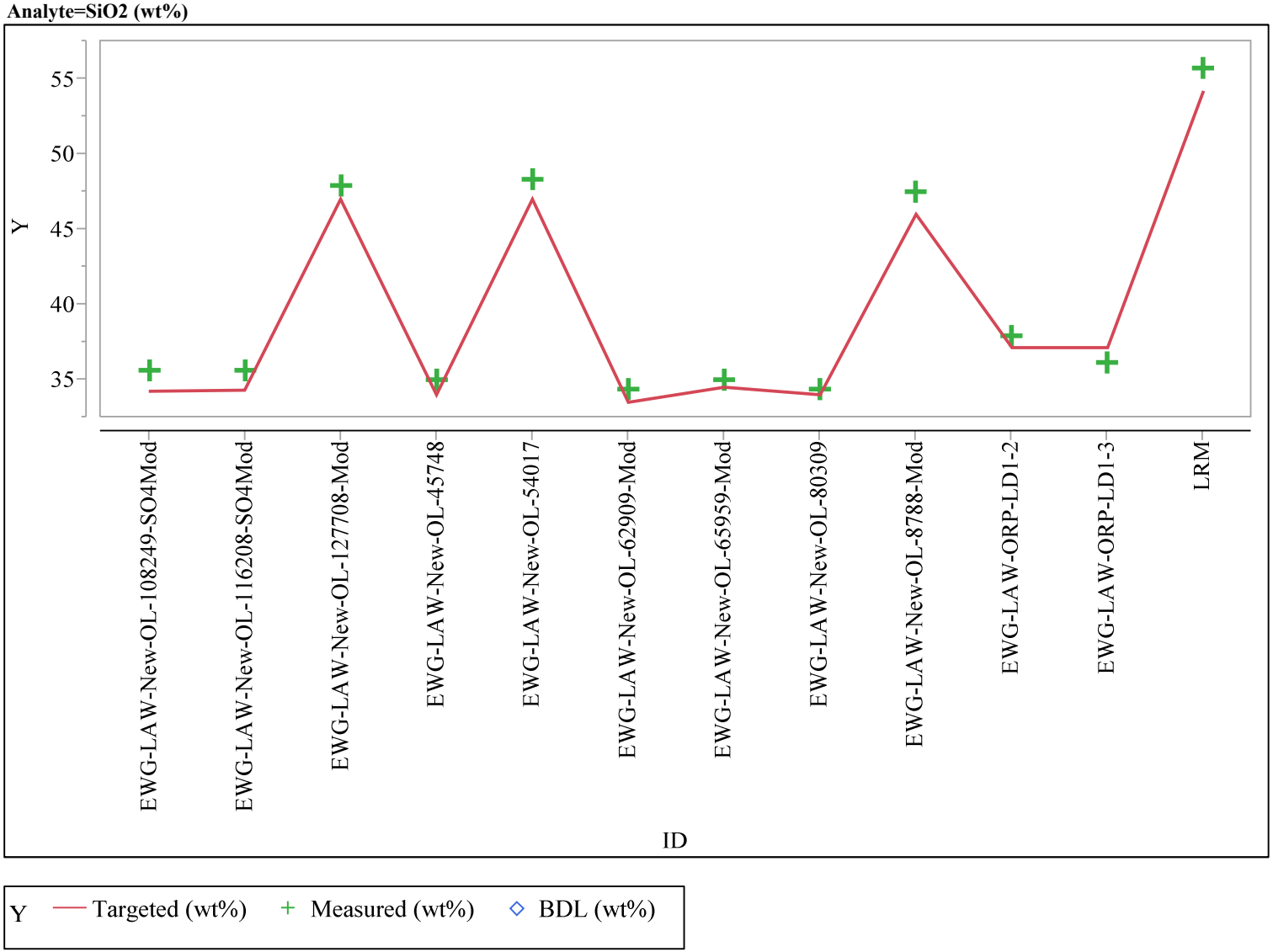


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

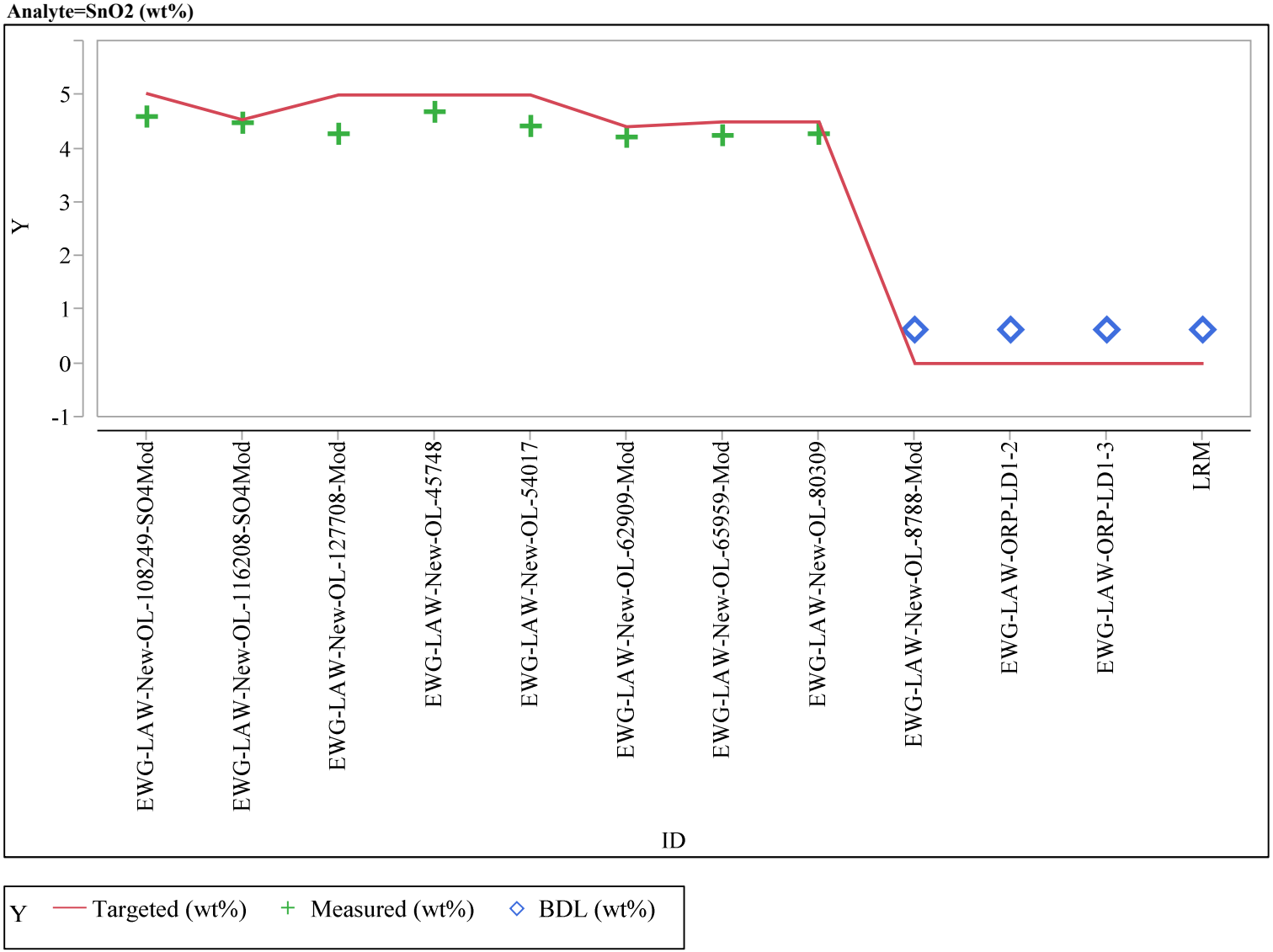


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

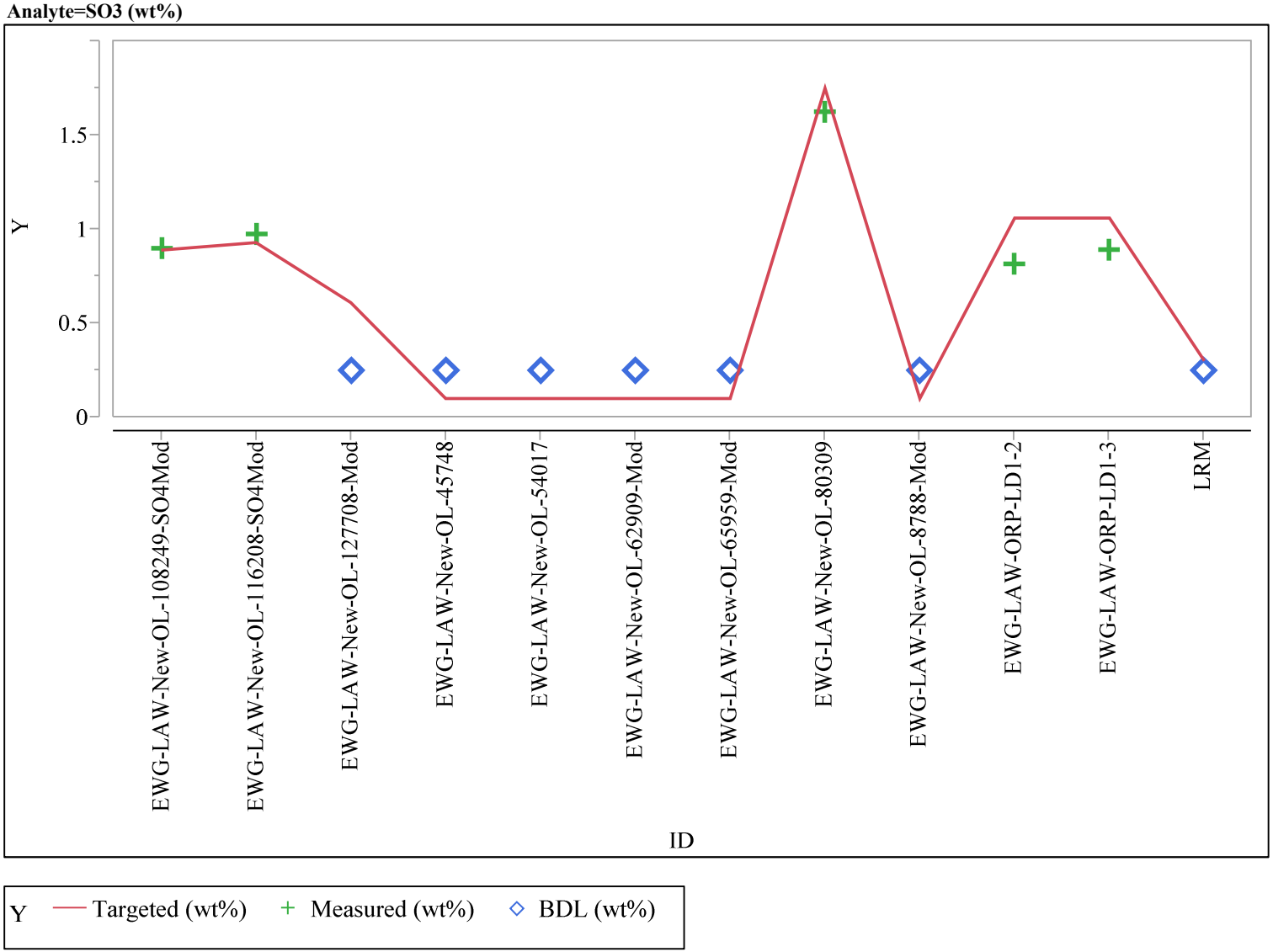


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

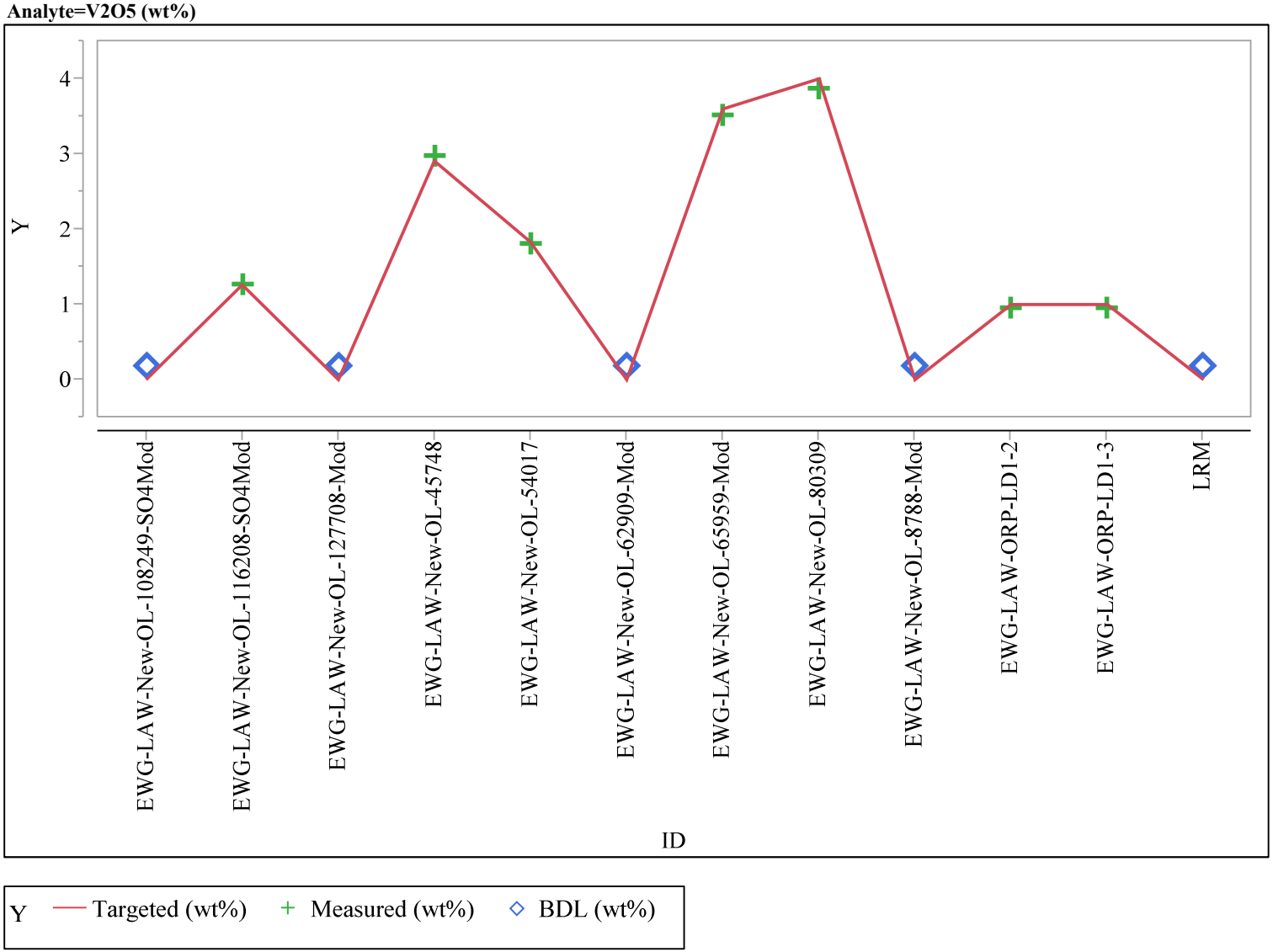


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

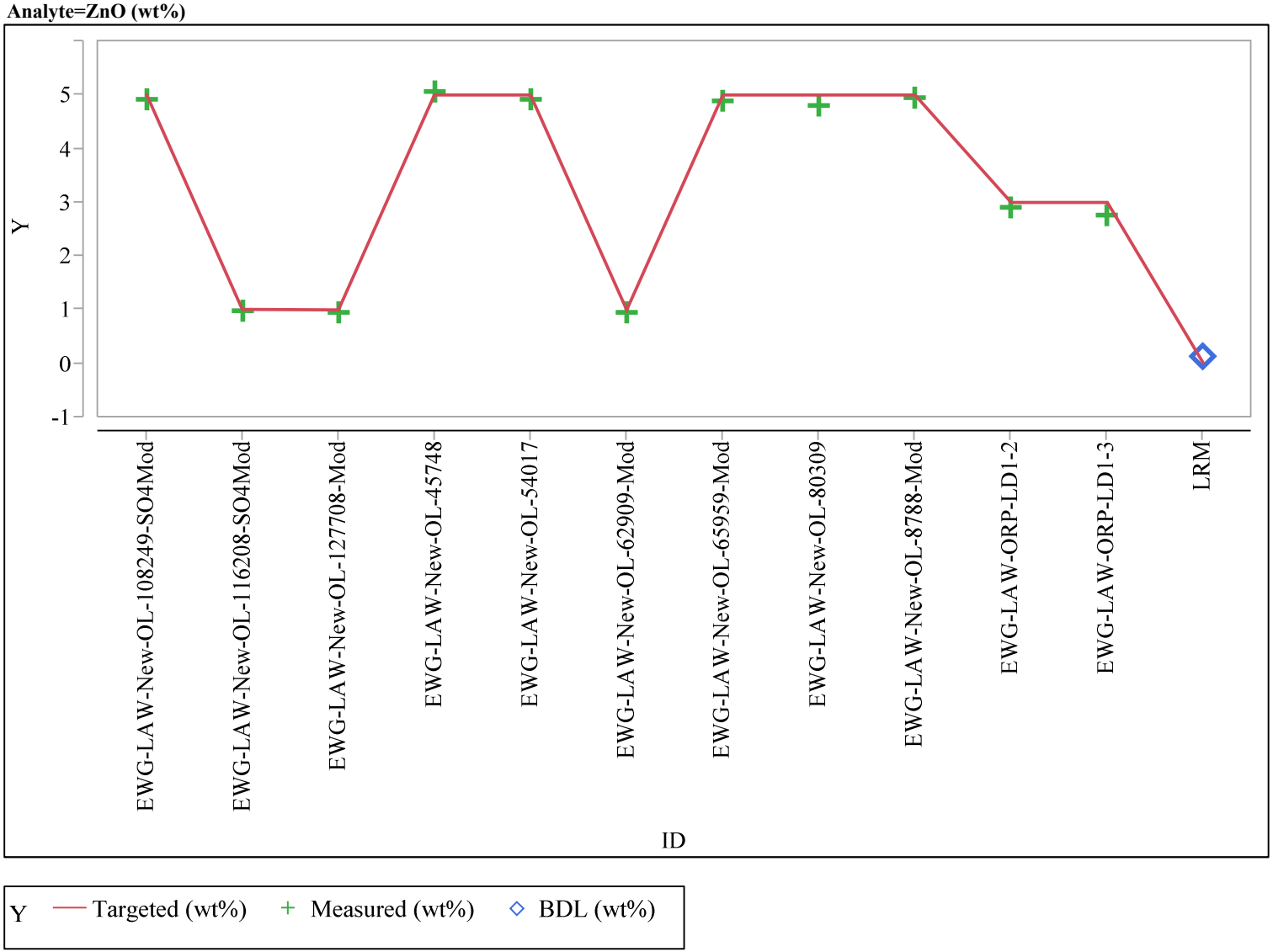


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

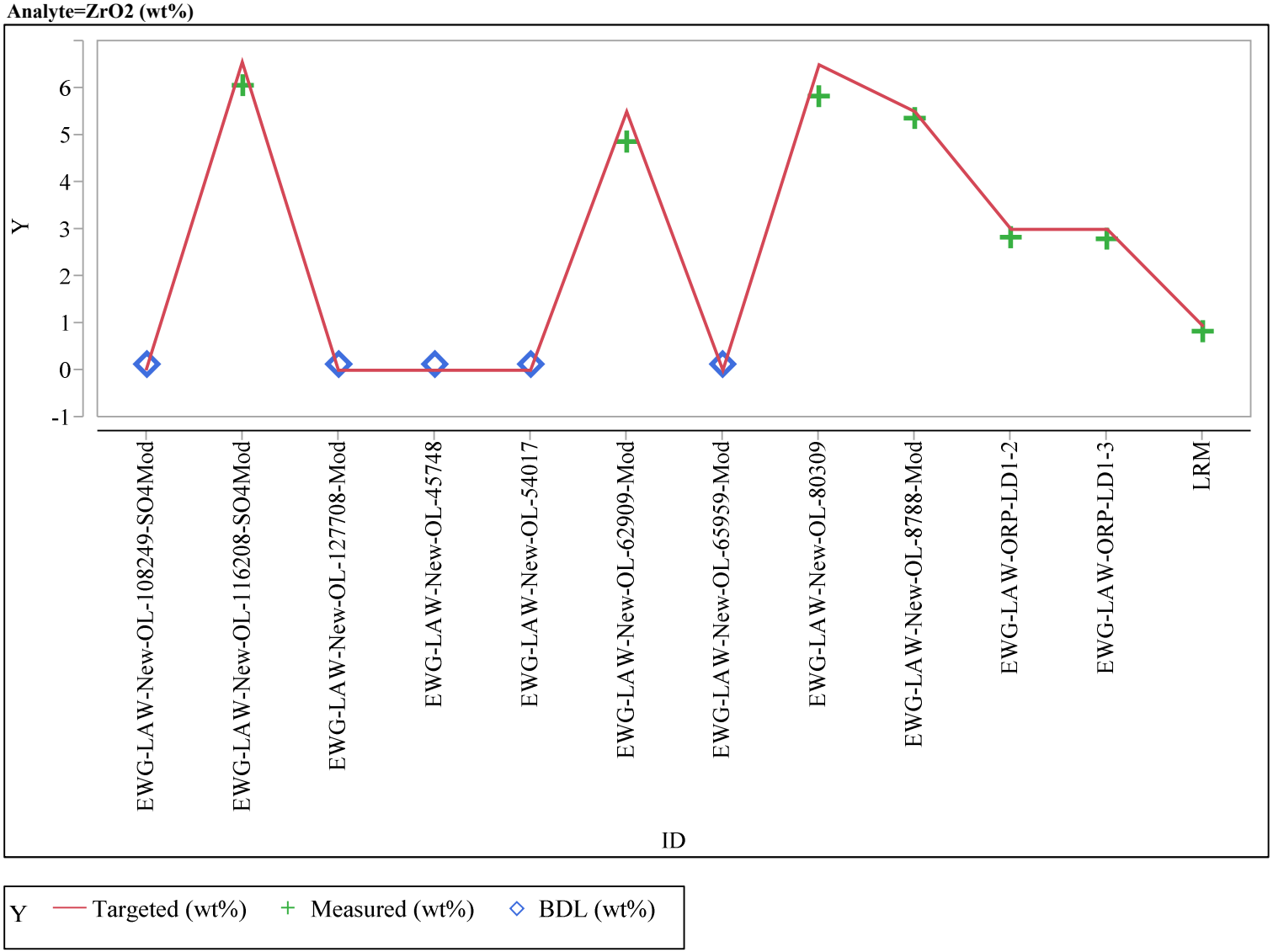
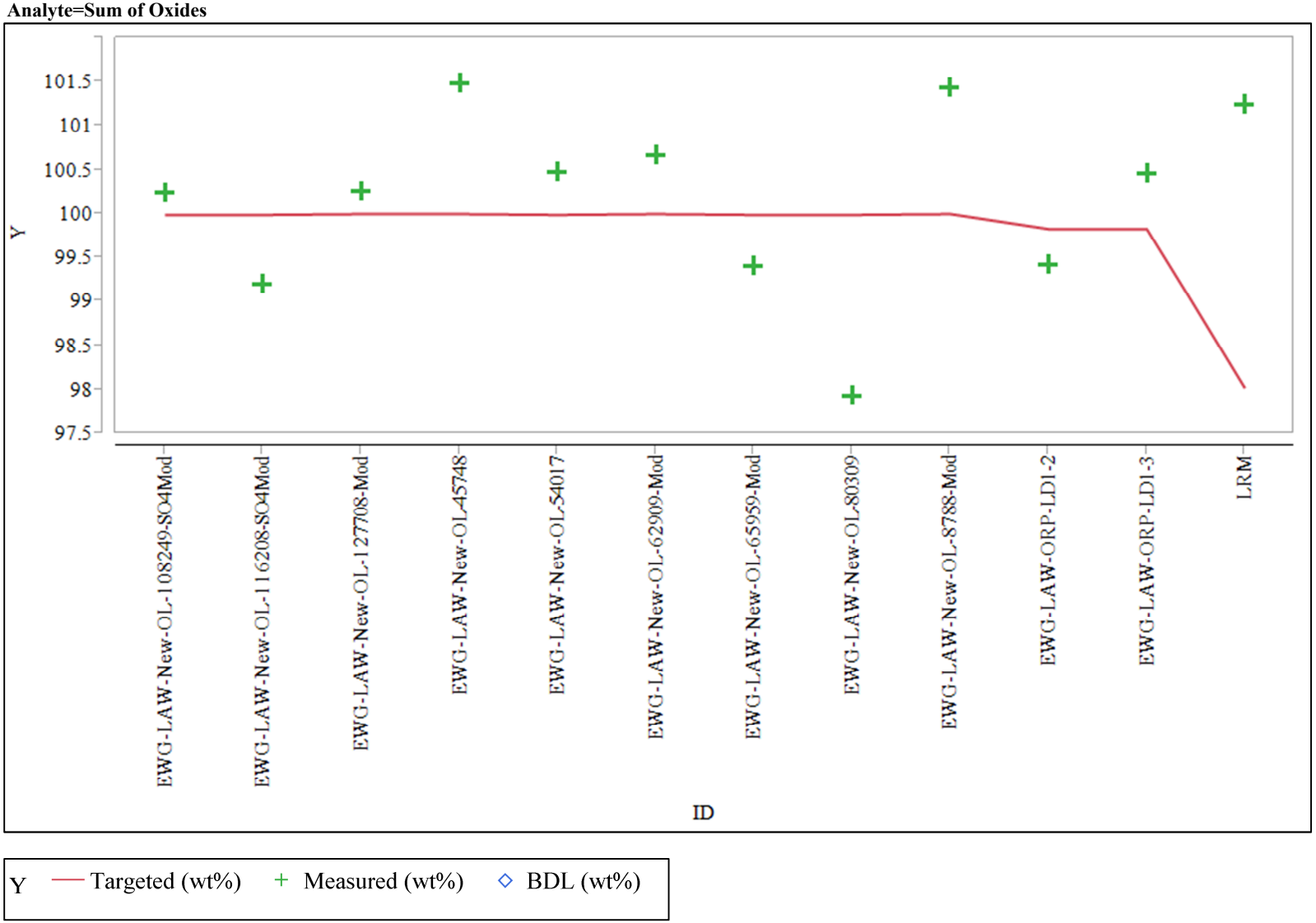


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)



Appendix B Tables and Exhibits Supporting the PCT Results

Table B-1. PCT Measurements for January, March, and April 2015 LAW Glasses (ar – as received)

Set	Glass ID (with heat treatment)	Block	Sequence	Lab ID	B ar	Li ar	Na ar	Si ar	B (ppm)	Li (ppm)	Na (ppm)	Si (ppm)
Jan set 1	soln std	1	1	std-a1-1	19.1	10.1	83.0	48.6	19.100	10.100	83.000	48.600
Jan set 1	EWG-LAW-New-OL-8788-Mod-Q	1	2	G29	2.66	3.45	22.9	28.1	4.433	5.750	38.167	46.834
Jan set 1	EWG-LAW-New-OL-90780-CCC	1	3	G38	715	275	836	57.2	1191.691	458.343	1393.361	95.335
Jan set 1	EWG-LAW-ORP-LD1-2-Q	1	4	G19	22.0	<1.00	104	26.2	36.667	<1.667	173.337	43.668
Jan set 1	EWG-LAW-New-OL-15493-CCC	1	5	G16	1030	<1.00	4610	172	1716.701	<1.667	7683.487	286.672
Jan set 1	EWG-LAW-New-IL-1721-CCC	1	6	G36	36.2	13.4	101	60.2	60.335	22.334	168.337	100.335
Jan set 1	EA	1	7	G01	23.9	7.83	63.3	38.9	398.334	130.500	1055.002	648.335
Jan set 1	ARM-1	1	8	G10	10.5	8.17	20.9	35.0	17.500	13.617	34.834	58.335
Jan set 1	soln std	1	9	std-a1-2	20.2	9.87	81.3	47.4	20.200	9.870	81.300	47.400
Jan set 1	EWG-LAW-New-OL-54017-Q	1	10	G34	2.66	<1.00	33.2	23.3	4.433	<1.667	55.334	38.834
Jan set 1	EWG-LAW-New-OL-80309-Q	1	11	G09	591	245	1040	98.7	985.020	408.342	1733.368	164.503
Jan set 1	EWG-LAW-New-OL-45748-Q	1	12	G30	3.27	5.76	20.0	10.2	5.450	9.600	33.334	17.000
Jan set 1	EWG-LAW-New-OL-62380-CCC	1	13	G14	6.44	<1.00	26.9	9.11	10.734	<1.667	44.834	15.184
Jan set 1	blank	1	14	G11	<1.00	<1.00	<1.00	<1.00	<1.667	<1.667	<1.667	<1.667
Jan set 1	EWG-LAW-Centroid-1-CCC	1	15	G25	15.9	4.56	88.1	34.4	26.501	7.600	146.836	57.334
Jan set 1	soln std	1	16	std-a1-3	18.6	9.54	78.5	46.0	18.600	9.540	78.500	46.000
Jan set 1	soln std	2	1	std-a2-1	20.7	9.84	82.8	49.1	20.700	9.840	82.800	49.100
Jan set 1	EWG-LAW-New-OL-80309-Q	2	2	G28	587	234	1010	95.7	978.353	390.008	1683.367	159.503
Jan set 1	EWG-LAW-New-IL-1721-CCC	2	3	G04	35.9	13.9	106	60.7	59.835	23.167	176.670	101.169
Jan set 1	EWG-LAW-New-OL-8788-Mod-Q	2	4	G31	5.45	3.39	23.7	28.1	9.084	5.650	39.501	46.834
Jan set 1	EA	2	5	G20	20.4	7.03	57.5	35.9	340.001	117.167	958.335	598.335
Jan set 1	EWG-LAW-New-OL-45748-Q	2	6	G05	2.20	5.66	20.7	11.4	3.667	9.434	34.501	19.000
Jan set 1	EWG-LAW-New-OL-62380-CCC	2	7	G37	6.31	<1.00	28.9	10.8	10.517	<1.667	48.168	18.000
Jan set 1	EWG-LAW-ORP-LD1-2-Q	2	8	G03	18.9	<1.00	93.3	24.6	31.501	<1.667	155.503	41.001
Jan set 1	soln std	2	9	std-a2-2	20.7	9.87	83.5	48.9	20.700	9.870	83.500	48.900
Jan set 1	EWG-LAW-Centroid-1-CCC	2	10	G33	16.2	4.29	85.1	35.0	27.001	7.150	141.836	58.335
Jan set 1	ARM-1	2	11	G12	10.1	8.07	21.9	35.3	16.834	13.450	36.501	58.835
Jan set 1	EWG-LAW-New-OL-90780-CCC	2	12	G35	722	269	827	55.8	1203.357	448.342	1378.361	93.002
Jan set 1	EWG-LAW-New-OL-15493-CCC	2	13	G22	1060	<1.00	4590	266	1766.702	<1.667	7650.153	443.342
Jan set 1	EWG-LAW-New-OL-54017-Q	2	14	G06	6.53	<1.00	34.7	24.1	10.884	<1.667	57.834	40.167
Jan set 1	soln std	2	15	std-a2-3	22.0	9.92	84.1	49.0	22.000	9.920	84.100	49.000
Jan set 1	soln std	3	1	std-a3-1	20.0	9.73	84.4	49.5	20.000	9.730	84.400	49.500
Jan set 1	ARM-1	3	2	G17	9.14	8.18	23.0	36.9	15.234	13.634	38.334	61.501
Jan set 1	EWG-LAW-New-OL-8788-Mod-Q	3	3	G18	2.89	3.11	23.6	28.4	4.817	5.183	39.334	47.334

Table B-1. PCT Measurements for January, March, and April 2015 LAW Glasses (ar – as received) (continued)

