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EXECUTIVE SUMMARY

In this report, the Savannah River National Laboratory (SRNL) provides chemical analyses and Product Consistency Test (PCT) results for a series of simulated high-level waste glass compositions fabricated by the Pacific Northwest National Laboratory (PNNL). These data will be used in the development of improved models for the prediction of nepheline crystallization in support of the Hanford Tank Waste Treatment and Immobilization Plant (WTP).

Chemical analyses were performed on a representative sample of each of the quenched glasses to allow for comparisons with the targeted compositions. Glass standards were intermittently measured to assess the performance of the analytical instruments over the course of these analyses. There were no issues with measurements of the glass standards. A review of the individual glass composition measurements identified no analytical issues of concern. Some degree of scatter among the Al_2O_3, B_2O_3, Na_2O, and SiO_2 measurements was noted. There were no indications of an error in preparation or measurement that had to be addressed in treatment of the data. Minor differences between the targeted and measured concentrations of some of the baseline glass components were noted, including some high values for CaO and Fe_2O_3, and some low values for Li_2O and Na_2O.

The PCT Method-A was performed in triplicate on each of the quenched and canister centerline cooled (CCC) versions of the glasses to assess chemical durability. A review of the leachate analyses and standard solution data identified no issues with the analytical methods. Normalized concentrations were calculated based on the targeted (provided by PNNL) and measured (quenched) compositions using the average of the common logarithms of the leachate concentrations. The compositional view (targeted or measured) had no practical impact on the PCT result for each of the study glasses. NP5-08 was the only quenched glass with a normalized concentration for boron (NC_B) value higher than the Enivironmental Assessment glass benchmark of 16.695 g/L. For several of the study glasses, the NC_B values were higher after the CCC heat treatment. For some of these glasses, the measured NC_{Si} values were inversely related to the change in NC_B.

It may be valuable for PNNL to perform a more complete review of the influence of composition and heat treatment on the PCT responses of the glasses described in this report to draw further conclusions, including any potential correlations with the methods used in selecting these glass compositions for study.

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LIST OF ABBREVIATIONS

ARM-1	Approved Reference Material
BDL	Below Detection Limit
CCC	Canister Centerline Cooled
DOE	U.S. Department of Energy
EA	Environmental Assessment
IC	Ion Chromatography
ICP-AES	Inductively Coupled Plasma – Atomic Emission Spectroscopy
HLW	High-Level Waste
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
SRNL	Savannah River National Laboratory
TTQAP	Task Technical and Quality Assurance Plan
wt %	Weight Percent
WTP	Hanford Tank Waste Treatment and Immobilization Plant
%RSD	Percent Relative Standard Deviation

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 program. 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.

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).[1] One of these areas is the development of advanced, predictive models for the crystallization of nepheline in glasses formulated at high alumina and soda concentrations.

The performance of HLW glass is generally quantified by its resistance to chemical degradation, or durability. The durability of a HLW glass is dependent upon its composition and its crystalline content. If crystalline phases form within a glass during cooling, the composition of the residual glass network is altered, potentially affecting the durability of the glass. Crystallization of nepheline ($NaAlSiO_4$) has been shown to adversely impact the durability of HLW glasses since it removes glass forming species (in this case, Al and Si) from the glass network.[2] The propensity for nepheline crystallization in a HLW glass increases with increasing concentrations of Al_2O_3 and Na_2O in the glass.[3] Nepheline crystallization is therefore of concern for processing of HLW at WTP since a significant fraction of Hanford tank wastes is rich in Al_2O_3 and Na_2O. The ability to correctly predict the formation of nepheline as a function of glass composition will allow WTP to maximize the loading of Al_2O_3 and Na_2O in glass while maintaining acceptable durability.

In this report, SRNL provides chemical analyses and Product Consistency Test (PCT) results for a series of simulated HLW glasses fabricated by Pacific Northwest National Laboratory (PNNL) as part of an ongoing nepheline crystallization study.[4] The glasses are described as the Phase 5 ORP Nepheline Study. The results of this effort will improve the ability to predict the impacts of glass composition and nepheline crystallization on the durability of HLW glasses.

2.0 Experimental Procedure

2.1 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. Laboratory data for this study were recorded in the SRNL Electronic Laboratory Notebook system, experiment C3489-00079-13.

2.2 Glasses Selected for Study

The glass compositions characterized in this report were selected and fabricated at PNNL.[a] Identifiers for each of the glasses are listed in Table 2-1. In addition, samples of the Environmental

[a] Refer to: J. Kroll, "EWG – Nepheline Phase 5 Batching and Melting," PNNL document EWG-TI-0044, 3/1/2017

Assessment (EA) reference glass were included for both composition analysis and durability testing. Samples of the EA glass included with earlier studies of HLW glasses developed as part of the ORP glass program exhibited durability responses that were lower than expected.[5-7] It was hypothesized that one of the sources of EA glass used at SRNL may be outside specification. Additional EA glass was included in the present study in an attempt to identify any potential issues.

In the sections that follow, the methods used for measuring chemical compositions of the glasses are described, the Product Consistency Tests are described, and reviews of the resulting data are provided. Detailed data from these analyses are included in the appendices.

Table 2-1. Identifiers for the Phase 5 ORP Nepheline Study Glasses

NP5-01	NP5-16
NP5-04	NP5-17
NP5-05	NP5-18
NP5-06	NP5-19
NP5-07	NP5-20
NP5-08	NP5-21
NP5-09	NP5-22
NP5-10	NP5-23
NP5-11	NP5-24
NP5-12	NP5-25
NP5-13	NP5-26
NP5-14	NP5-27
NP5-15	BL3

2.3 Glass Composition Analysis

Chemical analyses were performed under the auspices of an analytical plan[8] on a representative sample of each of the glasses listed in Table 2-1 to allow for comparisons with the targeted compositions. Three dissolution techniques, sodium peroxide fusion (PF),[9] lithium metaborate fusion (LM),[10] and potassium hydroxide fusion (KH),[11] were used for preparing each of the glass samples, in duplicate, for analysis.[a]

Each of the duplicate samples was analyzed twice for each element of interest by Inductively Coupled Plasma – Atomic Emission Spectroscopy (ICP-AES)[12] or ion chromatography (IC),[13] 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)[14] 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.[14] The preparation and measurement methods used for each of the reported glass components are listed in Table 2-2.

[a] Note that the analytical plan originally specified an acid digestion as part of the sample preparation process. The acid digestion was found to be producing incomplete dissolution of the glasses and was replaced by LM.

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

Analyte	Preparation Method	Measurement Method
Al	PF	ICP-AES
B	PF	ICP-AES
Bi	LM	ICP-AES
Ca	PF	ICP-AES
Cr	PF	ICP-AES
F	KH	IC
Fe	PF	ICP-AES
Li	PF	ICP-AES
Mn	PF	ICP-AES
Na	LM	ICP-AES
Ni	PF	ICP-AES
P	PF	ICP-AES
Pb	LM	ICP-AES
Ru	LM	ICP-AES
S	LM	ICP-AES
Si	PF	ICP-AES
Sr	LM	ICP-AES
Zr	PF	ICP-AES

2.4 Product Consistency Test

The PCT Method-A[15] was performed using three replicate samples of each of the quenched and WTP canister centerline cooled (CCC)[16] versions of the study glasses to assess chemical durability. Also included in the experimental test matrix was the Approved Reference Material (ARM-1) glass[17] and blanks from the vessel cleaning batch. Glass samples were ground, washed, and prepared according to the standard procedure.[15] Fifteen milliliters of Type-I ASTM water were added to 1.5 g of glass in stainless steel vessels. The vessels were closed, sealed, and placed in an oven at 90 ± 2 °C where the samples were maintained at temperature for 7 days (+/-2%). The vessels were then removed from the oven and cooled to ambient temperature. Once cooled, a small aliquot was drawn from each vessel and used to determine the ambient temperature pH of the leachate. The remaining solution from each vessel was sampled (filtered and acidified), then labeled and analyzed by ICP-AES under the auspices of an analytical plan.[8] Samples of a multi-element, standard solution[a] were also included in the analytical plan as a check on the accuracy of the ICP-AES instrument used for these measurements. Note that due to the large number of glasses in this study, the PCTs were divided into four groups, labelled (chronologically) as Group N, Group S, Group E, and Group Z. Normalized concentrations of B, Li, Na, and Si were calculated based on the targeted (provided by PNNL) and measured (quenched) compositions using the average of the common logarithms of the leachate concentrations.

3.0 Results and Discussion

3.1 Review and Evaluation of the Quenched Glass Composition Measurements

Table A-1 in Appendix A provides the elemental concentration measurements in weight percent (wt %) for the study glasses as prepared by the LM method. Table A-2 and Table A-3 in

[a] ICP multi-element custom solution, product number SM-744-013, High Purity Standards, Charleston, SC.

Appendix A provide 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 included in the tables of Appendix A. These unprocessed data are provided so that the values are readily available should they be of interest for future reviews.

In the sections that follow, the analytical sequences of the measurements are explored, the measurements of the LRM standard glass are investigated, the measurements for each glass are reviewed, the average chemical composition for each glass is determined, and comparisons are made between the measurements and the targeted compositions of the glasses. JMP™ Pro Version 11.2.1 (SAS Institute, Inc.)[18] 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 measurement 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 one or more concentration measurements that were below the associated detection limit (BDL) 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 the measurement data from Table A-1 through Table A-4 in Appendix A, with each plotted point identified by its Lab ID (from the analytical study plan). 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. Only minor, block-to-block calibration shifts are seen. For example, minor calibration effects are visible between the two sub-blocks within each analytical block for the Na_2O measurements. In all cases, the instrument check standards were within specification. These small calibration effects are typical of ICP-AES analyses and are mitigated by taking the average of the measurements for each analyte.

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. The symbols and colors used to represent each of the study glasses are consistent throughout the exhibits. 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. Some degree of scatter among the Al_2O_3, B_2O_3, Na_2O, and SiO_2 measurements was noted for the study glasses. There were no indications of 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.[12] The review is in the form of plots 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 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 Table A-1 through Table A-4 in Appendix A) 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. The following observations are offered from a review of these plots:

- The measured concentrations of CaO are above the targeted values for those glasses targeting concentrations above about 3 wt %.
- The measured concentrations of fluorine are low for most of the study glasses, perhaps due to volatility during melting.
- The measured Fe_2O_3 values are higher than the targeted concentrations for all of the study glasses, but the measured value for the LRM glass is close to the target.
- The measured Li_2O and Na_2O values are somewhat lower than the targeted concentrations for most of the study glasses.
- The measured P_2O_5 concentrations are low for several of the study glasses.
- The measured ZrO_2 concentrations are low for some of the study 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 the measured sums of oxides for the study glasses fall within the interval of 96.4 to 102.5 wt %, indicating acceptable recovery of the glass 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] The highlighted cells are consistent with the observations noted above regarding the measured CaO, Fe_2O_3, and Na_2O concentrations for the study glasses.

The measured oxide concentrations for the EA glass were similar for the two samples (EA1 and EA2), and were also close to the results of the multiple analyses reported in developing this reference glass.[19] Thus, the chemical composition analyses yielded no apparent cause for the lower than expected PCT results observed in recent studies,[5-7] as discussed earlier in Section 2.2.

3.2 Review and Evaluation of PCT Measurements

Table B-1 in Appendix B provides the elemental leachate concentration measurements for the solution samples generated by the PCTs for the study glasses and standards. The values for these measurements are given in the table as-received ("ar") from the laboratory analyses. To adjust for the dilution factors, the measurements for the study glasses, blanks, and the ARM-1 glass were multiplied by 1.6667 to determine the values in mg/L. The measurements for the EA glass were multiplied by 16.667.

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

Based on the masses of the PCT vessels before and after the 7-day procedures, excess water was inadvertently added to one of the three PCT vessels for glass NP5-16-CCC (shown shaded in Table B-1). The leachate from this vessel was measured but was excluded from the PCT normalization calculations. The analyses of the leachates from the remaining two vessels were used to determine the normalized PCT response for this glass. There were no issues with loss of water from any of the vessels during the PCTs.

The ratio of leachant volume to the mass of ground glass was confirmed to be correct for each vessel (except for one of the three vessels for glass NP5-16-CCC as described above). The measured concentrations of B, Li, Na, and Si in the leachates from the ARM glasses were compared to the control charts to demonstrate proper performance of the PCTs.[17] Two of the triplicate B values from the Group N PCTs, one of the triplicate B values from the Group S PCTs, and one of the triplicate B values from the Group E PCTs fell above the limits of the control chart. These values are highlighted in Table B-1. All the measured Li, Na, and Si concentrations in the ARM glass leachates fell within the limits of the control charts. The expectation is that an error in the performance of a PCT would result in a consistent divergence of the concentrations of the analytes of the ARM glass away from the limits of the control charts. Since there were no consistent issues with the ARM values for any of the four sets of PCTs, the tests were considered to have been performed properly and no bias correction was performed.

The measured, ambient temperature pH values for each of the PCT leachates are provided in Table B-2 through Table B-5 of 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 PCT results for each glass are determined, and comparisons are made between the PCT results for the two heat treatments of each glass. JMP Pro Version 11.2.1 (SAS Institute, Inc.)[18] was used to support these analyses.

3.2.1 Treatment of Detection Limits

Some of the "ar" measurements (Table B-1 in Appendix B) were below the analytical detection limits. 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 leachate values. Those elements with measured concentrations that were below the associated detection limit will be denoted with a less than symbol (<) as the normalized leachate values are reported.

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

Table B-6 and Table B-7 in Appendix B provide 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 B-6 and Table B-7 satisfy these criteria, and thus, the results for the standard suggest no significant issues with the analytical outcomes for the measurements of the PCT solutions.

3.2.3 Measurements in Analytical Sequence

Exhibit B-1 in Appendix B provides plots of the common logarithms of the leachate concentrations (mg/L) in analytical sequence by analytical block by analytical group. Each of the analytical groups corresponds to an oven run that was used to conduct the PCT measurements needed to support the analyses of the study glasses. Plotting the data in this format provides an opportunity to identify gross trends in performance of the analytical instrument within and among calibration blocks. No issues were observed in a review of 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 of each of the study glasses and for the standards for each analytical set. These plots are in common logarithms of the mg/L values and allow for the assessment of the repeatability of the measurements for each glass. For some of the glasses, minor scatter among the triplicate values of some analytes is observed. A closer look at the quenched and CCC outcomes is provided in the following sections.

3.2.5 Normalization of the PCT Results

The PCT leachate data were used to determine normalized concentrations for each element of interest using both the targeted and measured (quenched) compositions of the glasses following the expression given in ASTM C1285:

$$NC_i = \frac{c_i\left(sample\right)}{f_i}$$

where NC_i is the normalized concentration in units of $g_{waste\ form}/L_{leachant}$, c_i is the concentration of element "*i*" in the leachate in units of g_i/L, and f_i is the mass fraction of element "*i*" in the unleached glass in units of g_i/g_{glass}.[a]

An equation was developed to allow for calculation of the NC_i values using the units of measurement provided with the analytical results for this study, and to accommodate the triplicate leachate measurements for each of the study glasses. Note that the symbols in this second equation were kept consistent with those used in ASTM C1285, but the units of measurement differ. The common logarithm of the normalized concentration for each element "*i*" (NC_i) for each of the study glasses was determined using the equation:

$$\log_{10}\left(NC_i\right) = \overline{\log_{10} c_i} - \left[1 + \log_{10}\ f_i\right]$$

where NC_i remains in units of $g_{waste\ form}/L_{leachant}$, $\overline{\log_{10} c_i}$ is the average of the common logarithms of the measured concentrations of element "*i*" in the triplicate leachates in units of mg/L, and $\log_{10}\ f_i$ is either the common logarithm of the targeted concentration of element "*i*" in the glass in units of wt %, or the common logarithm of the average measured concentration of element "*i*" in the glass in units of wt % (from Table A-5 of Appendix A). The calculated NC_i values are discussed further in the following sections.

[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.

3.2.6 Effects of Heat Treatments

Exhibit B-3 in Appendix B provides plots of the normalized PCT responses for the quenched and CCC versions of each of the study glasses as well as the responses for EA and ARM-1. The results are grouped by compositional view. 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 quenched and CCC versions of each study glass. Table 3-1 provides a listing of the normalized PCT responses in g/L.

A review of the PCT data resulted in the following observations:

- The use of either the targeted or measured compositions in calculating the normalized concentration values has little if any practical effect.
- Some of the CCC versions of the study glasses have NC_B values that are higher than the EA benchmark NC_B value of 16.695 g/L.[19] NP5-08 is the only quenched glass with an NC_B value higher than the EA benchmark.
    - The CCC version of glass NP5-11 had the highest NC_B value, 84.7 g/L based on normalization to the targeted composition.
- The effect of heat treatment on the PCT results can be categorized into three groups:
    - For several of the study glasses, the NC_B values were higher after the CCC heat treatment. The measured NC_{Li} and NC_{Na} values followed this same trend. However, the measured NC_{Si} values were inversely related to the change in NC_B. Examples include glasses BL3, NP5-10, and NP5-16.
    - For several of the study glasses, heat treatment had little practical effect on the measured PCT responses. Examples include glasses NP5-01, NP5-07, and NP5-14.
    - Glass NP5-11 had higher NC_i values for all four of the analytes after the CCC heat treatment.

The NC_B values for EA2 were within one standard deviation of the mean (or reference) value of 16.695 g/L.[19] One of the measured NC_B values for EA1 was close to the reference value (16.678 g/L), while the other measured value was not (10.667 g/L). The cause of this inconsistent and lower than expected PCT response remains unclear, but may be the result of previously identified REDOX sensitivity of the EA glass. The source of the EA1 material will be discarded in the hope of avoiding future issues.

PNNL may wish to perform a more complete review of the influence of composition and heat treatment on the PCT responses of the glasses described in this report to draw further conclusions, including any potential correlations with the methods used in selecting these glass compositions for study.

Table 3-1. Normalized PCT Results

Group	Glass ID	Heat Treatment	Comp. View	NC_B (g/L)	NC_{Li} (g/L)	NC_{Na} (g/L)	NC_{Si} (g/L)
E	ARM-1	ref	ref	0.680	0.560	0.489	0.280
N	ARM-1	ref	ref	0.778	0.548	0.472	0.265
S	ARM-1	ref	ref	0.617	0.582	0.524	0.264
Z	ARM-1	ref	ref	0.543	0.588	0.517	0.294
E	EA1	ref	measured	16.678	9.421	11.964	3.661
N	EA1	ref	measured	10.667	6.252	7.084	2.509
E	EA1	ref	ref	17.085	8.451	11.903	3.640
N	EA1	ref	ref	10.927	5.608	7.049	2.495
S	EA2	ref	measured	16.902	10.232	13.814	3.605
Z	EA2	ref	measured	15.825	9.954	12.988	3.840
S	EA2	ref	ref	17.736	9.205	13.938	3.589
Z	EA2	ref	ref	16.605	8.955	13.104	3.823
N	BL3	CCC	measured	5.103	3.527	2.075	0.213
N	BL3	CCC	targeted	5.562	3.454	1.947	0.218
N	BL3	quenched	measured	1.498	1.599	1.108	0.447
N	BL3	quenched	targeted	1.632	1.566	1.040	0.458
N	NP5-01	CCC	measured	1.130	< 1.667	1.025	0.188
N	NP5-01	CCC	targeted	1.123	NA	0.967	0.195
N	NP5-01	quenched	measured	1.084	< 1.667	1.021	0.207
N	NP5-01	quenched	targeted	1.077	NA	0.964	0.215
N	NP5-04	CCC	measured	2.217	2.045	1.315	0.336
N	NP5-04	CCC	targeted	2.257	1.935	1.210	0.330
N	NP5-04	quenched	measured	1.808	1.724	1.162	0.359
N	NP5-04	quenched	targeted	1.840	1.631	1.069	0.352
N	NP5-05	CCC	measured	0.673	0.762	0.581	0.232
N	NP5-05	CCC	targeted	0.673	0.728	0.519	0.242
N	NP5-05	quenched	measured	0.893	0.979	0.749	0.233
N	NP5-05	quenched	targeted	0.892	0.935	0.670	0.242
N	NP5-06	CCC	measured	3.152	2.707	1.612	0.389
N	NP5-06	CCC	targeted	3.014	2.512	1.472	0.392
N	NP5-06	quenched	measured	2.700	2.422	1.448	0.370
N	NP5-06	quenched	targeted	2.582	2.248	1.323	0.373
N	NP5-07	CCC	measured	3.039	3.260	2.374	0.245
N	NP5-07	CCC	targeted	3.323	2.958	2.276	0.244
N	NP5-07	quenched	measured	2.176	2.392	1.900	0.261
N	NP5-07	quenched	targeted	2.380	2.170	1.822	0.260

Table 3-1. Normalized PCT Results (continued)

Group	Glass ID	Heat Treatment	Comp. View	NC_B (g/L)	NC_{Li} (g/L)	NC_{Na} (g/L)	NC_{Si} (g/L)
N	NP5-08	CCC	measured	19.641	10.206	13.971	0.031
N	NP5-08	CCC	targeted	18.985	9.358	12.876	0.031
N	NP5-08	quenched	measured	24.030	13.288	17.336	< 0.019
N	NP5-08	quenched	targeted	23.227	12.184	15.978	< 0.019
S	NP5-09	CCC	measured	2.694	2.531	1.965	0.299
S	NP5-09	CCC	targeted	2.597	2.222	1.767	0.301
S	NP5-09	quenched	measured	1.996	1.974	1.622	0.305
S	NP5-09	quenched	targeted	1.925	1.733	1.458	0.306
S	NP5-10	CCC	measured	49.369	62.838	6.844	0.025
S	NP5-10	CCC	targeted	52.605	55.893	6.418	0.026
S	NP5-10	quenched	measured	0.387	0.560	0.526	0.154
S	NP5-10	quenched	targeted	0.412	0.498	0.493	0.161
S	NP5-11	CCC	measured	84.003	84.900	17.030	0.355
S	NP5-11	CCC	targeted	84.747	80.134	15.406	0.360
S	NP5-11	quenched	measured	0.494	0.490	0.566	0.220
S	NP5-11	quenched	targeted	0.499	0.463	0.512	0.223
S	NP5-12	CCC	measured	0.307	0.387	0.278	0.079
S	NP5-12	CCC	targeted	0.302	0.354	0.251	0.081
S	NP5-12	quenched	measured	0.259	0.386	0.349	0.088
S	NP5-12	quenched	targeted	0.255	0.353	0.315	0.091
S	NP5-13	CCC	measured	1.790	1.670	1.032	< 0.018
S	NP5-13	CCC	targeted	1.853	1.533	0.950	< 0.018
S	NP5-13	quenched	measured	0.628	0.617	0.776	0.166
S	NP5-13	quenched	targeted	0.650	0.566	0.714	0.167
S	NP5-14	CCC	measured	3.546	3.121	2.130	0.326
S	NP5-14	CCC	targeted	3.401	2.734	1.972	0.326
S	NP5-14	quenched	measured	3.183	2.869	2.075	0.301
S	NP5-14	quenched	targeted	3.052	2.513	1.921	0.301
S	NP5-15	CCC	measured	1.031	1.134	0.800	0.436
S	NP5-15	CCC	targeted	1.068	1.031	0.721	0.450
S	NP5-15	quenched	measured	1.071	1.180	0.774	0.402
S	NP5-15	quenched	targeted	1.109	1.073	0.697	0.416
E	NP5-16	CCC	measured	58.477	60.124	22.619	< 0.020
E	NP5-16	CCC	targeted	59.076	55.421	21.273	< 0.021
E	NP5-16	quenched	measured	2.449	2.330	2.289	0.293
E	NP5-16	quenched	targeted	2.474	2.148	2.153	0.297

Table 3-1. Normalized PCT Results (continued)

Group	Glass ID	Heat Treatment	Comp. View	NC_B (g/L)	NC_{Li} (g/L)	NC_{Na} (g/L)	NC_{Si} (g/L)
E	NP5-17	CCC	measured	0.397	0.572	0.447	0.116
E	NP5-17	CCC	targeted	0.426	0.515	0.408	0.115
E	NP5-17	quenched	measured	0.439	0.631	0.495	0.119
E	NP5-17	quenched	targeted	0.471	0.568	0.452	0.117
E	NP5-18	CCC	measured	0.420	0.624	0.421	0.156
E	NP5-18	CCC	targeted	0.427	0.486	0.391	0.160
E	NP5-18	quenched	measured	0.499	0.717	0.485	0.165
E	NP5-18	quenched	targeted	0.507	0.558	0.450	0.169
E	NP5-19	CCC	measured	5.508	4.335	1.648	0.062
E	NP5-19	CCC	targeted	5.384	3.844	1.560	0.063
E	NP5-19	quenched	measured	0.697	0.752	0.647	0.308
E	NP5-19	quenched	targeted	0.682	0.666	0.613	0.312
E	NP5-20	CCC	measured	0.793	0.998	0.708	0.310
E	NP5-20	CCC	targeted	0.822	0.868	0.660	0.318
E	NP5-20	quenched	measured	0.748	0.943	0.690	0.270
E	NP5-20	quenched	targeted	0.775	0.820	0.644	0.277
E	NP5-21	CCC	measured	42.204	26.574	15.010	0.120
E	NP5-21	CCC	targeted	42.836	25.581	13.365	0.124
E	NP5-21	quenched	measured	2.684	2.638	2.043	0.352
E	NP5-21	quenched	targeted	2.724	2.540	1.819	0.365
Z	NP5-22	CCC	measured	0.576	0.739	0.601	0.197
Z	NP5-22	CCC	targeted	0.588	0.687	0.569	0.205
Z	NP5-22	quenched	measured	0.470	0.593	0.503	0.137
Z	NP5-22	quenched	targeted	0.480	0.552	0.476	0.142
Z	NP5-23	CCC	measured	12.126	11.540	8.053	< 0.016
Z	NP5-23	CCC	targeted	12.571	10.746	7.194	< 0.016
Z	NP5-23	quenched	measured	1.015	1.232	1.200	0.178
Z	NP5-23	quenched	targeted	1.052	1.147	1.072	0.178
Z	NP5-24	CCC	measured	6.377	6.534	2.753	< 0.014
Z	NP5-24	CCC	targeted	6.696	5.490	2.518	< 0.015
Z	NP5-24	quenched	measured	0.572	0.727	0.624	0.289
Z	NP5-24	quenched	targeted	0.601	0.611	0.570	0.302
Z	NP5-25	CCC	measured	79.257	70.446	15.743	0.063
Z	NP5-25	CCC	targeted	81.844	64.450	14.172	0.061
Z	NP5-25	quenched	measured	2.188	2.227	1.893	0.429
Z	NP5-25	quenched	targeted	2.260	2.037	1.704	0.416

Table 3-1. Normalized PCT Results (continued)

Group	Glass ID	Heat Treatment	Comp. View	NC_B (g/L)	NC_{Li} (g/L)	NC_{Na} (g/L)	NC_{Si} (g/L)
Z	NP5-26	CCC	measured	3.395	3.518	2.423	0.235
Z	NP5-26	CCC	targeted	3.309	3.167	2.309	0.236
Z	NP5-26	quenched	measured	3.358	3.385	2.394	0.227
Z	NP5-26	quenched	targeted	3.273	3.048	2.281	0.227
Z	NP5-27	CCC	measured	2.602	1.902	0.906	0.023
Z	NP5-27	CCC	targeted	2.535	1.757	0.838	0.023
Z	NP5-27	quenched	measured	0.577	0.746	0.587	0.260
Z	NP5-27	quenched	targeted	0.563	0.689	0.543	0.259

4.0 Summary

In this report, SRNL provides chemical analyses and PCT results for a series of simulated HLW glass compositions fabricated at PNNL. The results of this effort will improve the ability to predict the impacts of glass composition and nepheline crystallization on the durability of HLW glasses.

Chemical analyses were performed on a representative sample of each of the quenched glasses to allow for comparisons with the targeted compositions. Three dissolution techniques, sodium peroxide fusion, lithium metaborate fusion, and potassium hydroxide fusion, were used for preparing each of the glass samples, in duplicate, for analysis. Each of the duplicate samples was analyzed twice for each element of interest by ICP-AES or IC, for a total of four measurements per element per glass. Glass standards were intermittently measured to assess the performance of the analytical instruments over the course of these analyses. There were no issues with measurements of the glass standards. A review of the individual glass composition measurements identified no analytical issues of concern. Some degree of scatter among the Al_2O_3, B_2O_3, Na_2O, and SiO_2 measurements was noted. There were no indications of an error in preparation or measurement that had to be addressed in treatment of the data. Minor differences between the targeted and measured concentrations of some of the baseline glass components were noted, including some high values for CaO and Fe_2O_3, and some low values for Li_2O and Na_2O.

The PCT Method-A was performed in triplicate on each of the quenched and CCC versions of the glasses to assess chemical durability. One of the triplicate PCT vessels for the CCC version of glass NP5-16 had excess water and was omitted from further analysis. A review of the leachate analyses and standard solution data identified no issues with the analytical methods. Normalized concentrations were calculated based on the targeted (provided by PNNL) and measured (quenched) compositions using the average of the common logarithms of the leachate concentrations. The compositional view (targeted or measured) had no practical impact on the PCT result for each of the study glasses. Some of the CCC versions of the study glasses have NC_B values that are higher than the EA benchmark NC_B value of 16.695 g/L. NP5-08 was the only quenched glass with an NC_B value higher than the EA benchmark. For several of the study glasses, the NC_B values were higher after the CCC heat treatment. The measured NC_{Li} and NC_{Na} values followed this same trend. For some of these glasses, the measured NC_{Si} values were inversely related to the change in NC_B.

It may be valuable for PNNL to perform a more complete review of the influence of composition and heat treatment on the PCT responses of the glasses described in this report to draw further conclusions, including any potential correlations with the methods used in selecting these glass compositions for study.

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Appendix A Tables and Exhibits Supporting the Chemical Composition Measurements

Table A-1. LM Measurements of the Nepheline Study Glasses

ID	Block	Sub-Blk	Sequence	Lab ID	Bi (wt %)	Na (wt %)	Pb (wt %)	Ru (wt %)	S (wt %)	Sr (wt %)
LRM	1	1	1	LRMLM111	<0.100	14.7	<0.100	<0.0500	0.0916	<0.100
NP5-15-Q	1	1	2	G27LM21	1.22	6.92	0.214	<0.0500	0.201	0.196
NP5-21-Q	1	1	3	G18LM11	2.09	6.47	0.361	<0.0500	0.321	0.336
NP5-09-Q	1	1	4	G05LM11	1.20	8.25	0.217	<0.0500	0.196	0.203
NP5-25-Q	1	1	5	G09LM11	1.34	8.78	0.231	<0.0500	0.218	0.222
NP5-09-Q	1	1	6	G05LM21	1.17	8.09	0.215	<0.0500	0.190	0.203
NP5-21-Q	1	1	7	G18LM21	1.94	6.04	0.350	<0.0500	0.298	0.334
NP5-13-Q	1	1	8	G22LM11	1.84	9.61	0.336	<0.0500	0.289	0.301
LRM	1	1	9	LRMLM112	<0.100	14.6	<0.100	<0.0500	0.0988	<0.100
NP5-07-Q	1	1	10	G20LM11	0.801	10.5	0.131	<0.0500	0.116	0.120
NP5-24-Q	1	1	11	G02LM21	0.830	10.6	0.137	<0.0500	0.120	0.131
NP5-15-Q	1	1	12	G27LM11	1.16	6.71	0.207	<0.0500	0.182	0.192
NP5-13-Q	1	1	13	G22LM21	1.75	9.19	0.327	<0.0500	0.271	0.308
NP5-24-Q	1	1	14	G02LM11	0.798	10.2	0.134	<0.0500	0.125	0.128
NP5-25-Q	1	1	15	G09LM21	1.32	8.71	0.224	<0.0500	0.215	0.224
NP5-07-Q	1	1	16	G20LM21	0.817	10.7	0.134	<0.0500	0.123	0.124
LRM	1	1	17	LRMLM113	<0.100	14.7	<0.100	<0.0500	0.0961	<0.100
LRM	1	2	1	LRMLM121	<0.100	14.1	<0.100	<0.0500	0.0831	<0.100
NP5-24-Q	1	2	2	G02LM12	0.802	9.68	0.138	<0.0500	0.116	0.128
NP5-07-Q	1	2	3	G20LM12	0.762	10.1	0.129	<0.0500	0.1028	0.114
NP5-13-Q	1	2	4	G22LM12	1.91	9.17	0.329	<0.0500	0.263	0.292
NP5-24-Q	1	2	5	G02LM22	0.752	10.2	0.138	<0.0500	0.115	0.118
NP5-07-Q	1	2	6	G20LM22	0.790	9.95	0.126	<0.0500	0.100	0.119
NP5-13-Q	1	2	7	G22LM22	1.97	9.14	0.323	<0.0500	0.264	0.306
NP5-25-Q	1	2	8	G09LM22	1.45	8.61	0.228	<0.0500	0.204	0.217
LRM	1	2	9	LRMLM122	<0.100	14.1	<0.100	<0.0500	0.0857	<0.100
NP5-09-Q	1	2	10	G05LM22	1.27	7.75	0.206	<0.0500	0.170	0.192
NP5-25-Q	1	2	11	G09LM12	1.49	8.68	0.236	<0.0500	0.204	0.210
NP5-09-Q	1	2	12	G05LM12	1.32	8.15	0.221	<0.0500	0.189	0.190
NP5-15-Q	1	2	13	G27LM22	1.31	6.56	0.212	<0.0500	0.181	0.192
NP5-21-Q	1	2	14	G18LM12	2.26	6.20	0.364	<0.0500	0.308	0.329
NP5-15-Q	1	2	15	G27LM12	1.32	6.49	0.215	<0.0500	0.174	0.192
NP5-21-Q	1	2	16	G18LM22	2.13	5.94	0.361	<0.0500	0.313	0.332
LRM	1	2	17	LRMLM123	<0.100	13.9	<0.100	<0.0500	0.0847	<0.100
LRM	2	1	1	LRMLM211	<0.100	14.0	<0.100	<0.0500	0.0889	<0.100
NP5-22-Q	2	1	2	G17LM11	2.05	7.44	0.328	<0.0500	0.215	0.310
NP5-12-Q	2	1	3	G04LM11	1.52	6.04	0.262	<0.0500	0.216	0.226

Table A-1. LM Measurements of the Nepheline Study Glasses **(continued)**

ID	Block	Sub-Blk	Sequence	Lab ID	Bi (wt %)	Na (wt %)	Pb (wt %)	Ru (wt %)	S (wt %)	Sr (wt %)
NP5-23-Q	2	1	4	G23LM21	1.22	7.44	0.213	<0.0500	0.191	0.187
NP5-16-Q	2	1	5	G10LM21	1.28	10.9	0.203	<0.0500	0.191	0.181
NP5-08-Q	2	1	6	G28LM11	0.788	7.76	0.144	<0.0500	0.127	0.127
NP5-20-Q	2	1	7	G01LM11	2.06	6.89	0.329	<0.0500	0.272	0.325
NP5-26-Q	2	1	8	G03LM11	1.97	9.52	0.322	<0.0500	0.212	0.317
LRM	2	1	9	LRMLM212	<0.100	13.7	<0.100	<0.0500	0.100	<0.100
NP5-26-Q	2	1	10	G03LM21	2.12	10.1	0.339	<0.0500	0.223	0.306
NP5-23-Q	2	1	11	G23LM11	1.30	7.69	0.216	<0.0500	0.178	0.188
NP5-22-Q	2	1	12	G17LM21	2.08	7.31	0.333	<0.0500	0.221	0.320
NP5-16-Q	2	1	13	G10LM11	1.20	9.88	0.206	<0.0500	0.176	0.180
NP5-20-Q	2	1	14	G01LM21	2.09	6.80	0.334	<0.0500	0.277	0.331
NP5-08-Q	2	1	15	G28LM21	0.780	7.57	0.143	<0.0500	0.142	0.126
NP5-12-Q	2	1	16	G04LM21	1.55	5.87	0.256	<0.0500	0.210	0.241
LRM	2	1	17	LRMLM213	<0.100	13.8	<0.100	<0.0500	0.0933	<0.100
LRM	2	2	1	LRMLM221	<0.100	15.2	<0.100	<0.0500	0.0822	<0.100
NP5-26-Q	2	2	2	G03LM12	2.09	10.4	0.329	<0.0500	0.225	0.304
NP5-12-Q	2	2	3	G04LM12	1.56	6.25	0.272	<0.0500	0.229	0.230
NP5-16-Q	2	2	4	G10LM22	1.16	9.99	0.211	<0.0500	0.184	0.169
NP5-23-Q	2	2	5	G23LM12	1.24	7.62	0.215	<0.0500	0.190	0.194
NP5-22-Q	2	2	6	G17LM12	2.15	7.95	0.339	<0.0500	0.216	0.315
NP5-20-Q	2	2	7	G01LM22	2.21	7.50	0.345	<0.0500	0.282	0.323
NP5-20-Q	2	2	8	G01LM12	2.22	7.41	0.343	<0.0500	0.283	0.320
LRM	2	2	9	LRMLM222	<0.100	15.2	<0.100	<0.0500	0.0922	<0.100
NP5-08-Q	2	2	10	G28LM12	0.733	8.23	0.138	<0.0500	0.132	0.117
NP5-16-Q	2	2	11	G10LM12	1.17	10.2	0.209	<0.0500	0.188	0.179
NP5-23-Q	2	2	12	G23LM22	1.28	7.60	0.212	<0.0500	0.185	0.195
NP5-08-Q	2	2	13	G28LM22	0.791	8.11	0.143	<0.0500	0.131	0.126
NP5-12-Q	2	2	14	G04LM22	1.64	6.54	0.267	<0.0500	0.225	0.237
NP5-22-Q	2	2	15	G17LM22	2.13	7.79	0.344	<0.0500	0.226	0.312
NP5-26-Q	2	2	16	G03LM22	2.14	10.7	0.350	<0.0500	0.238	0.308
LRM	2	2	17	LRMLM223	<0.100	15.0	<0.100	<0.0500	0.0942	<0.100
LRM	3	1	1	LRMLM311	<0.100	13.9	<0.100	<0.0500	0.0818	<0.100
NP5-05-Q	3	1	2	G26LM21	1.17	5.41	0.195	<0.0500	0.158	0.169
EA2	3	1	3	G08LM21	<0.100	12.7	<0.100	<0.0500	<0.0500	<0.100
NP5-10-Q	3	1	4	G16LM11	1.10	8.09	0.172	<0.0500	0.150	0.163
NP5-27-Q	3	1	5	G14LM21	0.932	6.87	0.147	<0.0500	0.123	0.134
NP5-04-Q	3	1	6	G12LM21	1.00	7.55	0.163	<0.0500	0.134	0.155
NP5-04-Q	3	1	7	G12LM11	1.00	7.41	0.166	<0.0500	0.148	0.154

Table A-1. LM Measurements of the Nepheline Study Glasses **(continued)**

ID	Block	Sub-Blk	Sequence	Lab ID	Bi (wt %)	Na (wt %)	Pb (wt %)	Ru (wt %)	S (wt %)	Sr (wt %)
NP5-10-Q	3	1	8	G16LM21	1.09	7.82	0.179	<0.0500	0.153	0.161
LRM	3	1	9	LRMLM312	<0.100	13.7	<0.100	<0.0500	0.0802	<0.100
NP5-06-Q	3	1	10	G21LM11	0.886	5.28	0.152	<0.0500	0.112	0.137
NP5-14-Q	3	1	11	G24LM11	1.36	9.29	0.217	<0.0500	0.188	0.219
EA2	3	1	12	G08LM11	<0.100	12.7	<0.100	<0.0500	<0.0500	<0.100
NP5-14-Q	3	1	13	G24LM21	1.41	9.70	0.217	<0.0500	0.178	0.219
NP5-06-Q	3	1	14	G21LM21	0.954	5.44	0.148	<0.0500	0.105	0.146
NP5-27-Q	3	1	15	G14LM11	0.910	6.63	0.157	<0.0500	0.134	0.132
NP5-05-Q	3	1	16	G26LM11	1.21	5.27	0.200	<0.0500	0.162	0.178
LRM	3	1	17	LRMLM313	<0.100	14.0	<0.100	<0.0500	0.0863	<0.100
LRM	3	2	1	LRMLM321	<0.100	16.2	<0.100	<0.0500	0.0880	<0.100
EA2	3	2	2	G08LM12	<0.100	12.5	<0.100	<0.0500	<0.0500	<0.100
NP5-06-Q	3	2	3	G21LM12	1.05	5.81	0.162	<0.0500	0.118	0.137
NP5-04-Q	3	2	4	G12LM12	1.09	7.80	0.168	<0.0500	0.144	0.157
NP5-27-Q	3	2	5	G14LM22	0.928	6.97	0.155	<0.0500	0.137	0.135
NP5-10-Q	3	2	6	G16LM12	1.11	7.88	0.179	<0.0500	0.153	0.159
NP5-05-Q	3	2	7	G26LM12	1.21	5.31	0.194	<0.0500	0.159	0.177
NP5-06-Q	3	2	8	G21LM22	1.06	5.94	0.149	<0.0500	0.105	0.144
LRM	3	2	9	LRMLM322	<0.100	15.8	<0.100	<0.0500	0.0801	<0.100
NP5-14-Q	3	2	10	G24LM22	1.49	10.3	0.234	<0.0500	0.200	0.207
EA2	3	2	11	G08LM22	<0.100	12.4	<0.100	<0.0500	<0.0500	<0.100
NP5-14-Q	3	2	12	G24LM12	1.47	10.0	0.230	<0.0500	0.194	0.218
NP5-05-Q	3	2	13	G26LM22	1.25	5.44	0.202	<0.0500	0.165	0.178
NP5-04-Q	3	2	14	G12LM22	1.05	7.59	0.164	<0.0500	0.135	0.149
NP5-10-Q	3	2	15	G16LM22	1.19	8.35	0.175	<0.0500	0.147	0.161
NP5-27-Q	3	2	16	G14LM12	1.05	7.18	0.148	<0.0500	0.135	0.130
LRM	3	2	17	LRMLM323	<0.100	15.6	<0.100	<0.0500	0.0970	<0.100
LRM	4	1	1	LRMLM411	<0.100	14.9	<0.100	<0.0500	0.0940	<0.100
NP5-01-Q	4	1	2	G19LM11	0.883	9.28	0.142	<0.0500	0.108	0.130
NP5-11-Q	4	1	3	G07LM21	1.10	8.84	0.183	<0.0500	0.177	0.172
EA1	4	1	4	G15LM11	<0.100	12.6	<0.100	<0.0500	<0.0500	<0.100
EA1	4	1	5	G15LM21	<0.100	12.7	<0.100	<0.0500	<0.0500	<0.100
BL3-Q	4	1	6	G06LM21	0.554	8.93	<0.100	<0.0500	0.0973	<0.100
NP5-19-Q	4	1	7	G13LM11	1.76	9.37	0.277	<0.0500	0.245	0.275
NP5-17-Q	4	1	8	G25LM21	1.56	5.68	0.243	<0.0500	0.123	0.233
LRM	4	1	9	LRMLM412	<0.100	14.9	<0.100	<0.0500	0.104	<0.100
NP5-01-Q	4	1	10	G19LM21	0.875	9.46	0.151	<0.0500	0.107	0.130
NP5-17-Q	4	1	11	G25LM11	1.46	5.47	0.243	<0.0500	0.128	0.224

Table A-1. LM Measurements of the Nepheline Study Glasses **(continued)**

ID	Block	Sub-Blk	Sequence	Lab ID	Bi (wt %)	Na (wt %)	Pb (wt %)	Ru (wt %)	S (wt %)	Sr (wt %)
NP5-11-Q	4	1	12	G07LM11	1.06	8.97	0.182	<0.0500	0.175	0.182
NP5-18-Q	4	1	13	G11LM21	0.745	8.72	0.123	<0.0500	0.105	0.117
NP5-18-Q	4	1	14	G11LM11	0.742	8.44	0.122	<0.0500	0.0876	0.117
NP5-19-Q	4	1	15	G13LM21	1.79	9.65	0.279	<0.0500	0.232	0.280
BL3-Q	4	1	16	G06LM11	0.556	8.68	<0.100	<0.0500	0.0883	<0.100
LRM	4	1	17	LRMLM413	<0.100	14.8	0.101	<0.0500	0.108	<0.100
LRM	4	2	1	LRMLM421	<0.100	14.5	<0.100	<0.0500	0.0883	<0.100
BL3-Q	4	2	2	G06LM22	0.560	8.66	<0.100	<0.0500	0.0933	<0.100
BL3-Q	4	2	3	G06LM12	0.542	8.54	<0.100	<0.0500	0.104	<0.100
EA1	4	2	4	G15LM12	<0.100	11.8	<0.100	<0.0500	<0.0500	<0.100
NP5-11-Q	4	2	5	G07LM22	1.03	8.65	0.187	<0.0500	0.185	0.169
NP5-18-Q	4	2	6	G11LM12	0.740	8.39	0.122	<0.0500	0.102	0.116
NP5-19-Q	4	2	7	G13LM12	1.73	9.28	0.284	<0.0500	0.263	0.275
NP5-17-Q	4	2	8	G25LM12	1.51	5.49	0.252	<0.0500	0.131	0.233
LRM	4	2	9	LRMLM422	<0.100	14.3	<0.100	<0.0500	0.0980	<0.100
NP5-11-Q	4	2	10	G07LM12	1.14	9.19	0.178	<0.0500	0.186	0.175
NP5-01-Q	4	2	11	G19LM22	0.891	9.18	0.164	<0.0500	0.117	0.129
NP5-18-Q	4	2	12	G11LM22	0.710	8.18	0.127	<0.0500	0.101	0.111
NP5-17-Q	4	2	13	G25LM22	1.49	5.38	0.260	<0.0500	0.140	0.222
NP5-19-Q	4	2	14	G13LM22	1.79	9.60	0.292	<0.0500	0.264	0.275
NP5-01-Q	4	2	15	G19LM12	0.931	9.42	0.155	<0.0500	0.117	0.133
EA1	4	2	16	G15LM22	<0.100	12.5	<0.100	<0.0500	<0.0500	<0.100
LRM	4	2	17	LRMLM423	<0.100	14.5	<0.100	<0.0500	0.0915	<0.100

Table A-2. PF Measurements of the Nepheline Study Glasses (Part 1)

ID	Block	Sub-Blk	Sequence	Lab ID	Al (wt %)	B (wt %)	Ca (wt %)	Cr (wt %)	Fe (wt %)	Li (wt %)
LRM	1	1	1	LRMPF111	4.58	2.15	0.247	<0.100	0.888	<0.100
NP5-26-Q	1	1	2	G03PF11	10.4	6.01	0.922	1.46	1.79	0.220
NP5-08-Q	1	1	3	G28PF11	14.9	5.49	0.192	0.649	3.31	2.26
NP5-05-Q	1	1	4	G26PF11	14.6	4.65	3.43	0.916	2.81	2.16
NP5-16-Q	1	1	5	G10PF11	14.2	4.23	2.63	0.936	4.06	1.50
NP5-11-Q	1	1	6	G07PF21	10.8	4.35	3.09	0.913	1.89	2.15
NP5-26-Q	1	1	7	G03PF21	10.6	6.25	0.897	1.49	1.84	0.223
NP5-08-Q	1	1	8	G28PF21	15.4	5.69	0.233	0.670	3.43	2.32
LRM	1	1	9	LRMPF112	4.99	2.42	0.290	<0.100	0.962	<0.100
NP5-27-Q	1	1	10	G14PF21	13.2	4.90	3.54	0.698	1.89	2.23
NP5-06-Q	1	1	11	G21PF11	12.2	6.62	0.456	0.753	3.27	2.01
NP5-06-Q	1	1	12	G21PF21	12.0	6.59	0.498	0.744	3.24	1.97
NP5-16-Q	1	1	13	G10PF21	13.8	4.04	2.57	0.900	3.91	1.47
NP5-05-Q	1	1	14	G26PF21	15.0	4.83	3.49	0.951	2.91	2.21
NP5-11-Q	1	1	15	G07PF11	10.9	4.42	3.13	0.922	1.90	2.15
NP5-27-Q	1	1	16	G14PF11	13.9	5.20	3.82	0.739	2.00	2.35
LRM	1	1	17	LRMPF113	4.94	2.44	0.303	<0.100	0.958	<0.100
LRM	1	2	1	LRMPF121	4.98	2.47	0.364	0.147	0.985	<0.100
NP5-11-Q	1	2	2	G07PF12	10.4	4.22	3.08	0.932	1.84	2.05
NP5-27-Q	1	2	3	G14PF12	13.3	4.73	3.67	0.744	1.88	2.20
NP5-05-Q	1	2	4	G26PF22	14.9	4.34	3.58	0.988	2.90	2.17
NP5-06-Q	1	2	5	G21PF12	12.2	6.33	0.478	0.800	3.29	1.96
NP5-16-Q	1	2	6	G10PF22	14.3	4.30	2.72	0.991	4.13	1.50
NP5-26-Q	1	2	7	G03PF12	10.8	6.45	1.02	1.58	1.89	0.208
NP5-06-Q	1	2	8	G21PF22	11.9	6.58	0.450	0.783	3.20	1.94
LRM	1	2	9	LRMPF122	4.99	2.48	0.368	0.149	0.987	<0.100
NP5-08-Q	1	2	10	G28PF22	15.5	5.70	0.312	0.727	3.51	2.29
NP5-05-Q	1	2	11	G26PF12	14.8	4.83	3.50	0.988	2.92	2.17
NP5-26-Q	1	2	12	G03PF22	10.8	6.49	0.990	1.58	1.91	0.202
NP5-16-Q	1	2	13	G10PF12	14.3	4.36	2.72	1.00	4.17	1.49
NP5-27-Q	1	2	14	G14PF22	13.8	5.23	3.67	0.785	2.00	2.28
NP5-11-Q	1	2	15	G07PF22	10.3	4.23	3.07	0.930	1.83	2.05
NP5-08-Q	1	2	16	G28PF12	14.8	5.55	0.267	0.696	3.34	2.21
LRM	1	2	17	LRMPF123	5.17	2.60	0.393	0.156	1.04	<0.100
LRM	2	1	1	LRMPF112	5.10	2.61	0.274	<0.100	0.956	<0.100
NP5-15-Q	2	1	2	G27PF11	10.7	5.10	0.536	0.968	4.24	2.43
NP5-18-Q	2	1	3	G11PF21	10.9	6.52	4.60	0.590	2.16	0.579

Table A-2. PF Measurements of the Nepheline Study Glasses (Part 1) (continued)

ID	Block	Sub-Blk	Sequence	Lab ID	Al (wt %)	B (wt %)	Ca (wt %)	Cr (wt %)	Fe (wt %)	Li (wt %)
EA2	2	1	4	G08PF11	1.91	3.77	0.815	<0.100	6.71	1.77
NP5-18-Q	2	1	5	G11PF11	11.1	6.67	4.64	0.600	2.19	0.576
EA1	2	1	6	G15PF11	1.88	3.57	0.732	<0.100	6.51	1.73
NP5-20-Q	2	1	7	G01PF21	11.1	5.71	2.49	1.64	3.28	1.37
NP5-10-Q	2	1	8	G16PF11	13.1	4.42	4.58	0.843	4.49	1.67
LRM	2	1	9	LRMPF212	5.25	2.73	0.296	<0.100	0.989	<0.100
EA1	2	1	10	G15PF21	1.95	3.83	0.790	<0.100	6.79	1.80
NP5-24-Q	2	1	11	G02PF11	12.7	5.79	2.41	0.648	1.68	0.780
NP5-24-Q	2	1	12	G02PF21	13.0	5.87	2.39	0.649	1.68	0.809
EA2	2	1	13	G08PF21	1.99	3.86	0.814	<0.100	6.82	1.80
NP5-20-Q	2	1	14	G01PF11	10.7	5.49	2.58	1.60	3.20	1.36
NP5-10-Q	2	1	15	G16PF21	12.8	4.40	4.51	0.821	4.38	1.66
NP5-15-Q	2	1	16	G27PF21	11.1	5.54	0.510	0.987	4.33	2.51
LRM	2	1	17	LRMPF213	5.09	2.61	0.285	<0.100	0.956	<0.100
LRM	2	2	1	LRMPF221	5.03	2.39	0.246	<0.100	0.924	<0.100
NP5-15-Q	2	2	2	G27PF12	10.6	4.93	0.523	0.948	4.16	2.43
NP5-20-Q	2	2	3	G01PF12	10.5	5.03	2.51	1.54	3.07	1.34
NP5-20-Q	2	2	4	G01PF22	10.5	4.99	2.41	1.55	3.09	1.34
EA1	2	2	5	G15PF12	1.85	3.45	0.743	<0.100	6.56	1.78
NP5-18-Q	2	2	6	G11PF22	10.8	5.95	4.51	0.558	2.05	0.580
NP5-18-Q	2	2	7	G11PF12	10.8	6.11	4.64	0.574	2.09	0.579
NP5-10-Q	2	2	8	G16PF22	12.9	4.17	4.53	0.811	4.37	1.68
LRM	2	2	9	LRMPF222	4.90	2.29	0.228	<0.100	0.905	<0.100
EA2	2	2	10	G08PF22	1.89	3.55	0.792	<0.100	6.74	1.79
NP5-24-Q	2	2	11	G02PF22	12.7	5.48	2.37	0.625	1.63	0.810
EA1	2	2	12	G15PF22	1.89	3.53	0.760	<0.100	6.68	1.79
NP5-10-Q	2	2	13	G16PF12	12.7	3.98	4.58	0.803	4.33	1.65
EA2	2	2	14	G08PF12	1.88	3.55	0.805	<0.100	6.58	1.76
NP5-24-Q	2	2	15	G02PF12	12.8	5.57	2.41	0.639	1.67	0.801
NP5-15-Q	2	2	16	G27PF22	11.0	5.12	0.486	0.972	4.28	2.51
LRM	2	2	17	LRMPF123	5.05	2.38	0.261	<0.100	0.937	<0.100
LRM	3	1	1	LRMPF311	5.18	2.59	0.227	<0.100	0.933	<0.100
BL3-Q	3	1	2	G06PF11	14.9	5.38	0.349	0.814	2.13	2.24
NP5-23-Q	3	1	3	G23PF11	14.9	5.36	5.04	0.965	1.71	1.25
NP5-04-Q	3	1	4	G12PF11	10.4	5.91	1.18	0.770	3.06	1.68
NP5-07-Q	3	1	5	G20PF11	14.6	7.01	1.80	0.632	2.35	0.338
NP5-04-Q	3	1	6	G12PF21	10.5	6.03	1.17	0.762	3.06	1.71
NP5-25-Q	3	1	7	G09PF21	14.6	3.93	0.978	1.05	1.54	2.41

Table A-2. PF Measurements of the Nepheline Study Glasses (Part 1) (continued)

ID	Block	Sub-Blk	Sequence	Lab ID	Al (wt %)	B (wt %)	Ca (wt %)	Cr (wt %)	Fe (wt %)	Li (wt %)
NP5-17-Q	3	1	8	G25PF11	12.8	6.71	4.20	1.13	1.97	0.539
LRM	3	1	9	LRMPF312	5.27	2.51	0.224	<0.100	0.979	<0.100
NP5-07-Q	3	1	10	G20PF21	14.8	7.15	1.82	0.642	2.41	0.342
BL3-Q	3	1	11	G06PF21	15.6	5.76	0.368	0.838	2.19	2.30
NP5-25-Q	3	1	12	G09PF11	15.1	4.20	1.07	1.08	1.60	2.41
NP5-13-Q	3	1	13	G22PF11	10.9	4.62	5.16	1.48	3.47	0.429
NP5-17-Q	3	1	14	G25PF21	13.7	7.31	4.54	1.23	2.11	0.564
NP5-13-Q	3	1	15	G22PF21	11.4	4.84	5.21	1.53	3.53	0.443
NP5-23-Q	3	1	16	G23PF21	14.8	5.51	5.06	0.979	1.74	1.22
LRM	3	1	17	LRMPF313	4.94	2.31	0.180	<0.100	0.913	<0.100
LRM	3	2	1	LRMPF321	5.33	2.56	0.251	<0.100	0.995	<0.100
NP5-07-Q	3	2	2	G20PF12	14.3	7.92	1.76	0.606	2.21	0.350
BL3-Q	3	2	3	G06PF22	15.3	6.37	0.352	0.803	2.08	2.30
NP5-17-Q	3	2	4	G25PF12	13.3	7.83	4.30	1.15	1.98	0.573
NP5-17-Q	3	2	5	G25PF22	13.6	7.86	4.39	1.18	2.02	0.582
NP5-25-Q	3	2	6	G09PF22	15.0	4.42	1.02	1.05	1.53	2.45
NP5-07-Q	3	2	7	G20PF22	14.5	7.34	1.73	0.618	2.27	0.352
NP5-04-Q	3	2	8	G12PF22	10.6	6.36	1.17	0.761	3.00	1.72
LRM	3	2	9	LRMPF322	4.94	2.39	0.197	<0.100	0.885	<0.100
BL3-Q	3	2	10	G06PF12	15.3	5.78	0.366	0.826	2.15	2.26
NP5-23-Q	3	2	11	G23PF22	15.3	5.80	5.15	1.01	1.76	1.25
NP5-13-Q	3	2	12	G22PF22	11.5	4.89	5.22	1.54	3.51	0.457
NP5-23-Q	3	2	13	G23PF12	15.2	5.61	5.14	1.00	1.74	1.28
NP5-04-Q	3	2	14	G12PF12	10.5	6.14	1.21	0.772	3.05	1.66
NP5-25-Q	3	2	15	G09PF12	14.3	3.96	0.993	1.031	1.49	2.30
NP5-13-Q	3	2	16	G22PF12	10.7	4.53	4.91	1.44	3.31	0.427
LRM	3	2	17	LRMPF323	5.28	2.53	0.245	<0.100	0.972	<0.100
LRM	4	1	1	LRMPF411	4.90	2.39	0.325	0.130	0.990	<0.100
NP5-14-Q	4	1	2	G24PF11	11.1	5.59	<0.0500	1.10	3.78	1.33
NP5-19-Q	4	1	3	G13PF11	11.2	4.30	1.89	1.37	2.93	1.20
NP5-21-Q	4	1	4	G18PF21	13.6	4.37	1.63	1.74	2.31	2.64
NP5-09-Q	4	1	5	G05PF21	12.7	5.74	1.84	1.06	2.61	1.73
NP5-09-Q	4	1	6	G05PF11	12.8	5.68	1.75	1.03	2.60	1.75
NP5-12-Q	4	1	7	G04PF11	10.2	4.70	5.22	1.21	4.39	1.09
NP5-14-Q	4	1	8	G24PF21	10.8	5.36	<0.0500	1.07	3.68	1.30
LRM	4	1	9	LRMPF412	4.84	2.23	0.305	0.130	0.967	<0.100
NP5-01-Q	4	1	10	G19PF11	11.7	6.82	4.05	0.772	4.01	<0.100
NP5-12-Q	4	1	11	G04PF21	10.7	4.91	5.52	1.28	4.60	1.19

Table A-2. PF Measurements of the Nepheline Study Glasses (Part 1) (continued)

ID	Block	Sub-Blk	Sequence	Lab ID	Al (wt %)	B (wt %)	Ca (wt %)	Cr (wt %)	Fe (wt %)	Li (wt %)
NP5-22-Q	4	1	12	G17PF21	12.2	6.16	4.33	1.66	1.80	0.521
NP5-21-Q	4	1	13	G18PF11	13.6	4.47	1.64	1.74	2.33	2.66
NP5-01-Q	4	1	14	G19PF21	11.6	6.72	4.15	0.765	3.98	<0.100
NP5-22-Q	4	1	15	G17PF11	12.2	6.02	4.26	1.64	1.78	0.518
NP5-19-Q	4	1	16	G13PF21	11.6	4.44	1.96	1.42	3.03	1.22
LRM	4	1	17	LRMPF413	4.89	2.78	0.291	0.127	0.965	<0.100
LRM	4	2	1	LRMPF421	4.93	2.16	0.307	0.115	0.987	<0.100
NP5-19-Q	4	2	2	G13PF22	11.5	4.15	1.90	1.40	3.00	1.22
NP5-21-Q	4	2	3	G18PF12	13.5	4.19	1.61	1.72	2.29	2.65
NP5-12-Q	4	2	4	G04PF22	10.6	4.59	5.52	1.25	4.57	1.19
NP5-01-Q	4	2	5	G19PF22	11.3	6.22	4.09	0.730	3.89	<0.100
NP5-22-Q	4	2	6	G17PF12	11.9	5.56	4.22	1.60	1.73	0.514
NP5-14-Q	4	2	7	G24PF12	10.9	5.09	<0.0500	1.08	3.75	1.32
NP5-09-Q	4	2	8	G05PF12	12.5	5.18	1.72	1.00	2.54	1.73
LRM	4	2	9	LRMPF422	4.97	2.17	0.313	0.116	0.987	<0.100
NP5-01-Q	4	2	10	G19PF12	11.4	6.33	4.01	0.742	3.95	<0.100
NP5-22-Q	4	2	11	G17PF22	12.2	5.71	4.36	1.64	1.77	0.521
NP5-09-Q	4	2	12	G05PF22	12.5	5.21	1.78	1.02	2.54	1.69
NP5-21-Q	4	2	13	G18PF22	13.5	4.03	1.58	1.71	2.27	2.62
NP5-14-Q	4	2	14	G24PF22	10.7	4.95	<0.0500	1.06	3.67	1.29
NP5-19-Q	4	2	15	G13PF12	11.0	3.88	1.86	1.34	2.90	1.17
NP5-12-Q	4	2	16	G04PF12	10.2	4.30	5.29	1.21	4.42	1.15
LRM	4	2	17	LRMPF423	5.05	2.17	0.316	0.118	0.994	<0.100

Table A-3. PF Measurements of the Nepheline Study Glasses (Part 2)

ID	Block	Sub-Blk	Sequence	Lab ID	Mn (wt %)	Ni (wt %)	P (wt %)	Si (wt %)	Zr (wt %)
LRM	1	1	1	LRMPF111	<0.100	<0.100	0.175	25.7	0.706
NP5-26-Q	1	1	2	G03PF11	3.42	0.552	0.0803	11.9	0.994
NP5-08-Q	1	1	3	G28PF11	1.39	0.204	0.369	10.6	0.300
NP5-05-Q	1	1	4	G26PF11	2.10	0.333	0.412	12.3	0.114
NP5-16-Q	1	1	5	G10PF11	2.09	0.342	0.203	11.0	0.587
NP5-11-Q	1	1	6	G07PF21	2.09	0.325	0.430	15.7	0.465
NP5-26-Q	1	1	7	G03PF21	3.50	0.557	0.0835	12.2	0.993
NP5-08-Q	1	1	8	G28PF21	1.43	0.222	0.343	10.9	0.279
LRM	1	1	9	LRMPF112	<0.100	<0.100	0.209	27.3	0.756
NP5-27-Q	1	1	10	G14PF21	1.52	0.241	<0.0500	12.7	0.460
NP5-06-Q	1	1	11	G21PF11	1.68	0.265	0.278	14.2	0.483
NP5-06-Q	1	1	12	G21PF21	1.63	0.265	0.267	13.9	0.481
NP5-16-Q	1	1	13	G10PF21	2.04	0.315	0.171	10.8	0.577
NP5-05-Q	1	1	14	G26PF21	2.17	0.365	0.486	12.8	0.109
NP5-11-Q	1	1	15	G07PF11	2.08	0.326	0.370	15.8	0.398
NP5-27-Q	1	1	16	G14PF11	1.61	0.258	<0.0500	13.6	0.476
LRM	1	1	17	LRMPF113	<0.100	<0.100	0.144	26.4	0.760
LRM	1	2	1	LRMPF121	<0.100	0.115	0.242	26.9	0.800
NP5-11-Q	1	2	2	G07PF12	2.07	0.348	0.426	15.5	0.437
NP5-27-Q	1	2	3	G14PF12	1.57	0.263	0.111	12.7	0.507
NP5-05-Q	1	2	4	G26PF22	2.17	0.381	0.523	12.5	0.195
NP5-06-Q	1	2	5	G21PF12	1.68	0.284	0.306	14.3	0.534
NP5-16-Q	1	2	6	G10PF22	2.18	0.385	0.313	11.5	0.652
NP5-26-Q	1	2	7	G03PF12	3.60	0.598	0.165	12.7	1.087
NP5-06-Q	1	2	8	G21PF22	1.64	0.277	0.339	13.9	0.532
LRM	1	2	9	LRMPF122	<0.100	0.113	0.249	27.2	0.808
NP5-08-Q	1	2	10	G28PF22	1.48	0.250	0.445	11.2	0.370
NP5-05-Q	1	2	11	G26PF12	2.20	0.367	0.490	12.8	0.159
NP5-26-Q	1	2	12	G03PF22	3.62	0.599	0.138	12.5	1.066
NP5-16-Q	1	2	13	G10PF12	2.15	0.373	0.277	11.5	0.657
NP5-27-Q	1	2	14	G14PF22	1.63	0.280	0.0994	13.4	0.531
NP5-11-Q	1	2	15	G07PF22	2.02	0.341	0.498	15.0	0.503
NP5-08-Q	1	2	16	G28PF12	1.44	0.237	0.420	10.7	0.357
LRM	1	2	17	LRMPF123	<0.100	0.126	0.286	25.9	0.838
LRM	2	1	1	LRMPF112	<0.100	<0.100	0.189	26.0	0.724
NP5-15-Q	2	1	2	G27PF11	2.19	0.306	0.179	15.1	0.595
NP5-18-Q	2	1	3	G11PF21	1.30	0.176	<0.0500	15.0	0.360

Table A-3. PF Measurements of the Nepheline Study Glasses (Part 2) (continued)

ID	Block	Sub-Blk	Sequence	Lab ID	Mn (wt %)	Ni (wt %)	P (wt %)	Si (wt %)	Zr (wt %)
EA2	2	1	4	G08PF11	1.01	0.434	<0.0500	23.0	0.330
NP5-18-Q	2	1	5	G11PF11	1.34	0.179	<0.0500	15.5	0.362
EA1	2	1	6	G15PF11	0.976	0.388	<0.0500	22.1	0.334
NP5-20-Q	2	1	7	G01PF21	3.96	0.586	0.466	13.6	1.03
NP5-10-Q	2	1	8	G16PF11	1.92	0.264	0.648	13.5	0.370
LRM	2	1	9	LRMPF212	<0.100	<0.100	0.241	27.5	0.751
EA1	2	1	10	G15PF21	1.03	0.435	<0.0500	22.3	0.351
NP5-24-Q	2	1	11	G02PF11	1.41	0.185	0.216	14.6	0.378
NP5-24-Q	2	1	12	G02PF21	1.44	0.177	0.219	15.0	0.383
EA2	2	1	13	G08PF21	1.04	0.407	<0.0500	21.6	0.342
NP5-20-Q	2	1	14	G01PF11	3.79	0.556	0.450	12.9	1.02
NP5-10-Q	2	1	15	G16PF21	1.88	0.257	0.659	13.2	0.376
NP5-15-Q	2	1	16	G27PF21	2.33	0.304	0.196	15.9	0.607
LRM	2	1	17	LRMPF213	<0.100	<0.100	0.201	26.3	0.728
LRM	2	2	1	LRMPF221	<0.100	0.037	0.133	27.0	0.690
NP5-15-Q	2	2	2	G27PF12	2.18	0.271	0.112	15.0	0.561
NP5-20-Q	2	2	3	G01PF12	3.68	0.509	0.338	12.5	0.964
NP5-20-Q	2	2	4	G01PF22	3.66	0.513	0.413	12.6	0.961
EA1	2	2	5	G15PF12	0.983	0.352	<0.0500	23.2	0.310
NP5-18-Q	2	2	6	G11PF22	1.27	0.136	<0.0500	14.5	0.320
NP5-18-Q	2	2	7	G11PF12	1.28	0.152	<0.0500	14.6	0.324
NP5-10-Q	2	2	8	G16PF22	1.87	0.238	0.567	13.3	0.307
LRM	2	2	9	LRMPF222	<0.100	0.030	0.105	25.8	0.677
EA2	2	2	10	G08PF22	1.01	0.366	<0.0500	22.7	0.307
NP5-24-Q	2	2	11	G02PF22	1.40	0.156	0.127	14.6	0.341
EA1	2	2	12	G15PF22	1.00	0.405	<0.0500	23.0	0.311
NP5-10-Q	2	2	13	G16PF12	1.83	0.232	0.555	12.8	0.311
EA2	2	2	14	G08PF12	1.00	0.401	<0.0500	23.4	0.294
NP5-24-Q	2	2	15	G02PF12	1.41	0.162	0.152	14.7	0.348
NP5-15-Q	2	2	16	G27PF22	2.31	0.277	0.121	15.8	0.576
LRM	2	2	17	LRMPF123	<0.100	0.032	0.106	26.3	0.703
LRM	3	1	1	LRMPF311	<0.100	<0.100	0.0823	27.4	0.677
BL3-Q	3	1	2	G06PF11	0.725	<0.100	0.138	14.1	0.114
NP5-23-Q	3	1	3	G23PF11	2.17	0.269	<0.0500	10.9	0.558
NP5-04-Q	3	1	4	G12PF11	1.67	0.195	0.379	14.3	<0.100
NP5-07-Q	3	1	5	G20PF11	1.36	0.132	0.483	10.9	0.177
NP5-04-Q	3	1	6	G12PF21	1.69	0.199	0.492	15.0	0.160
NP5-25-Q	3	1	7	G09PF21	2.37	0.295	<0.0500	11.9	0.610

Table A-3. PF Measurements of the Nepheline Study Glasses (Part 2) (continued)

ID	Block	Sub-Blk	Sequence	Lab ID	Mn (wt %)	Ni (wt %)	P (wt %)	Si (wt %)	Zr (wt %)
NP5-17-Q	3	1	8	G25PF11	2.54	0.320	0.100	10.3	0.637
LRM	3	1	9	LRMPF312	<0.100	<0.100	0.0835	26.9	0.707
NP5-07-Q	3	1	10	G20PF21	1.39	0.144	0.482	11.1	0.156
BL3-Q	3	1	11	G06PF21	0.760	<0.100	0.148	14.5	0.125
NP5-25-Q	3	1	12	G09PF11	2.50	0.330	<0.0500	12.6	0.631
NP5-13-Q	3	1	13	G22PF11	3.43	0.469	0.445	11.2	0.393
NP5-17-Q	3	1	14	G25PF21	2.78	0.364	0.121	11.5	0.693
NP5-13-Q	3	1	15	G22PF21	3.60	0.569	0.350	11.9	0.331
NP5-23-Q	3	1	16	G23PF21	2.18	0.282	<0.0500	10.6	0.554
LRM	3	1	17	LRMPF313	<0.100	<0.100	0.0873	25.5	0.654
LRM	3	2	1	LRMPF321	<0.100	<0.100	0.179	27.3	0.725
NP5-07-Q	3	2	2	G20PF12	1.30	0.145	0.479	10.1	0.128
BL3-Q	3	2	3	G06PF22	0.723	<0.100	0.229	13.5	0.141
NP5-17-Q	3	2	4	G25PF12	2.58	0.345	0.194	10.7	0.675
NP5-17-Q	3	2	5	G25PF22	2.67	0.369	0.213	11.0	0.699
NP5-25-Q	3	2	6	G09PF22	2.38	0.316	0.0912	11.9	0.642
NP5-07-Q	3	2	7	G20PF22	1.34	0.153	0.459	10.7	0.113
NP5-04-Q	3	2	8	G12PF22	1.67	0.214	0.521	14.1	0.129
LRM	3	2	9	LRMPF322	<0.100	<0.100	0.146	23.9	0.663
BL3-Q	3	2	10	G06PF12	0.768	<0.100	0.186	14.1	0.135
NP5-23-Q	3	2	11	G23PF22	2.24	0.293	<0.0500	10.6	0.582
NP5-13-Q	3	2	12	G22PF22	3.54	0.578	0.281	11.2	0.298
NP5-23-Q	3	2	13	G23PF12	2.21	0.297	<0.0500	10.3	0.591
NP5-04-Q	3	2	14	G12PF12	1.71	0.233	0.414	14.4	<0.100
NP5-25-Q	3	2	15	G09PF12	2.38	0.307	0.0540	11.6	0.617
NP5-13-Q	3	2	16	G22PF12	3.37	0.461	0.422	10.6	0.301
LRM	3	2	17	LRMPF323	<0.100	<0.100	0.129	23.0	0.723
LRM	4	1	1	LRMPF411	<0.100	0.106	0.244	26.3	0.781
NP5-14-Q	4	1	2	G24PF11	2.48	0.391	0.619	13.2	0.717
NP5-19-Q	4	1	3	G13PF11	3.15	0.494	0.0789	13.5	0.912
NP5-21-Q	4	1	4	G18PF21	4.01	0.640	0.885	11.8	1.14
NP5-09-Q	4	1	5	G05PF21	2.27	0.450	0.341	12.0	0.674
NP5-09-Q	4	1	6	G05PF11	2.30	0.365	0.298	12.0	0.675
NP5-12-Q	4	1	7	G04PF11	2.70	0.439	0.515	13.5	0.778
NP5-14-Q	4	1	8	G24PF21	2.40	0.381	0.567	12.8	0.699
LRM	4	1	9	LRMPF412	<0.100	0.104	0.217	26.9	0.769
NP5-01-Q	4	1	10	G19PF11	1.69	0.286	0.434	12.7	0.510
NP5-12-Q	4	1	11	G04PF21	2.80	0.474	0.570	14.0	0.832