Set	Glass ID (with heat treatment)	Block	Sequence	Lab ID	B ar	Li ar	Na ar	Si ar	B (ppm)	Li (ppm)	Na (ppm)	Si (ppm)
Jan set 1	EWG-LAW-ORP-LD1-2-Q	3	4	G27	16.5	<1.00	92.6	24.4	27.501	<1.667	154.336	40.667
Jan set 1	EWG-LAW-New-OL-15493-CCC	3	5	G21	1100	<1.00	4630	293	1833.370	<1.667	7716.821	488.343
Jan set 1	EWG-LAW-New-OL-80309-Q	3	6	G24	593	232	1000	101	988.353	386.674	1666.700	168.337
Jan set 1	EWG-LAW-Centroid-1-CCC	3	7	G15	17.6	4.23	90.9	37.3	29.334	7.050	151.503	62.168
Jan set 1	EWG-LAW-New-OL-54017-Q	3	8	G13	3.79	<1.00	35.4	24.8	6.317	<1.667	59.001	41.334
Jan set 1	soln std	3	9	std-a3-2	21.3	9.72	84.8	49.6	21.300	9.720	84.800	49.600
Jan set 1	EWG-LAW-New-OL-90780-CCC	3	10	G32	726	265	819	57.5	1210.024	441.676	1365.027	95.835
Jan set 1	EA	3	11	G02	21.5	6.71	56.8	36.2	358.334	111.834	946.669	603.335
Jan set 1	EWG-LAW-New-OL-45748-Q	3	12	G07	2.22	5.36	20.4	11.2	3.700	8.934	34.001	18.667
Jan set 1	EWG-LAW-New-OL-62380-CCC	3	13	G26	6.53	<1.00	29.2	10.6	10.884	<1.667	48.668	17.667
Jan set 1	EWG-LAW-New-IL-1721-CCC	3	14	G08	33.1	12.8	101	59.6	55.168	21.334	168.337	99.335
Jan set 1	blank	3	15	G23	<1.00	<1.00	<1.00	<1.00	<1.667	<1.667	<1.667	<1.667
Jan set 1	soln std	3	16	std-a3-3	20.4	9.65	83.5	48.9	20.400	9.650	83.500	48.900
Jan set 2	soln std	1	1	std-b1-1	19.5	9.58	82.4	48.1	19.500	9.580	82.400	48.100
Jan set 2	EWG-LAW-NEW-IL-70316-CCC	1	2	H18	8.64	2.14	114	34.3	14.400	3.567	190.004	57.168
Jan set 2	EA	1	3	H36	25.1	8.27	71.0	42.9	418.334	137.834	1183.336	715.001
Jan set 2	EWG-LAW-Centroid-2-CCC-1150	1	4	H32	17.9	4.42	93.6	36.7	29.834	7.367	156.003	61.168
Jan set 2	EWG-LAW-NEW-OL-62909-Mod-Q	1	5	H08	6.58	3.80	35.4	11.1	10.967	6.333	59.001	18.500
Jan set 2	EWG-LAW-NEW-OL-8445-CCC-1200	1	6	H19	10.3	2.57	22.4	7.36	17.167	4.283	37.334	12.267
Jan set 2	EWG-LAW-NEW-IL-103151-CCC-1250	1	7	H16	24.8	2.84	190	78.1	41.334	4.733	316.673	130.169
Jan set 2	EWG-LAW-NEW-OL-54017-Sn-CCC-1225	1	8	H07	1.49	<1.00	30.6	22.7	2.483	<1.667	51.001	37.834
Jan set 2	soln std	1	9	std-b1-2	19.0	9.63	83.3	48.4	19.000	9.630	83.300	48.400
Jan set 2	ARM-1	1	10	H33	8.88	7.65	21.4	34.8	14.800	12.750	35.667	58.001
Jan set 2	EWG-LAW-NEW-OL-65959-Mod-Q	1	11	H35	80.6	37.5	178	65.1	134.336	62.501	296.673	108.502
Jan set 2	EWG-LAW-NEW-OL-127708-Mod-Q	1	12	H21	13.3	3.67	29.6	34.1	22.167	6.117	49.334	56.834
Jan set 2	blank	1	13	H22	<1.00	<1.00	<1.00	<1.00	<1.667	<1.667	<1.667	<1.667
Jan set 2	EWG-LAW-NEW-OL-45748-Sn-CCC-1300	1	14	H01	9.89	21.2	18.6	29.3	16.484	35.334	31.001	48.834
Jan set 2	EWG-LAW-NEW-IL-94020-CCC-1300	1	15	H30	4.91	4.83	37.1	29.2	8.183	8.050	61.835	48.668
Jan set 2	soln std	1	16	std-b1-3	18.6	9.68	83.7	48.6	18.600	9.680	83.700	48.600
Jan set 2	soln std	2	1	std-b2-1	20.4	9.64	82.9	48.5	20.400	9.640	82.900	48.500
Jan set 2	EWG-LAW-NEW-OL-54017-Sn-CCC-1225	2	2	H17	2.83	<1.00	29.7	22.3	4.717	<1.667	49.501	37.167
Jan set 2	ARM-1	2	3	H09	10.5	8.08	22.4	35.6	17.500	13.467	37.334	59.335
Jan set 2	EWG-LAW-NEW-OL-62909-Mod-Q	2	4	H02	7.38	3.86	35.5	11.2	12.300	6.433	59.168	18.667
Jan set 2	EWG-LAW-Centroid-2-CCC-1150	2	5	H20	16.2	4.04	87.5	35.0	27.001	6.733	145.836	58.335

Table B-1. PCT Measurements for January, March, and April 2015 LAW Glasses (ar – as received) (continued)

Set	Glass ID (with heat treatment)	Block	Sequence	Lab ID	B ar	Li ar	Na ar	Si ar	B (ppm)	Li (ppm)	Na (ppm)	Si (ppm)
Jan set 2	EWG-LAW-NEW-IL-94020-CCC-1300	2	6	H27	6.93	5.02	37.7	30.1	11.550	8.367	62.835	50.168
Jan set 2	EWG-LAW-NEW-OL-65959-Mod-Q	2	7	H11	82.1	38.0	179.6	66.5	136.836	63.335	299.339	110.836
Jan set 2	EWG-LAW-NEW-OL-8445-CCC-1200	2	8	H03	10.9	2.51	21.3	7.50	18.167	4.183	35.501	12.500
Jan set 2	soln std	2	9	std-b2-2	19.8	9.54	81.6	48.1	19.800	9.540	81.600	48.100
Jan set 2	EWG-LAW-NEW-IL-70316-CCC	2	10	H25	9.27	2.24	115	34.3	15.450	3.733	191.671	57.168
Jan set 2	EA	2	11	H06	23.4	8.07	67.0	40.4	390.001	134.500	1116.669	673.335
Jan set 2	EWG-LAW-NEW-IL-103151-CCC-1250	2	12	H26	25.4	2.95	190	77.6	42.334	4.917	316.673	129.336
Jan set 2	EWG-LAW-NEW-OL-45748-Sn-CCC-1300	2	13	H23	11.5	21.7	18.9	29.7	19.167	36.167	31.501	49.501
Jan set 2	EWG-LAW-NEW-OL-127708-Mod-Q	2	14	H14	14.7	3.74	29.7	34.5	24.500	6.233	49.501	57.501
Jan set 2	soln std	2	15	std-b2-3	20.0	9.48	81.4	47.7	20.000	9.480	81.400	47.700
Jan set 2	soln std	3	1	std-b3-1	20.1	9.77	82.8	48.8	20.100	9.770	82.800	48.800
Jan set 2	EWG-LAW-NEW-OL-127708-Mod-Q	3	2	H15	14.5	3.95	30.4	34.8	24.167	6.583	50.668	58.001
Jan set 2	EWG-LAW-Centroid-2-CCC-1150	3	3	H37	15.8	4.12	85.9	34.6	26.334	6.867	143.170	57.668
Jan set 2	EWG-LAW-NEW-IL-94020-CCC-1300	3	4	H29	6.63	5.12	37.9	30.2	11.050	8.534	63.168	50.334
Jan set 2	EWG-LAW-NEW-OL-65959-Mod-Q	3	5	H12	81.0	37.8	179	65.9	135.003	63.001	298.339	109.836
Jan set 2	EWG-LAW-NEW-OL-54017-Sn-CCC-1225	3	6	H28	2.75	<1.00	30.2	22.9	4.583	<1.667	50.334	38.167
Jan set 2	ARM-1	3	7	H38	9.43	7.57	20.7	33.8	15.717	12.617	34.501	56.334
Jan set 2	EWG-LAW-NEW-IL-70316-CCC	3	8	H04	9.01	2.38	113	33.9	15.017	3.967	188.337	56.501
Jan set 2	soln std	3	9	std-b3-2	20.2	9.78	82.2	48.8	20.200	9.780	82.200	48.800
Jan set 2	blank	3	10	H05	<1.00	<1.00	<1.00	<1.00	<1.667	<1.667	<1.667	<1.667
Jan set 2	EA	3	11	H13	25.1	8.41	69.7	42.4	418.334	140.167	1161.669	706.668
Jan set 2	EWG-LAW-NEW-OL-62909-Mod-Q	3	12	H31	7.03	3.98	35.0	10.9	11.717	6.633	58.335	18.167
Jan set 2	EWG-LAW-NEW-OL-45748-Sn-CCC-1300	3	13	H24	10.9	21.0	18.3	29.1	18.167	35.001	30.501	48.501
Jan set 2	EWG-LAW-NEW-OL-8445-CCC-1200	3	14	H34	10.7	2.80	22.5	7.63	17.834	4.667	37.501	12.717
Jan set 2	EWG-LAW-NEW-IL-103151-CCC-1250	3	15	H10	25.3	3.08	187	78.3	42.168	5.133	311.673	130.503
Jan set 2	soln std	3	16	std-b3-3	19.8	9.76	82.1	48.3	19.800	9.760	82.100	48.300
Mar set 1	soln std	1	1	std-a1-1	20.3	9.83	81.1	50.5	20.300	9.830	81.100	50.500
Mar set 1	EWG-LAW-New-IL-93907-CCC	1	2	J25	8.86	4.53	32.1	30.1	14.767	7.550	53.501	50.168
Mar set 1	EA	1	3	J22	17.8	6.55	50.6	33.7	296.667	109.167	843.335	561.668
Mar set 1	ARM-1	1	4	J33	11.0	8.64	23.1	38.0	18.334	14.400	38.501	63.335
Mar set 1	EWG-LAW-New-IL-151542-CCC-1225	1	5	J28	11.7	2.20	72.0	31.4	19.500	3.667	120.002	52.334
Mar set 1	EWG-LAW-New-IL-42295-CCC-1150	1	6	J18	366	132	931	272	610.012	220.004	1551.698	453.342
Mar set 1	EWG-LAW-New-OL-17130-CCC-1150	1	7	J20	544	257	1210	655	906.685	428.342	2016.707	1091.689
Mar set 1	EWG-LAW-New-OL-8788-Mod-CCC-1300	1	8	J02	7.04	3.56	24.6	32.2	11.734	5.933	41.001	53.668

Table B-1. PCT Measurements for January, March, and April 2015 LAW Glasses (ar – as received) (continued)

Set	Glass ID (with heat treatment)	Block	Sequence	Lab ID	B ar	Li ar	Na ar	Si ar	B (ppm)	Li (ppm)	Na (ppm)	Si (ppm)
Mar set 1	soln std	1	9	std-a1-2	19.5	9.92	83.4	50.7	19.500	9.920	83.400	50.700
Mar set 1	EWG-LAW-New-OL-14844-CCC-1250	1	10	J40	81.4	99.1	483	109	135.669	165.170	805.016	181.670
Mar set 1	blank	1	11	J21	1.35	<1.00	<1.00	<1.00	2.250	<1.667	<1.667	<1.667
Mar set 1	EWG-LAW-New-OL-57284-CCC-1200	1	12	J32	54.9	<1.00	113	58.0	91.502	<1.667	188.337	96.669
Mar set 1	EWG-LAW-New-IL-5253-CCC	1	13	J10	42.5	17.6	110	53.0	70.835	29.334	183.337	88.335
Mar set 1	EWG-LAW-New-IL-456-CCC-1200	1	14	J08	6.90	7.03	50.0	28.7	11.500	11.717	83.335	47.834
Mar set 1	EWG-LAW-New-OL-15493-CCC-1225	1	15	J26	1010	<1.00	4800	179	1683.367	<1.667	8000.160	298.339
Mar set 1	EWG-LAW-New-IL-5255-CCC-1200	1	16	J17	270	99.2	695	156	450.009	165.337	1158.357	260.005
Mar set 1	soln std	1	17	std-a1-3	19.8	9.86	82.9	50.3	19.800	9.860	82.900	50.300
Mar set 1	soln std	2	1	std-a2-1	19.8	9.85	80.3	49.6	19.800	9.850	80.300	49.600
Mar set 1	EWG-LAW-New-OL-17130-CCC-1150	2	2	J29	543	255	1200	649	905.018	425.009	2000.040	1081.688
Mar set 1	EWG-LAW-New-IL-456-CCC-1200	2	3	J11	8.57	7.46	51.3	31.3	14.284	12.434	85.502	52.168
Mar set 1	EWG-LAW-New-IL-5255-CCC-1200	2	4	J23	284	102	746	166	473.343	170.003	1243.358	276.672
Mar set 1	EWG-LAW-New-IL-42295-CCC-1150	2	5	J14	344	124	881	259	573.345	206.671	1468.363	431.675
Mar set 1	EWG-LAW-New-OL-8788-Mod-CCC-1300	2	6	J34	6.13	3.68	24.1	32.2	10.217	6.133	40.167	53.668
Mar set 1	EWG-LAW-New-OL-15493-CCC-1225	2	7	J15	985	<1.00	4700	326	1641.700	<1.667	7833.490	543.344
Mar set 1	EWG-LAW-New-OL-57284-CCC-1200	2	8	J36	58.6	<1.00	111	58.0	97.669	<1.667	185.004	96.669
Mar set 1	soln std	2	9	std-a2-2	21.1	9.78	79.4	49.0	21.100	9.780	79.400	49.000
Mar set 1	ARM-1	2	10	J06	11.9	8.70	22.7	38.4	19.834	14.500	37.834	64.001
Mar set 1	EWG-LAW-New-IL-5253-CCC	2	11	J13	52.9	21.3	129	60.1	88.168	35.501	215.004	100.169
Mar set 1	EWG-LAW-New-IL-93907-CCC	2	12	J35	9.33	4.47	30.2	29.3	15.550	7.450	50.334	48.834
Mar set 1	EA	2	13	J19	21.8	7.68	58.8	39.5	363.334	128.000	980.002	658.335
Mar set 1	EWG-LAW-New-OL-14844-CCC-1250	2	14	J07	78.3	94.9	464	106	130.503	158.170	773.349	176.670
Mar set 1	EWG-LAW-New-IL-151542-CCC-1225	2	15	J30	13.1	2.41	73.2	32.8	21.834	4.017	122.002	54.668
Mar set 1	soln std	2	16	std-a2-3	20.4	9.90	80.8	49.9	20.400	9.900	80.800	49.900
Mar set 1	soln std	3	1	std-a3-1	19.7	9.66	82.2	49.7	19.700	9.660	82.200	49.700
Mar set 1	blank	3	2	J12	<1.00	<1.00	<1.00	<1.00	<1.667	<1.667	<1.667	<1.667
Mar set 1	ARM-1	3	3	J09	10.5	8.60	23.3	38.5	17.500	14.334	38.834	64.168
Mar set 1	EWG-LAW-New-IL-151542-CCC-1225	3	4	J39	11.8	2.04	72.4	31.9	19.667	3.400	120.669	53.168
Mar set 1	EWG-LAW-New-OL-15493-CCC-1225	3	5	J31	1010	<1.00	4590	216	1683.367	<1.667	7650.153	360.007
Mar set 1	EWG-LAW-New-IL-42295-CCC-1150	3	6	J03	361	126	903	261	601.679	210.004	1505.030	435.009
Mar set 1	EWG-LAW-New-IL-93907-CCC	3	7	J38	11.2	4.31	31.8	30.9	18.667	7.183	53.001	51.501
Mar set 1	EWG-LAW-New-IL-456-CCC-1200	3	8	J24	7.33	7.14	51.7	30.2	12.217	11.900	86.168	50.334
Mar set 1	soln std	3	9	std-a3-2	20.8	9.86	83.6	51.2	20.800	9.860	83.600	51.200

Table B-1. PCT Measurements for January, March, and April 2015 LAW Glasses (ar – as received) (continued)

Set	Glass ID (with heat treatment)	Block	Sequence	Lab ID	B ar	Li ar	Na ar	Si ar	B (ppm)	Li (ppm)	Na (ppm)	Si (ppm)
Mar set 1	EWG-LAW-New-OL-14844-CCC-1250	3	10	J01	80.9	96.9	459	109	134.836	161.503	765.015	181.670
Mar set 1	EWG-LAW-New-IL-5253-CCC	3	11	J41	50.3	19.9	124	58.1	83.835	33.167	206.671	96.835
Mar set 1	EA	3	12	J05	22.3	7.52	60.7	40.4	371.667	125.334	1011.669	673.335
Mar set 1	EWG-LAW-New-OL-8788-Mod-CCC-1300	3	13	J16	4.61	3.35	24.5	31.7	7.683	5.583	40.834	52.834
Mar set 1	EWG-LAW-New-OL-17130-CCC-1150	3	14	J27	561	260	1190	663	935.019	433.342	1983.373	1105.022
Mar set 1	EWG-LAW-New-IL-5255-CCC-1200	3	15	J04	272	102	725	157	453.342	170.003	1208.358	261.672
Mar set 1	EWG-LAW-New-OL-57284-CCC-1200	3	16	J37	57.6	<1.00	114	59.2	96.002	<1.667	190.004	98.669
Mar set 1	soln std	3	17	std-a3-3	21.9	9.96	84.8	51.9	21.900	9.960	84.800	51.900
Mar set 2	soln std	1	1	std-a1-1	19.0	9.35	80.5	47.5	19.000	9.350	80.500	47.500
Mar set 2	EWG-LAW-New-OL-65959-Mod-CCC-1250	1	2	K19	1140	253	1350	49.3	1900.038	421.675	2250.045	82.168
Mar set 2	EWG-LAW-New-OL-100210-CCC-1250	1	3	K20	24.1	<1.00	288	153	40.167	<1.667	480.010	255.005
Mar set 2	EWG-LAW-ORP-LD1-1-CCC-1300	1	4	K11	13.4	<1.00	68.9	30.8	22.334	<1.667	114.836	51.334
Mar set 2	EWG-LAW-New-OL-127708-Mod-CCC-1300	1	5	K30	12.9	3.51	22.4	35.1	21.500	5.850	37.334	58.501
Mar set 2	EWG-LAW-ORP-LD1-3-Q	1	6	K08	13.1	<1.00	67.6	17.8	21.834	<1.667	112.669	29.667
Mar set 2	EWG-LAW-New-OL-108249-(SO4 Mod)-Q	1	7	K22	3.20	8.14	57.2	17.0	5.333	13.567	95.335	28.334
Mar set 2	EWG-LAW-New-OL-108249-(SO4 Mod)-CCC-1300	1	8	K06	183	69.4	308	11.7	305.006	115.669	513.344	19.500
Mar set 2	soln std	1	9	std-a1-2	21.4	10.0	86.8	50.8	21.400	10.000	86.800	50.800
Mar set 2	EWG-LAW-New-OL-116208-(SO4 Mod)-CCC-1300	1	10	K23	207	106.4	834	103	345.007	177.337	1390.028	171.670
Mar set 2	EWG-LAW-New-OL-122817-CCC-1200	1	11	K24	3.98	<1.00	78.0	25.9	6.633	<1.667	130.003	43.168
Mar set 2	ARM-1	1	12	K07	10.1	7.85	19.3	35.4	16.834	13.084	32.167	59.001
Mar set 2	blank	1	13	K03	<1.00	<1.00	2.62	<1.00	<1.667	<1.667	4.367	<1.667
Mar set 2	EWG-LAW-New-OL-116208-(SO4 Mod)-Q	1	14	K36	96.1	102	565	116	160.170	170.003	941.686	193.337
Mar set 2	EA	1	15	K15	24.0	8.02	65.9	41.5	400.001	133.667	1098.336	691.668
Mar set 2	soln std	1	16	std-a1-3	20.1	9.81	83.1	49.6	20.100	9.810	83.100	49.600
Mar set 2	soln std	2	1	std-a2-1	21.3	10.5	82.7	50.9	21.300	10.500	82.700	50.900
Mar set 2	EWG-LAW-New-OL-108249-(SO4 Mod)-Q	2	2	K17	4.26	9.00	59.7	18.9	7.100	15.000	99.502	31.501
Mar set 2	EWG-LAW-ORP-LD1-1-CCC-1300	2	3	K16	12.3	1.20	68.3	31.1	20.500	2.000	113.836	51.834
Mar set 2	EWG-LAW-New-OL-65959-Mod-CCC-1250	2	4	K38	1130	247	1360	50.1	1883.371	411.675	2266.712	83.502
Mar set 2	EA	2	5	K28	28.0	8.82	67.9	42.7	466.668	147.000	1131.669	711.668
Mar set 2	EWG-LAW-New-OL-127708-Mod-CCC-1300	2	6	K21	14.2	4.14	24.1	35.5	23.667	6.900	40.167	59.168
Mar set 2	EWG-LAW-New-OL-108249-(SO4 Mod)-CCC-1300	2	7	K29	178	68.4	318	13.1	296.673	114.002	530.011	21.834
Mar set 2	EWG-LAW-New-OL-122817-CCC-1200	2	8	K35	5.87	1.17	77.0	27.4	9.784	1.950	128.336	45.668
Mar set 2	soln std	2	9	std-a2-2	21.8	10.4	80.6	50.2	21.800	10.400	80.600	50.200
Mar set 2	EWG-LAW-ORP-LD1-3-Q	2	10	K32	13.9	1.16	65.3	19.2	23.167	1.933	108.836	32.001

Table B-1. PCT Measurements for January, March, and April 2015 LAW Glasses (ar – as received) (continued)

Set	Glass ID (with heat treatment)	Block	Sequence	Lab ID	B ar	Li ar	Na ar	Si ar	B (ppm)	Li (ppm)	Na (ppm)	Si (ppm)
Mar set 2	EWG-LAW-New-OL-116208-(SO4 Mod)-CCC-1300	2	11	K02	202	103.9	817	101	336.673	173.170	1361.694	168.337
Mar set 2	EWG-LAW-New-OL-100210-CCC-1250	2	12	K25	22.5	1.17	286	168	37.501	1.950	476.676	280.006
Mar set 2	EWG-LAW-New-OL-116208-(SO4 Mod)-Q	2	13	K09	95.0	112.8	568	127	158.337	188.004	946.686	211.671
Mar set 2	ARM-1	2	14	K14	11.4	8.6	20.3	36.3	19.000	14.334	33.834	60.501
Mar set 2	soln std	2	15	std-a2-3	21.8	10.6	82.7	51.3	21.800	10.600	82.700	51.300
Mar set 2	soln std	3	1	std-a3-1	21.1	10.0	82.5	50.5	21.100	10.000	82.500	50.500
Mar set 2	EWG-LAW-ORP-LD1-1-CCC-1300	3	2	K04	12.6	<1.00	68.9	31.7	21.000	<1.667	114.836	52.834
Mar set 2	blank	3	3	K34	<1.00	<1.00	<1.00	<1.00	<1.667	<1.667	<1.667	<1.667
Mar set 2	ARM-1	3	4	K37	10.3	8.26	18.4	37.5	17.167	13.767	30.667	62.501
Mar set 2	EWG-LAW-New-OL-127708-Mod-CCC-1300	3	5	K31	12.8	3.90	26.6	36.7	21.334	6.500	44.334	61.168
Mar set 2	EWG-LAW-New-OL-108249-(SO4 Mod)-CCC-1300	3	6	K26	183	68.8	324	13.1	305.006	114.669	540.011	21.834
Mar set 2	EWG-LAW-New-OL-116208-(SO4 Mod)-CCC-1300	3	7	K12	202	104	846	102	336.673	173.337	1410.028	170.003
Mar set 2	EWG-LAW-New-OL-65959-Mod-CCC-1250	3	8	K33	1120	253	1340	49.8	1866.704	421.675	2233.378	83.002
Mar set 2	soln std	3	9	std-a3-2	21.1	9.94	82.9	49.7	21.100	9.940	82.900	49.700
Mar set 2	EWG-LAW-New-OL-122817-CCC-1200	3	10	K27	5.1	<1.00	76.5	25.9	8.500	<1.667	127.503	43.168
Mar set 2	EWG-LAW-New-OL-116208-(SO4 Mod)-Q	3	11	K13	100	103	584	126	166.670	171.670	973.353	210.004
Mar set 2	EWG-LAW-ORP-LD1-3-Q	3	12	K10	13.8	<1.00	65.3	18.4	23.000	<1.667	108.836	30.667
Mar set 2	EWG-LAW-New-OL-100210-CCC-1250	3	13	K05	19.4	<1.00	281	149	32.334	<1.667	468.343	248.338
Mar set 2	EA	3	14	K18	24.9	8.54	69.7	43.3	415.001	142.334	1161.669	721.668
Mar set 2	EWG-LAW-New-OL-108249-(SO4 Mod)-Q	3	15	K01	3.68	8.27	58.3	17.6	6.133	13.784	97.169	29.334
Mar set 2	soln std	3	16	std-a3-3	20.7	10.1	83.8	50.4	20.700	10.100	83.800	50.400
April	std soln	1	1	std-a1-1	20.1	9.19	84.6	47.8	20.100	9.190	84.600	47.800
April	EA	1	2	P12	20.8	7.01	63.4	37.3	346.667	116.834	1056.669	621.668
April	EWG-LAW-New-OL-80309-CCC-1300	1	3	P24	312	126	498	119	520.010	210.004	830.017	198.337
April	EWG-LAW-ORP-LD1-2-CCC-1300	1	4	P05	13.9	<1.00	78.6	28.4	23.167	<1.667	131.003	47.334
April	ARM-1	1	5	P19	8.91	7.54	21.1	33.8	14.850	12.567	35.167	56.334
April	EWG-LAW-New-IL-166731-CCC-1225	1	6	P26	87.8	42.6	237.9	79.2	146.336	71.001	396.508	132.003
April	std soln	1	7	std-a1-2	20.1	9.57	87.3	49.6	20.100	9.570	87.300	49.600
April	EWG-LAW-New-OL-62909-Mod-CCC-1300	1	8	P28	2.99	2.24	24.8	12.6	4.983	3.733	41.334	21.000
April	blank	1	9	P11	<1.00	<1.00	<1.00	<1.00	<1.667	<1.667	<1.667	<1.667
April	EWG-LAW-New-IL-166697-CCC-1250	1	10	P09	12.6	5.74	67.4	34.8	21.000	9.567	112.336	58.001
April	EWG-LAW-New-IL-87749-CCC-1225	1	11	P03	3.30	5.94	68.2	21.9	5.500	9.900	113.669	36.501
April	EWG-LAW-ORP-LD1-3-CCC-1300	1	12	P10	9.21	<1.00	57.7	15.6	15.350	<1.667	96.169	26.001
April	std soln	1	13	std-a1-3	18.6	9.11	82.8	47.4	18.600	9.110	82.800	47.400

Table B-1. PCT Measurements for January, March, and April 2015 LAW Glasses (ar – as received) (continued)

Set	Glass ID (with heat treatment)	Block	Sequence	Lab ID	B ar	Li ar	Na ar	Si ar	B (ppm)	Li (ppm)	Na (ppm)	Si (ppm)
April	std soln	2	1	std-a2-1	19.8	9.72	78.7	45.7	19.800	9.720	78.700	45.700
April	ARM-1	2	2	P27	12.3	9.17	24.1	38.5	20.500	15.284	40.167	64.168
April	EWG-LAW-New-OL-62909-Mod-CCC-1300	2	3	P16	5.40	3.48	26.4	14.9	9.000	5.800	44.001	24.834
April	EWG-LAW-New-IL-166697-CCC-1250	2	4	P22	15.9	7.03	69.1	37.3	26.501	11.717	115.169	62.168
April	EWG-LAW-ORP-LD1-3-CCC-1300	2	5	P02	10.8	<1.00	54.2	16.1	18.000	<1.667	90.335	26.834
April	EA	2	6	P06	33.0	10.6	94.7	48.1	550.001	176.667	1578.336	801.668
April	std soln	2	7	std-a2-2	19.3	9.68	78.7	45.8	19.300	9.680	78.700	45.800
April	EWG-LAW-New-IL-166731-CCC-1225	2	8	P13	71.4	35.9	229	65.1	119.002	59.835	381.674	108.502
April	EWG-LAW-New-IL-87749-CCC-1225	2	9	P29	5.41	6.67	64.7	21.8	9.017	11.117	107.835	36.334
April	EWG-LAW-ORP-LD1-2-CCC-1300	2	10	P25	14.2	<1.00	76.4	28.0	23.667	<1.667	127.336	46.668
April	EWG-LAW-New-OL-80309-CCC-1300	2	11	P17	263	118	466	114	438.342	196.671	776.682	190.004
April	std soln	2	12	std-a2-3	19.1	9.42	76.8	45.6	19.100	9.420	76.800	45.600
April	std soln	3	1	std-a3-1	20.7	10.1	82.6	47.1	20.700	10.100	82.600	47.100
April	EA	3	2	P21	28.9	9.36	79.0	43.1	481.668	156.000	1316.669	718.335
April	ARM-1	3	3	P08	11.2	8.83	23.2	36.3	18.667	14.717	38.667	60.501
April	EWG-LAW-New-IL-87749-CCC-1225	3	4	P14	5.59	7.16	69.6	23.3	9.317	11.934	116.002	38.834
April	EWG-LAW-New-OL-80309-CCC-1300	3	5	P01	286	119	473	117	476.676	198.337	788.349	195.004
April	EWG-LAW-ORP-LD1-2-CCC-1300	3	6	P20	15.3	<1.00	76.6	28.3	25.501	<1.667	127.669	47.168
April	std soln	3	7	std-a3-2	19.9	9.70	77.7	45.5	19.900	9.700	77.700	45.500
April	EWG-LAW-New-IL-166697-CCC-1250	3	8	P18	14.8	6.59	64.5	34.3	24.667	10.984	107.502	57.168
April	EWG-LAW-ORP-LD1-3-CCC-1300	3	9	P15	11.2	<1.00	55.4	15.5	18.667	<1.667	92.335	25.834
April	EWG-LAW-New-IL-166731-CCC-1225	3	10	P07	86.5	41.8	234	76.5	144.170	69.668	390.008	127.503
April	EWG-LAW-New-OL-62909-Mod-CCC-1300	3	11	P04	5.18	3.49	26.4	13.8	8.634	5.817	44.001	23.000
April	blank	3	12	P23	<1.00	<1.00	<1.00	<1.00	<1.667	<1.667	<1.667	<1.667
April	std soln	3	13	std-a3-3	21.5	10.5	85.1	49.2	21.500	10.500	85.100	49.200

Table B-2. PCT Leachate pH Values for Set 1 of the January 2015 LAW Glasses

Identifier	pH	Identifier	pH
Blank-1	6.83	EWG-LAW-NEW-OL-45748-Q-3	11.09
Blank-2	6.75	EWG-LAW-NEW-OL-54017-Q-1	10.91
ARM-1-1	10.42	EWG-LAW-NEW-OL-54017-Q-2	10.91
ARM-1-2	10.41	EWG-LAW-NEW-OL-54017-Q-3	10.94
ARM-1-3	10.41	EWG-LAW-NEW-OL-62380-CCC-1	10.73
EA-1	11.77	EWG-LAW-NEW-OL-62380-CCC-2	10.70
EA-2	11.67	EWG-LAW-NEW-OL-62380-CCC-3	10.70
EA-3	11.68	EWG-LAW-NEW-OL-80309-Q-1	11.52
EWG-LAW-Centroid-1-CCC-1	11.20	EWG-LAW-NEW-OL-80309-Q-2	11.51
EWG-LAW-Centroid-1-CCC-2	11.22	EWG-LAW-NEW-OL-80309-Q-3	11.50
EWG-LAW-Centroid-1-CCC-3	11.07	EWG-LAW-NEW-OL-8788-Mod-Q-1	10.34
EWG-LAW-NEW-IL-1721-CCC-1	10.65	EWG-LAW-NEW-OL-8788-Mod-Q-2	10.37
EWG-LAW-NEW-IL-1721-CCC-2	10.67	EWG-LAW-NEW-OL-8788-Mod-Q-3	10.37
EWG-LAW-NEW-IL-1721-CCC-3	10.63	EWG-LAW-NEW-OL-90780-CCC-1	10.41
EWG-LAW-NEW-OL-15493-CCC-1	12.50	EWG-LAW-NEW-OL-90780-CCC-2	10.44
EWG-LAW-NEW-OL-15493-CCC-2	12.45	EWG-LAW-NEW-OL-90780-CCC-3	10.46
EWG-LAW-NEW-OL-15493-CCC-3	12.54	EWG-LAW-ORP-LD1-2-Q-1	11.06
EWG-LAW-NEW-OL-45748-Q-1	11.27	EWG-LAW-ORP-LD1-2-Q-2	11.05
EWG-LAW-NEW-OL-45748-Q-2	11.18	EWG-LAW-ORP-LD1-2-Q-3	11.09

Table B-3. PCT Leachate pH Values for Set 2 of the January 2015 LAW Glasses

Identifier	pH	Identifier	pH
Blank-1	6.90	EWG-LAW-New-IL-94020-CCC-1300-3	10.92
Blank-2	6.91	EWG-LAW-New-OL-127708-Mod-Q-1	10.21
ARM-1-1	10.38	EWG-LAW-New-OL-127708-Mod-Q-2	10.12
ARM-1-2	10.30	EWG-LAW-New-OL-127708-Mod-Q-3	10.05
ARM-1-3	10.31	EWG-LAW-New-OL-45748-Sn-CCC-1300-1	11.44
EA-1	11.82	EWG-LAW-New-OL-45748-Sn-CCC-1300-2	11.46
EA-2	11.78	EWG-LAW-New-OL-45748-Sn-CCC-1300-3	11.48
EA-3	11.81	EWG-LAW-New-OL-54017-Sn-CCC-1225-1	11.08
EWG-LAW-Centroid-2-CCC-1150-1	11.15	EWG-LAW-New-OL-54017-Sn-CCC-1225-2	11.01
EWG-LAW-Centroid-2-CCC-1150-2	11.16	EWG-LAW-New-OL-54017-Sn-CCC-1225-3	10.97
EWG-LAW-Centroid-2-CCC-1150-3	11.15	EWG-LAW-New-OL-62909-Mod-Q-1	11.19
EWG-LAW-New-IL-103151-CCC-1250-1	11.45	EWG-LAW-New-OL-62909-Mod-Q-2	11.17
EWG-LAW-New-IL-103151-CCC-1250-2	11.45	EWG-LAW-New-OL-62909-Mod-Q-3	11.16
EWG-LAW-New-IL-103151-CCC-1250-3	11.46	EWG-LAW-New-OL-65959-Mod-Q-1	11.63
EWG-LAW-New-IL-70316-CCC-1	11.64	EWG-LAW-New-OL-65959-Mod-Q-2	11.58
EWG-LAW-New-IL-70316-CCC-2	11.57	EWG-LAW-New-OL-65959-Mod-Q-3	11.59
EWG-LAW-New-IL-70316-CCC-3	11.59	EWG-LAW-New-OL-8445-CCC-1200-1	10.64
EWG-LAW-New-IL-94020-CCC-1300-1	10.97	EWG-LAW-New-OL-8445-CCC-1200-2	10.61
EWG-LAW-New-IL-94020-CCC-1300-2	10.94	EWG-LAW-New-OL-8445-CCC-1200-3	10.58