Table A-3. PF Measurements of the Nepheline Study Glasses (Part 2) (continued)

ID	Block	Sub-Blk	Sequence	Lab ID	Mn (wt %)	Ni (wt %)	P (wt %)	Si (wt %)	Zr (wt %)
NP5-22-Q	4	1	12	G17PF21	3.86	0.627	0.649	12.1	1.09
NP5-21-Q	4	1	13	G18PF11	4.02	0.655	0.861	11.8	1.14
NP5-01-Q	4	1	14	G19PF21	1.69	0.269	0.440	12.9	0.534
NP5-22-Q	4	1	15	G17PF11	3.82	0.610	0.623	12.0	1.09
NP5-19-Q	4	1	16	G13PF21	3.30	0.501	0.102	14.2	0.933
LRM	4	1	17	LRMPF413	<0.100	<0.100	0.220	24.6	0.762
LRM	4	2	1	LRMPF421	<0.100	<0.100	0.202	25.7	0.772
NP5-19-Q	4	2	2	G13PF22	3.28	0.472	0.0898	13.9	0.915
NP5-21-Q	4	2	3	G18PF12	3.99	0.627	0.850	11.8	1.12
NP5-12-Q	4	2	4	G04PF22	2.81	0.458	0.515	13.9	0.811
NP5-01-Q	4	2	5	G19PF22	1.63	0.225	0.353	12.6	0.510
NP5-22-Q	4	2	6	G17PF12	3.78	0.585	0.596	11.8	1.06
NP5-14-Q	4	2	7	G24PF12	2.50	0.372	0.567	13.0	0.692
NP5-09-Q	4	2	8	G05PF12	2.25	0.336	0.249	11.8	0.650
LRM	4	2	9	LRMPF422	<0.100	<0.100	0.190	25.5	0.777
NP5-01-Q	4	2	10	G19PF12	1.66	0.236	0.378	12.5	0.487
NP5-22-Q	4	2	11	G17PF22	3.87	0.596	0.604	11.9	1.07
NP5-09-Q	4	2	12	G05PF22	2.25	0.418	0.280	12.0	0.644
NP5-21-Q	4	2	13	G18PF22	4.04	0.634	0.822	11.7	1.11
NP5-14-Q	4	2	14	G24PF22	2.43	0.369	0.574	12.7	0.678
NP5-19-Q	4	2	15	G13PF12	3.17	0.472	0.0673	13.3	0.894
NP5-12-Q	4	2	16	G04PF12	2.74	0.434	0.507	13.6	0.783
LRM	4	2	17	LRMPF423	<0.100	<0.100	0.214	25.2	0.782

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

ID	Block	Sub-Blk	Sequence	Lab ID	F (wt %)
LRM	1	1	1	LRMKH111	0.886
NP5-26-Q	1	1	2	G03KH11	0.539
NP5-18-Q	1	1	3	G11KH11	0.155
NP5-18-Q	1	1	4	G11KH21	0.155
BL3-Q	1	1	5	G06KH21	0.194
NP5-12-Q	1	1	6	G04KH11	0.406
NP5-08-Q	1	1	7	G28KH21	0.196
NP5-12-Q	1	1	8	G04KH21	0.406
LRM	1	1	9	LRMKH112	0.863
NP5-21-Q	1	1	10	G18KH11	0.605
BL3-Q	1	1	11	G06KH11	0.194
NP5-26-Q	1	1	12	G03KH21	0.525
NP5-21-Q	1	1	13	G18KH21	0.610
NP5-27-Q	1	1	14	G14KH11	0.210
NP5-08-Q	1	1	15	G28KH11	0.197
NP5-27-Q	1	1	16	G14KH21	0.207
LRM	1	1	17	LRMKH113	0.855
LRM	1	2	1	LRMKH121	0.887
NP5-12-Q	1	2	2	G04KH12	0.418
NP5-26-Q	1	2	3	G03KH22	0.532
NP5-21-Q	1	2	4	G18KH22	0.612
NP5-21-Q	1	2	5	G18KH12	0.612
NP5-26-Q	1	2	6	G03KH12	0.534
NP5-08-Q	1	2	7	G28KH22	0.196
NP5-27-Q	1	2	8	G14KH12	0.212
LRM	1	2	9	LRMKH122	0.871
BL3-Q	1	2	10	G06KH12	0.193
NP5-27-Q	1	2	11	G14KH22	0.211
NP5-18-Q	1	2	12	G11KH22	0.155
NP5-08-Q	1	2	13	G28KH12	0.198
BL3-Q	1	2	14	G06KH22	0.197
NP5-18-Q	1	2	15	G11KH12	0.156
NP5-12-Q	1	2	16	G04KH22	0.405
LRM	1	2	17	LRMKH123	0.870
LRM	2	1	1	LRMKH211	0.895
NP5-10-Q	2	1	2	G16KH21	0.264
NP5-10-Q	2	1	3	G16KH11	0.266
NP5-11-Q	2	1	4	G07KH21	0.320
NP5-15-Q	2	1	5	G27KH21	0.337
NP5-11-Q	2	1	6	G07KH11	0.311
NP5-25-Q	2	1	7	G09KH11	0.381
NP5-25-Q	2	1	8	G09KH21	0.378
LRM	2	1	9	LRMKH212	0.876
NP5-05-Q	2	1	10	G26KH21	0.244
NP5-05-Q	2	1	11	G26KH11	0.242
NP5-15-Q	2	1	12	G27KH11	0.332
NP5-17-Q	2	1	13	G25KH11	0.382
NP5-17-Q	2	1	14	G25KH21	0.377
NP5-14-Q	2	1	15	G24KH21	0.355
NP5-14-Q	2	1	16	G24KH11	0.357
LRM	2	1	17	LRMKH213	0.877
LRM	2	2	1	LRMKH221	0.895
NP5-10-Q	2	2	2	G16KH22	0.264
NP5-10-Q	2	2	3	G16KH12	0.264
NP5-05-Q	2	2	4	G26KH22	0.242
NP5-14-Q	2	2	5	G24KH12	0.354
NP5-17-Q	2	2	6	G25KH12	0.377
NP5-05-Q	2	2	7	G26KH12	0.240
NP5-15-Q	2	2	8	G27KH22	0.334

Table A-4. KH Measurements of the Nepheline Study Glasses (continued)

ID	Block	Sub-Blk	Sequence	Lab ID	F (wt %)
LRM	2	2	9	LRMKH222	0.876
NP5-15-Q	2	2	10	G27KH12	0.337
NP5-14-Q	2	2	11	G24KH22	0.355
NP5-25-Q	2	2	12	G09KH12	0.384
NP5-25-Q	2	2	13	G09KH22	0.380
NP5-11-Q	2	2	14	G07KH12	0.309
NP5-17-Q	2	2	15	G25KH22	0.376
NP5-11-Q	2	2	16	G07KH22	0.336
LRM	2	2	17	LRMKH223	0.882
LRM	3	1	1	LRMKH311	0.884
NP5-22-Q	3	1	2	G17KH11	0.549
NP5-20-Q	3	1	3	G01KH11	0.558
EA2	3	1	4	G08KH21	<0.0500
NP5-23-Q	3	1	5	G23KH21	0.323
NP5-06-Q	3	1	6	G21KH11	0.189
NP5-01-Q	3	1	7	G19KH21	0.174
EA2	3	1	8	G08KH11	<0.0500
LRM	3	1	9	LRMKH312	0.874
NP5-06-Q	3	1	10	G21KH21	0.190
NP5-01-Q	3	1	11	G19KH11	0.179
NP5-24-Q	3	1	12	G02KH11	0.196
NP5-24-Q	3	1	13	G02KH21	0.198
NP5-23-Q	3	1	14	G23KH11	0.323
NP5-20-Q	3	1	15	G01KH21	0.557
NP5-22-Q	3	1	16	G17KH21	0.551
LRM	3	1	17	LRMKH313	0.875
LRM	3	2	1	LRMKH321	0.897
NP5-22-Q	3	2	2	G17KH22	0.559
NP5-01-Q	3	2	3	G19KH12	0.181
EA2	3	2	4	G08KH12	<0.0500
NP5-20-Q	3	2	5	G01KH12	0.560
NP5-24-Q	3	2	6	G02KH22	0.201
NP5-24-Q	3	2	7	G02KH12	0.198
NP5-01-Q	3	2	8	G19KH22	0.180
LRM	3	2	9	LRMKH322	0.875
NP5-06-Q	3	2	10	G21KH12	0.188
NP5-22-Q	3	2	11	G17KH12	0.540
NP5-23-Q	3	2	12	G23KH22	0.327
NP5-20-Q	3	2	13	G01KH22	0.559
EA2	3	2	14	G08KH22	<0.0500
NP5-23-Q	3	2	15	G23KH12	0.326
NP5-06-Q	3	2	16	G21KH22	0.188
LRM	3	2	17	LRMKH323	0.872
LRM	4	1	1	LRMKH411	0.885
EA1	4	1	2	G15KH11	<0.0500
NP5-07-Q	4	1	3	G20KH11	0.191
NP5-04-Q	4	1	4	G12KH11	0.244
NP5-16-Q	4	1	5	G10KH21	0.328
EA1	4	1	6	G15KH21	<0.0500
NP5-13-Q	4	1	7	G22KH11	0.522
NP5-09-Q	4	1	8	G05KH11	0.341
LRM	4	1	9	LRMKH412	0.865
NP5-19-Q	4	1	10	G13KH11	0.507
NP5-19-Q	4	1	11	G13KH21	0.504
NP5-04-Q	4	1	12	G12KH21	0.246
NP5-07-Q	4	1	13	G20KH21	0.192
NP5-09-Q	4	1	14	G05KH21	0.327
NP5-16-Q	4	1	15	G10KH11	0.328
NP5-13-Q	4	1	16	G22KH21	0.520
LRM	4	1	17	LRMKH413	0.850

Table A-4. KH Measurements of the Nepheline Study Glasses (continued)

ID	Block	Sub-Blk	Sequence	Lab ID	F (wt %)
LRM	4	2	1	LRMKH421	0.885
NP5-09-Q	4	2	2	G05KH12	0.334
NP5-19-Q	4	2	3	G13KH12	0.506
NP5-13-Q	4	2	4	G22KH12	0.526
NP5-09-Q	4	2	5	G05KH22	0.325
NP5-04-Q	4	2	6	G12KH12	0.241
NP5-13-Q	4	2	7	G22KH22	0.524
EA1	4	2	8	G15KH22	<0.0500
LRM	4	2	9	LRMKH422	0.871
NP5-07-Q	4	2	10	G20KH12	0.190
EA1	4	2	11	G15KH12	<0.0500
NP5-04-Q	4	2	12	G12KH22	0.237
NP5-16-Q	4	2	13	G10KH22	0.315
NP5-19-Q	4	2	14	G13KH22	0.508
NP5-07-Q	4	2	15	G20KH22	0.187
NP5-16-Q	4	2	16	G10KH12	0.323
LRM	4	2	17	LRMKH423	0.863

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

Glass ID	Oxide	BDL (<)	Measured (wt %)	Targeted (wt %)	Difference of Measured versus Targeted (wt %)	% Difference of Measured versus Targeted
BL3-Q	Al_2O_3		28.862	28.500	0.362	1.3%
BL3-Q	B_2O_3		18.748	17.200	1.548	9.0%
BL3-Q	Bi_2O_3		0.616	0.650	-0.034	
BL3-Q	CaO		0.502	0.650	-0.148	
BL3-Q	Cr_2O_3		1.199	1.100	0.099	
BL3-Q	F		0.195	0.300	-0.105	
BL3-Q	Fe_2O_3		3.056	2.500	0.556	
BL3-Q	Li_2O		4.898	5.000	-0.102	-2.0%
BL3-Q	MnO		0.961	1.000	-0.039	
BL3-Q	Na_2O		11.731	12.500	-0.769	-6.2%
BL3-Q	NiO	<	0.127	0.000	0.127	
BL3-Q	P_2O_5		0.402	0.700	-0.298	
BL3-Q	PbO	<	0.108	0.000	0.108	
BL3-Q	RuO_2	<	0.066	0.050	0.016	
BL3-Q	SiO_2		30.057	29.350	0.707	2.4%
BL3-Q	SO_3		0.239	0.250	-0.011	
BL3-Q	SrO	<	0.118	0.000	0.118	
BL3-Q	ZrO_2		0.174	0.250	-0.076	
BL3-Q	Sum		102.058	100.000	2.058	2.1%
EA1	Al_2O_3		3.576	3.700	-0.124	
EA1	B_2O_3		11.576	11.280	0.296	2.6%
EA1	Bi_2O_3	<	0.111	0.000	0.111	
EA1	CaO		1.058	1.120	-0.062	
EA1	Cr_2O_3	<	0.146	0.000	0.146	
EA1	F	<	0.050	0.000	0.050	
EA1	Fe_2O_3		9.486	8.990	0.496	5.5%
EA1	Li_2O		3.821	4.260	-0.439	
EA1	MnO		1.288	1.340	-0.052	
EA1	Na_2O		16.715	16.810	-0.095	-0.6%
EA1	NiO		0.503	0.570	-0.067	
EA1	P_2O_5	<	0.115	0.000	0.115	
EA1	PbO	<	0.108	0.000	0.108	
EA1	RuO_2	<	0.066	0.000	0.066	
EA1	SiO_2		48.455	48.730	-0.275	-0.6%
EA1	SO_3	<	0.125	0.000	0.125	
EA1	SrO	<	0.118	0.000	0.118	
EA1	ZrO_2		0.441	0.460	-0.019	
EA1	Sum		97.758	97.260	0.498	0.5%
EA2	Al_2O_3		3.623	3.700	-0.077	
EA2	B_2O_3		11.857	11.280	0.577	5.1%
EA2	Bi_2O_3	<	0.111	0.000	0.111	
EA2	CaO		1.128	1.120	0.008	
EA2	Cr_2O_3	<	0.146	0.000	0.146	
EA2	F	<	0.050	0.000	0.050	
EA2	Fe_2O_3		9.597	8.990	0.607	6.8%
EA2	Li_2O		3.832	4.260	-0.428	
EA2	MnO		1.311	1.340	-0.029	
EA2	Na_2O		16.951	16.810	0.141	0.8%
EA2	NiO		0.512	0.570	-0.058	
EA2	P_2O_5	<	0.115	0.000	0.115	
EA2	PbO	<	0.108	0.000	0.108	
EA2	RuO_2	<	0.066	0.000	0.066	
EA2	SiO_2		48.509	48.730	-0.221	-0.5%
EA2	SO_3	<	0.125	0.000	0.125	
EA2	SrO	<	0.118	0.000	0.118	
EA2	ZrO_2		0.430	0.460	-0.030	
EA2	Sum		98.588	97.260	1.328	1.4%

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

Glass ID	Oxide	BDL (<)	Measured (wt %)	Targeted (wt %)	Difference of Measured versus Targeted (wt %)	% Difference of Measured versus Targeted
LRM	Al_2O_3		9.494	9.510	-0.016	-0.2%
LRM	B_2O_3		7.830	7.850	-0.020	-0.3%
LRM	Bi_2O_3	<	0.111	0.000	0.111	
LRM	CaO		0.393	0.540	-0.147	
LRM	Cr_2O_3	<	0.164	0.190	-0.026	
LRM	F		0.876	0.860	0.016	
LRM	Fe_2O_3		1.373	1.380	-0.007	
LRM	Li_2O	<	0.215	0.110	0.105	
LRM	MnO	<	0.129	0.080	0.049	
LRM	Na_2O		19.664	20.030	-0.366	-1.8%
LRM	NiO	<	0.120	0.190	-0.070	
LRM	P_2O_5		0.408	0.540	-0.132	
LRM	PbO	<	0.108	0.100	0.008	
LRM	RuO_2	<	0.066	0.000	0.066	
LRM	SiO_2		55.845	54.200	1.645	3.0%
LRM	SO_3		0.228	0.300	-0.072	
LRM	SrO	<	0.118	0.000	0.118	
LRM	ZrO_2		0.998	0.930	0.068	
LRM	Sum		98.140	96.810	1.330	1.4%
NP5-01-Q	Al_2O_3		21.729	22.310	-0.581	-2.6%
NP5-01-Q	B_2O_3		21.002	21.120	-0.118	-0.6%
NP5-01-Q	Bi_2O_3		0.998	1.060	-0.062	
NP5-01-Q	CaO		5.702	5.000	0.702	14.0%
NP5-01-Q	Cr_2O_3		1.099	0.980	0.119	
NP5-01-Q	F		0.179	0.340	-0.161	
NP5-01-Q	Fe_2O_3		5.658	5.060	0.598	11.8%
NP5-01-Q	Li_2O	<	0.215	0.000	0.215	
NP5-01-Q	MnO		2.153	2.080	0.073	
NP5-01-Q	Na_2O		12.584	13.330	-0.746	-5.6%
NP5-01-Q	NiO		0.323	0.330	-0.007	
NP5-01-Q	P_2O_5		0.919	0.950	-0.031	
NP5-01-Q	PbO		0.165	0.170	-0.005	
NP5-01-Q	RuO_2	<	0.066	0.010	0.056	
NP5-01-Q	SiO_2		27.116	26.140	0.976	3.7%
NP5-01-Q	SO_3		0.280	0.350	-0.070	
NP5-01-Q	SrO		0.154	0.160	-0.006	
NP5-01-Q	ZrO_2		0.689	0.610	0.079	
NP5-01-Q	Sum		101.031	100.000	1.031	1.0%
NP5-04-Q	Al_2O_3		19.840	20.200	-0.360	-1.8%
NP5-04-Q	B_2O_3		19.674	19.330	0.344	1.8%
NP5-04-Q	Bi_2O_3		1.154	1.140	0.014	
NP5-04-Q	CaO		1.655	1.690	-0.035	
NP5-04-Q	Cr_2O_3		1.120	1.060	0.060	
NP5-04-Q	F		0.242	0.370	-0.128	
NP5-04-Q	Fe_2O_3		4.350	3.870	0.480	
NP5-04-Q	Li_2O		3.644	3.850	-0.206	
NP5-04-Q	MnO		2.176	2.250	-0.074	
NP5-04-Q	Na_2O		10.228	11.120	-0.892	-8.0%
NP5-04-Q	NiO		0.268	0.360	-0.092	
NP5-04-Q	P_2O_5		1.035	1.900	-0.865	
NP5-04-Q	PbO		0.178	0.180	-0.002	
NP5-04-Q	RuO_2	<	0.066	0.010	0.056	
NP5-04-Q	SiO_2		30.913	31.450	-0.537	-1.7%
NP5-04-Q	SO_3		0.350	0.380	-0.030	
NP5-04-Q	SrO		0.182	0.180	0.002	
NP5-04-Q	ZrO_2	<	0.165	0.660	-0.495	
NP5-04-Q	Sum		97.237	100.000	-2.763	-2.8%
NP5-05-Q	Al_2O_3		28.012	28.300	-0.288	-1.0%

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

Glass ID	Oxide	BDL (<)	Measured (wt %)	Targeted (wt %)	Difference of Measured versus Targeted (wt %)	% Difference of Measured versus Targeted
NP5-05-Q	B_2O_3		15.013	15.030	-0.017	-0.1%
NP5-05-Q	Bi_2O_3		1.349	1.380	-0.031	
NP5-05-Q	CaO		4.897	4.400	0.497	
NP5-05-Q	Cr_2O_3		1.404	1.290	0.114	
NP5-05-Q	F		0.242	0.440	-0.198	
NP5-05-Q	Fe_2O_3		4.125	3.500	0.625	
NP5-05-Q	Li_2O		4.688	4.910	-0.222	
NP5-05-Q	MnO		2.789	2.720	0.069	
NP5-05-Q	Na_2O		7.222	8.080	-0.858	-10.6%
NP5-05-Q	NiO		0.460	0.430	0.030	
NP5-05-Q	P_2O_5		1.095	1.890	-0.795	
NP5-05-Q	PbO		0.213	0.220	-0.007	
NP5-05-Q	RuO_2	<	0.066	0.010	0.056	
NP5-05-Q	SiO_2		26.955	25.940	1.015	3.9%
NP5-05-Q	SO_3		0.402	0.460	-0.058	
NP5-05-Q	SrO		0.208	0.210	-0.002	
NP5-05-Q	ZrO_2		0.195	0.790	-0.595	
NP5-05-Q	Sum		99.334	100.000	-0.666	-0.7%
NP5-06-Q	Al_2O_3		22.816	23.500	-0.684	-2.9%
NP5-06-Q	B_2O_3		21.026	21.990	-0.964	-4.4%
NP5-06-Q	Bi_2O_3		1.101	1.090	0.011	
NP5-06-Q	CaO		0.658	0.700	-0.042	
NP5-06-Q	Cr_2O_3		1.125	1.010	0.115	
NP5-06-Q	F		0.189	0.350	-0.161	
NP5-06-Q	Fe_2O_3		4.647	4.120	0.527	
NP5-06-Q	Li_2O		4.241	4.570	-0.329	
NP5-06-Q	MnO		2.140	2.140	0.000	
NP5-06-Q	Na_2O		7.572	8.290	-0.718	-8.7%
NP5-06-Q	NiO		0.347	0.340	0.007	
NP5-06-Q	P_2O_5		0.682	0.720	-0.038	
NP5-06-Q	PbO		0.165	0.170	-0.005	
NP5-06-Q	RuO_2	<	0.066	0.010	0.056	
NP5-06-Q	SiO_2		30.111	29.850	0.261	0.9%
NP5-06-Q	SO_3		0.275	0.360	-0.085	
NP5-06-Q	SrO		0.167	0.170	-0.003	
NP5-06-Q	ZrO_2		0.686	0.620	0.066	
NP5-06-Q	Sum		98.012	100.000	-1.988	-2.0%
NP5-07-Q	Al_2O_3		27.492	27.970	-0.478	-1.7%
NP5-07-Q	B_2O_3		23.682	21.660	2.022	9.3%
NP5-07-Q	Bi_2O_3		0.883	0.920	-0.037	
NP5-07-Q	CaO		2.487	2.350	0.137	
NP5-07-Q	Cr_2O_3		0.913	0.850	0.063	
NP5-07-Q	F		0.190	0.290	-0.100	
NP5-07-Q	Fe_2O_3		3.303	2.840	0.463	
NP5-07-Q	Li_2O		0.744	0.820	-0.076	
NP5-07-Q	MnO		1.740	1.800	-0.060	
NP5-07-Q	Na_2O		13.901	14.500	-0.599	-4.1%
NP5-07-Q	NiO		0.183	0.280	-0.097	
NP5-07-Q	P_2O_5		1.090	1.560	-0.470	
NP5-07-Q	PbO		0.140	0.140	0.000	
NP5-07-Q	RuO_2	<	0.066	0.010	0.056	
NP5-07-Q	SiO_2		22.891	23.050	-0.159	-0.7%
NP5-07-Q	SO_3		0.276	0.300	-0.024	
NP5-07-Q	SrO		0.141	0.140	0.001	
NP5-07-Q	ZrO_2		0.194	0.520	-0.326	
NP5-07-Q	Sum		100.315	100.000	0.315	0.3%
NP5-08-Q	Al_2O_3		28.626	29.710	-1.084	-3.6%
NP5-08-Q	B_2O_3		18.056	18.680	-0.624	-3.3%

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

Glass ID	Oxide	BDL (<)	Measured (wt %)	Targeted (wt %)	Difference of Measured versus Targeted (wt %)	% Difference of Measured versus Targeted
NP5-08-Q	Bi_2O_3		0.862	0.960	-0.098	
NP5-08-Q	CaO		0.351	0.440	-0.089	
NP5-08-Q	Cr_2O_3		1.002	0.900	0.102	
NP5-08-Q	F		0.197	0.310	-0.113	
NP5-08-Q	Fe_2O_3		4.857	4.410	0.447	
NP5-08-Q	Li_2O		4.887	5.330	-0.443	-8.3%
NP5-08-Q	MnO		1.853	1.890	-0.037	
NP5-08-Q	Na_2O		10.673	11.580	-0.907	-7.8%
NP5-08-Q	NiO		0.290	0.300	-0.010	
NP5-08-Q	P_2O_5		0.903	1.140	-0.237	
NP5-08-Q	PbO		0.153	0.150	0.003	
NP5-08-Q	RuO_2	<	0.066	0.010	0.056	
NP5-08-Q	SiO_2		23.211	23.170	0.041	0.2%
NP5-08-Q	SO_3		0.332	0.320	0.012	
NP5-08-Q	SrO		0.147	0.150	-0.003	
NP5-08-Q	ZrO_2		0.441	0.550	-0.109	
NP5-08-Q	Sum		96.907	100.000	-3.093	-3.1%
NP5-09-Q	Al_2O_3		23.855	25.390	-1.535	-6.0%
NP5-09-Q	B_2O_3		17.557	18.210	-0.653	-3.6%
NP5-09-Q	Bi_2O_3		1.382	1.490	-0.108	
NP5-09-Q	CaO		2.480	2.290	0.190	
NP5-09-Q	Cr_2O_3		1.502	1.390	0.112	
NP5-09-Q	F		0.332	0.480	-0.148	
NP5-09-Q	Fe_2O_3		3.678	3.110	0.568	
NP5-09-Q	Li_2O		3.714	4.230	-0.516	
NP5-09-Q	MnO		2.928	2.920	0.008	
NP5-09-Q	Na_2O		10.865	12.080	-1.215	-10.1%
NP5-09-Q	NiO		0.499	0.460	0.039	
NP5-09-Q	P_2O_5		0.669	0.660	0.009	
NP5-09-Q	PbO		0.231	0.240	-0.009	
NP5-09-Q	RuO_2	<	0.066	0.010	0.056	
NP5-09-Q	SiO_2		25.565	25.470	0.095	0.4%
NP5-09-Q	SO_3		0.465	0.490	-0.025	
NP5-09-Q	SrO		0.233	0.230	0.003	
NP5-09-Q	ZrO_2		0.893	0.850	0.043	
NP5-09-Q	Sum		96.912	100.000	-3.088	-3.1%
NP5-10-Q	Al_2O_3		24.327	24.570	-0.243	-1.0%
NP5-10-Q	B_2O_3		13.660	12.820	0.840	6.6%
NP5-10-Q	Bi_2O_3		1.251	1.220	0.031	
NP5-10-Q	CaO		6.366	5.710	0.656	11.5%
NP5-10-Q	Cr_2O_3		1.198	1.130	0.068	
NP5-10-Q	F		0.265	0.390	-0.125	
NP5-10-Q	Fe_2O_3		6.280	5.640	0.640	11.3%
NP5-10-Q	Li_2O		3.585	4.030	-0.445	
NP5-10-Q	MnO		2.421	2.390	0.031	
NP5-10-Q	Na_2O		10.831	11.550	-0.719	-6.2%
NP5-10-Q	NiO		0.315	0.380	-0.065	
NP5-10-Q	P_2O_5		1.391	1.680	-0.289	
NP5-10-Q	PbO		0.190	0.190	0.000	
NP5-10-Q	RuO_2	<	0.066	0.010	0.056	
NP5-10-Q	SiO_2		28.239	27.000	1.239	4.6%
NP5-10-Q	SO_3		0.376	0.400	-0.024	
NP5-10-Q	SrO		0.190	0.190	0.000	
NP5-10-Q	ZrO_2		0.461	0.700	-0.239	
NP5-10-Q	Sum		101.413	100.000	1.413	1.4%
NP5-11-Q	Al_2O_3		20.029	20.500	-0.471	-2.3%
NP5-11-Q	B_2O_3		13.862	13.740	0.122	0.9%
NP5-11-Q	Bi_2O_3		1.207	1.340	-0.133	

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

Glass ID	Oxide	BDL (<)	Measured (wt %)	Targeted (wt %)	Difference of Measured versus Targeted (wt %)	% Difference of Measured versus Targeted
NP5-11-Q	CaO		4.327	4.010	0.317	
NP5-11-Q	Cr_2O_3		1.351	1.240	0.111	
NP5-11-Q	F		0.319	0.430	-0.111	
NP5-11-Q	Fe_2O_3		2.666	2.080	0.586	
NP5-11-Q	Li_2O		4.521	4.790	-0.269	
NP5-11-Q	MnO		2.666	2.620	0.046	
NP5-11-Q	Na_2O		12.014	13.280	-1.266	-9.5%
NP5-11-Q	NiO		0.426	0.420	0.006	
NP5-11-Q	P_2O_5		0.988	1.260	-0.272	
NP5-11-Q	PbO		0.197	0.210	-0.013	
NP5-11-Q	RuO_2	<	0.066	0.010	0.056	
NP5-11-Q	SiO_2		33.159	32.650	0.509	1.6%
NP5-11-Q	SO_3		0.451	0.440	0.011	
NP5-11-Q	SrO		0.206	0.210	-0.004	
NP5-11-Q	ZrO_2		0.609	0.770	-0.161	
NP5-11-Q	Sum		99.064	100.000	-0.936	-0.9%
NP5-12-Q	Al_2O_3		19.698	20.220	-0.522	-2.6%
NP5-12-Q	B_2O_3		14.892	15.140	-0.248	-1.6%
NP5-12-Q	Bi_2O_3		1.747	1.790	-0.043	
NP5-12-Q	CaO		7.538	6.770	0.768	11.3%
NP5-12-Q	Cr_2O_3		1.809	1.660	0.149	
NP5-12-Q	F		0.409	0.580	-0.171	
NP5-12-Q	Fe_2O_3		6.427	5.830	0.597	10.2%
NP5-12-Q	Li_2O		2.487	2.720	-0.233	
NP5-12-Q	MnO		3.567	3.510	0.057	
NP5-12-Q	Na_2O		8.324	9.220	-0.896	-9.7%
NP5-12-Q	NiO		0.574	0.560	0.014	
NP5-12-Q	P_2O_5		1.207	1.220	-0.013	
NP5-12-Q	PbO		0.285	0.280	0.005	
NP5-12-Q	RuO_2	<	0.066	0.010	0.056	
NP5-12-Q	SiO_2		29.415	28.600	0.815	2.8%
NP5-12-Q	SO_3		0.549	0.590	-0.041	
NP5-12-Q	SrO		0.276	0.280	-0.004	
NP5-12-Q	ZrO_2		1.082	1.020	0.062	
NP5-12-Q	Sum		100.352	100.000	0.352	0.4%
NP5-13-Q	Al_2O_3		21.021	21.070	-0.049	-0.2%
NP5-13-Q	B_2O_3		15.198	14.680	0.518	3.5%
NP5-13-Q	Bi_2O_3		2.082	2.250	-0.168	
NP5-13-Q	CaO		7.171	6.470	0.701	10.8%
NP5-13-Q	Cr_2O_3		2.189	2.090	0.099	
NP5-13-Q	F		0.523	0.720	-0.197	
NP5-13-Q	Fe_2O_3		4.940	4.440	0.500	
NP5-13-Q	Li_2O		0.945	1.030	-0.085	
NP5-13-Q	MnO		4.500	4.420	0.080	
NP5-13-Q	Na_2O		12.506	13.580	-1.074	-7.9%
NP5-13-Q	NiO		0.661	0.700	-0.039	
NP5-13-Q	P_2O_5		0.858	1.970	-1.112	
NP5-13-Q	PbO		0.354	0.360	-0.006	
NP5-13-Q	RuO_2	<	0.066	0.020	0.046	
NP5-13-Q	SiO_2		24.014	23.820	0.194	0.8%
NP5-13-Q	SO_3		0.679	0.740	-0.061	
NP5-13-Q	SrO		0.357	0.350	0.007	
NP5-13-Q	ZrO_2		0.447	1.290	-0.843	
NP5-13-Q	Sum		98.508	100.000	-1.492	-1.5%
NP5-14-Q	Al_2O_3		20.548	21.700	-1.152	-5.3%
NP5-14-Q	B_2O_3		16.896	17.620	-0.724	-4.1%
NP5-14-Q	Bi_2O_3		1.597	1.590	0.007	
NP5-14-Q	CaO	<	0.070	0.070	0.000	

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

Glass ID	Oxide	BDL (<)	Measured (wt %)	Targeted (wt %)	Difference of Measured versus Targeted (wt %)	% Difference of Measured versus Targeted
NP5-14-Q	Cr_2O_3		1.575	1.480	0.095	
NP5-14-Q	F		0.355	0.510	-0.155	
NP5-14-Q	Fe_2O_3		5.318	4.870	0.448	
NP5-14-Q	Li_2O		2.820	3.220	-0.400	
NP5-14-Q	MnO		3.167	3.130	0.037	
NP5-14-Q	Na_2O		13.241	14.300	-1.059	-7.4%
NP5-14-Q	NiO		0.481	0.500	-0.019	
NP5-14-Q	P_2O_5		1.333	1.400	-0.067	
NP5-14-Q	PbO		0.242	0.250	-0.008	
NP5-14-Q	RuO_2	<	0.066	0.010	0.056	
NP5-14-Q	SiO_2		27.650	27.660	-0.010	0.0%
NP5-14-Q	SO_3		0.474	0.530	-0.056	
NP5-14-Q	SrO		0.255	0.250	0.005	
NP5-14-Q	ZrO_2		0.941	0.910	0.031	
NP5-14-Q	Sum		97.031	100.000	-2.969	-3.0%
NP5-15-Q	Al_2O_3		20.501	20.890	-0.389	-1.9%
NP5-15-Q	B_2O_3		16.655	16.080	0.575	3.6%
NP5-15-Q	Bi_2O_3		1.396	1.460	-0.064	
NP5-15-Q	CaO		0.719	0.830	-0.111	
NP5-15-Q	Cr_2O_3		1.416	1.360	0.056	
NP5-15-Q	F		0.335	0.470	-0.135	
NP5-15-Q	Fe_2O_3		6.080	5.510	0.570	10.3%
NP5-15-Q	Li_2O		5.318	5.850	-0.532	-9.1%
NP5-15-Q	MnO		2.908	2.860	0.048	
NP5-15-Q	Na_2O		8.991	9.980	-0.989	-9.9%
NP5-15-Q	NiO		0.368	0.450	-0.082	
NP5-15-Q	P_2O_5		0.348	0.490	-0.142	
NP5-15-Q	PbO		0.228	0.230	-0.002	
NP5-15-Q	RuO_2	<	0.066	0.010	0.056	
NP5-15-Q	SiO_2		33.052	32.000	1.052	3.3%
NP5-15-Q	SO_3		0.461	0.480	-0.019	
NP5-15-Q	SrO		0.228	0.220	0.008	
NP5-15-Q	ZrO_2		0.790	0.830	-0.040	
NP5-15-Q	Sum		99.861	100.000	-0.139	-0.1%
NP5-16-Q	Al_2O_3		26.736	27.470	-0.734	-2.7%
NP5-16-Q	B_2O_3		13.628	13.490	0.138	1.0%
NP5-16-Q	Bi_2O_3		1.341	1.370	-0.029	
NP5-16-Q	CaO		3.722	3.420	0.302	
NP5-16-Q	Cr_2O_3		1.398	1.280	0.118	
NP5-16-Q	F		0.324	0.440	-0.116	
NP5-16-Q	Fe_2O_3		5.815	5.310	0.505	9.5%
NP5-16-Q	Li_2O		3.208	3.480	-0.272	
NP5-16-Q	MnO		2.731	2.700	0.031	
NP5-16-Q	Na_2O		13.807	14.680	-0.873	-5.9%
NP5-16-Q	NiO		0.450	0.430	0.020	
NP5-16-Q	P_2O_5		0.552	0.610	-0.058	
NP5-16-Q	PbO		0.223	0.220	0.003	
NP5-16-Q	RuO_2	<	0.066	0.010	0.056	
NP5-16-Q	SiO_2		23.960	23.640	0.320	1.4%
NP5-16-Q	SO_3		0.461	0.450	0.011	
NP5-16-Q	SrO		0.210	0.210	0.000	
NP5-16-Q	ZrO_2		0.835	0.790	0.045	
NP5-16-Q	Sum		99.468	100.000	-0.532	-0.5%
NP5-17-Q	Al_2O_3		25.225	25.830	-0.605	-2.3%
NP5-17-Q	B_2O_3		23.916	22.270	1.646	7.4%
NP5-17-Q	Bi_2O_3		1.678	1.780	-0.102	
NP5-17-Q	CaO		6.097	5.740	0.357	6.2%
NP5-17-Q	Cr_2O_3		1.714	1.650	0.064	

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

Glass ID	Oxide	BDL (<)	Measured (wt %)	Targeted (wt %)	Difference of Measured versus Targeted (wt %)	% Difference of Measured versus Targeted
NP5-17-Q	F		0.378	0.570	-0.192	
NP5-17-Q	Fe_2O_3		2.888	2.340	0.548	
NP5-17-Q	Li_2O		1.215	1.350	-0.135	
NP5-17-Q	MnO		3.412	3.480	-0.068	
NP5-17-Q	Na_2O		7.421	8.130	-0.709	-8.7%
NP5-17-Q	NiO		0.445	0.550	-0.105	
NP5-17-Q	P_2O_5		0.360	0.580	-0.220	
NP5-17-Q	PbO		0.269	0.280	-0.011	
NP5-17-Q	RuO_2	<	0.066	0.010	0.056	
NP5-17-Q	SiO_2		23.265	23.560	-0.295	-1.3%
NP5-17-Q	SO_3		0.326	0.590	-0.264	
NP5-17-Q	SrO		0.270	0.270	0.000	
NP5-17-Q	ZrO_2		0.913	1.020	-0.107	
NP5-17-Q	Sum		99.856	100.000	-0.144	-0.1%
NP5-18-Q	Al_2O_3		20.596	21.350	-0.754	-3.5%
NP5-18-Q	B_2O_3		20.326	20.020	0.306	1.5%
NP5-18-Q	Bi_2O_3		0.819	0.880	-0.061	
NP5-18-Q	CaO		6.433	5.930	0.503	8.5%
NP5-18-Q	Cr_2O_3		0.848	0.820	0.028	
NP5-18-Q	F		0.155	0.280	-0.125	
NP5-18-Q	Fe_2O_3		3.035	2.560	0.475	
NP5-18-Q	Li_2O		1.245	1.600	-0.355	
NP5-18-Q	MnO		1.675	1.730	-0.055	
NP5-18-Q	Na_2O		11.367	12.260	-0.893	-7.3%
NP5-18-Q	NiO		0.205	0.280	-0.075	
NP5-18-Q	P_2O_5	<	0.115	0.020	0.095	
NP5-18-Q	PbO		0.133	0.140	-0.007	
NP5-18-Q	RuO_2	<	0.066	0.010	0.056	
NP5-18-Q	SiO_2		31.876	31.180	0.696	2.2%
NP5-18-Q	SO_3		0.247	0.290	-0.043	
NP5-18-Q	SrO		0.136	0.140	-0.004	
NP5-18-Q	ZrO_2		0.461	0.510	-0.049	
NP5-18-Q	Sum		99.737	100.000	-0.263	-0.3%
NP5-19-Q	Al_2O_3		21.399	22.430	-1.031	-4.6%
NP5-19-Q	B_2O_3		13.499	13.810	-0.311	-2.3%
NP5-19-Q	Bi_2O_3		1.970	2.080	-0.110	
NP5-19-Q	CaO		2.662	2.480	0.182	
NP5-19-Q	Cr_2O_3		2.021	1.940	0.081	
NP5-19-Q	F		0.506	0.670	-0.164	
NP5-19-Q	Fe_2O_3		4.239	3.770	0.469	
NP5-19-Q	Li_2O		2.589	2.920	-0.331	
NP5-19-Q	MnO		4.164	4.080	0.084	
NP5-19-Q	Na_2O		12.772	13.490	-0.718	-5.3%
NP5-19-Q	NiO		0.617	0.650	-0.033	
NP5-19-Q	P_2O_5		0.194	0.140	0.054	
NP5-19-Q	PbO		0.305	0.330	-0.025	
NP5-19-Q	RuO_2	<	0.066	0.020	0.046	
NP5-19-Q	SiO_2		29.362	28.990	0.372	1.3%
NP5-19-Q	SO_3		0.627	0.690	-0.063	
NP5-19-Q	SrO		0.327	0.320	0.007	
NP5-19-Q	ZrO_2		1.234	1.190	0.044	
NP5-19-Q	Sum		98.552	100.000	-1.448	-1.4%
NP5-20-Q	Al_2O_3		20.218	20.610	-0.392	-1.9%
NP5-20-Q	B_2O_3		17.082	16.490	0.592	3.6%
NP5-20-Q	Bi_2O_3		2.391	2.430	-0.039	
NP5-20-Q	CaO		3.495	3.220	0.275	
NP5-20-Q	Cr_2O_3		2.313	2.260	0.053	
NP5-20-Q	F		0.559	0.780	-0.221	

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

Glass ID	Oxide	BDL (<)	Measured (wt %)	Targeted (wt %)	Difference of Measured versus Targeted (wt %)	% Difference of Measured versus Targeted
NP5-20-Q	Fe_2O_3		4.518	4.040	0.478	
NP5-20-Q	Li_2O		2.912	3.350	-0.438	
NP5-20-Q	MnO		4.871	4.770	0.101	
NP5-20-Q	Na_2O		9.638	10.330	-0.692	-6.7%
NP5-20-Q	NiO		0.688	0.760	-0.072	
NP5-20-Q	P_2O_5		0.955	1.090	-0.135	
NP5-20-Q	PbO		0.364	0.380	-0.016	
NP5-20-Q	RuO_2	<	0.066	0.020	0.046	
NP5-20-Q	SiO_2		27.597	26.910	0.687	2.6%
NP5-20-Q	SO_3		0.695	0.800	-0.105	
NP5-20-Q	SrO		0.384	0.370	0.014	
NP5-20-Q	ZrO_2		1.342	1.390	-0.048	
NP5-20-Q	Sum		100.087	100.000	0.087	0.1%
NP5-21-Q	Al_2O_3		25.603	25.880	-0.277	-1.1%
NP5-21-Q	B_2O_3		13.733	13.530	0.203	1.5%
NP5-21-Q	Bi_2O_3		2.347	2.510	-0.163	
NP5-21-Q	CaO		2.260	2.050	0.210	
NP5-21-Q	Cr_2O_3		2.525	2.330	0.195	
NP5-21-Q	F		0.610	0.810	-0.200	
NP5-21-Q	Fe_2O_3		3.288	2.610	0.678	
NP5-21-Q	Li_2O		5.689	5.910	-0.221	-3.7%
NP5-21-Q	MnO		5.184	4.920	0.264	
NP5-21-Q	Na_2O		8.307	9.330	-1.023	-11.0%
NP5-21-Q	NiO		0.813	0.780	0.033	
NP5-21-Q	P_2O_5		1.958	1.940	0.018	
NP5-21-Q	PbO		0.387	0.400	-0.013	
NP5-21-Q	RuO_2	<	0.066	0.020	0.046	
NP5-21-Q	SiO_2		25.190	24.330	0.860	3.5%
NP5-21-Q	SO_3		0.774	0.830	-0.056	
NP5-21-Q	SrO		0.394	0.390	0.004	
NP5-21-Q	ZrO_2		1.523	1.430	0.093	
NP5-21-Q	Sum		100.650	100.000	0.650	0.7%
NP5-22-Q	Al_2O_3		22.910	22.910	0.000	0.0%
NP5-22-Q	B_2O_3		18.877	18.500	0.377	2.0%
NP5-22-Q	Bi_2O_3		2.344	2.360	-0.016	
NP5-22-Q	CaO		6.006	5.160	0.846	16.4%
NP5-22-Q	Cr_2O_3		2.390	2.200	0.190	
NP5-22-Q	F		0.550	0.760	-0.210	
NP5-22-Q	Fe_2O_3		2.531	1.910	0.621	
NP5-22-Q	Li_2O		1.116	1.200	-0.084	
NP5-22-Q	MnO		4.949	4.640	0.309	
NP5-22-Q	Na_2O		10.275	10.850	-0.575	-5.3%
NP5-22-Q	NiO		0.769	0.730	0.039	
NP5-22-Q	P_2O_5		1.416	1.350	0.066	
NP5-22-Q	PbO		0.362	0.370	-0.008	
NP5-22-Q	RuO_2	<	0.066	0.020	0.046	
NP5-22-Q	SiO_2		25.565	24.550	1.015	4.1%
NP5-22-Q	SO_3		0.548	0.780	-0.232	
NP5-22-Q	SrO		0.372	0.360	0.012	
NP5-22-Q	ZrO_2		1.455	1.350	0.105	
NP5-22-Q	Sum		102.500	100.000	2.500	2.5%
NP5-23-Q	Al_2O_3		28.437	28.660	-0.223	-0.8%
NP5-23-Q	B_2O_3		17.935	17.300	0.635	3.7%
NP5-23-Q	Bi_2O_3		1.405	1.470	-0.065	
NP5-23-Q	CaO		7.132	6.580	0.552	8.4%
NP5-23-Q	Cr_2O_3		1.445	1.370	0.075	
NP5-23-Q	F		0.325	0.470	-0.145	
NP5-23-Q	Fe_2O_3		2.484	1.960	0.524	

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

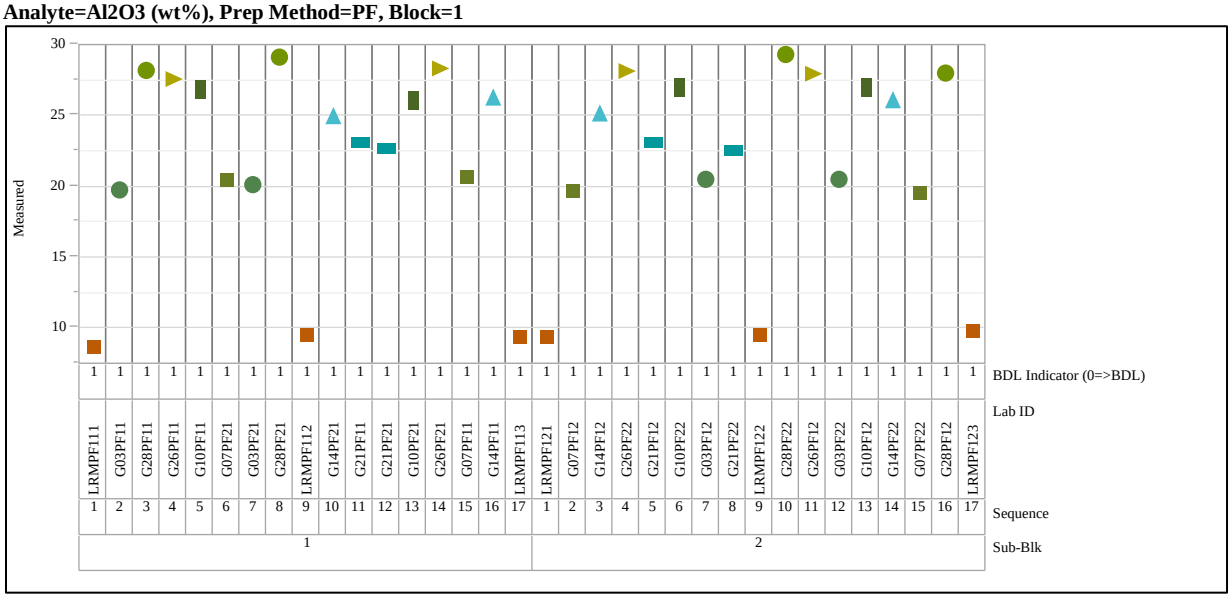
Glass ID	Oxide	BDL (<)	Measured (wt %)	Targeted (wt %)	Difference of Measured versus Targeted (wt %)	% Difference of Measured versus Targeted
NP5-23-Q	Li_2O		2.691	2.890	-0.199	
NP5-23-Q	MnO		2.841	2.880	-0.039	
NP5-23-Q	Na_2O		10.228	11.450	-1.222	-10.7%
NP5-23-Q	NiO		0.363	0.460	-0.097	
NP5-23-Q	P_2O_5	<	0.115	0.030	0.085	
NP5-23-Q	PbO		0.231	0.230	0.001	
NP5-23-Q	RuO_2	<	0.066	0.010	0.056	
NP5-23-Q	SiO_2		22.677	22.690	-0.013	-0.1%
NP5-23-Q	SO_3		0.464	0.480	-0.016	
NP5-23-Q	SrO		0.226	0.230	-0.004	
NP5-23-Q	ZrO_2		0.772	0.840	-0.068	
NP5-23-Q	Sum		99.835	100.000	-0.165	-0.2%
NP5-24-Q	Al_2O_3		24.186	24.420	-0.234	-1.0%
NP5-24-Q	B_2O_3		18.281	17.410	0.871	5.0%
NP5-24-Q	Bi_2O_3		0.887	0.950	-0.063	
NP5-24-Q	CaO		3.351	3.080	0.271	
NP5-24-Q	Cr_2O_3		0.936	0.880	0.056	
NP5-24-Q	F		0.198	0.300	-0.102	
NP5-24-Q	Fe_2O_3		2.380	1.830	0.550	
NP5-24-Q	Li_2O		1.722	2.050	-0.328	
NP5-24-Q	MnO		1.827	1.860	-0.033	
NP5-24-Q	Na_2O		13.709	14.990	-1.281	-8.5%
NP5-24-Q	NiO		0.216	0.290	-0.074	
NP5-24-Q	P_2O_5		0.409	0.560	-0.151	
NP5-24-Q	PbO		0.147	0.150	-0.003	
NP5-24-Q	RuO_2	<	0.066	0.010	0.056	
NP5-24-Q	SiO_2		31.501	30.220	1.281	4.2%
NP5-24-Q	SO_3		0.297	0.310	-0.013	
NP5-24-Q	SrO		0.149	0.150	-0.001	
NP5-24-Q	ZrO_2		0.490	0.540	-0.050	
NP5-24-Q	Sum		100.753	100.000	0.753	0.8%
NP5-25-Q	Al_2O_3		27.870	28.950	-1.080	-3.7%
NP5-25-Q	B_2O_3		13.290	12.870	0.420	3.3%
NP5-25-Q	Bi_2O_3		1.561	1.650	-0.089	
NP5-25-Q	CaO		1.421	1.460	-0.039	
NP5-25-Q	Cr_2O_3		1.539	1.540	-0.001	
NP5-25-Q	F		0.381	0.530	-0.149	
NP5-25-Q	Fe_2O_3		2.202	1.760	0.442	
NP5-25-Q	Li_2O		5.151	5.630	-0.479	-8.5%
NP5-25-Q	MnO		3.109	3.250	-0.141	
NP5-25-Q	Na_2O		11.721	13.020	-1.299	-10.0%
NP5-25-Q	NiO		0.397	0.510	-0.113	
NP5-25-Q	P_2O_5	<	0.140	0.360	-0.220	
NP5-25-Q	PbO		0.247	0.260	-0.013	
NP5-25-Q	RuO_2	<	0.066	0.010	0.056	
NP5-25-Q	SiO_2		25.672	26.450	-0.778	-2.9%
NP5-25-Q	SO_3		0.525	0.550	-0.025	
NP5-25-Q	SrO		0.258	0.250	0.008	
NP5-25-Q	ZrO_2		0.844	0.950	-0.106	
NP5-25-Q	Sum		96.393	100.000	-3.607	-3.6%
NP5-26-Q	Al_2O_3		20.123	20.790	-0.667	-3.2%
NP5-26-Q	B_2O_3		20.285	20.810	-0.525	-2.5%
NP5-26-Q	Bi_2O_3		2.319	2.340	-0.021	
NP5-26-Q	CaO		1.339	1.340	-0.001	
NP5-26-Q	Cr_2O_3		2.233	2.180	0.053	
NP5-26-Q	F		0.533	0.750	-0.217	
NP5-26-Q	Fe_2O_3		2.656	2.180	0.476	
NP5-26-Q	Li_2O		0.459	0.510	-0.051	

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

Glass ID	Oxide	BDL (<)	Measured (wt %)	Targeted (wt %)	Difference of Measured versus Targeted (wt %)	% Difference of Measured versus Targeted
NP5-26-Q	MnO		4.564	4.590	-0.026	
NP5-26-Q	Na_2O		13.723	14.400	-0.677	-4.7%
NP5-26-Q	NiO		0.734	0.730	0.004	
NP5-26-Q	P_2O_5		0.267	0.220	0.047	
NP5-26-Q	PbO		0.361	0.370	-0.009	
NP5-26-Q	RuO_2	<	0.066	0.020	0.046	
NP5-26-Q	SiO_2		26.367	26.300	0.067	0.3%
NP5-26-Q	SO_3		0.561	0.770	-0.209	
NP5-26-Q	SrO		0.365	0.360	0.005	
NP5-26-Q	ZrO_2		1.398	1.340	0.058	
NP5-26-Q	Sum		98.352	100.000	-1.648	-1.6%
NP5-27-Q	Al_2O_3		25.603	26.700	-1.097	-4.1%
NP5-27-Q	B_2O_3		16.148	16.570	-0.422	-2.5%
NP5-27-Q	Bi_2O_3		1.065	1.070	-0.005	
NP5-27-Q	CaO		5.142	4.730	0.412	
NP5-27-Q	Cr_2O_3		1.084	0.990	0.094	
NP5-27-Q	F		0.210	0.340	-0.130	
NP5-27-Q	Fe_2O_3		2.777	2.250	0.527	
NP5-27-Q	Li_2O		4.876	5.280	-0.404	-7.7%
NP5-27-Q	MnO		2.043	2.100	-0.057	
NP5-27-Q	Na_2O		9.318	10.080	-0.762	-7.6%
NP5-27-Q	NiO		0.331	0.330	0.001	
NP5-27-Q	P_2O_5	<	0.178	0.100	0.078	
NP5-27-Q	PbO		0.163	0.170	-0.007	
NP5-27-Q	RuO_2	<	0.066	0.010	0.056	
NP5-27-Q	SiO_2		28.025	28.160	-0.135	-0.5%
NP5-27-Q	SO_3		0.330	0.350	-0.020	
NP5-27-Q	SrO		0.157	0.160	-0.003	
NP5-27-Q	ZrO_2		0.667	0.610	0.057	
NP5-27-Q	Sum		98.183	100.000	-1.817	-1.8%

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

Analyte=Al2O3 (wt%), Prep Method=PF, Block=1



Analyte=Al2O3 (wt%), Prep Method=PF, Block=2

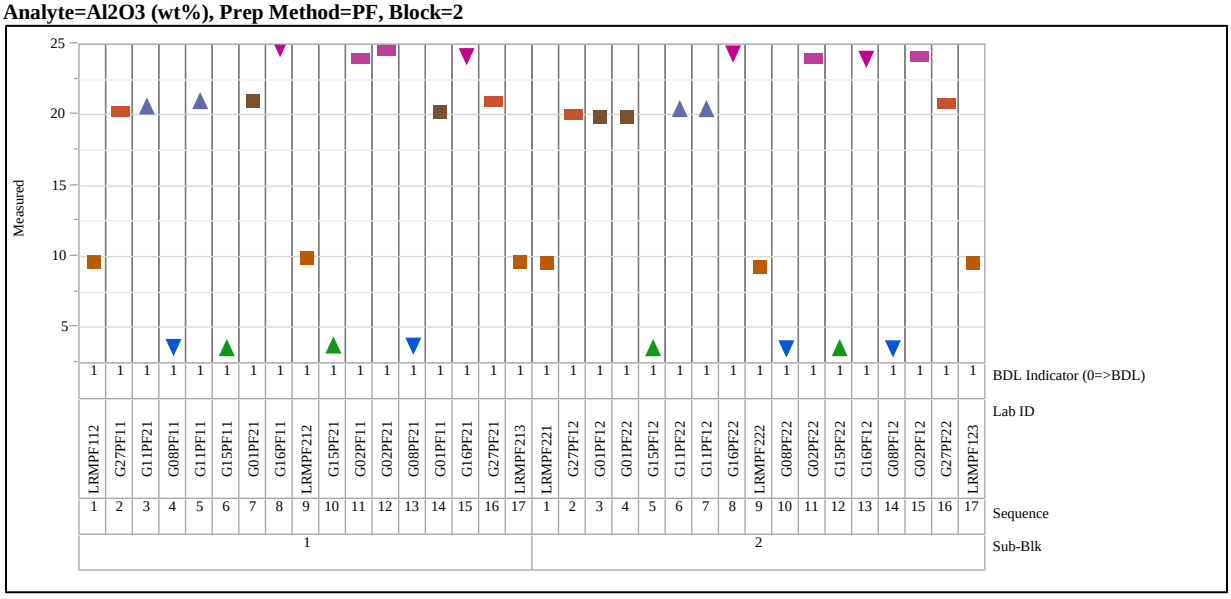
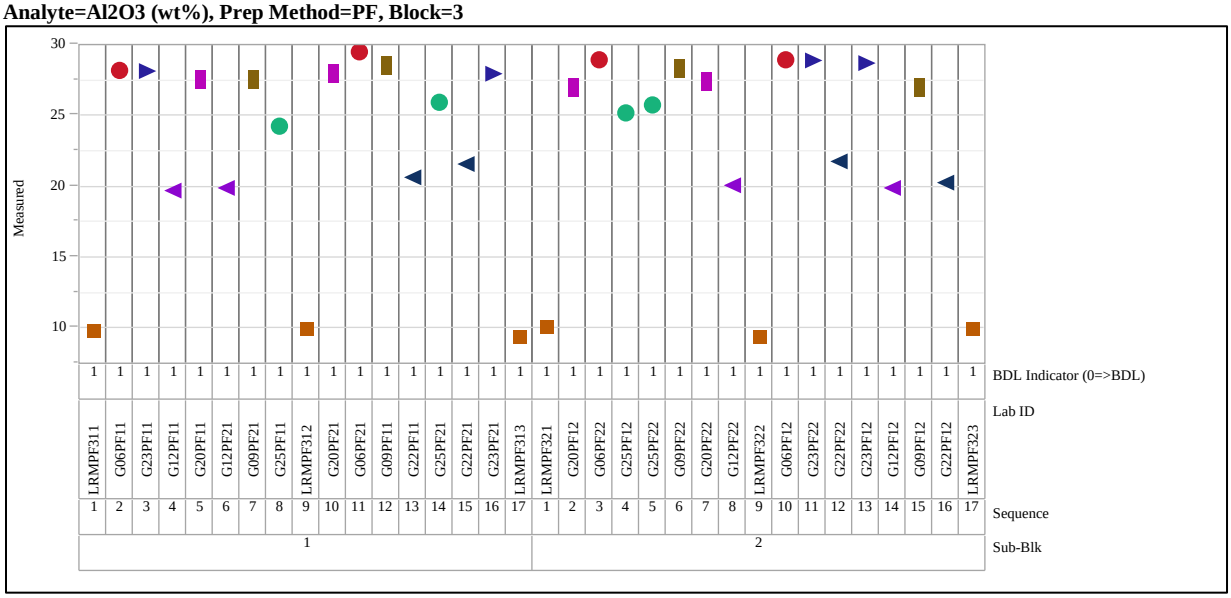


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=Al2O3 (wt%), Prep Method=PF, Block=3



Analyte=Al2O3 (wt%), Prep Method=PF, Block=4

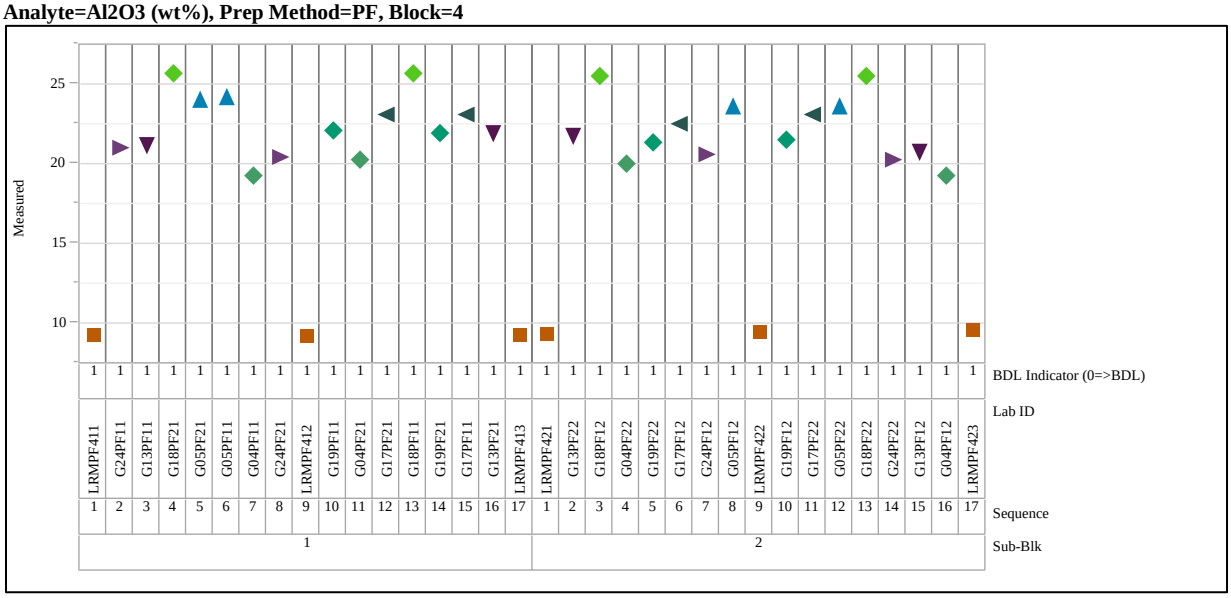
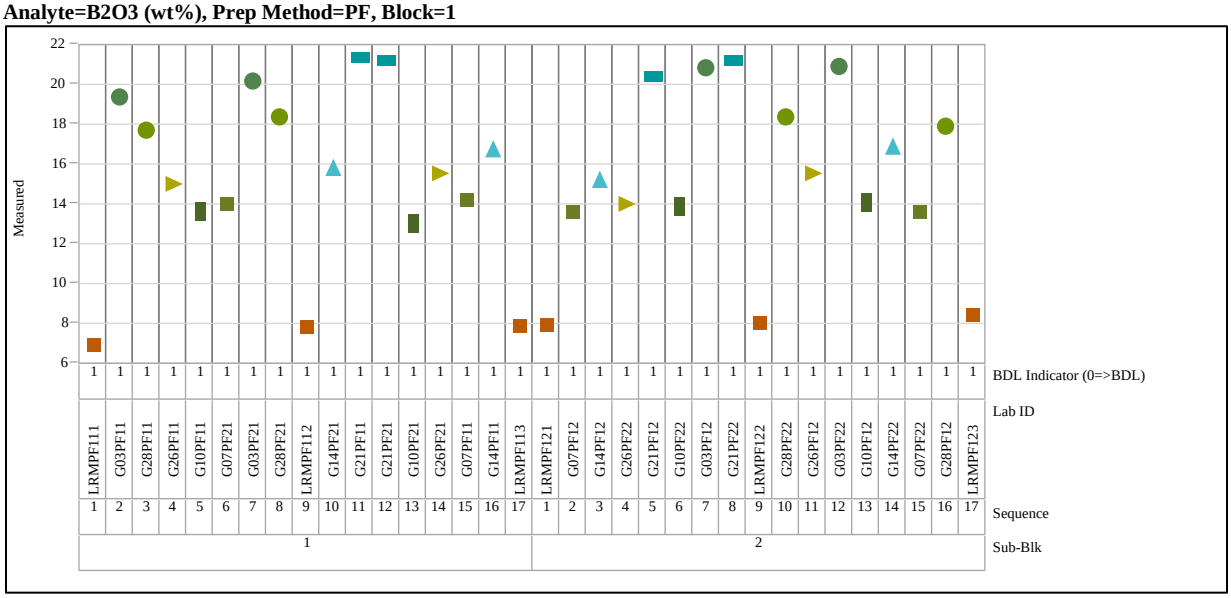


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=B2O3 (wt%), Prep Method=PF, Block=1



Analyte=B2O3 (wt%), Prep Method=PF, Block=2

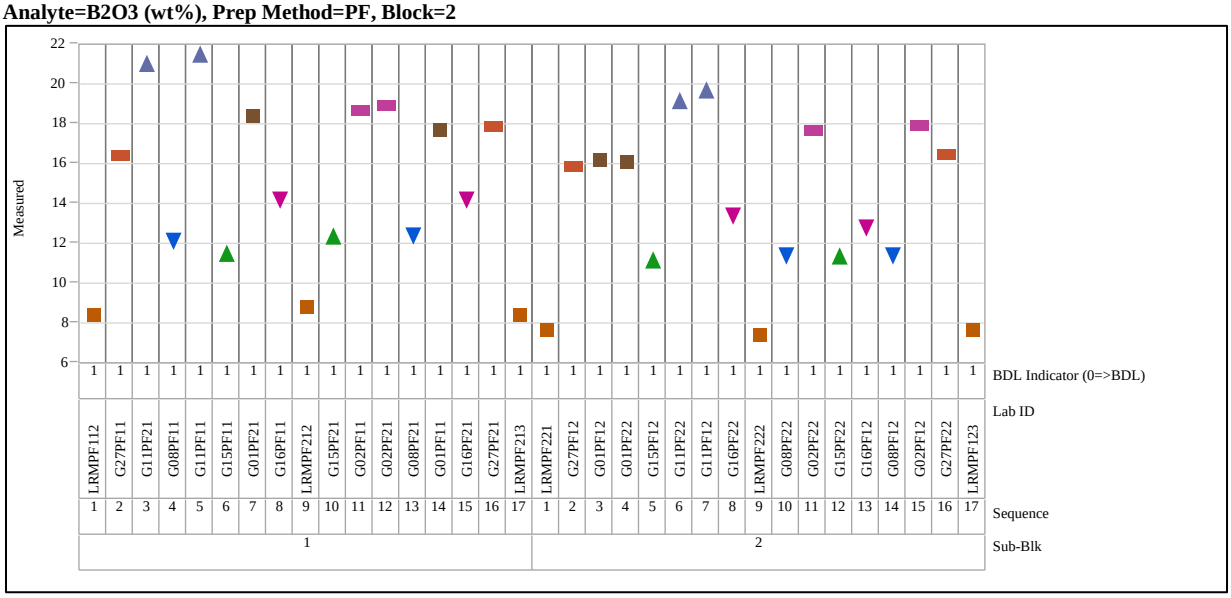
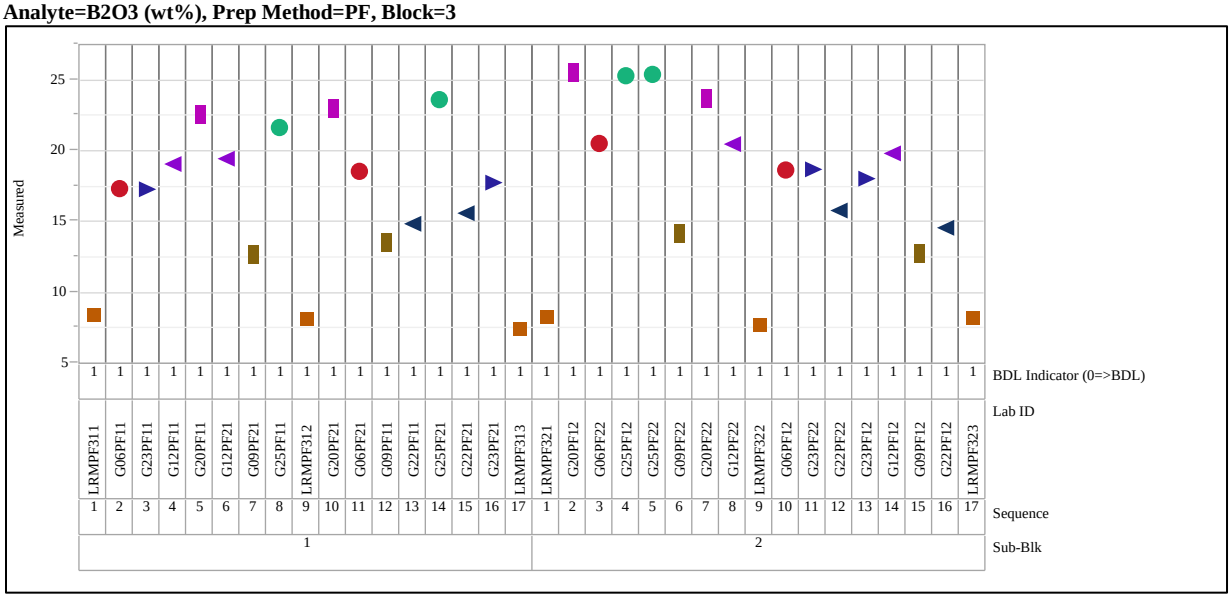


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=B2O3 (wt%), Prep Method=PF, Block=3



Analyte=B2O3 (wt%), Prep Method=PF, Block=4

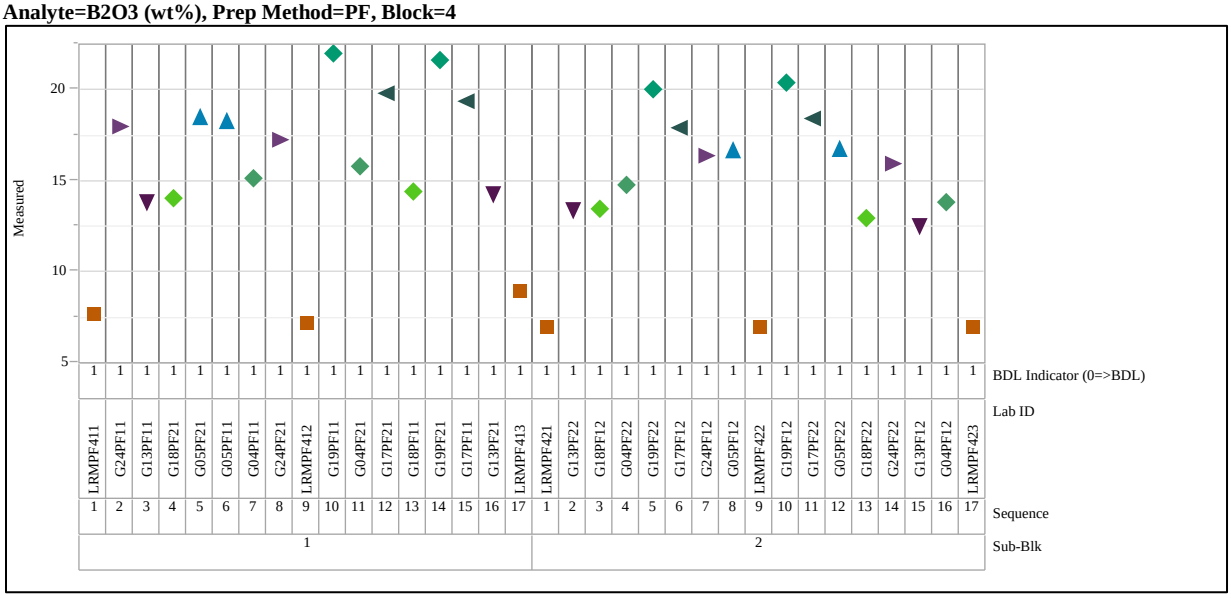
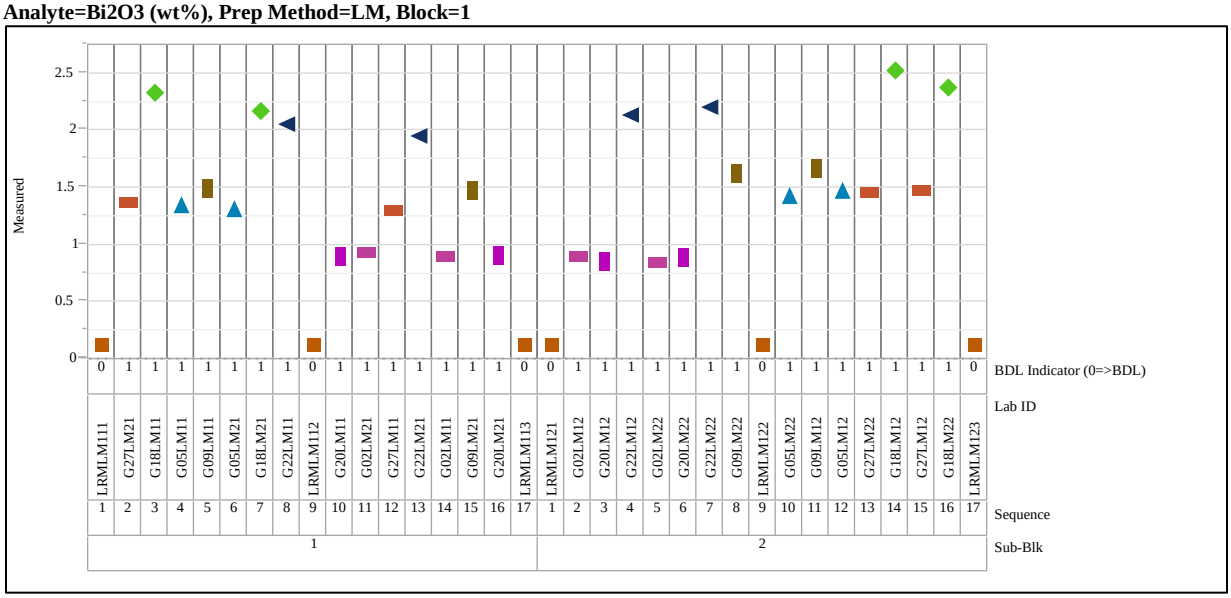


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=Bi2O3 (wt%), Prep Method=LM, Block=1



Analyte=Bi2O3 (wt%), Prep Method=LM, Block=2

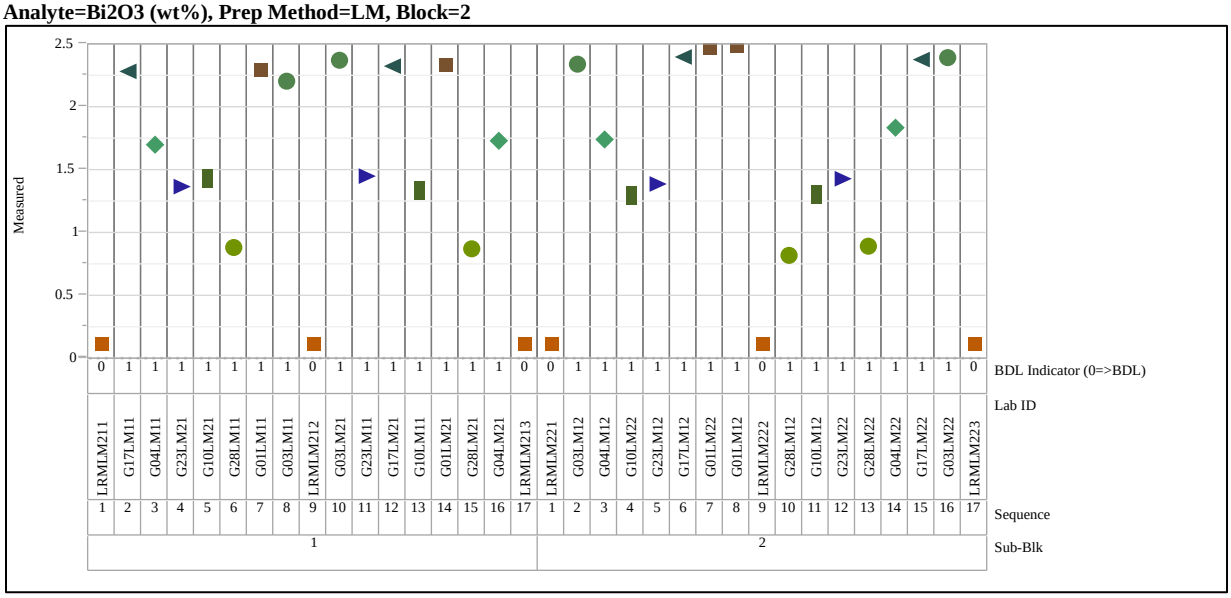
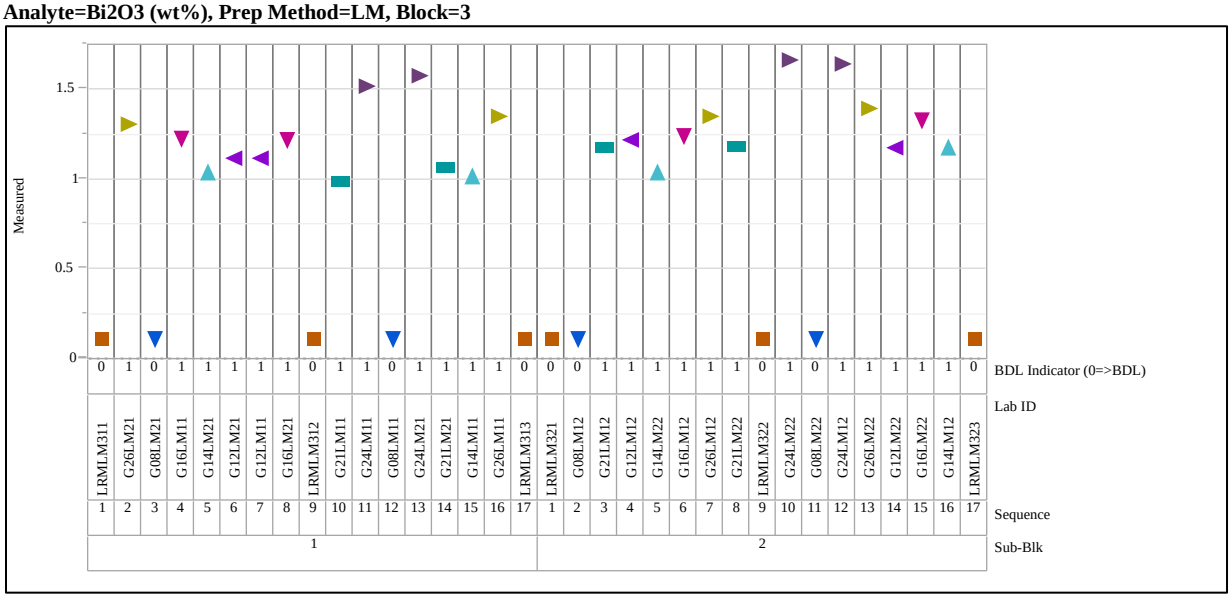


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=Bi2O3 (wt%), Prep Method=LM, Block=3



Analyte=Bi2O3 (wt%), Prep Method=LM, Block=4

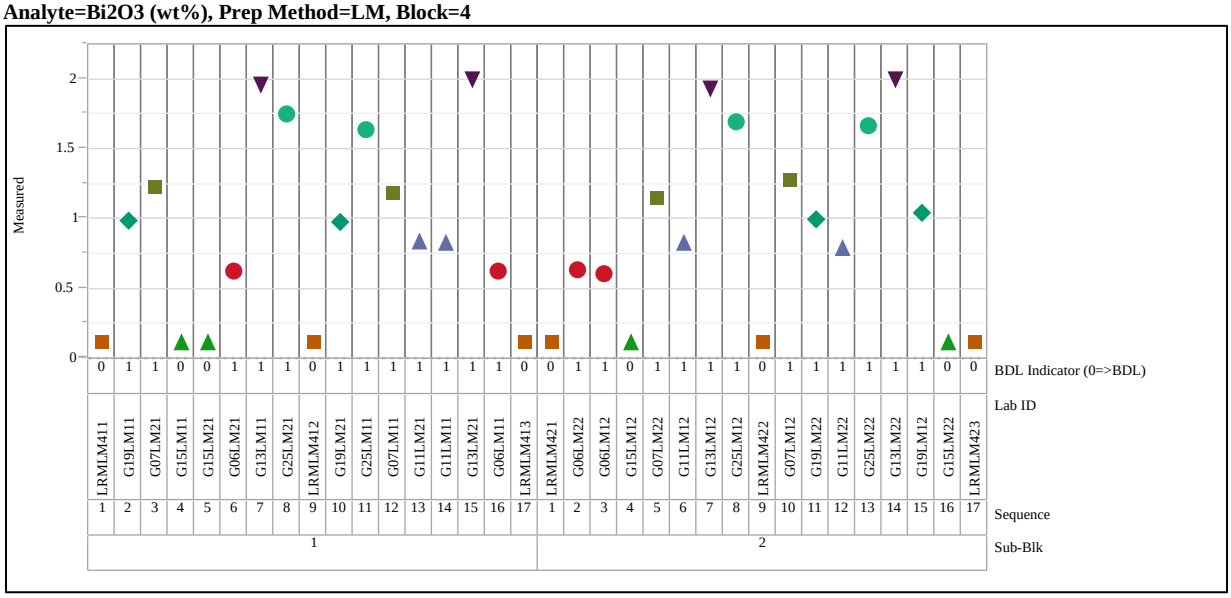
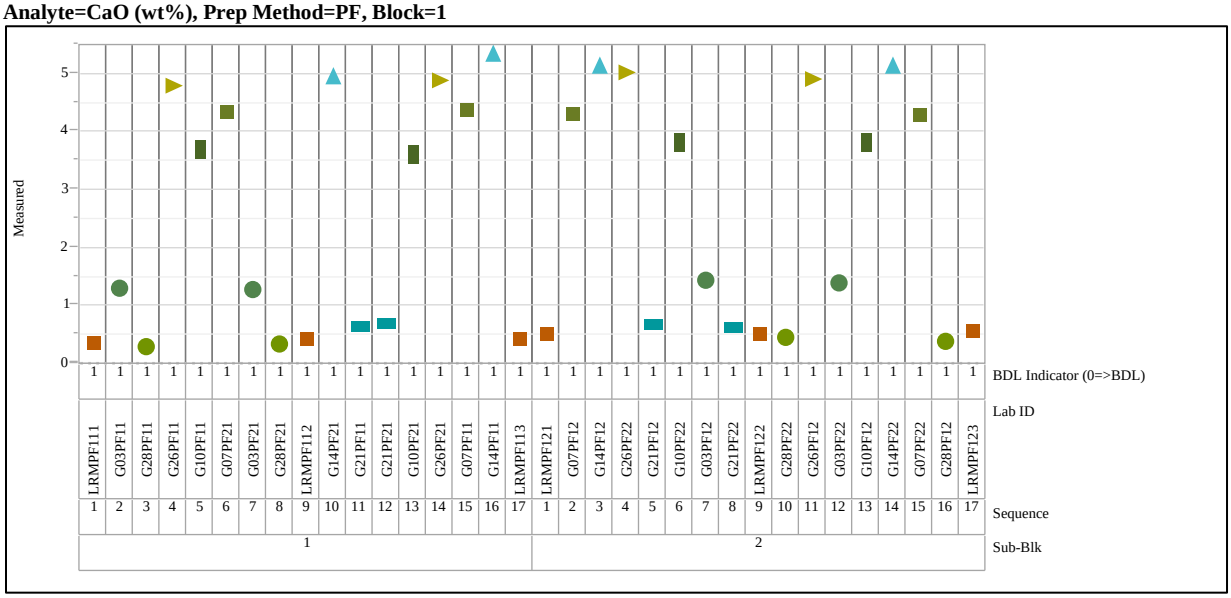


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=CaO (wt%), Prep Method=PF, Block=1



Analyte=CaO (wt%), Prep Method=PF, Block=2

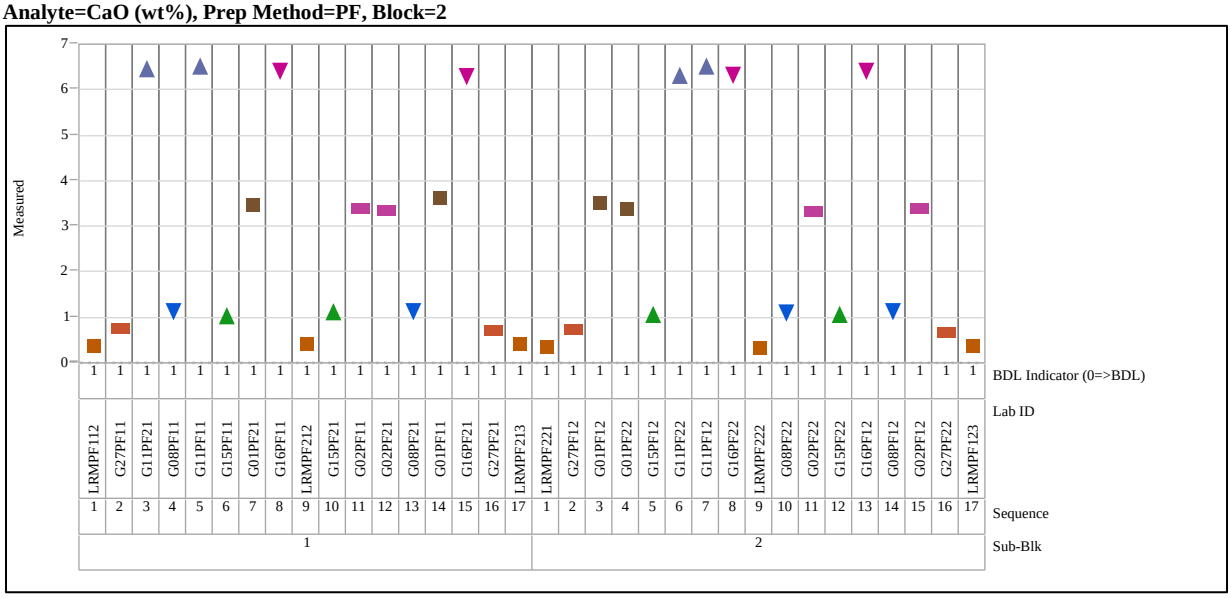
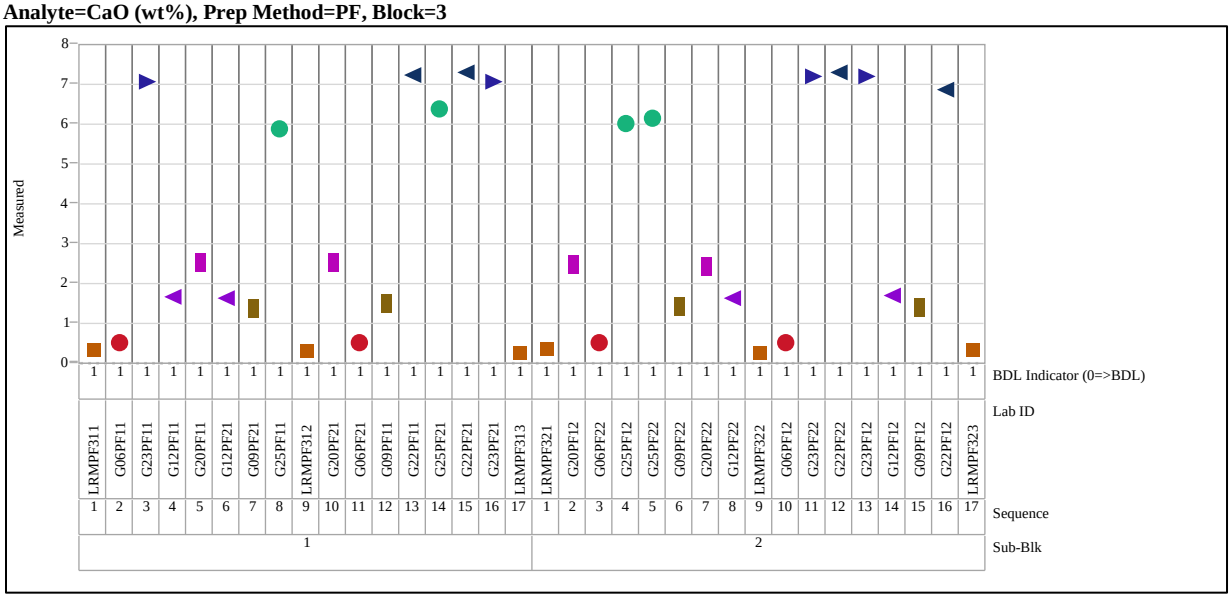


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=CaO (wt%), Prep Method=PF, Block=3



Analyte=CaO (wt%), Prep Method=PF, Block=4

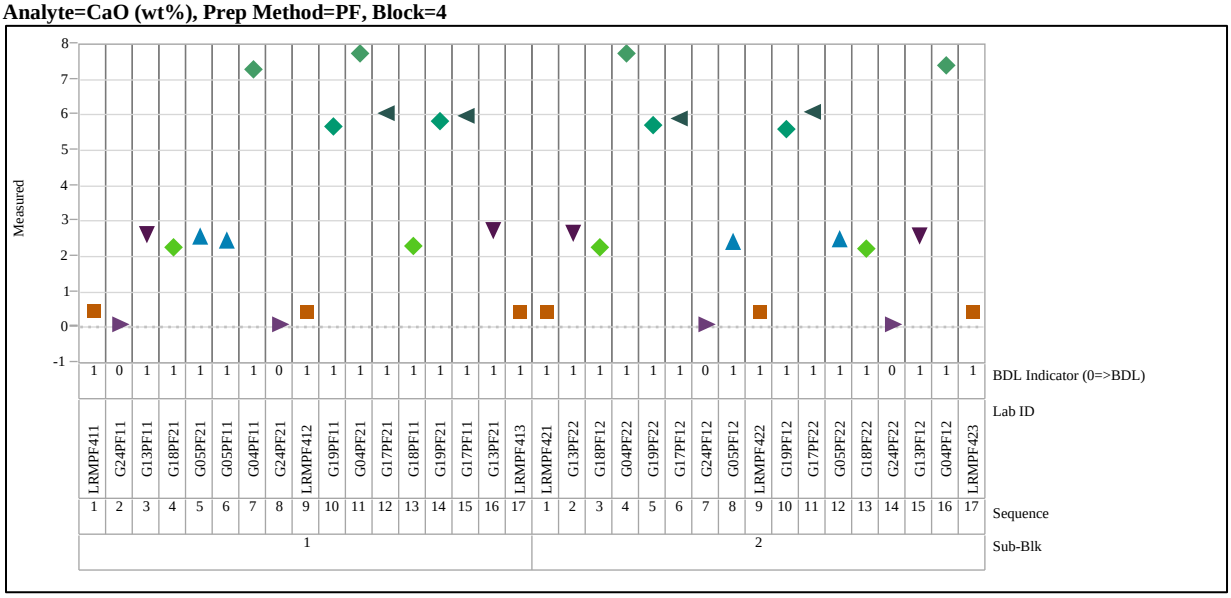
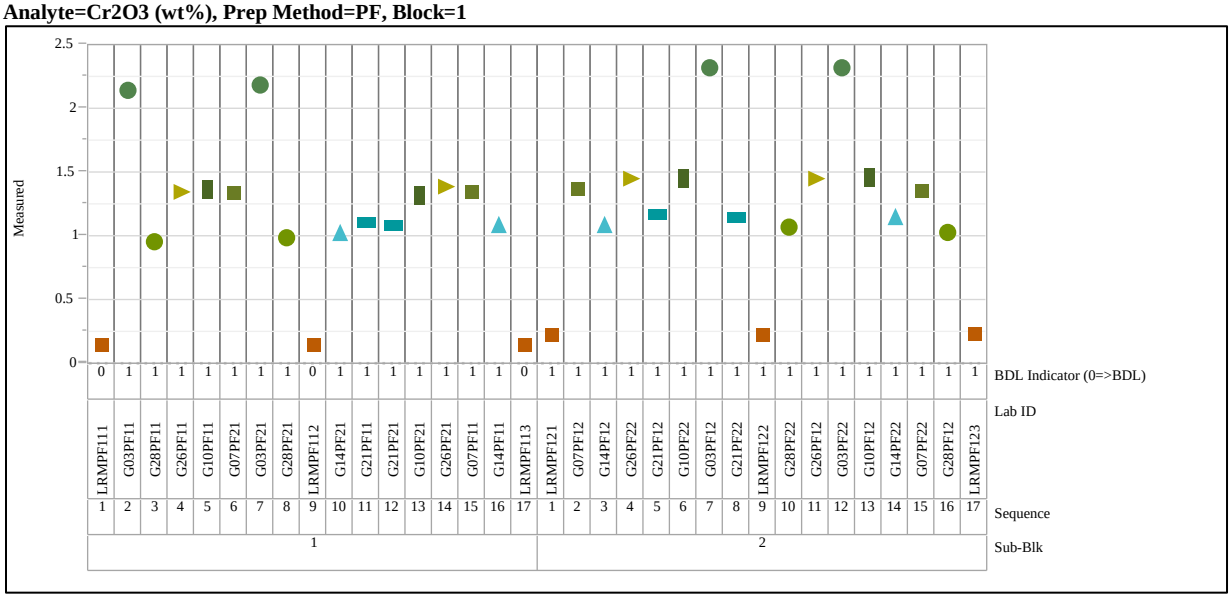


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=Cr2O3 (wt%), Prep Method=PF, Block=1



Analyte=Cr2O3 (wt%), Prep Method=PF, Block=2

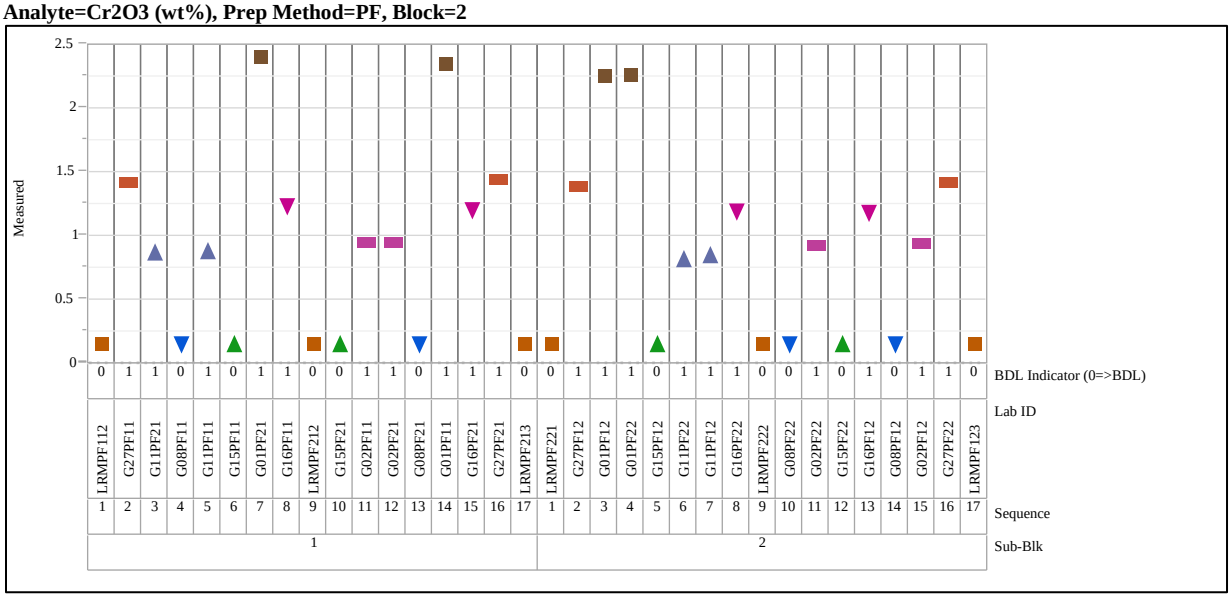
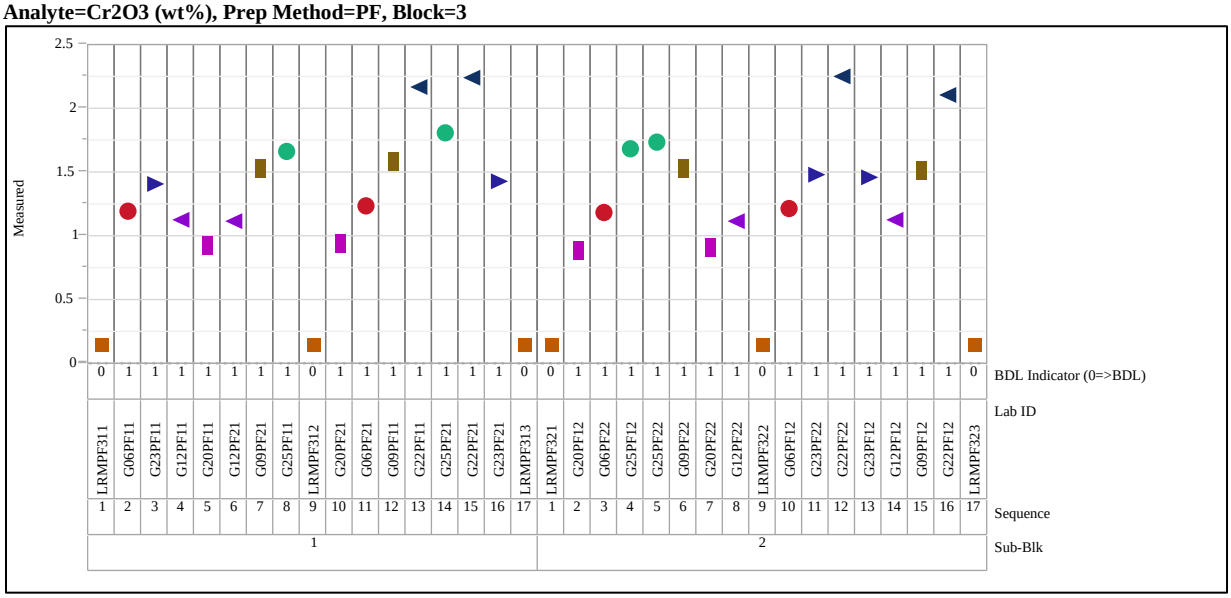


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=Cr2O3 (wt%), Prep Method=PF, Block=3



Analyte=Cr2O3 (wt%), Prep Method=PF, Block=4

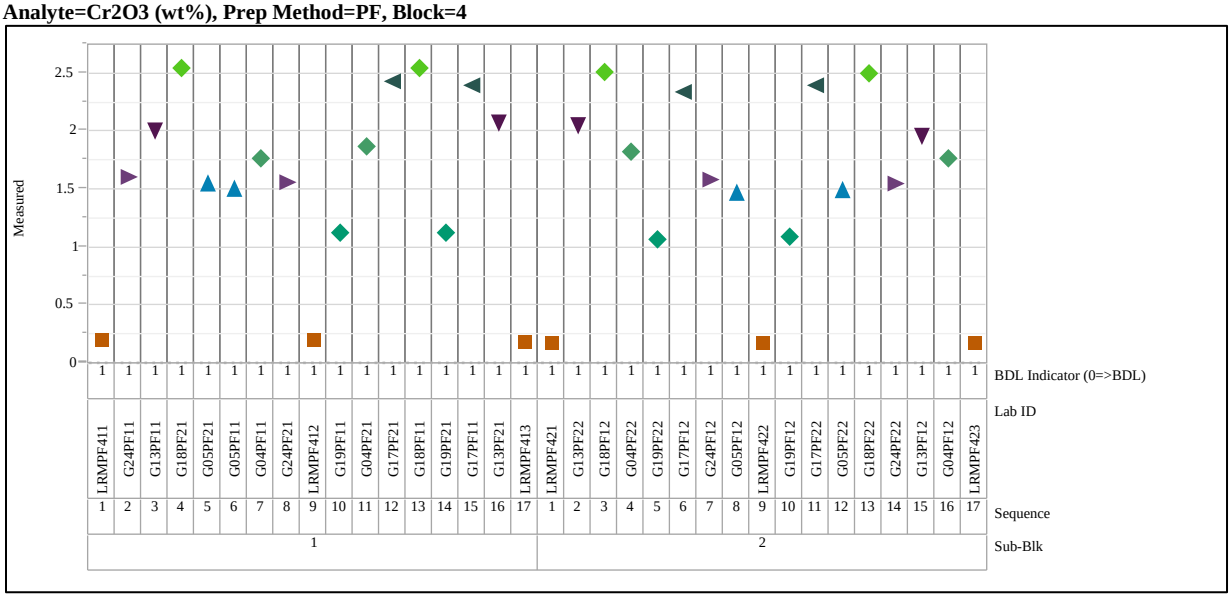
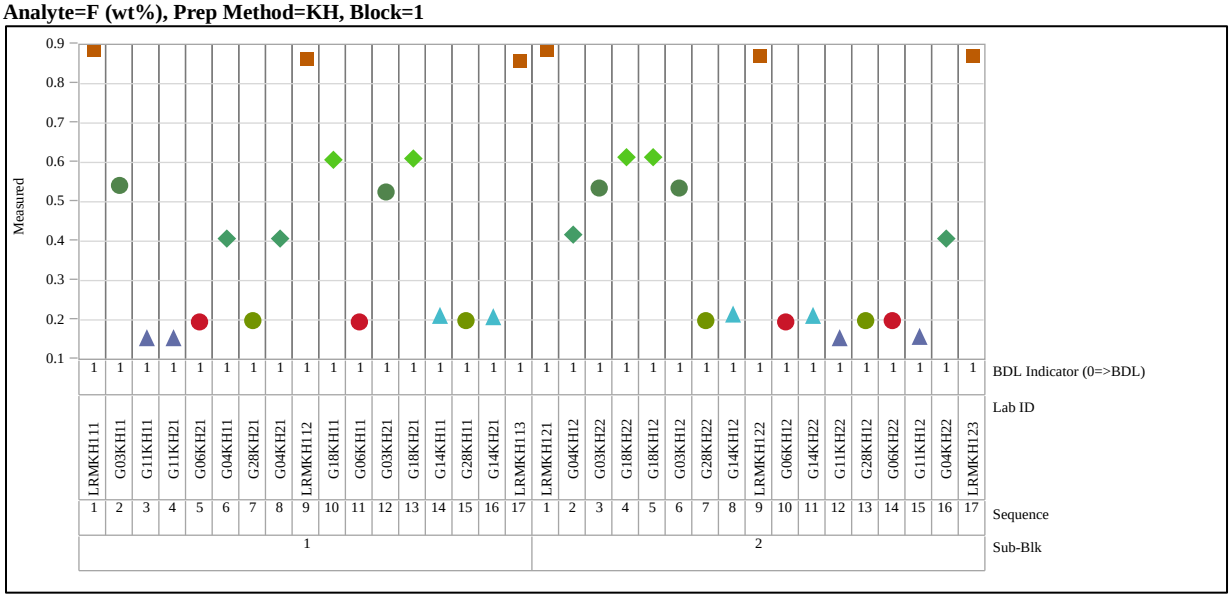


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=F (wt%), Prep Method=KH, Block=1



Analyte=F (wt%), Prep Method=KH, Block=2

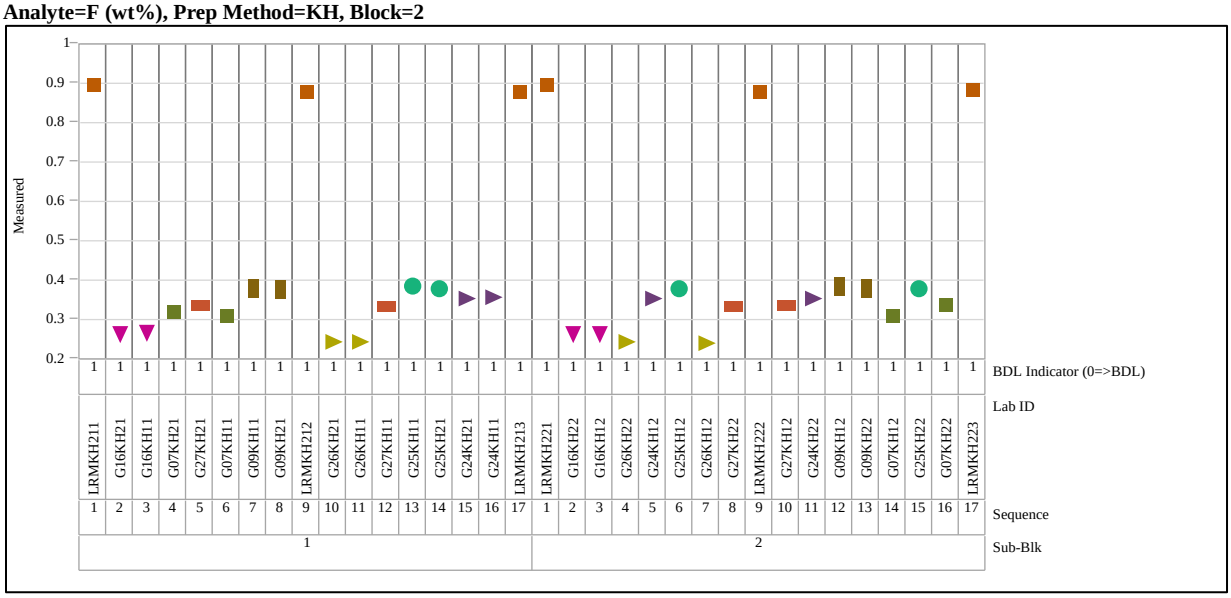
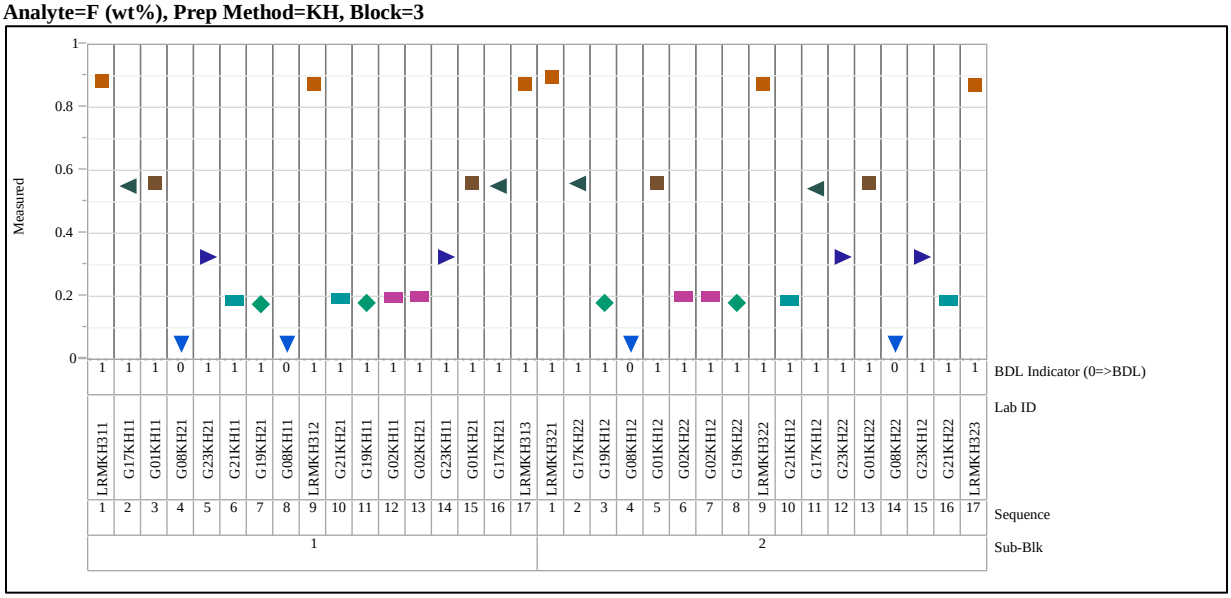


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=F (wt%), Prep Method=KH, Block=3



Analyte=F (wt%), Prep Method=KH, Block=4

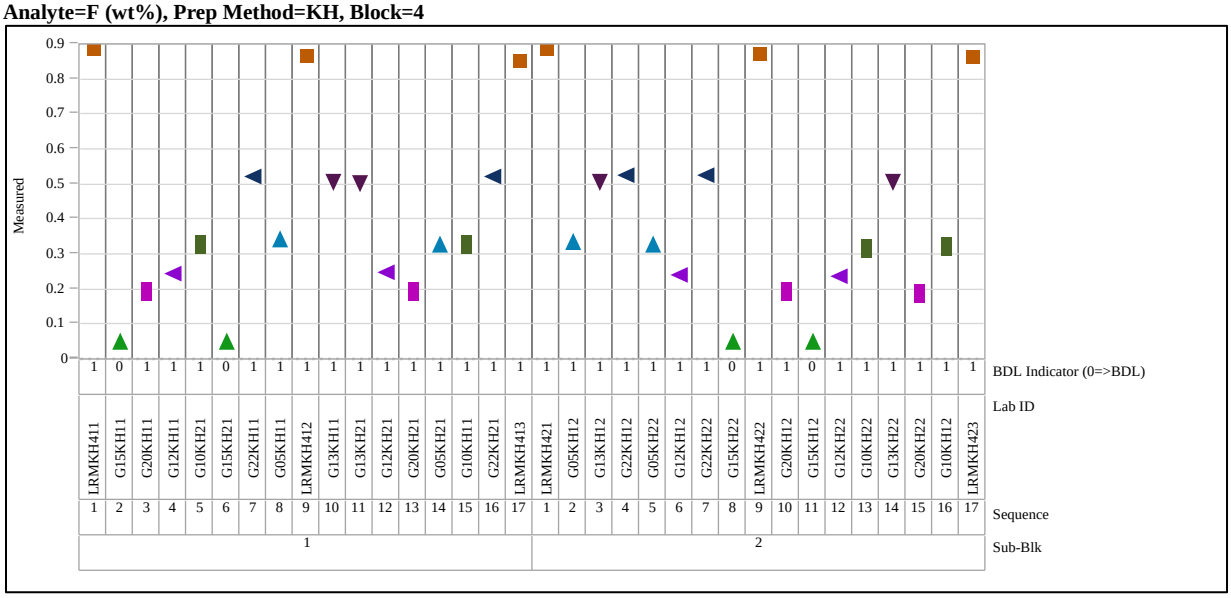
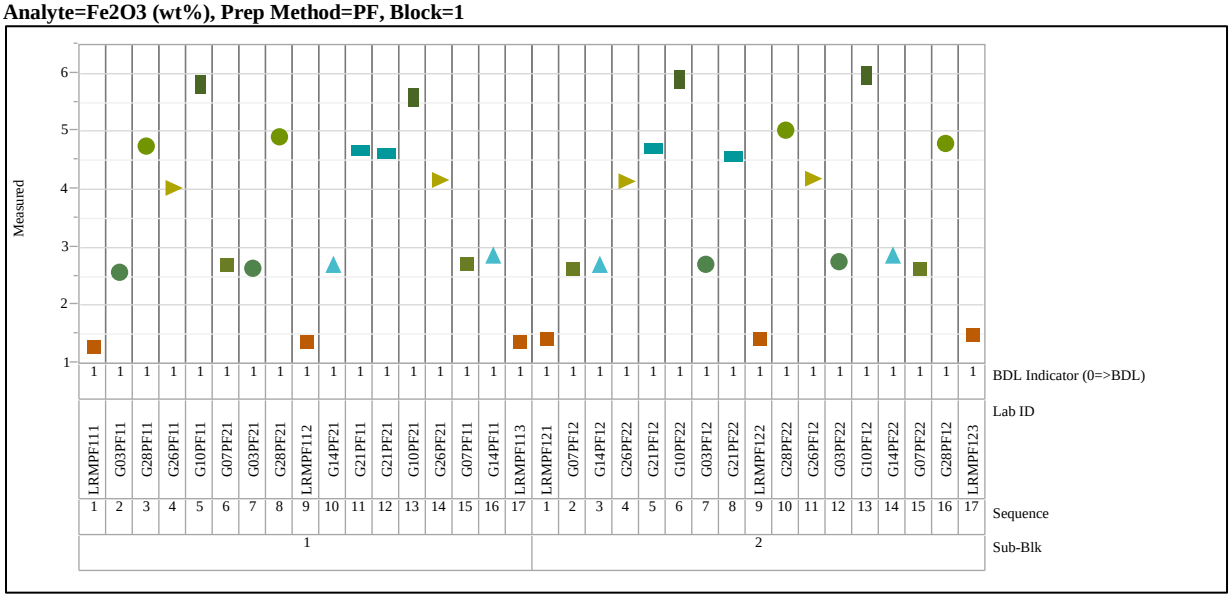


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=Fe2O3 (wt%), Prep Method=PF, Block=1



Analyte=Fe2O3 (wt%), Prep Method=PF, Block=2

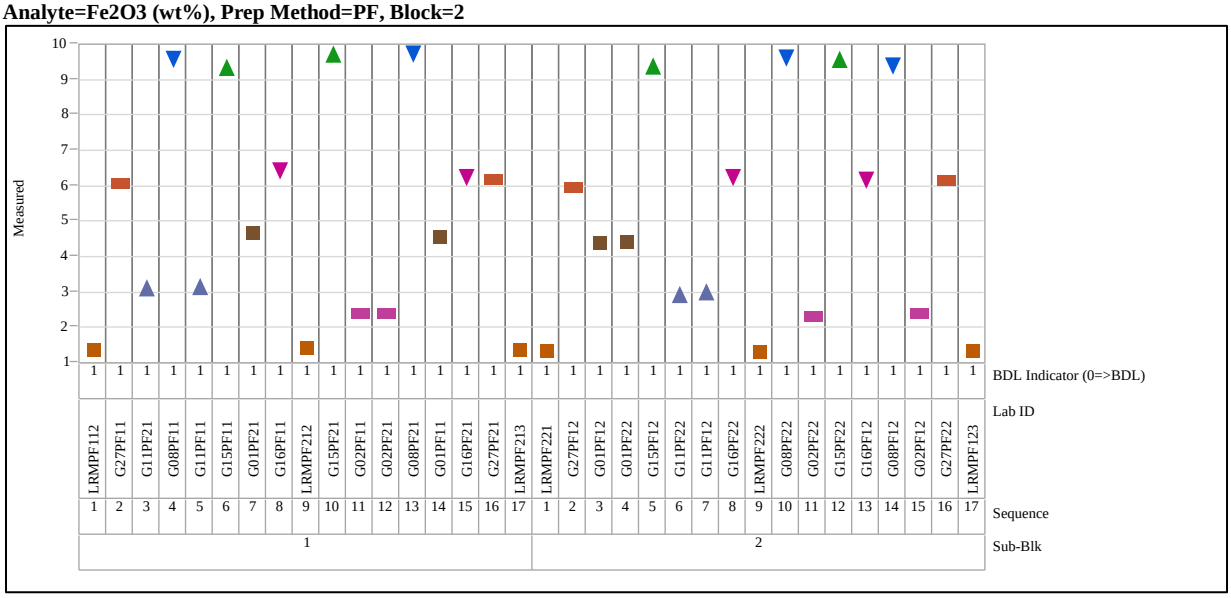
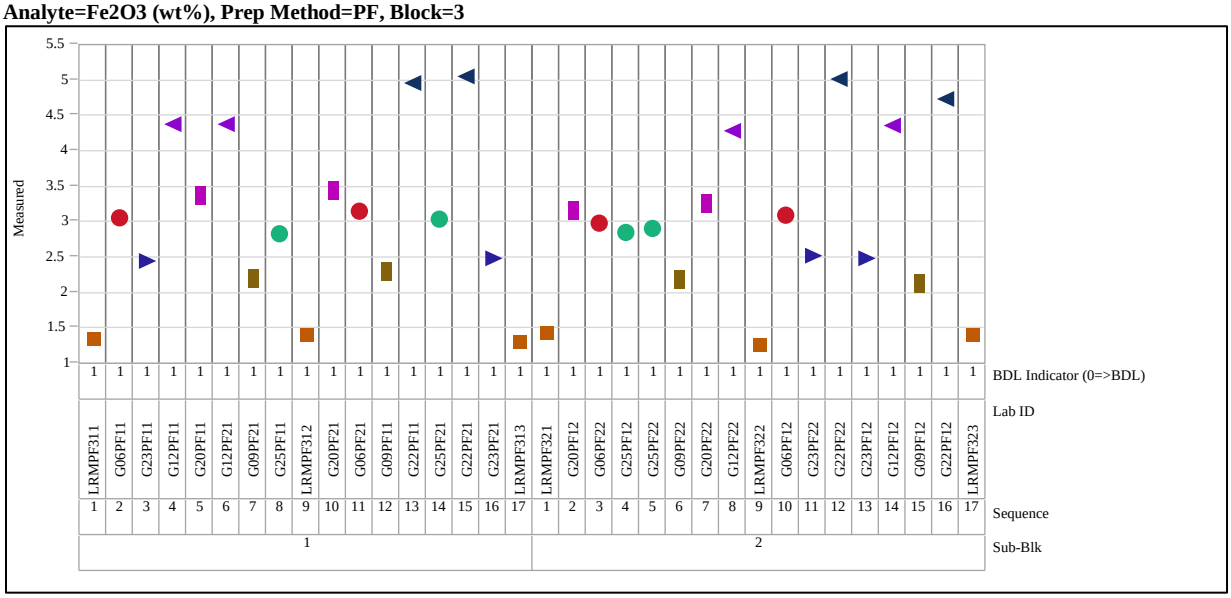


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=Fe2O3 (wt%), Prep Method=PF, Block=3



Analyte=Fe2O3 (wt%), Prep Method=PF, Block=4

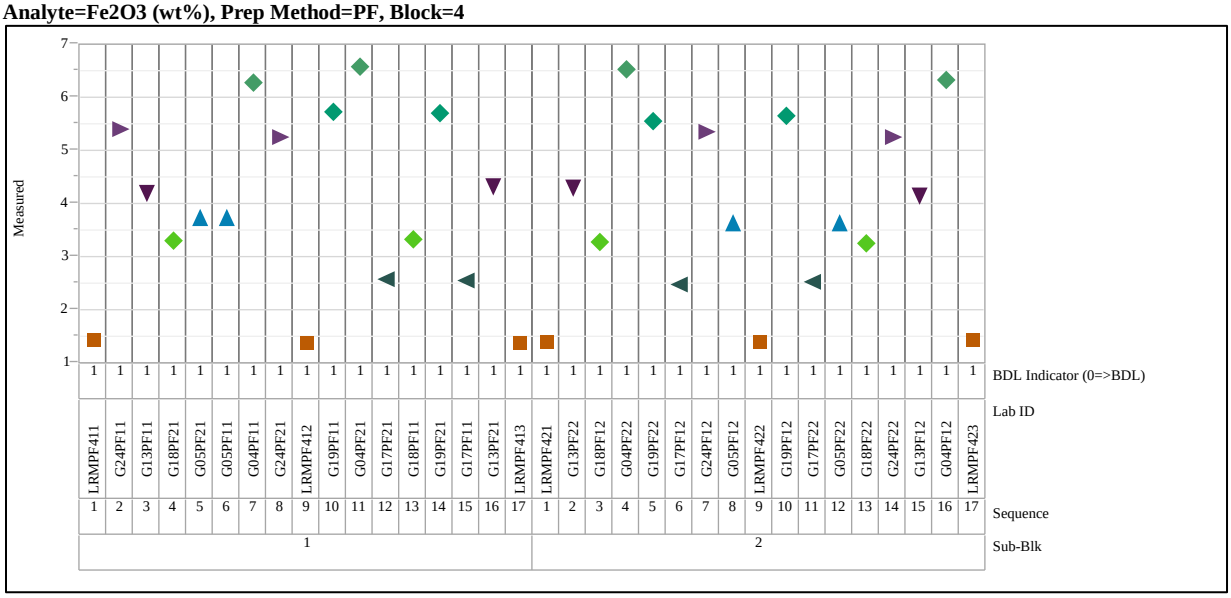
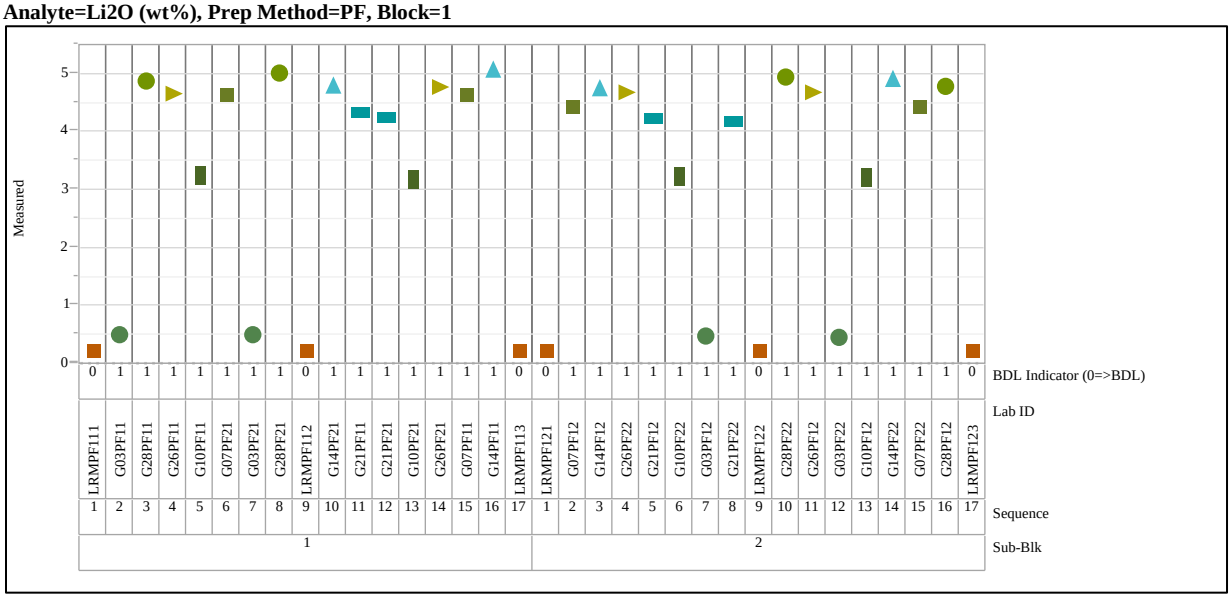


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=Li2O (wt%), Prep Method=PF, Block=1



Analyte=Li2O (wt%), Prep Method=PF, Block=2

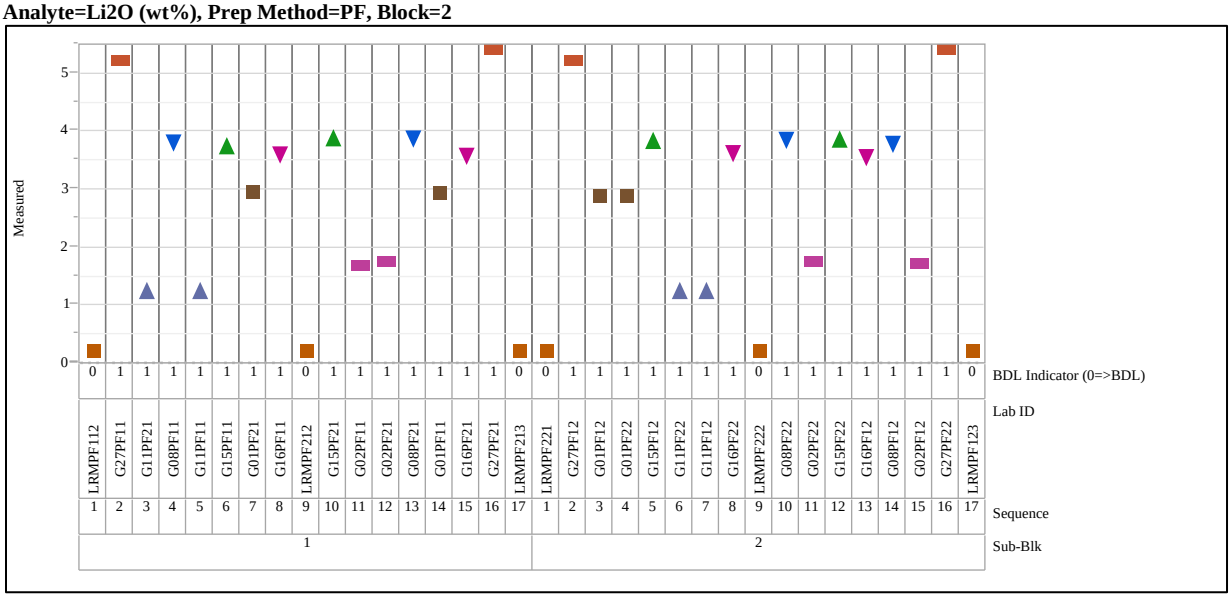
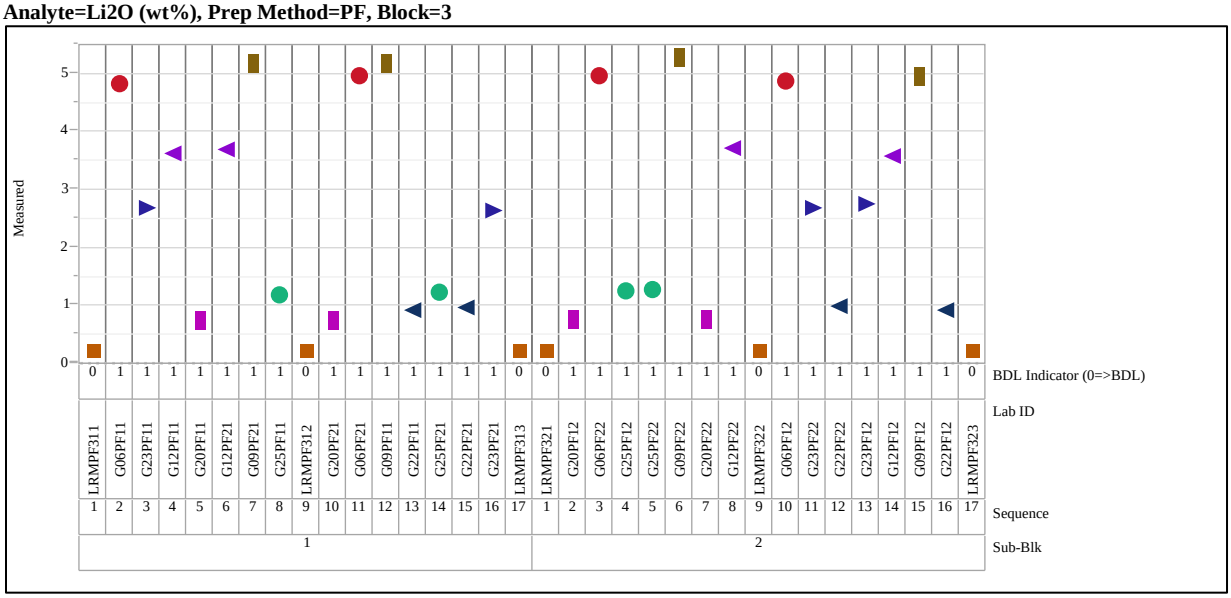


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=Li2O (wt%), Prep Method=PF, Block=3



Analyte=Li2O (wt%), Prep Method=PF, Block=4

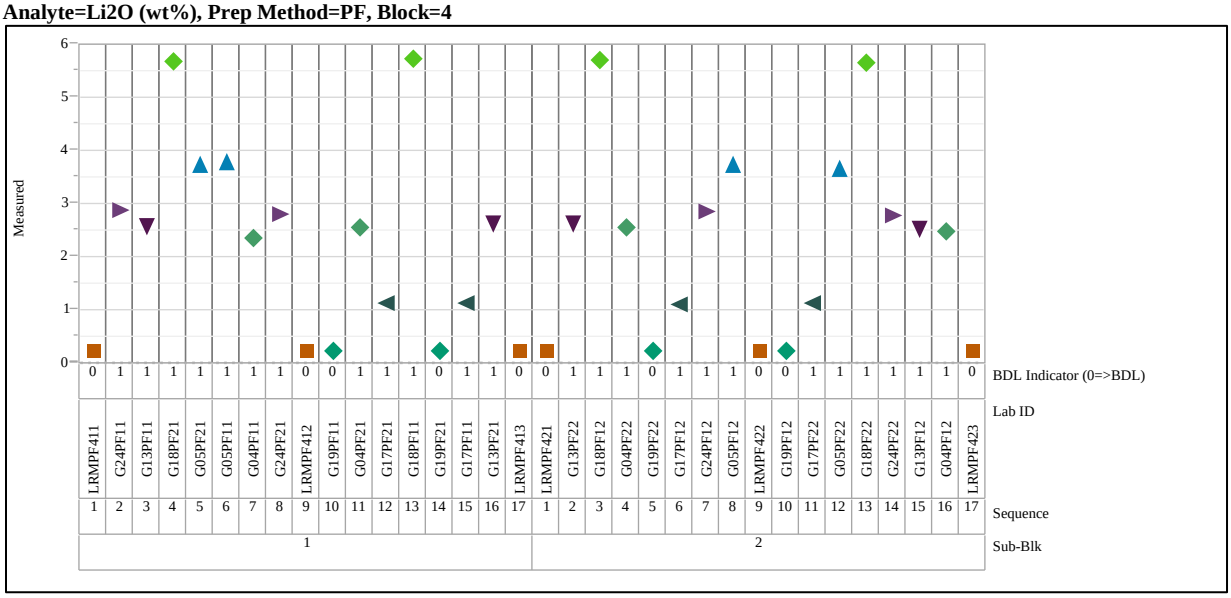
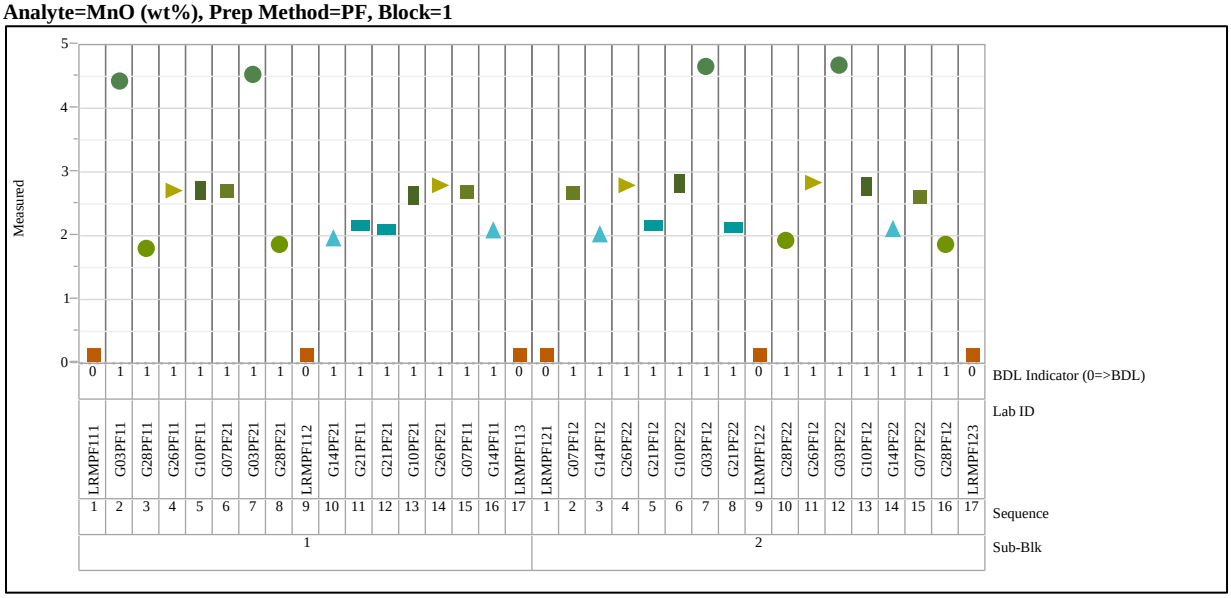


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=MnO (wt%), Prep Method=PF, Block=1



Analyte=MnO (wt%), Prep Method=PF, Block=2

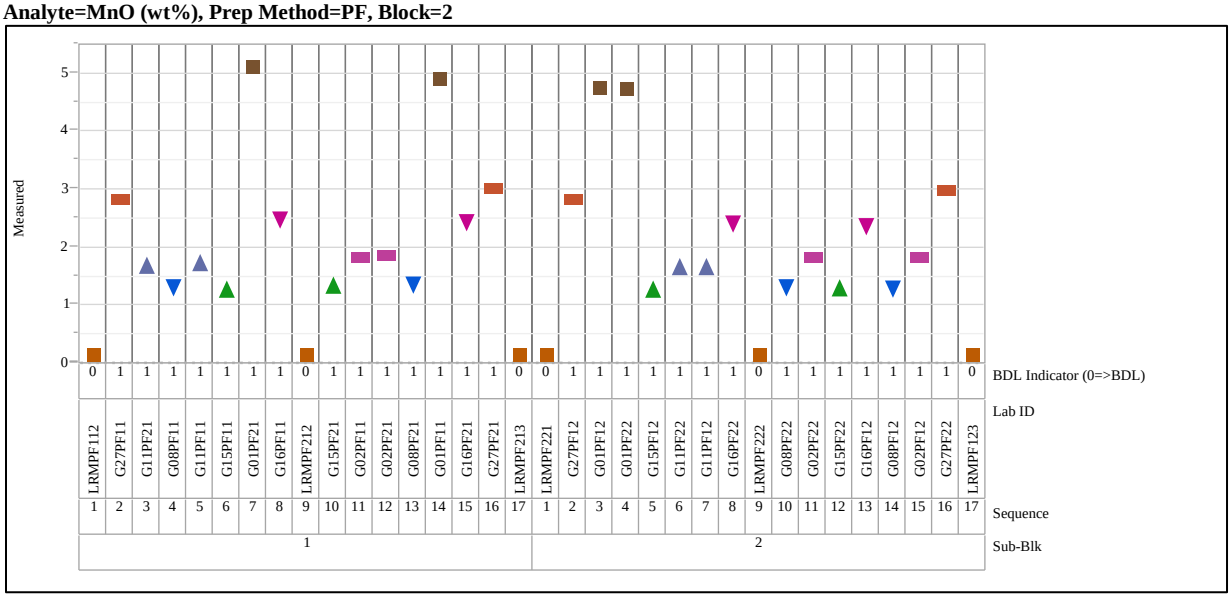
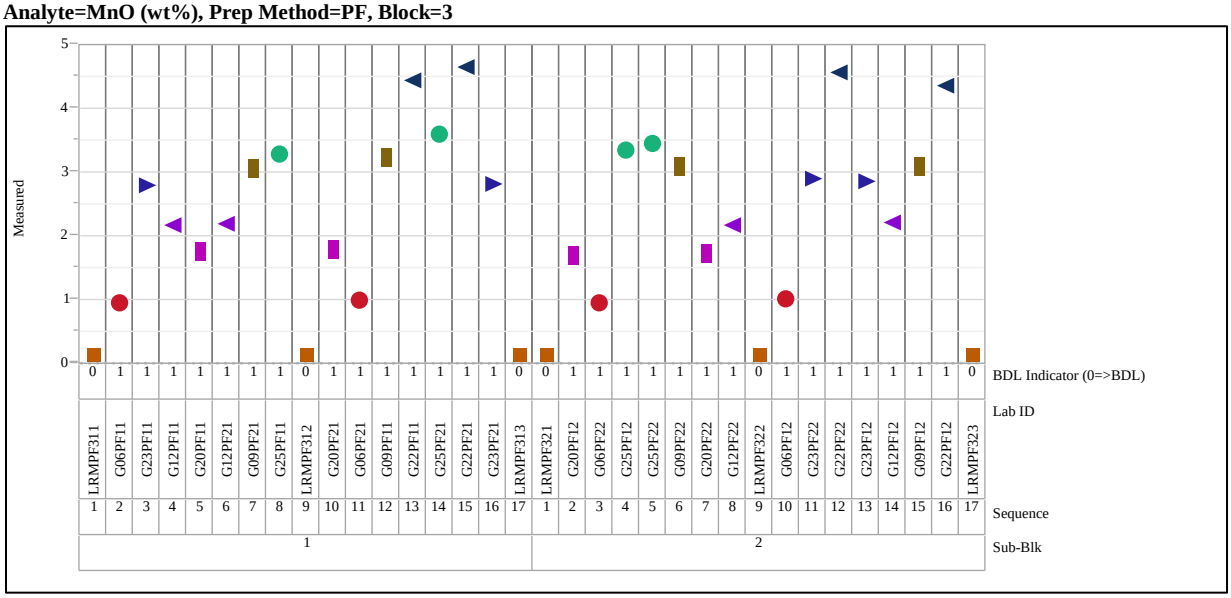


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=MnO (wt%), Prep Method=PF, Block=3



Analyte=MnO (wt%), Prep Method=PF, Block=4

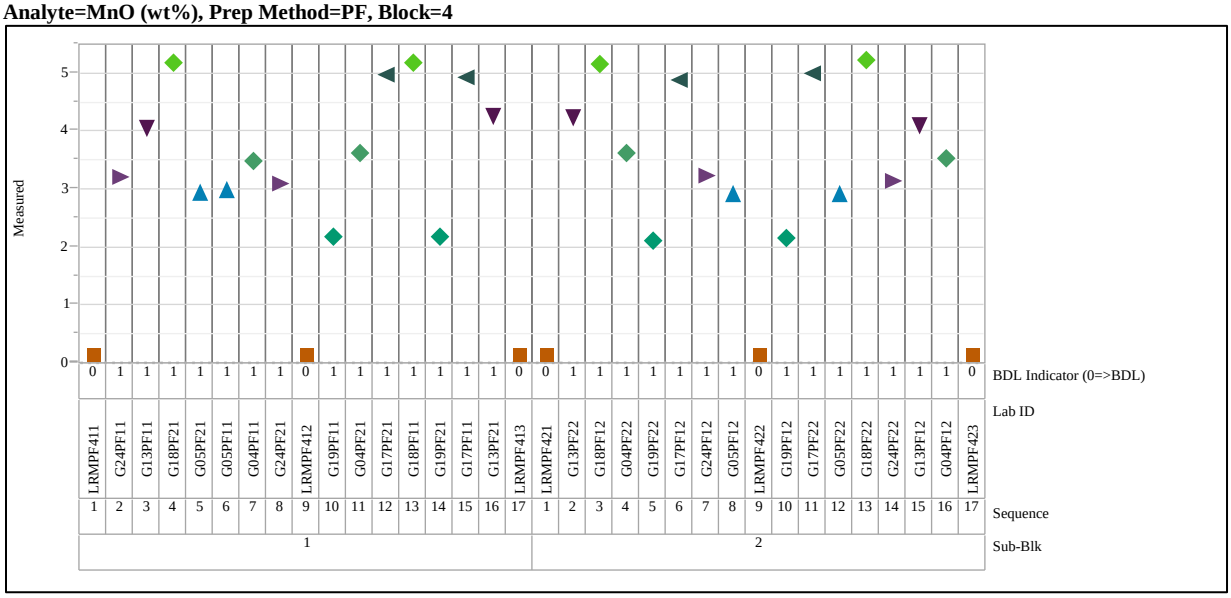
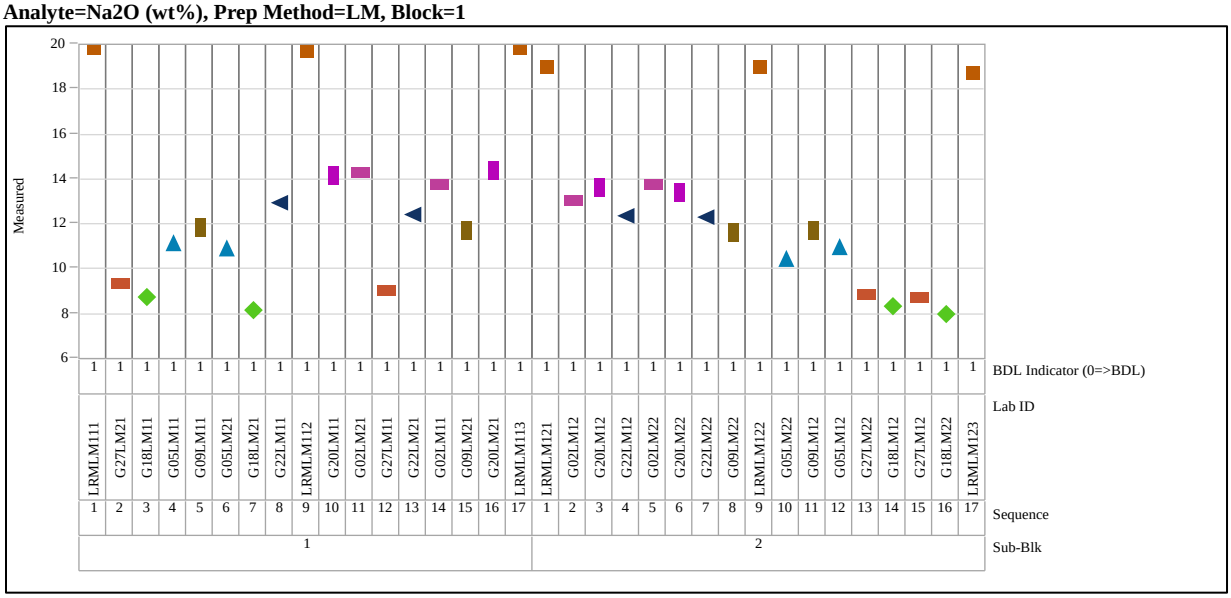


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=Na2O (wt%), Prep Method=LM, Block=1



Analyte=Na2O (wt%), Prep Method=LM, Block=2

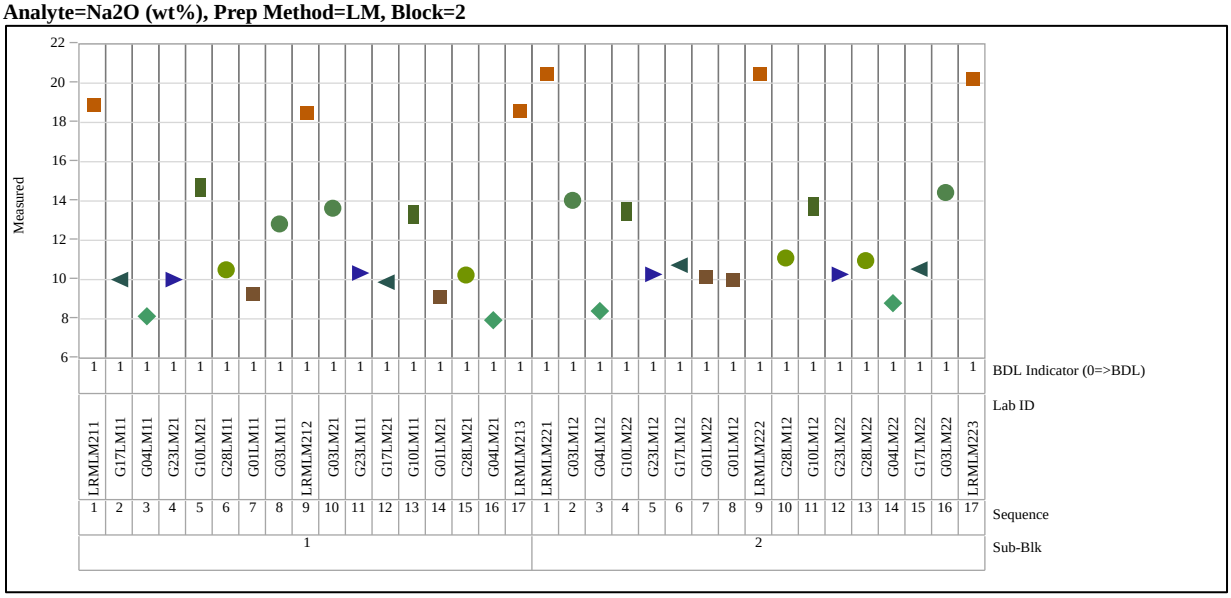
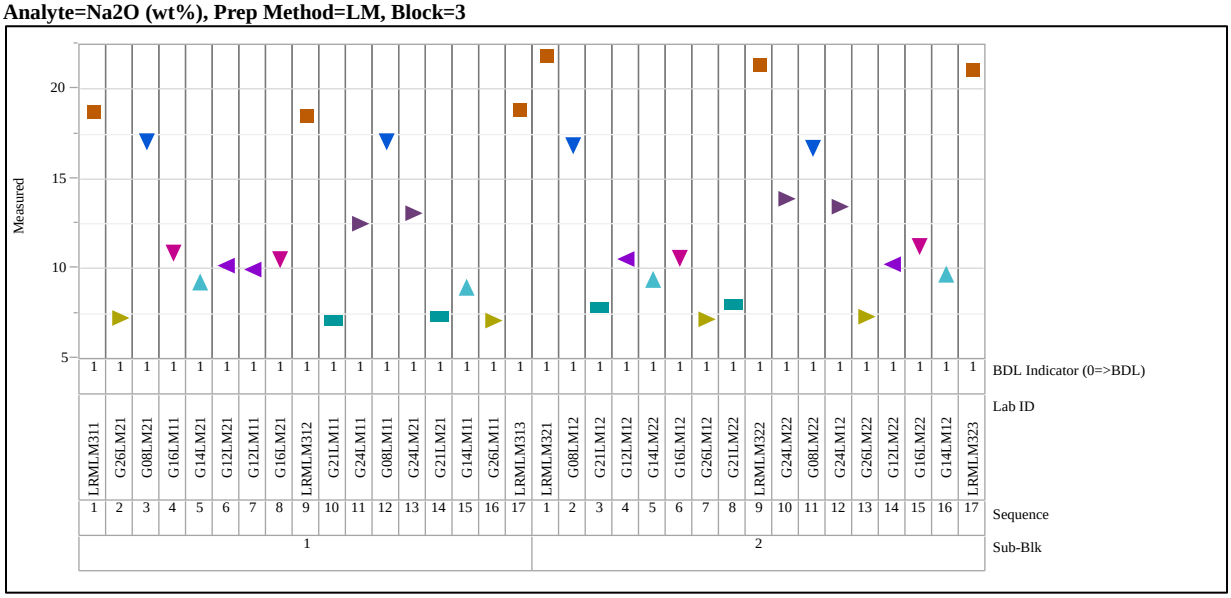