Table B-4. PCT Leachate pH Values for Set 1 of the March 2015 LAW Glasses

Identifier	pH		Identifier	pH
Blank-1	6.78		EWG-LAW-New-IL-5255-CCC-1200-1	11.74
Blank-2	6.75		EWG-LAW-New-IL-5255-CCC-1200-2	11.69
ARM-1-1	10.11		EWG-LAW-New-IL-5255-CCC-1200-3	11.69
ARM-1-2	10.04		EWG-LAW-New-IL-93907-CCC-1	10.39
ARM-1-3	10.04		EWG-LAW-New-IL-93907-CCC-2	10.32
EA-1	11.46		EWG-LAW-New-IL-93907-CCC-3	10.33
EA-2	11.46		EWG-LAW-New-OL-14844-CCC-1250-1	12.17
EA-3	11.45		EWG-LAW-New-OL-14844-CCC-1250-2	12.05
EWG-LAW-New-IL-151542-CCC-1225-1	10.84		EWG-LAW-New-OL-14844-CCC-1250-3	12.06
EWG-LAW-New-IL-151542-CCC-1225-2	10.83		EWG-LAW-New-OL-15493-CCC-1225-1	12.49
EWG-LAW-New-IL-151542-CCC-1225-3	10.85		EWG-LAW-New-OL-15493-CCC-1225-2	12.48
EWG-LAW-New-IL-42295-CCC-1150-1	11.76		EWG-LAW-New-OL-15493-CCC-1225-3	12.48
EWG-LAW-New-IL-42295-CCC-1150-2	11.68		EWG-LAW-New-OL-17130-CCC-1150-1	11.04
EWG-LAW-New-IL-42295-CCC-1150-3	11.72		EWG-LAW-New-OL-17130-CCC-1150-2	10.96
EWG-LAW-New-IL-456-CCC-1200-1	11.12		EWG-LAW-New-OL-17130-CCC-1150-3	10.98
EWG-LAW-New-IL-456-CCC-1200-2	11.12		EWG-LAW-New-OL-57284-CCC-1200-1	9.17
EWG-LAW-New-IL-456-CCC-1200-3	11.11		EWG-LAW-New-OL-57284-CCC-1200-2	9.16
EWG-LAW-New-IL-5253-CCC-1	10.67		EWG-LAW-New-OL-57284-CCC-1200-3	9.15
EWG-LAW-New-IL-5253-CCC-2	10.61		EWG-LAW-New-OL-8788-Mod-CCC-1300-1	10.27
EWG-LAW-New-IL-5253-CCC-3	10.66		EWG-LAW-New-OL-8788-Mod-CCC-1300-2	10.24
			EWG-LAW-New-OL-8788-Mod-CCC-1300-3	10.26

Table B-5. PCT Leachate pH Values for Set 2 of the March 2015 LAW Glasses

Identifier	pH		Identifier	pH
blank-1	6.86		EWG-LAW-New-OL-116208-(SO4 Mod)-CCC-1300-3	12.06
blank-2	6.68		EWG-LAW-New-OL-116208-(SO4 Mod)-Q-1	12.15
ARM-1-1	10.16		EWG-LAW-New-OL-116208-(SO4 Mod)-Q-2	12.15
ARM-1-2	10.18		EWG-LAW-New-OL-116208-(SO4 Mod)-Q-3	12.15
ARM-1-3	10.21		EWG-LAW-New-OL-122817-CCC-1200-1	11.36
EA-1	11.57		EWG-LAW-New-OL-122817-CCC-1200-2	11.32
EA-2	11.58		EWG-LAW-New-OL-122817-CCC-1200-3	11.31
EA-3	11.61		EWG-LAW-New-OL-127708-Mod-CCC-1300-1	9.86
EWG-LAW-New-OL-100210-CCC-1250-1	11.66		EWG-LAW-New-OL-127708-Mod-CCC-1300-2	9.83
EWG-LAW-New-OL-100210-CCC-1250-2	11.66		EWG-LAW-New-OL-127708-Mod-CCC-1300-3	9.82
EWG-LAW-New-OL-100210-CCC-1250-3	11.66		EWG-LAW-New-OL-65959-Mod-CCC-1250-1	9.89
EWG-LAW-New-OL-108249-(SO4 Mod)-CCC-1300-1	11.71		EWG-LAW-New-OL-65959-Mod-CCC-1250-2	9.87
EWG-LAW-New-OL-108249-(SO4 Mod)-CCC-1300-2	11.68		EWG-LAW-New-OL-65959-Mod-CCC-1250-3	9.88
EWG-LAW-New-OL-108249-(SO4 Mod)-CCC-1300-3	11.67		EWG-LAW-ORP-LD1-1-CCC-1300-1	10.85
EWG-LAW-New-OL-108249-(SO4 Mod)-Q-1	11.39		EWG-LAW-ORP-LD1-1-CCC-1300-2	10.86
EWG-LAW-New-OL-108249-(SO4 Mod)-Q-2	11.37		EWG-LAW-ORP-LD1-1-CCC-1300-3	10.87
EWG-LAW-New-OL-108249-(SO4 Mod)-Q-3	11.31		EWG-LAW-ORP-LD1-3-Q-1	10.88
EWG-LAW-New-OL-116208-(SO4 Mod)-CCC-1300-1	11.97		EWG-LAW-ORP-LD1-3-Q-2	10.83
EWG-LAW-New-OL-116208-(SO4 Mod)-CCC-1300-2	12.03		EWG-LAW-ORP-LD1-3-Q-3	10.81

Table B-6. PCT Leachate pH Values for the April 2015 LAW Glasses

Identifier	pH		Identifier	pH
blank-1	6.67		EWG-LAW-New-IL-87749-CCC-1225-1	11.33
blank-2	6.79		EWG-LAW-New-IL-87749-CCC-1225-2	11.34
ARM-1-1	10.18		EWG-LAW-New-IL-87749-CCC-1225-3	11.34
ARM-1-2	10.18		EWG-LAW-New-OL-62909-Mod-CCC-1300-1	10.83
ARM-1-3	10.21		EWG-LAW-New-OL-62909-Mod-CCC-1300-2	10.78
EA-1	11.65		EWG-LAW-New-OL-62909-Mod-CCC-1300-3	10.81
EA-2	11.71		EWG-LAW-New-OL-80309-CCC-1300-1	11.17
EA-3	11.78		EWG-LAW-New-OL-80309-CCC-1300-2	11.15
EWG-LAW-New-IL-166697-CCC-1250-1	10.9		EWG-LAW-New-OL-80309-CCC-1300-3	11.16
EWG-LAW-New-IL-166697-CCC-1250-2	10.88		EWG-LAW-ORP-LD1-2-CCC-1300-1	10.97
EWG-LAW-New-IL-166697-CCC-1250-3	10.88		EWG-LAW-ORP-LD1-2-CCC-1300-2	10.98
EWG-LAW-New-IL-166731-CCC-1225-1	11.44		EWG-LAW-ORP-LD1-2-CCC-1300-3	10.98
EWG-LAW-New-IL-166731-CCC-1225-2	11.43		EWG-LAW-ORP-LD1-3-CCC-1300-1	10.85
EWG-LAW-New-IL-166731-CCC-1225-3	11.42		EWG-LAW-ORP-LD1-3-CCC-1300-2	10.88
			EWG-LAW-ORP-LD1-3-CCC-1300-3	10.89

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

Set=Jan set 1, Analyte=B
Variability Chart for log[(ppm)]

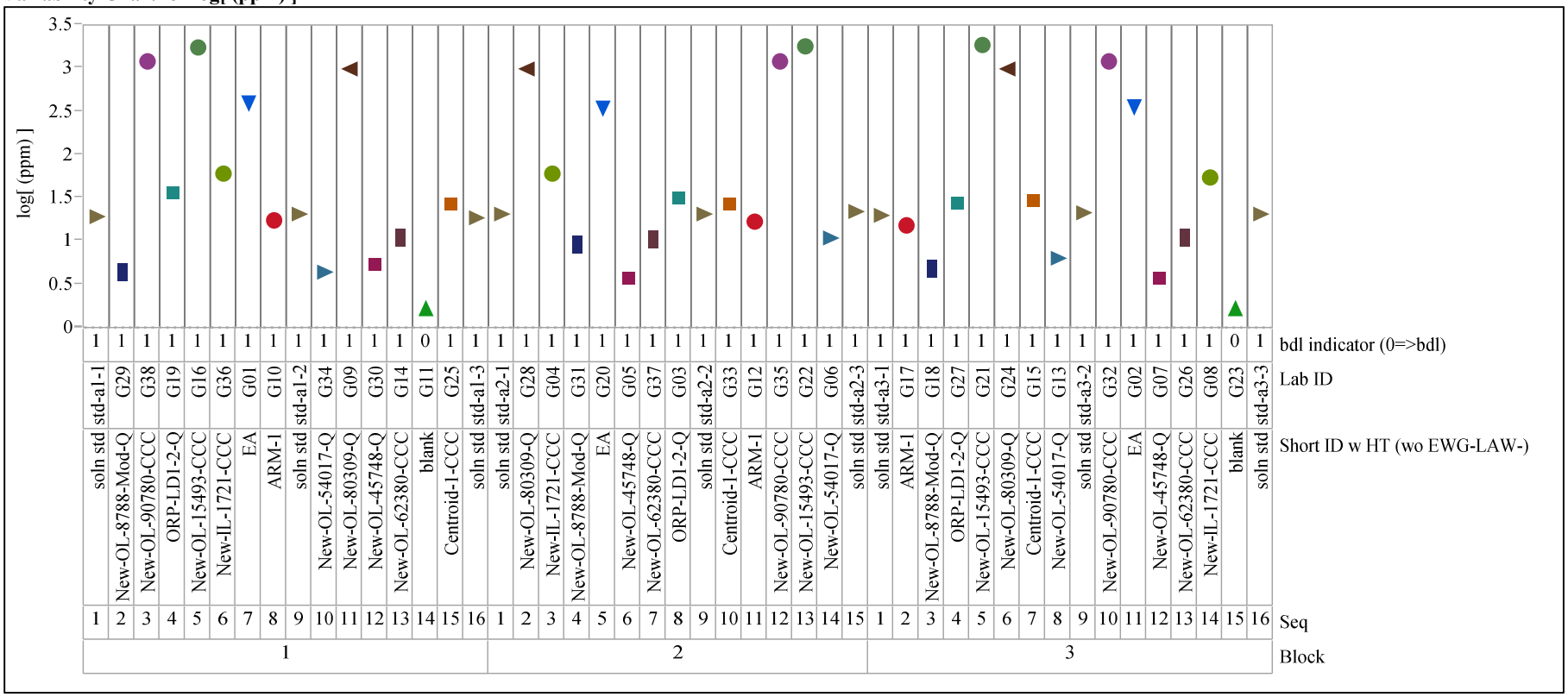


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

Set=Jan set 1, Analyte=Li
Variability Chart for log[(ppm)]

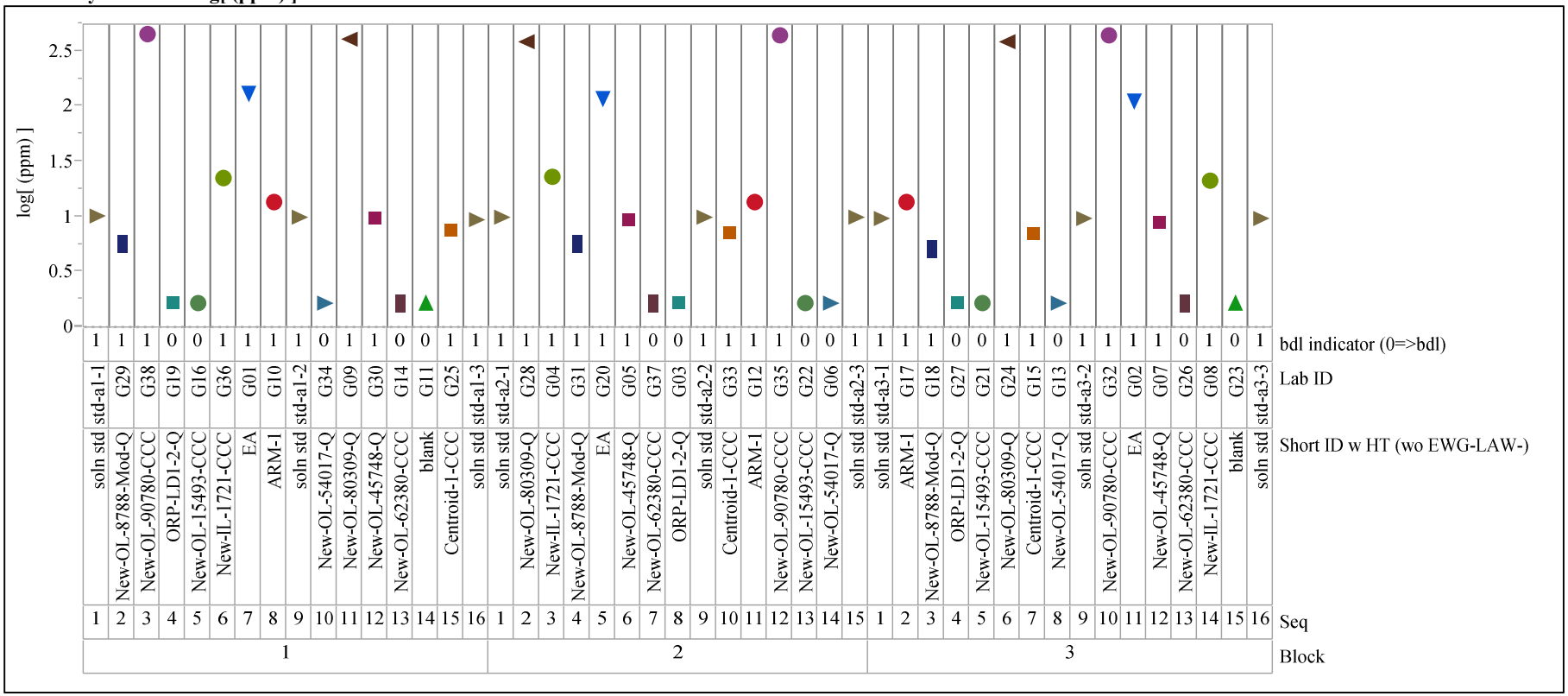


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

Set=Jan set 1, Analyte=Na
Variability Chart for log[(ppm)]

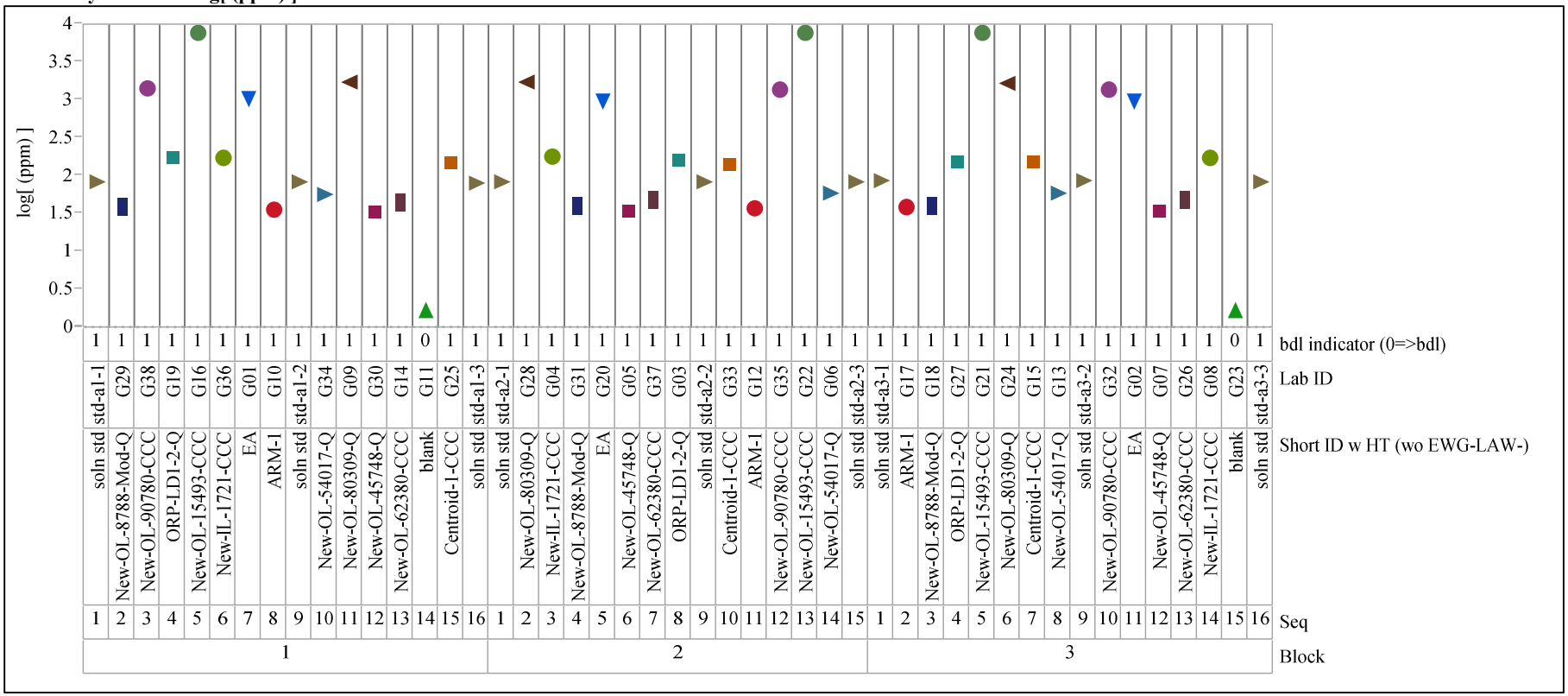


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

Set=Jan set 1, Analyte=Si
Variability Chart for log[(ppm)]

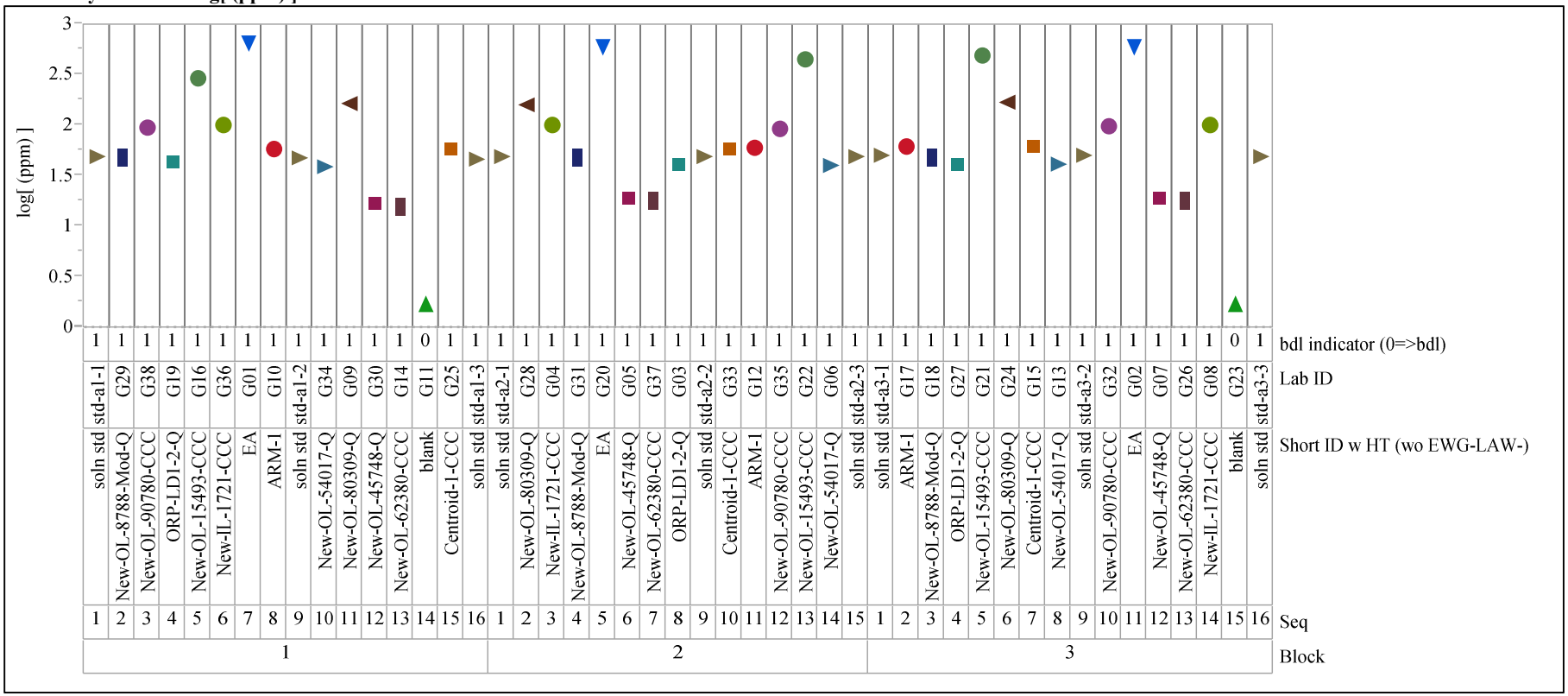


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

Set=Jan set 2, Analyte=B
Variability Chart for log[(ppm)]

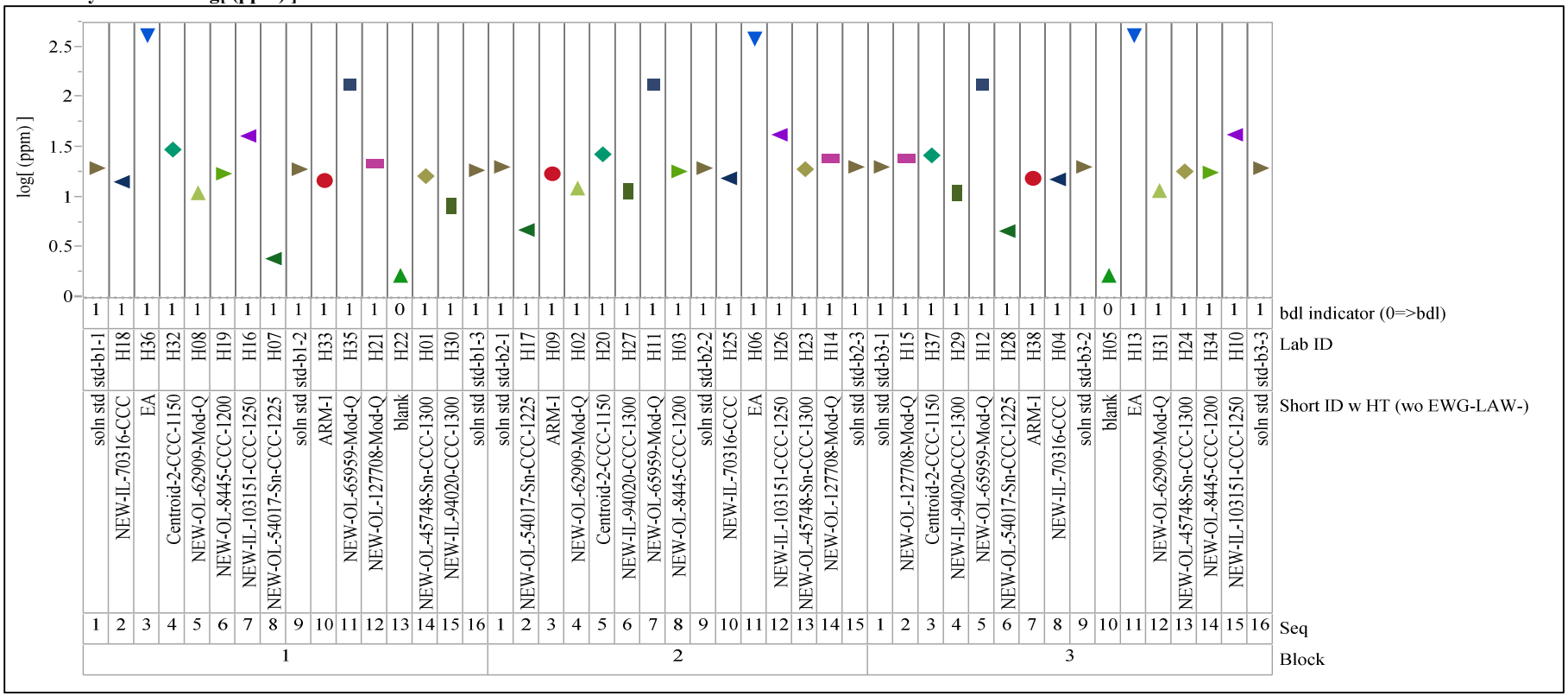


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

Set=Jan set 2, Analyte=Li
Variability Chart for log[(ppm)]

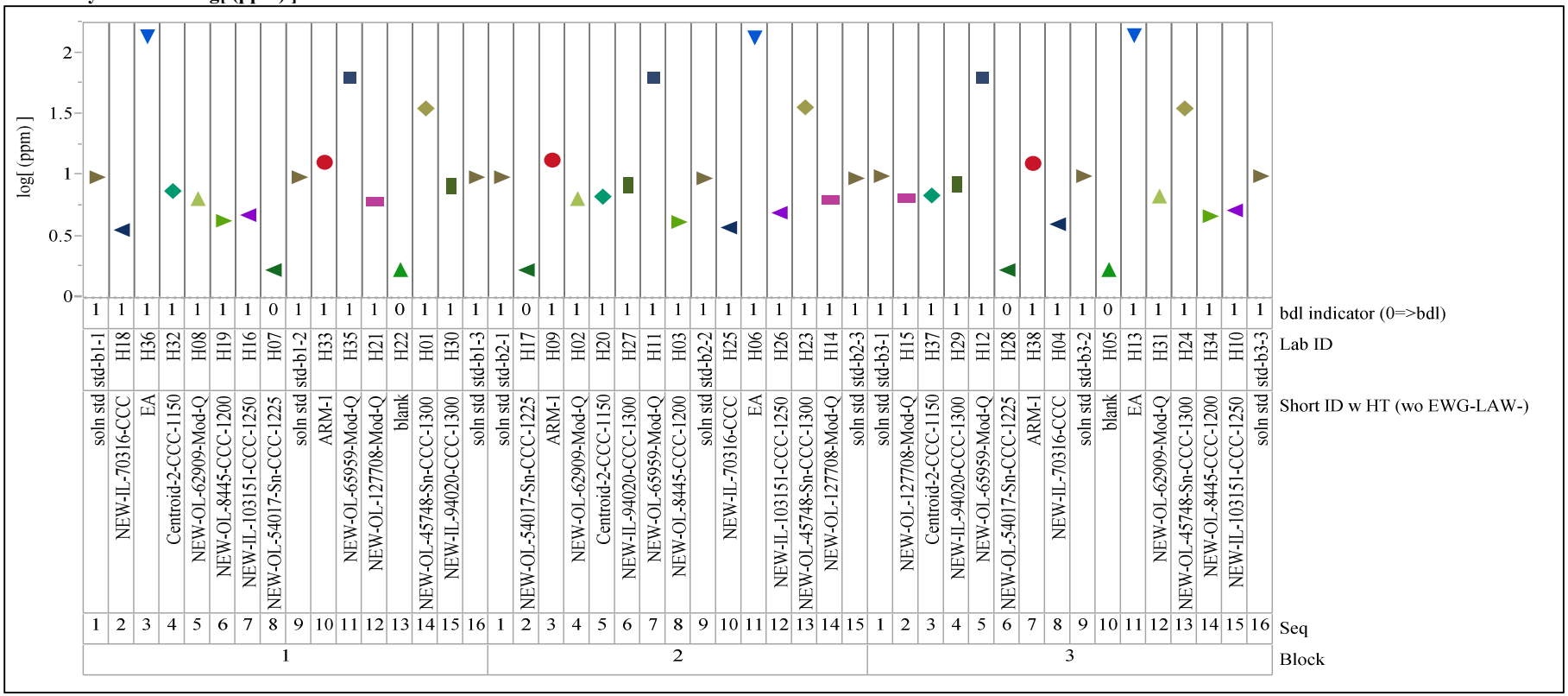


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

Set=Jan set 2, Analyte=Na
Variability Chart for log[(ppm)]

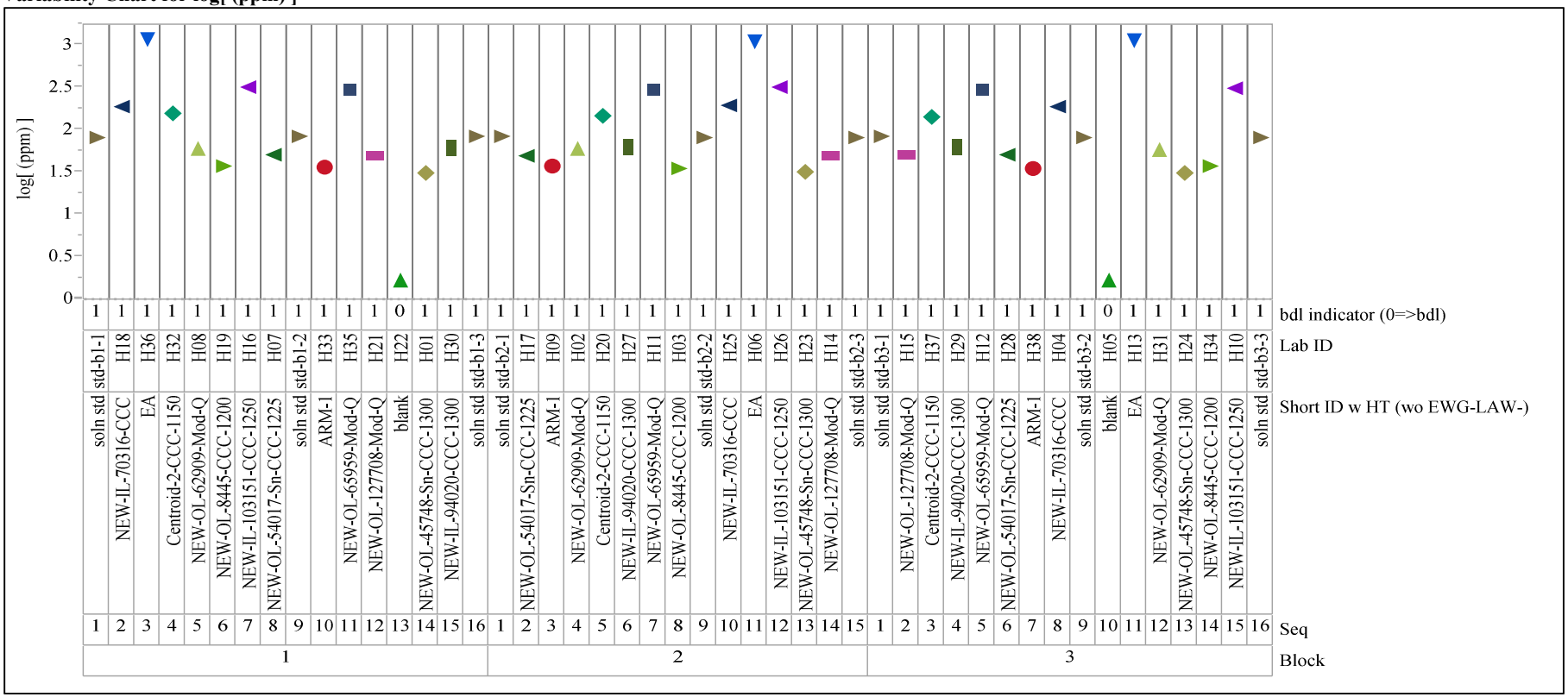


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

Set=Jan set 2, Analyte=Si
Variability Chart for log[(ppm)]