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=Na2O (wt%), Prep Method=LM, Block=3



Analyte=Na2O (wt%), Prep Method=LM, Block=4

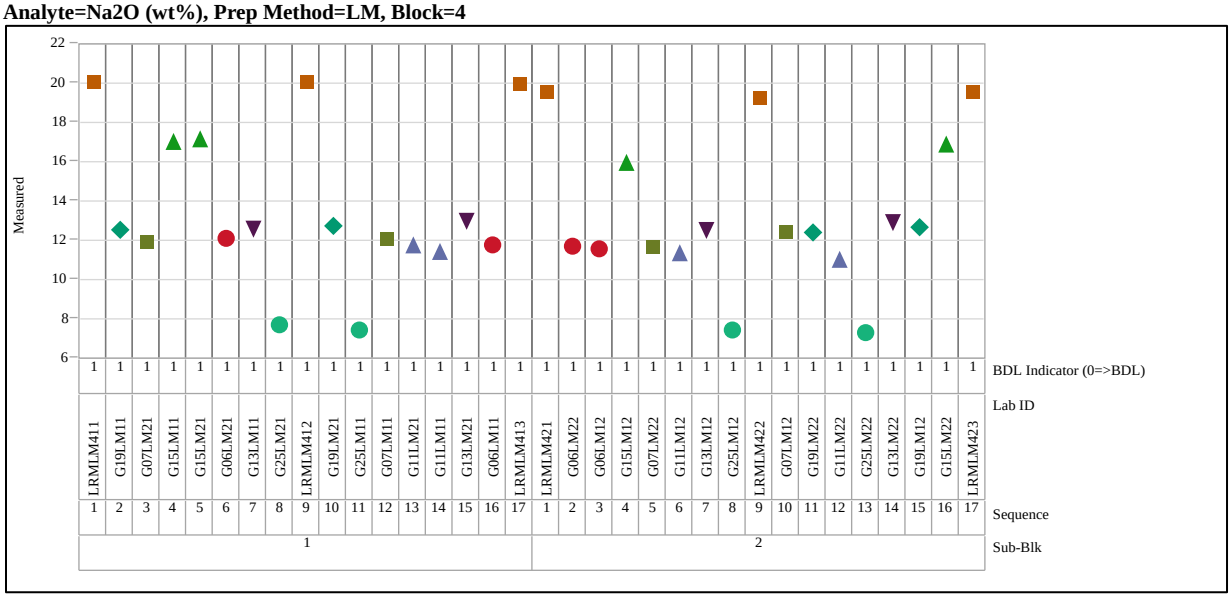
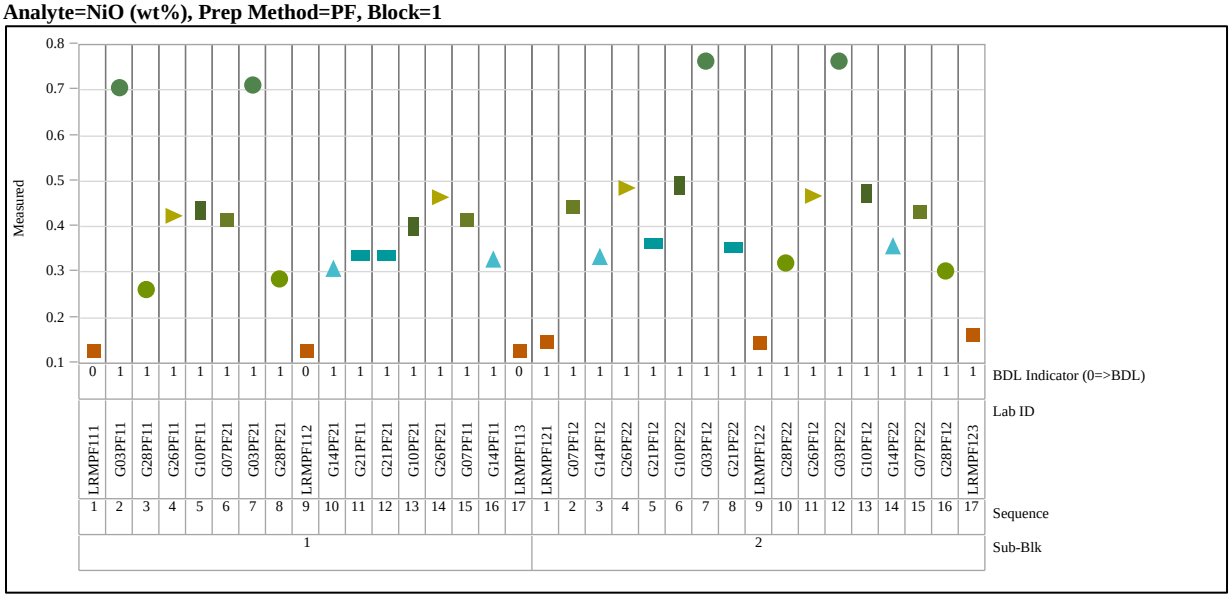


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=NiO (wt%), Prep Method=PF, Block=1



Analyte=NiO (wt%), Prep Method=PF, Block=2

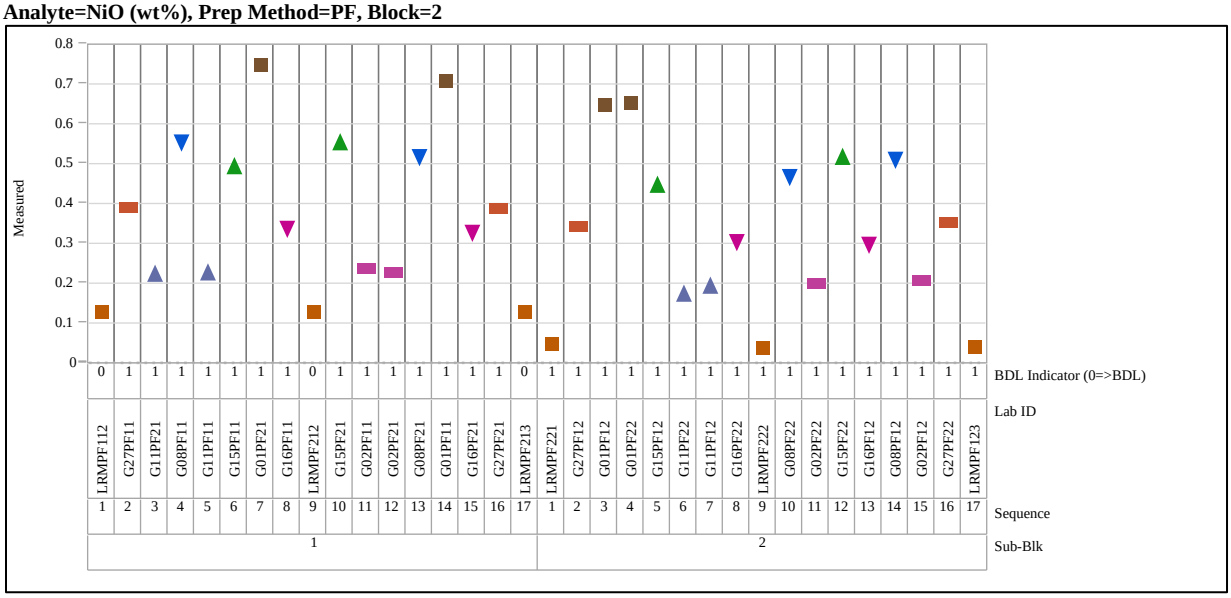
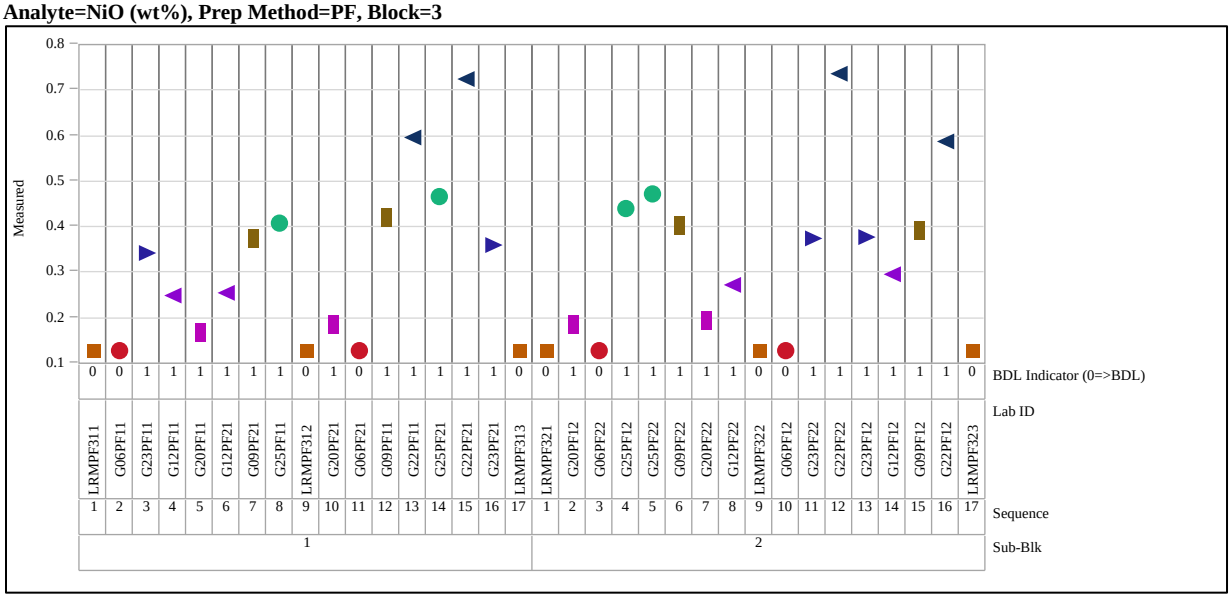


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=NiO (wt%), Prep Method=PF, Block=3



Analyte=NiO (wt%), Prep Method=PF, Block=4

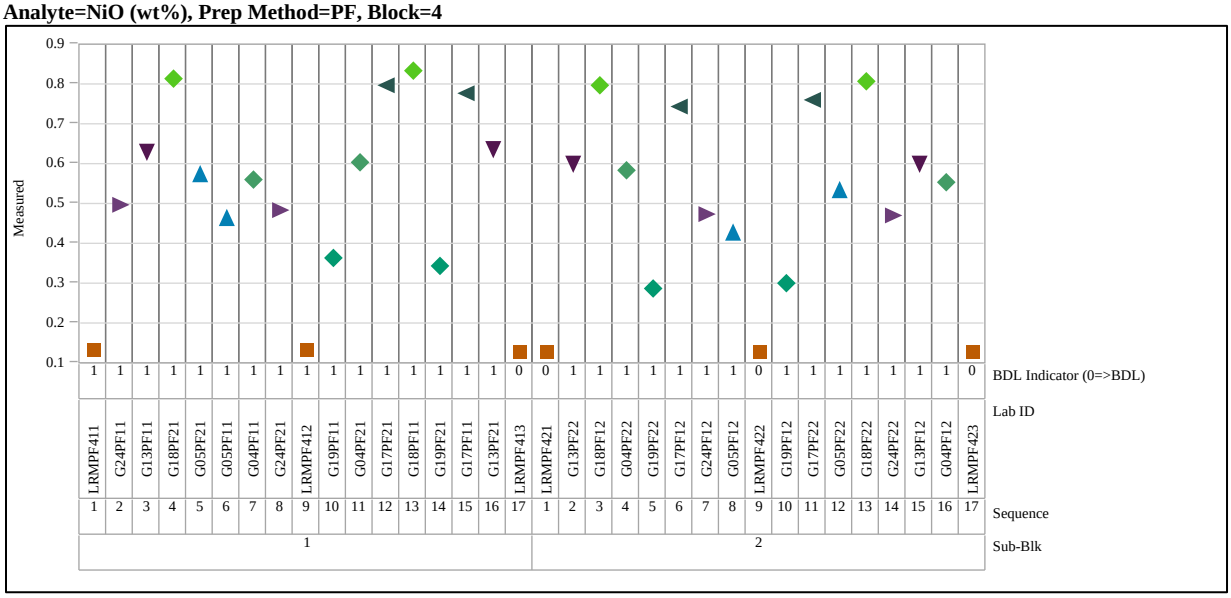
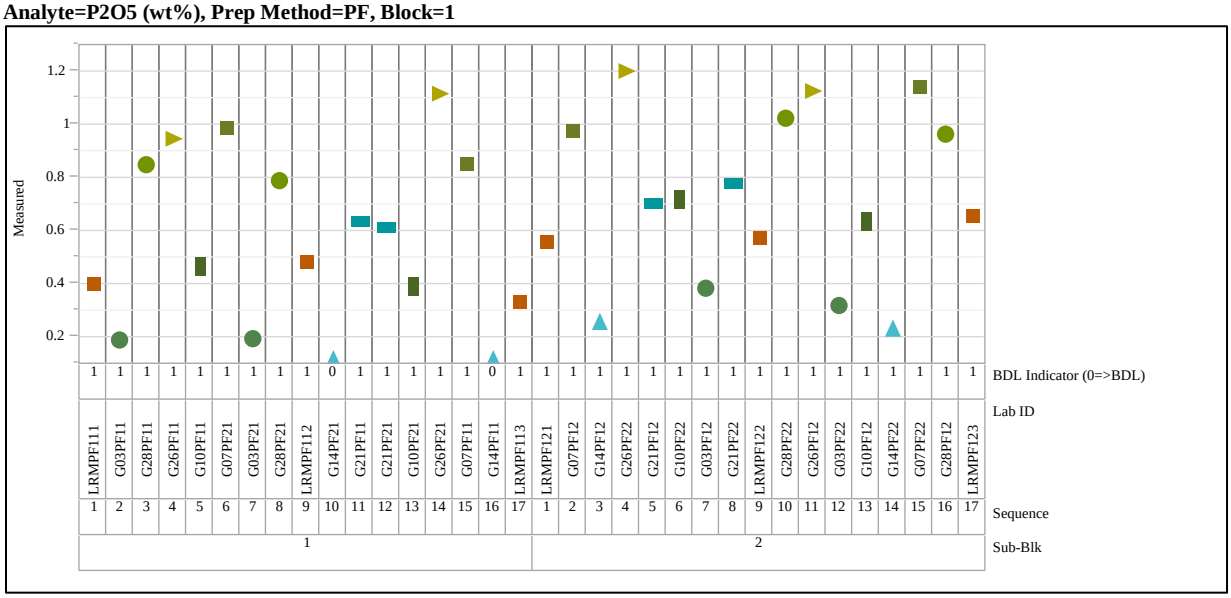


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=P2O5 (wt%), Prep Method=PF, Block=1



Analyte=P2O5 (wt%), Prep Method=PF, Block=2

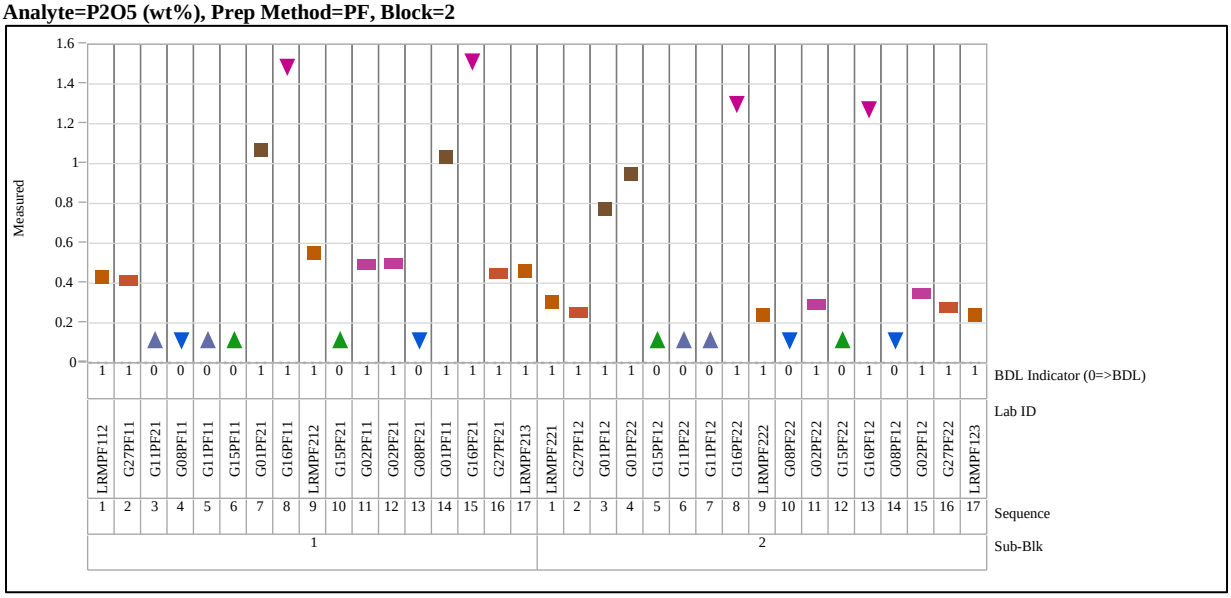
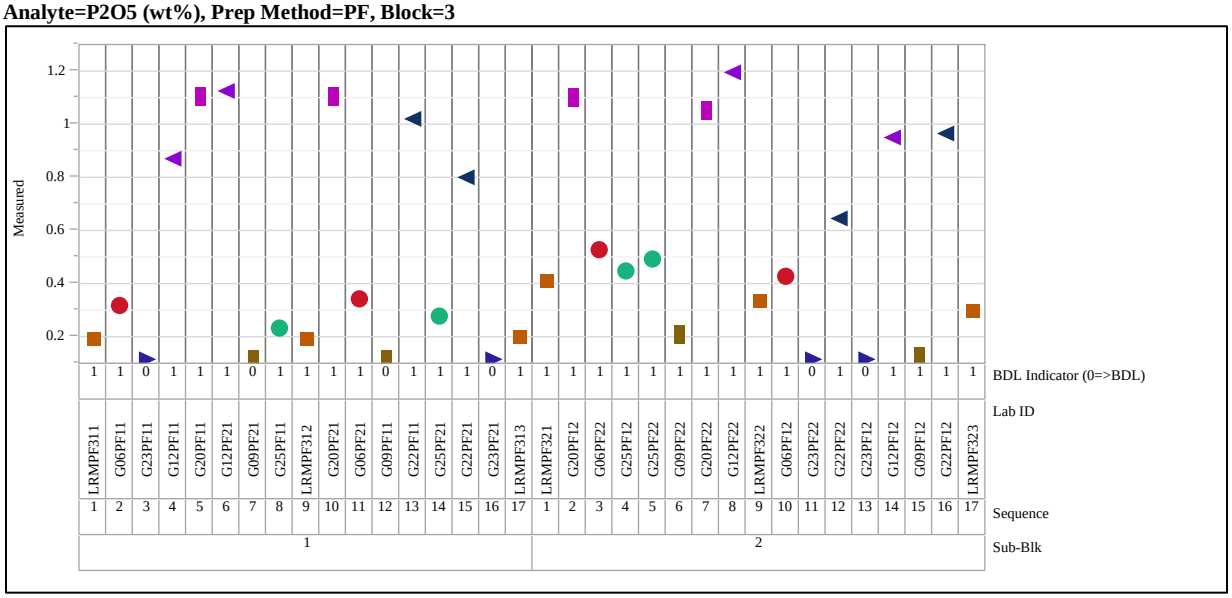


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=P2O5 (wt%), Prep Method=PF, Block=3



Analyte=P2O5 (wt%), Prep Method=PF, Block=4

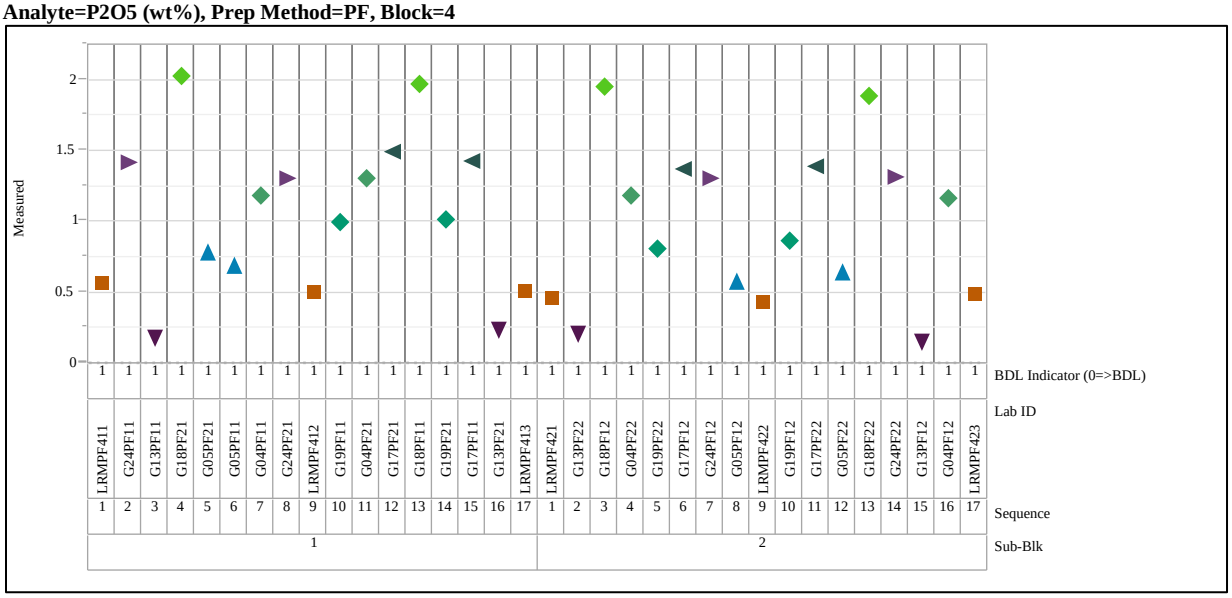
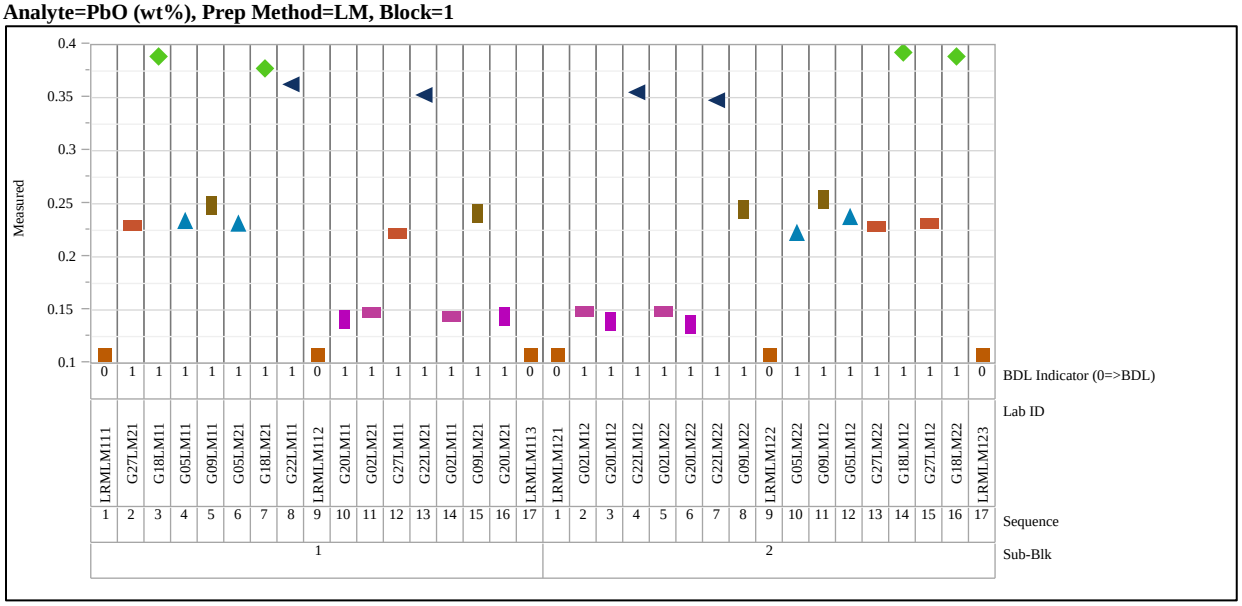


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=PbO (wt%), Prep Method=LM, Block=1



Analyte=PbO (wt%), Prep Method=LM, Block=2

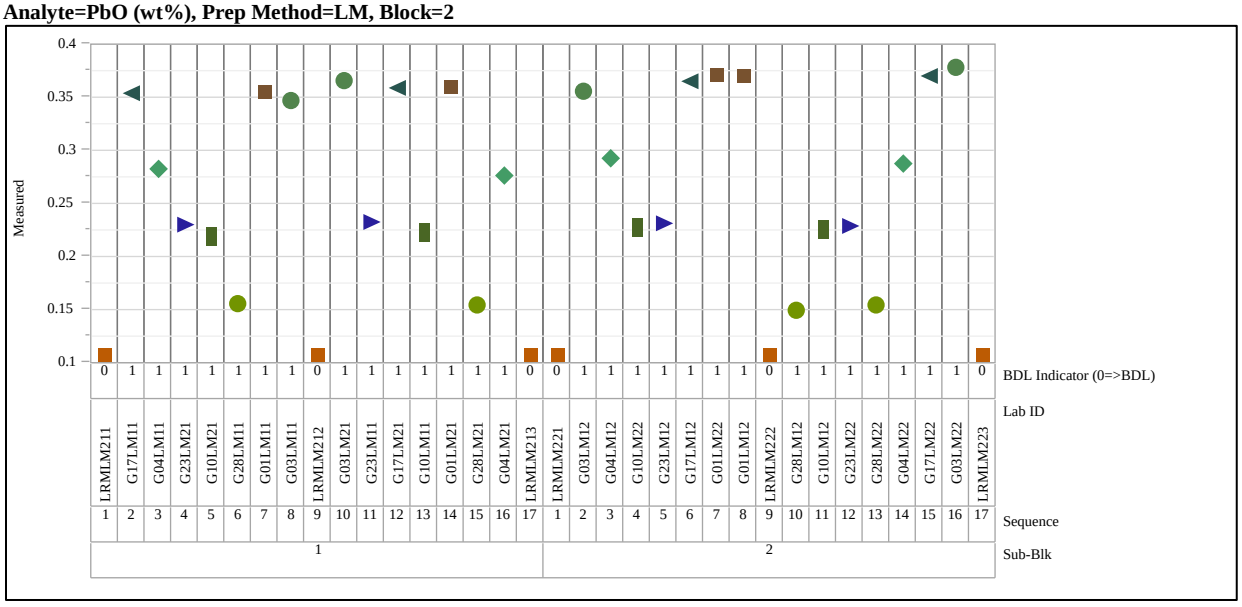
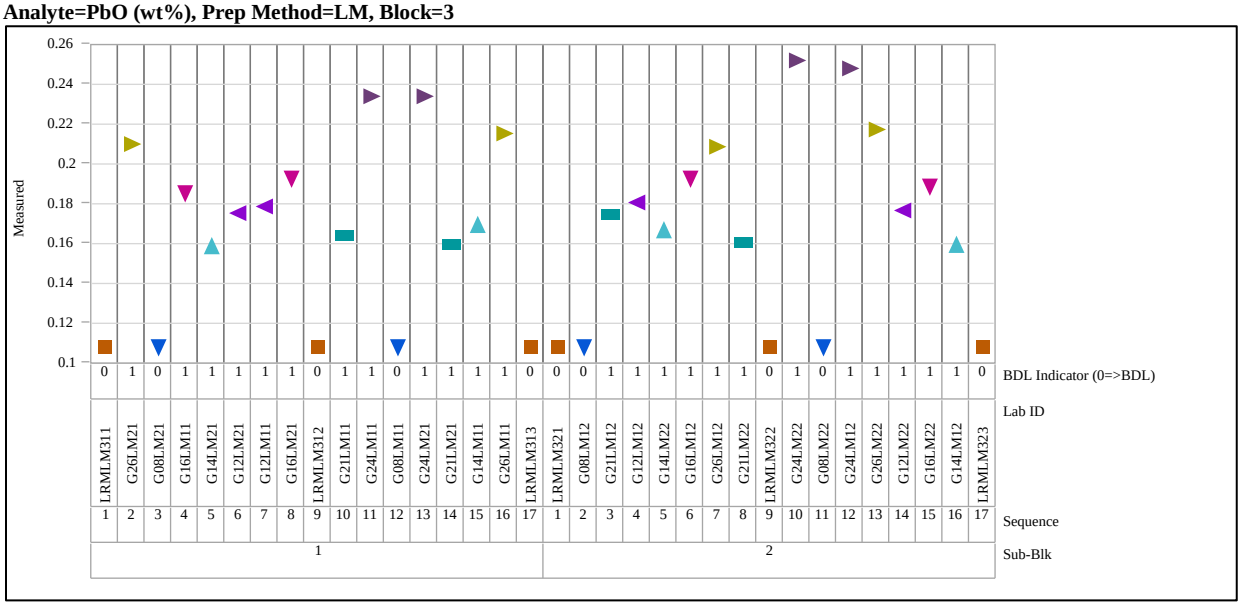


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=PbO (wt%), Prep Method=LM, Block=3



Analyte=PbO (wt%), Prep Method=LM, Block=4

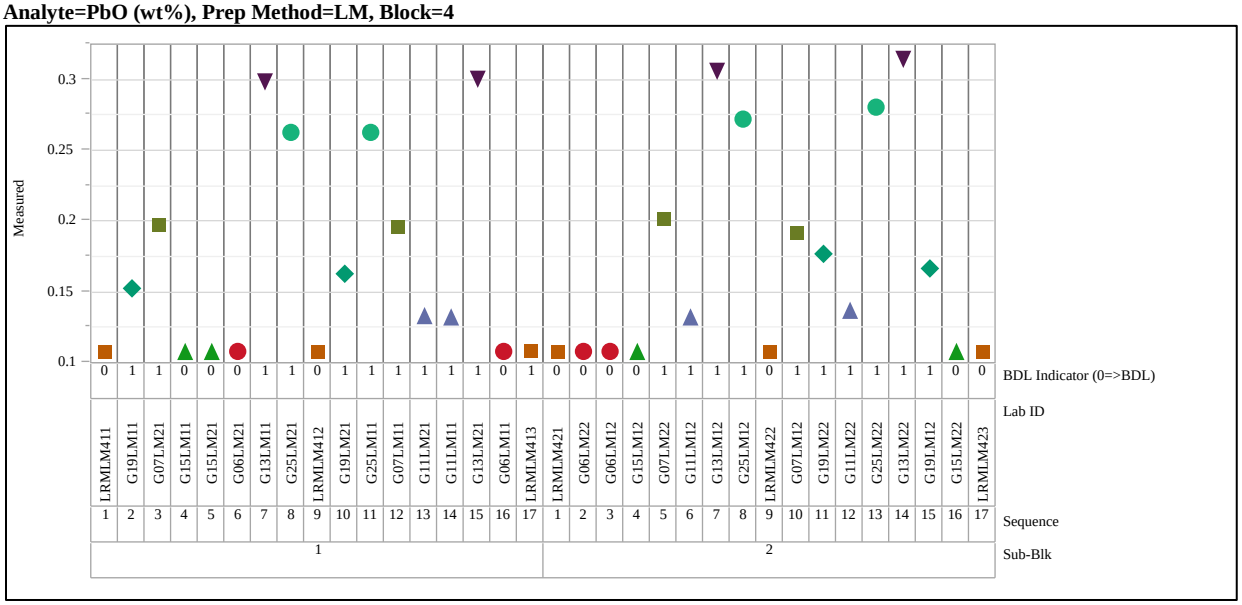
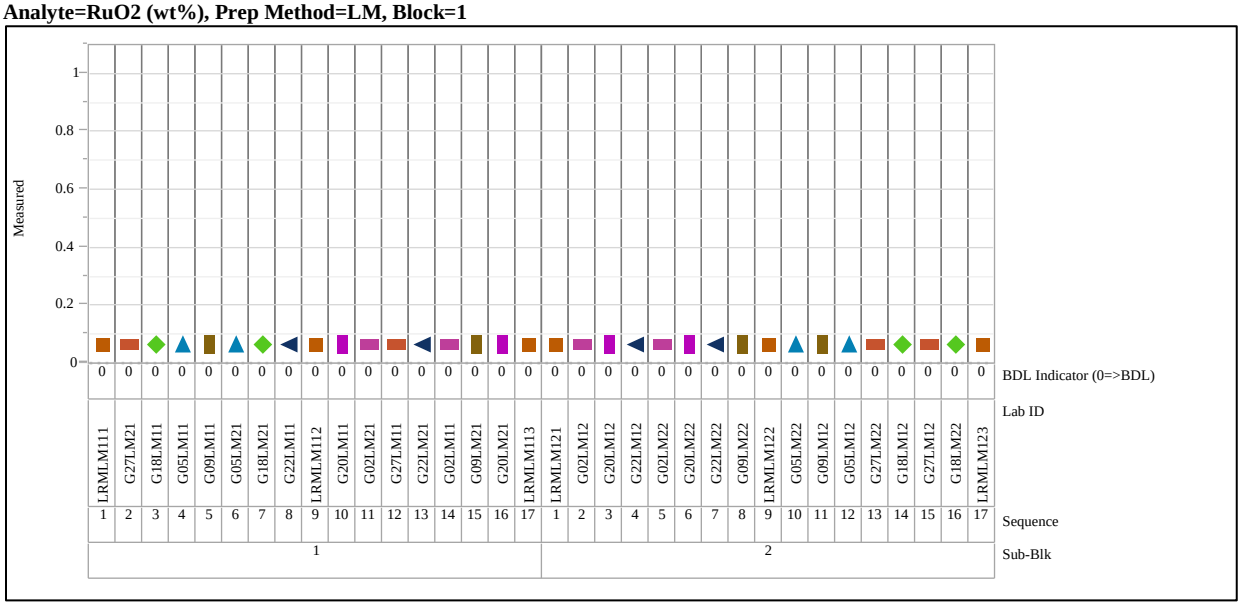


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=RuO2 (wt%), Prep Method=LM, Block=1



Analyte=RuO2 (wt%), Prep Method=LM, Block=2

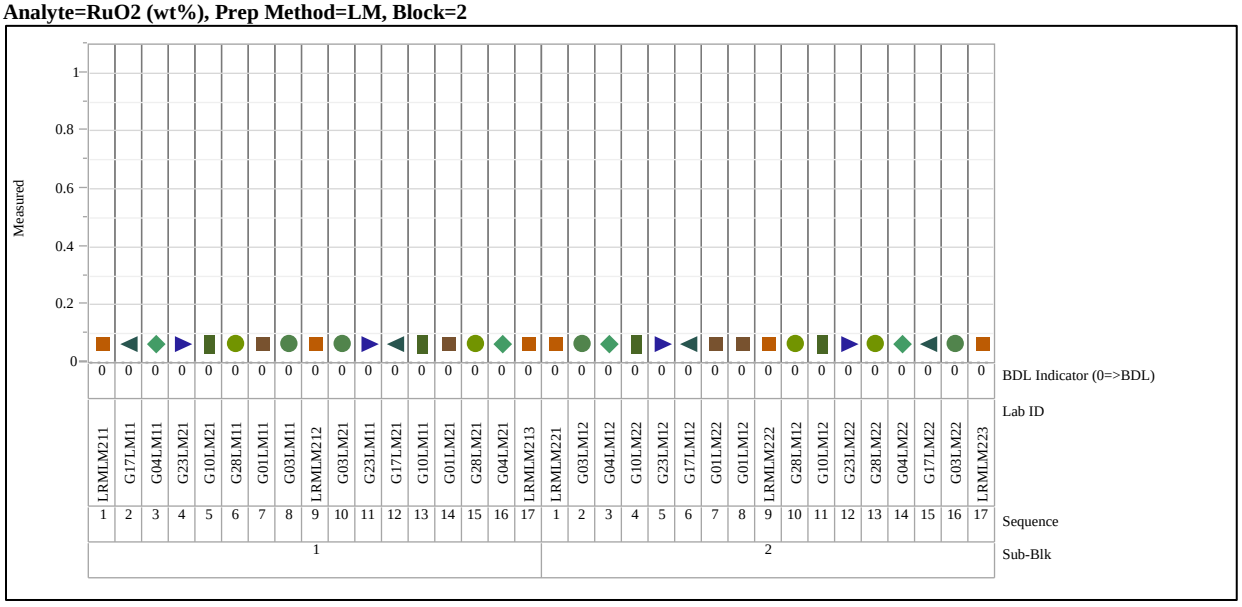
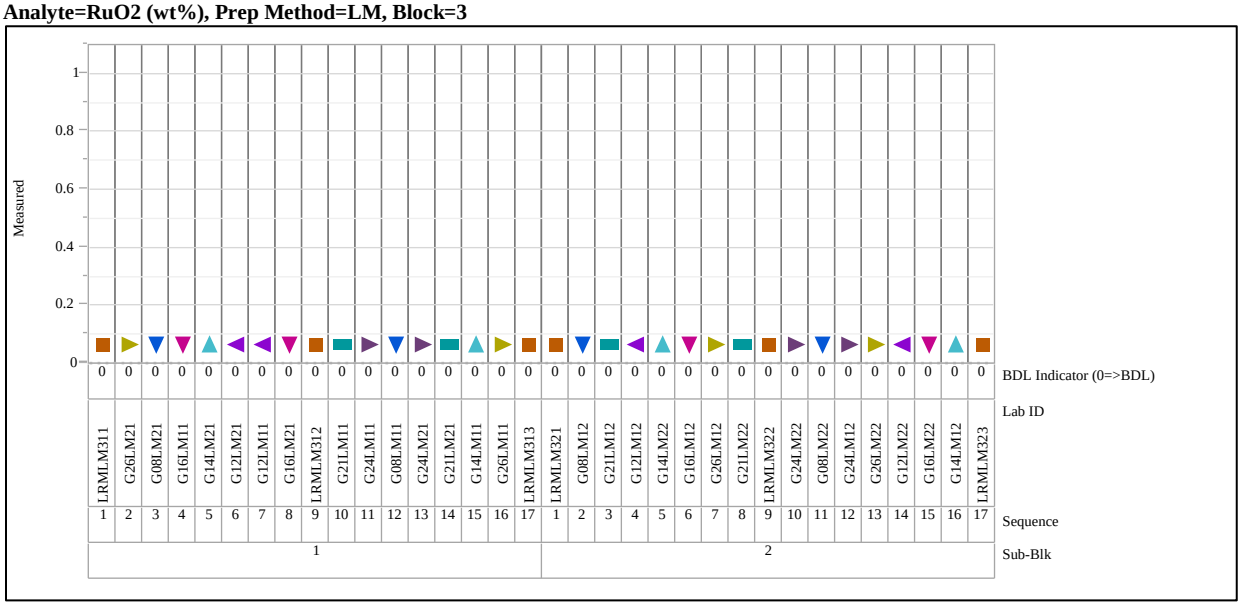


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=RuO2 (wt%), Prep Method=LM, Block=3



Analyte=RuO2 (wt%), Prep Method=LM, Block=4

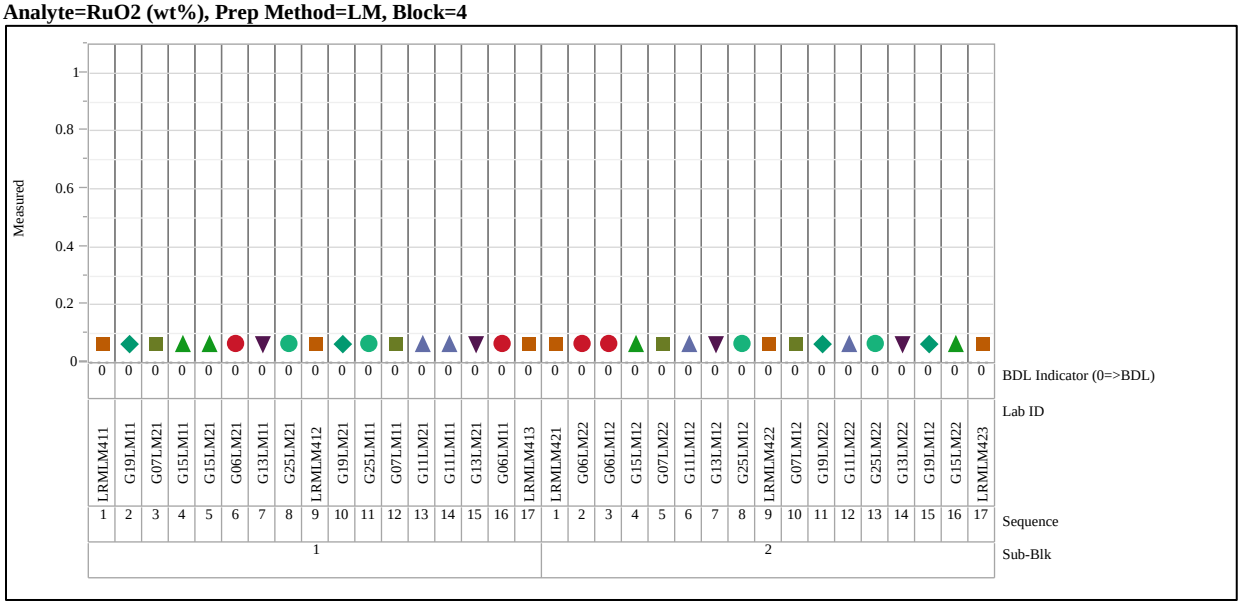
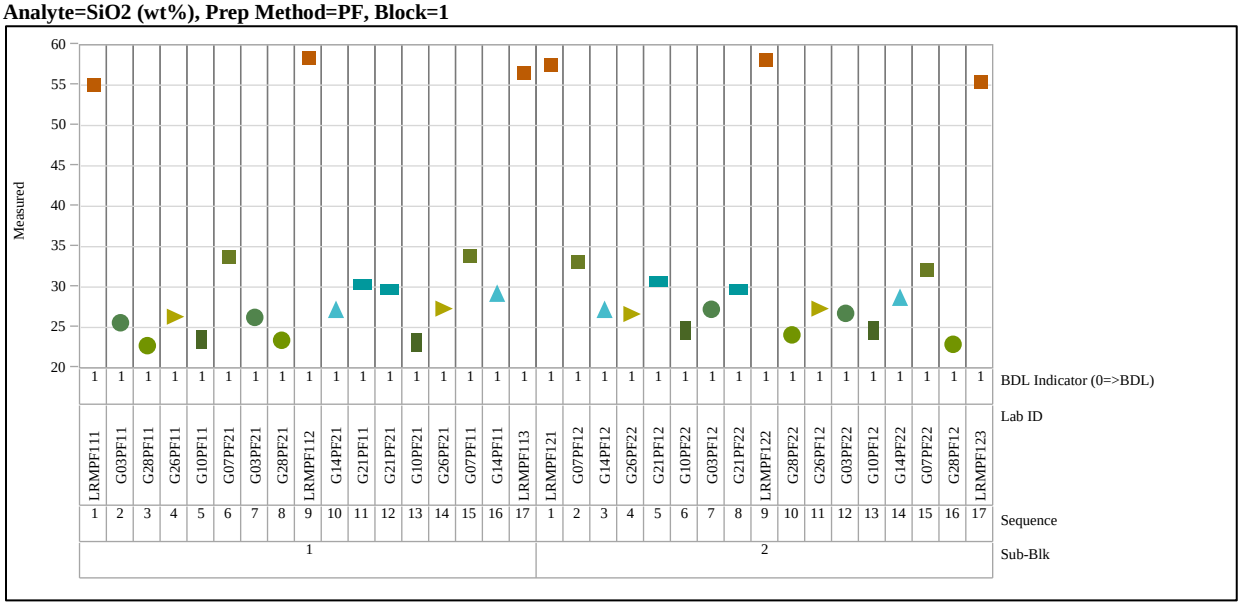


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=SiO2 (wt%), Prep Method=PF, Block=1



Analyte=SiO2 (wt%), Prep Method=PF, Block=2

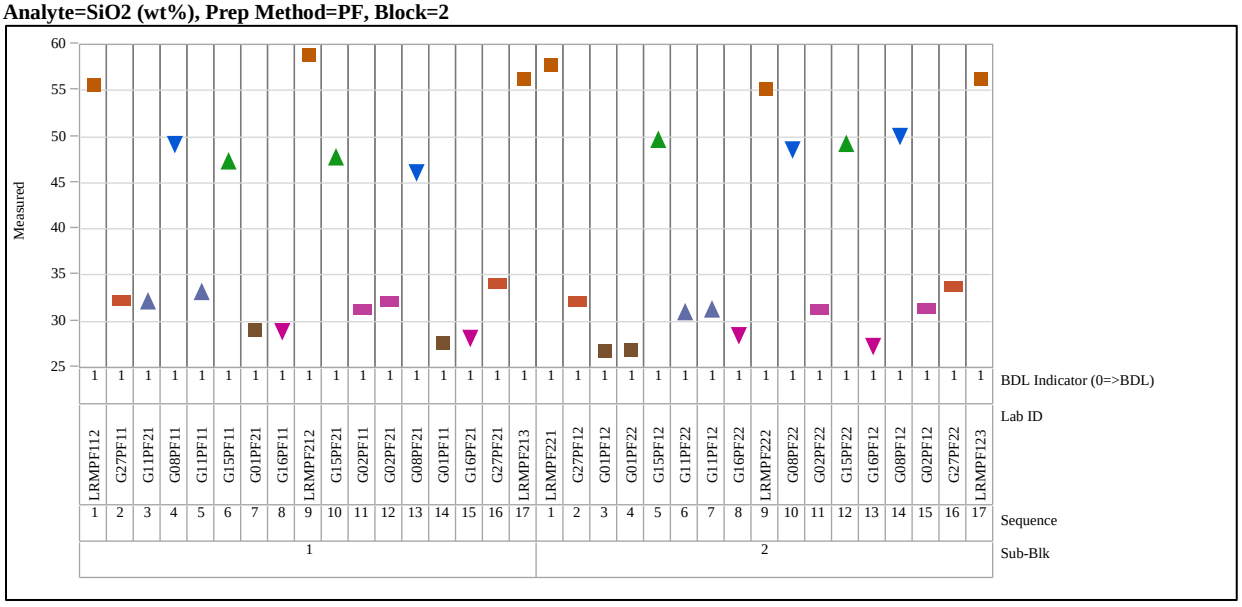
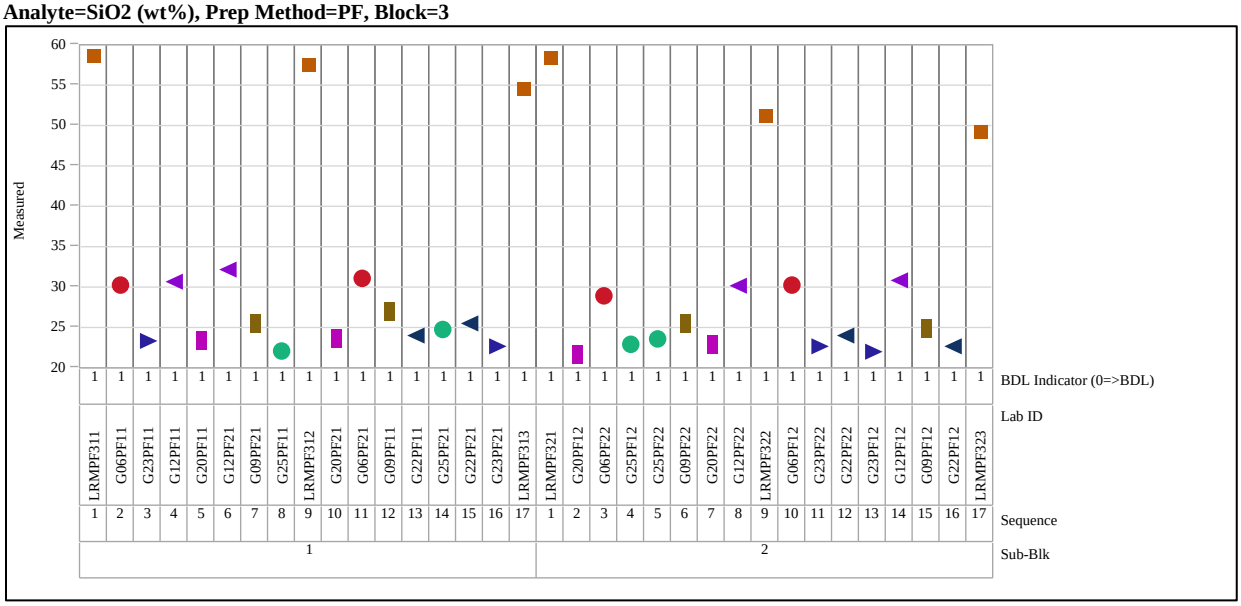


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=SiO2 (wt%), Prep Method=PF, Block=3



Analyte=SiO2 (wt%), Prep Method=PF, Block=4

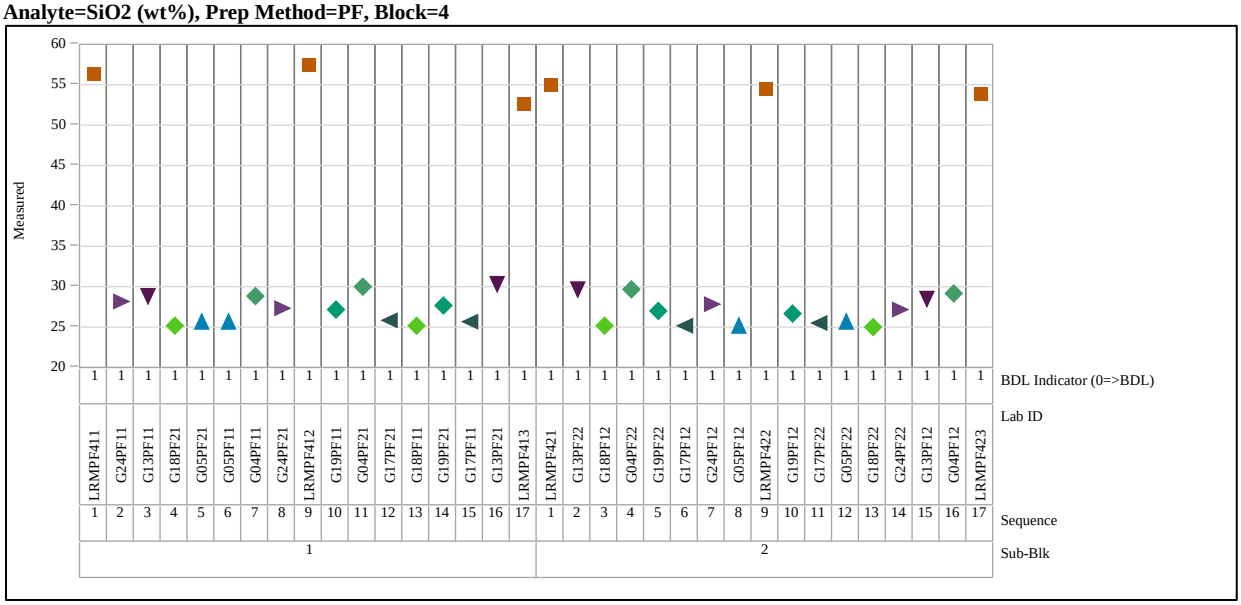
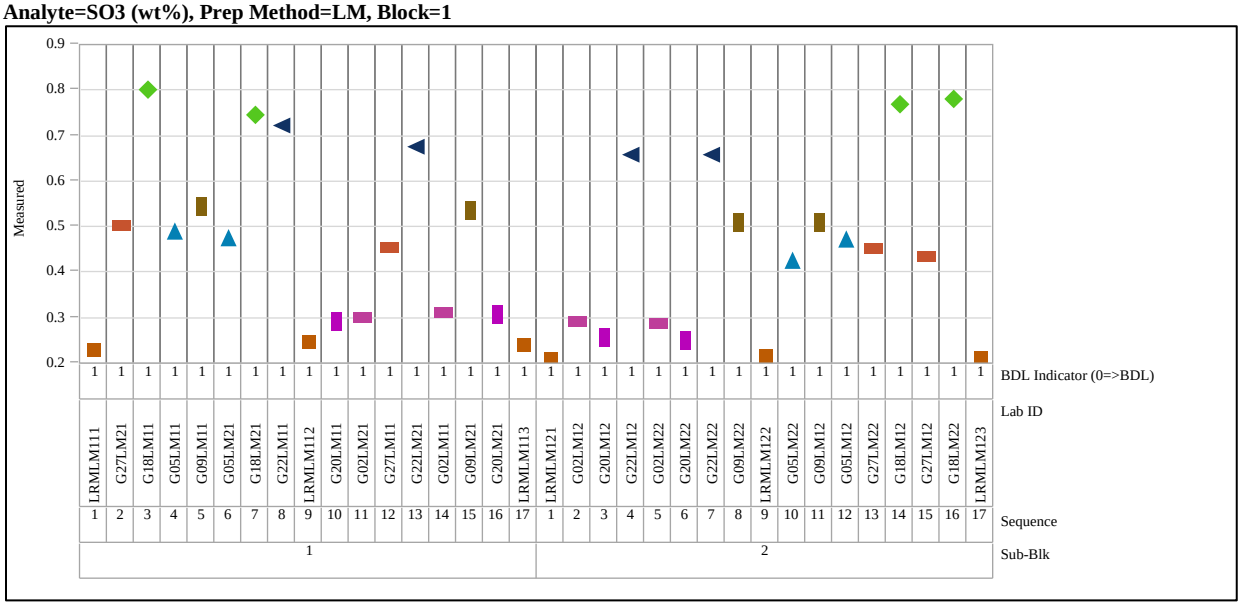


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=SO3 (wt%), Prep Method=LM, Block=1



Analyte=SO3 (wt%), Prep Method=LM, Block=2

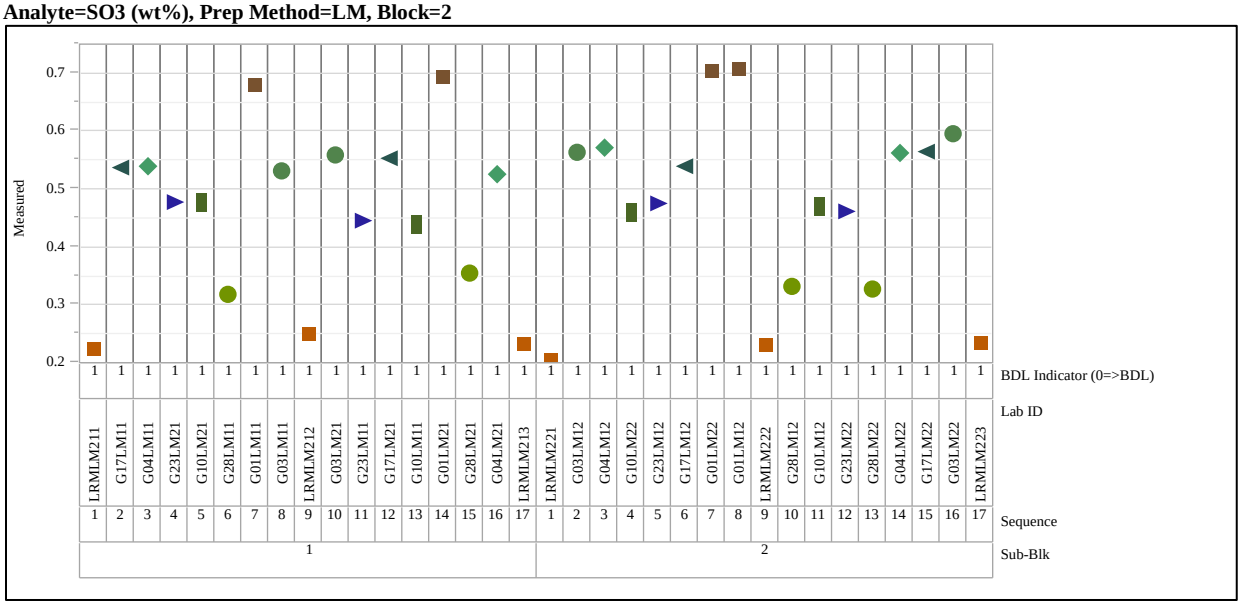
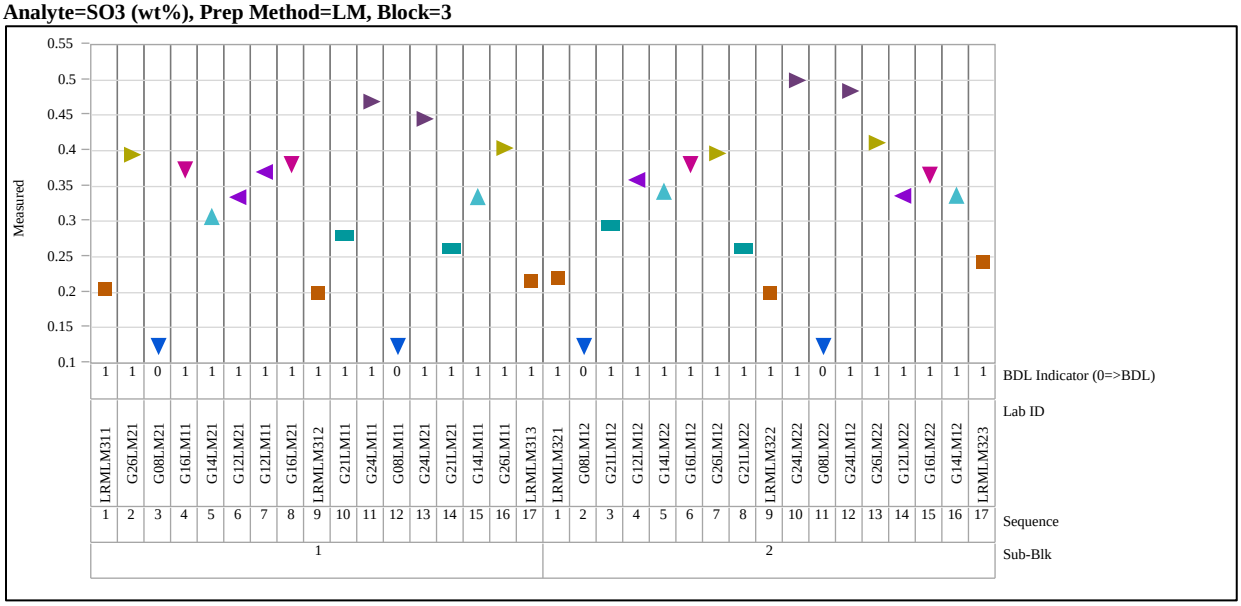


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=SO3 (wt%), Prep Method=LM, Block=3



Analyte=SO3 (wt%), Prep Method=LM, Block=4

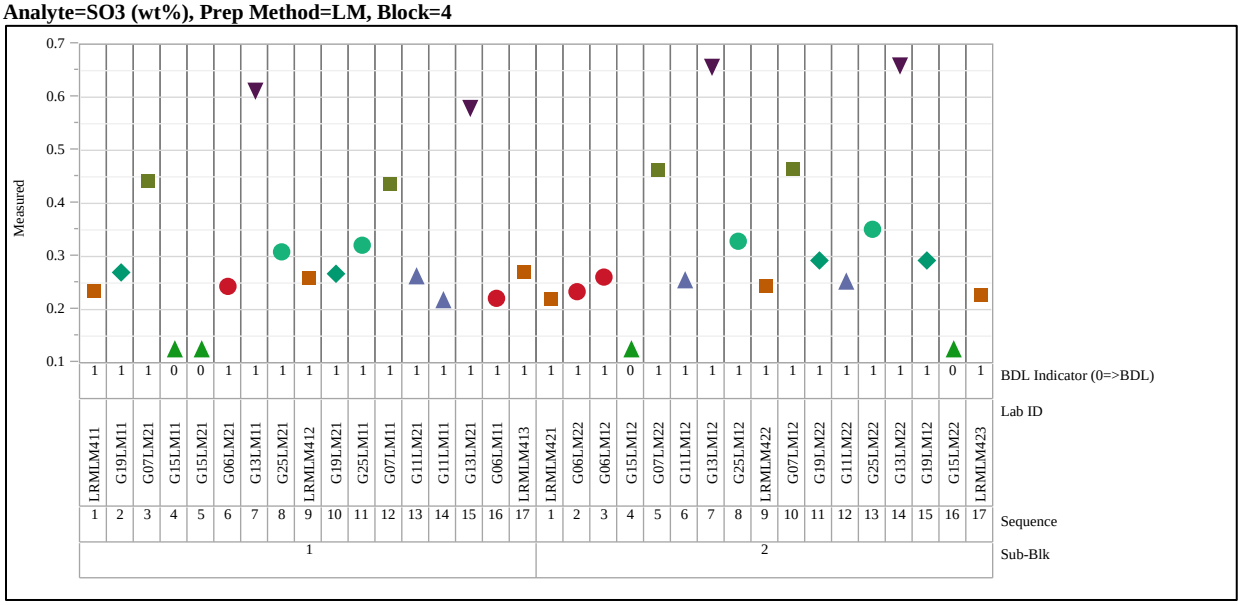
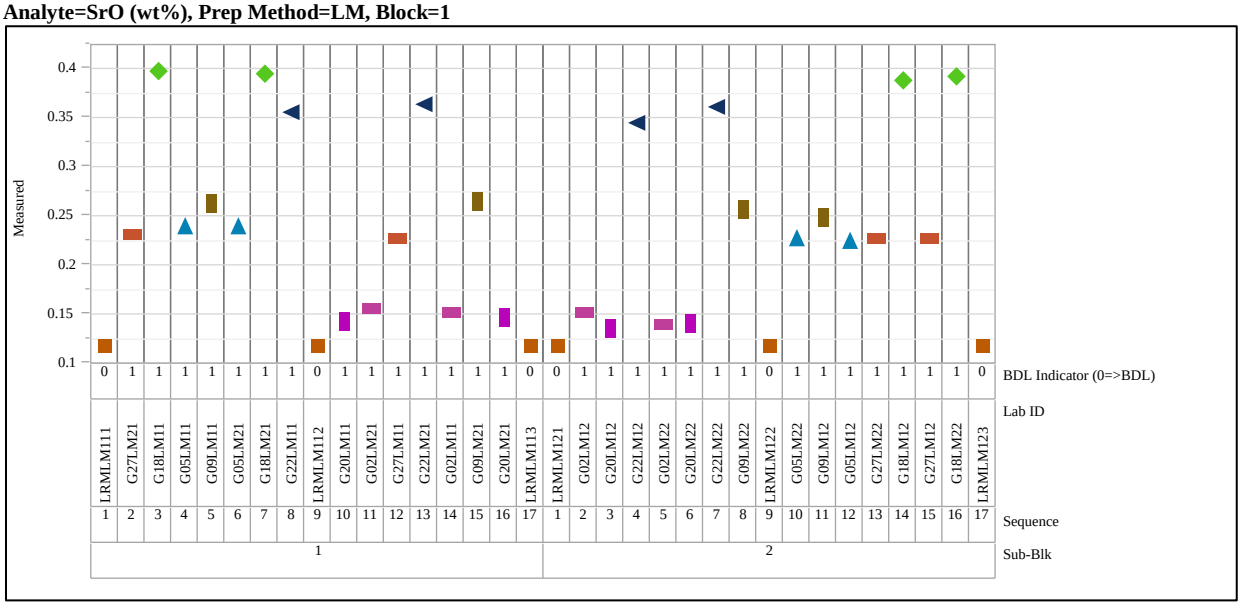


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=SrO (wt%), Prep Method=LM, Block=1



Analyte=SrO (wt%), Prep Method=LM, Block=2

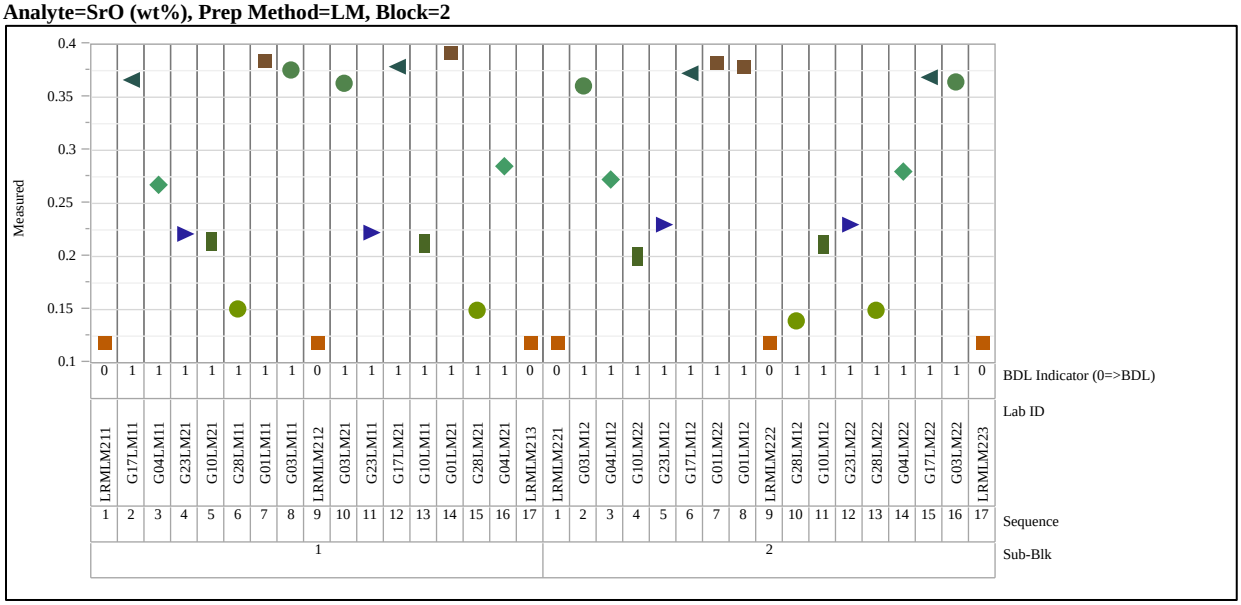
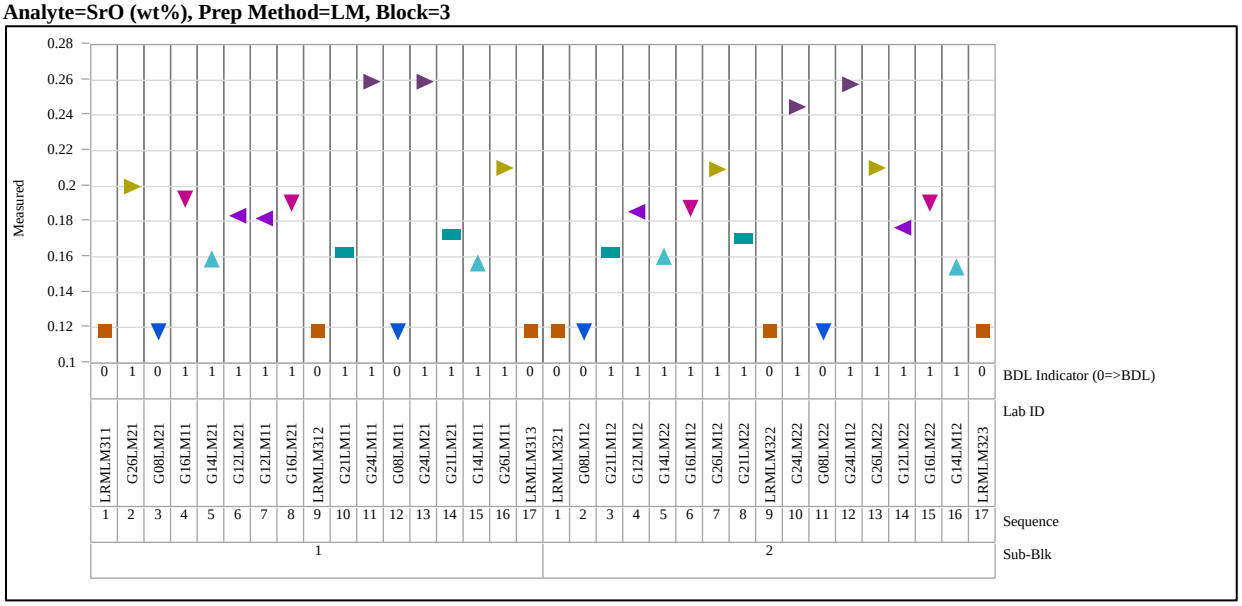


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=SrO (wt%), Prep Method=LM, Block=3



Analyte=SrO (wt%), Prep Method=LM, Block=4

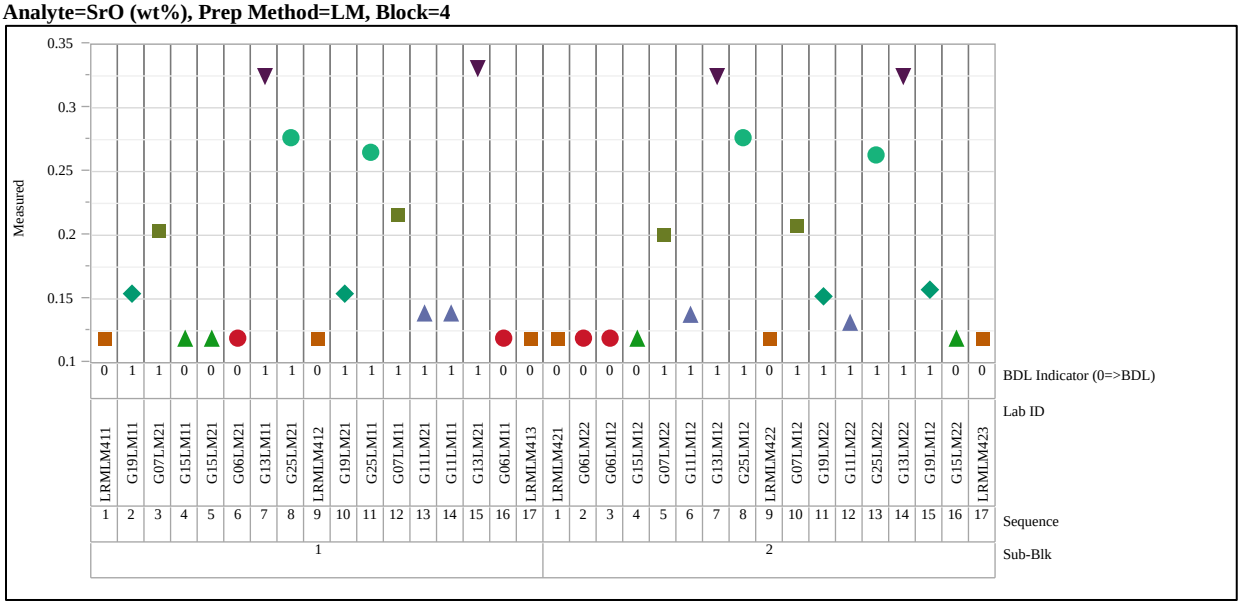
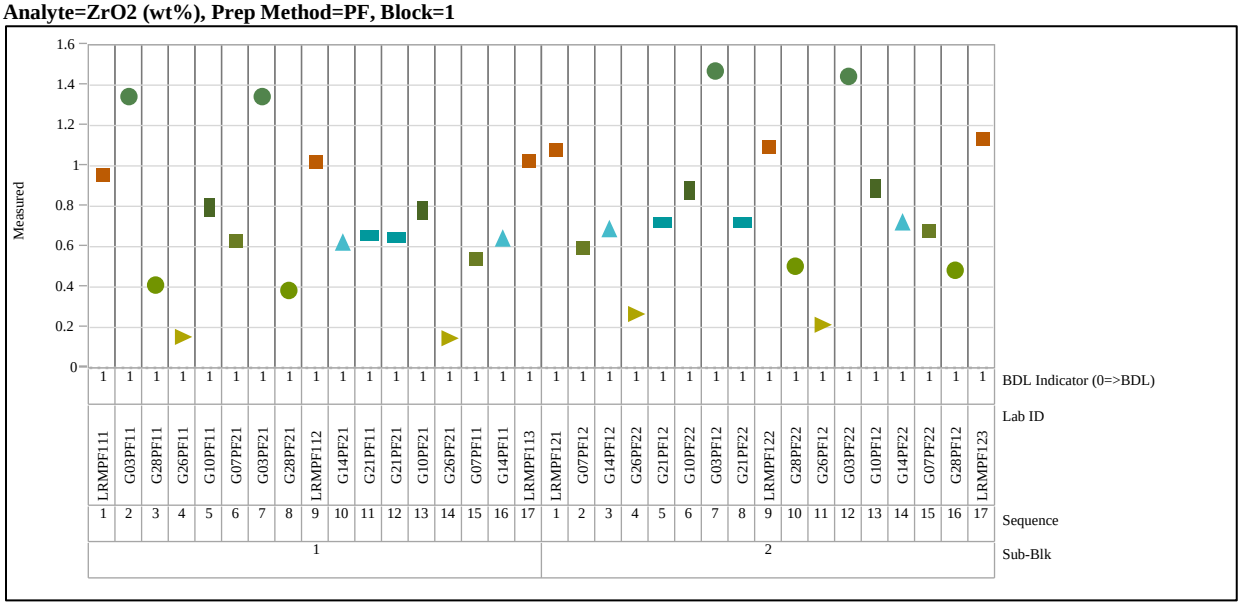


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=ZrO2 (wt%), Prep Method=PF, Block=1



Analyte=ZrO2 (wt%), Prep Method=PF, Block=2

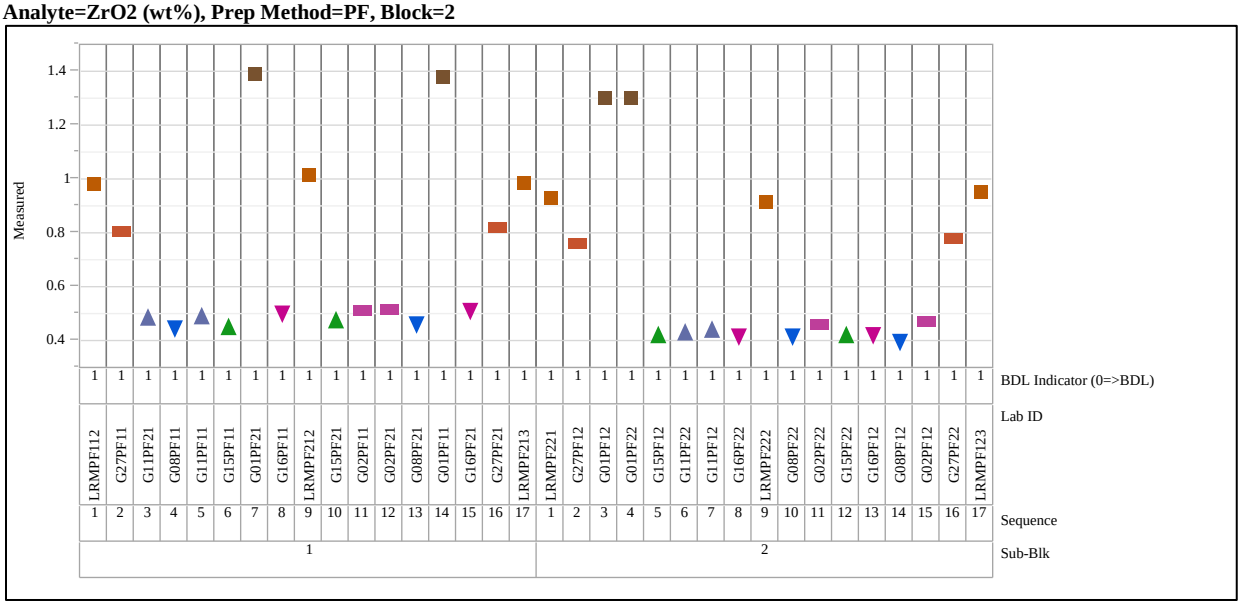
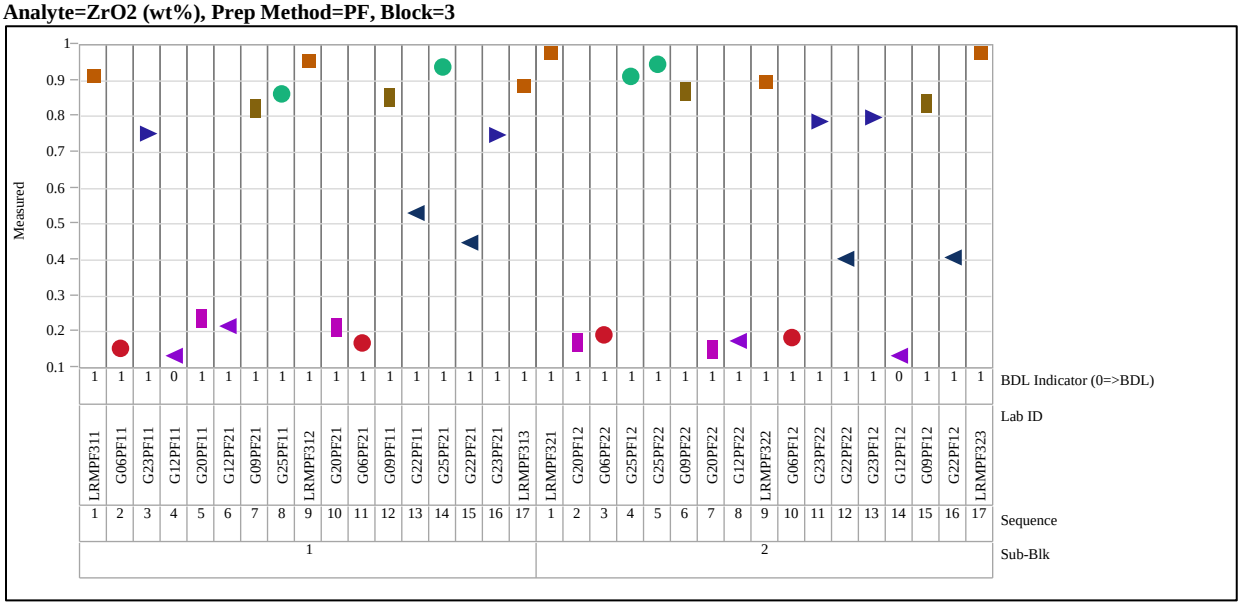


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=ZrO2 (wt%), Prep Method=PF, Block=3



Analyte=ZrO2 (wt%), Prep Method=PF, Block=4

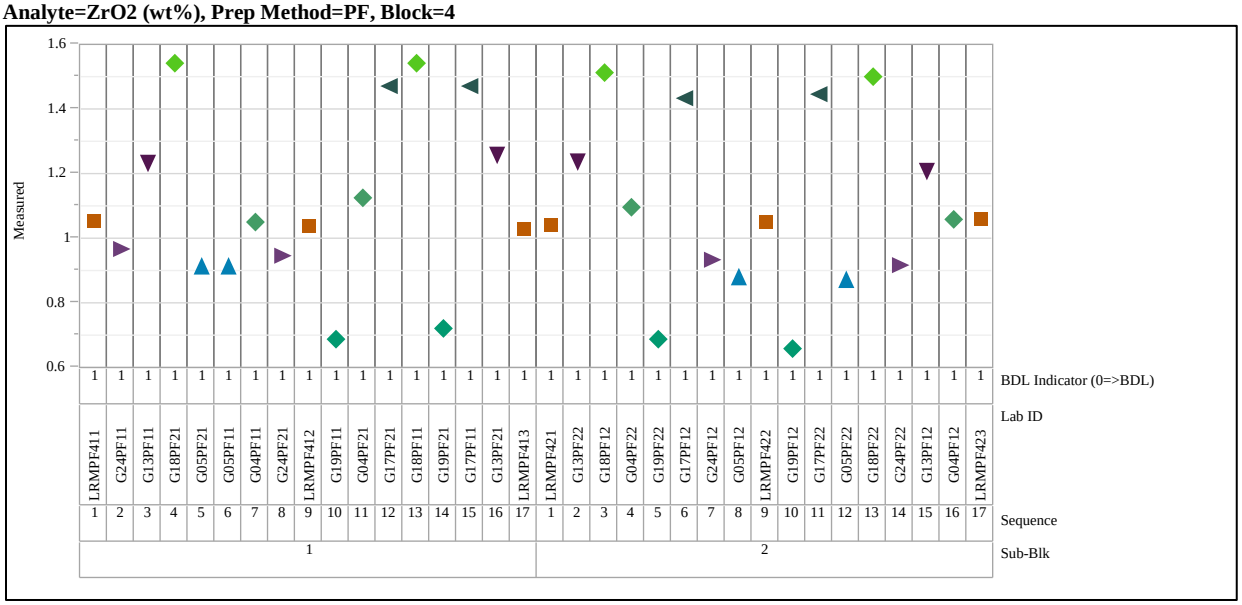
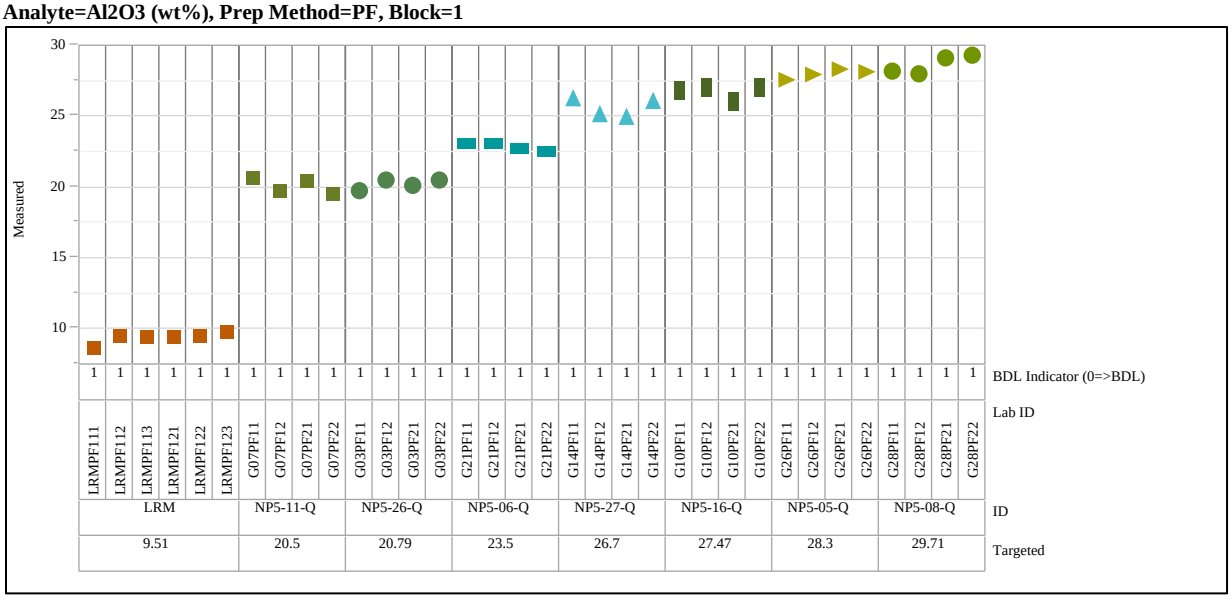


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block

Analyte=Al2O3 (wt%), Prep Method=PF, Block=1



Analyte=Al2O3 (wt%), Prep Method=PF, Block=2

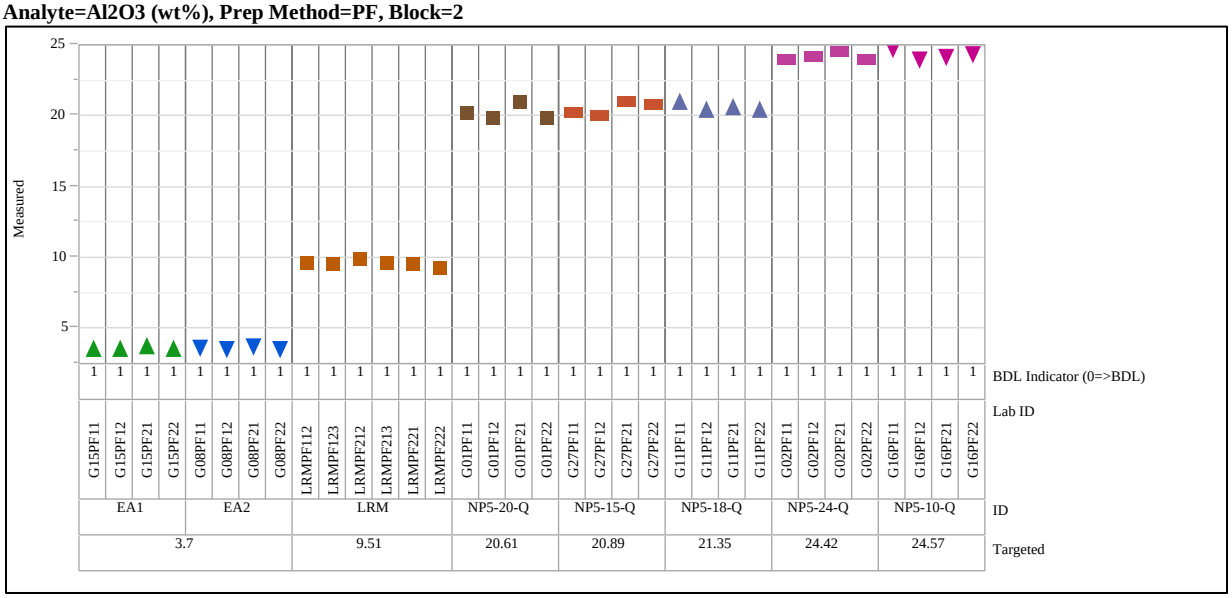
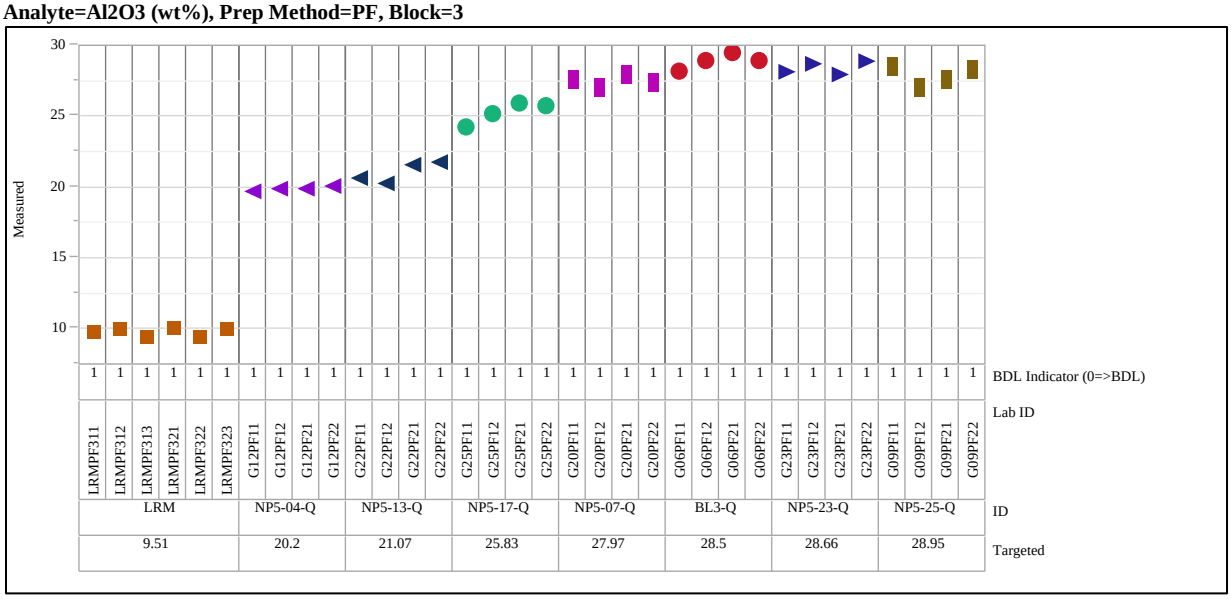


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=Al2O3 (wt%), Prep Method=PF, Block=3



Analyte=Al2O3 (wt%), Prep Method=PF, Block=4

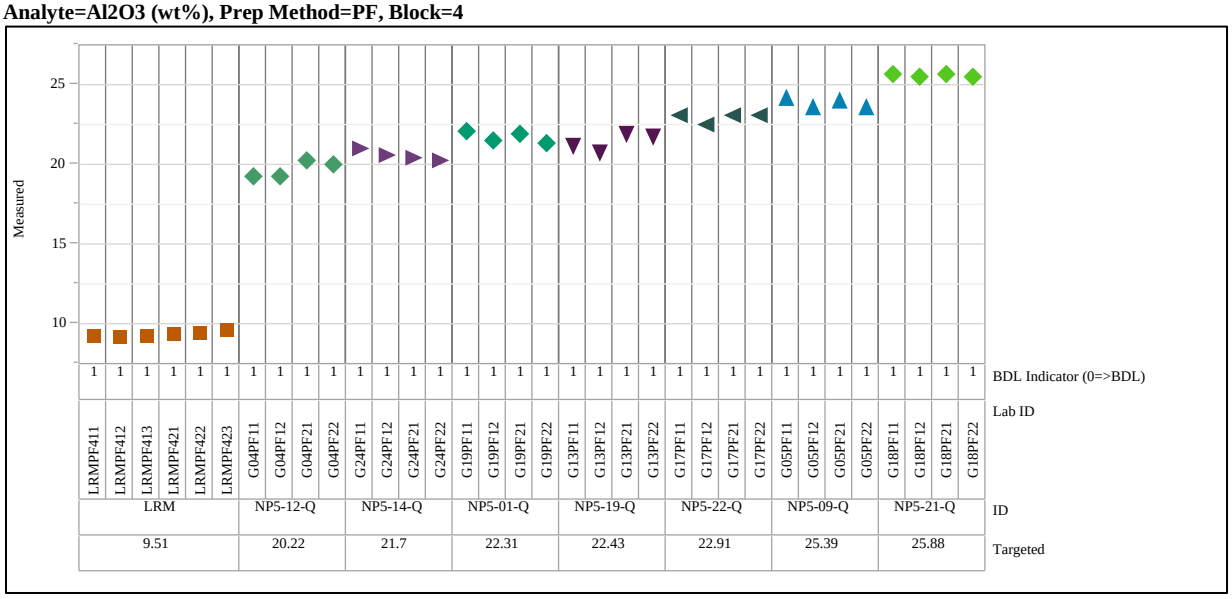
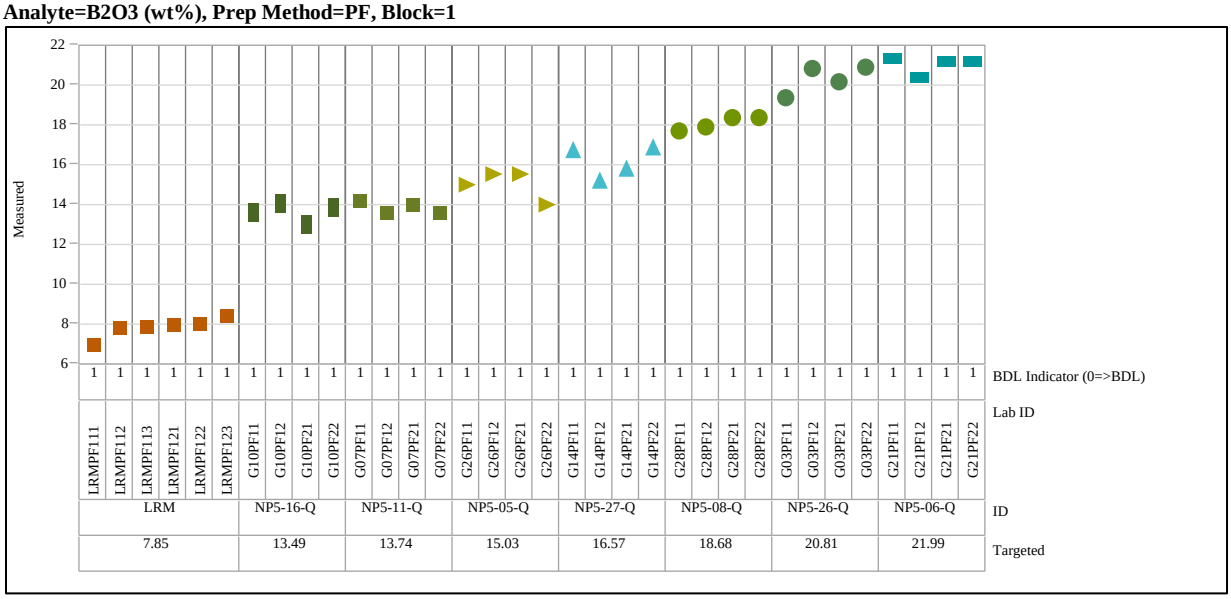


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=B2O3 (wt%), Prep Method=PF, Block=1



Analyte=B2O3 (wt%), Prep Method=PF, Block=2

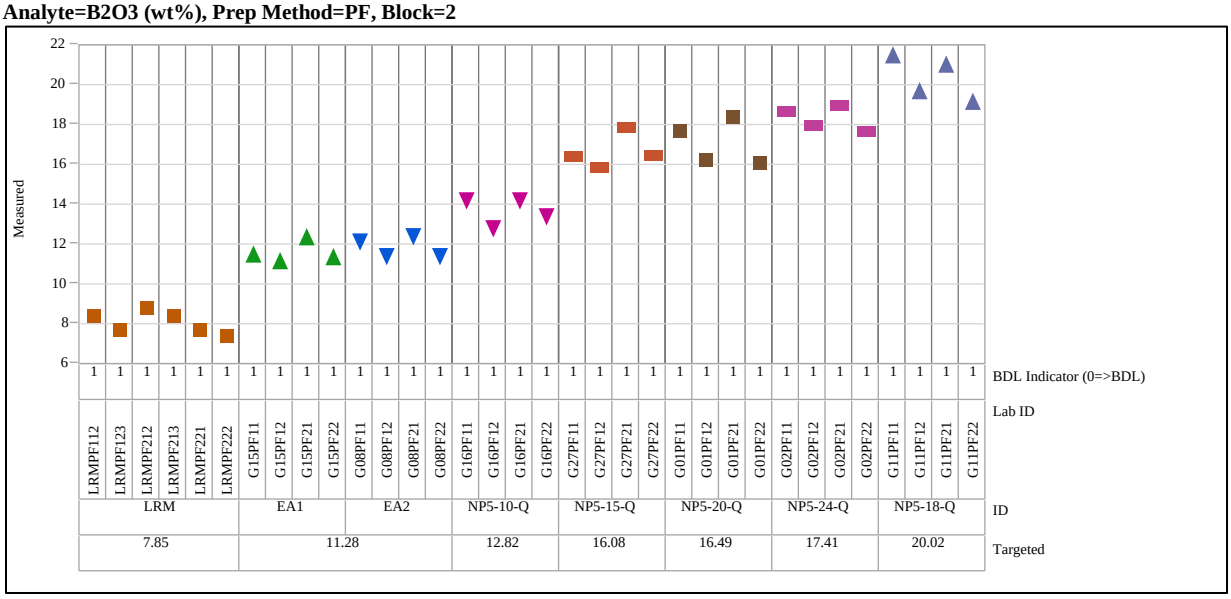
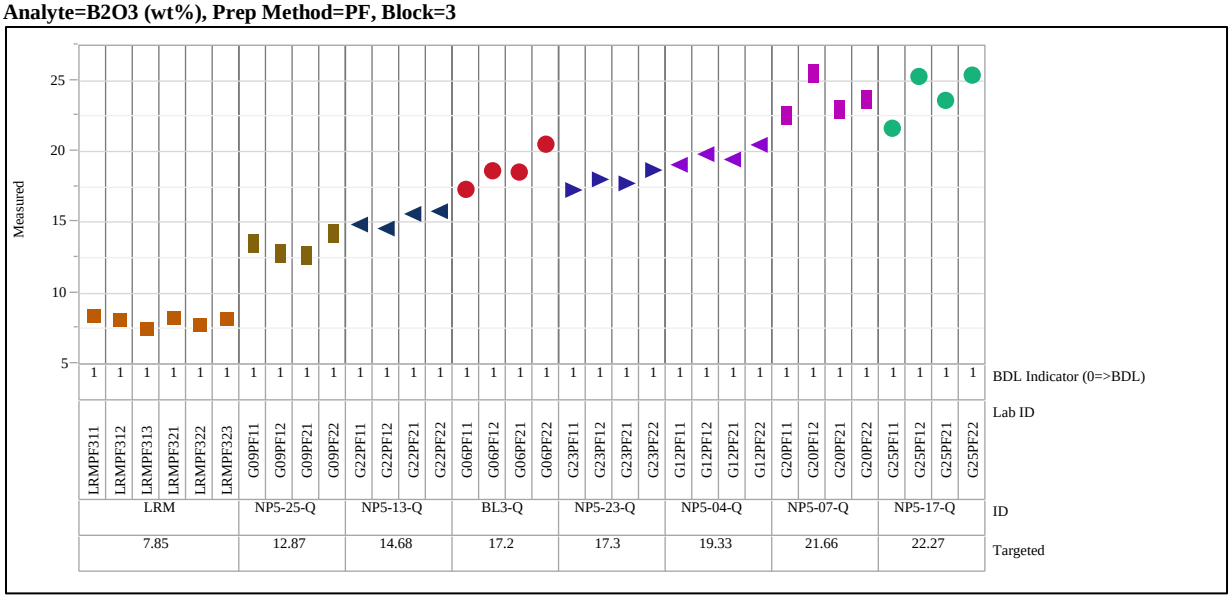


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=B2O3 (wt%), Prep Method=PF, Block=3



Analyte=B2O3 (wt%), Prep Method=PF, Block=4

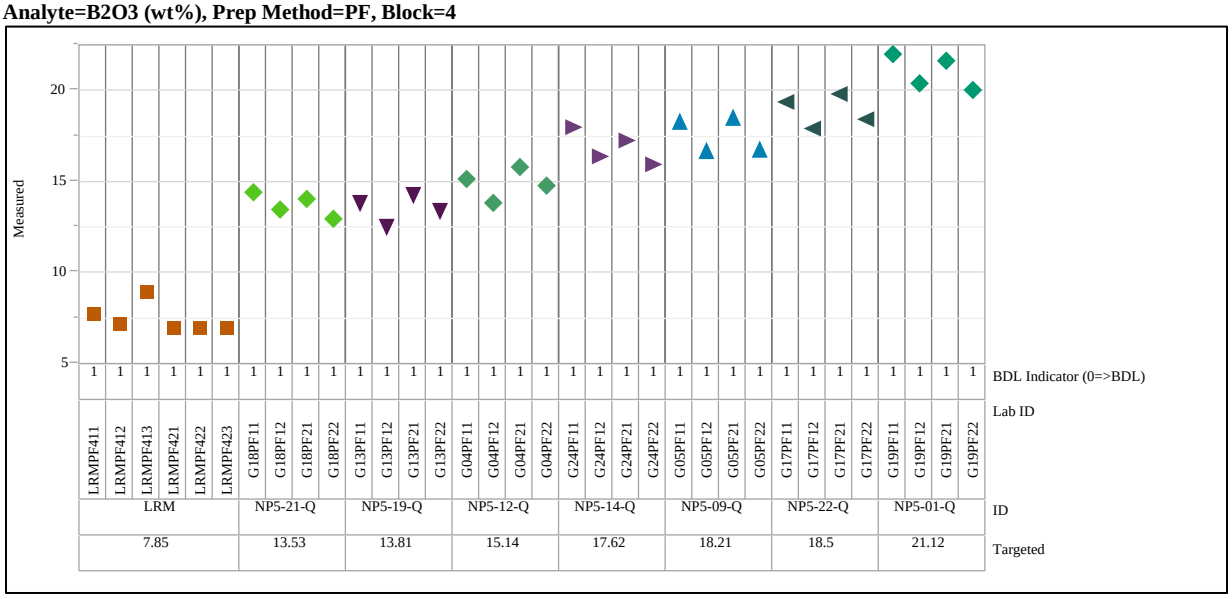
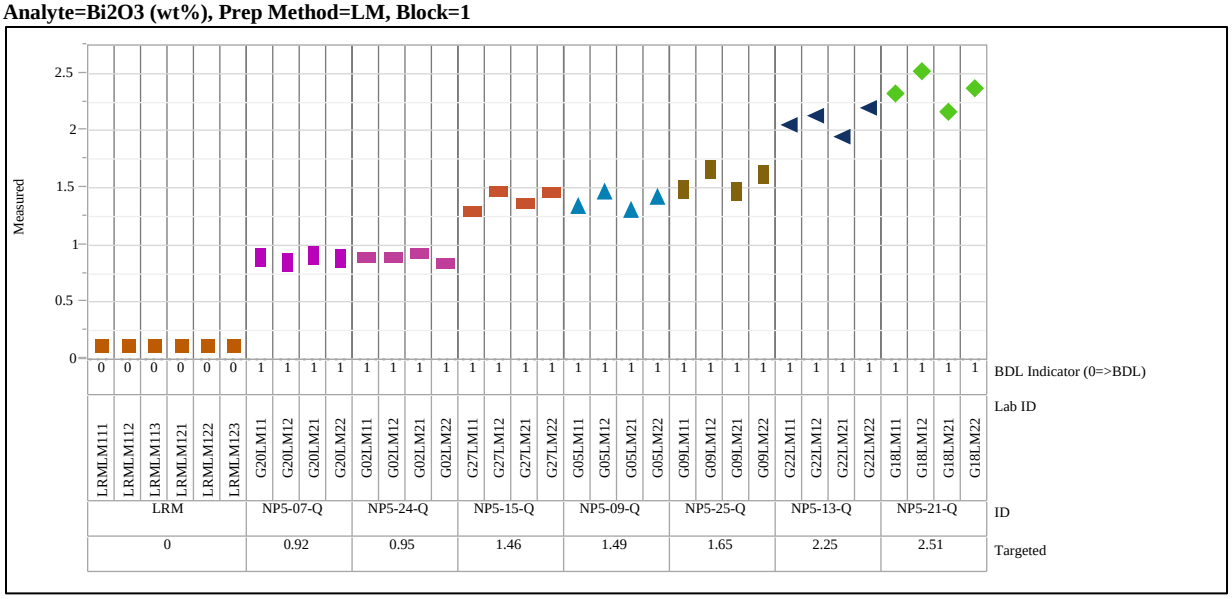


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=Bi2O3 (wt%), Prep Method=LM, Block=1



Analyte=Bi2O3 (wt%), Prep Method=LM, Block=2

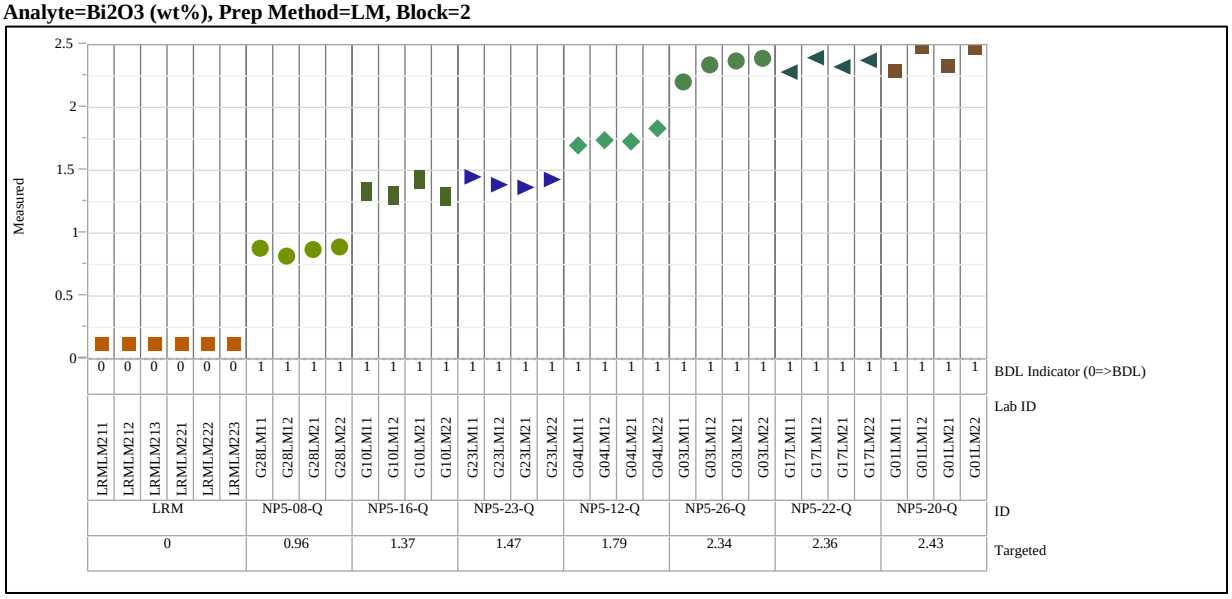
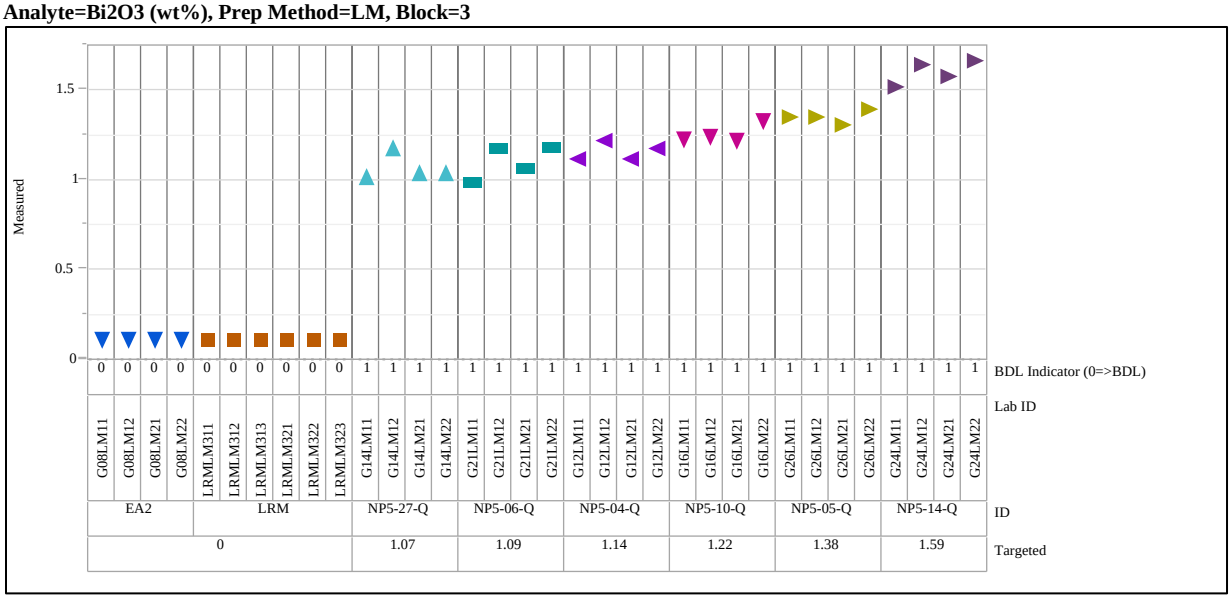


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=Bi2O3 (wt%), Prep Method=LM, Block=3



Analyte=Bi2O3 (wt%), Prep Method=LM, Block=4

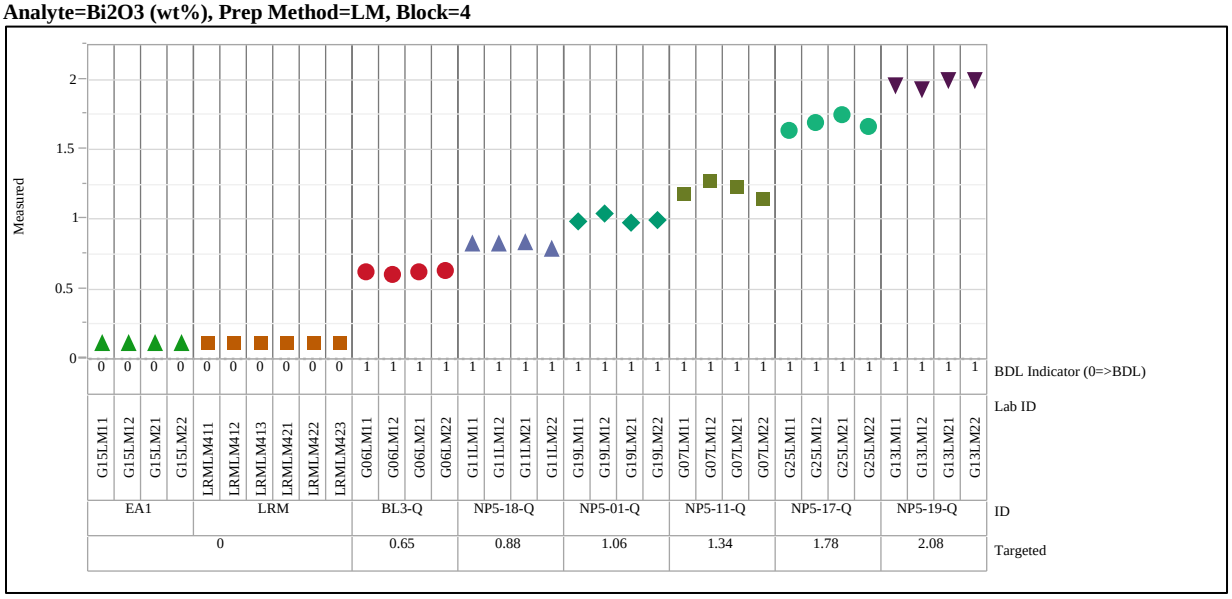
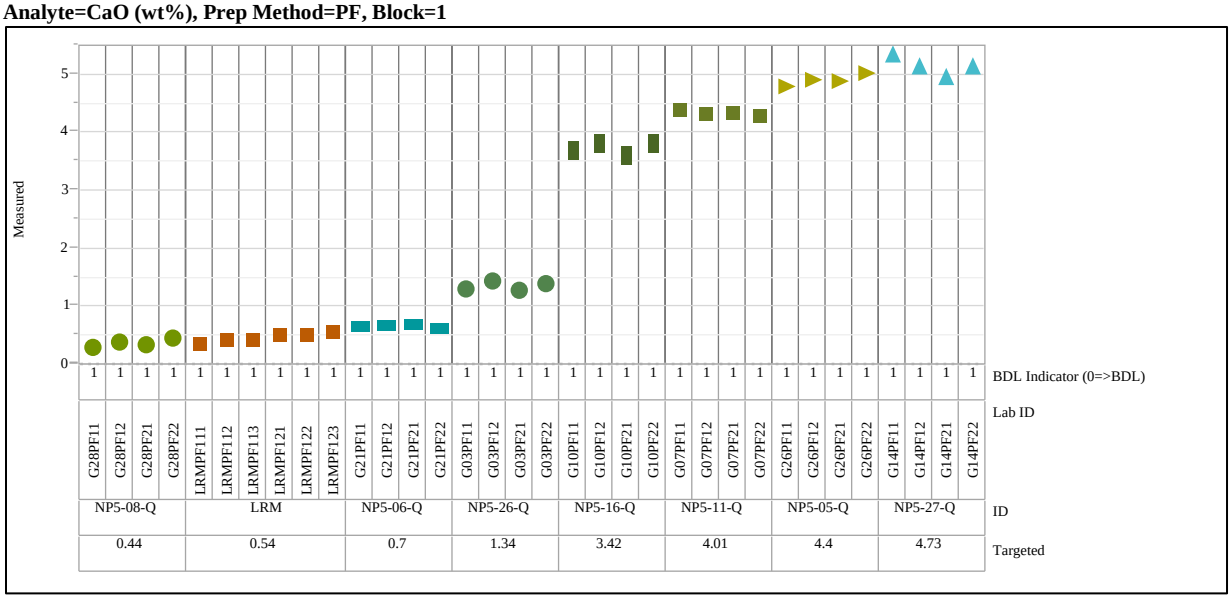


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=CaO (wt%), Prep Method=PF, Block=1



Analyte=CaO (wt%), Prep Method=PF, Block=2

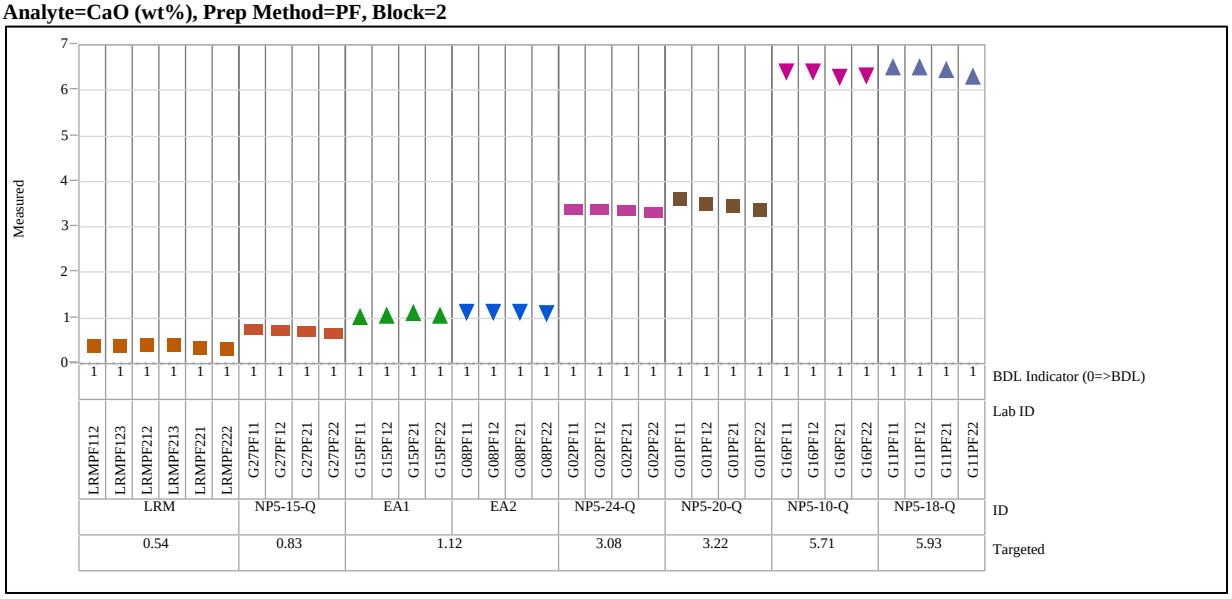
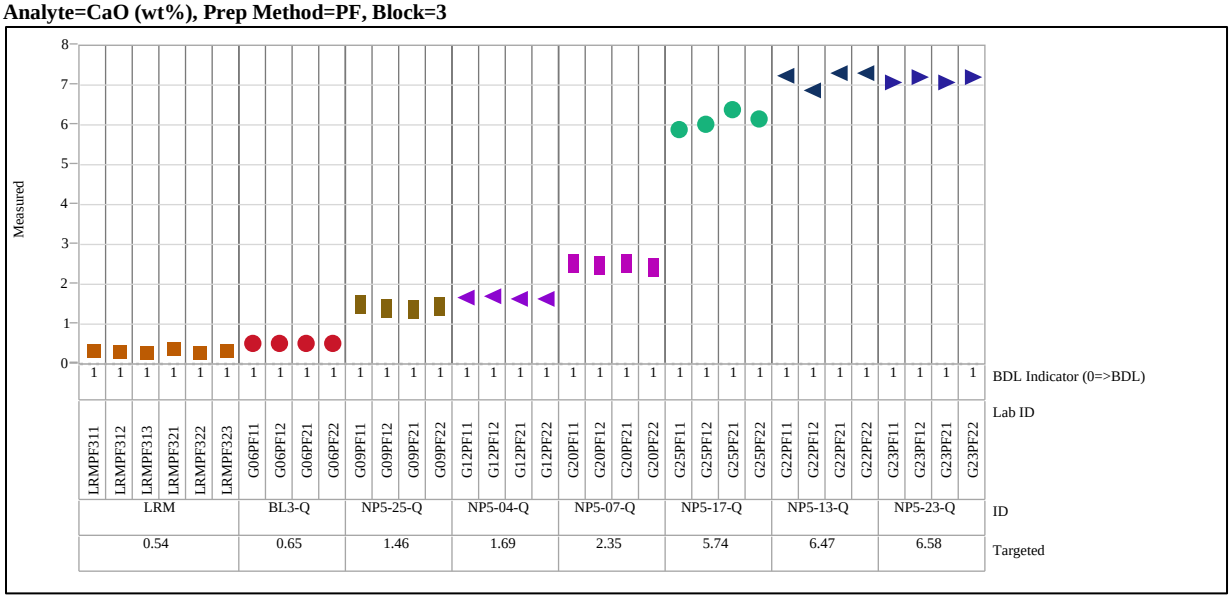


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=CaO (wt%), Prep Method=PF, Block=3



Analyte=CaO (wt%), Prep Method=PF, Block=4

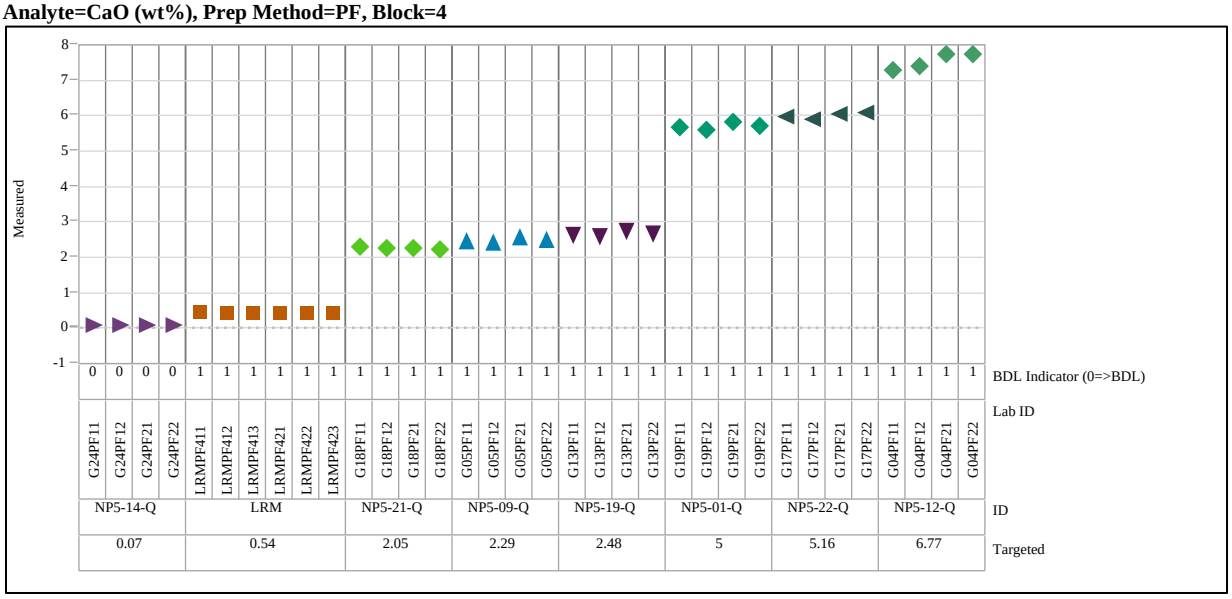
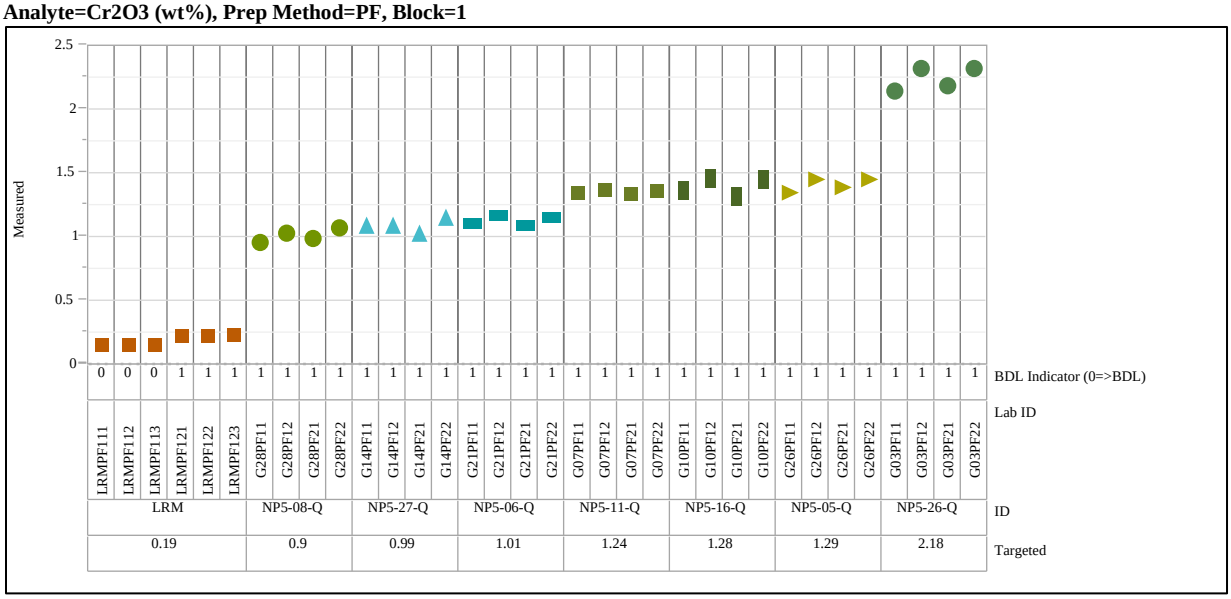


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=Cr2O3 (wt%), Prep Method=PF, Block=1



Analyte=Cr2O3 (wt%), Prep Method=PF, Block=2

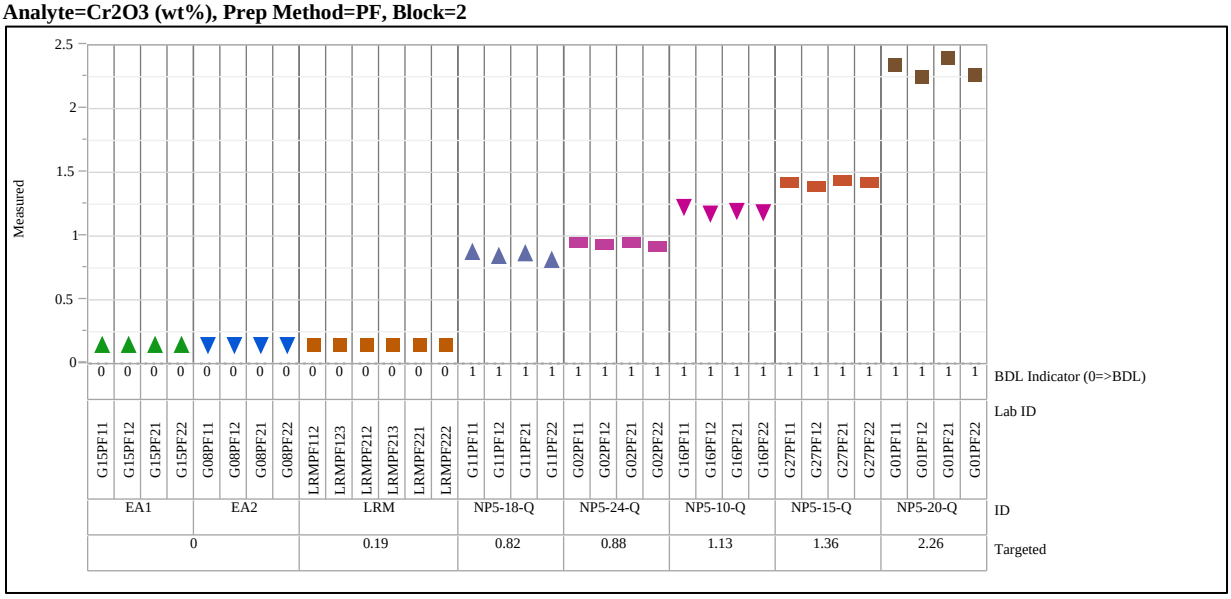
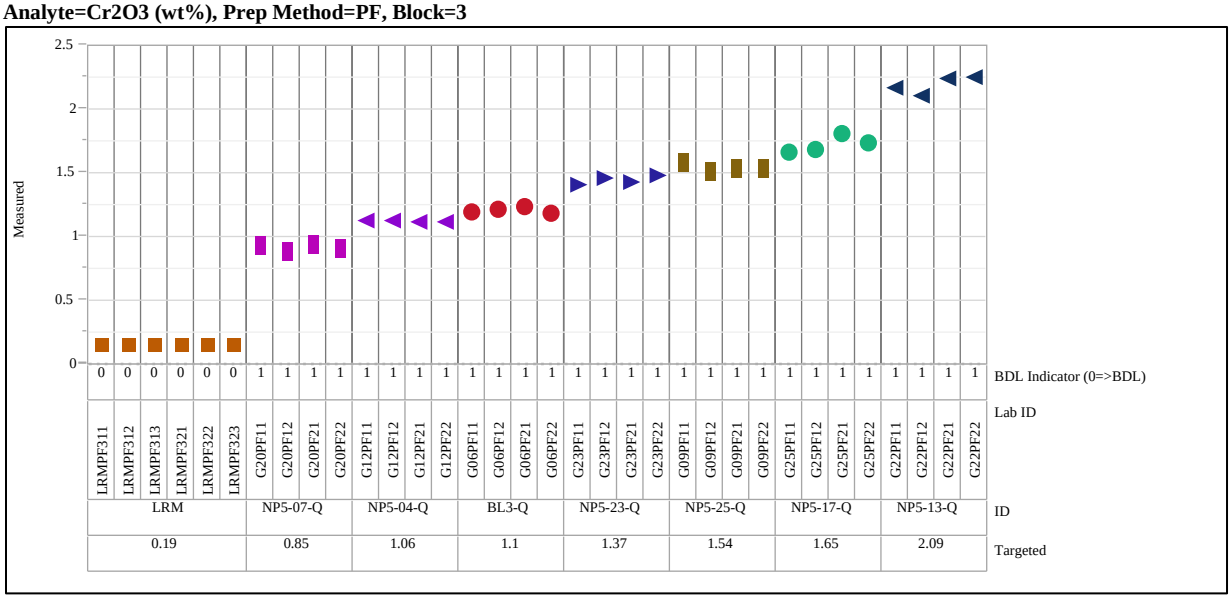


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=Cr2O3 (wt%), Prep Method=PF, Block=3



Analyte=Cr2O3 (wt%), Prep Method=PF, Block=4

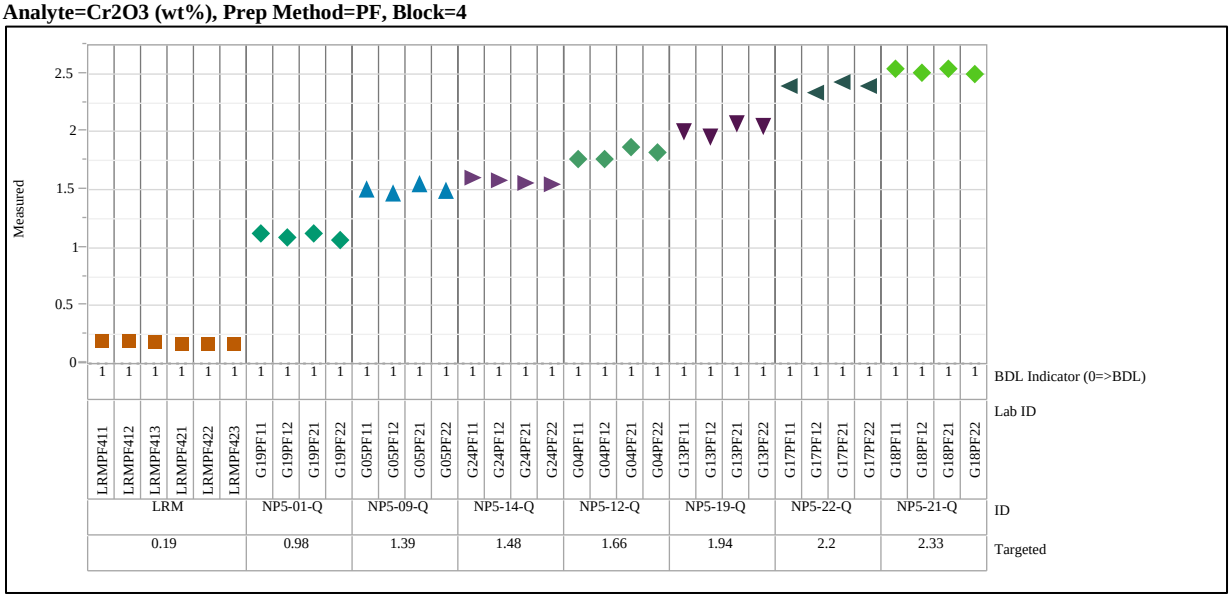
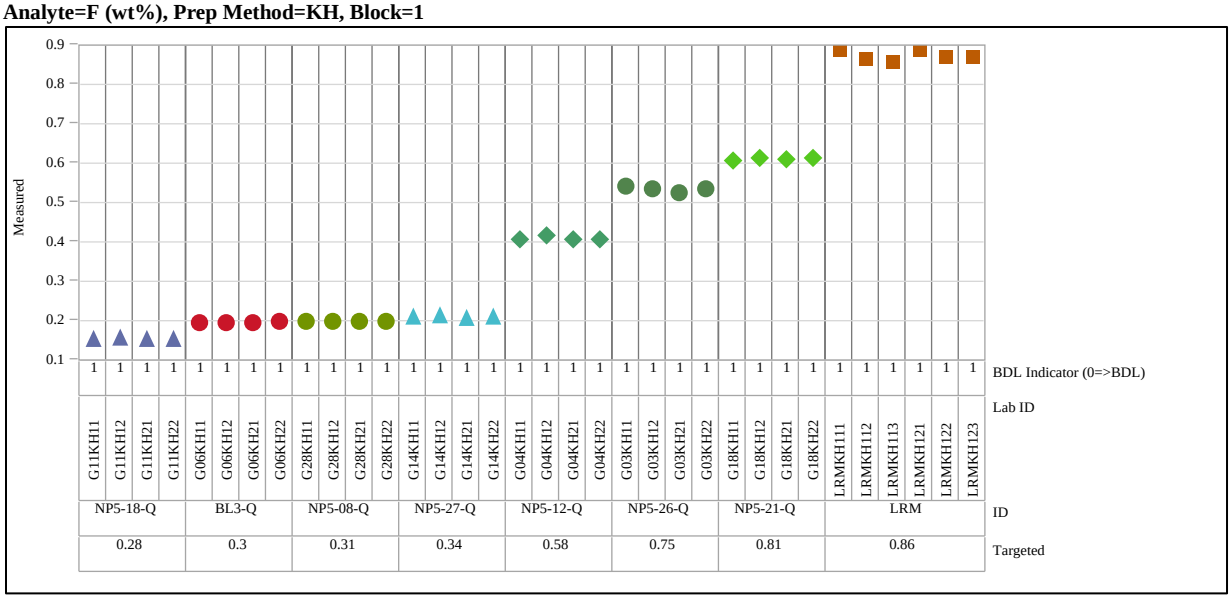


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=F (wt%), Prep Method=KH, Block=1



Analyte=F (wt%), Prep Method=KH, Block=2

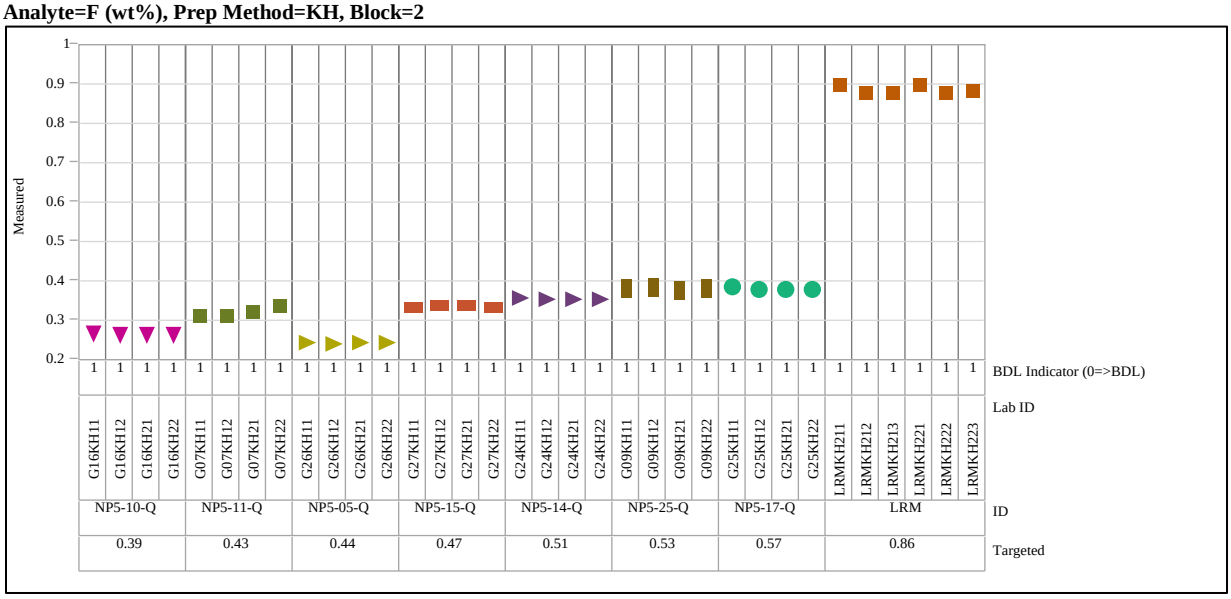
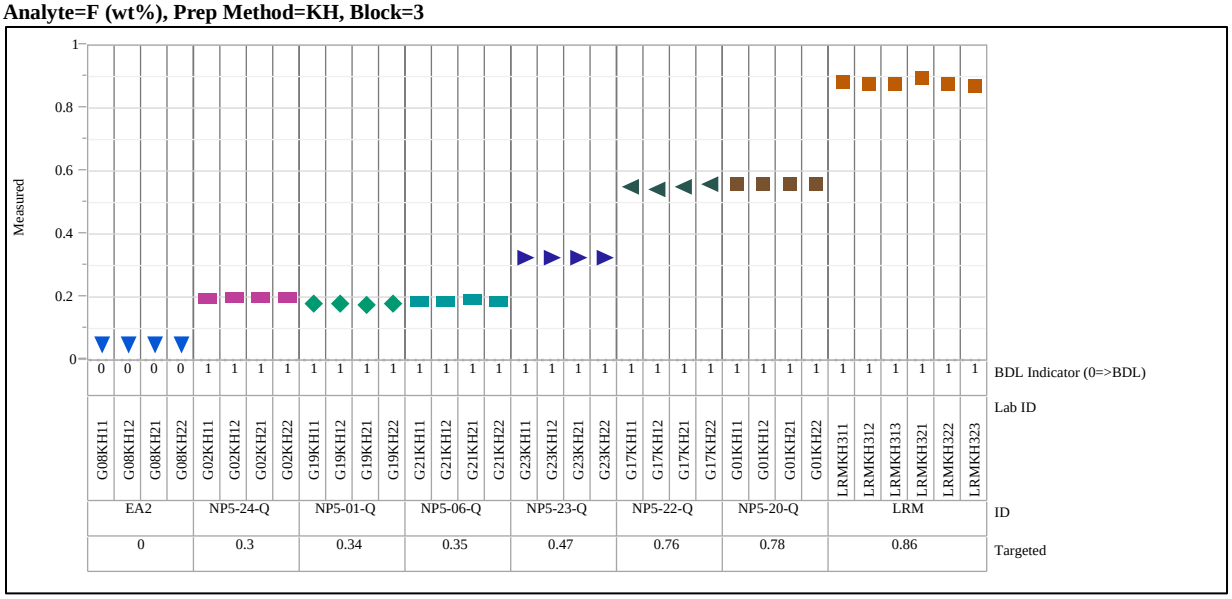


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=F (wt%), Prep Method=KH, Block=3



Analyte=F (wt%), Prep Method=KH, Block=4

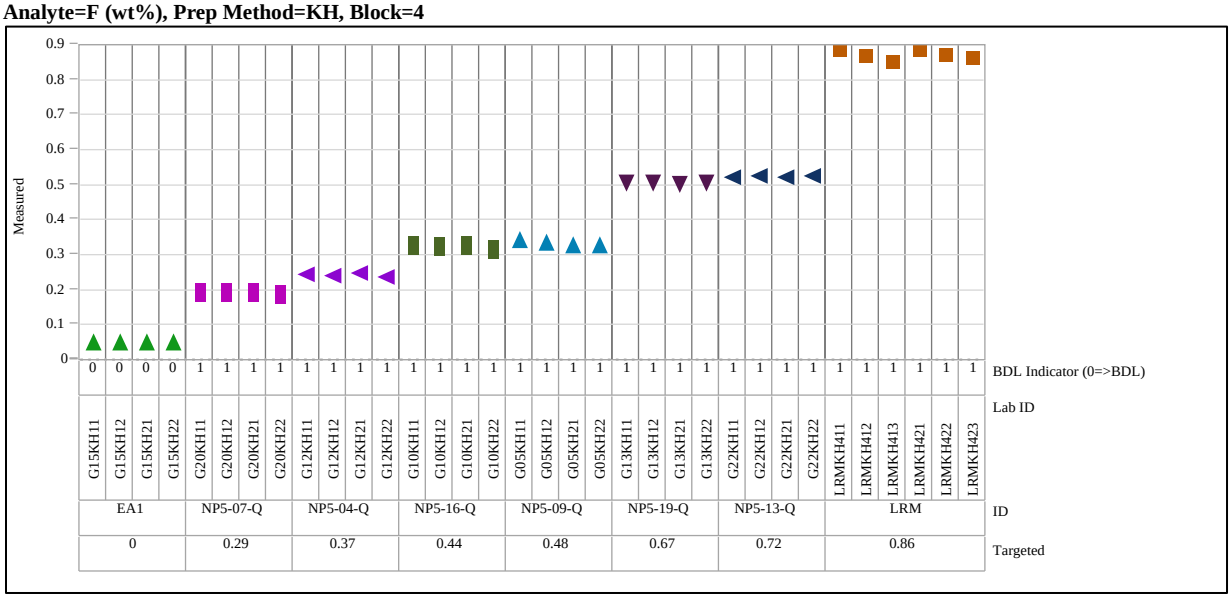
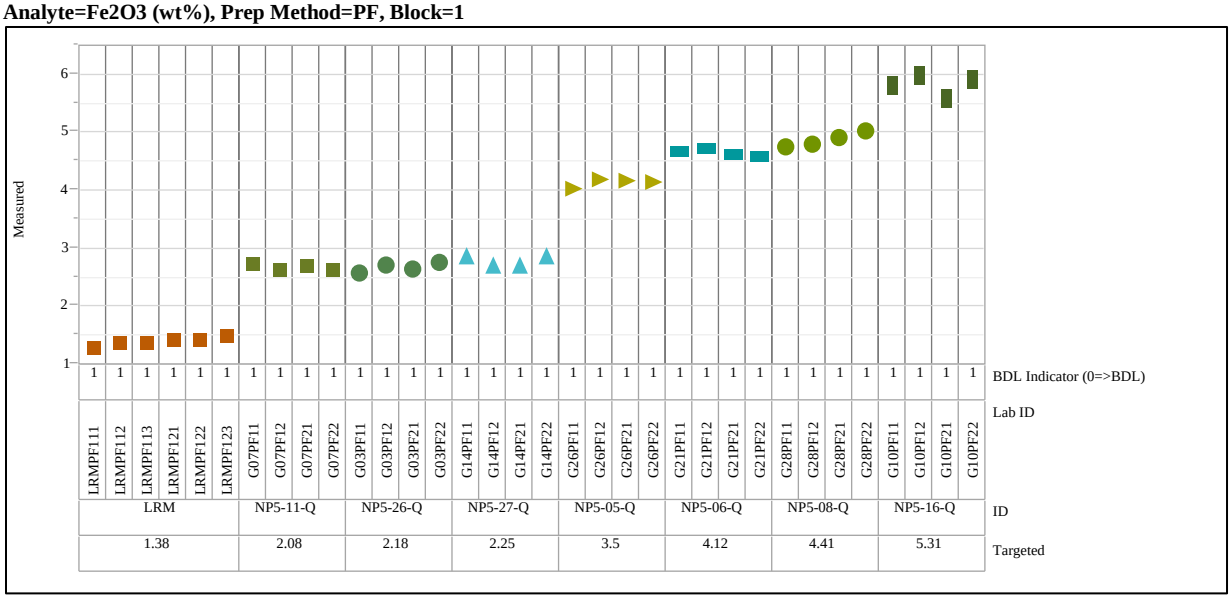


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=Fe2O3 (wt%), Prep Method=PF, Block=1



Analyte=Fe2O3 (wt%), Prep Method=PF, Block=2

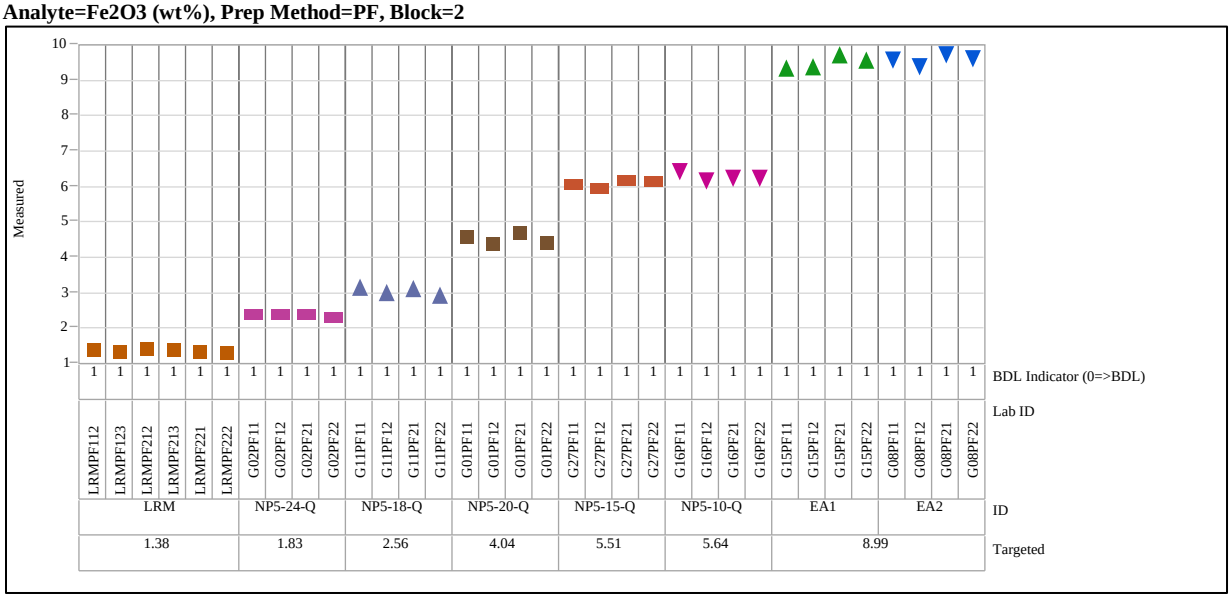
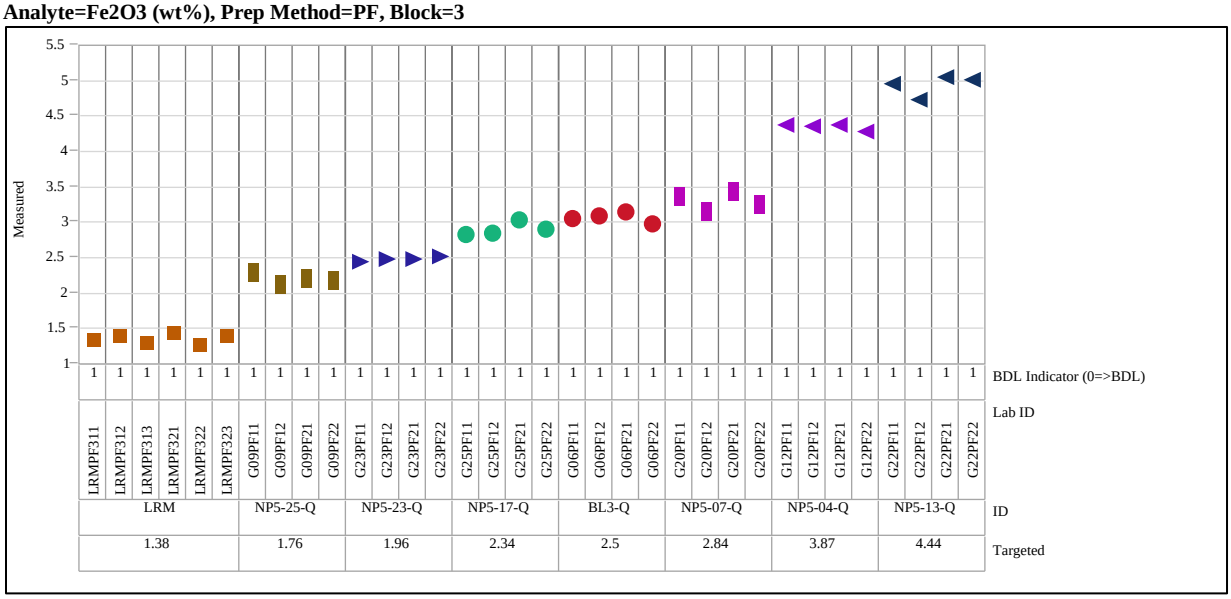