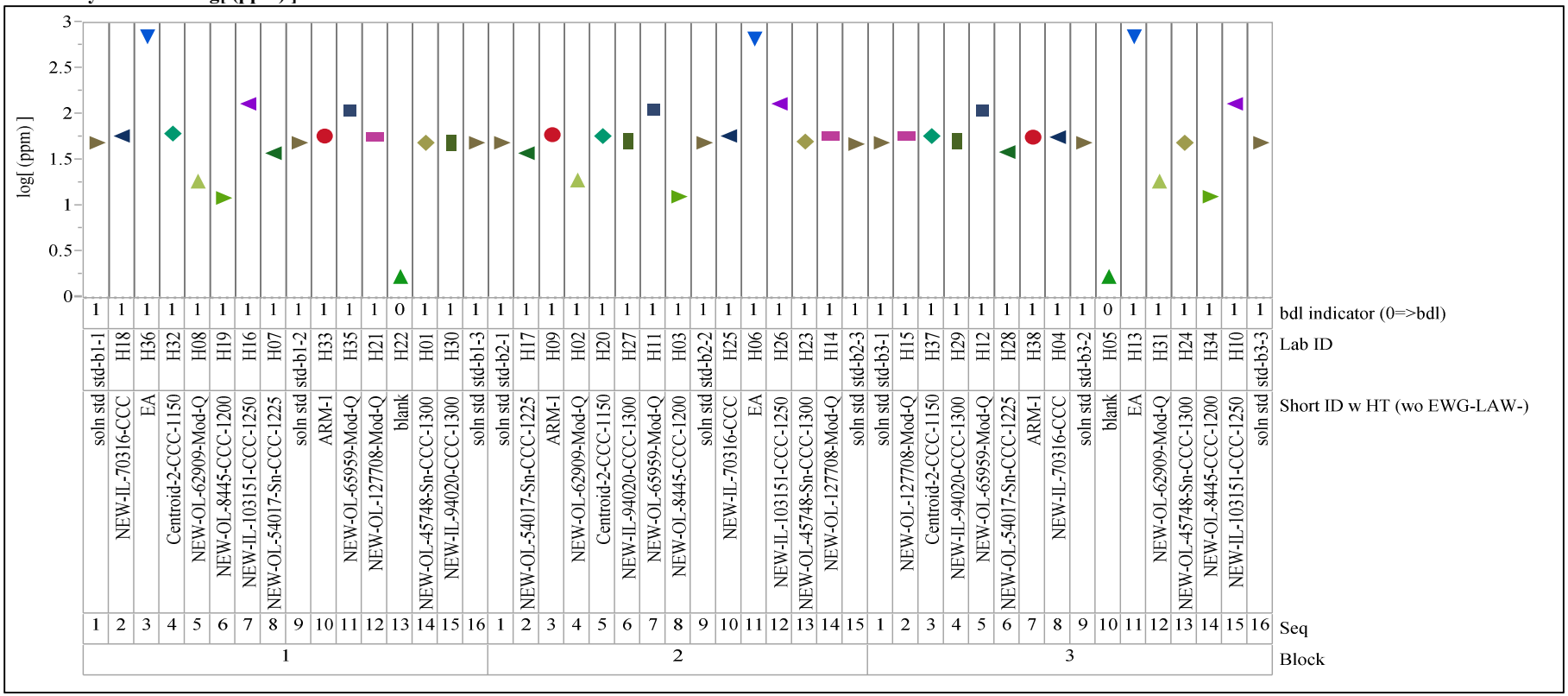


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

Set=Mar set 1, Analyte=B
Variability Chart for log[(ppm)]

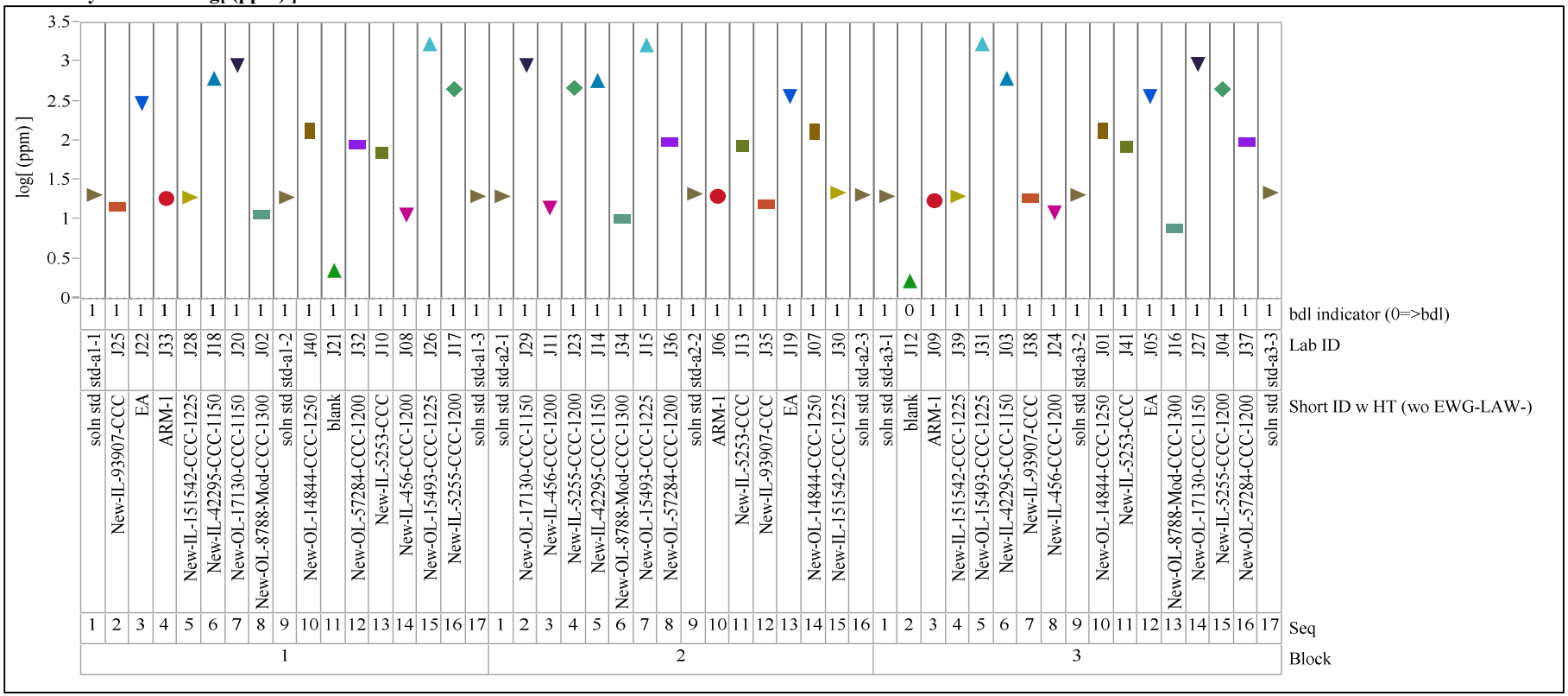


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

Set=Mar set 1, Analyte=Li
Variability Chart for log[(ppm)]

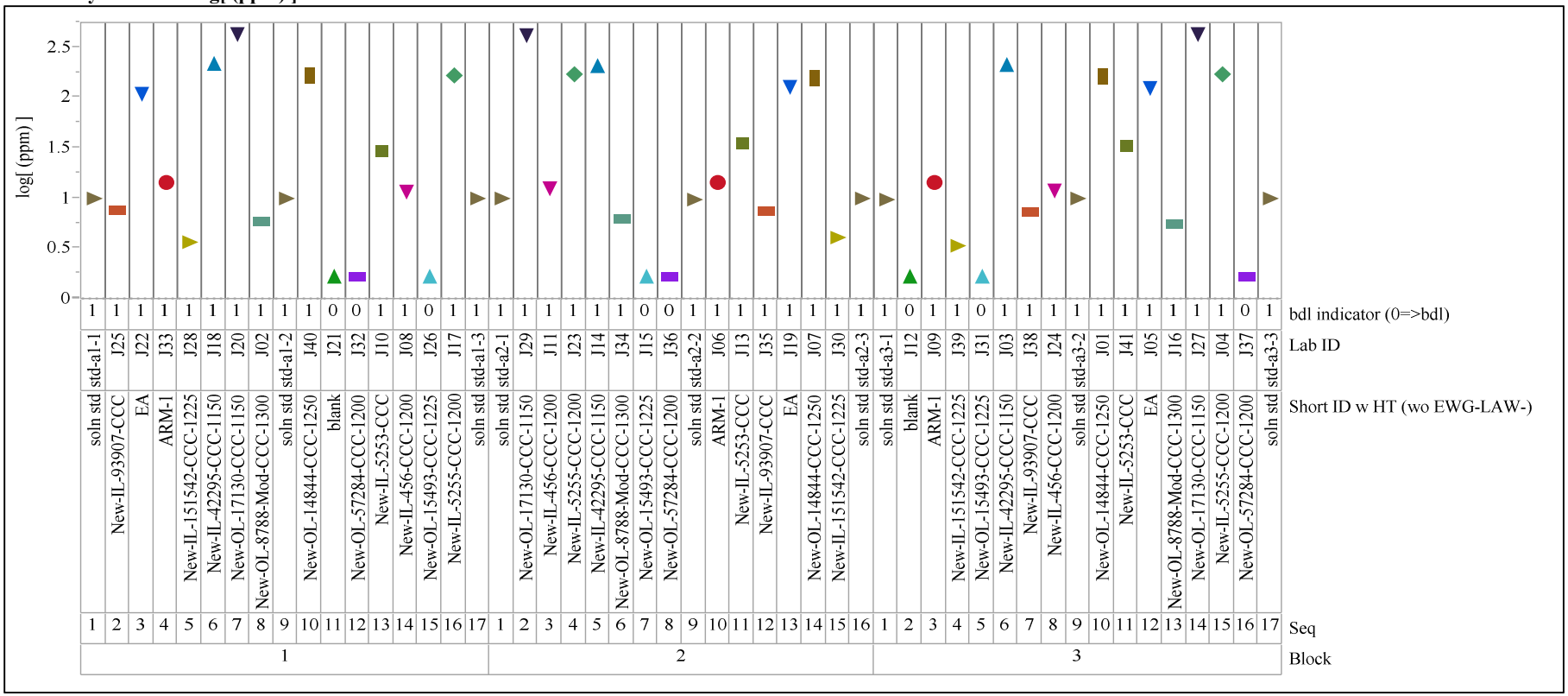


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

Set=Mar set 1, Analyte=Na
Variability Chart for log[(ppm)]

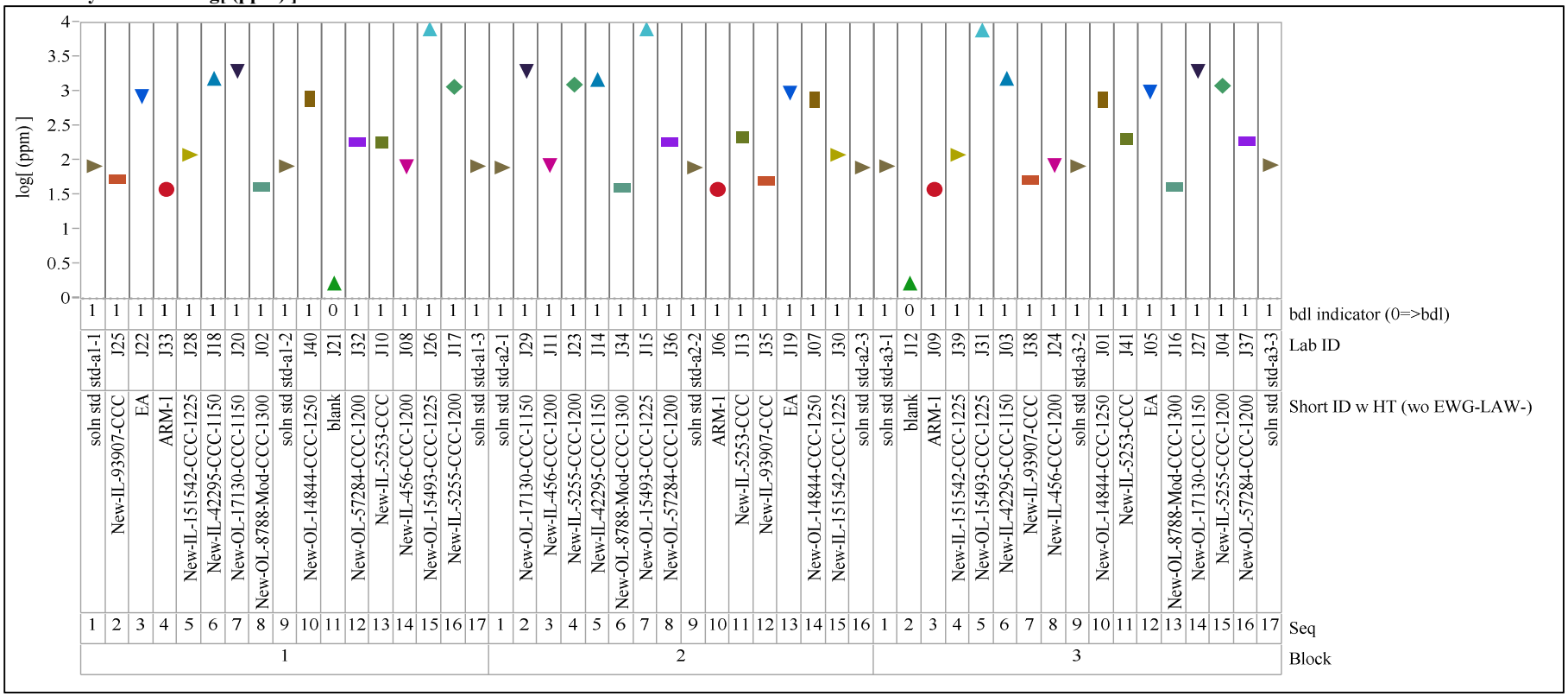


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

Set=Mar set 1, Analyte=Si
Variability Chart for log[(ppm)]

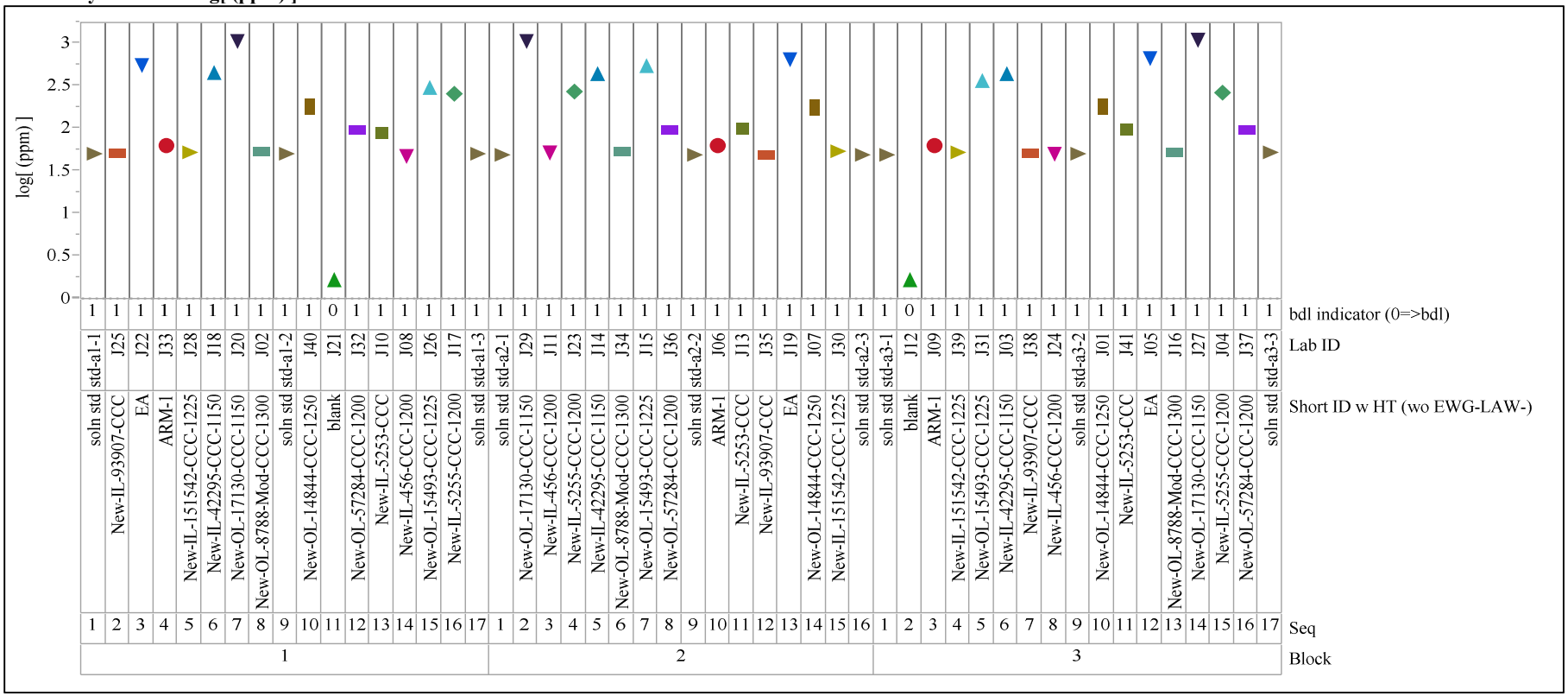


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

Set=Mar set 2, Analyte=B
Variability Chart for log[(ppm)]

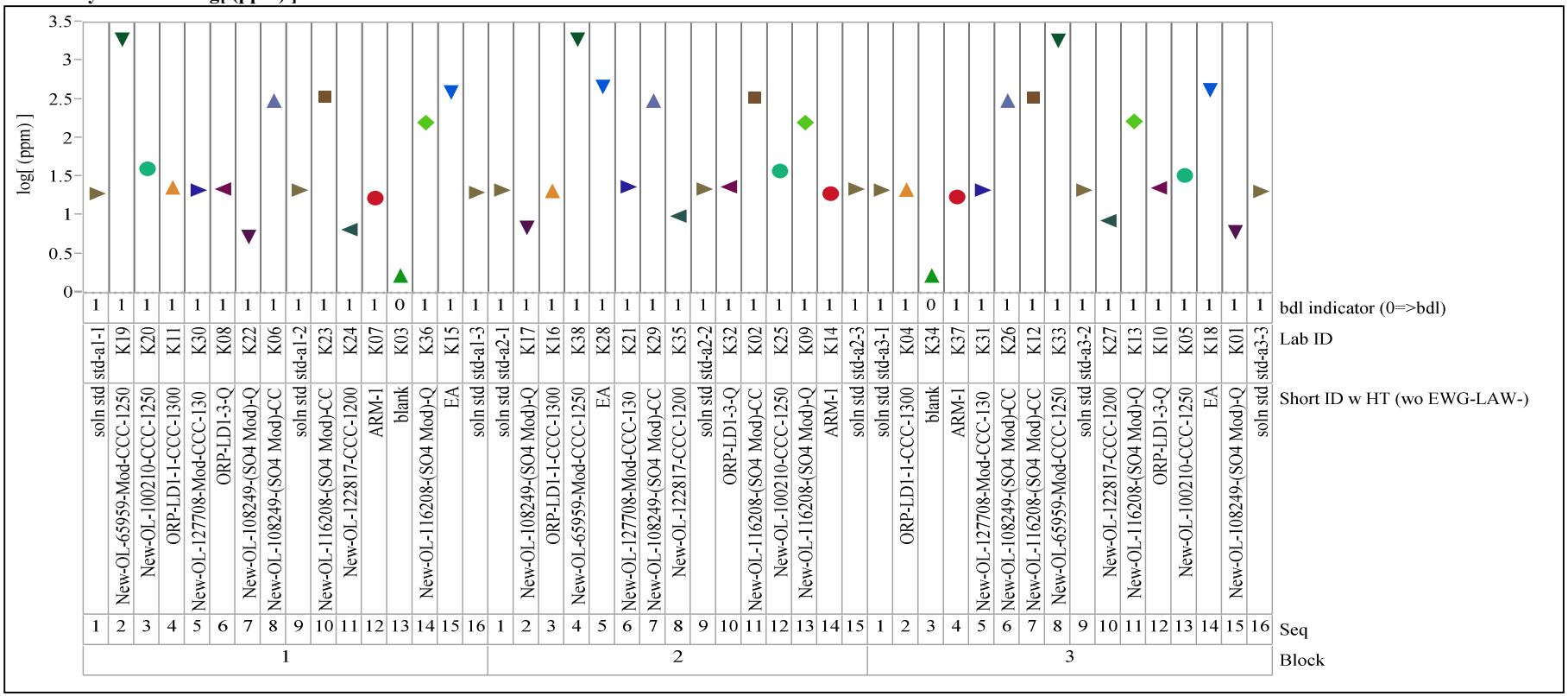


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

Set=Mar set 2, Analyte=Li
Variability Chart for log[(ppm)]

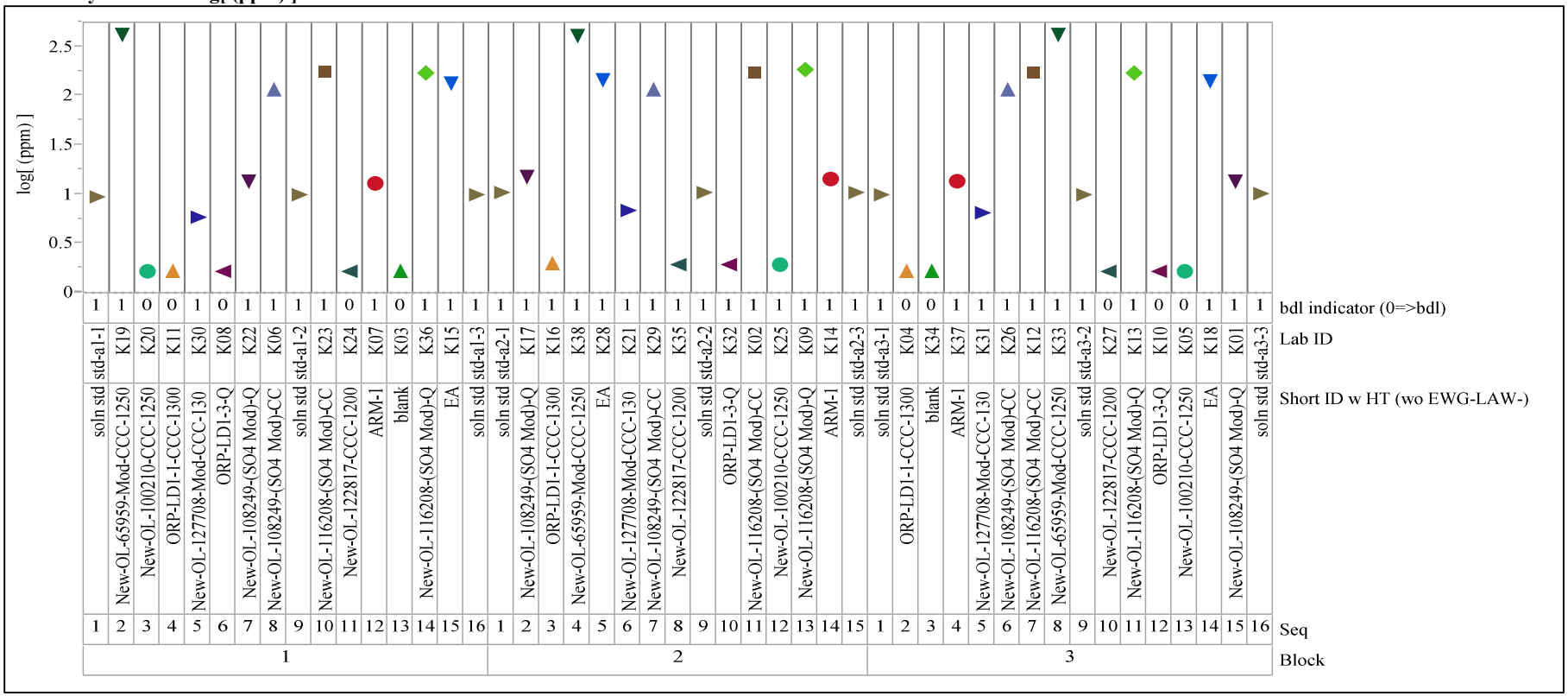


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

Set=Mar set 2, Analyte=Na
Variability Chart for log[(ppm)]

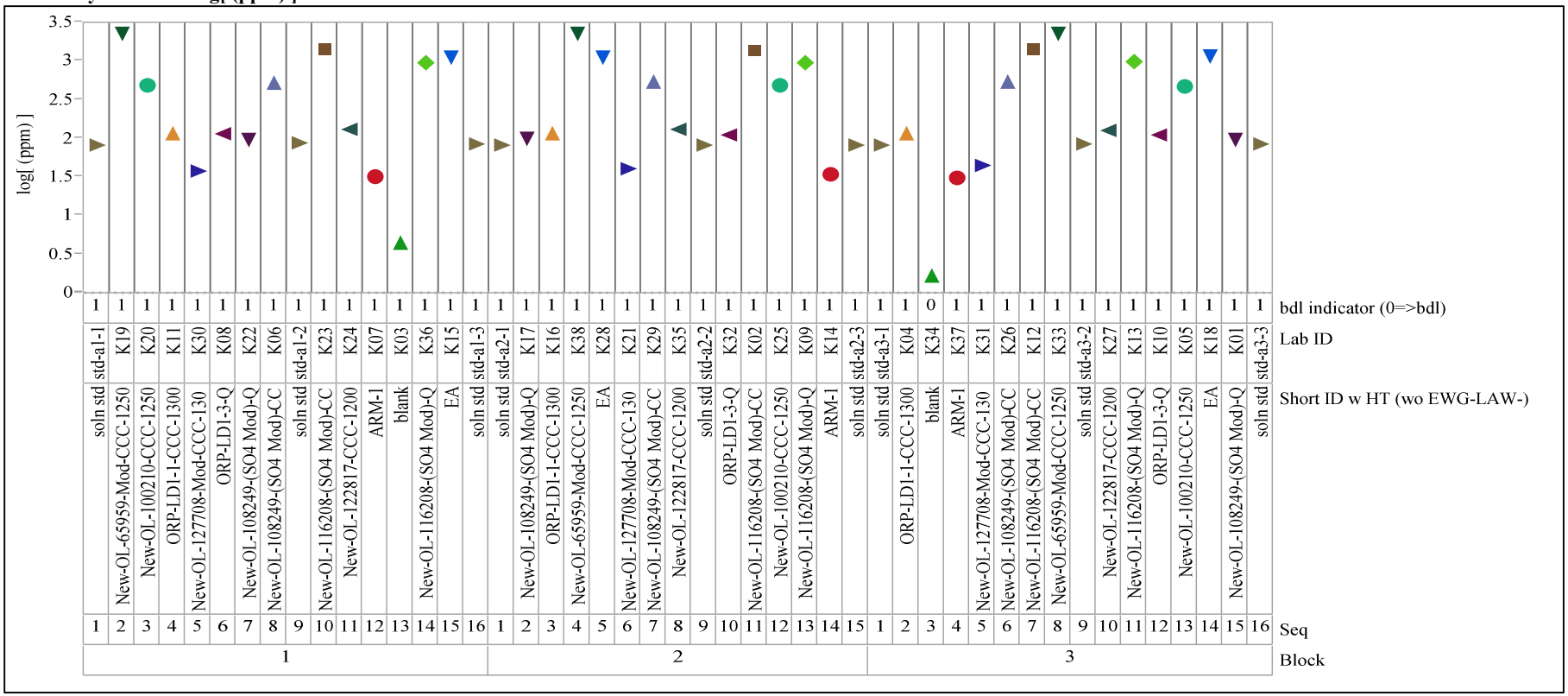


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

Set=Mar set 2, Analyte=Si
Variability Chart for log[(ppm)]

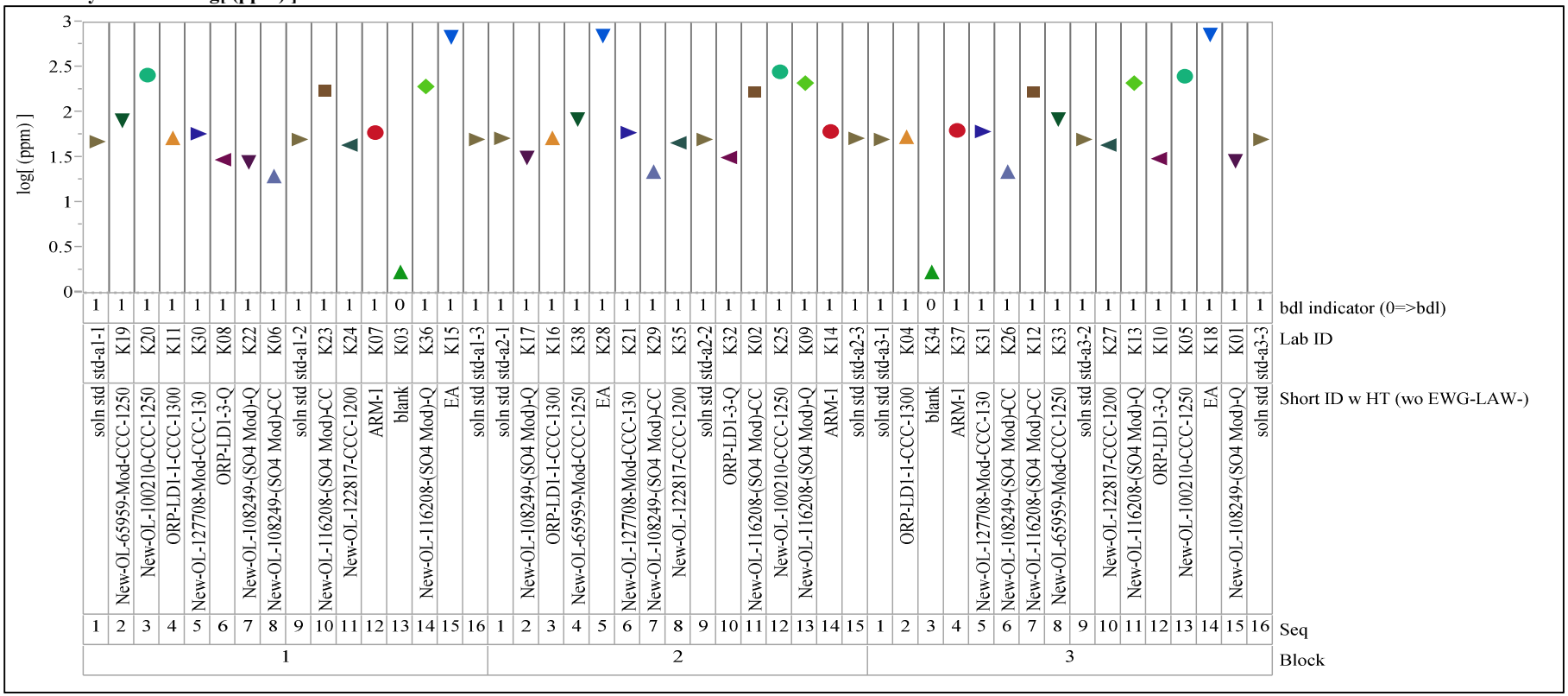


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

Set=April, Analyte=B
Variability Chart for log[(ppm)]

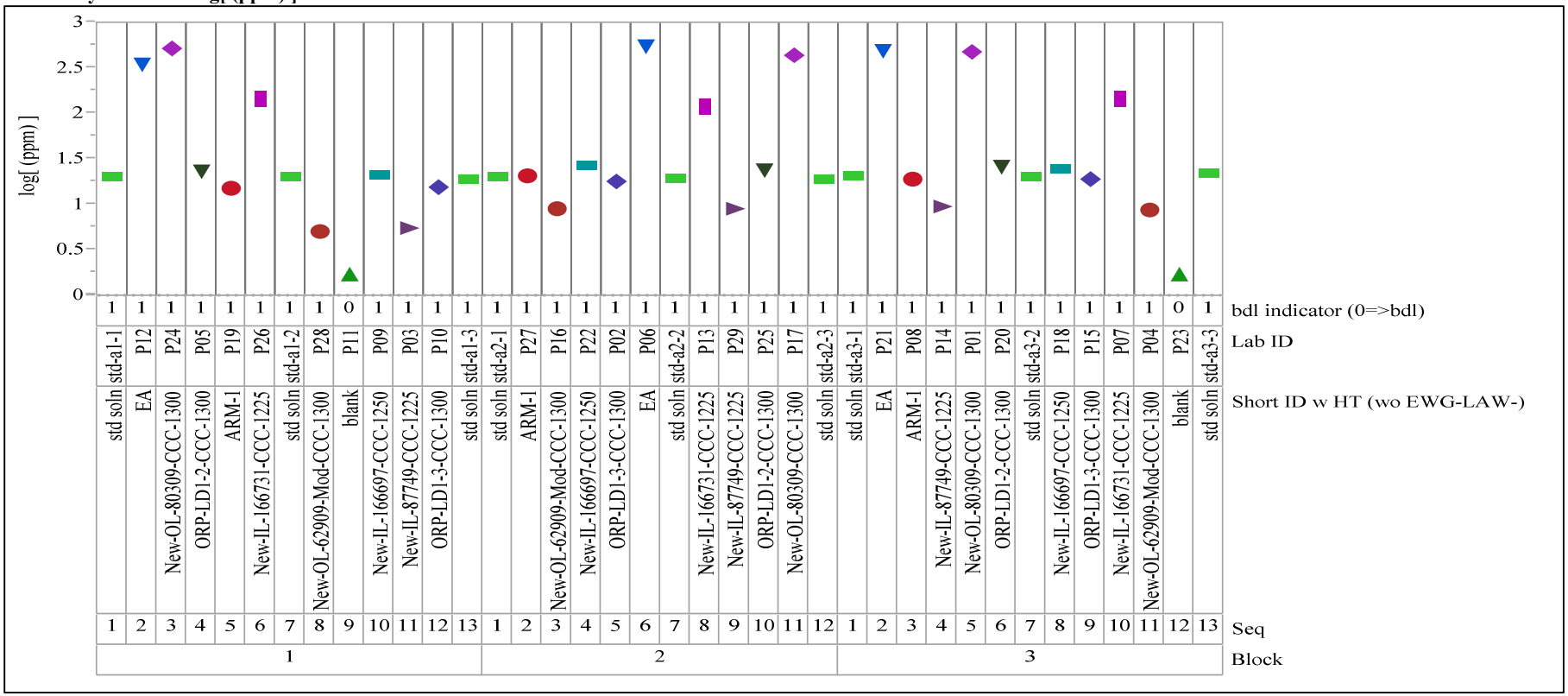


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

Set=April, Analyte=Li
Variability Chart for log[(ppm)]