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=Fe2O3 (wt%), Prep Method=PF, Block=3



Analyte=Fe2O3 (wt%), Prep Method=PF, Block=4

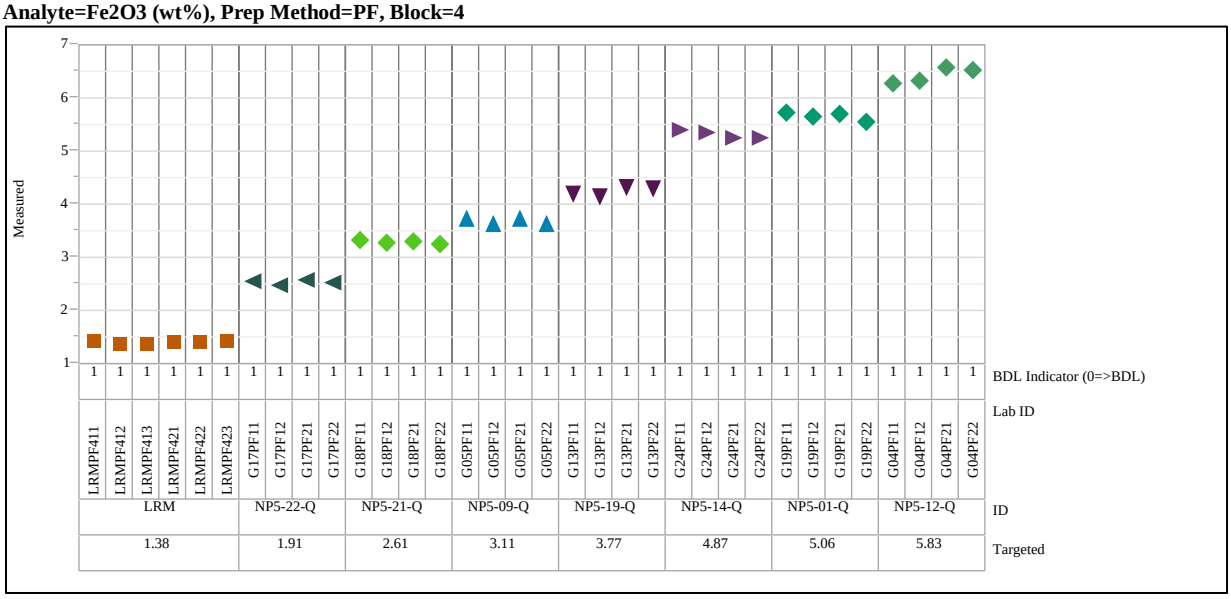
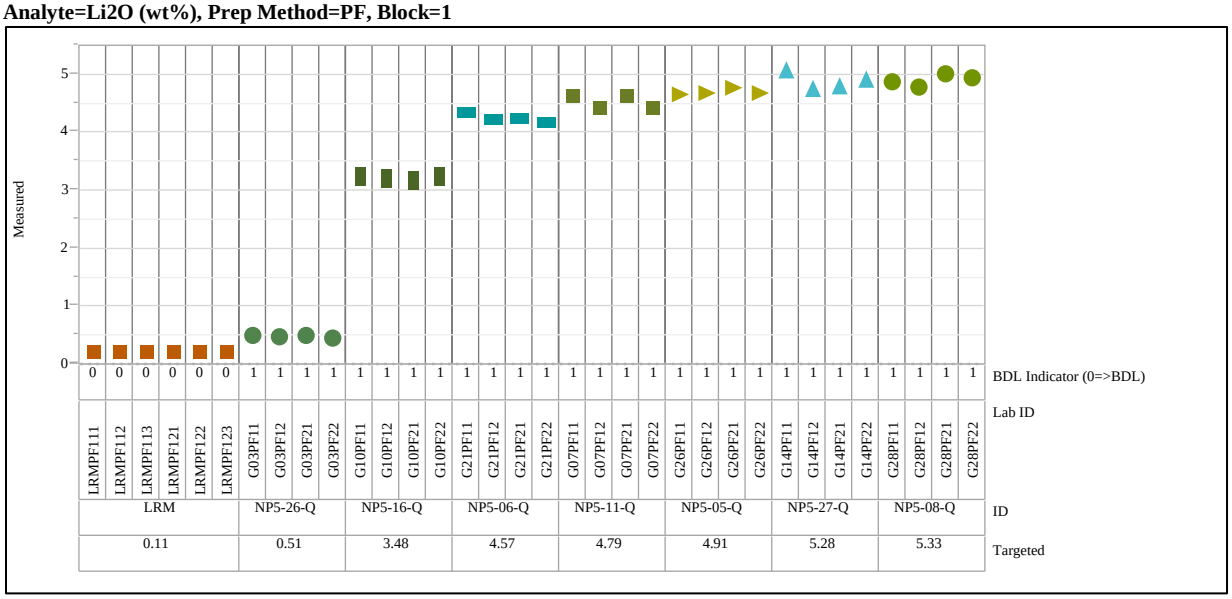


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=Li2O (wt%), Prep Method=PF, Block=1



Analyte=Li2O (wt%), Prep Method=PF, Block=2

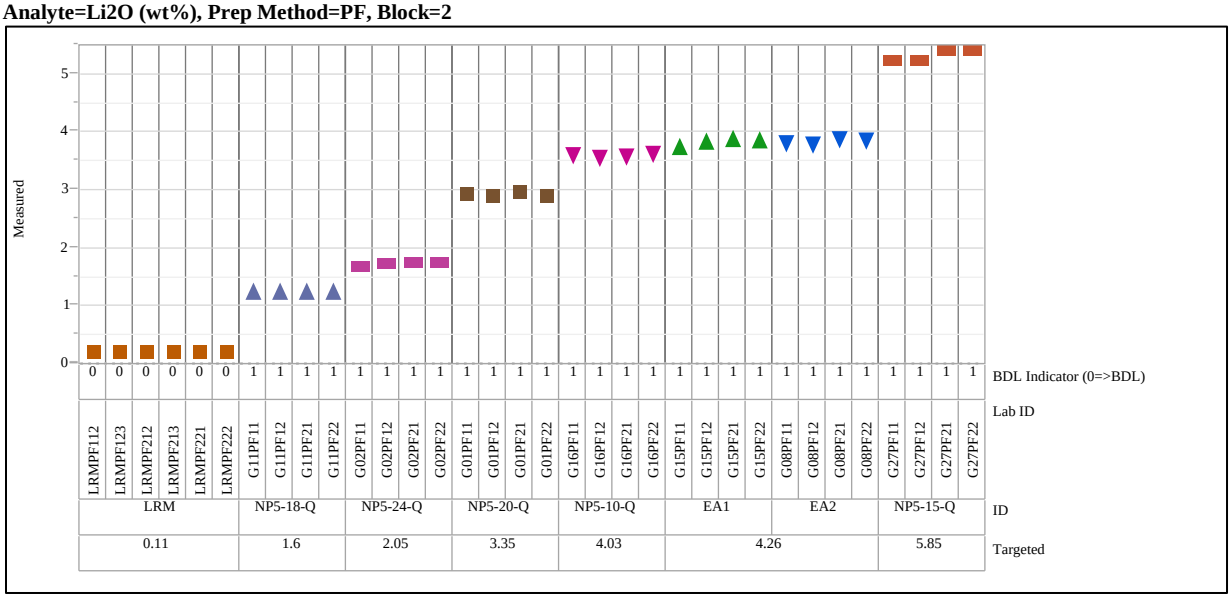
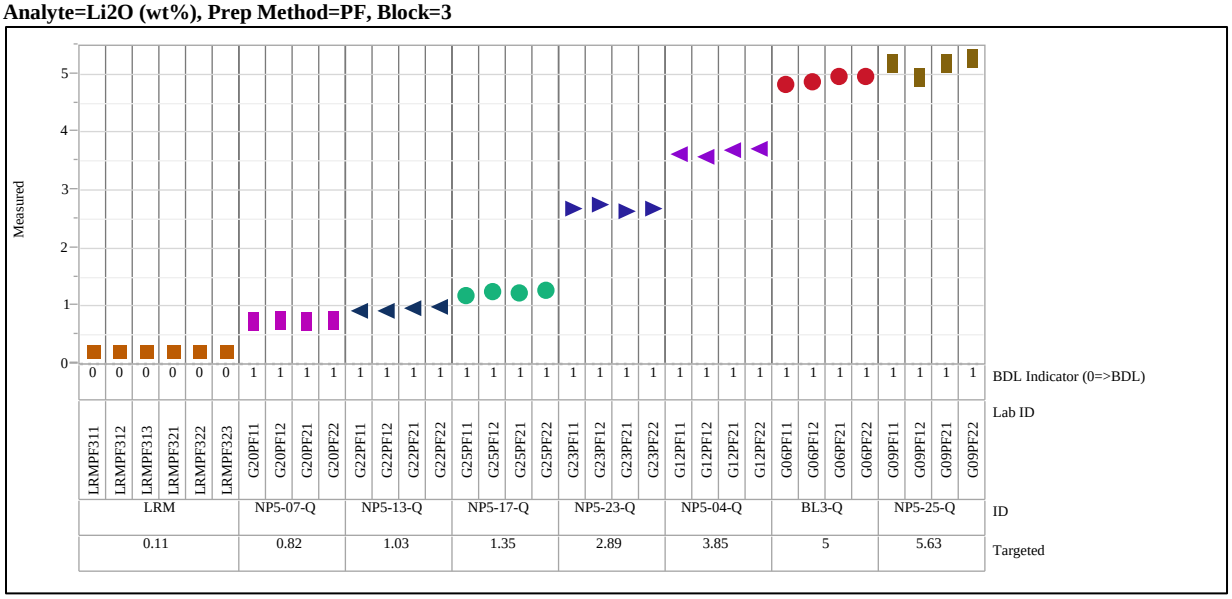


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=Li2O (wt%), Prep Method=PF, Block=3



Analyte=Li2O (wt%), Prep Method=PF, Block=4

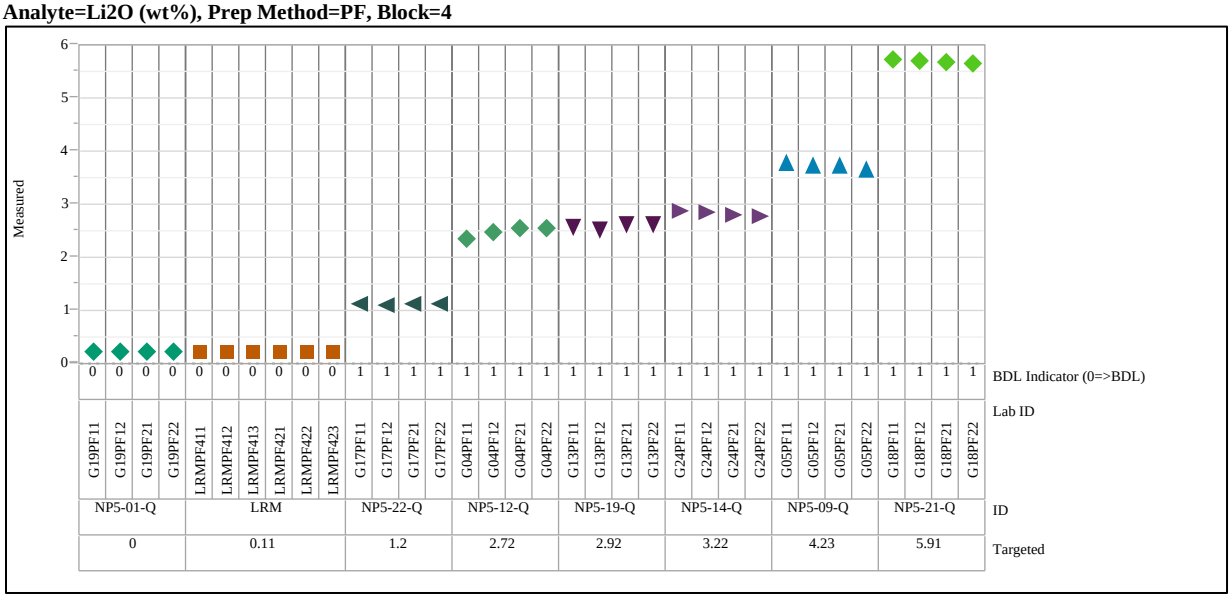
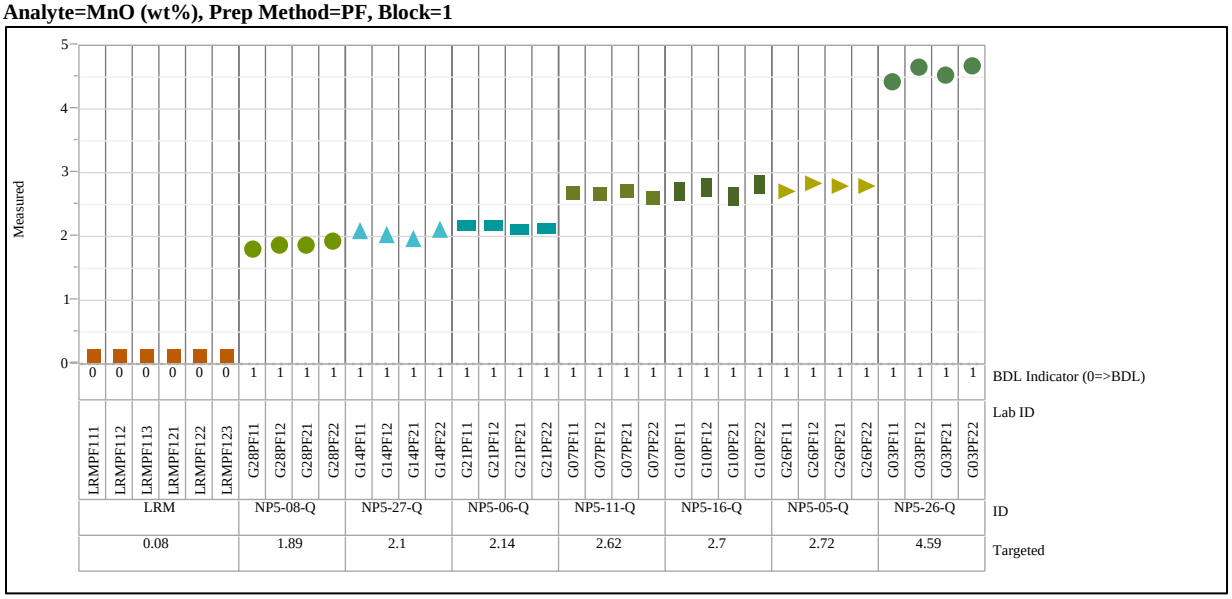


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=MnO (wt%), Prep Method=PF, Block=1



Analyte=MnO (wt%), Prep Method=PF, Block=2

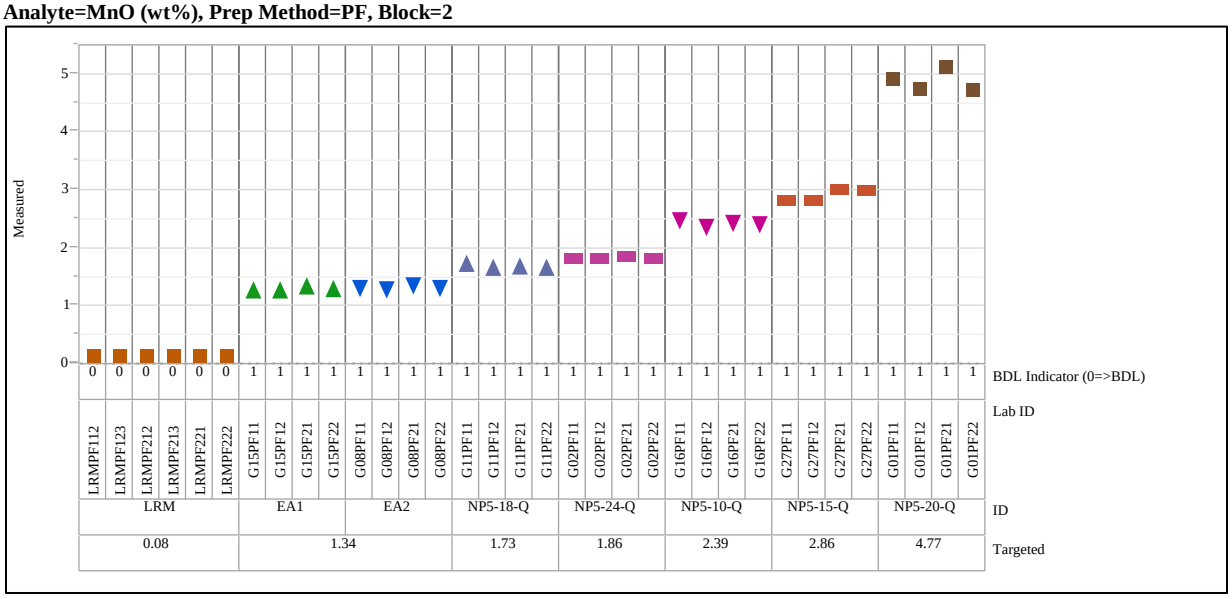
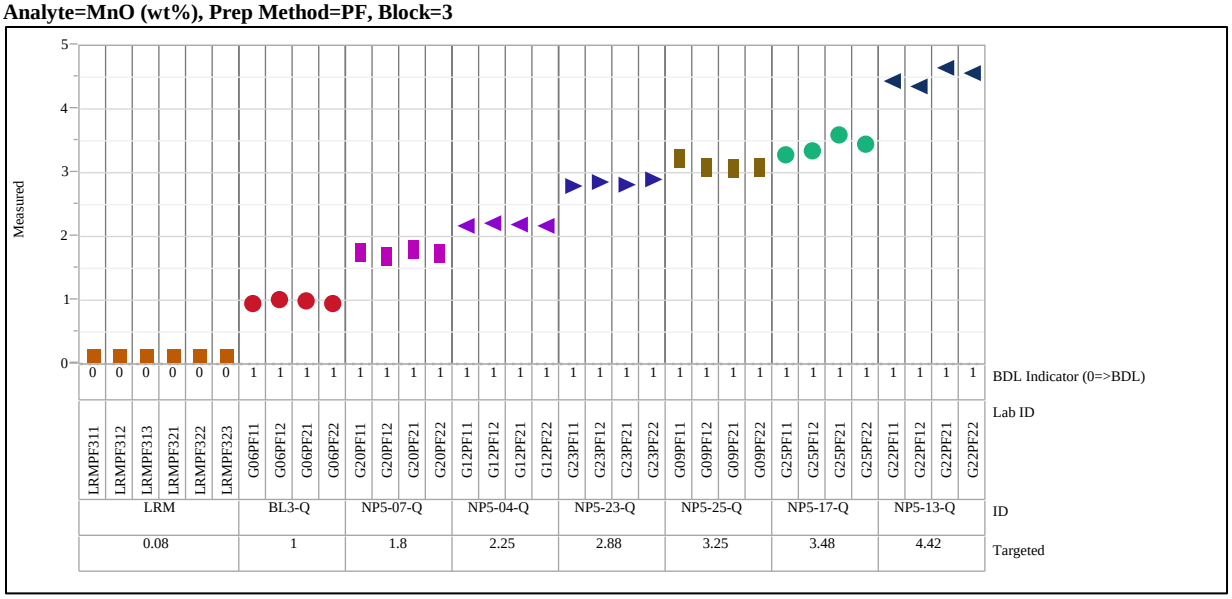


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=MnO (wt%), Prep Method=PF, Block=3



Analyte=MnO (wt%), Prep Method=PF, Block=4

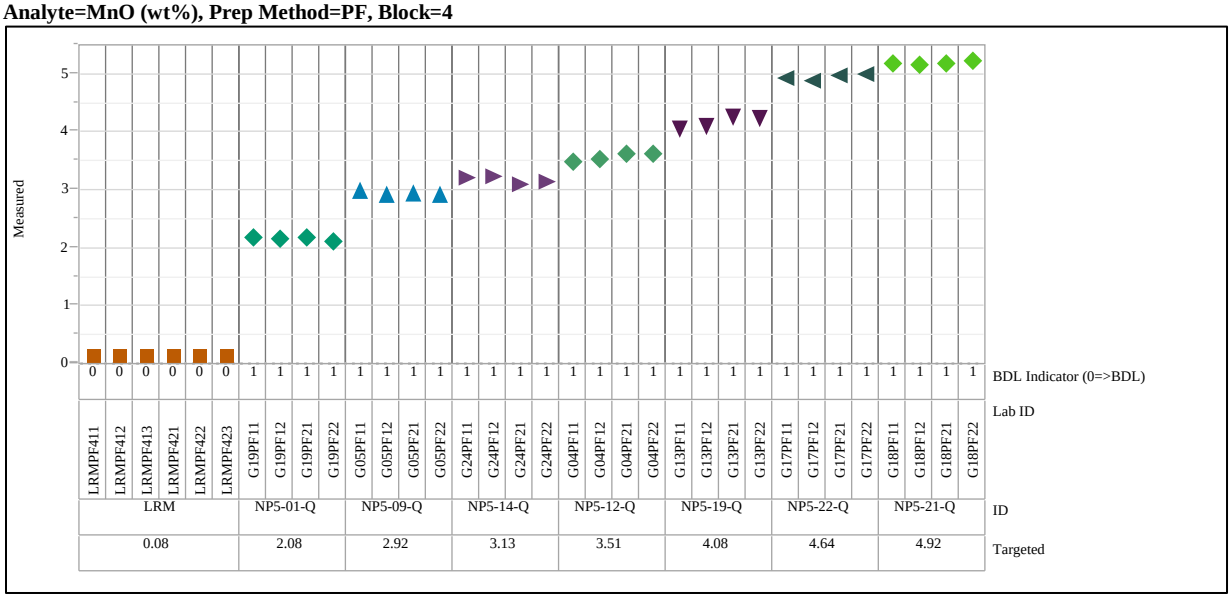
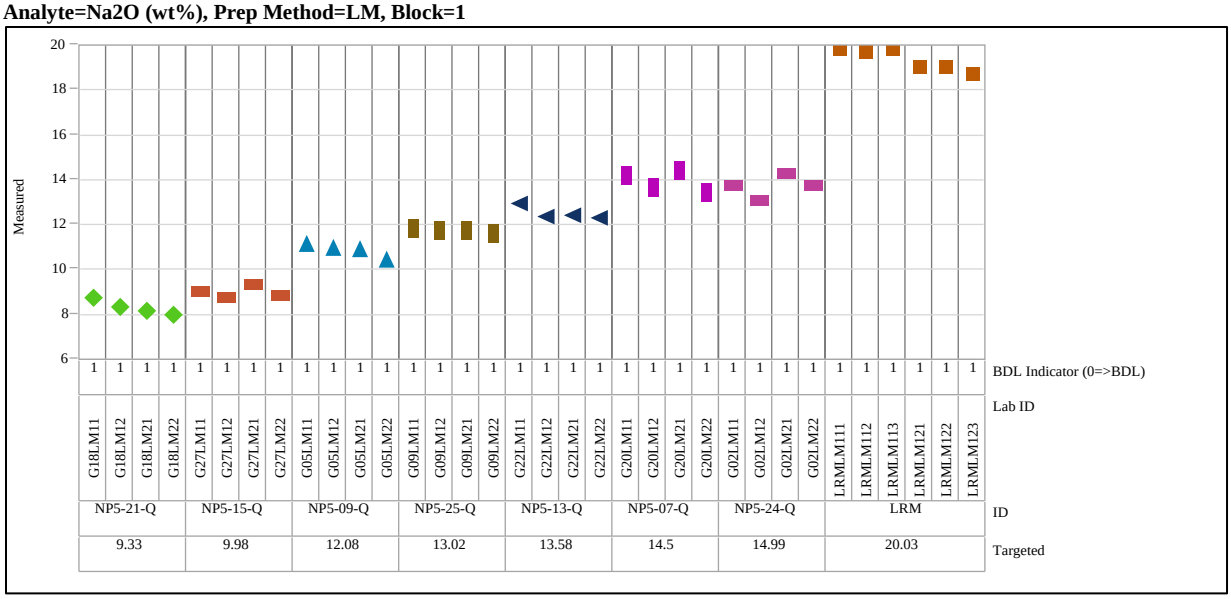


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=Na2O (wt%), Prep Method=LM, Block=1



Analyte=Na2O (wt%), Prep Method=LM, Block=2

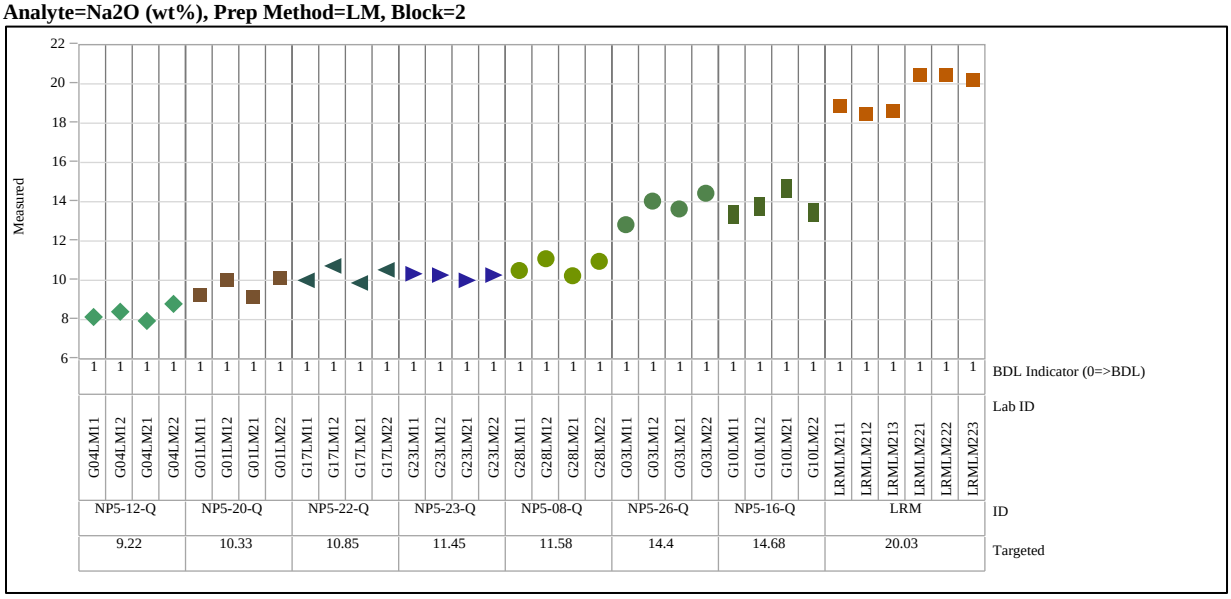
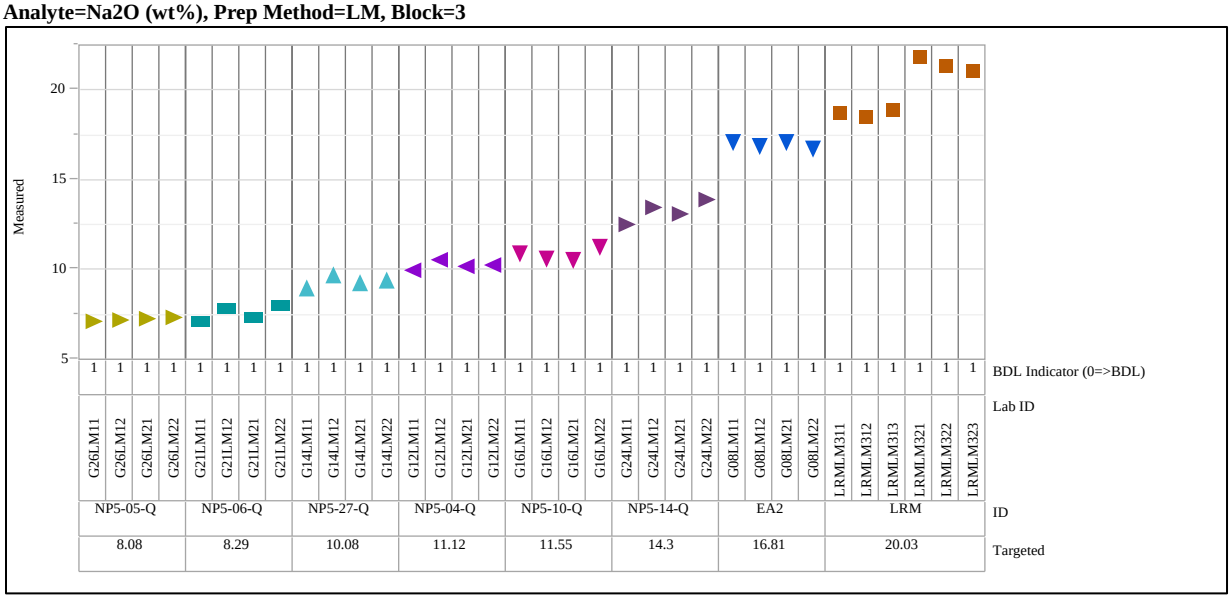


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=Na2O (wt%), Prep Method=LM, Block=3



Analyte=Na2O (wt%), Prep Method=LM, Block=4

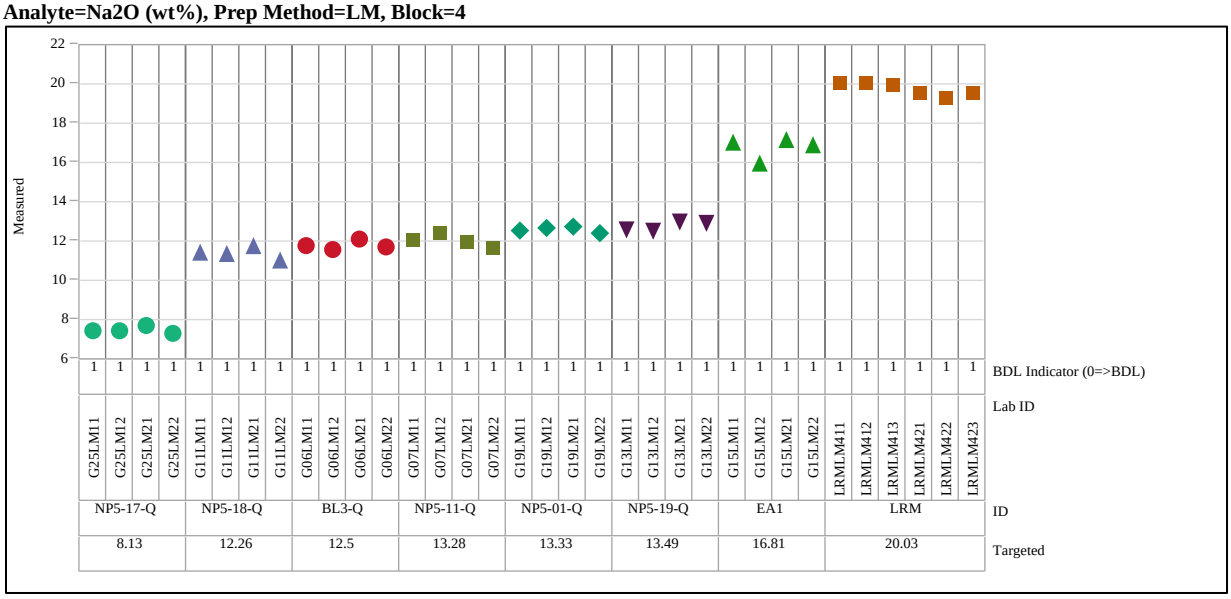
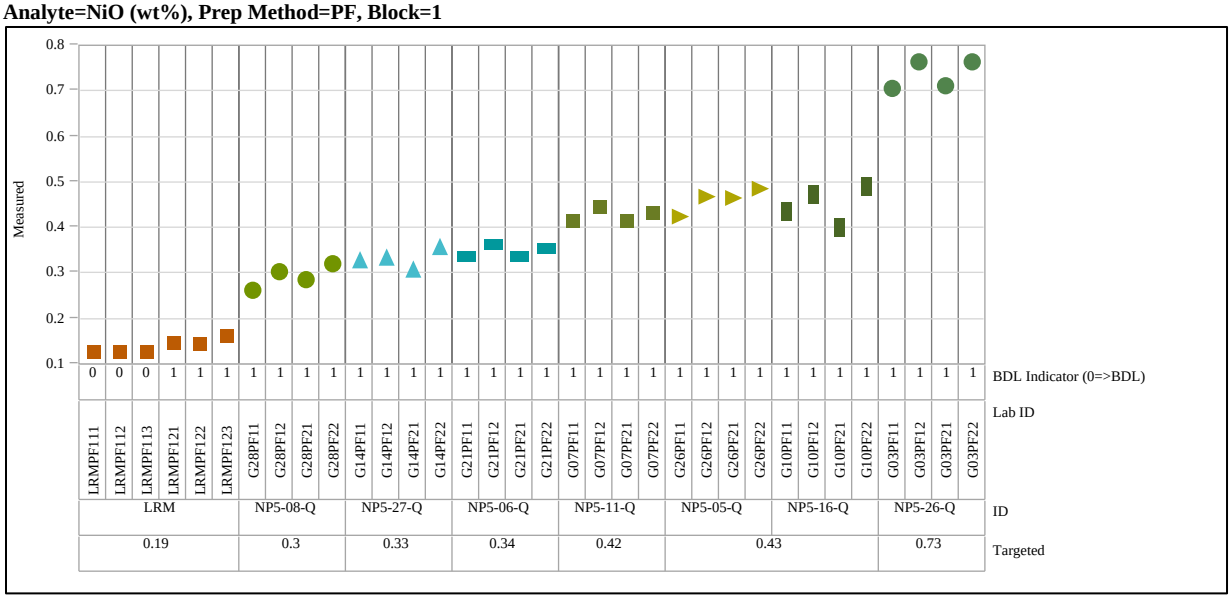


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=NiO (wt%), Prep Method=PF, Block=1



Analyte=NiO (wt%), Prep Method=PF, Block=2

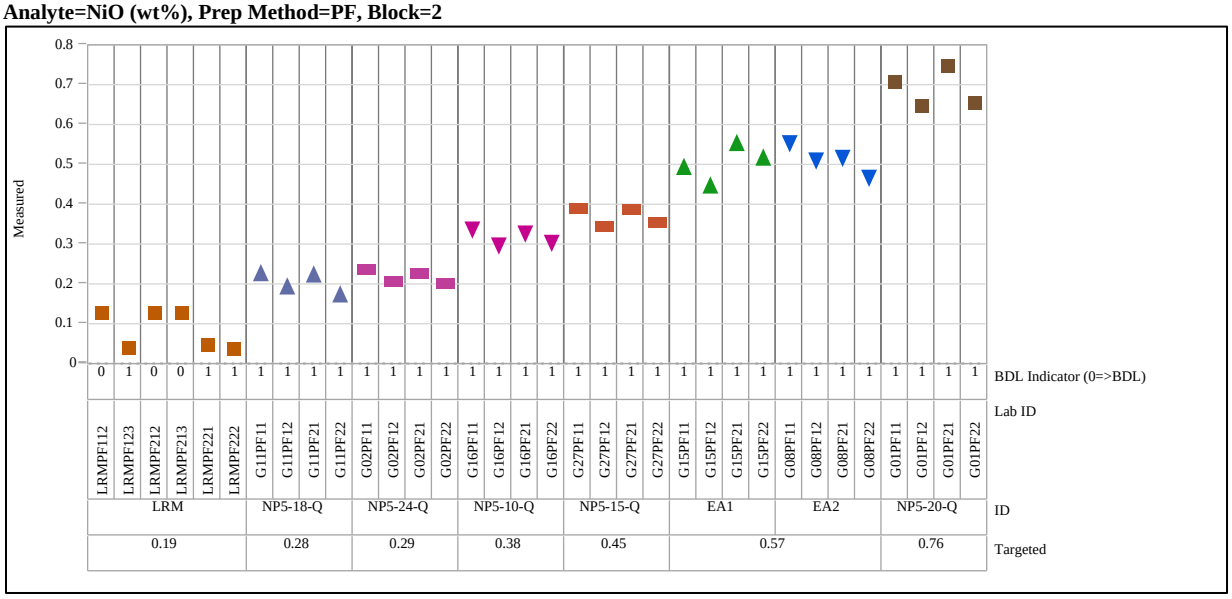
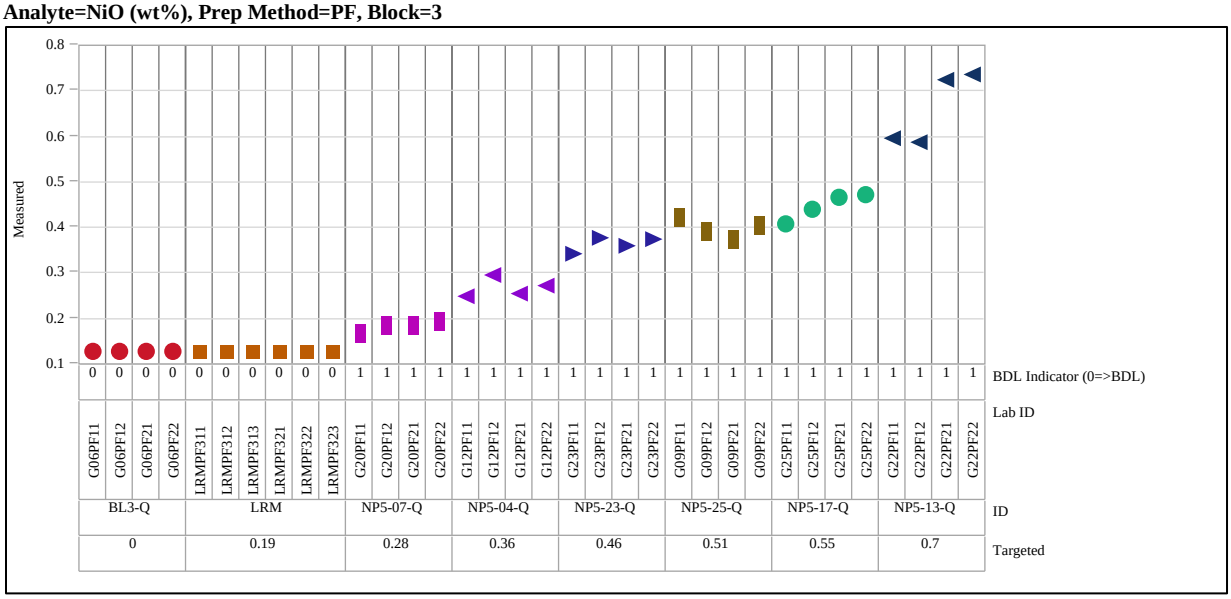


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=NiO (wt%), Prep Method=PF, Block=3



Analyte=NiO (wt%), Prep Method=PF, Block=4

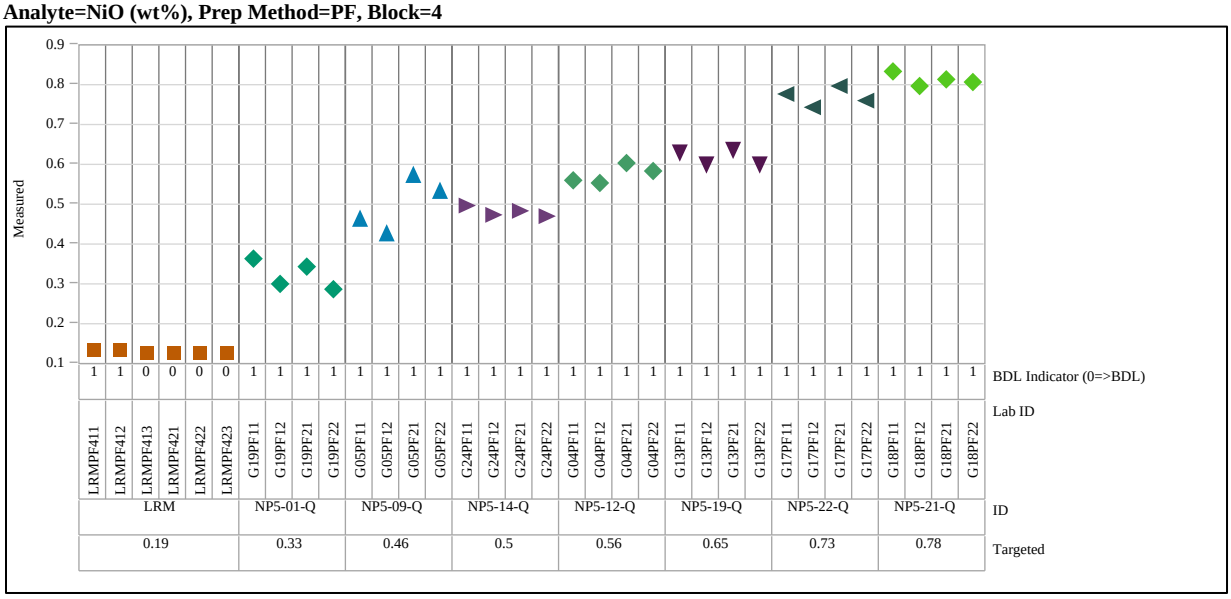
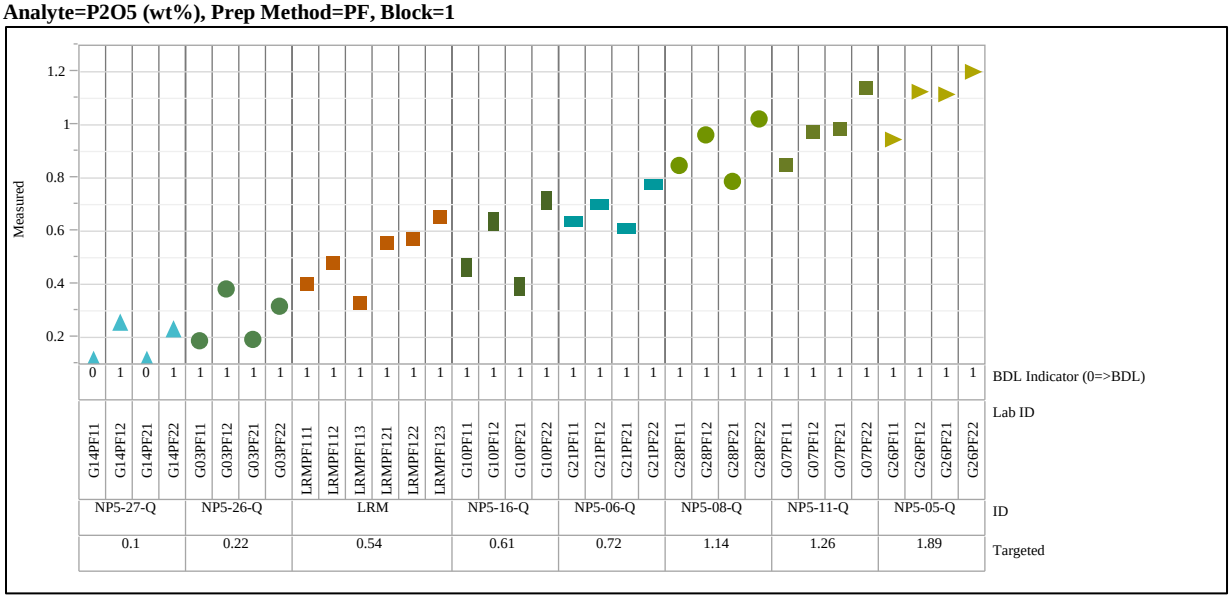


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=P2O5 (wt%), Prep Method=PF, Block=1



Analyte=P2O5 (wt%), Prep Method=PF, Block=2

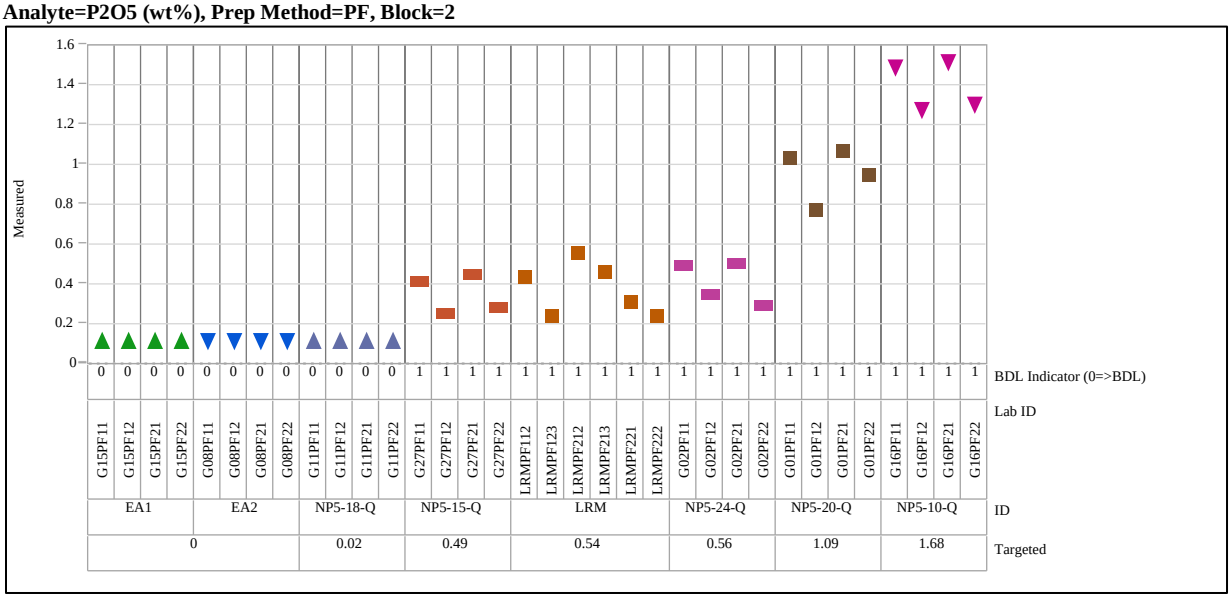
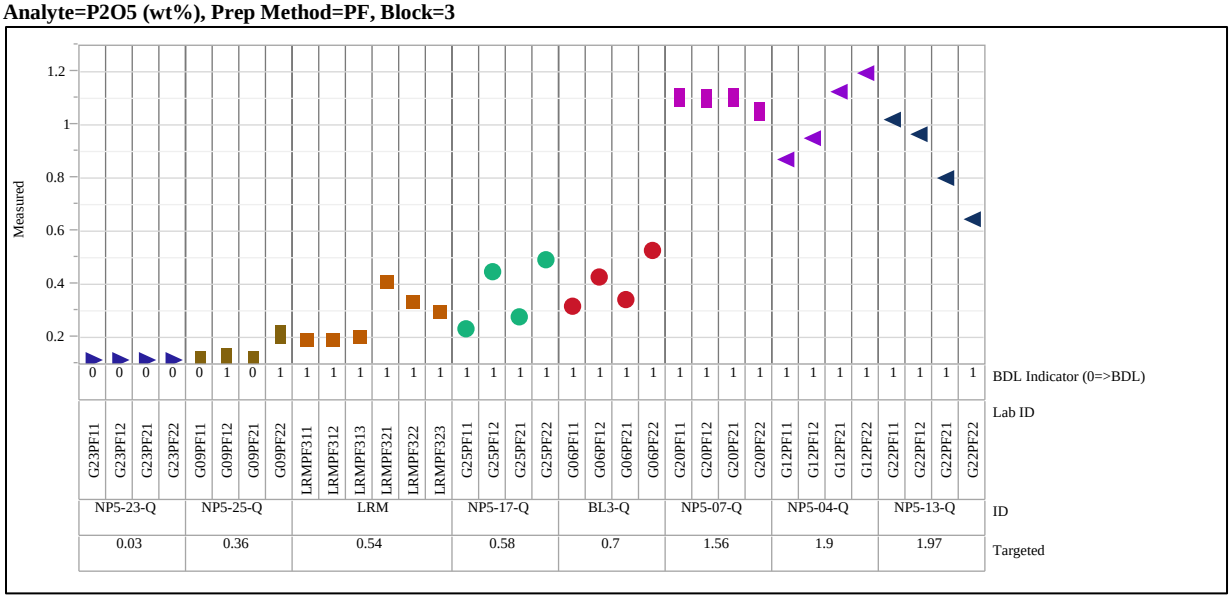


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=P2O5 (wt%), Prep Method=PF, Block=3



Analyte=P2O5 (wt%), Prep Method=PF, Block=4

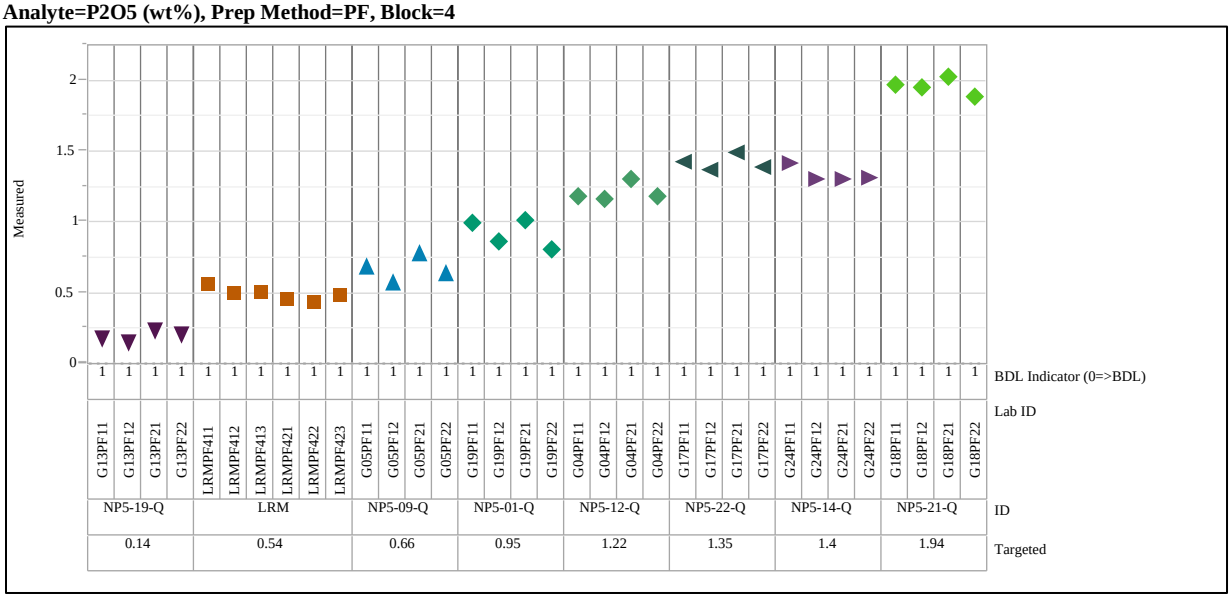
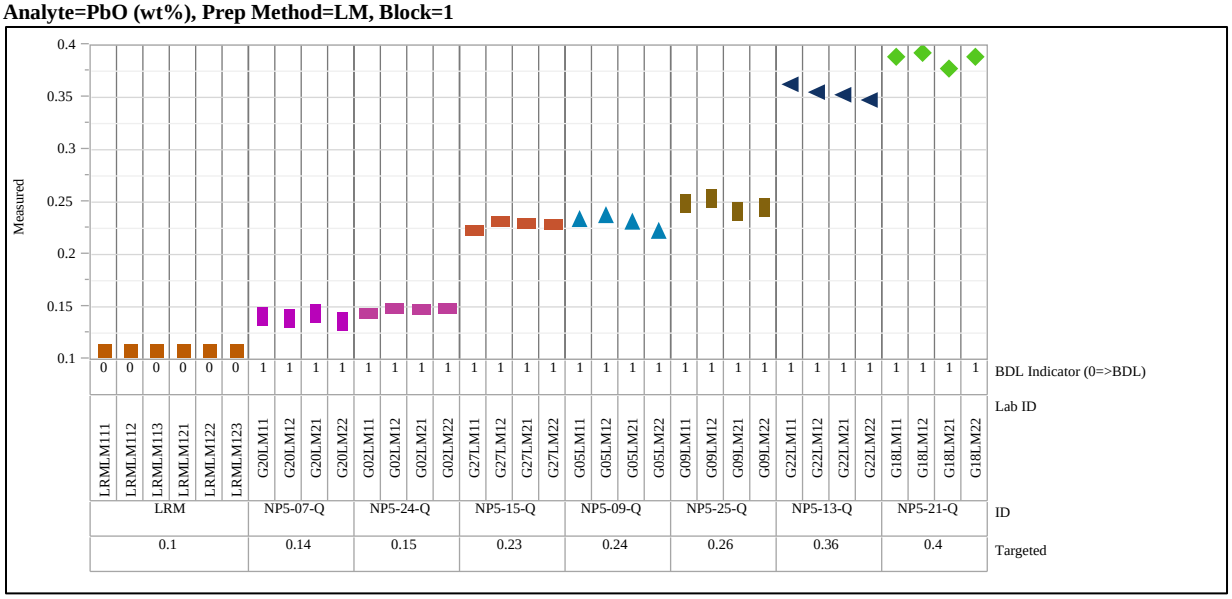


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=PbO (wt%), Prep Method=LM, Block=1



Analyte=PbO (wt%), Prep Method=LM, Block=2

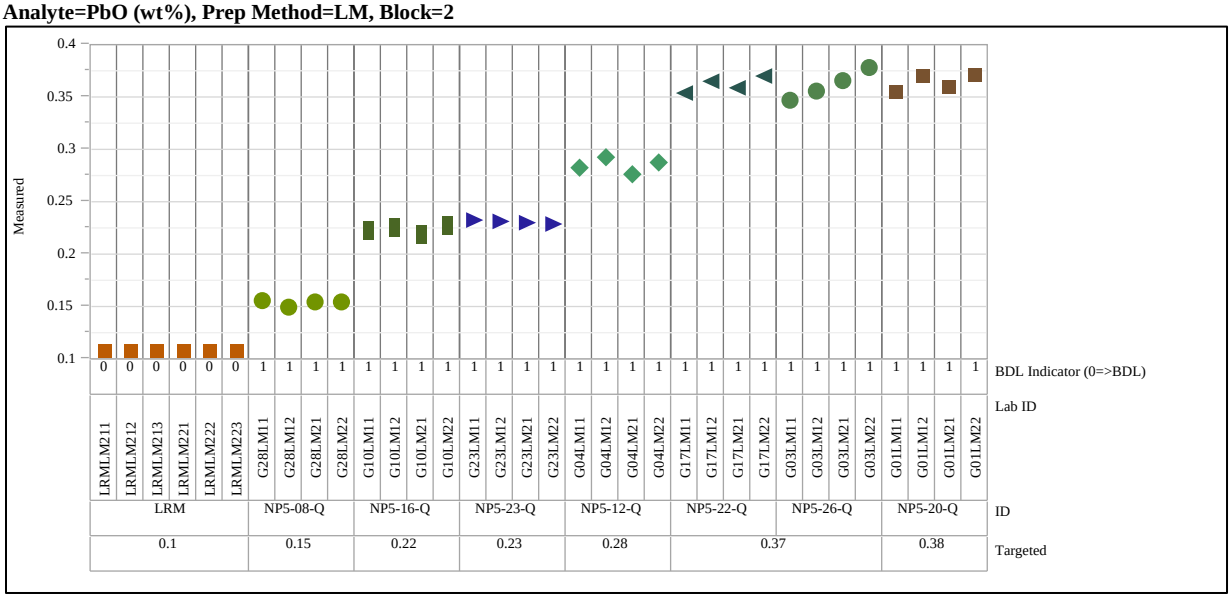
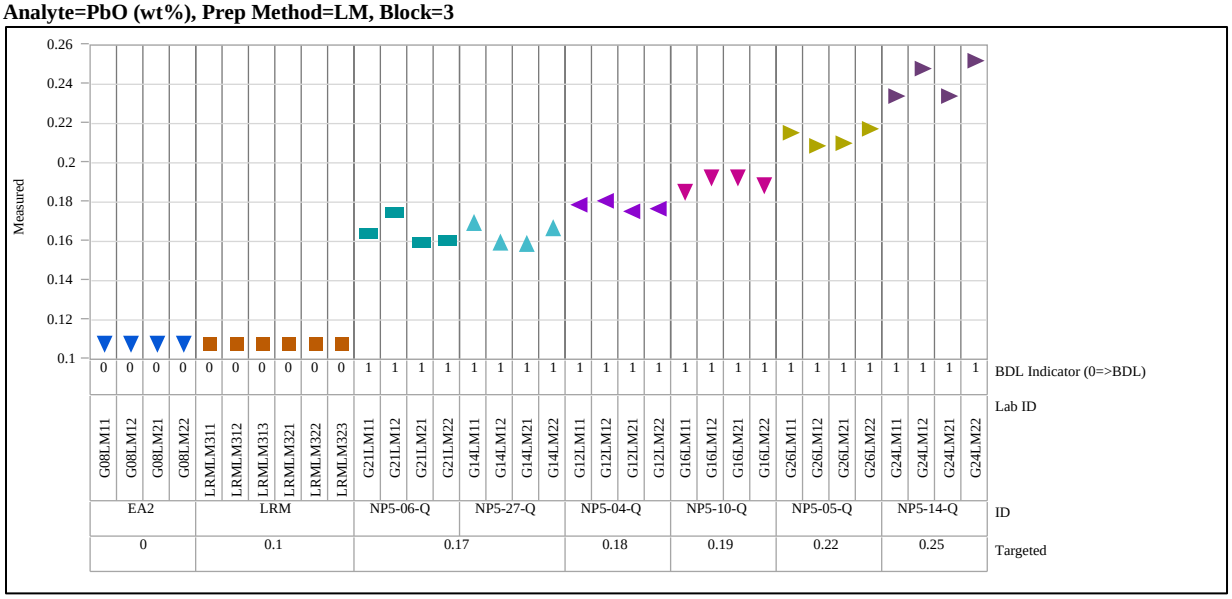


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=PbO (wt%), Prep Method=LM, Block=3



Analyte=PbO (wt%), Prep Method=LM, Block=4

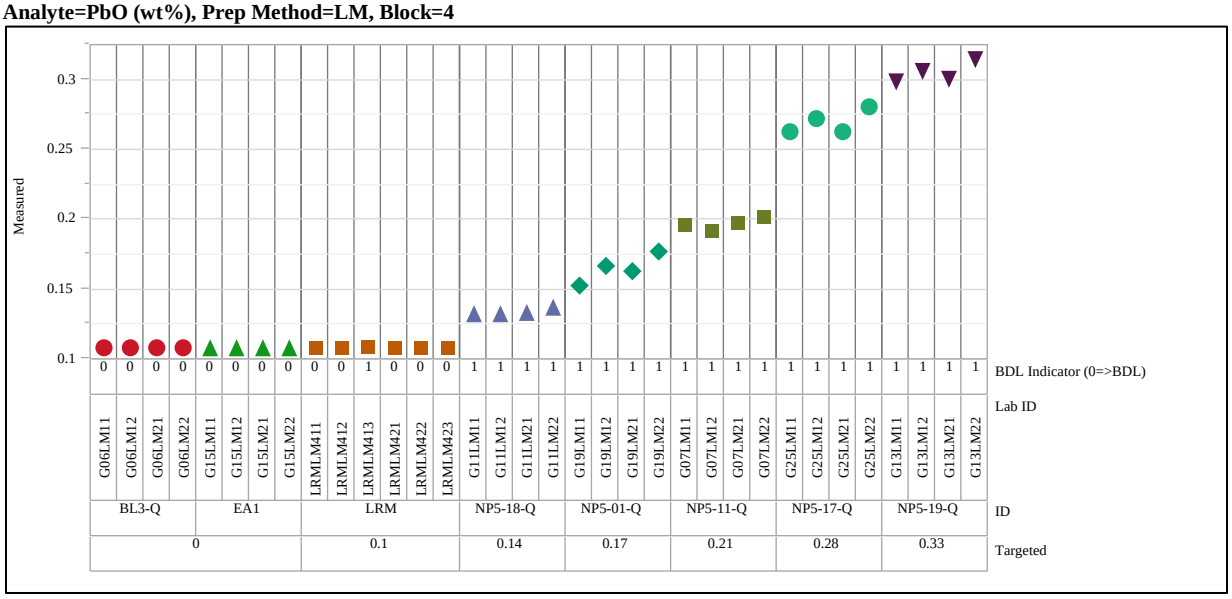
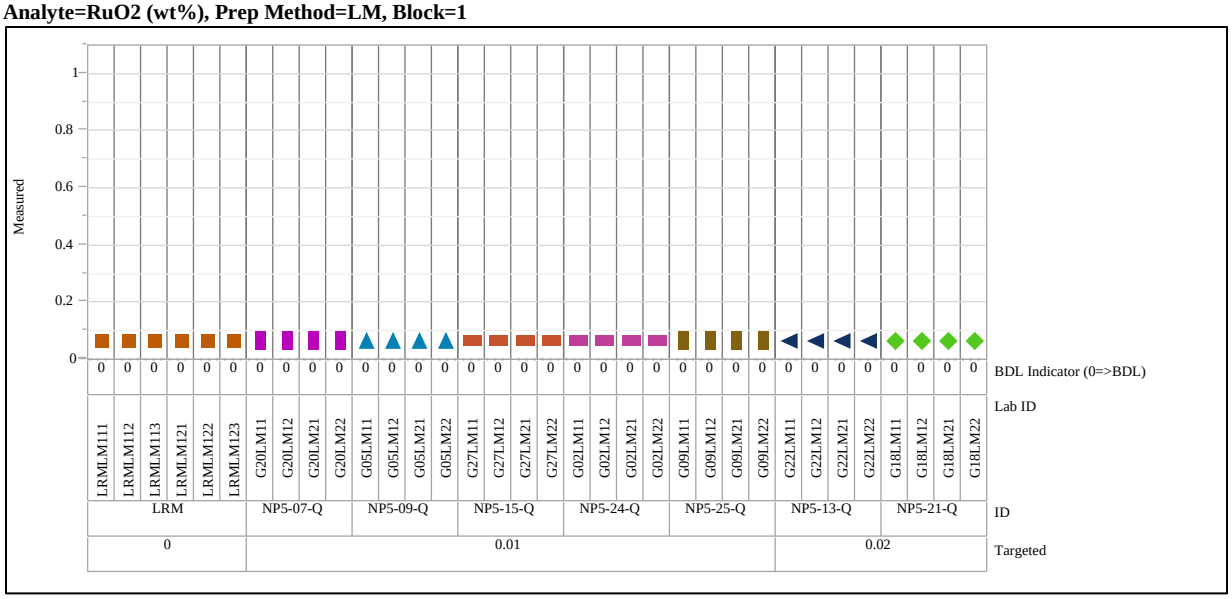


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=RuO2 (wt%), Prep Method=LM, Block=1



Analyte=RuO2 (wt%), Prep Method=LM, Block=2

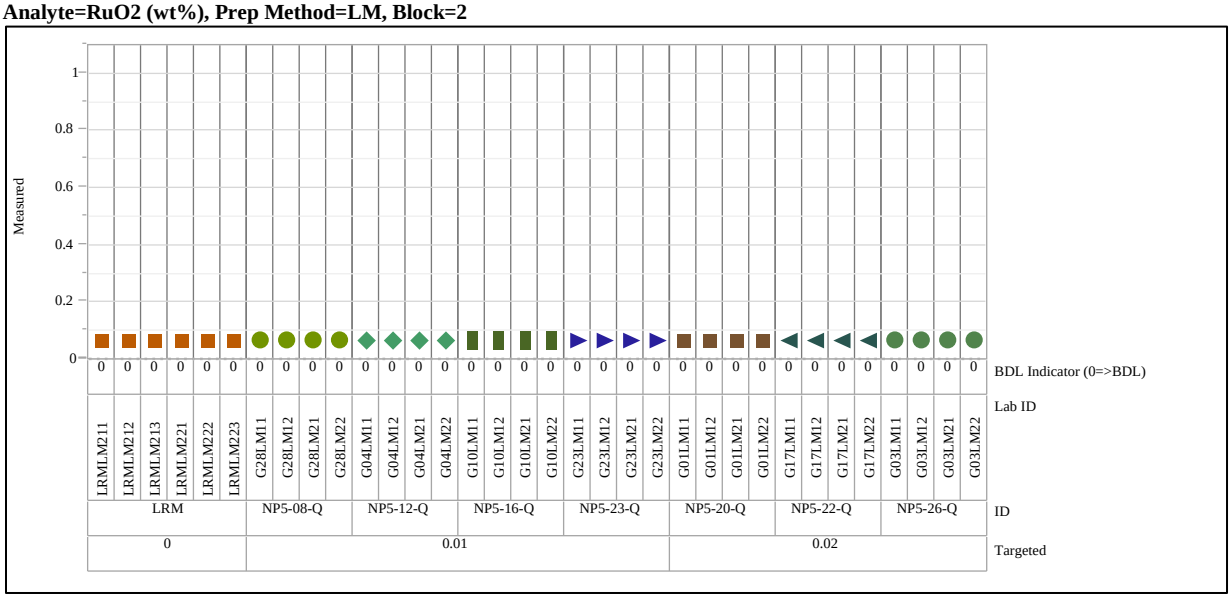
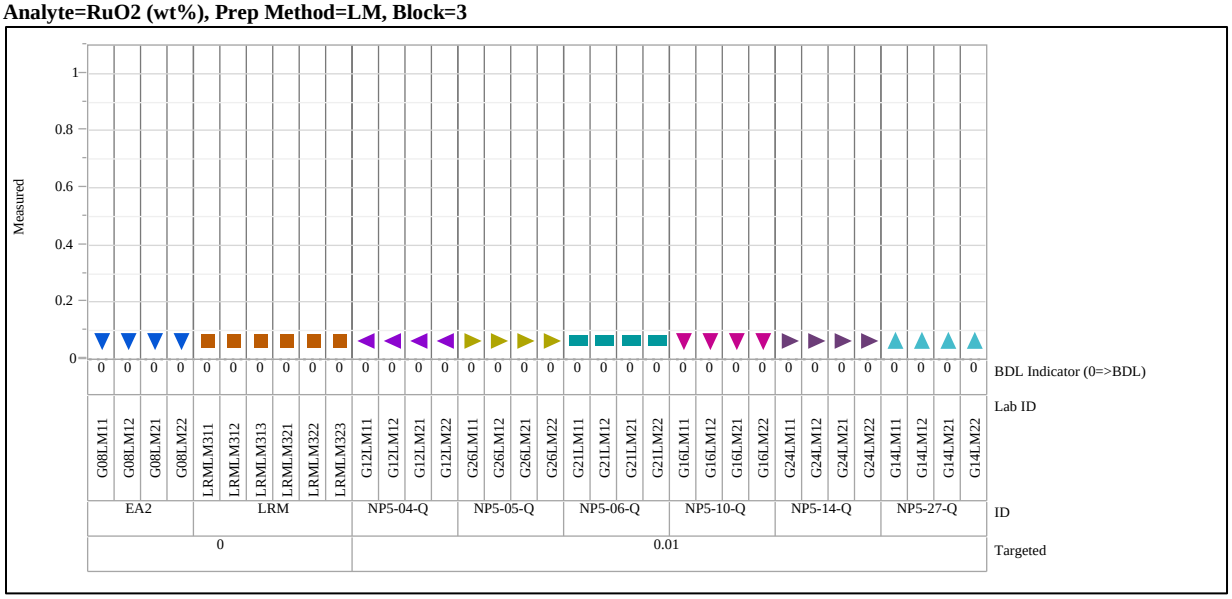


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=RuO2 (wt%), Prep Method=LM, Block=3



Analyte=RuO2 (wt%), Prep Method=LM, Block=4

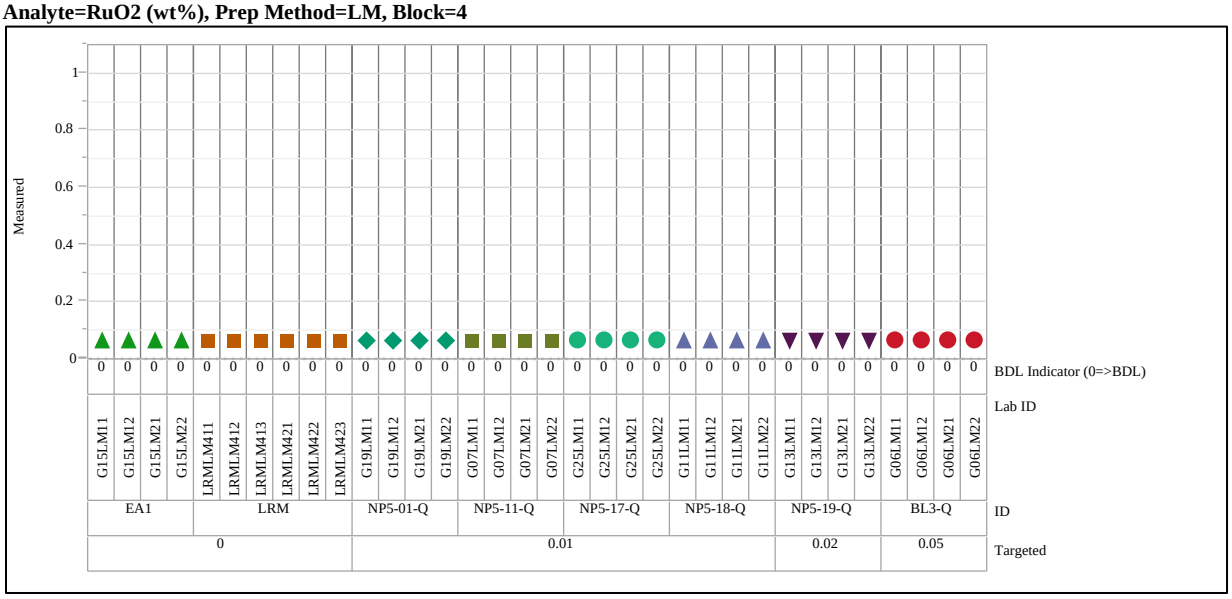
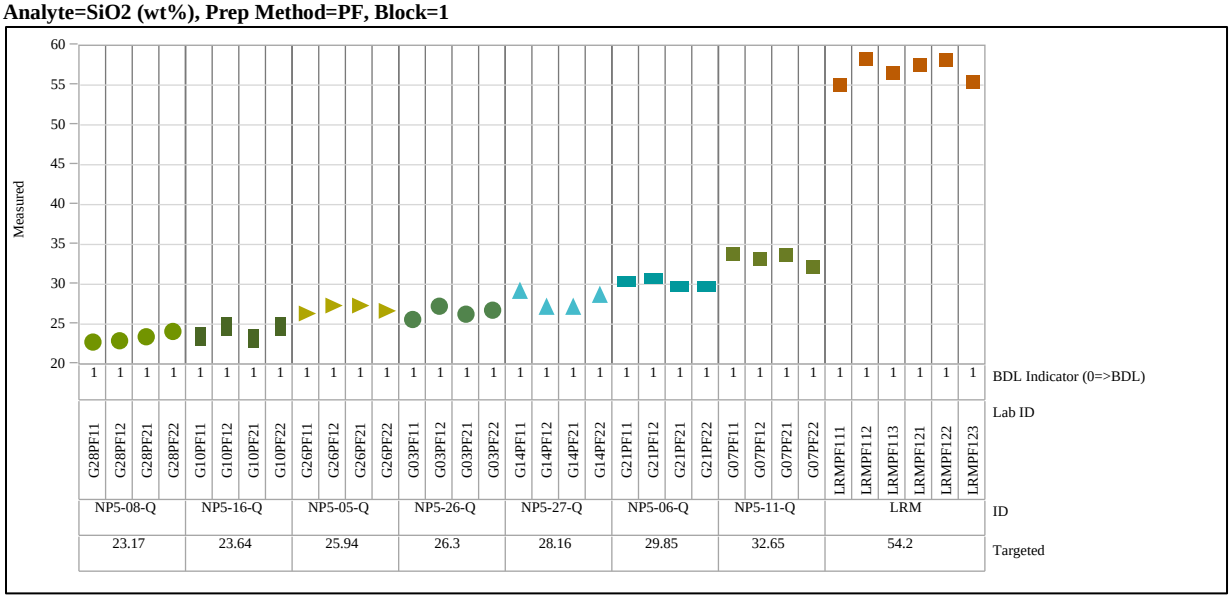