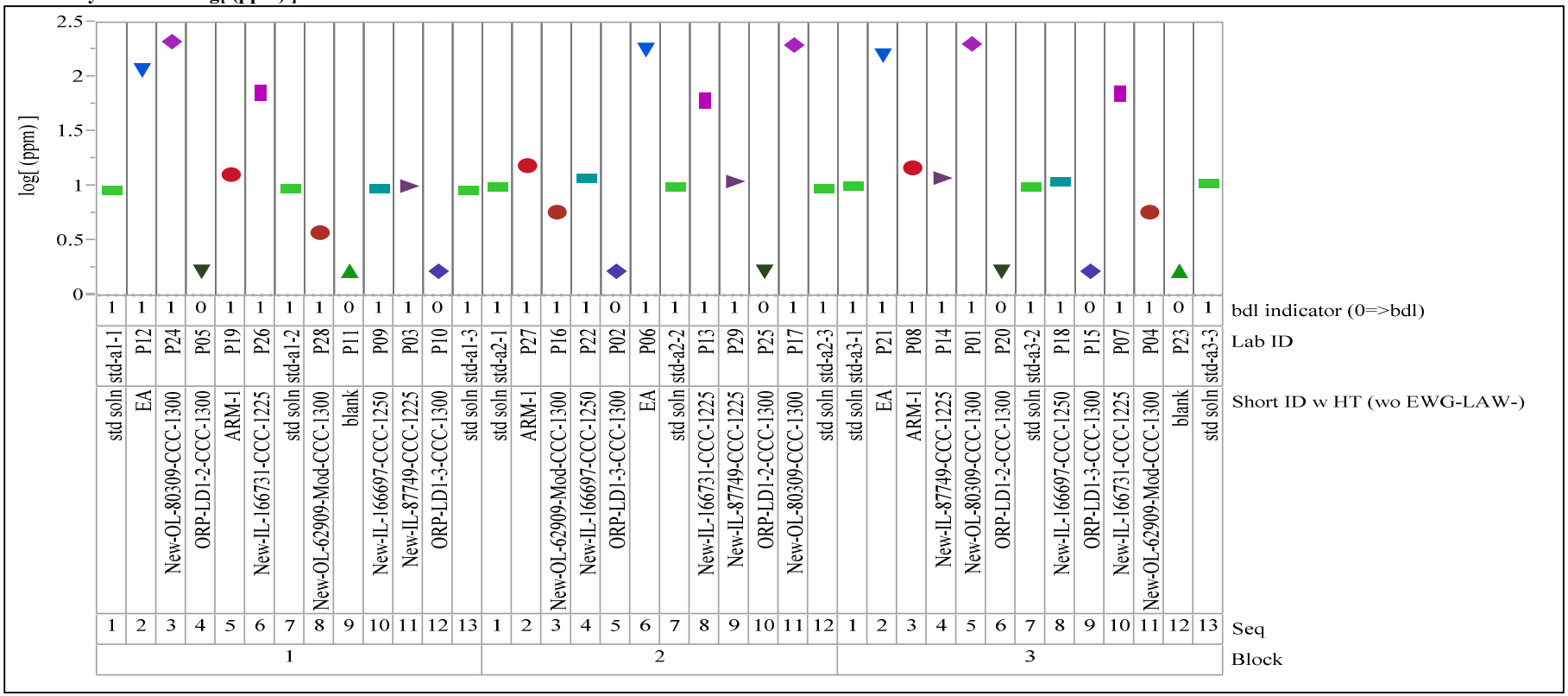


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

Set=April, Analyte=Na
Variability Chart for log[(ppm)]

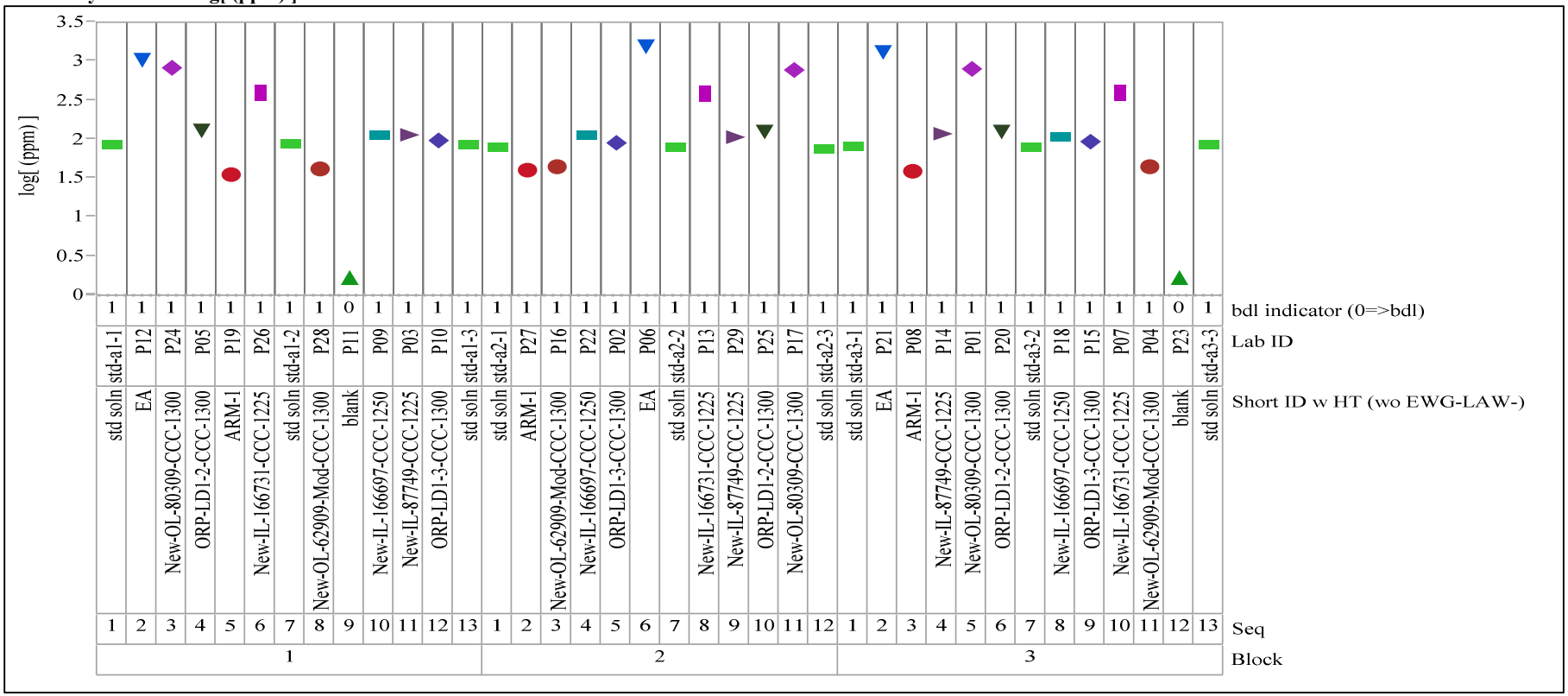


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

Set=April, Analyte=Si
Variability Chart for log[(ppm)]

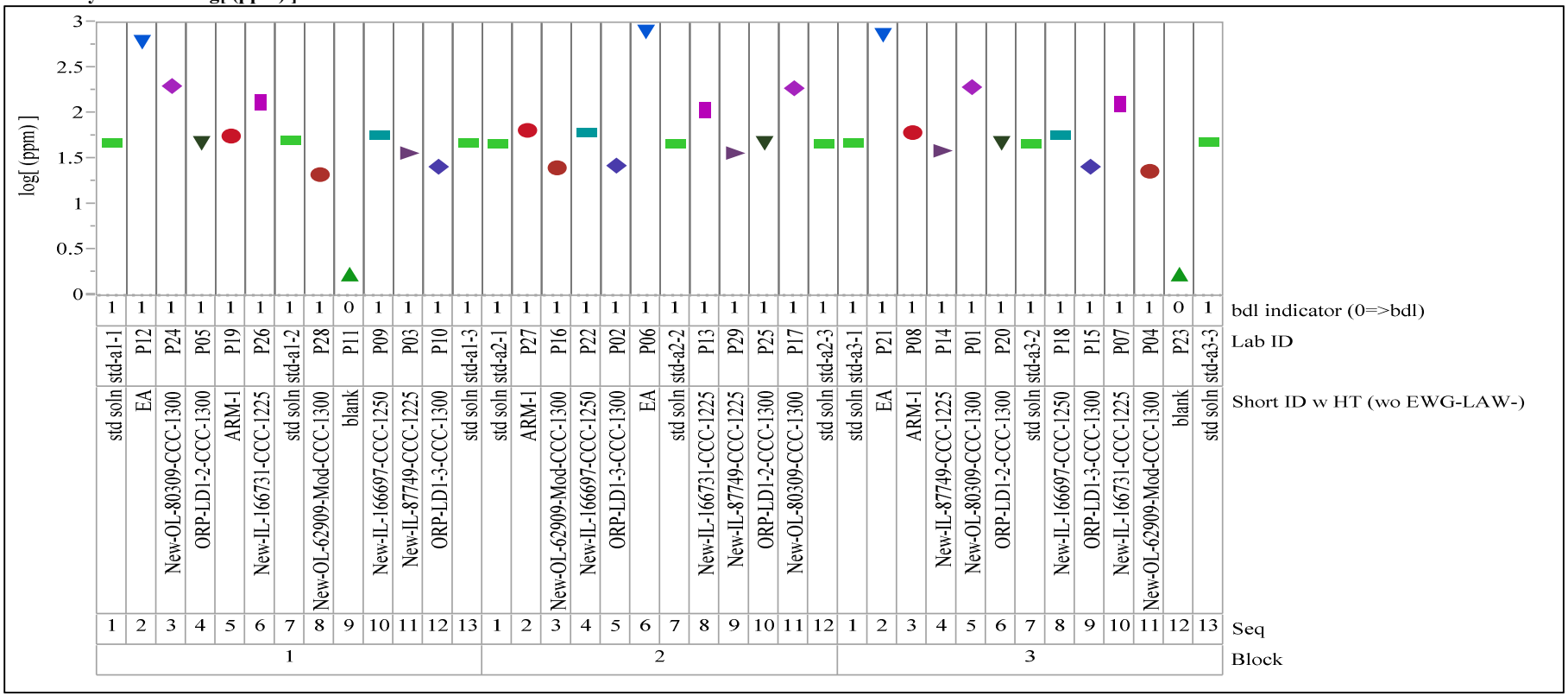


Exhibit B-2. PCT Measurements for Each Set of LAW Study Glasses

Set=Jan set 1, Analyte=B
Variability Chart for log[(ppm)]

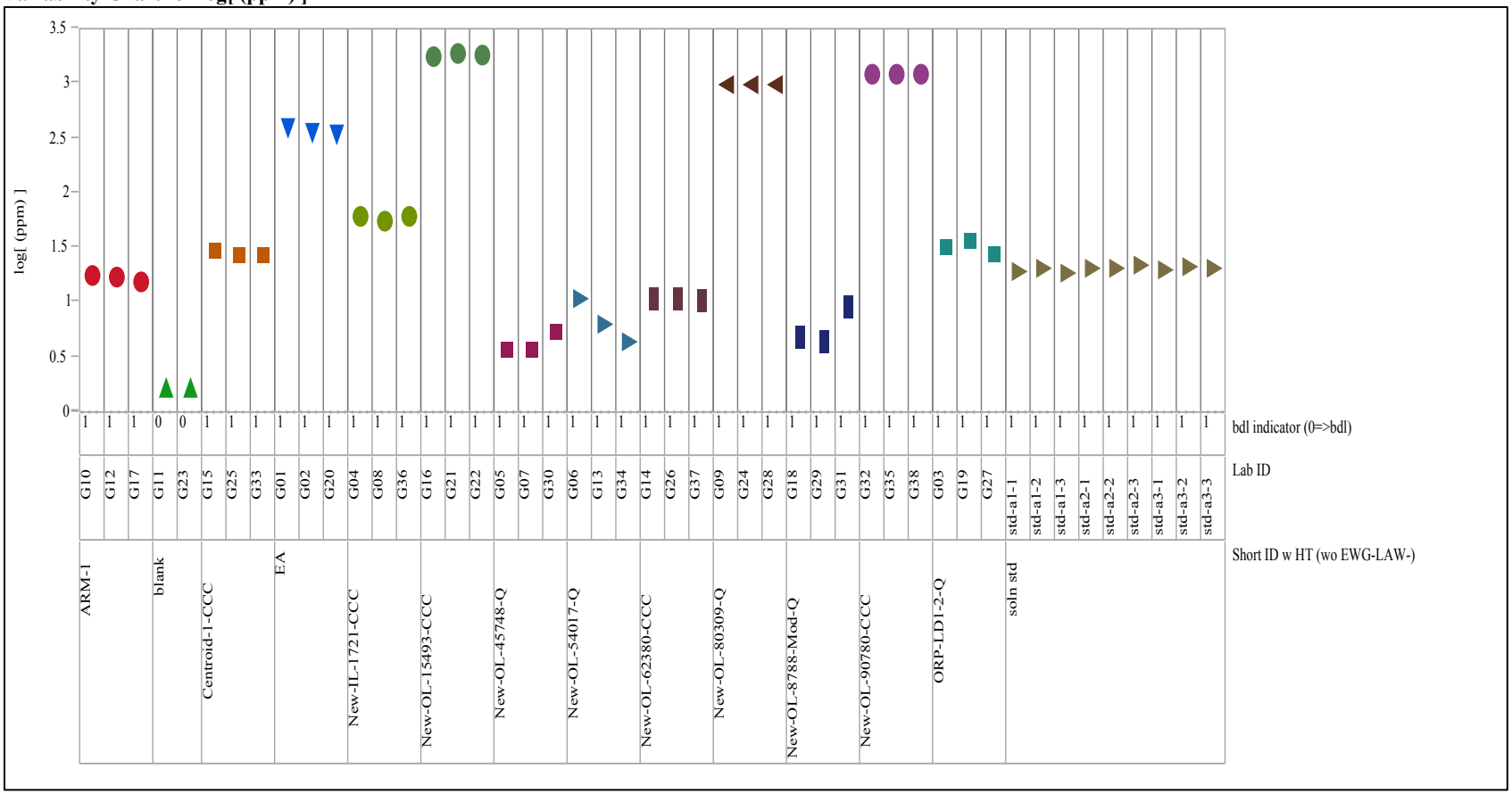


Exhibit B-2. PCT Measurements for Each Set of LAW Study Glasses (continued)

Set=Jan set 1, Analyte=Li
Variability Chart for log[(ppm)]

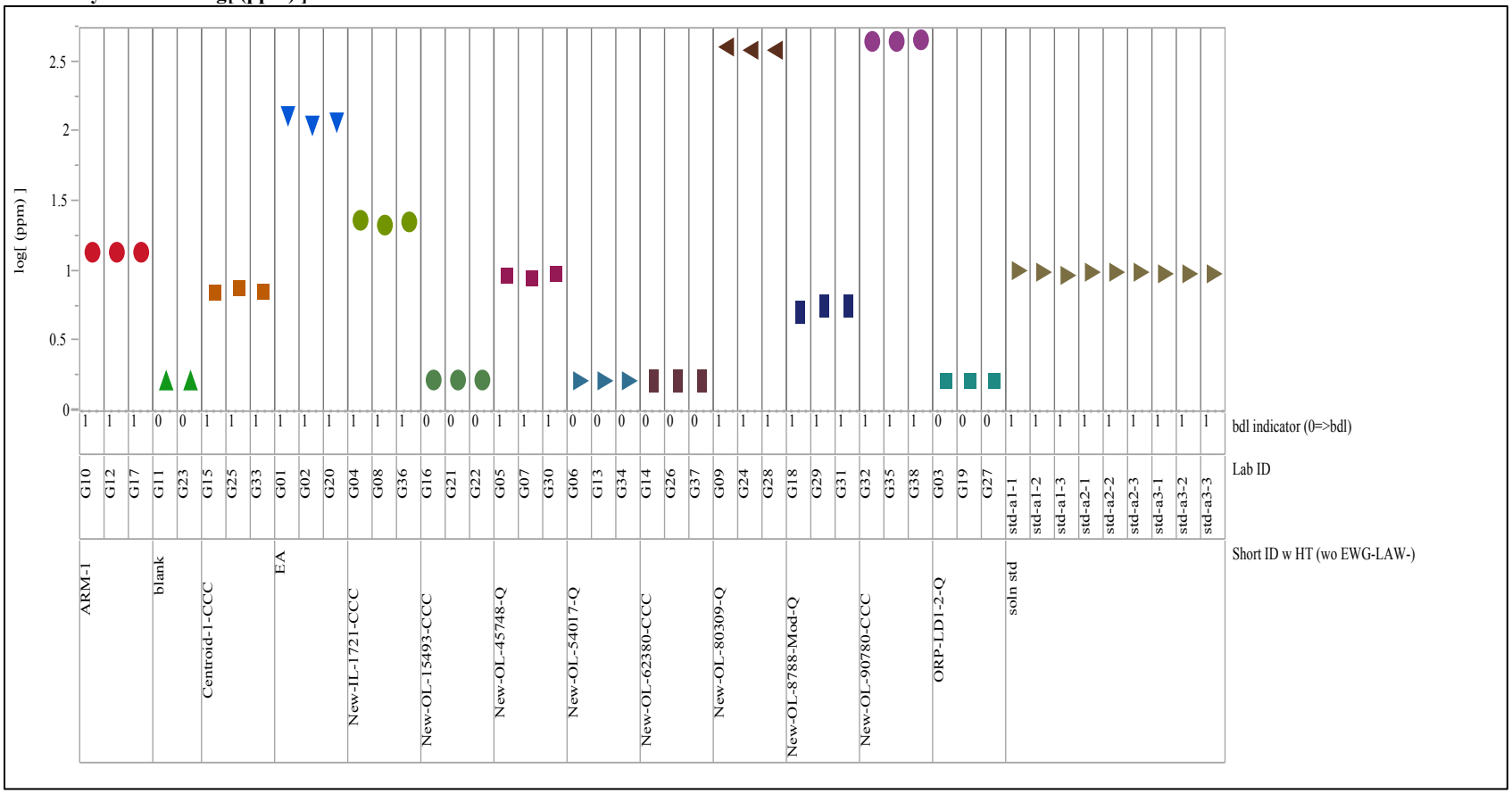


Exhibit B-2. PCT Measurements for Each Set of LAW Study Glasses (continued)

Set=Jan set 1, Analyte=Na
Variability Chart for log[(ppm)]

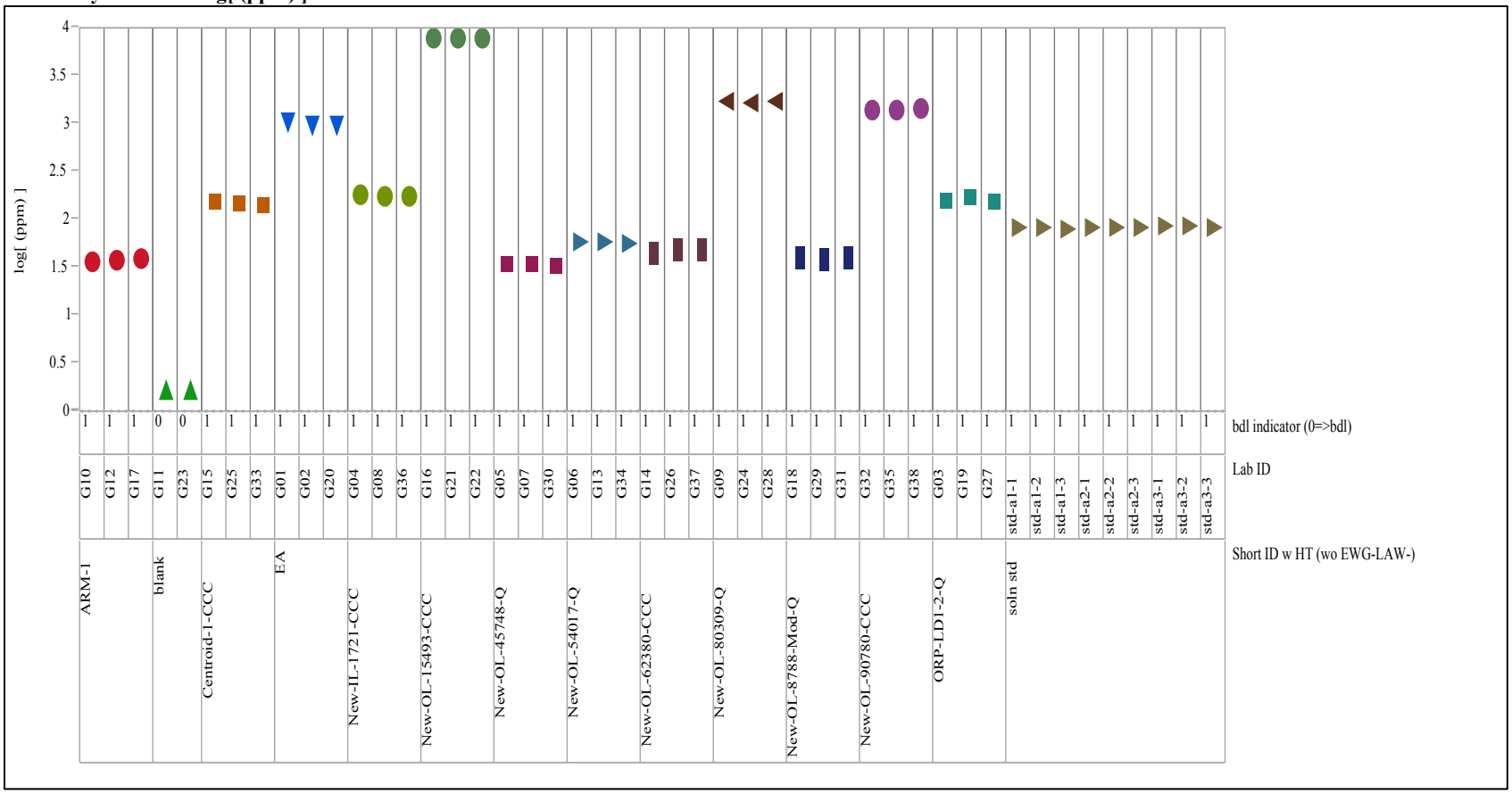


Exhibit B-2. PCT Measurements for Each Set of LAW Study Glasses (continued)

Set=Jan set 1, Analyte=Si
Variability Chart for log[(ppm)]

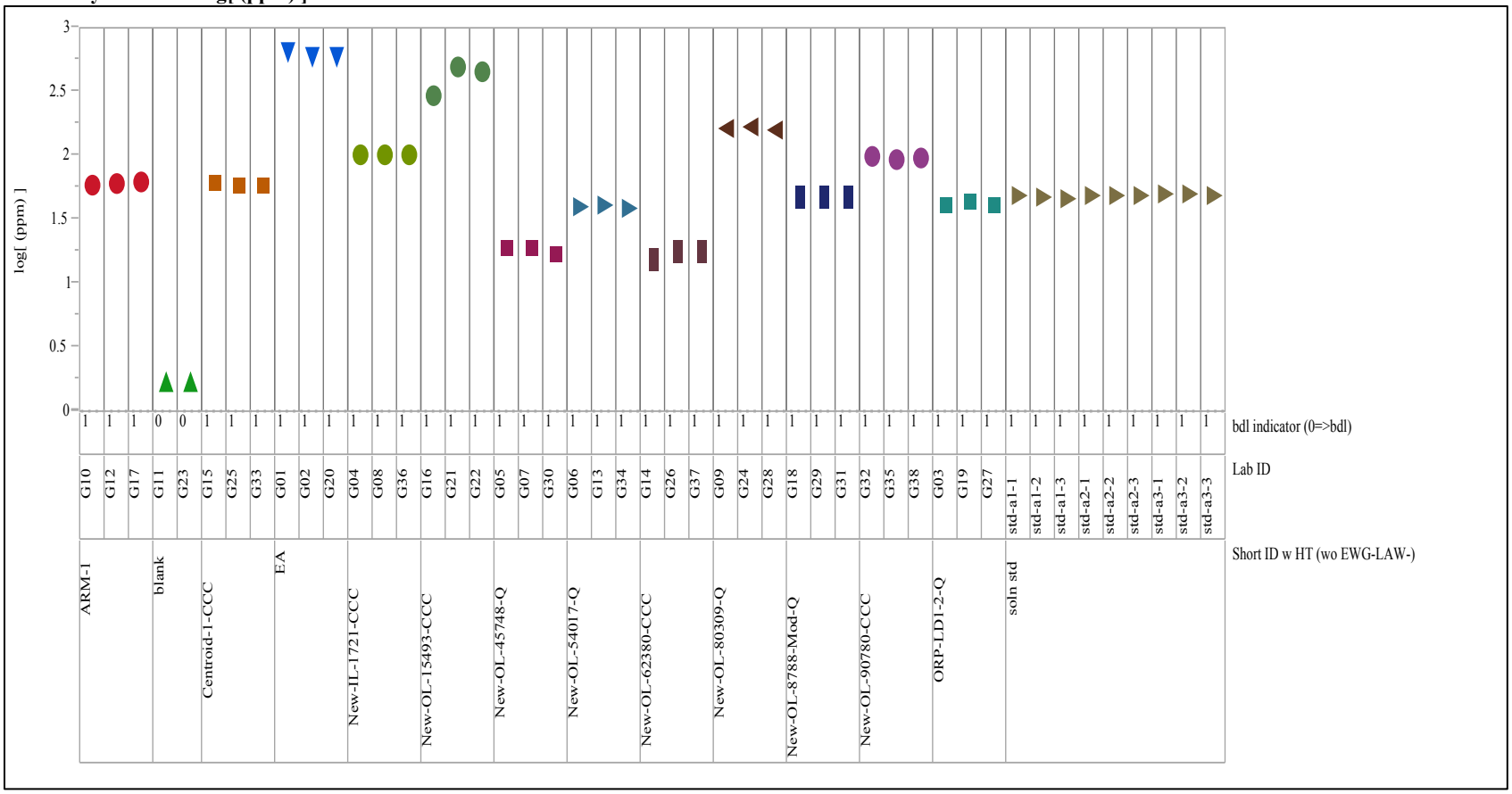


Exhibit B-2. PCT Measurements for Each Set of LAW Study Glasses (continued)

Set=Jan set 2, Analyte=B
Variability Chart for log[(ppm)]

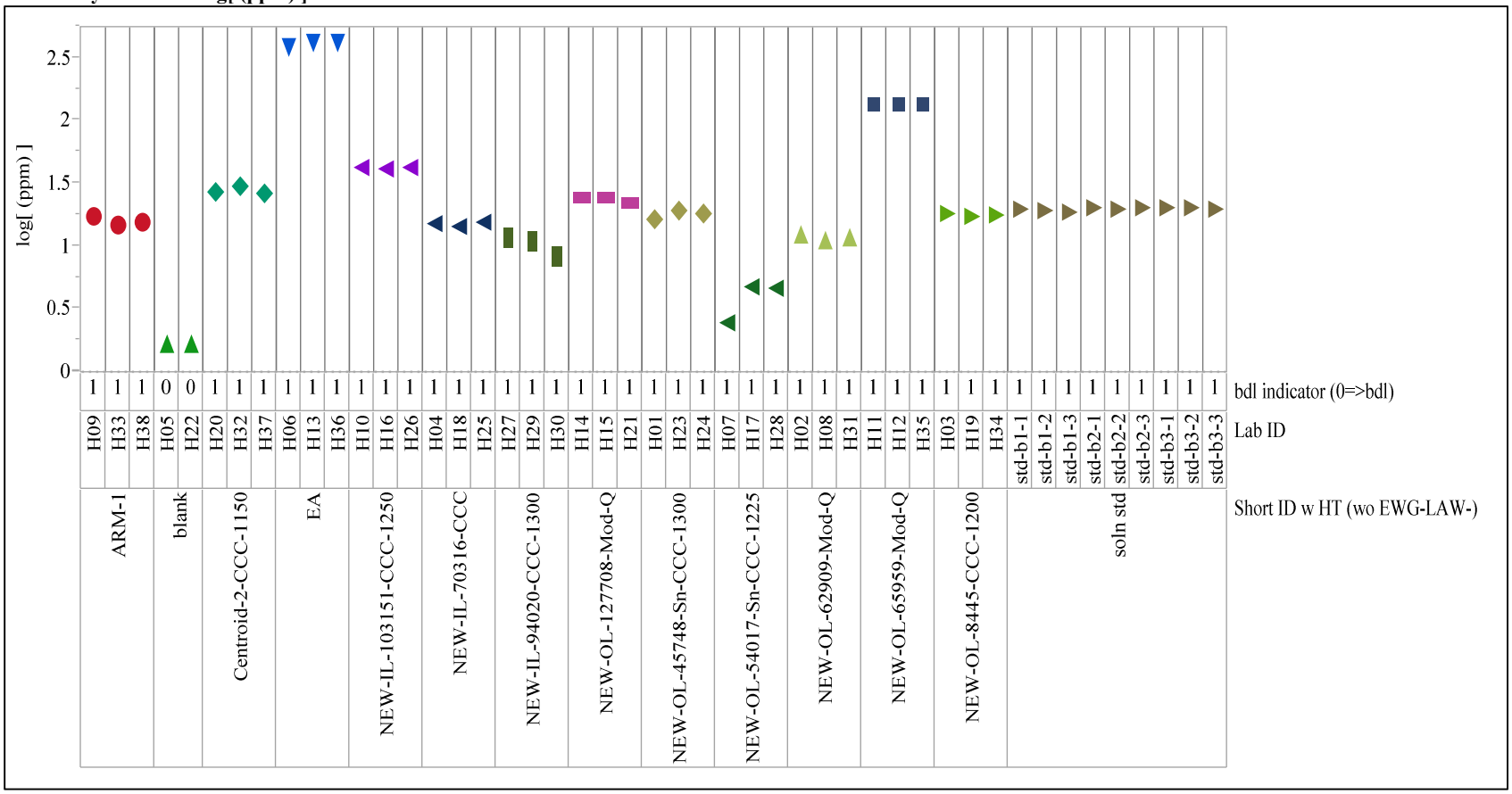


Exhibit B-2. PCT Measurements for Each Set of LAW Study Glasses (continued)

Set=Jan set 2, Analyte=Li
Variability Chart for log[(ppm)]

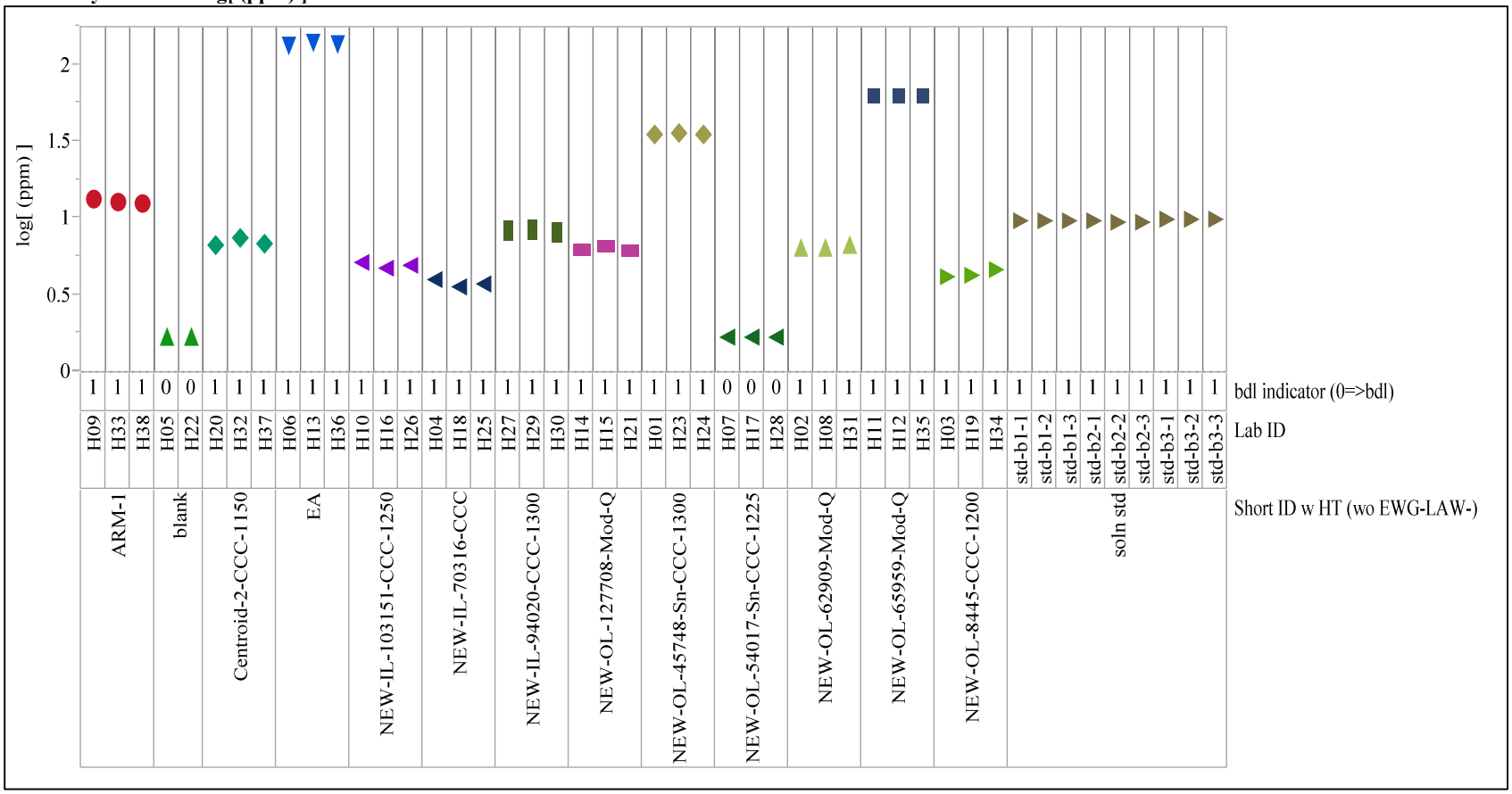


Exhibit B-2. PCT Measurements for Each Set of LAW Study Glasses (continued)

Set=Jan set 2, Analyte=Na
Variability Chart for log[(ppm)]

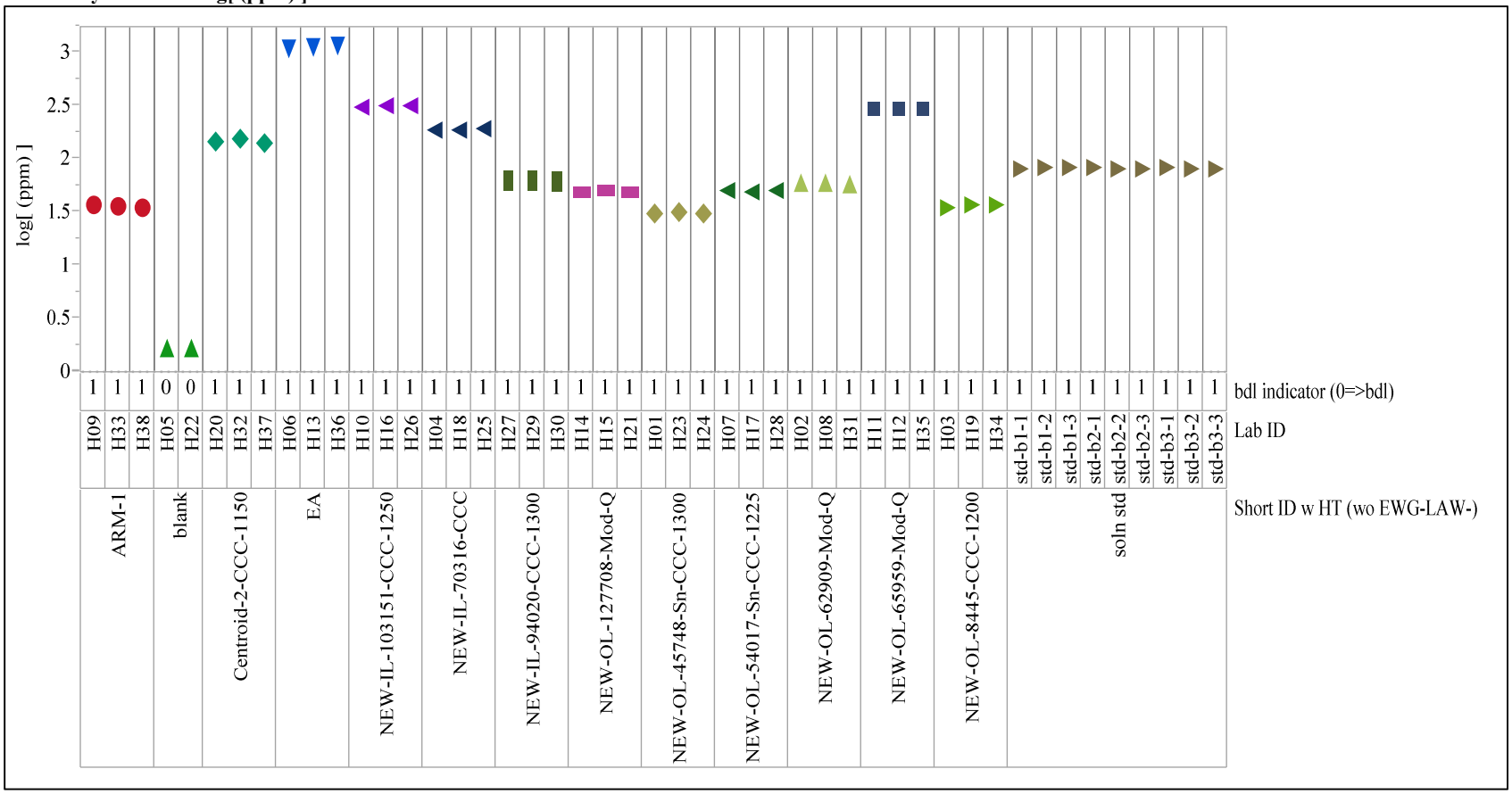


Exhibit B-2. PCT Measurements for Each Set of LAW Study Glasses (continued)

Set=Jan set 2, Analyte=Si
Variability Chart for log[(ppm)]

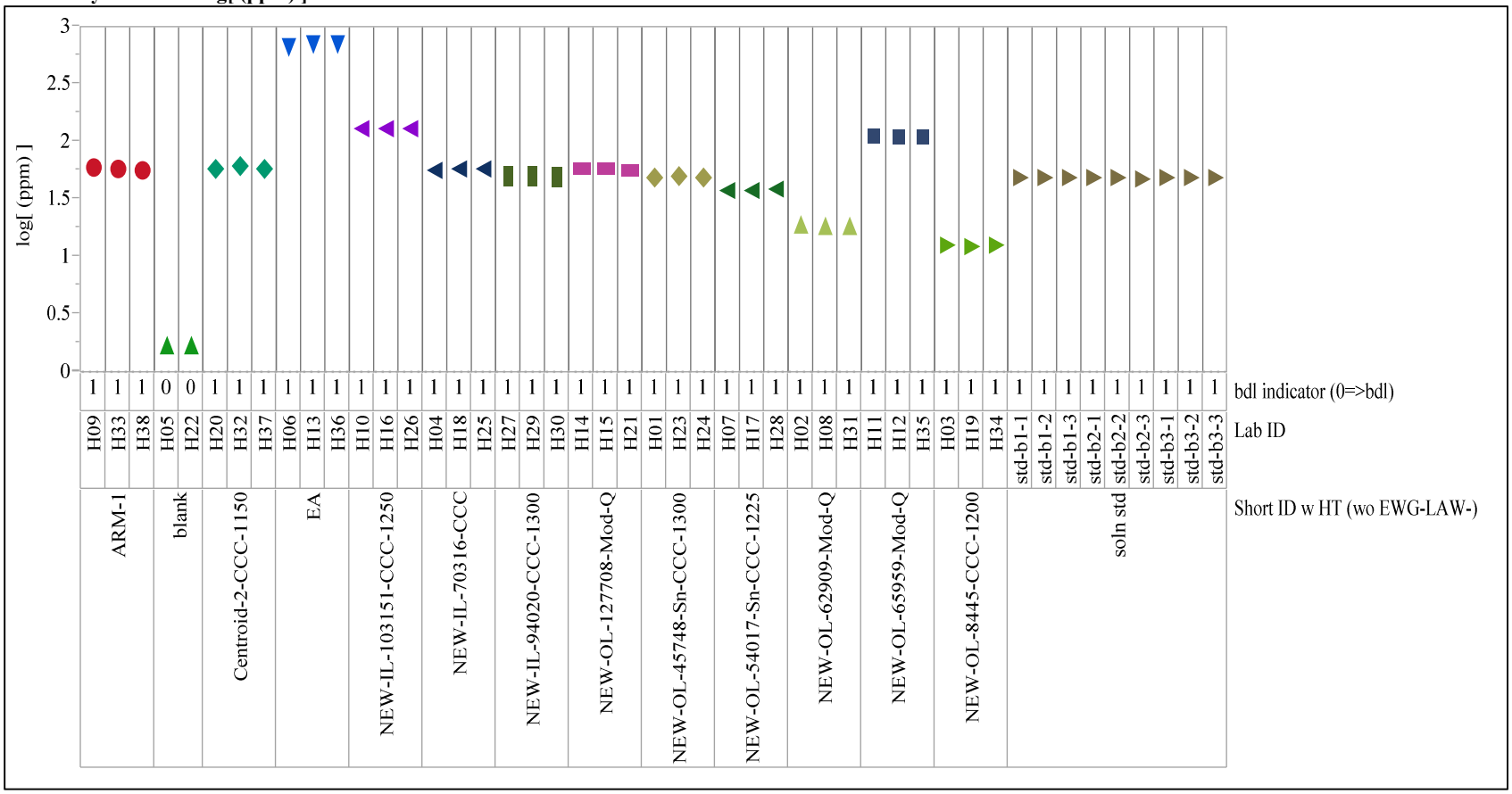


Exhibit B-2. PCT Measurements for Each Set of LAW Study Glasses (continued)

Set=Mar set 1, Analyte=B
Variability Chart for log[(ppm)]

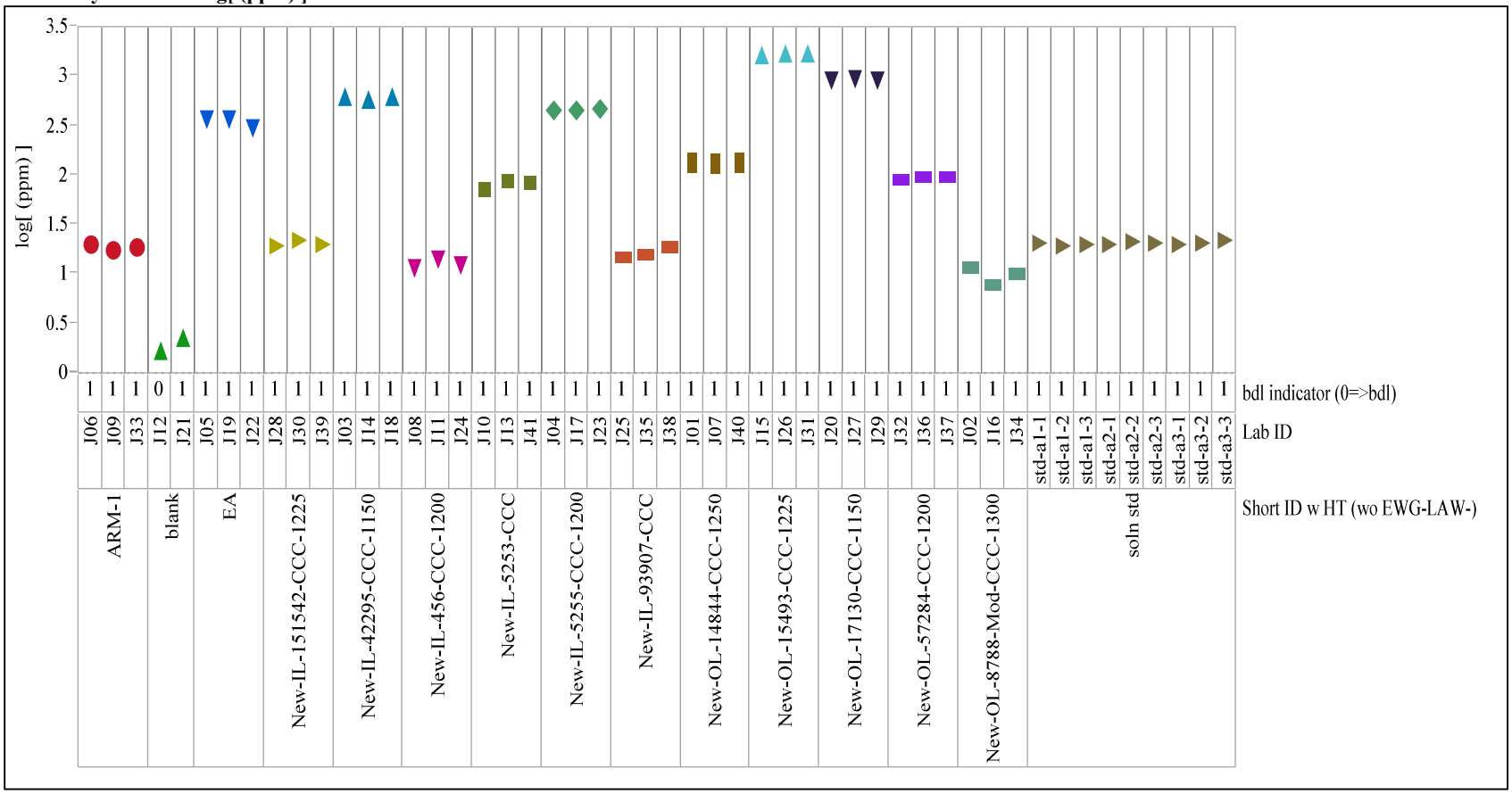


Exhibit B-2. PCT Measurements for Each Set of LAW Study Glasses (continued)

Set=Mar set 1, Analyte=Li
Variability Chart for log[(ppm)]

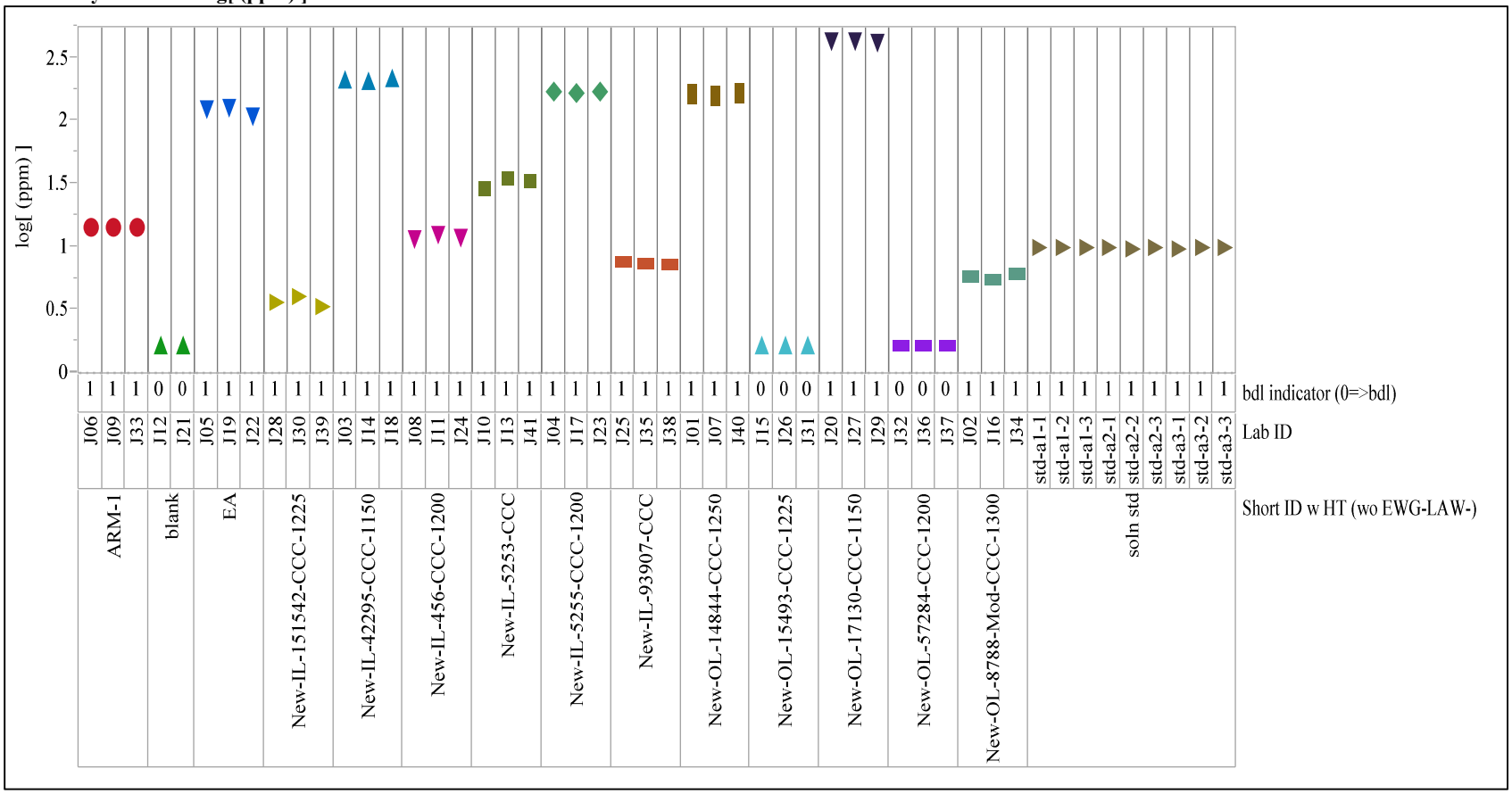


Exhibit B-2. PCT Measurements for Each Set of LAW Study Glasses (continued)

Set=Mar set 1, Analyte=Na
Variability Chart for log[(ppm)]

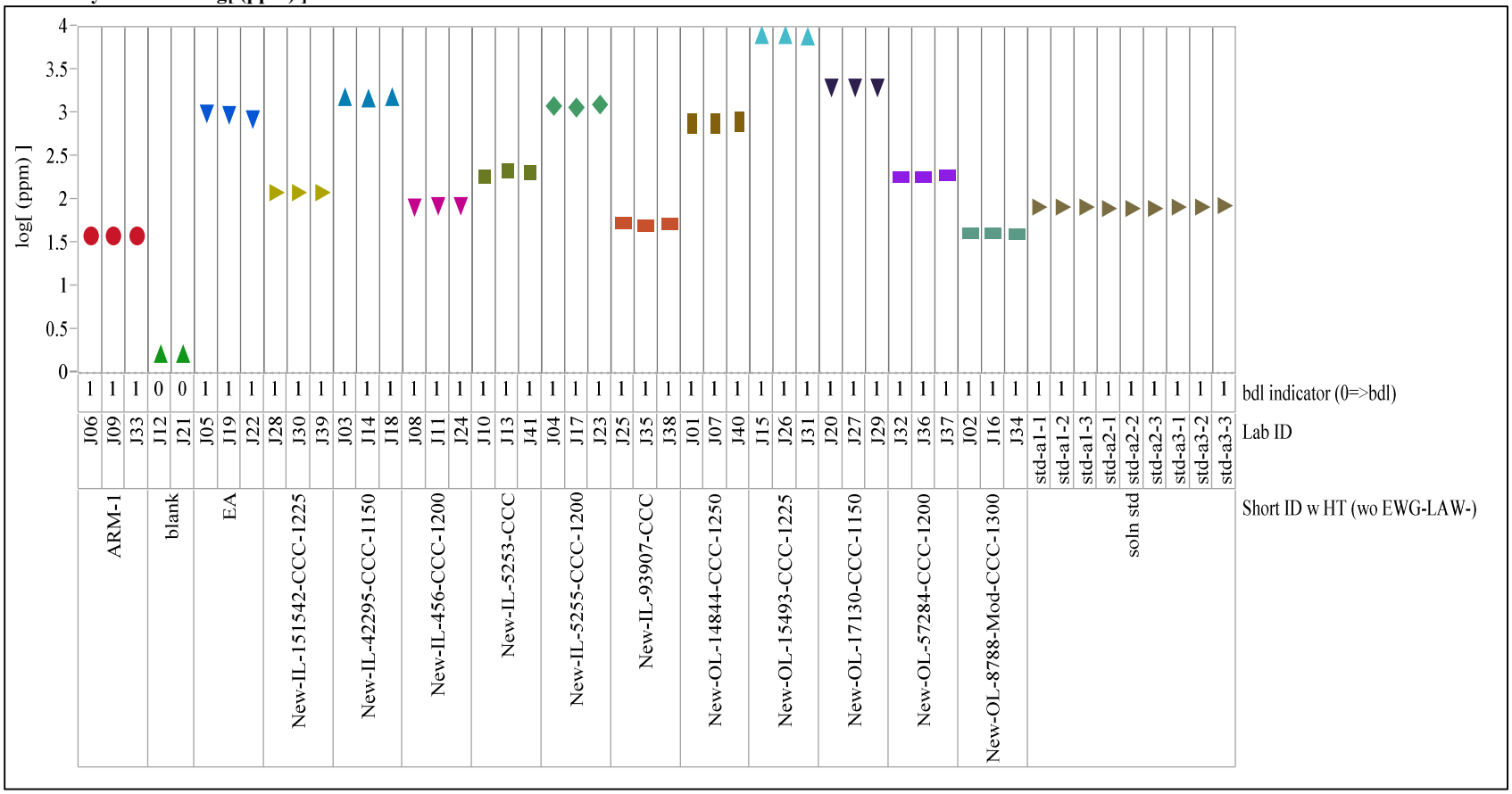


Exhibit B-2. PCT Measurements for Each Set of LAW Study Glasses (continued)

Set=Mar set 1, Analyte=Si
Variability Chart for log[(ppm)]

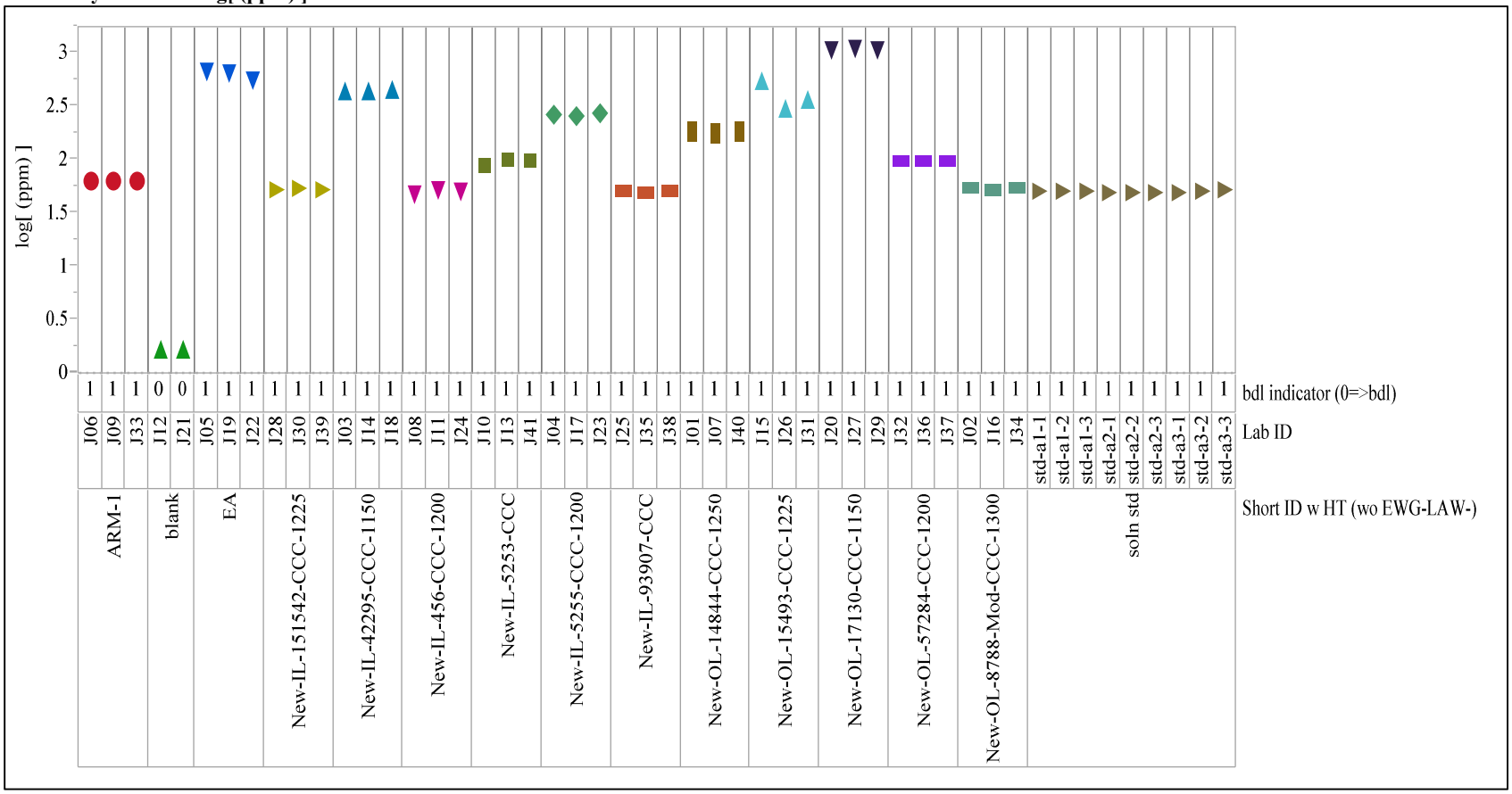


Exhibit B-2. PCT Measurements for Each Set of LAW Study Glasses (continued)

Set=Mar set 2, Analyte=B
Variability Chart for log[(ppm)]

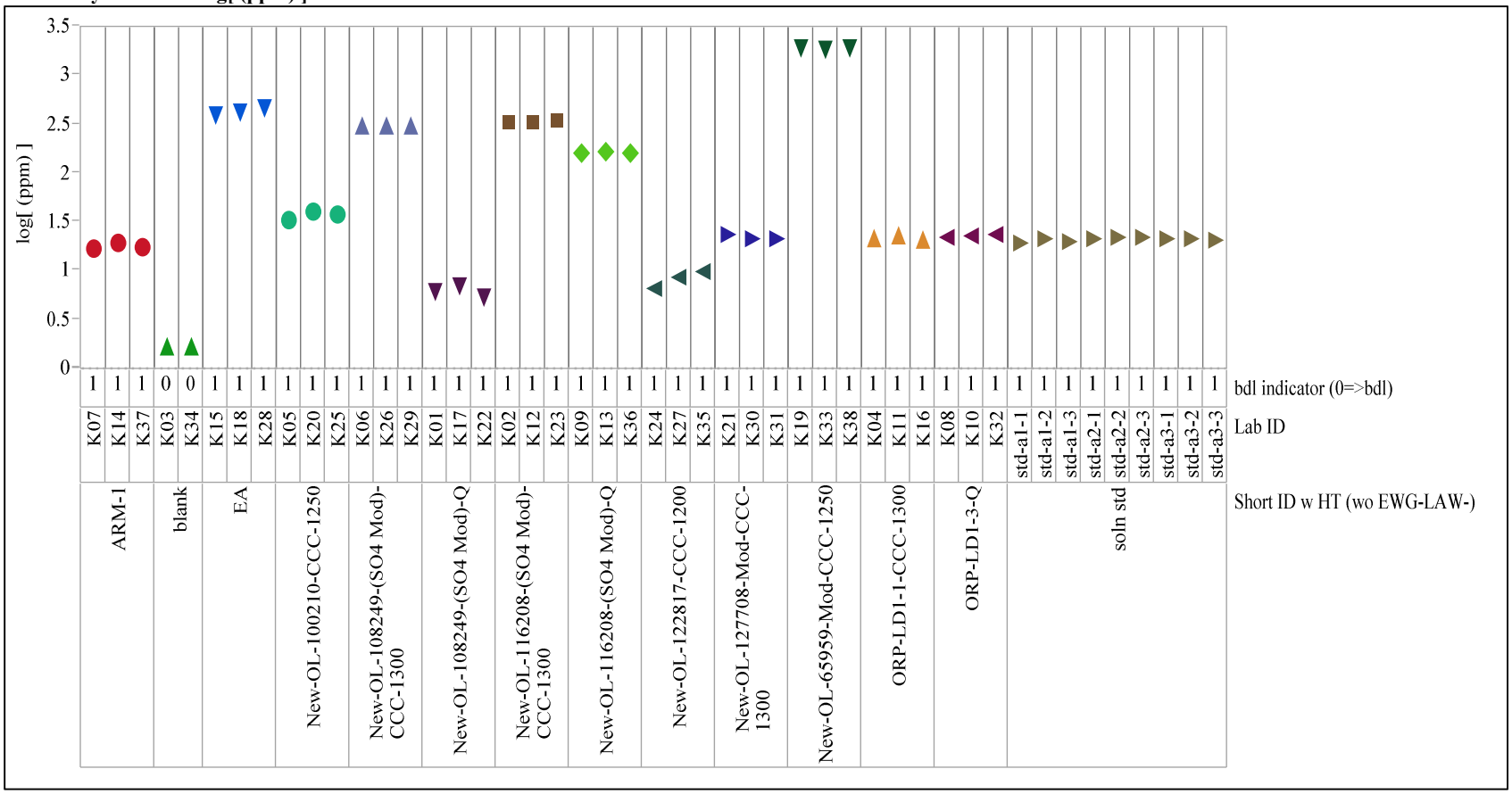


Exhibit B-2. PCT Measurements for Each Set of LAW Study Glasses (continued)

Set=Mar set 2, Analyte=Li
Variability Chart for log[(ppm)]

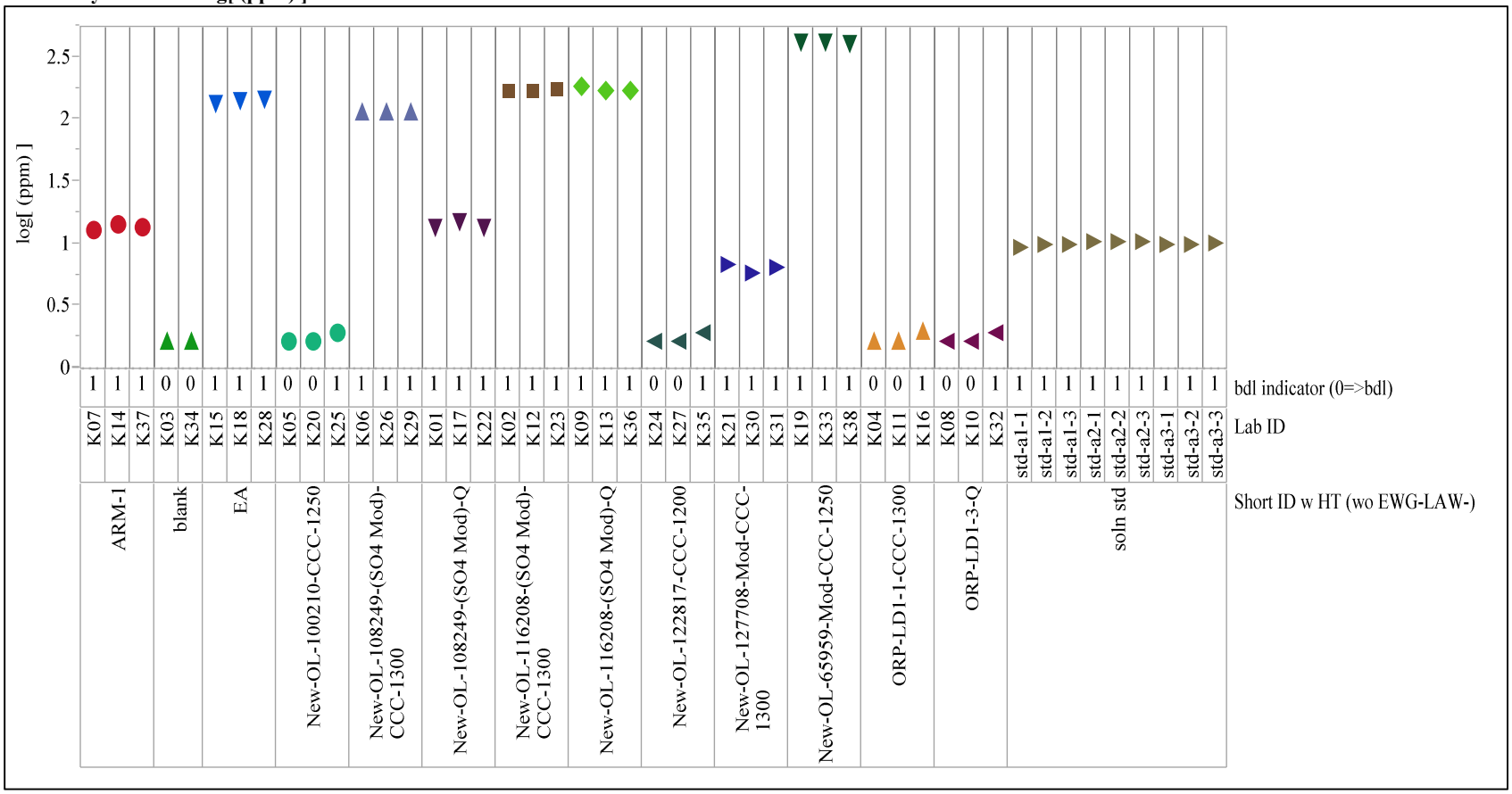


Exhibit B-2. PCT Measurements for Each Set of LAW Study Glasses (continued)

Set=Mar set 2, Analyte=Na
Variability Chart for log[(ppm)]