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=SiO2 (wt%), Prep Method=PF, Block=1



Analyte=SiO2 (wt%), Prep Method=PF, Block=2

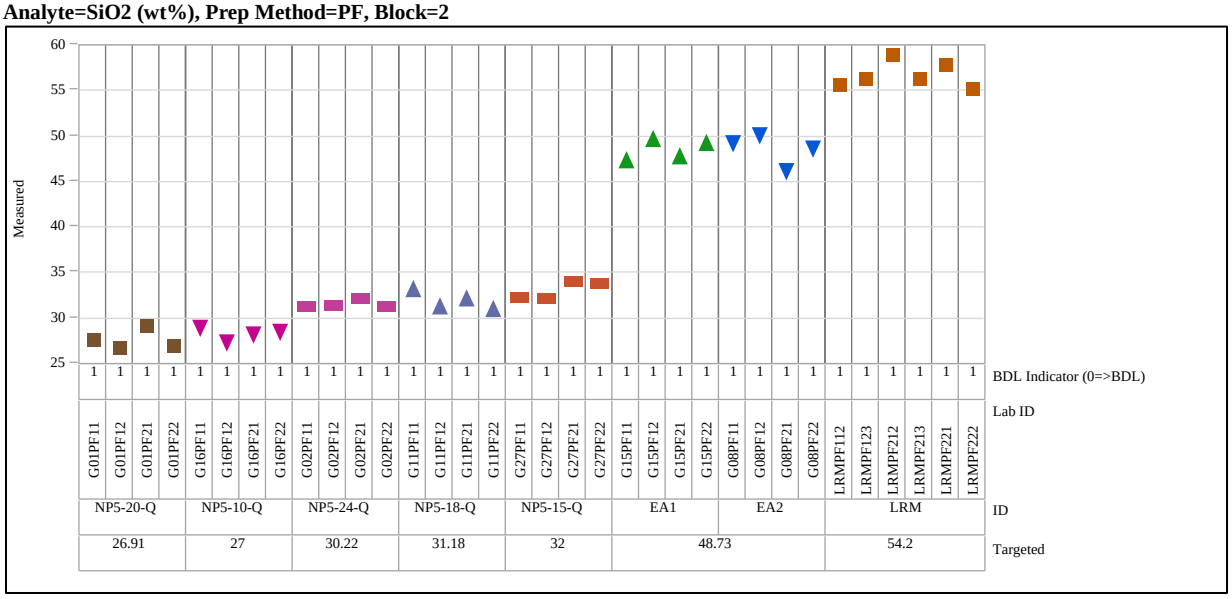
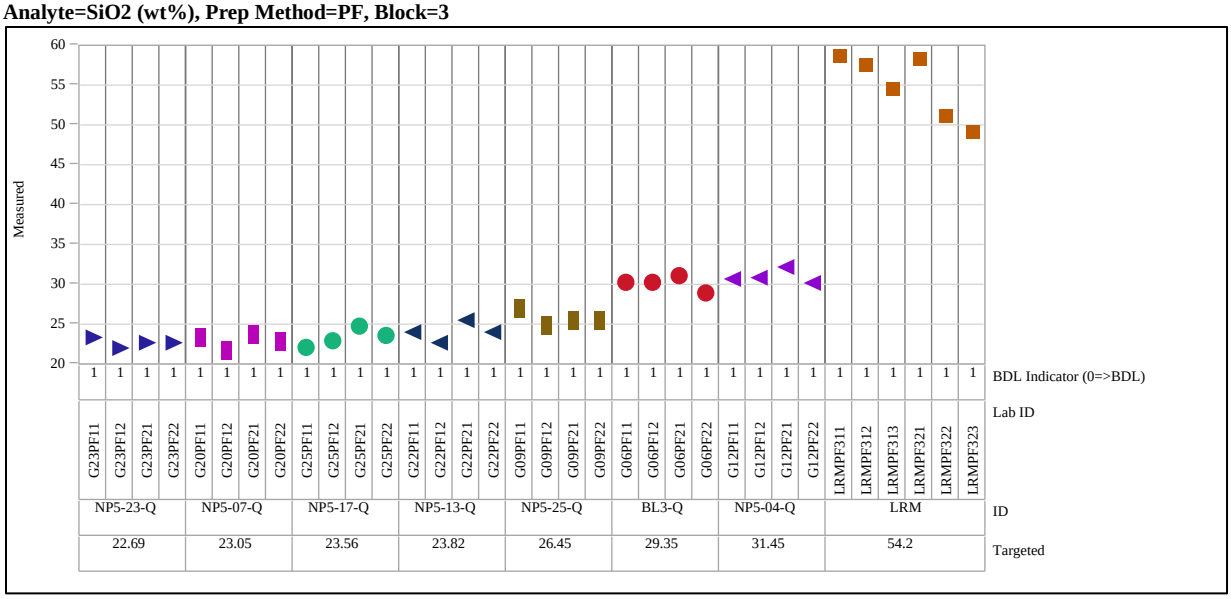


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=SiO2 (wt%), Prep Method=PF, Block=3



Analyte=SiO2 (wt%), Prep Method=PF, Block=4

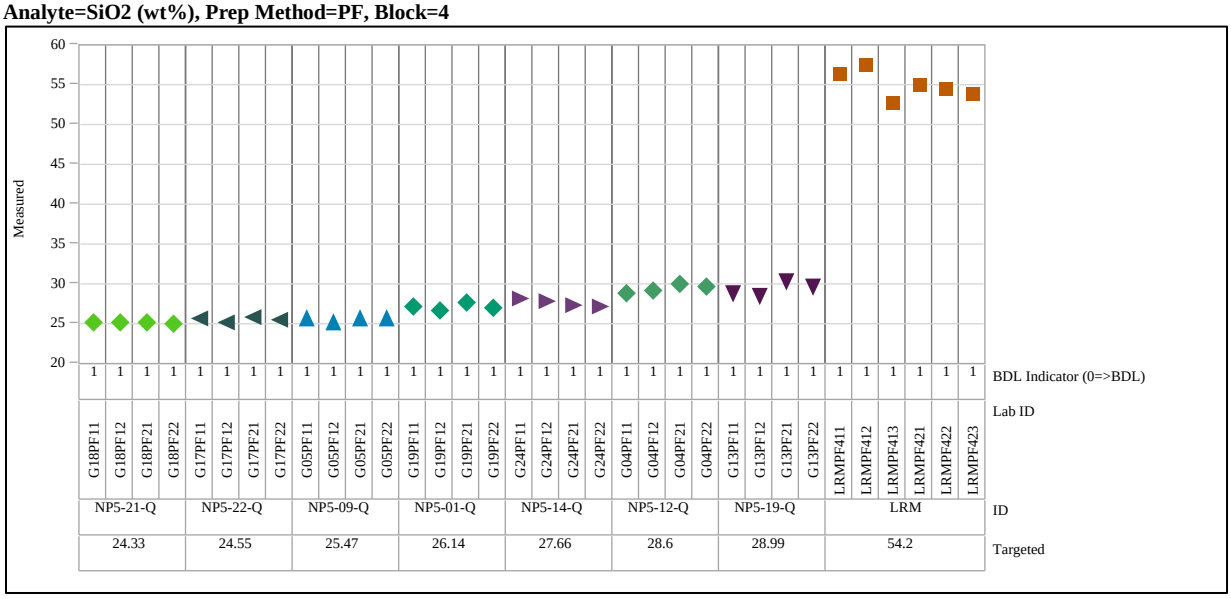
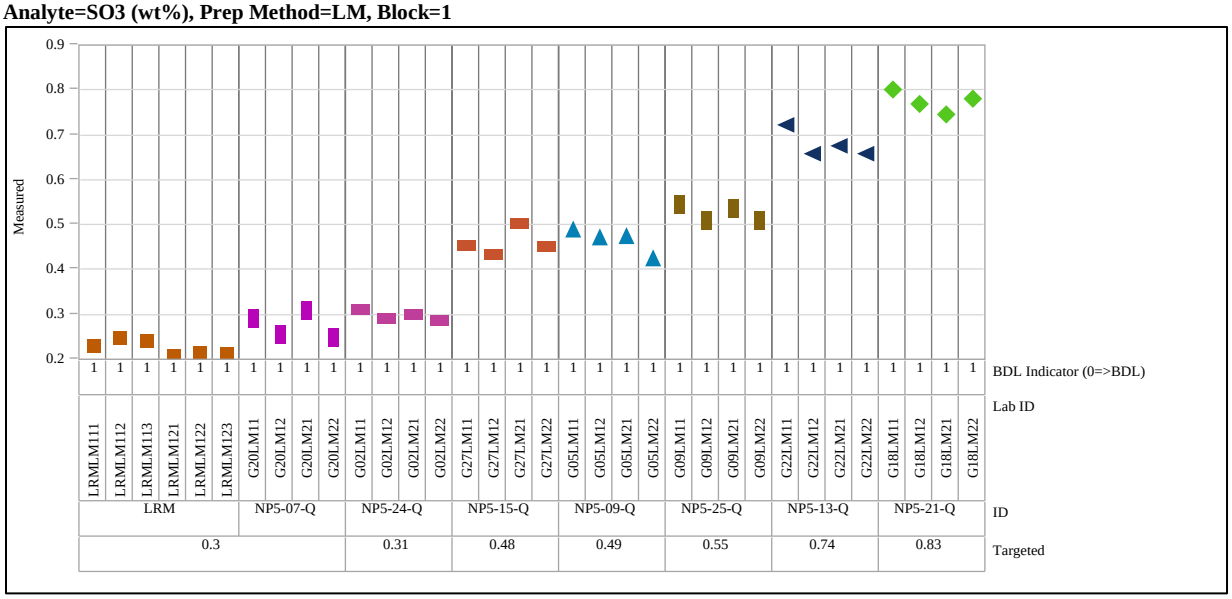


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=SO3 (wt%), Prep Method=LM, Block=1



Analyte=SO3 (wt%), Prep Method=LM, Block=2

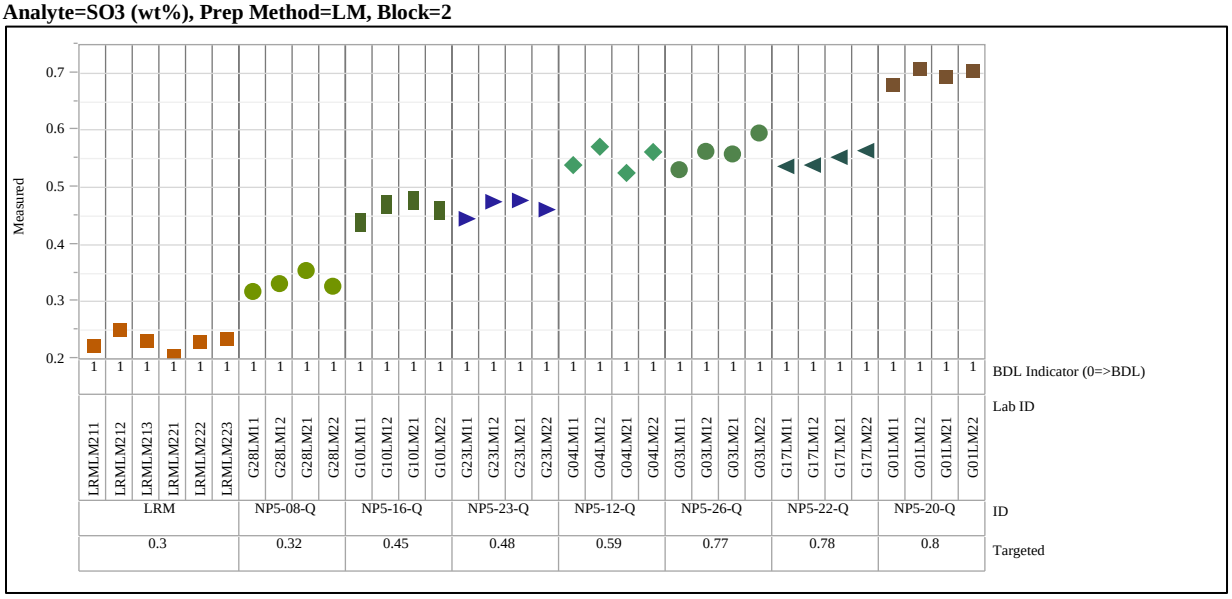
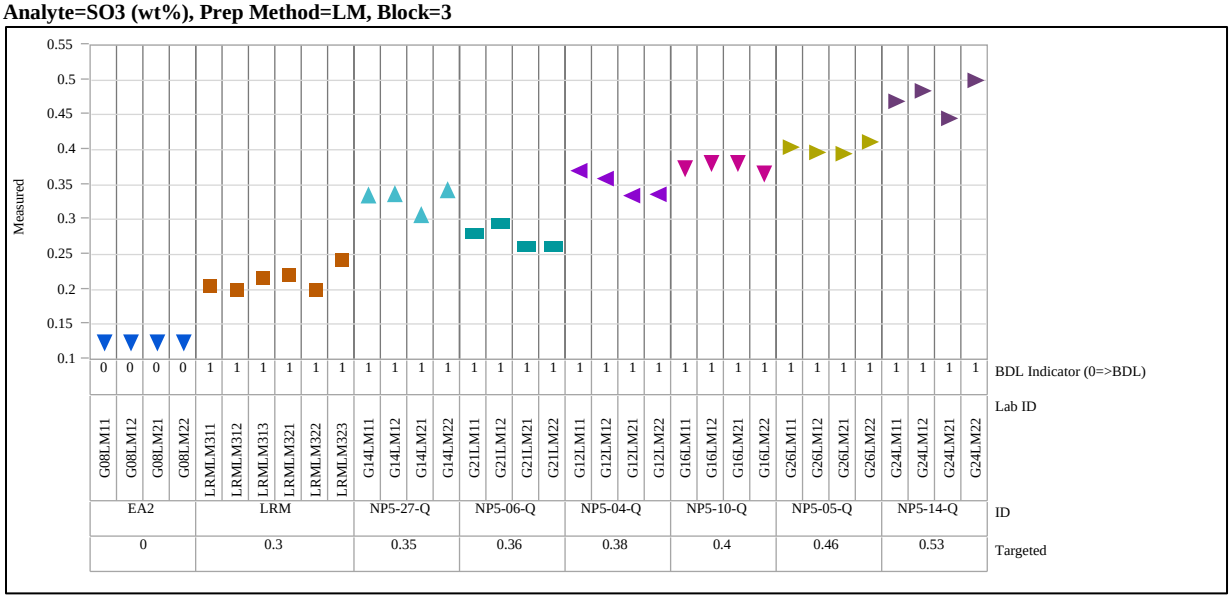


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=SO3 (wt%), Prep Method=LM, Block=3



Analyte=SO3 (wt%), Prep Method=LM, Block=4

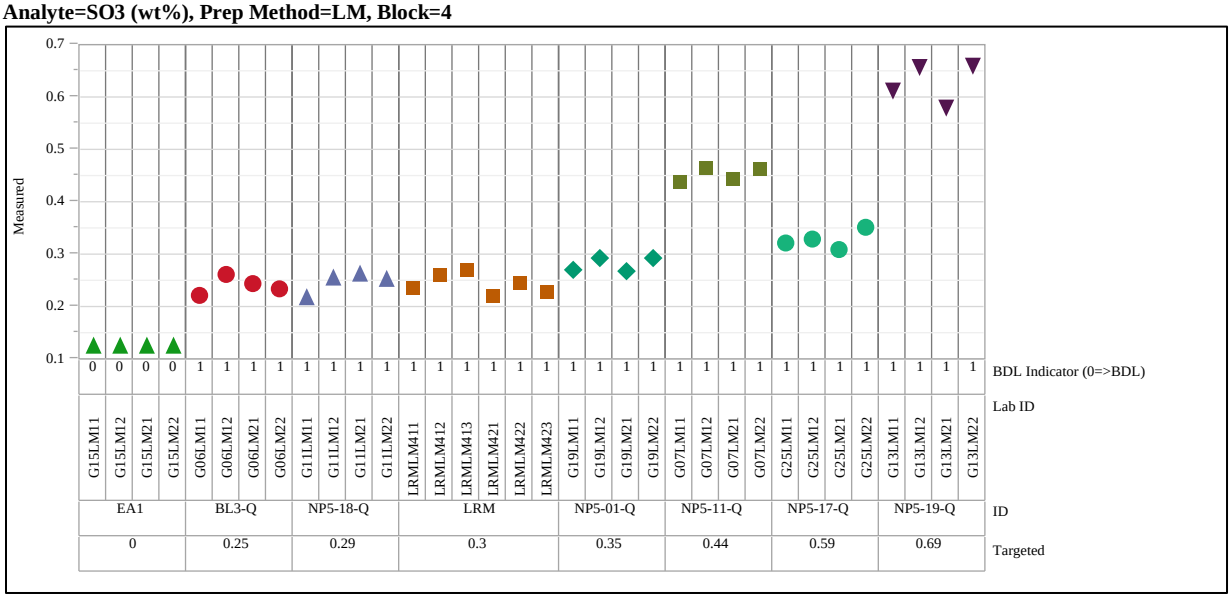
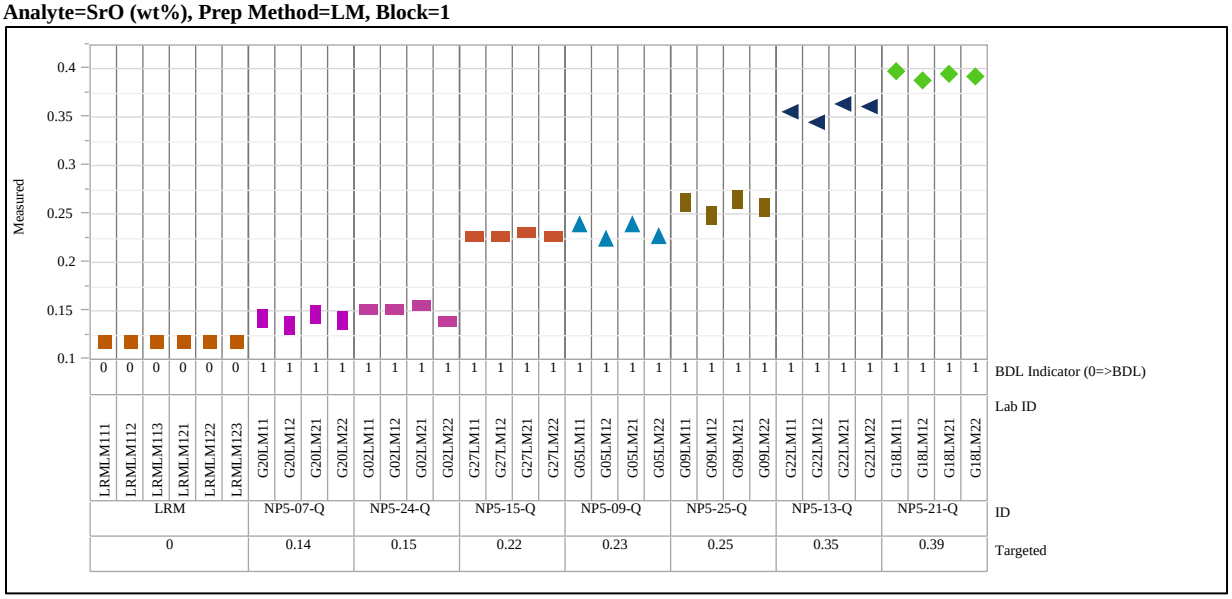


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=SrO (wt%), Prep Method=LM, Block=1



Analyte=SrO (wt%), Prep Method=LM, Block=2

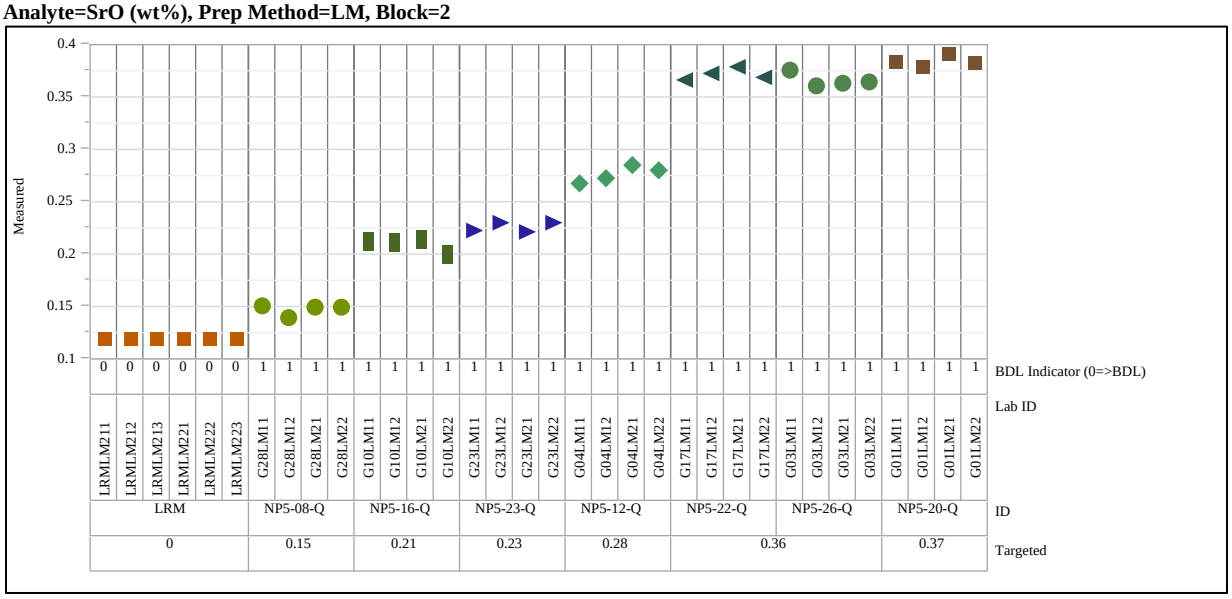
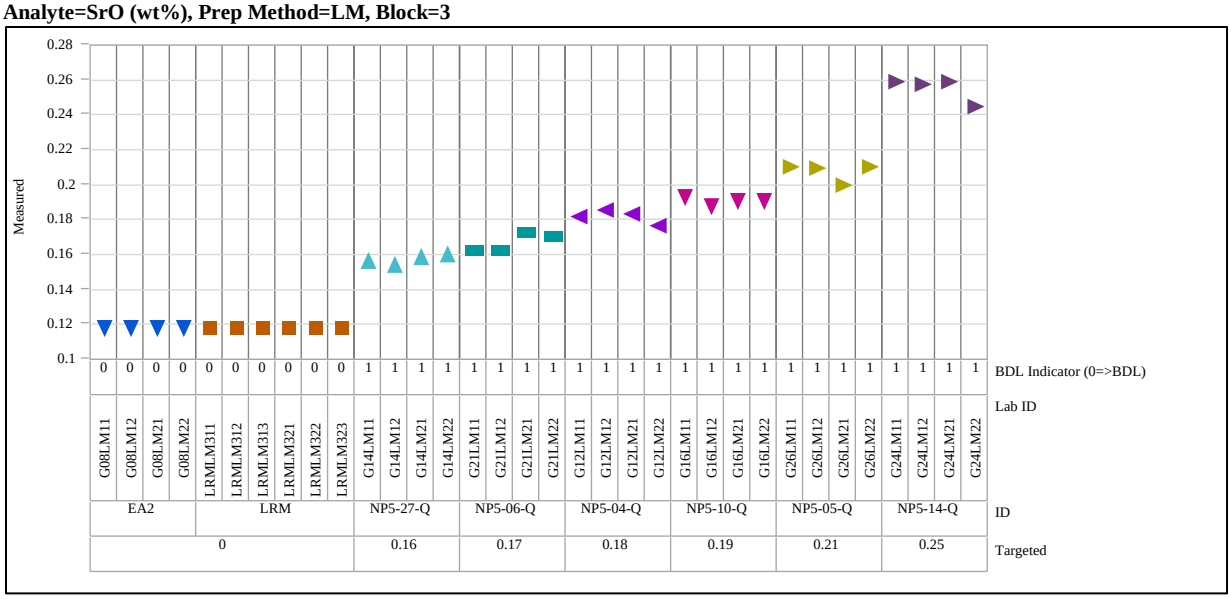


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=SrO (wt%), Prep Method=LM, Block=3



Analyte=SrO (wt%), Prep Method=LM, Block=4

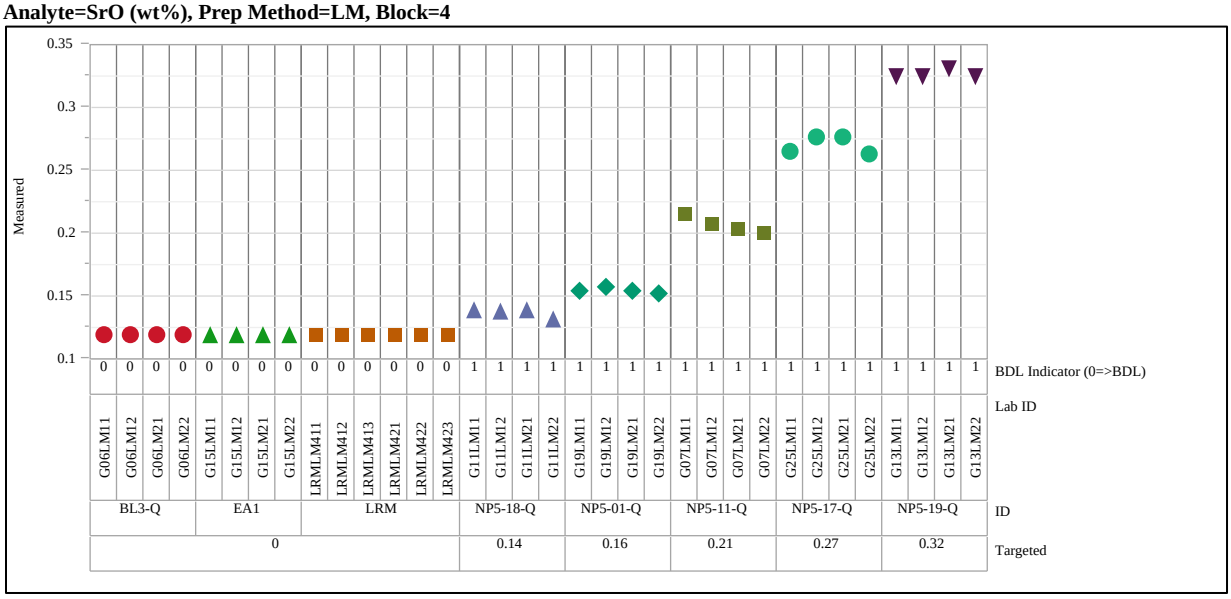
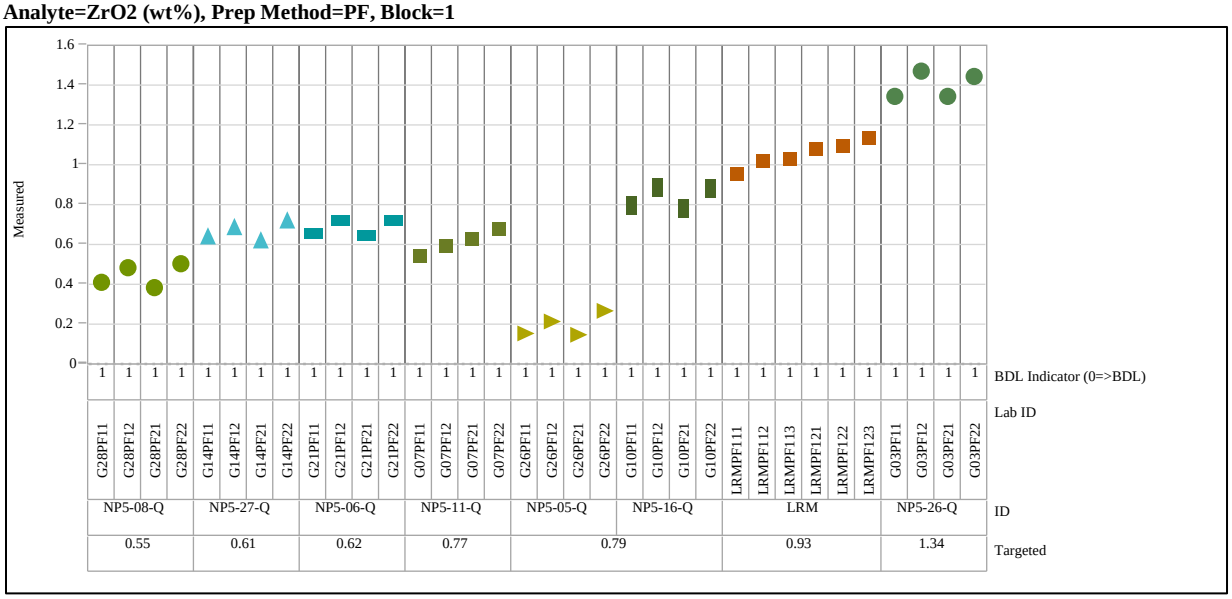


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=ZrO2 (wt%), Prep Method=PF, Block=1



Analyte=ZrO2 (wt%), Prep Method=PF, Block=2

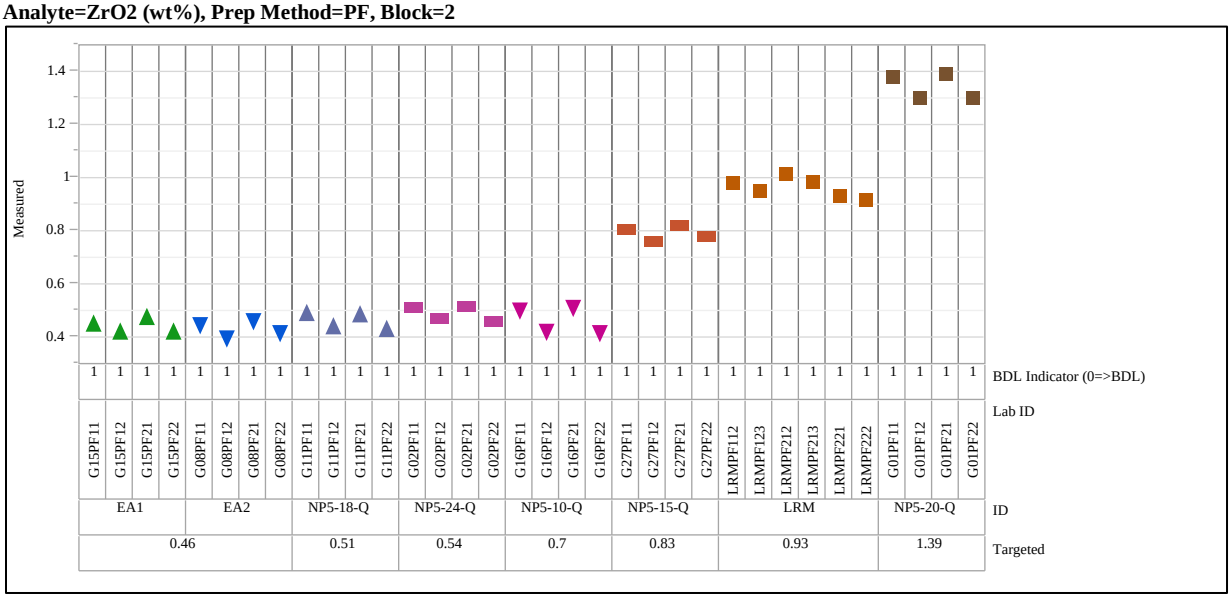
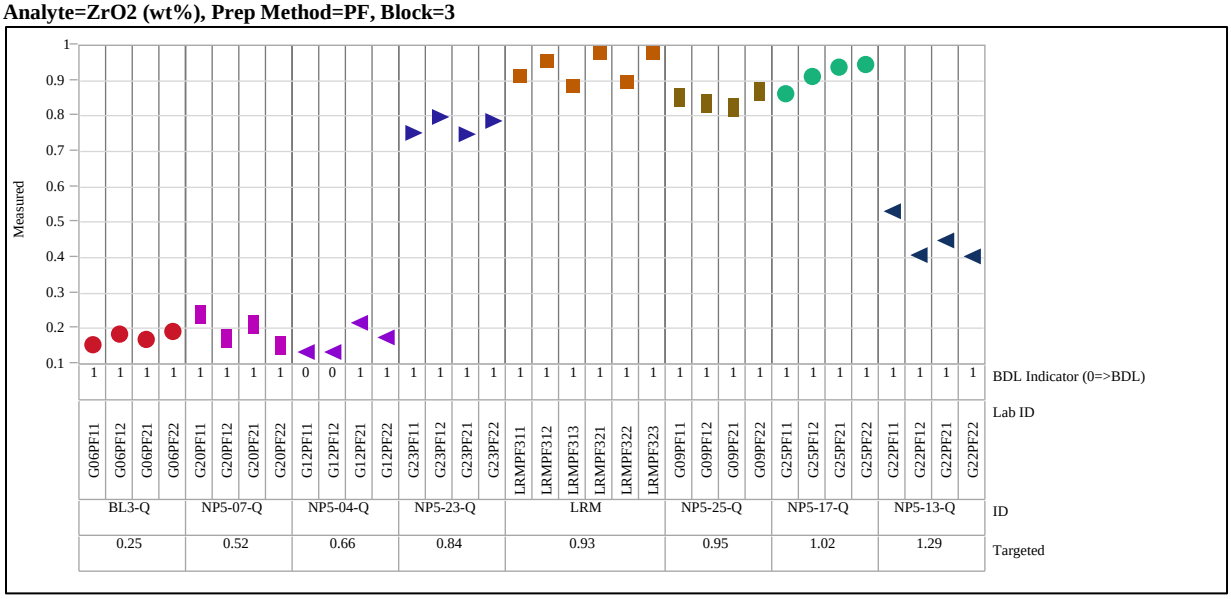


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=ZrO2 (wt%), Prep Method=PF, Block=3



Analyte=ZrO2 (wt%), Prep Method=PF, Block=4

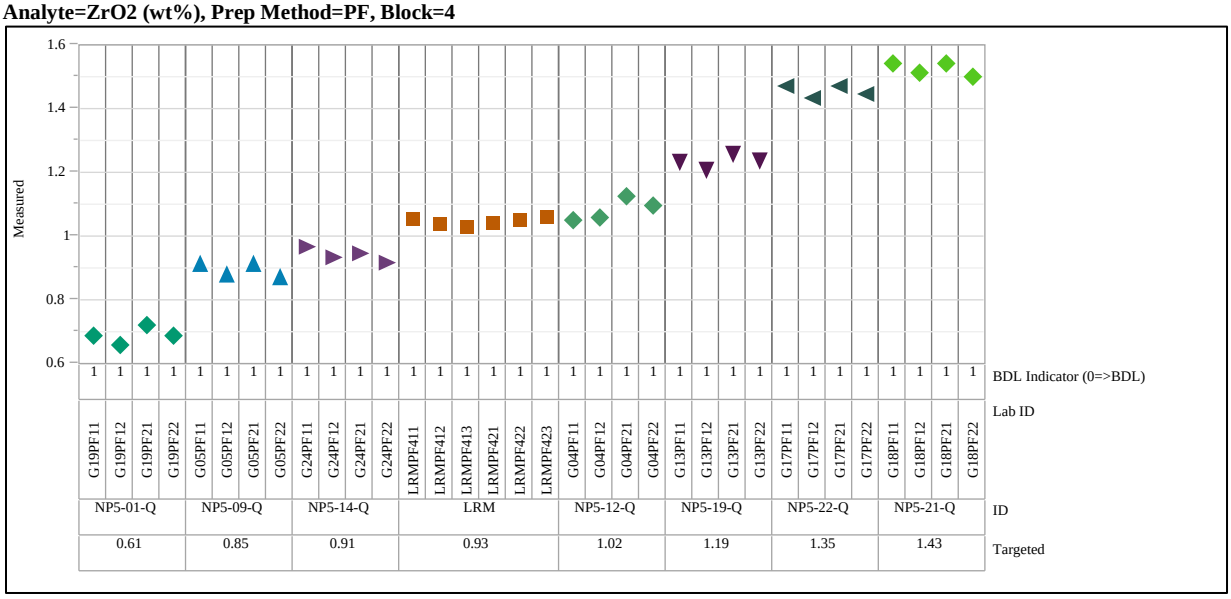
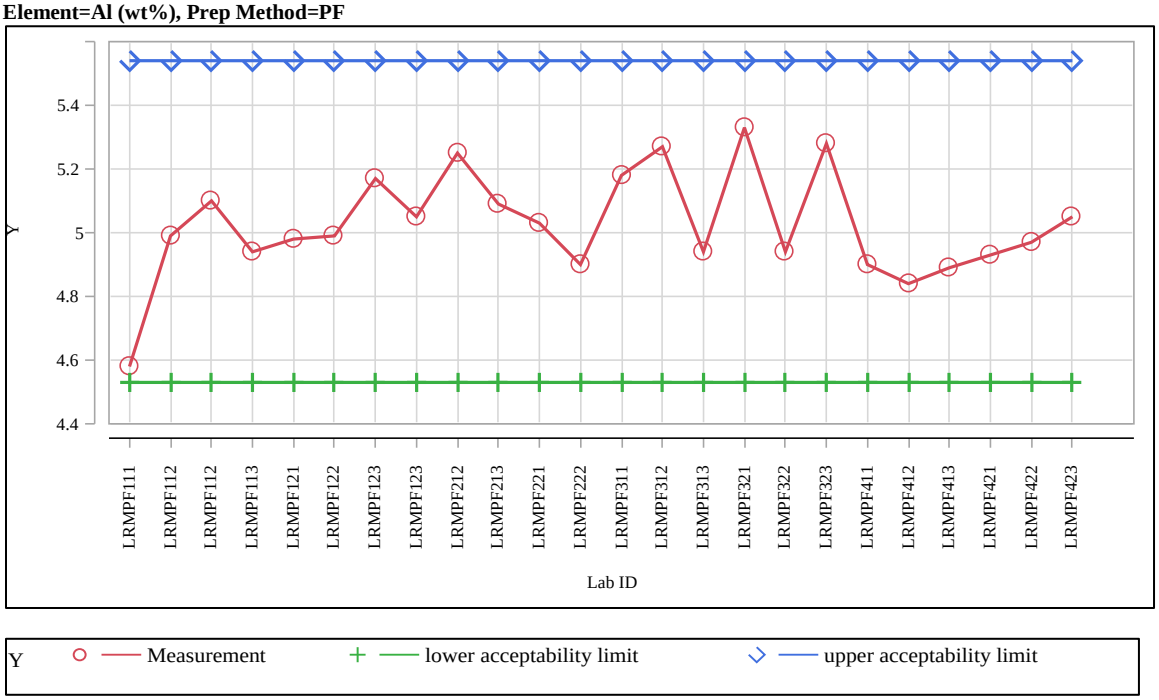


Exhibit A-3. Acceptability Evaluation for Measurements of the LRM Glass

Element=Al (wt%), Prep Method=PF



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

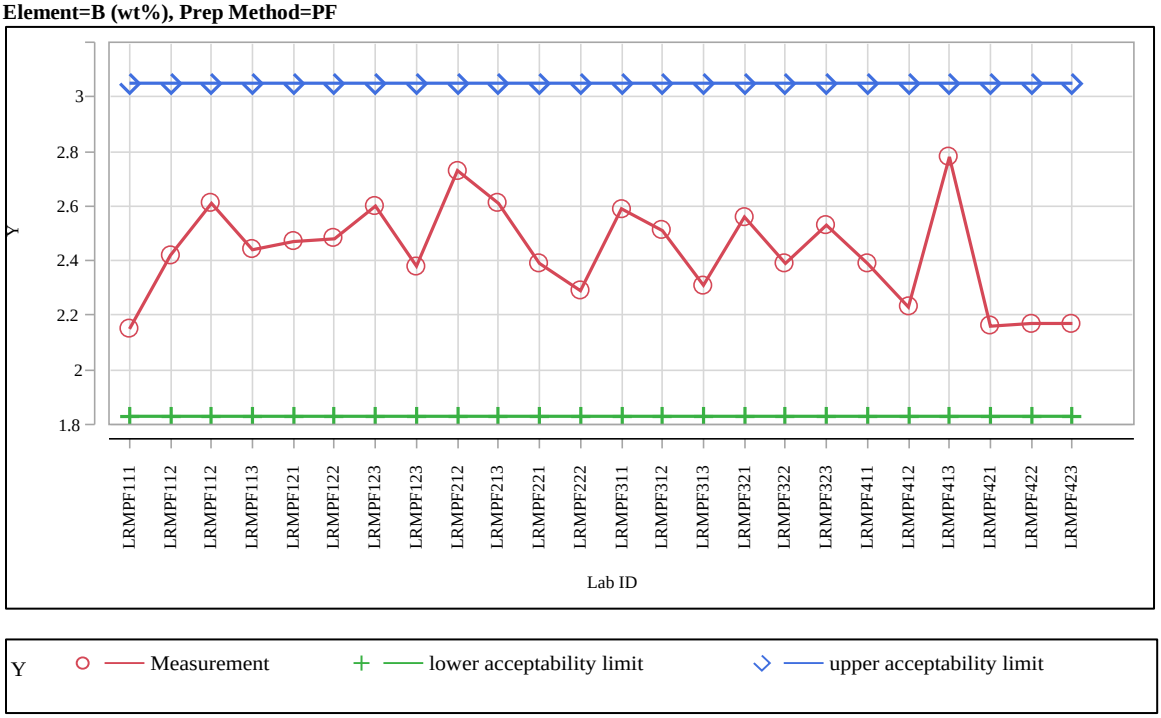
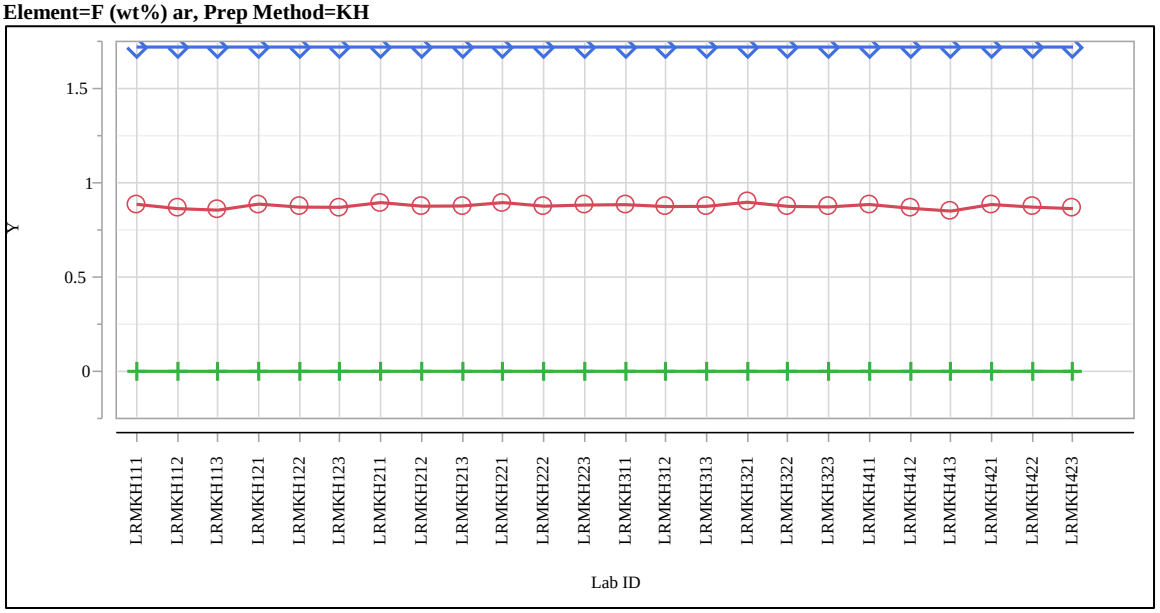
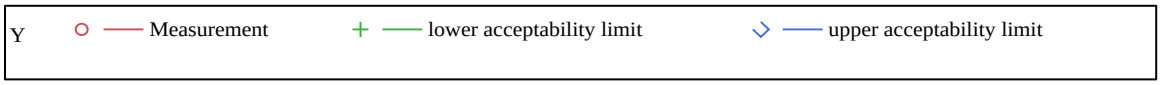


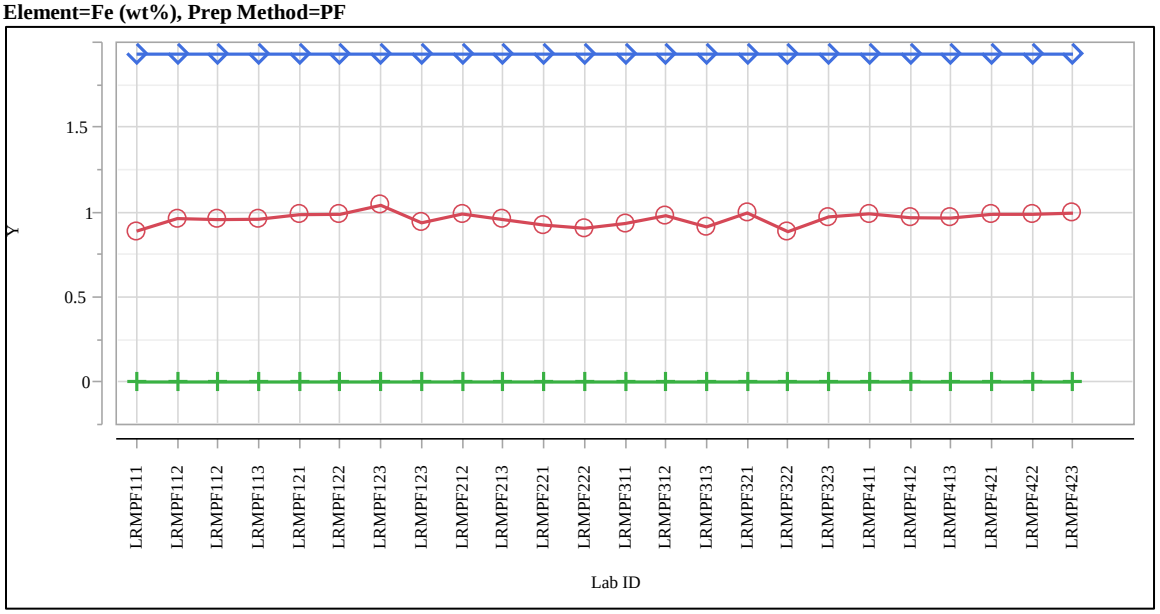
Exhibit A-3. Acceptability Evaluation for Measurements of the LRM Glass (continued)

Element=F (wt%) ar, Prep Method=KH





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



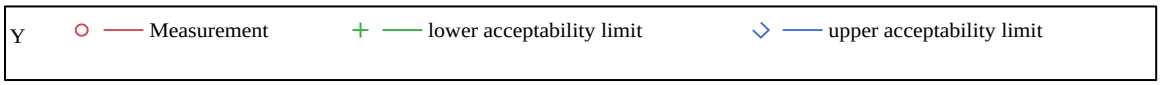
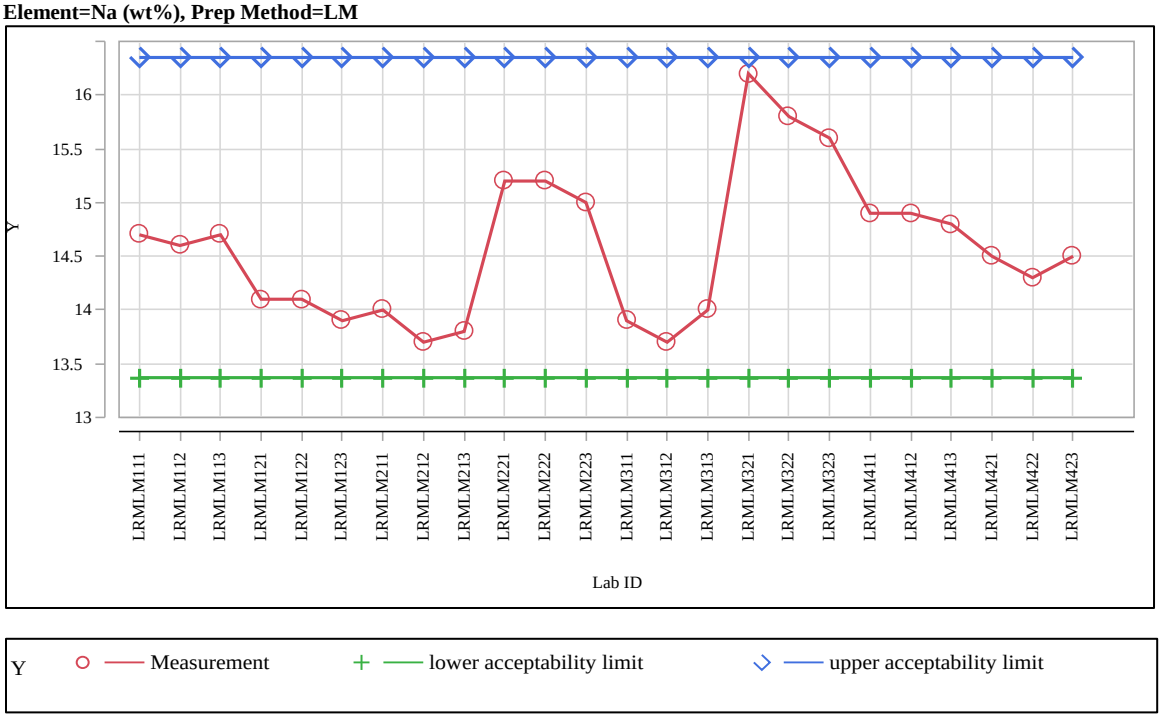
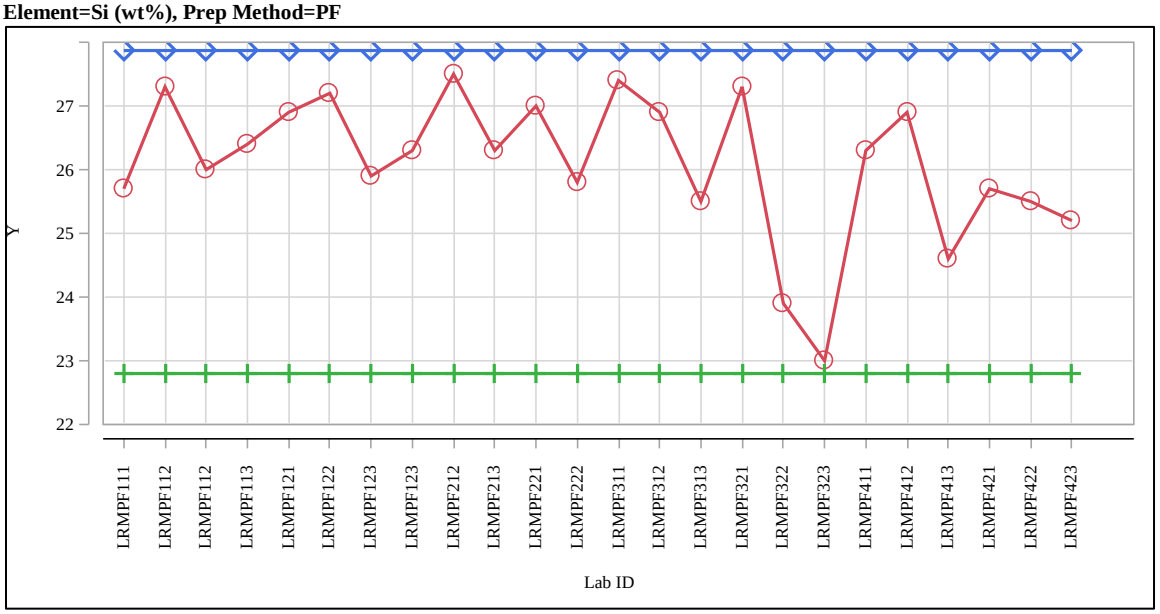


Exhibit A-3. Acceptability Evaluation for Measurements of the LRM Glass (continued)

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



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



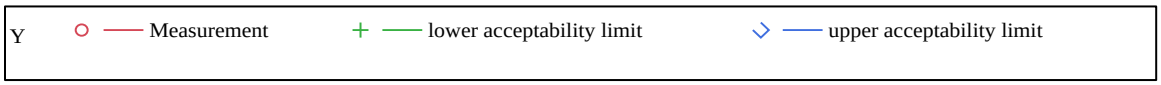


Exhibit A-3. Acceptability Evaluation for Measurements of the LRM Glass (continued)