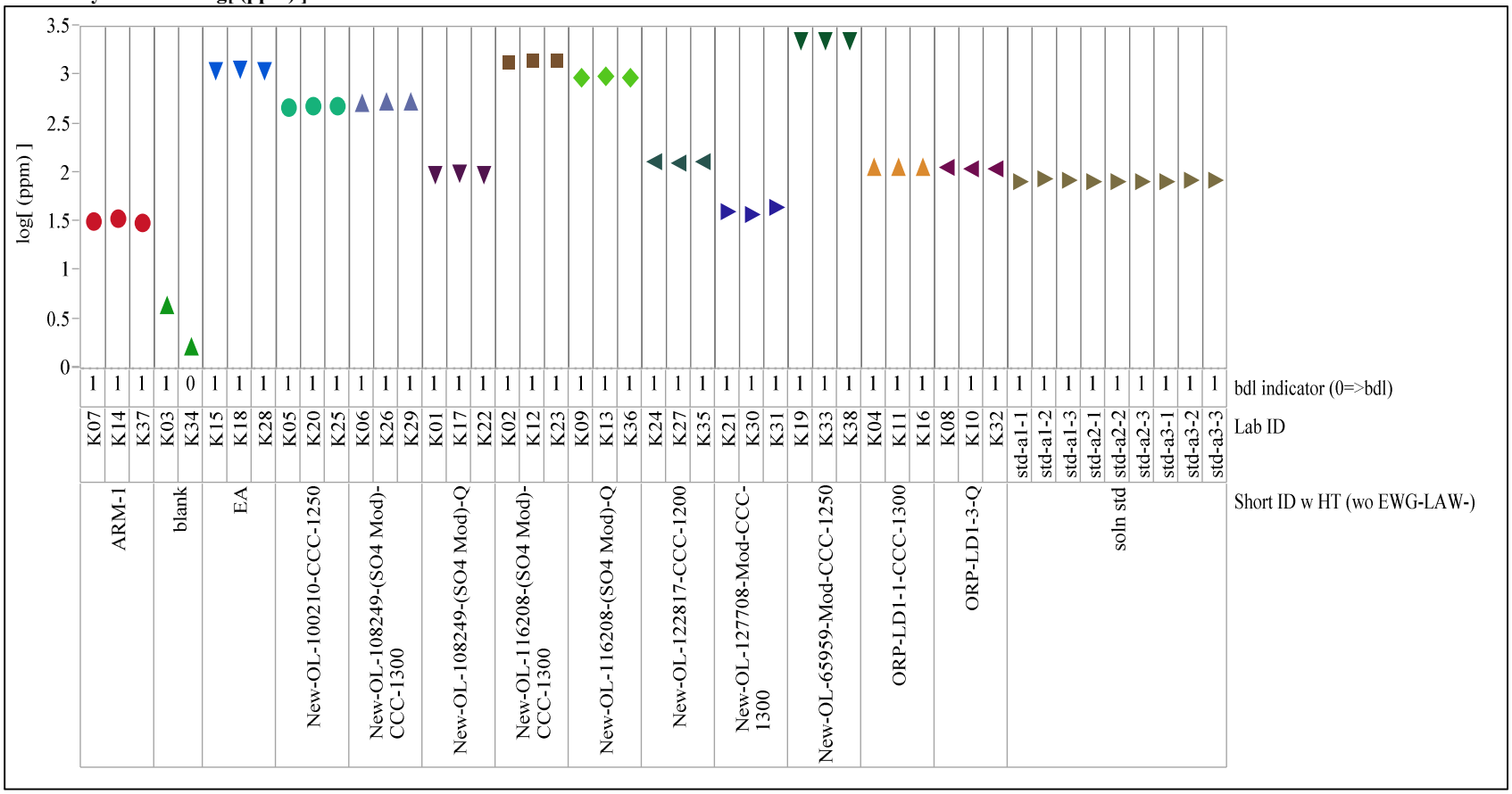


Exhibit B-2. PCT Measurements for Each Set of LAW Study Glasses (continued)

Set=Mar set 2, Analyte=Si
Variability Chart for log[(ppm)]

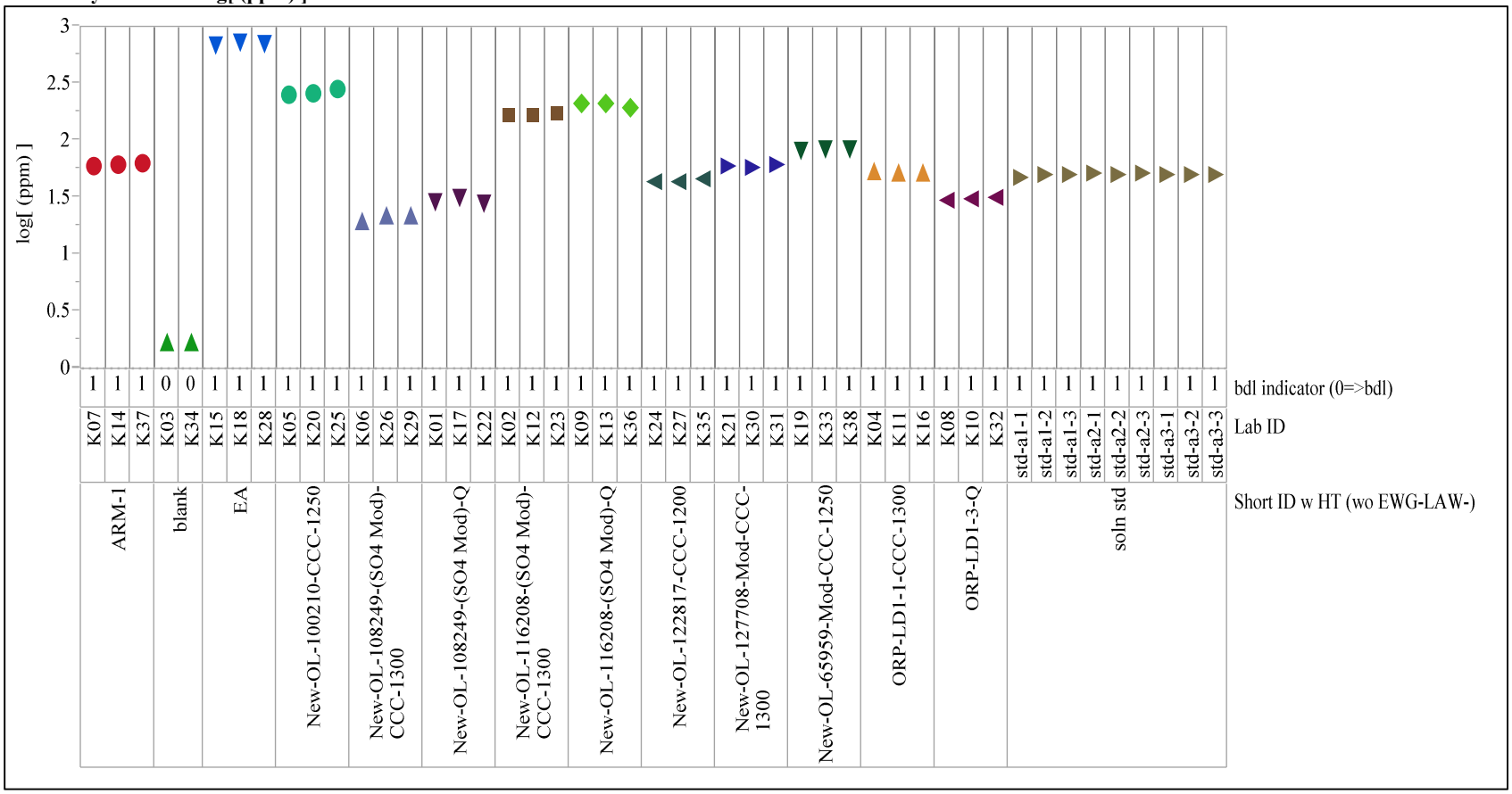


Exhibit B-2. PCT Measurements for Each Set of LAW Study Glasses (continued)

Set=April, Analyte=B
Variability Chart for log[(ppm)]

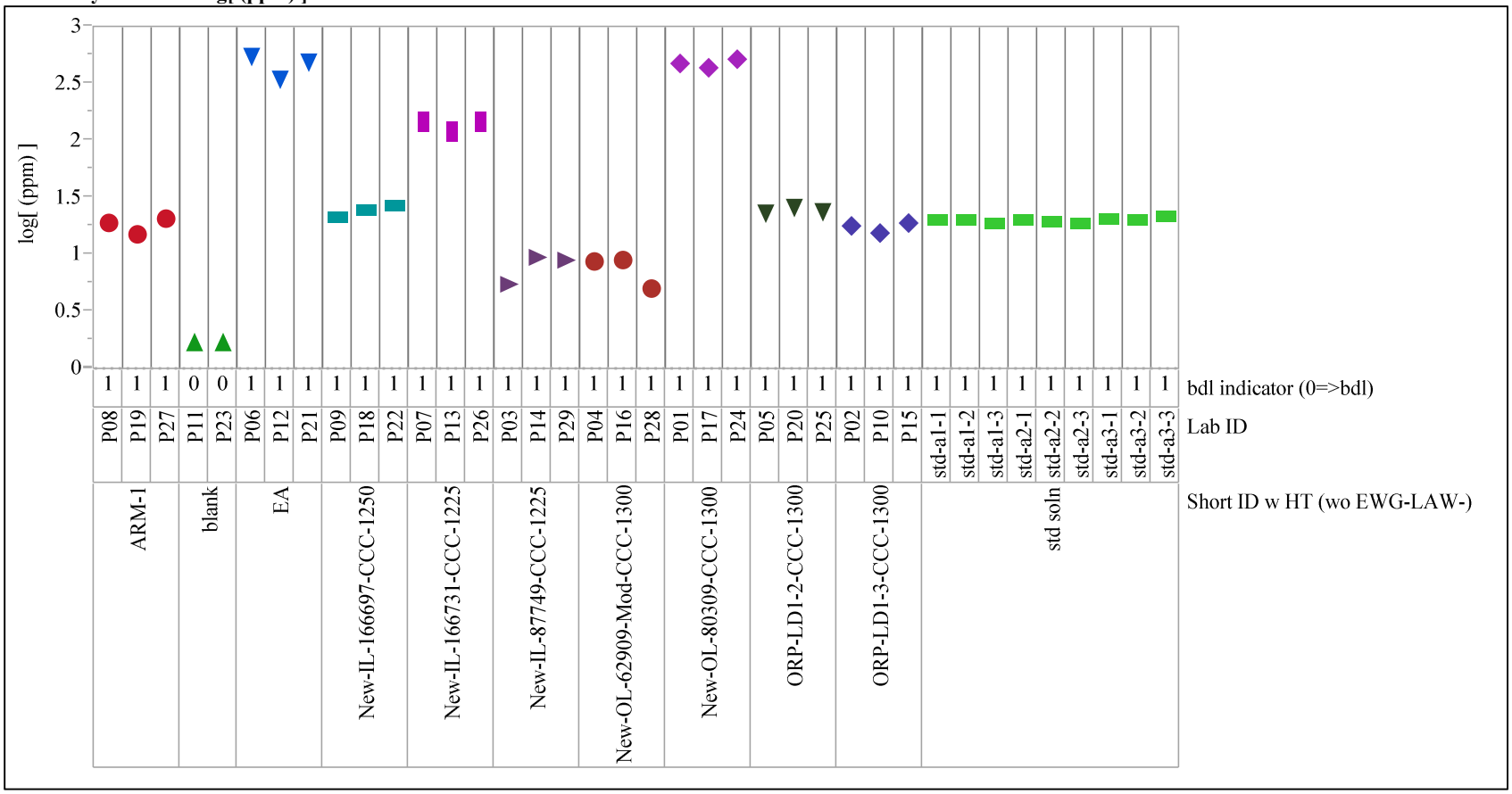


Exhibit B-2. PCT Measurements for Each Set of LAW Study Glasses (continued)

Set=April, Analyte=Li
Variability Chart for log[(ppm)]

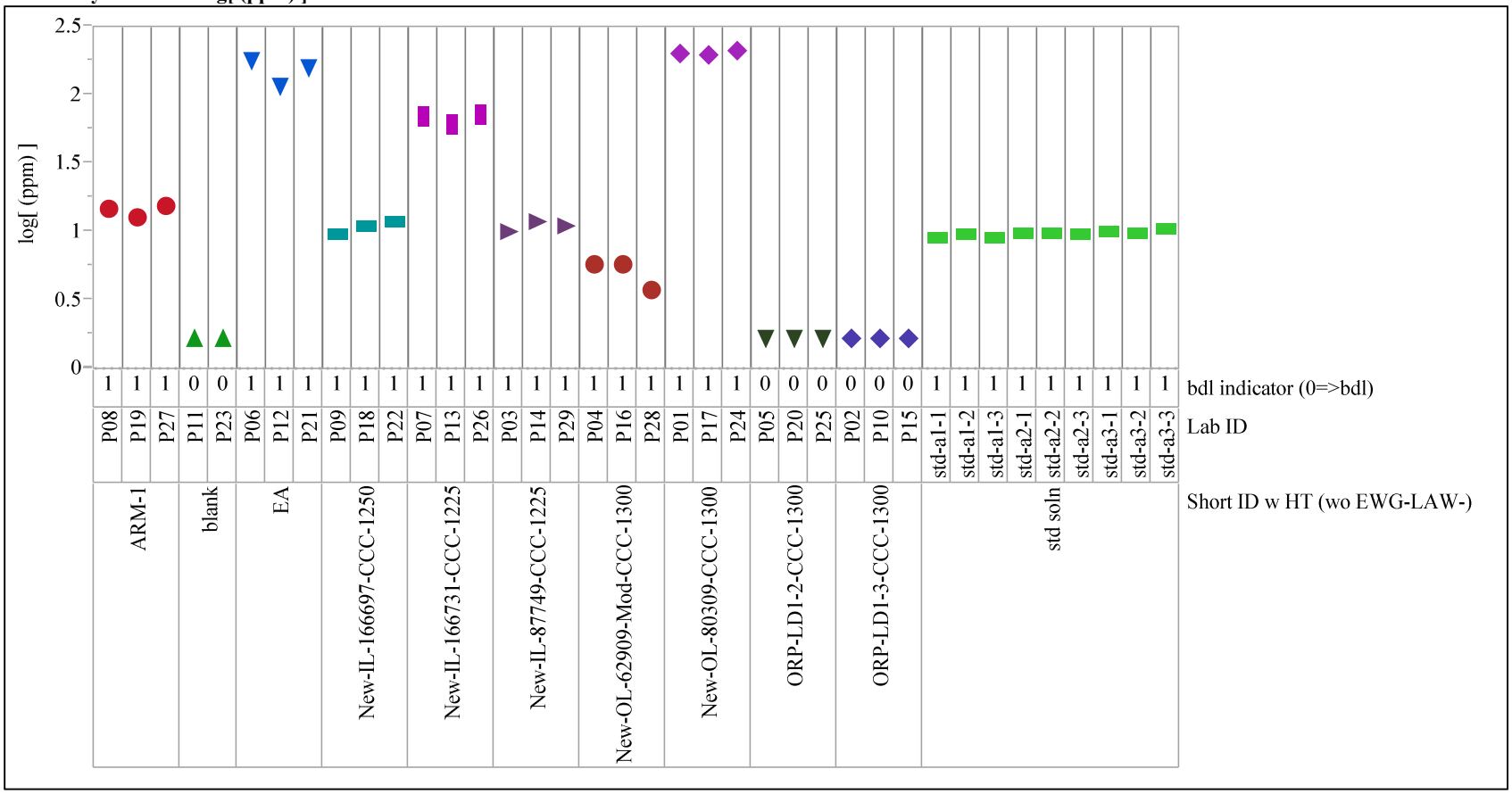


Exhibit B-2. PCT Measurements for Each Set of LAW Study Glasses (continued)

Set=April, Analyte=Na
Variability Chart for log[(ppm)]

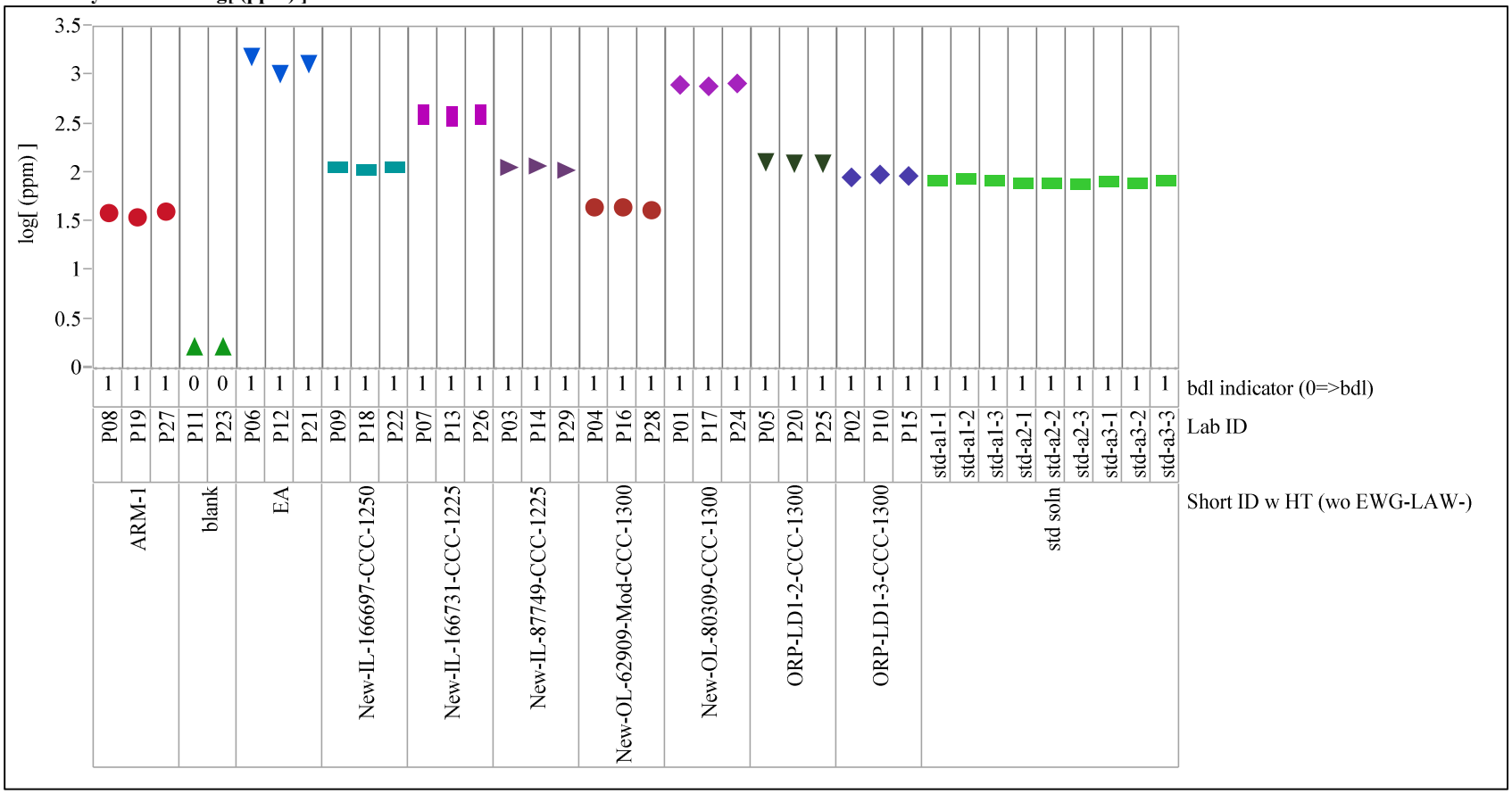


Exhibit B-2. PCT Measurements for Each Set of LAW Study Glasses (continued)

Set=April, Analyte=Si
Variability Chart for log[(ppm)]

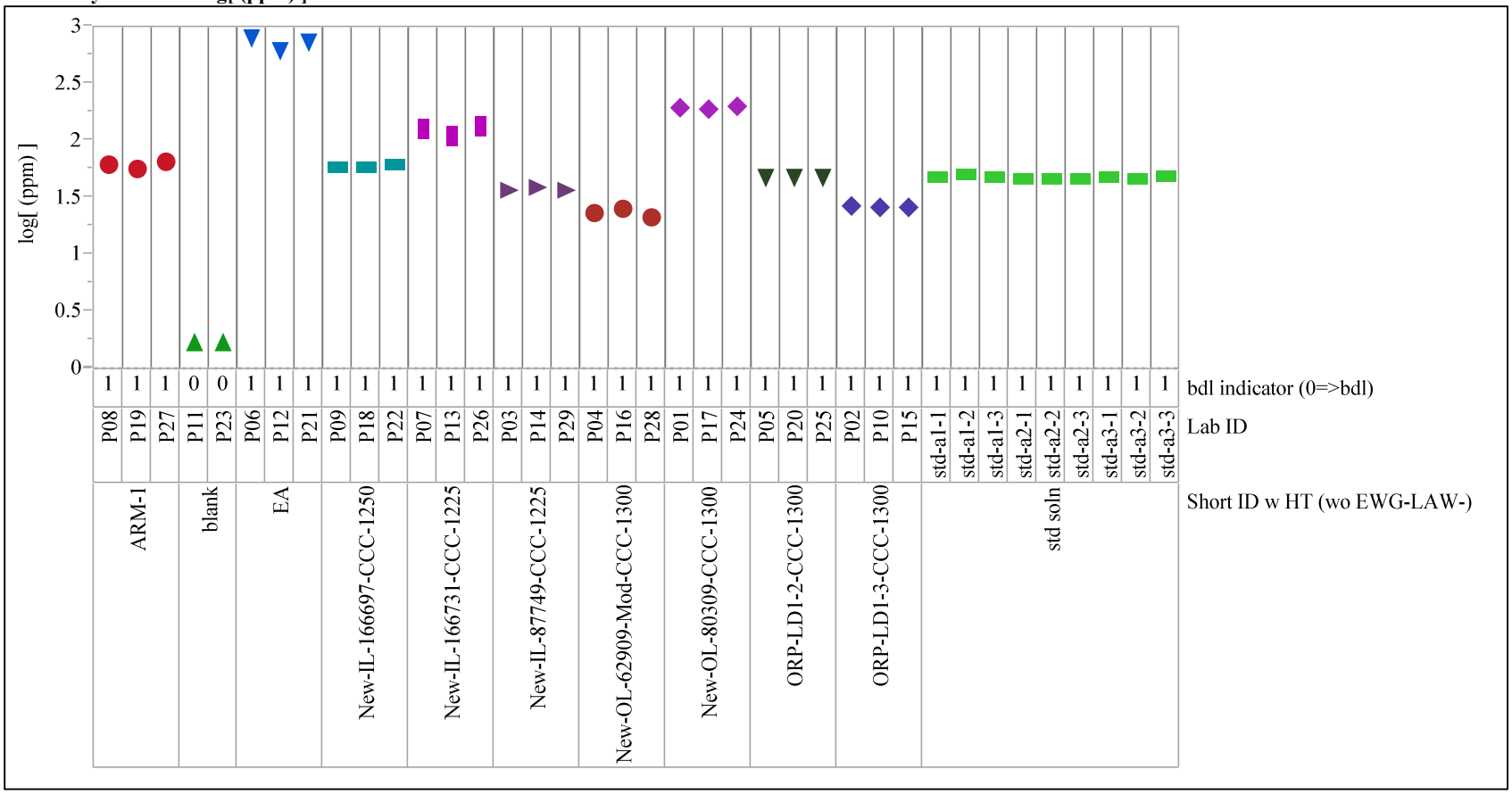


Exhibit B-3. Normalized PCT Results by Heat Treatment by Compositional View for Each Glass

PCT Set=January, Analyte=log NC_B (g/L)
Variability Chart for log *NC* (g/L)

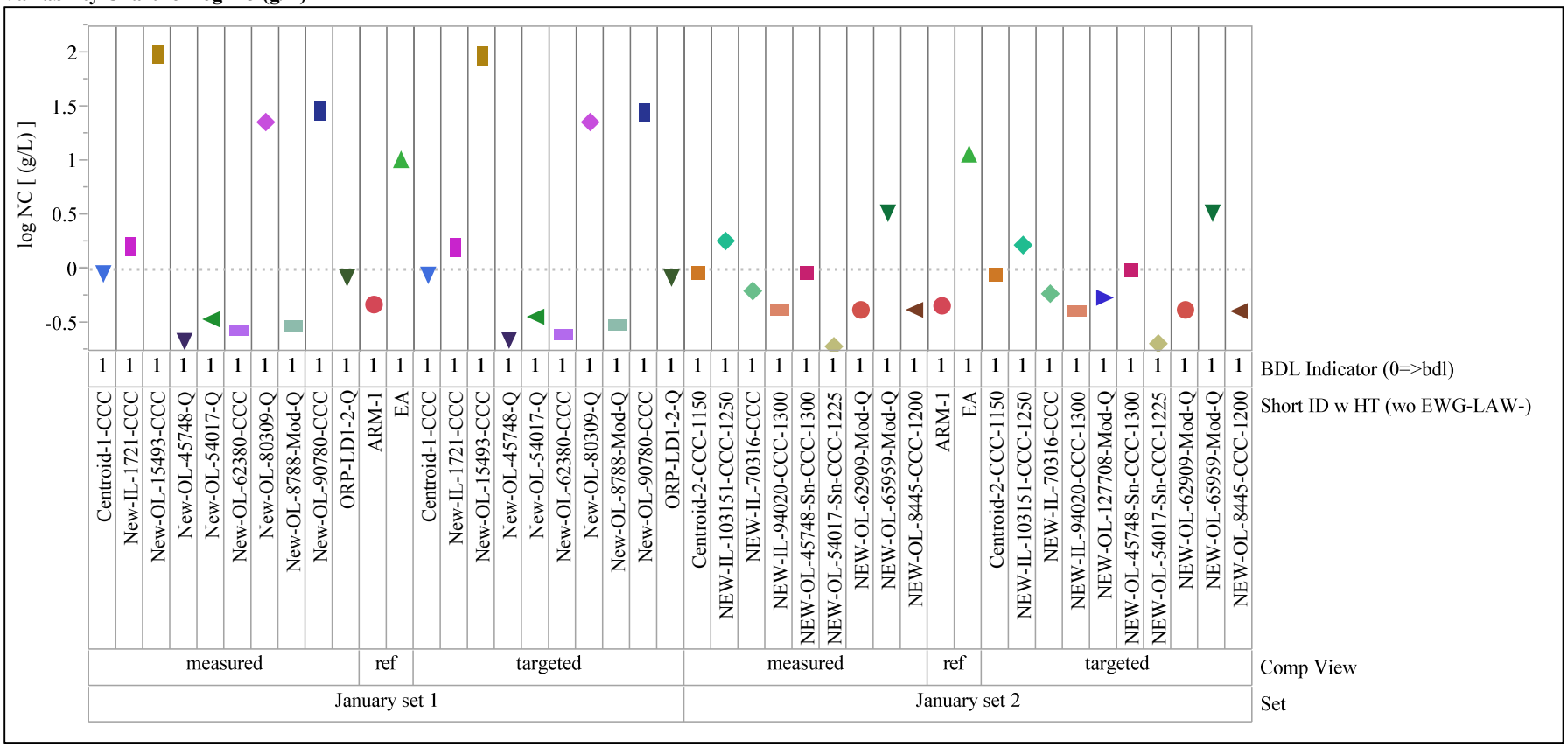


Exhibit B-3. Normalized PCT Results by Heat Treatment by Compositional View for Each Glass (continued)

PCT Set=January, Analyte=log NC_{Li} (g/L)
Variability Chart for log *NC* (g/L)

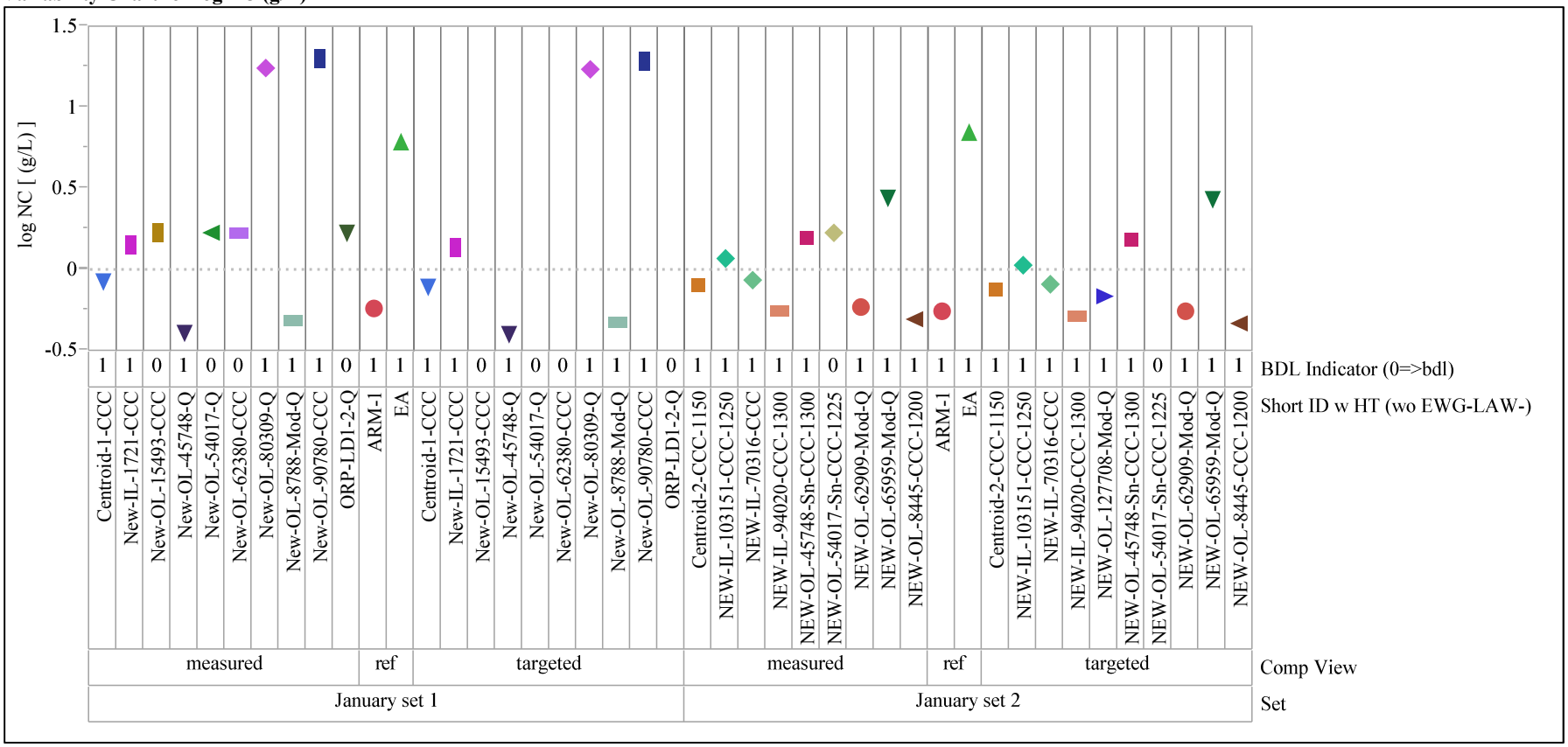


Exhibit B-3. Normalized PCT Results by Heat Treatment by Compositional View for Each Glass (continued)

PCT Set=January, Analyte=log NC_{Na} (g/L)
Variability Chart for log *NC* (g/L)

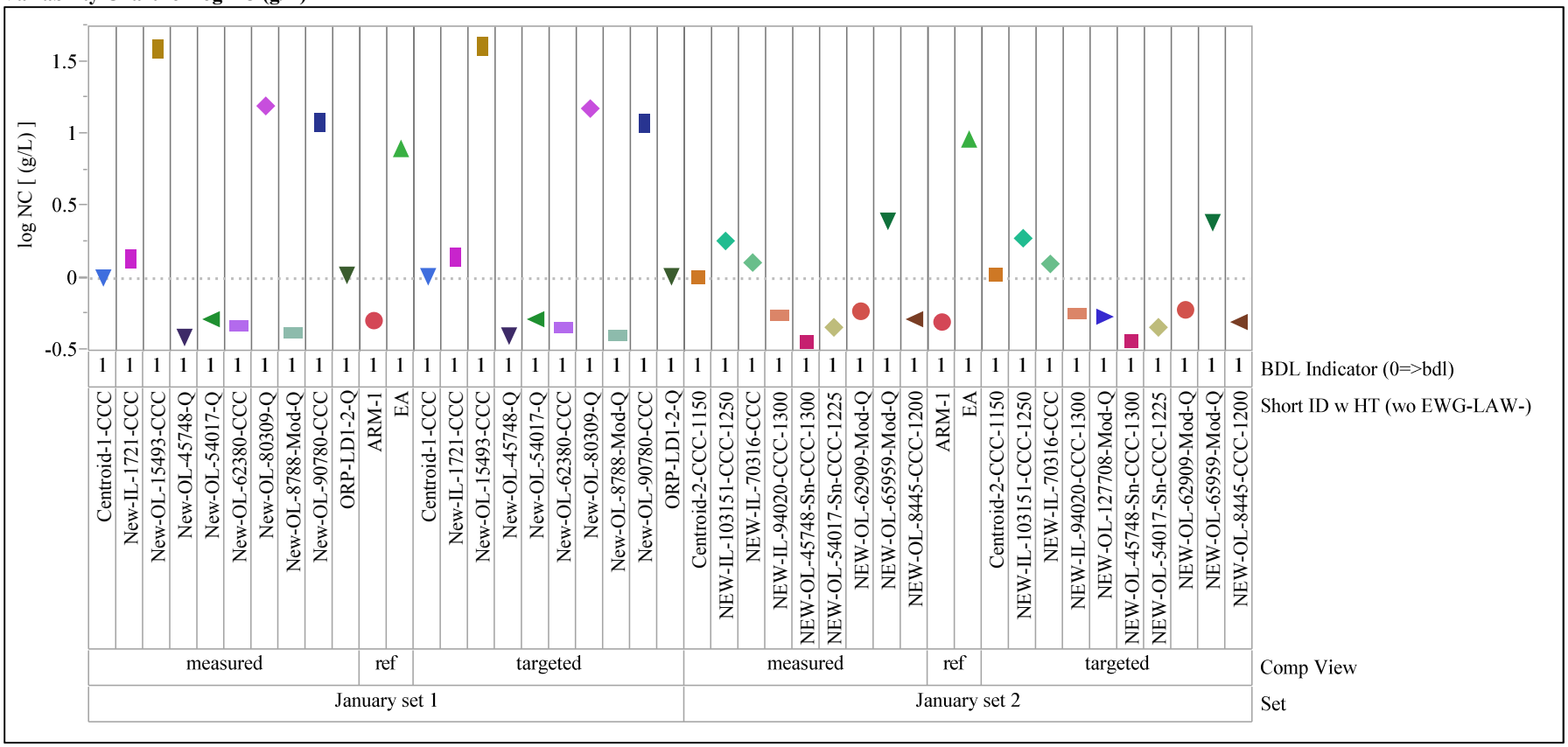


Exhibit B-3. Normalized PCT Results by Heat Treatment by Compositional View for Each Glass (continued)

PCT Set=January, Analyte=log NC_{Si} (g/L)
Variability Chart for log *NC* (g/L)

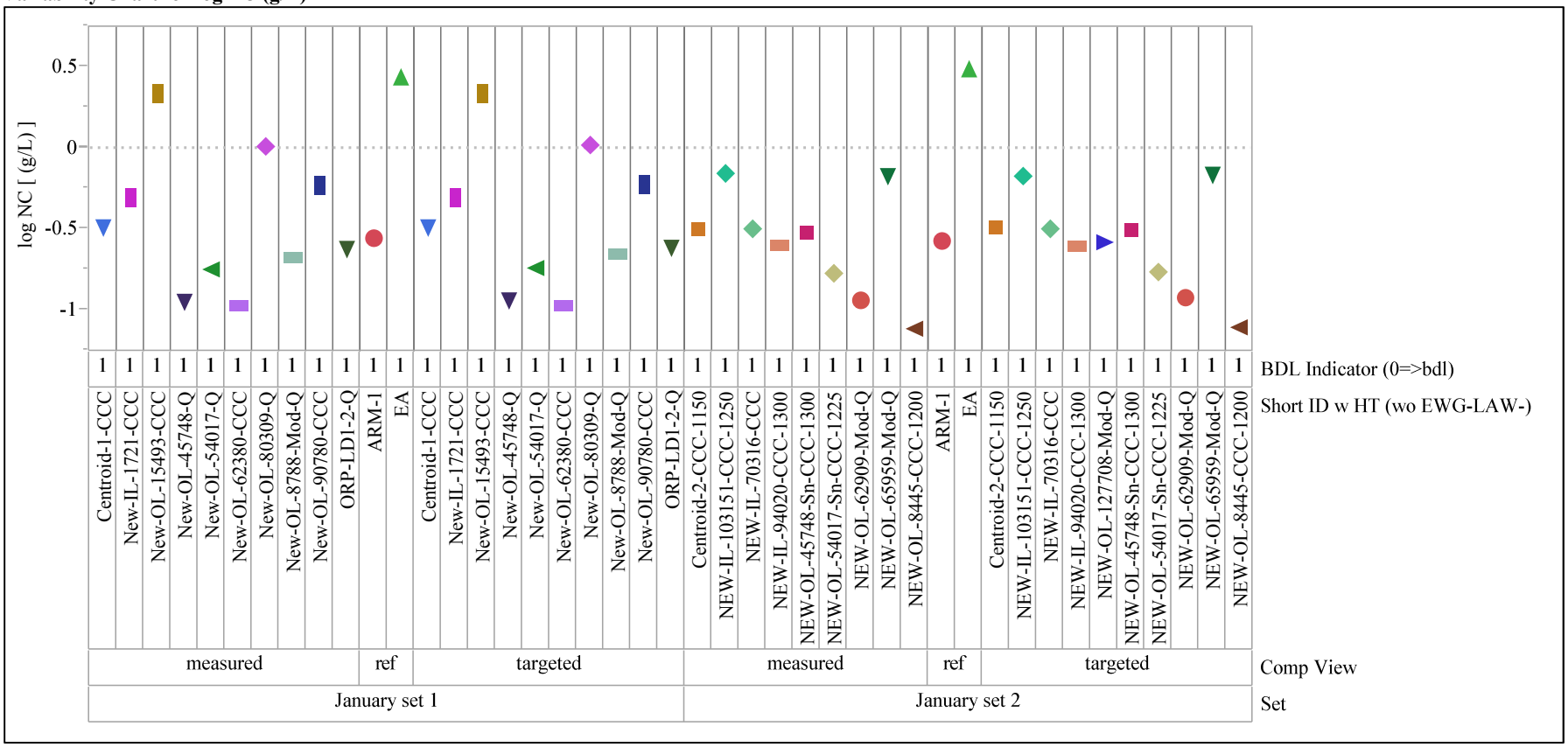


Exhibit B-3. Normalized PCT Results by Heat Treatment by Compositional View for Each Glass (continued)

PCT Set=March, Analyte=log NC_B (g/L)
Variability Chart for log *NC* (g/L)

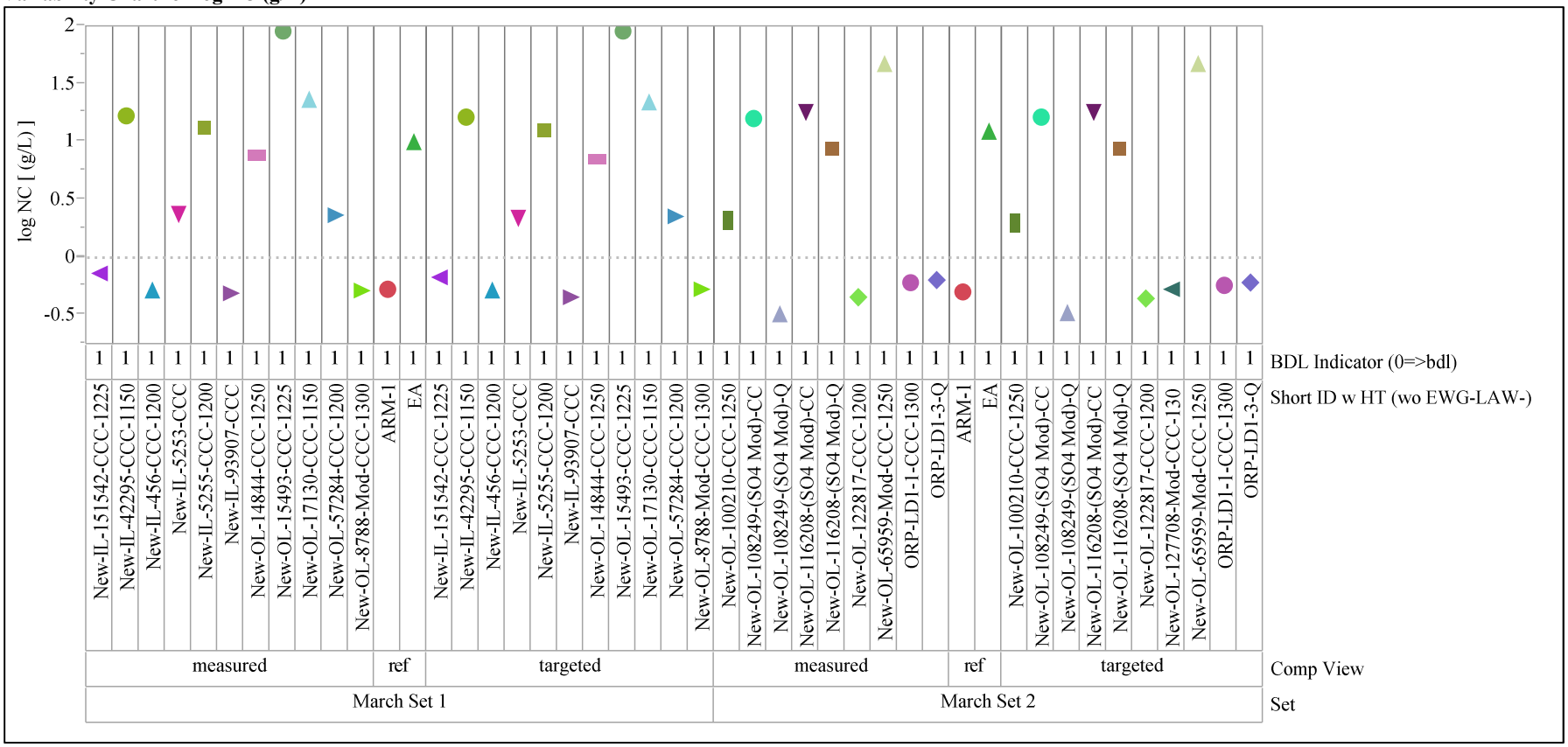


Exhibit B-3. Normalized PCT Results by Heat Treatment by Compositional View for Each Glass (continued)

PCT Set=March, Analyte=log NC_{Li} (g/L)
Variability Chart for log *NC* (g/L)

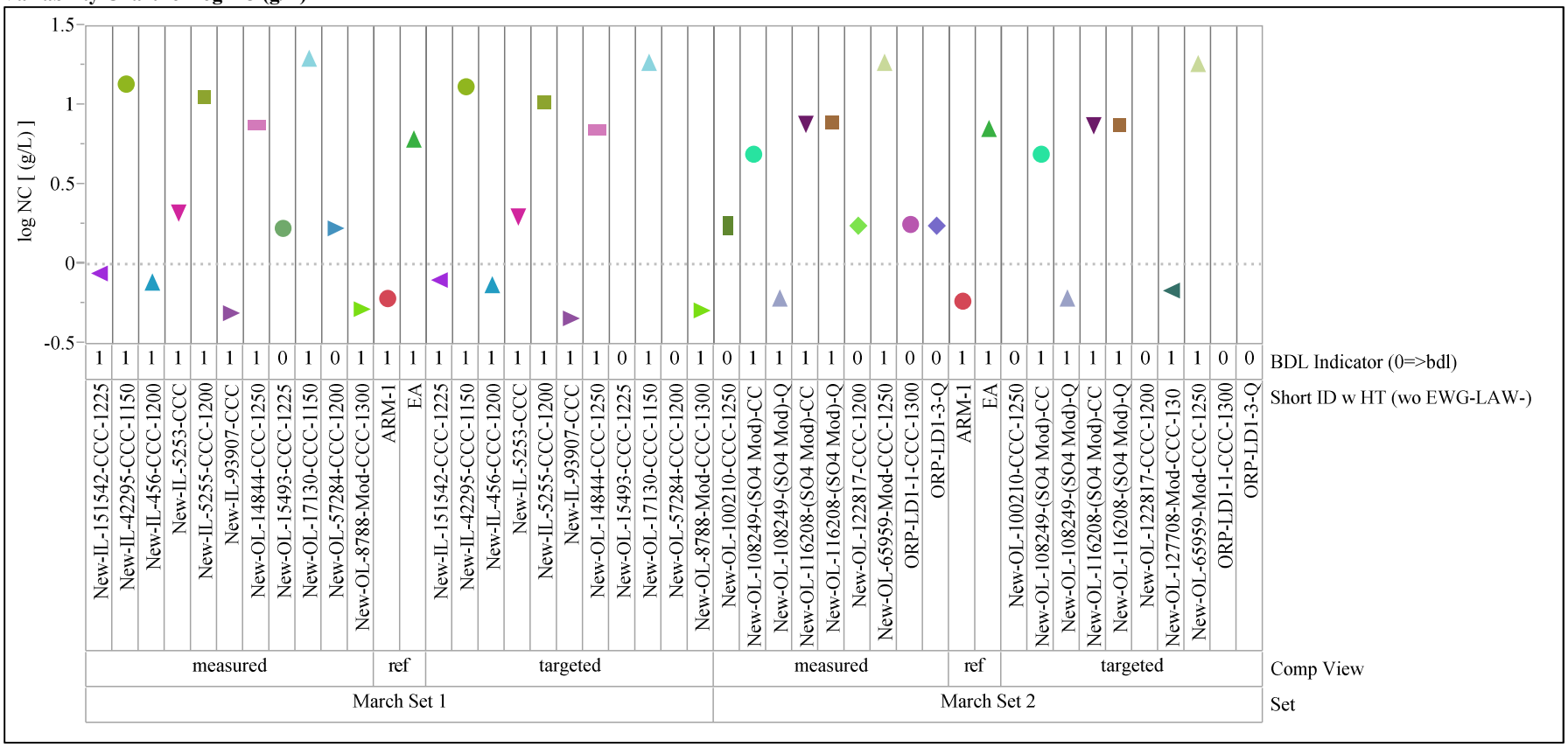


Exhibit B-3. Normalized PCT Results by Heat Treatment by Compositional View for Each Glass (continued)

PCT Set=March, Analyte=log NC_{Na} (g/L)
Variability Chart for log *NC* (g/L)

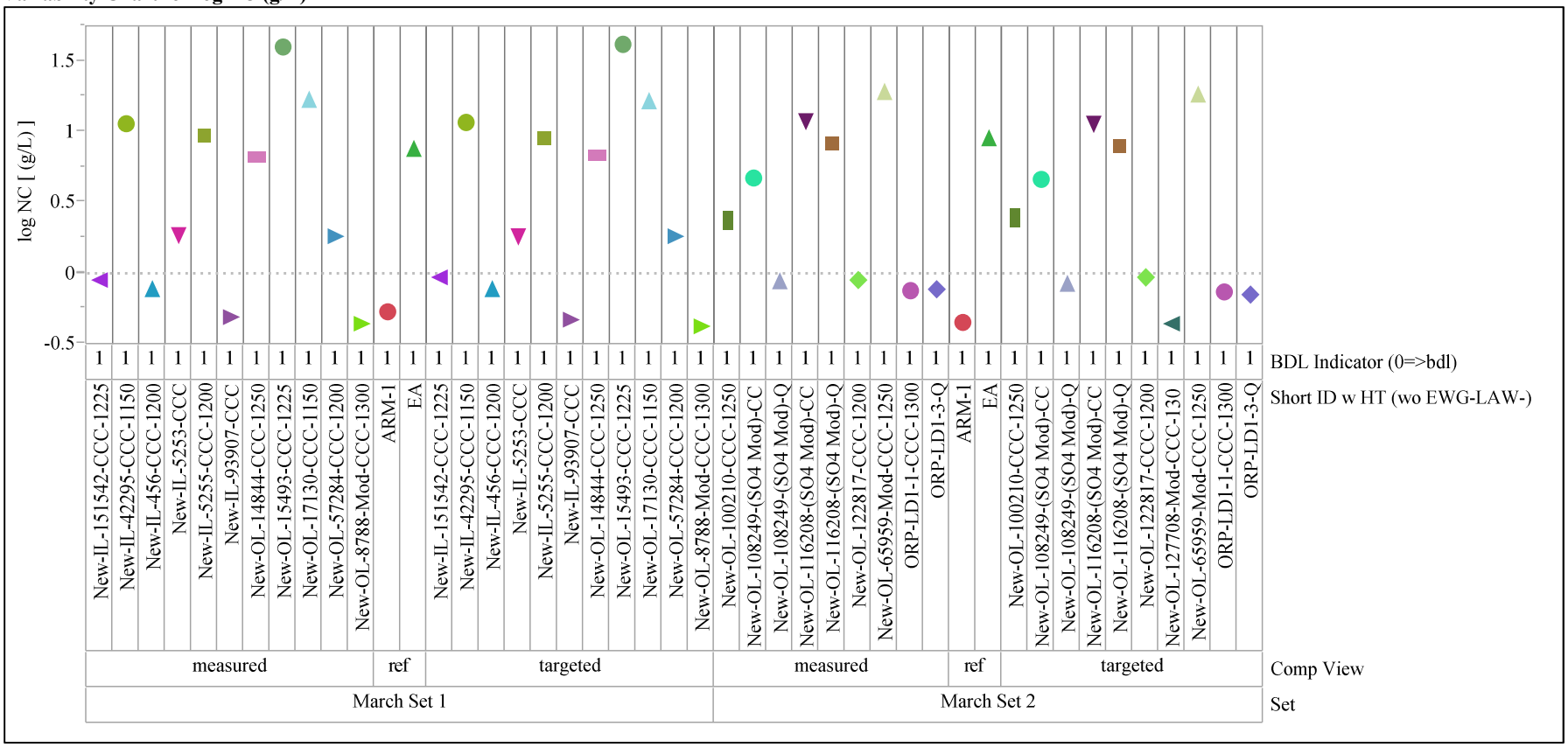


Exhibit B-3. Normalized PCT Results by Heat Treatment by Compositional View for Each Glass (continued)

PCT Set=March, Analyte=log NC_{Si} (g/L)
Variability Chart for log *NC* (g/L)

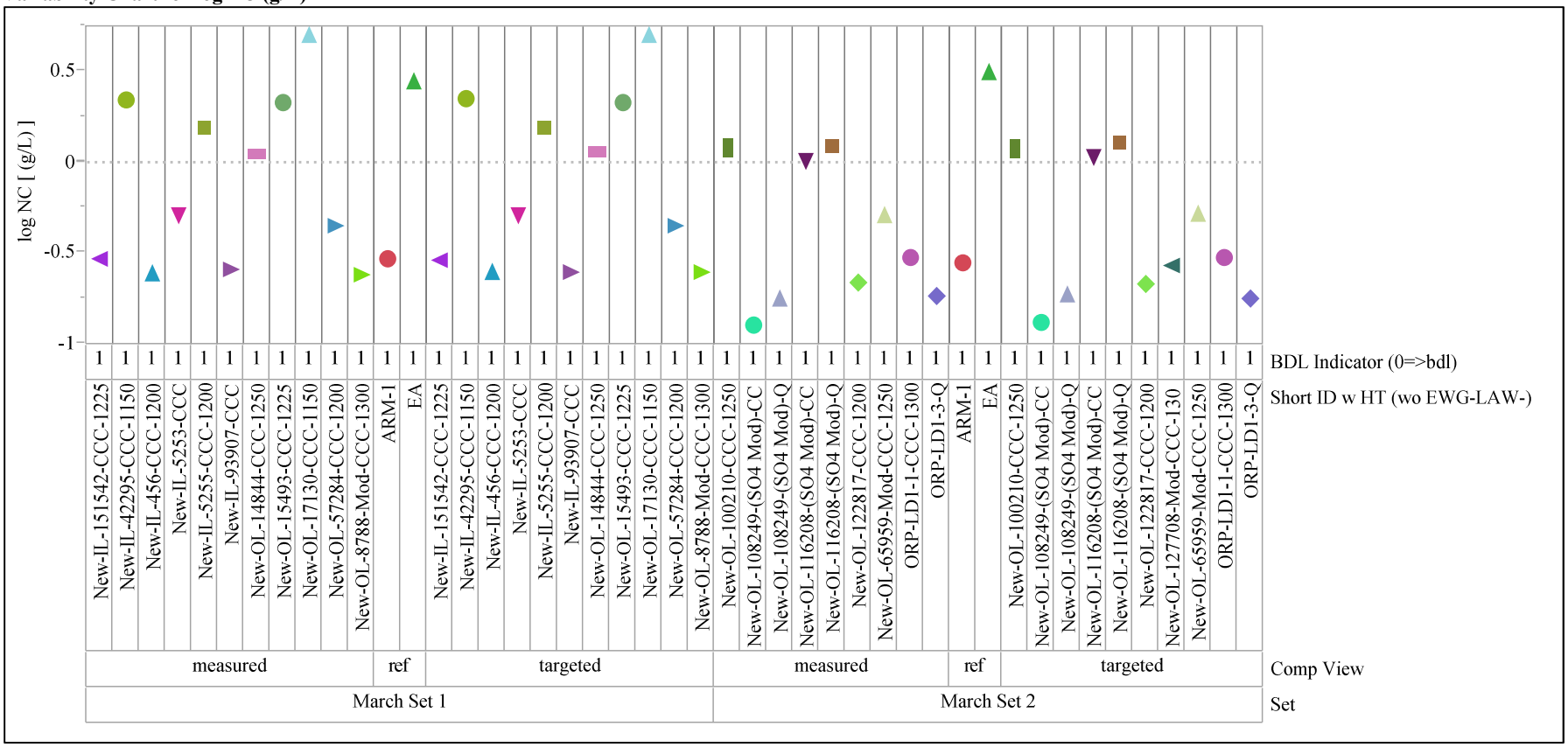


Exhibit B-3. Normalized PCT Results by Heat Treatment by Compositional View for Each Glass (continued)

PCT Set=April, Analyte=log NC_B (g/L)
Variability Chart for log *NC* (g/L)

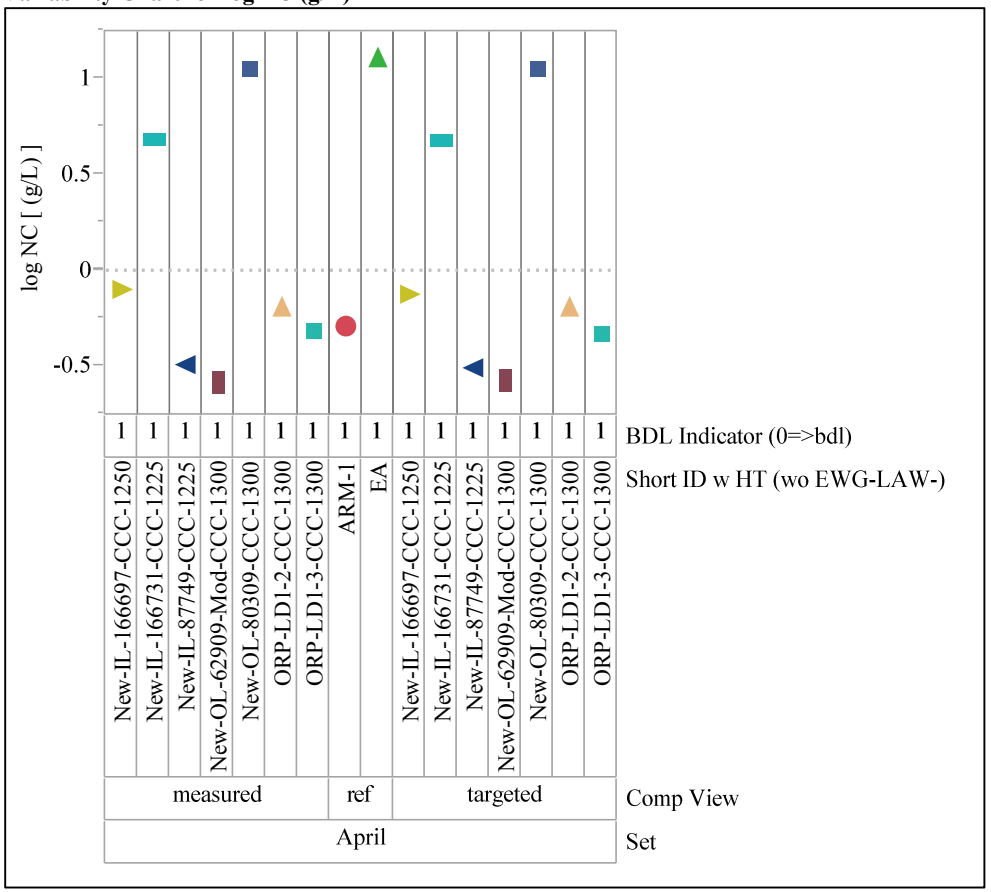


Exhibit B-3. Normalized PCT Results by Heat Treatment by Compositional View for Each Glass (continued)

PCT Set=April, Analyte=log NC_{Li} (g/L)
Variability Chart for log *NC* (g/L)

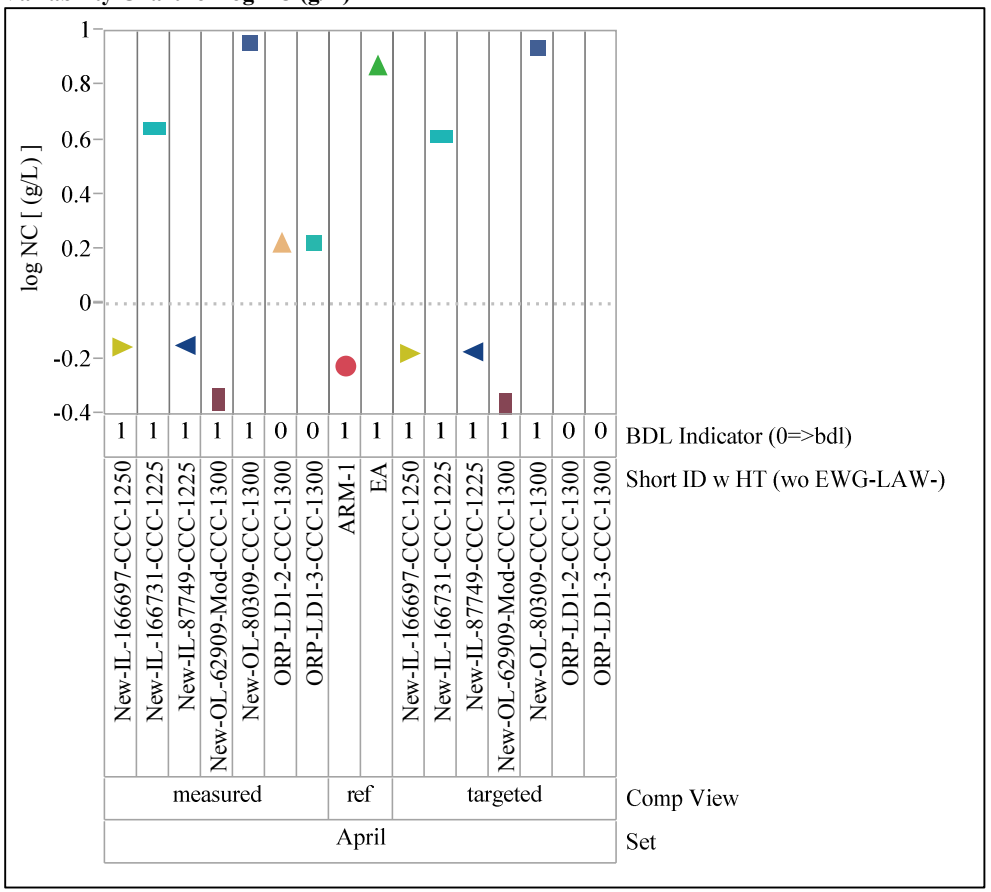


Exhibit B-3. Normalized PCT Results by Heat Treatment by Compositional View for Each Glass (continued)

PCT Set=April, Analyte=log NC_{Na} (g/L)
Variability Chart for log *NC* (g/L)

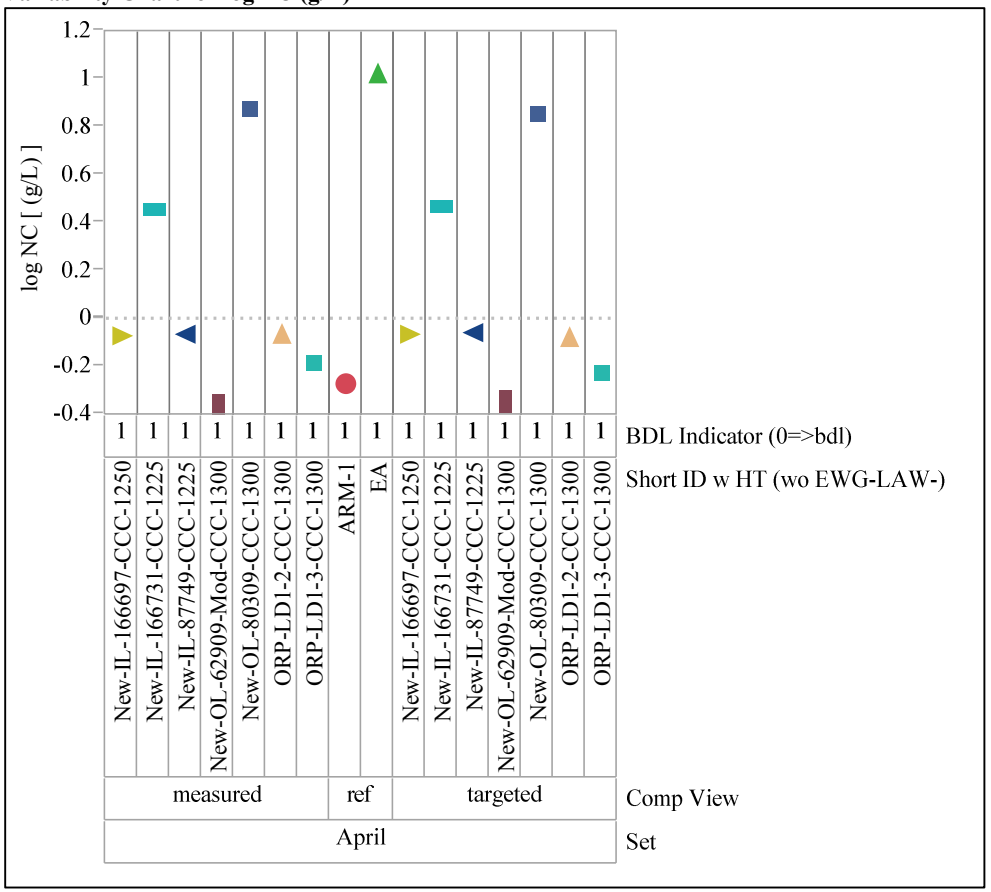
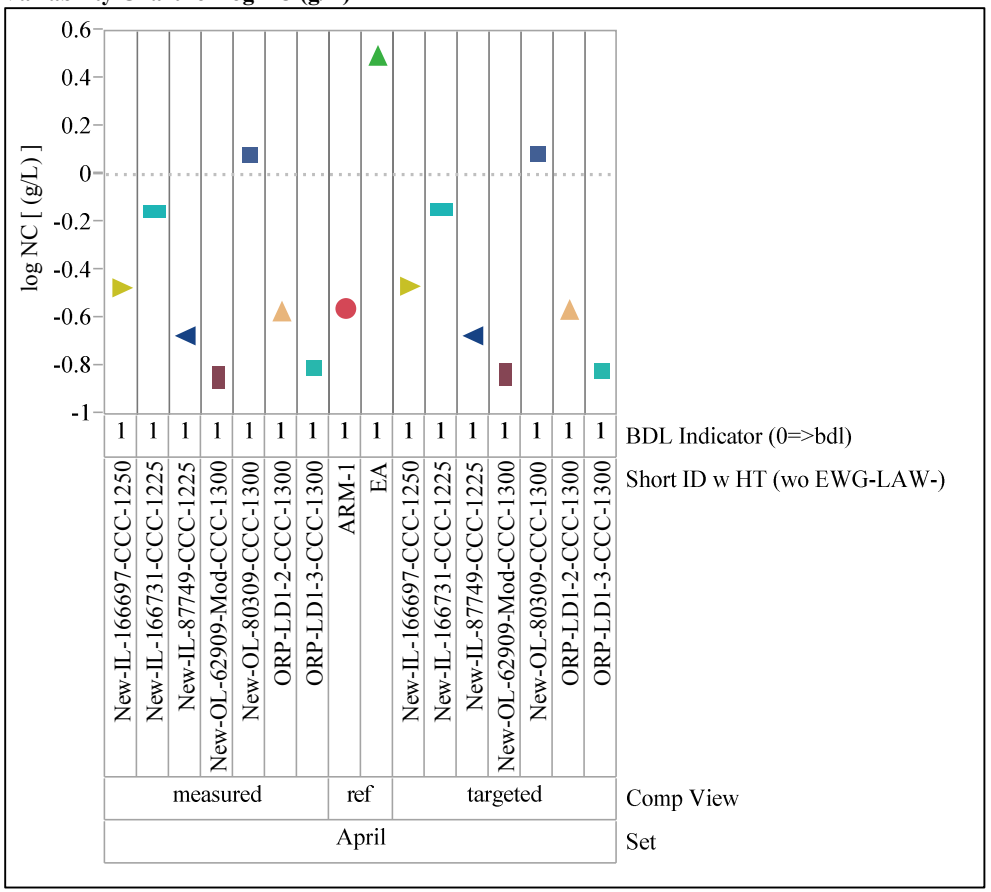


Exhibit B-3. Normalized PCT Results by Heat Treatment by Compositional View for Each Glass (continued)

PCT Set=April, Analyte=log NC_{Si} (g/L)
Variability Chart for log *NC* (g/L)



Distribution:

J. W. Amoroso, 999-W
T. B. Brown, 773-A
H. H. Burns, 773-41A
A. D. Cozzi, 999-W
C. L. Crawford, 773-42A
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
J. E. Hyatt, 773-A
C. M. Jantzen, 773-A
F. C. Johnson, 999-W
D. S. Kim, PNNL
A. A. Kruger, DOE-ORP
J. C. Marra, 999-2W
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)