Element=Zr (wt%), Prep Method=PF

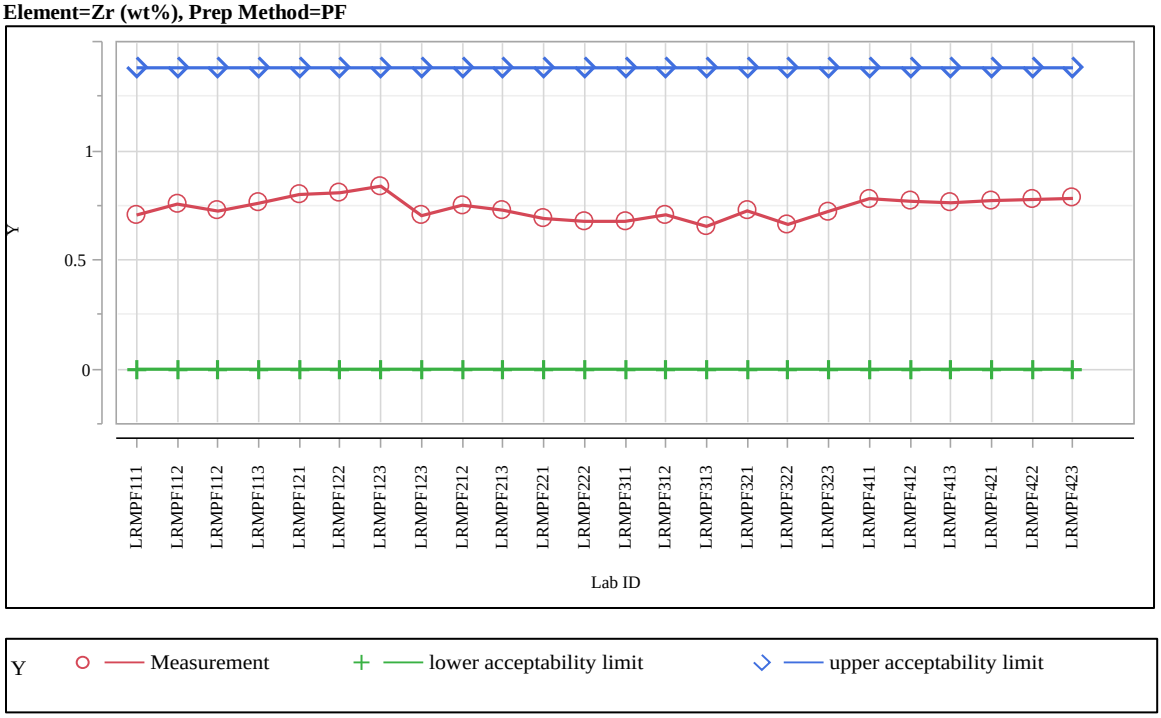


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide

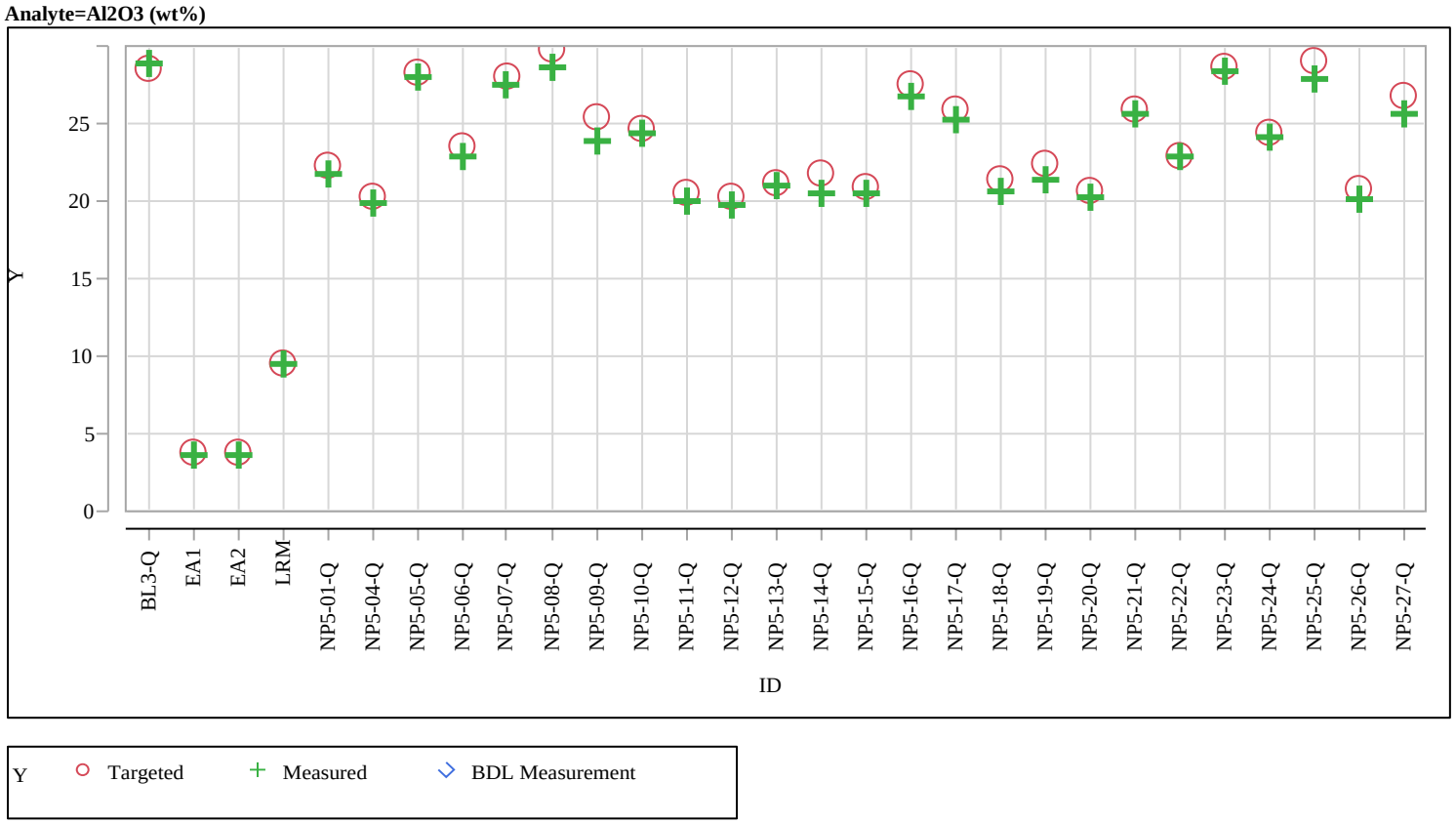


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

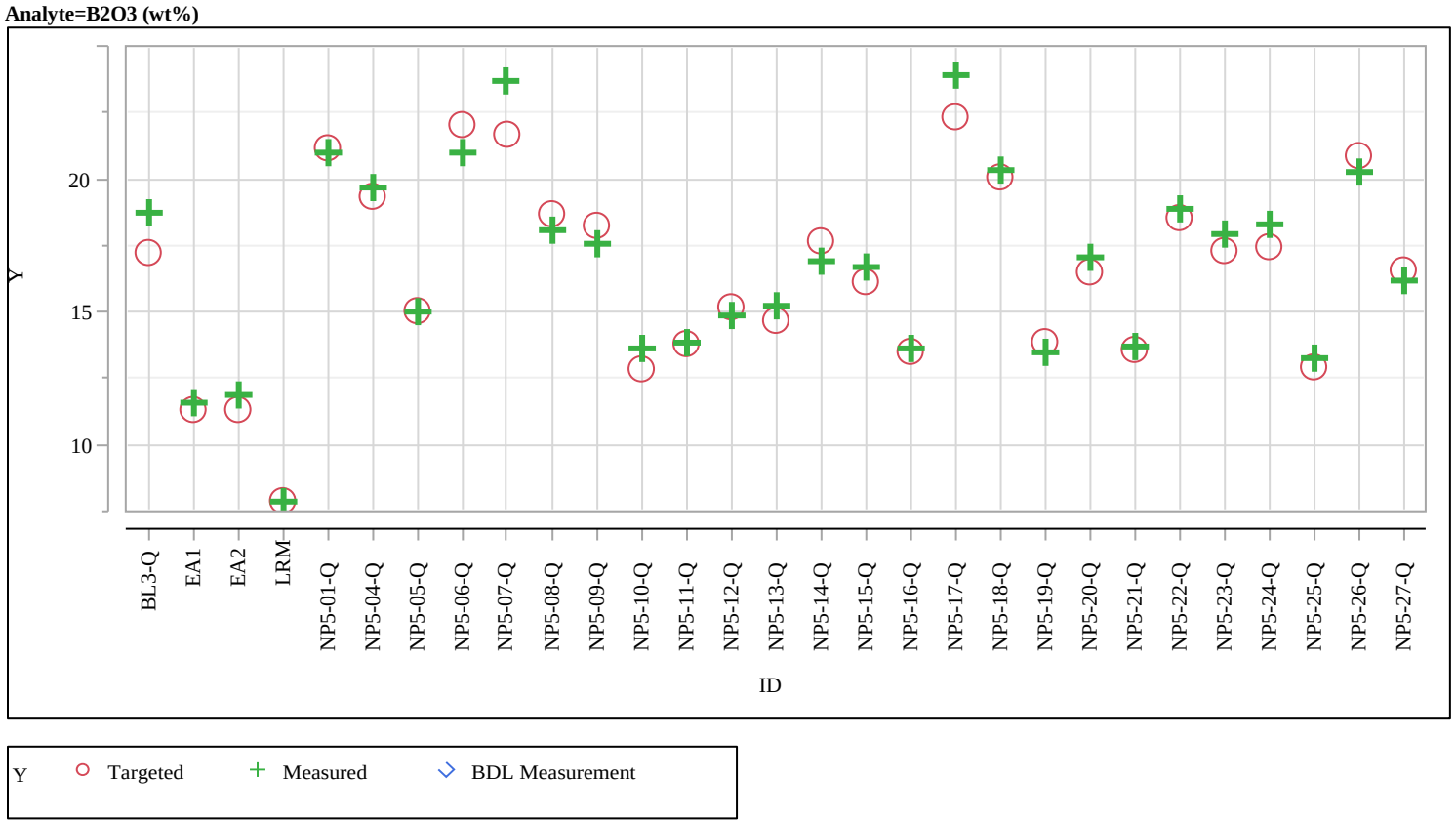


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

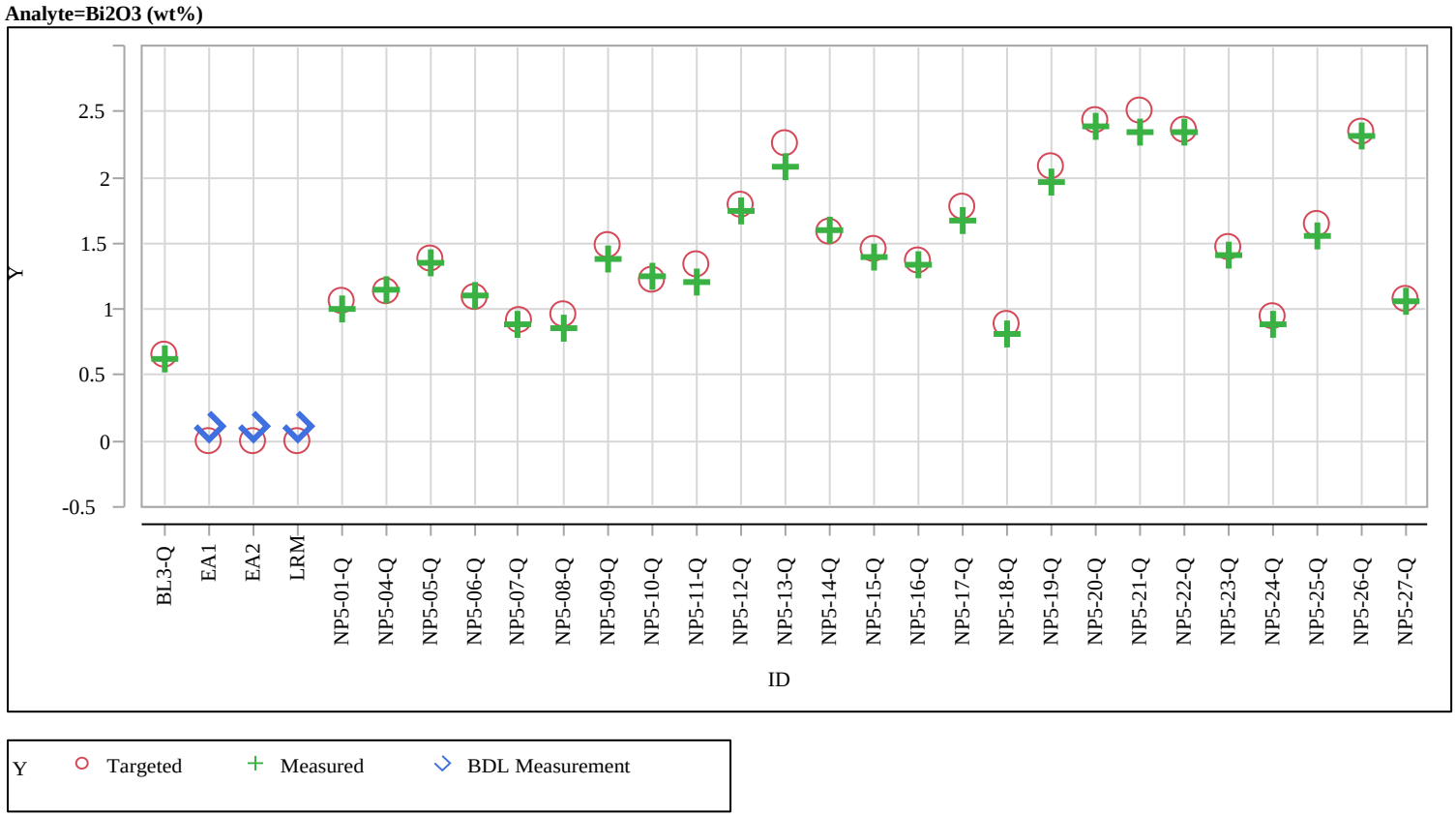


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

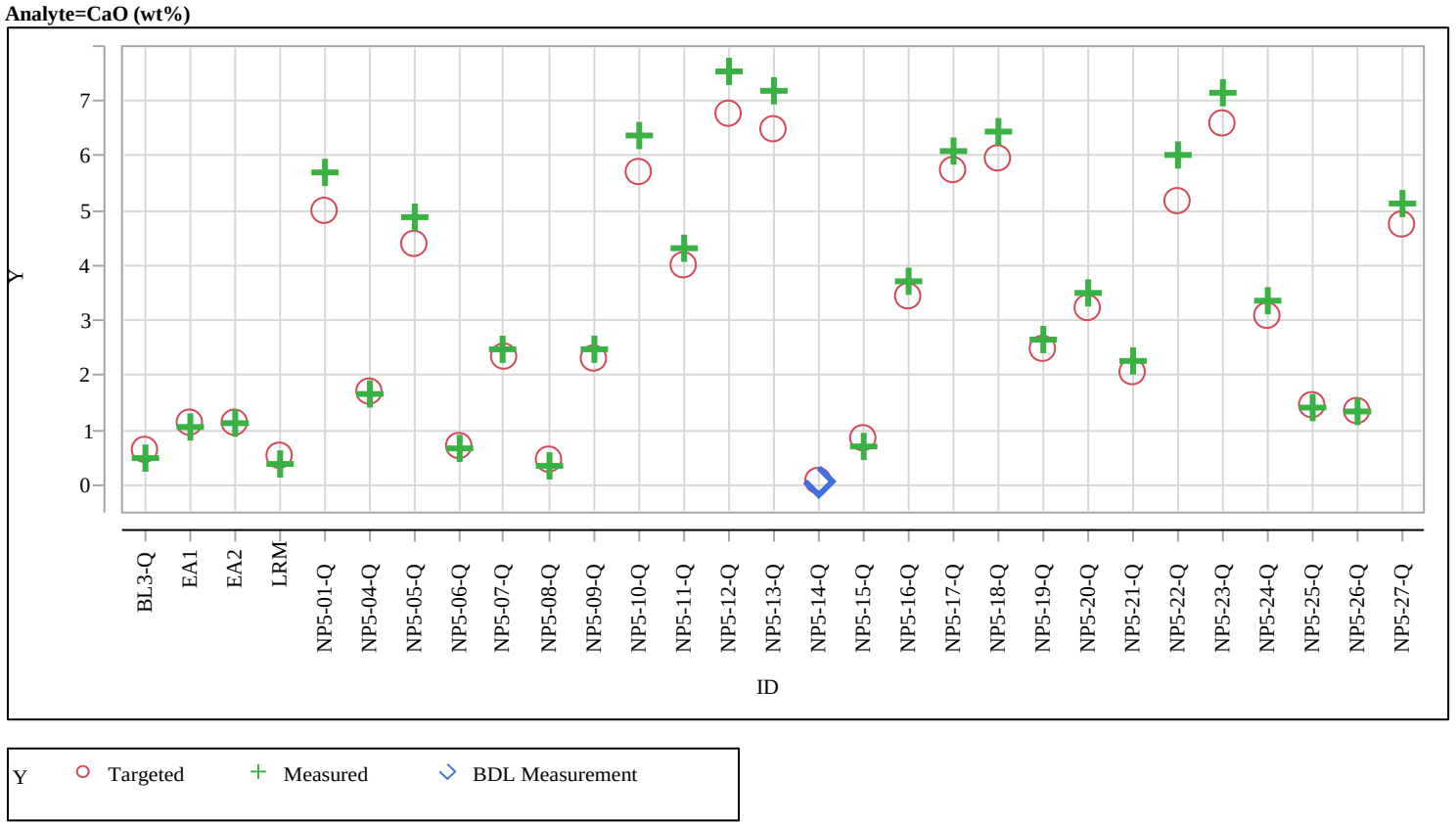


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

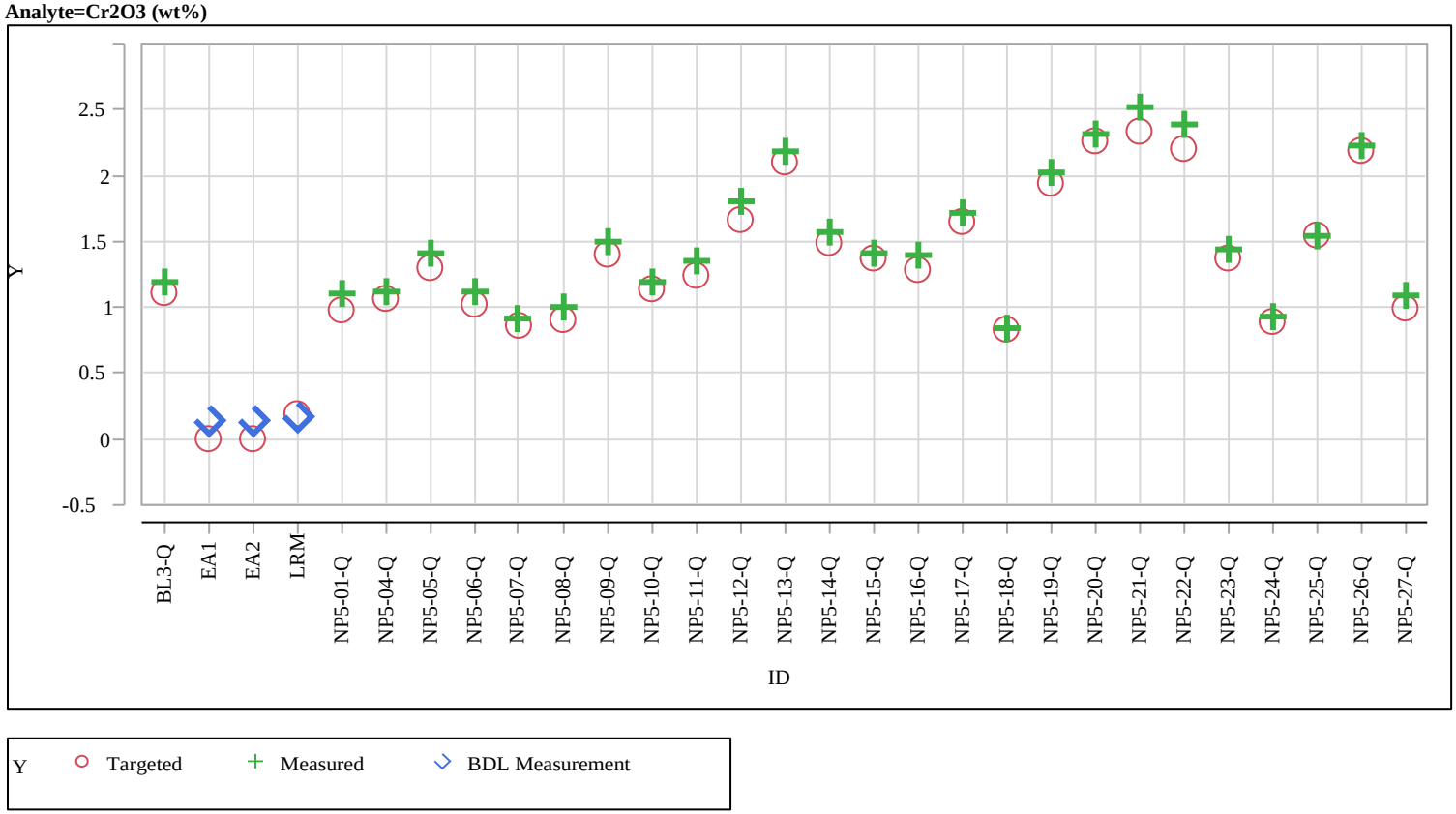


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

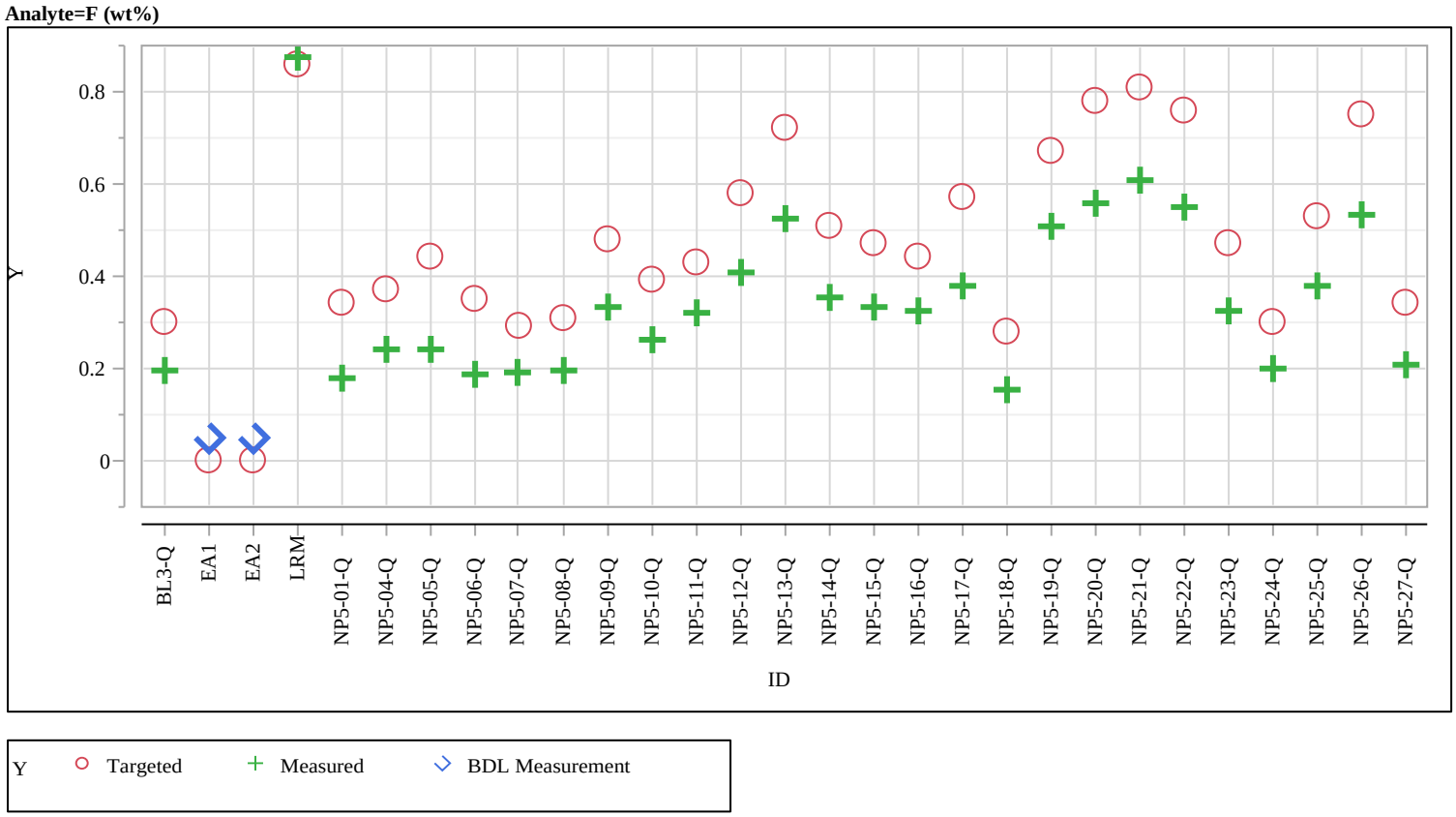


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

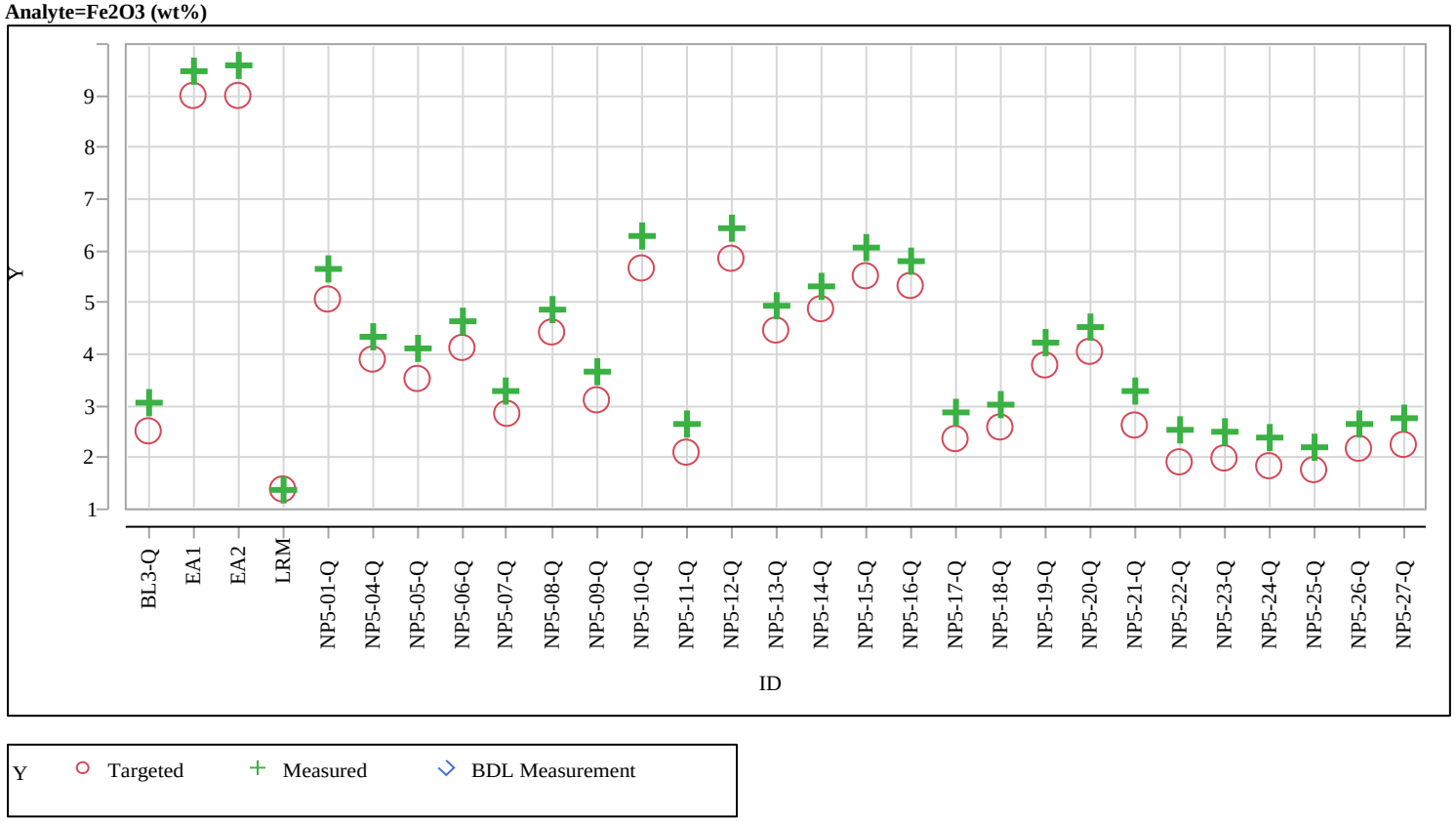


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

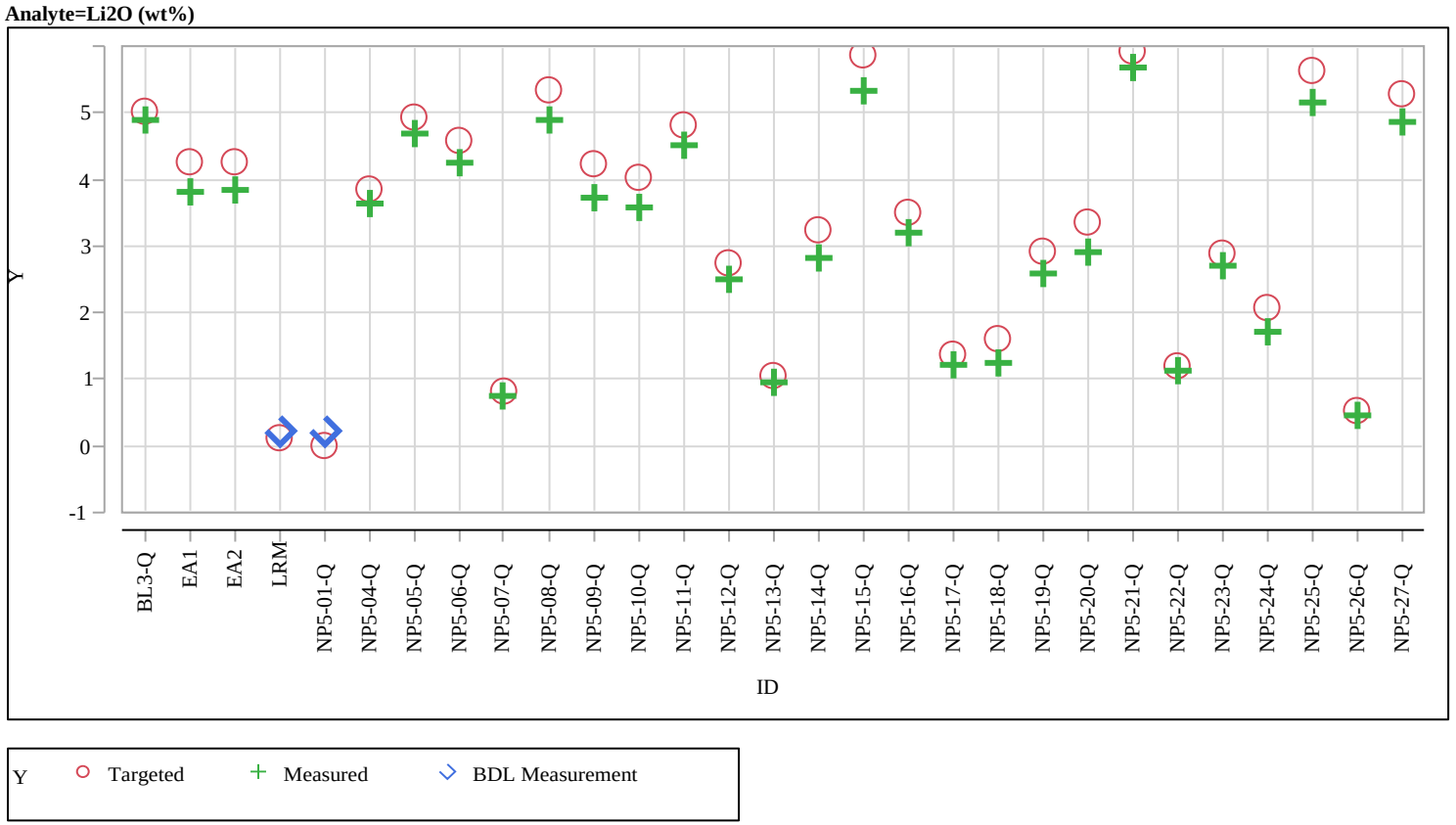


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

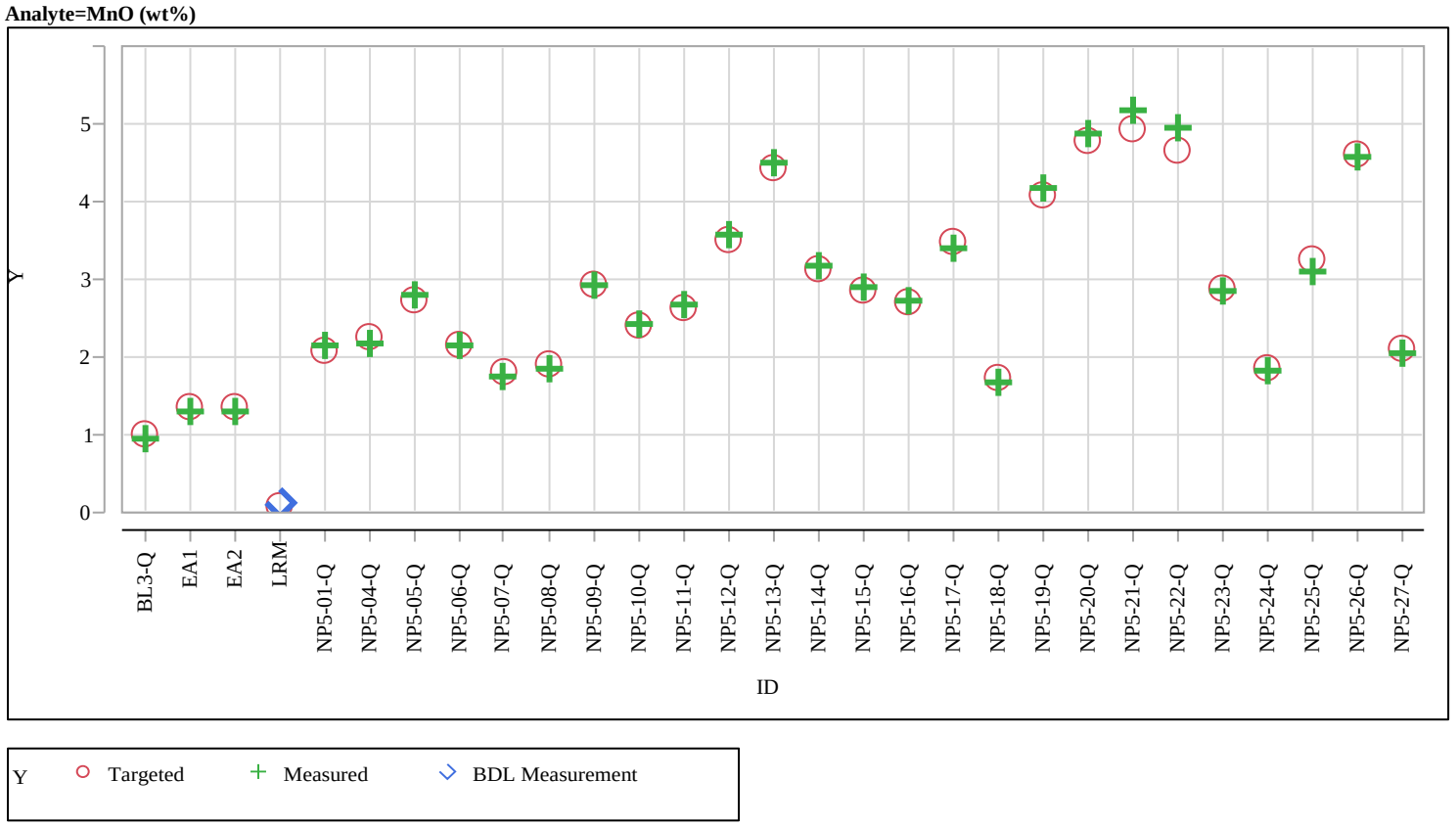


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

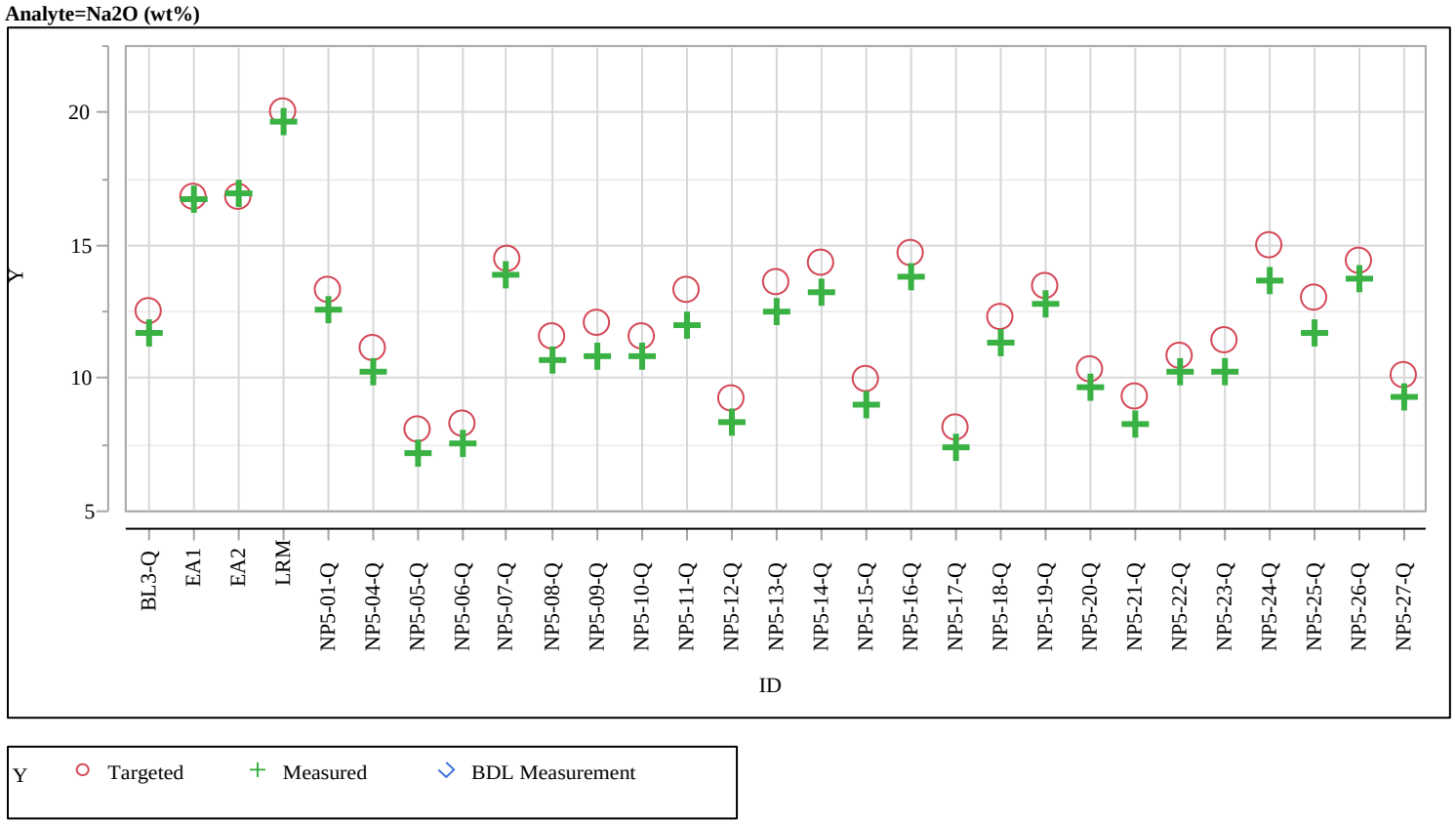


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

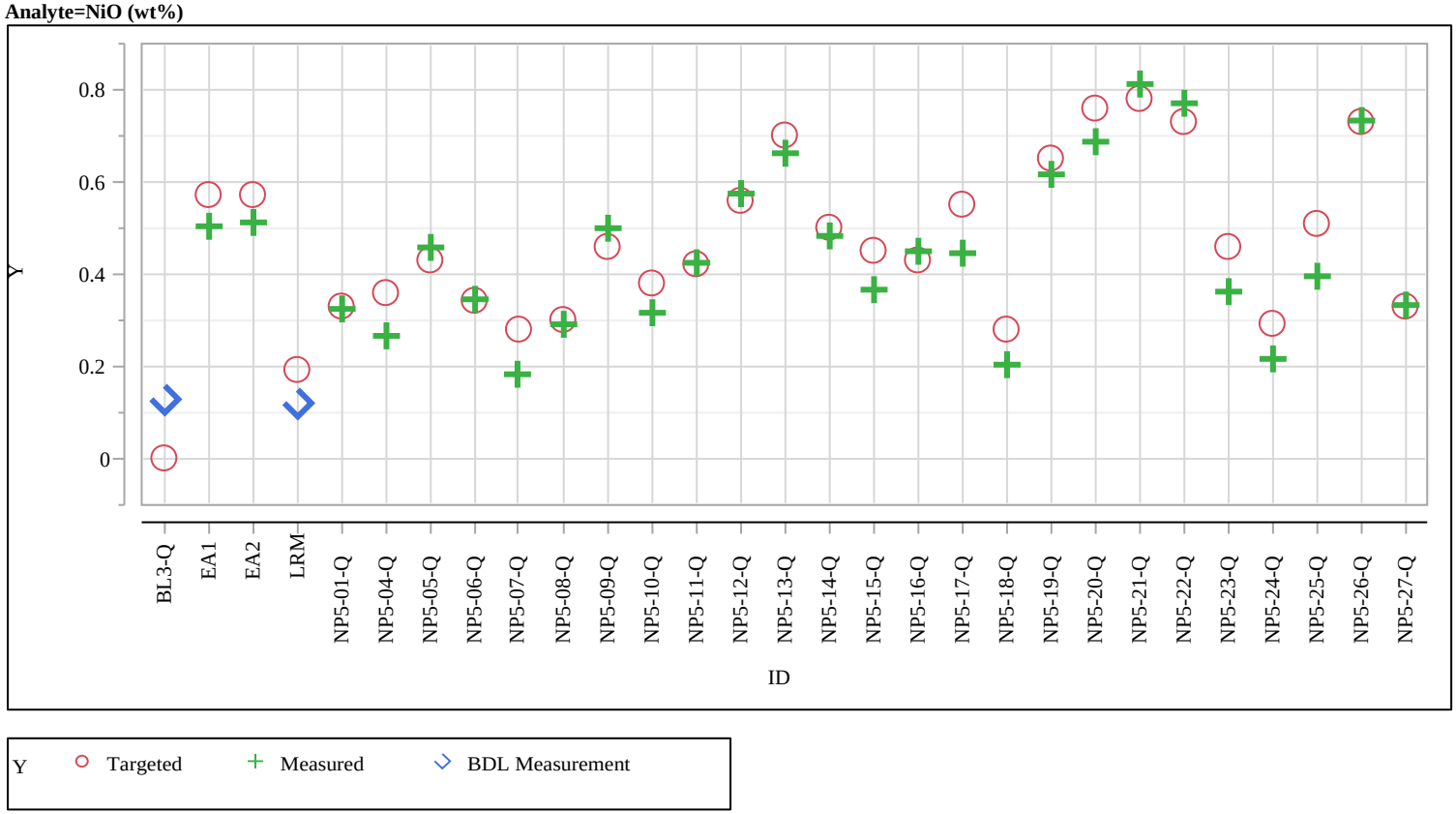


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

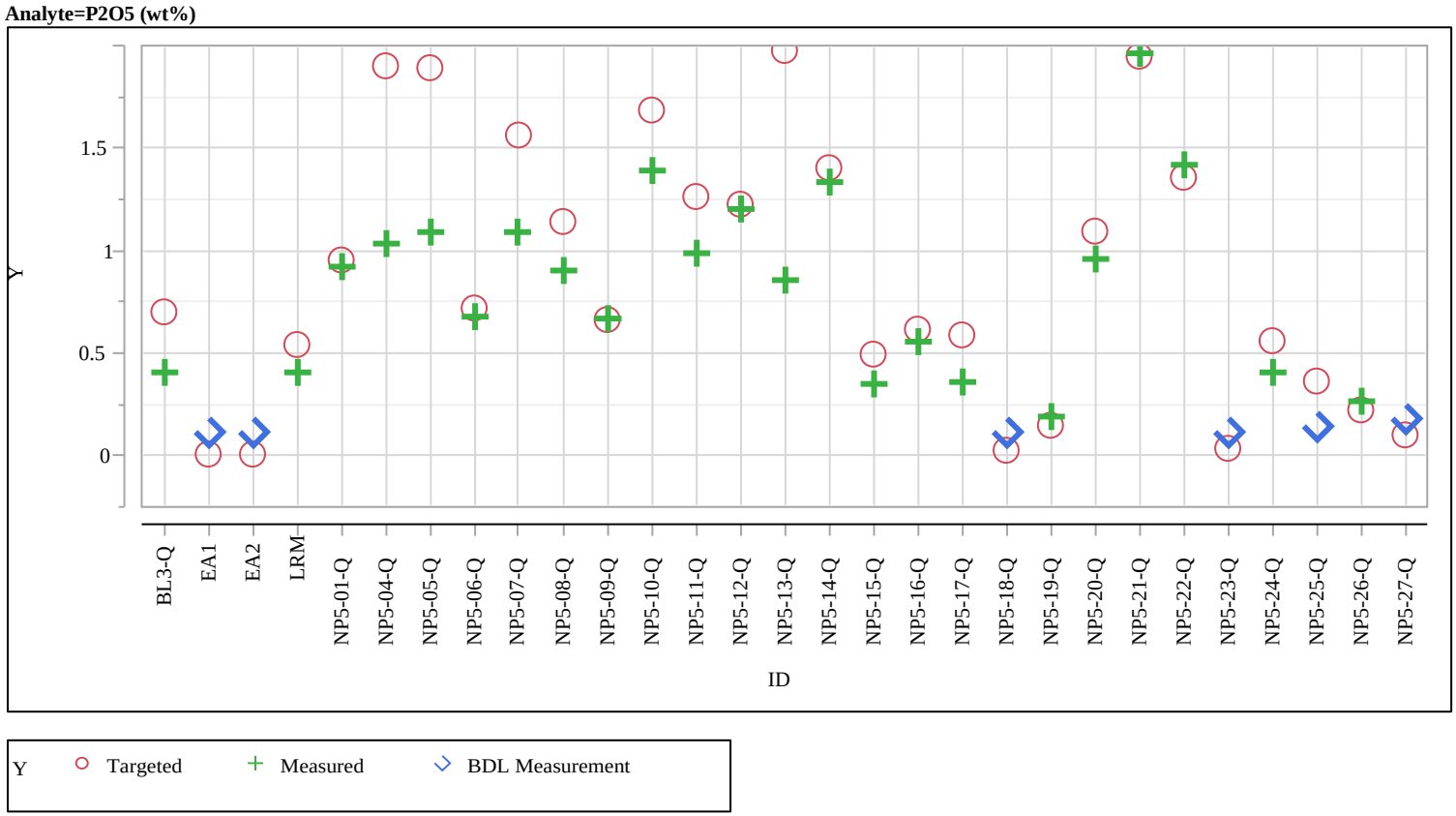


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

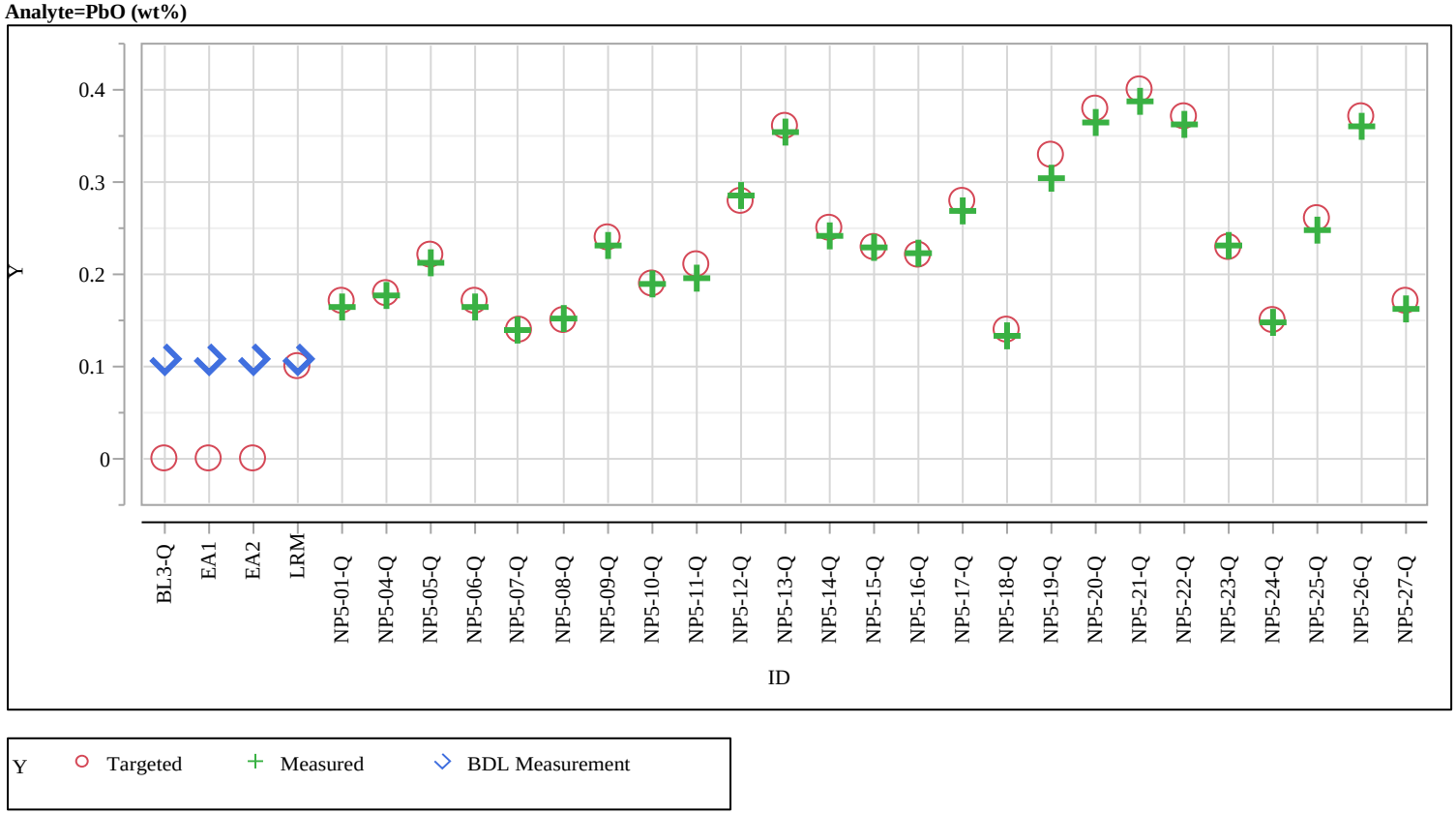


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

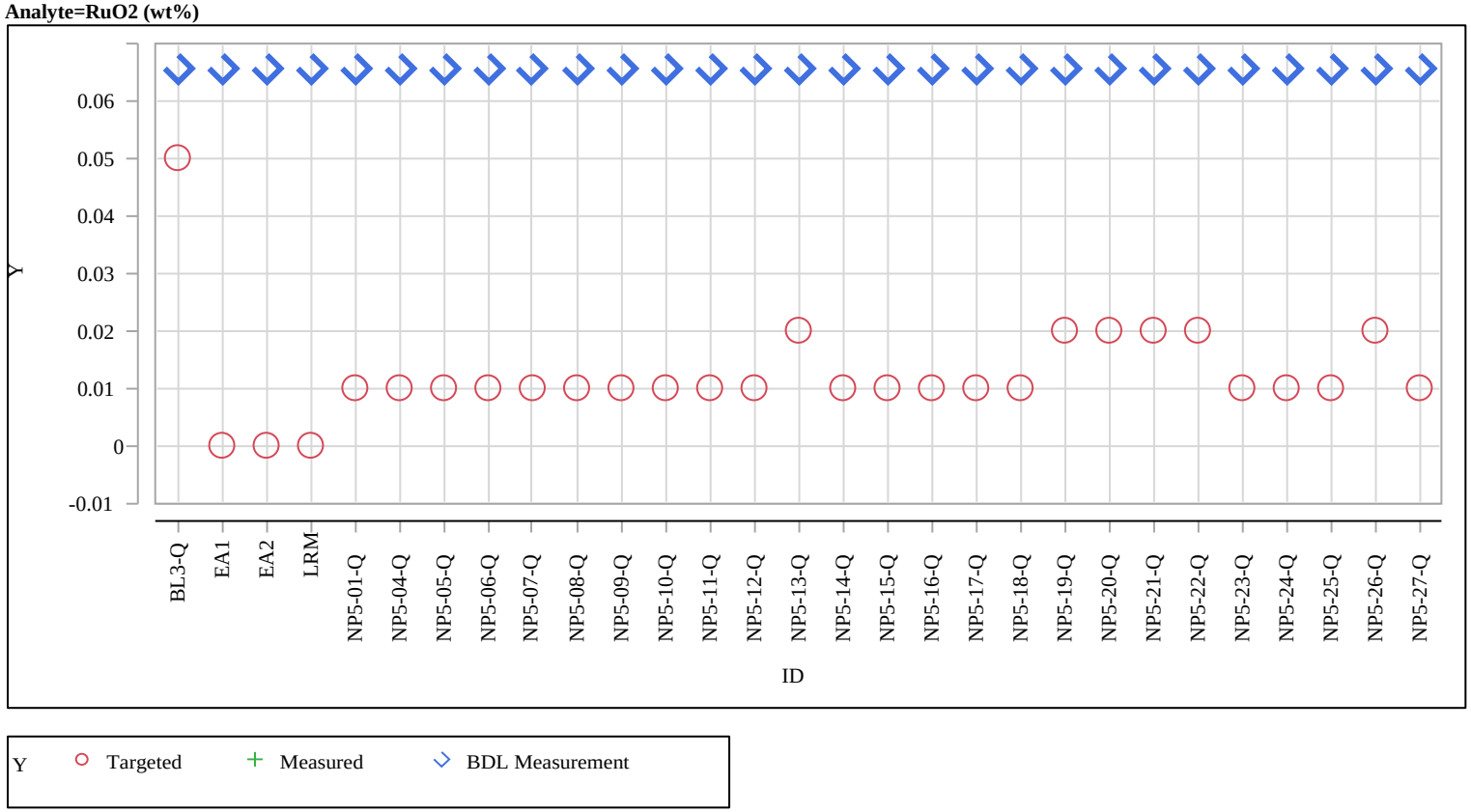


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

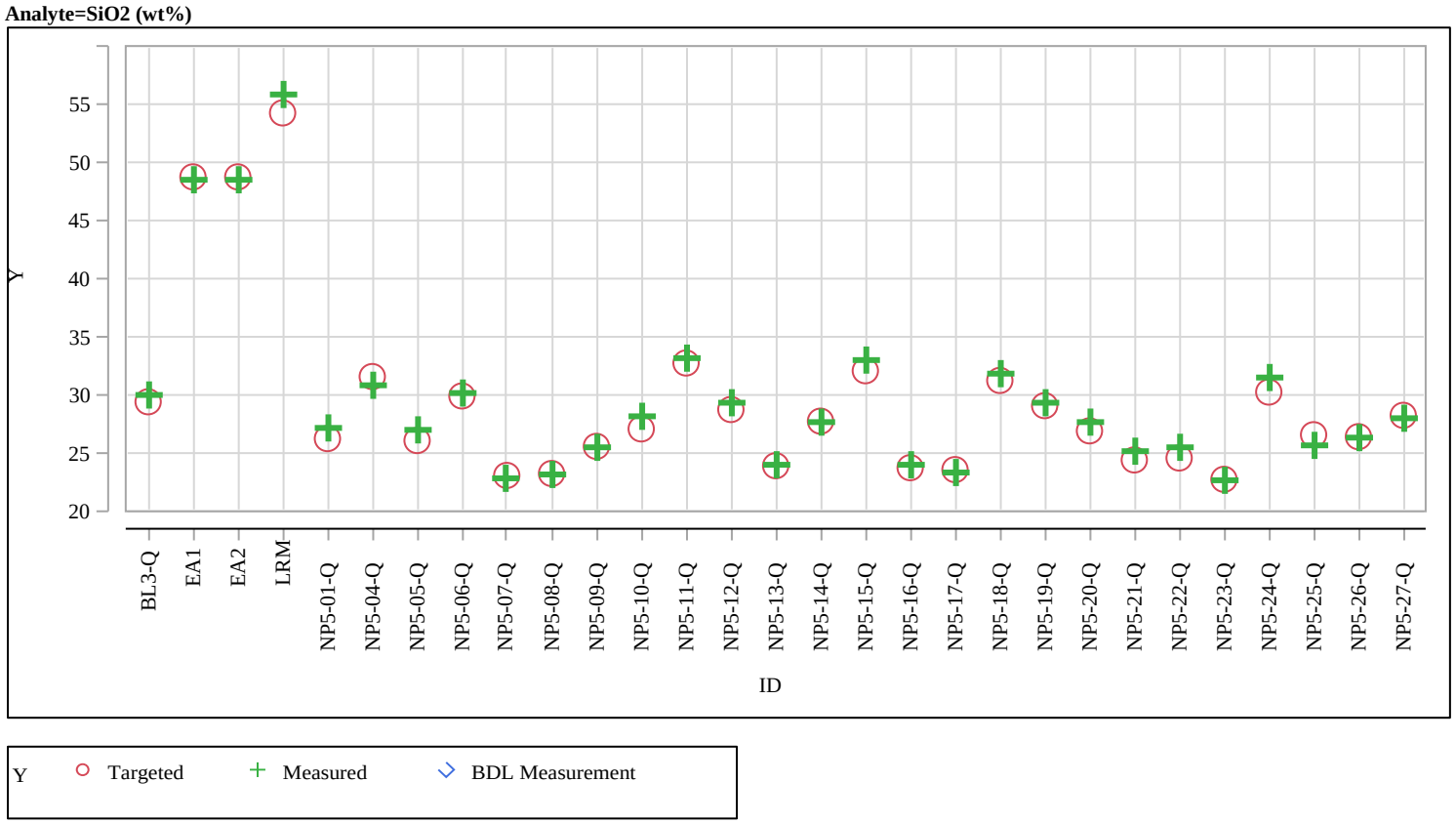


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

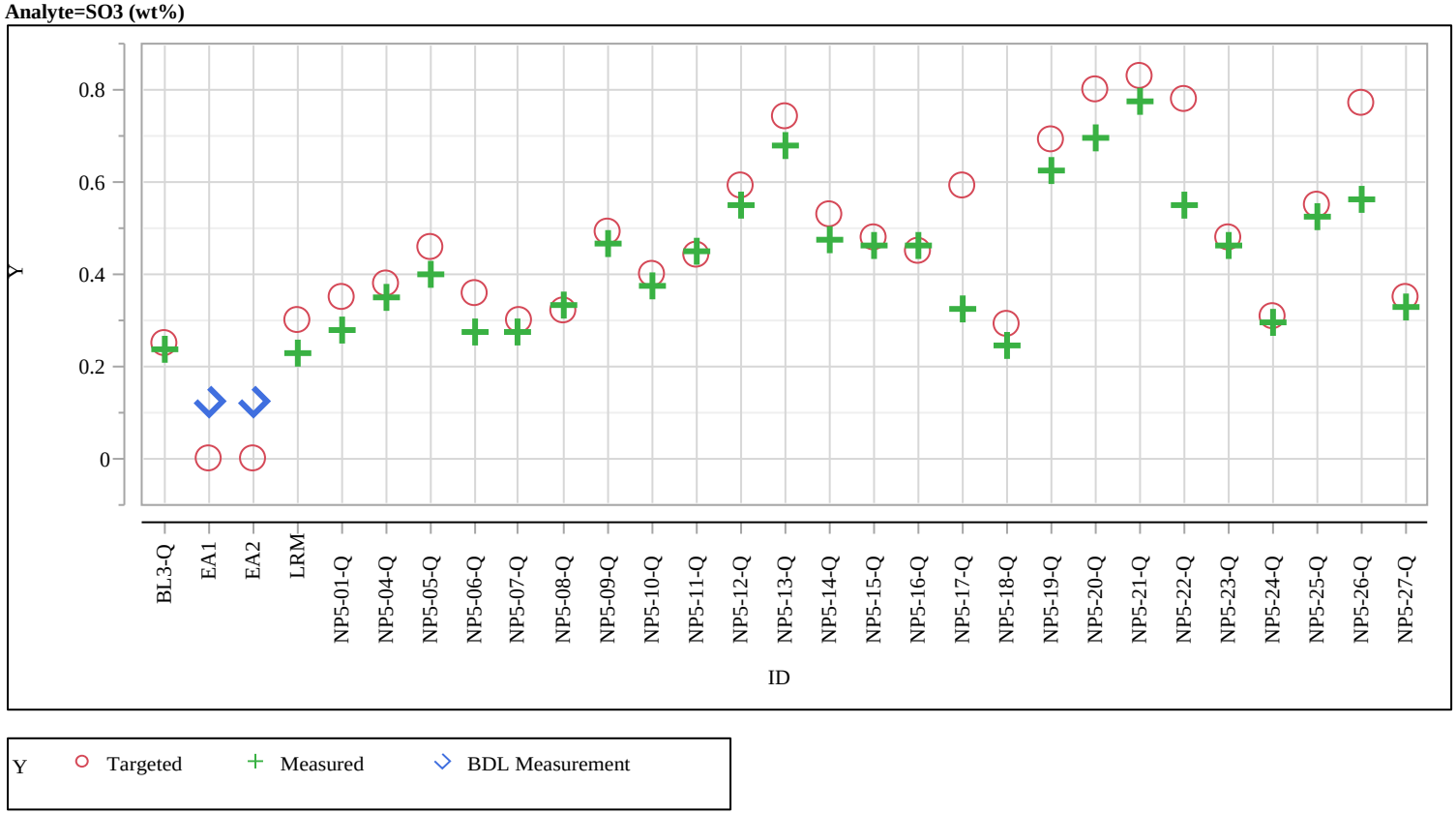


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

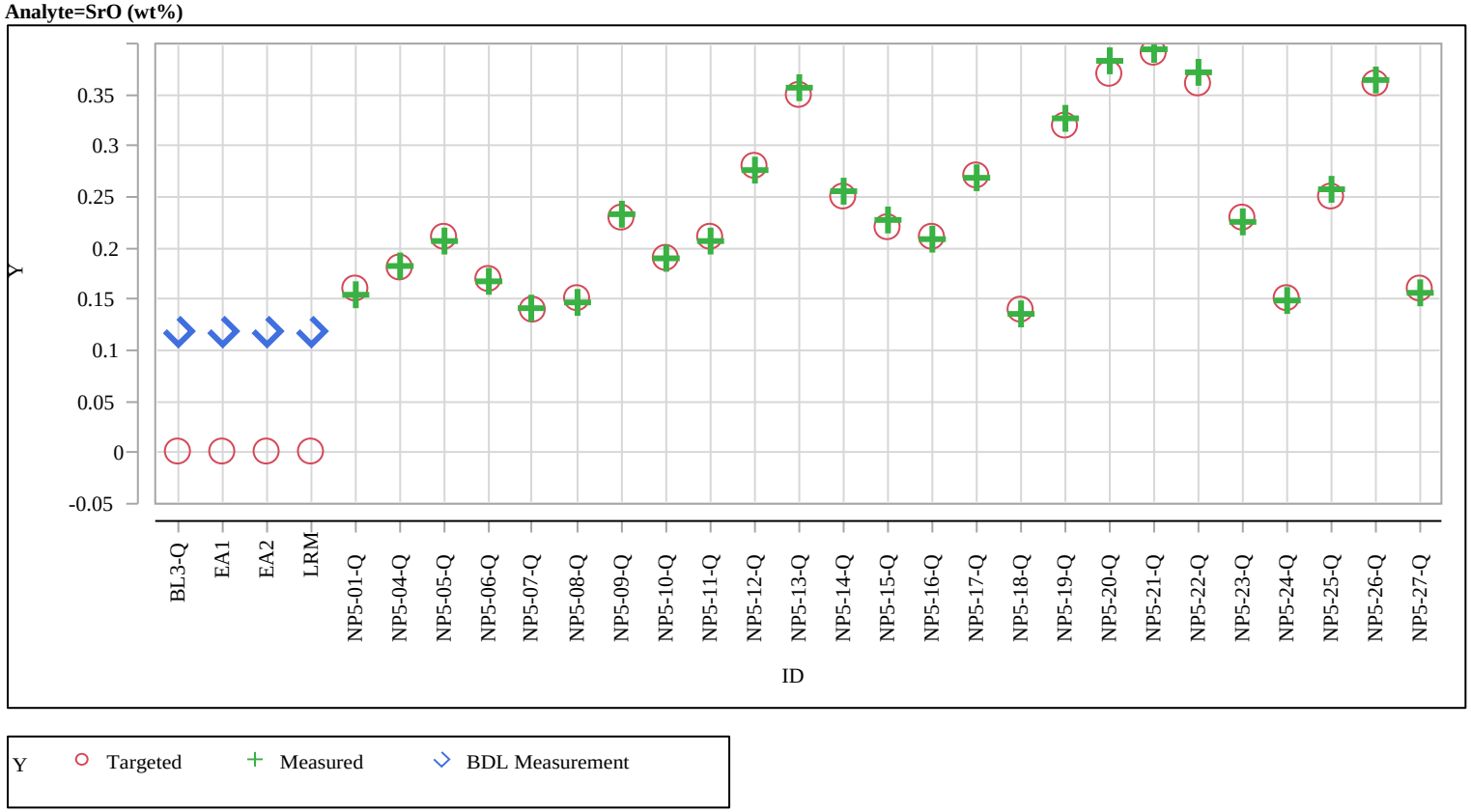


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

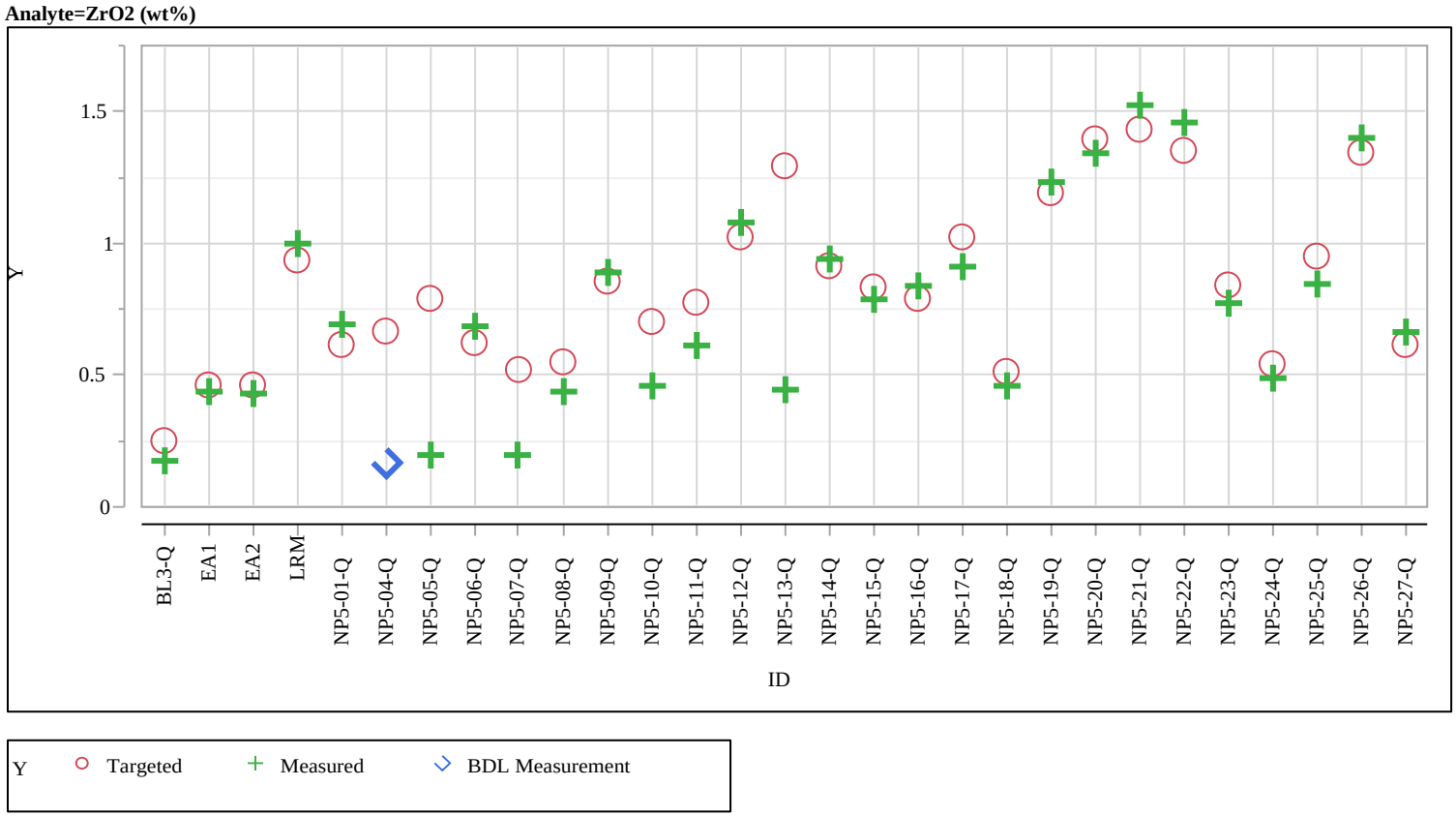
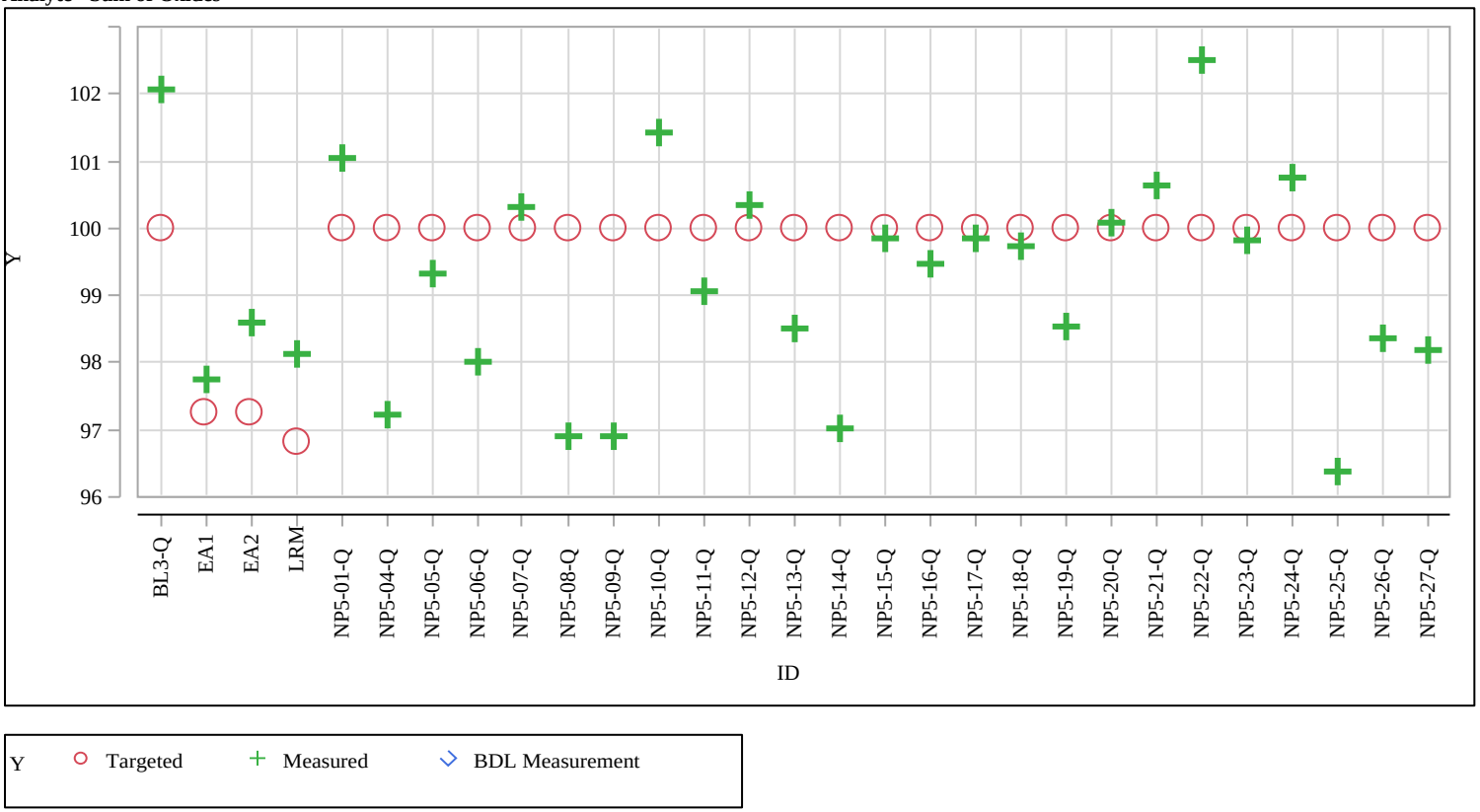


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

Analyte= Sum of Oxides



Appendix B Tables and Exhibits Supporting the PCT Results

Table B-1. PCT Measurements for the Nepheline Study Glasses

Group	Glass ID	Heat Treatment	Block	Seq	Lab ID	B ar	Li ar	Na ar	Si ar	B (mg/L)	Li (mg/L)	Na (mg/L)	Si (mg/L)
E	Soln Std	NA	1	1	std-E1-1	21.4	10.1	81.8	51.2	21.400	10.100	81.800	51.200
E	NP5-17	CCC	1	2	E19	18.1	2.49	16.2	7.29	30.167	4.150	27.001	12.150
E	NP5-21	CCC	1	3	E42	1080	419	556	9.38	1800.036	698.347	926.685	15.634
E	ARM	NA	1	4	E05	19.8	8.13	21.1	35.7	33.001	13.550	35.167	59.501
E	NP5-20	CCC	1	5	E07	25.7	8.15	29.4	23.0	42.834	13.584	49.001	38.334
E	NP5-16	Quenched	1	6	E01	60.5	20.9	139	18.4	100.835	34.834	231.671	30.667
E	NP5-19	CCC	1	7	E25	132	32.6	99.0	4.83	220.004	54.334	165.003	8.050
E	NP5-17	Quenched	1	8	E03	22.5	2.71	17.9	8.12	37.501	4.517	29.834	13.534
E	NP5-19	Quenched	1	9	E44	19.3	5.91	38.1	24.9	32.167	9.850	63.501	41.501
E	Soln Std	NA	1	10	std-E1-2	22.0	10.1	81.9	50.3	22.000	10.100	81.900	50.300
E	NP5-20	Quenched	1	11	E33	24.7	8.06	30.1	21.3	41.167	13.434	50.168	35.501
E	EA1	NA	1	12	E40	30.6	9.89	84.0	44.0	510.001	164.834	1400.003	733.335
E	NP5-18	Quenched	1	13	E35	18.3	2.89	24.6	13.7	30.501	4.817	41.001	22.834
E	blank	NA	1	14	E37	2.56	1.31	1.63	<1.00	4.267	2.183	2.717	<1.667
E	NP5-18	CCC	1	15	E06	16.5	2.69	22.3	13.0	27.501	4.483	37.167	21.667
E	NP5-21	Quenched	1	16	E30	71.3	42.6	78.0	24.2	118.836	71.001	130.003	40.334
E	NP5-16	CCC	1	17	E20	1440	515	1330	1.23	2400.048	858.351	2216.711	2.050
E	Soln Std	NA	1	18	std-E1-3	21.4	9.80	78.1	47.1	21.400	9.800	78.100	47.100
E	Soln Std	NA	2	1	std-E2-1	20.5	9.66	83.4	51.6	20.500	9.660	83.400	51.600
E	NP5-21	CCC	2	2	E17	1090	423	554	7.84	1816.703	705.014	923.352	13.067
E	EA1	NA	2	3	E28	40.9	10.4	96.5	53.3	681.668	173.334	1608.337	888.335
E	NP5-16	Quenched	2	4	E09	63.5	21.1	141	21.1	105.835	35.167	235.005	35.167
E	NP5-19	CCC	2	5	E43	138	31.5	96.3	5.28	230.005	52.501	160.503	8.800
E	NP5-17	CCC	2	6	E39	18.0	1.76	14.5	7.68	30.001	2.933	24.167	12.800
E	NP5-17	Quenched	2	7	E14	19.2	1.95	16.4	7.41	32.001	3.250	27.334	12.350
E	NP5-20	CCC	2	8	E27	26.2	8.30	32.6	24.7	43.668	13.834	54.334	41.167
E	NP5-19	Quenched	2	9	E23	17.6	5.31	37.8	25.6	29.334	8.850	63.001	42.668
E	Soln Std	NA	2	10	std-E2-2	19.7	9.58	81.9	50.1	19.700	9.580	81.900	50.100
E	NP5-16	CCC	2	11	E08	1490	540	1390	<1.00	2483.383	900.018	2316.713	<1.667
E	blank	NA	2	12	E45	1.30	<1.00	<1.00	<1.00	2.167	<1.667	<1.667	<1.667
E	ARM	NA	2	13	E02	11.5	8.22	22.6	39.4	19.167	13.700	37.667	65.668
E	blank	NA	2	14	E46	1.18	<1.00	<1.00	<1.00	1.967	<1.667	<1.667	<1.667
E	NP5-18	CCC	2	15	E18	17.0	2.00	21.5	14.6	28.334	3.333	35.834	24.334
E	NP5-18	Quenched	2	16	E12	20.1	2.38	25.4	14.5	33.501	3.967	42.334	24.167
E	NP5-20	Quenched	2	17	E26	24.1	7.44	29.8	18.9	40.167	12.400	49.668	31.501
E	NP5-21	Quenched	2	18	E10	66.8	41.7	76.5	24.3	111.336	69.501	127.503	40.501

(ar – as received)

Table B-1. PCT Measurements for the Nepheline Study Glasses (continued)

Group	Glass ID	Heat Treatment	Block	Seq	Lab ID	B ar	Li ar	Na ar	Si ar	B (mg/L)	Li (mg/L)	Na (mg/L)	Si (mg/L)
E	Soln Std	NA	2	19	std-E2-3	18.3	9.07	76.3	52.8	18.300	9.070	76.300	52.800
E	Soln Std	NA	3	1	std-E3-1	19.6	9.35	78.7	51.0	19.600	9.350	78.700	51.000
E	NP5-16	CCC	3	2	E29	1480	535	1390	1.89	2466.716	891.685	2316.713	3.150
E	NP5-20	CCC	3	3	E36	23.9	7.86	29.2	24.3	39.834	13.100	48.668	40.501
E	NP5-16	Quenched	3	4	E32	62.6	20.5	142	19.6	104.335	34.167	236.671	32.667
E	blank	NA	3	5	E04	2.46	<1.00	<1.00	<1.00	4.100	<1.667	<1.667	<1.667
E	NP5-17	CCC	3	6	E31	17.0	1.66	13.7	7.76	28.334	2.767	22.834	12.934
E	NP5-19	CCC	3	7	E11	146	29.8	86.2	5.17	243.338	49.668	143.670	8.617
E	NP5-21	Quenched	3	8	E34	68.0	41.2	72.2	26.2	113.336	68.668	120.336	43.668
E	NP5-18	Quenched	3	9	E41	18.4	2.24	23.7	16.3	30.667	3.733	39.501	27.167
E	Soln Std	NA	3	10	std-E3-2	19.4	9.21	75.6	49.9	19.400	9.210	75.600	49.900
E	NP5-17	Quenched	3	11	E38	17.3	1.85	14.9	7.69	28.834	3.083	24.834	12.817
E	NP5-18	CCC	3	12	E15	14.4	1.89	20.2	14.4	24.000	3.150	33.667	24.000
E	NP5-19	Quenched	3	13	E22	15.9	5.08	34.6	25.7	26.501	8.467	57.668	42.834
E	NP5-20	Quenched	3	14	E21	22.7	7.47	28.9	22.7	37.834	12.450	48.168	37.834
E	NP5-21	CCC	3	15	E16	1070	422	555	8.26	1783.369	703.347	925.019	13.767
E	EA1	NA	3	16	E24	37.2	9.82	87.0	52.5	620.001	163.667	1450.003	875.002
E	ARM	NA	3	17	E13	12.9	7.44	19.5	34.7	21.500	12.400	32.501	57.834
E	Soln Std	NA	3	18	std-E3-3	21.1	9.17	74.5	50.1	21.100	9.170	74.500	50.100
N	Soln Std	NA	1	1	std-N1-1	19.6	9.54	78.4	45.5	19.600	9.540	78.400	45.500
N	NP5-07	CCC	1	2	N14	129	6.67	142	14.7	215.004	11.117	236.671	24.500
N	NP5-01	CCC	1	3	N40	55.5	<1.00	71.5	18.0	92.502	<1.667	119.169	30.001
N	NP5-06	Quenched	1	4	N20	97.0	28.1	47.5	29.3	161.670	46.834	79.168	48.834
N	NP5-05	CCC	1	5	N27	18.3	9.94	18.7	16.3	30.501	16.567	31.167	27.167
N	NP5-04	CCC	1	6	N23	77.3	20.3	57.2	27.4	128.836	33.834	95.335	45.668
N	NP5-06	CCC	1	7	N45	110	30.7	51.2	30.0	183.337	51.168	85.335	50.001
N	blank	NA	1	8	N32	2.42	<1.00	<1.00	<1.00	4.033	<1.667	<1.667	<1.667
N	BL3	CCC	1	9	N31	171	46.0	109	16.7	285.006	76.668	181.670	27.834
N	NP5-07	Quenched	1	10	N37	94.2	5.20	123	16.3	157.003	8.667	205.004	27.167
N	Soln Std	NA	1	11	std-N1-2	21.2	9.40	77.0	45.0	21.200	9.400	77.000	45.000
N	BL3	Quenched	1	12	N12	54.1	22.9	60.4	37.6	90.168	38.167	100.669	62.668
N	NP5-05	Quenched	1	13	N24	23.9	12.8	23.6	17.1	39.834	21.334	39.334	28.501
N	NP5-08	Quenched	1	14	N29	712	158	705	<1.00	1186.690	263.339	1175.024	<1.667
N	NP5-08	CCC	1	15	N35	639	138	663	2.30	1065.021	230.005	1105.022	3.833
N	ARM	NA	1	16	N34	18.2	7.07	18.0	31.4	30.334	11.784	30.001	52.334
N	EA1	NA	1	17	N03	25.0	6.73	53.3	33.2	416.668	112.167	888.335	553.334
N	NP5-04	Quenched	1	18	N13	61.3	16.2	48.5	27.6	102.169	27.001	80.835	46.001

(ar – as received)

Table B-1. PCT Measurements for the Nepheline Study Glasses (continued)

Group	Glass ID	Heat Treatment	Block	Seq	Lab ID	B ar	Li ar	Na ar	Si ar	B (mg/L)	Li (mg/L)	Na (mg/L)	Si (mg/L)
N	NP5-01	Quenched	1	19	N11	42.0	<1.00	54.7	14.4	70.001	<1.667	91.168	24.000
N	Soln Std	NA	1	20	std-N1-3	21.6	9.90	83.2	45.7	21.600	9.900	83.200	45.700
N	Soln Std	NA	2	1	std-N2-1	20.4	9.34	80.3	50.1	20.400	9.340	80.300	50.100
N	NP5-04	Quenched	2	2	N33	66.5	17.8	53.5	33.4	110.836	29.667	89.168	55.668
N	NP5-08	CCC	2	3	N28	673	140	663	2.4	1121.689	233.338	1105.022	4.000
N	NP5-07	CCC	2	4	N15	129	6.42	144	16.2	215.004	10.700	240.005	27.001
N	EA1	NA	2	5	N18	21.0	6.16	49.5	33.0	350.001	102.667	825.002	550.001
N	NP5-01	CCC	2	6	N46	55.4	<1.00	70.7	18.8	92.335	<1.667	117.836	31.334
N	NP5-07	Quenched	2	7	N30	87.9	4.51	111	16.2	146.503	7.517	185.004	27.001
N	ARM	NA	2	8	N22	11.2	7.12	18.5	33.1	18.667	11.867	30.834	55.168
N	BL3	Quenched	2	9	N41	51.1	21.2	56.0	37.6	85.168	35.334	93.335	62.668
N	NP5-06	Quenched	2	10	N05	108	28.6	48.5	33.0	180.004	47.668	80.835	55.001
N	Soln Std	NA	2	11	std-N2-2	19.4	9.32	79.4	47.2	19.400	9.320	79.400	47.200
N	NP5-05	Quenched	2	12	N49	23.5	12.4	23.4	18.0	39.167	20.667	39.001	30.001
N	NP5-04	CCC	2	13	N38	83.1	20.9	60.8	31.4	138.503	34.834	101.335	52.334
N	NP5-05	CCC	2	14	N08	17.4	9.46	17.6	17.7	29.001	15.767	29.334	29.501
N	NP5-01	Quenched	2	15	N39	37.9	<1.00	53.8	15.1	63.168	<1.667	89.668	25.167
N	NP5-08	Quenched	2	16	N02	778	183	833	1.83	1296.693	305.006	1388.361	3.050
N	NP5-06	CCC	2	17	N17	125	31.0	52.0	33.0	208.338	51.668	86.668	55.001
N	BL3	CCC	2	18	N26	183	48.3	108	18.6	305.006	80.502	180.004	31.001
N	Soln Std	NA	2	19	std-N2-3	18.2	9.04	76.7	45.5	18.200	9.040	76.700	45.500
N	Soln Std	NA	3	1	std-N3-1	20.0	9.52	81.0	48.0	20.000	9.520	81.000	48.000
N	NP5-01	CCC	3	2	N43	28.1	<1.00	37.4	8.6	46.834	<1.667	62.335	14.334
N	NP5-07	Quenched	3	3	N36	107	5.20	119	17.9	178.337	8.667	198.337	29.834
N	BL3	CCC	3	4	N10	181	50.2	108	18.6	301.673	83.668	180.004	31.001
N	NP5-01	Quenched	3	5	N47	47.9	<1.00	63.6	17.9	79.835	<1.667	106.002	29.834
N	NP5-04	Quenched	3	6	N42	71.4	18.6	57.1	32.6	119.002	31.001	95.169	54.334
N	NP5-08	CCC	3	7	N01	671	139	665	1.49	1118.356	231.671	1108.356	2.483
N	NP5-07	CCC	3	8	N07	145	7.21	155	16.4	241.672	12.017	258.339	27.334
N	NP5-05	Quenched	3	9	N25	27.8	13.2	25.3	17.7	46.334	22.000	42.168	29.501
N	NP5-05	CCC	3	10	N04	21.0	10.5	19.8	18.8	35.001	17.500	33.001	31.334
N	Soln Std	NA	3	11	std-N3-2	22.0	9.63	81.8	47.6	22.000	9.630	81.800	47.600
N	NP5-04	CCC	3	12	N09	83.6	21.1	61.7	28.7	139.336	35.167	102.835	47.834
N	BL3	Quenched	3	13	N06	51.8	21.4	57.2	37.9	86.335	35.667	95.335	63.168
N	NP5-08	Quenched	3	14	N44	954	205	951	<1.00	1590.032	341.674	1585.032	<1.667
N	ARM	NA	3	15	N19	21.6	9.27	25.2	39.6	36.001	15.450	42.001	66.001
N	blank	NA	3	16	N16	3.82	<1.00	<1.00	<1.00	6.367	<1.667	<1.667	<1.667

(ar – as received)

Table B-1. PCT Measurements for the Nepheline Study Glasses (continued)

Group	Glass ID	Heat Treatment	Block	Seq	Lab ID	B ar	Li ar	Na ar	Si ar	B (mg/L)	Li (mg/L)	Na (mg/L)	Si (mg/L)
N	NP5-06	Quenched	3	17	N21	113	29.2	50.5	31.6	188.337	48.668	84.168	52.668
N	NP5-06	CCC	3	18	N48	137	34.4	60.2	35.8	228.338	57.334	100.335	59.668
N	EA1	NA	3	19	N50	23.2	7.12	55.5	36.2	386.667	118.667	925.002	603.335
N	Soln Std	NA	3	20	std-N3-3	22.0	9.73	82.9	48.5	22.000	9.730	82.900	48.500
S	Soln Std	NA	1	1	std-S1-1	19.3	9.71	81.9	45.9	19.300	9.710	81.900	45.900
S	NP5-13	CCC	1	2	S45	52.3	4.67	63.2	<1.00	87.168	7.783	105.335	<1.667
S	NP5-15	CCC	1	3	S26	31.8	17.0	34.2	37.1	53.001	28.334	57.001	61.835
S	EA2	NA	1	4	S08	38.9	11.4	113	47.5	648.335	190.000	1883.337	791.668
S	NP5-12	Quenched	1	5	S12	7.11	3.08	14.3	6.13	11.850	5.133	23.834	10.217
S	NP5-14	CCC	1	6	S17	112	24.8	120	24.3	186.670	41.334	200.004	40.501
S	NP5-13	Quenched	1	7	S05	17.3	1.92	46.9	10.5	28.834	3.200	78.168	17.500
S	NP5-10	Quenched	1	8	S22	8.54	5.83	27.2	11.6	14.234	9.717	45.334	19.334
S	NP5-10	CCC	1	9	S19	1250	607	314	1.83	2083.375	1011.687	523.344	3.050
S	NP5-09	CCC	1	10	S11	89.8	26.8	102	21.4	149.670	44.668	170.003	35.667
S	Soln Std	NA	1	11	std-S1-2	18.6	9.70	81.4	45.2	18.600	9.700	81.400	45.200
S	NP5-12	CCC	1	12	S31	7.58	2.88	10.6	6.64	12.634	4.800	17.667	11.067
S	NP5-15	Quenched	1	13	S27	31.1	17.4	32.8	36.5	51.834	29.001	54.668	60.835
S	NP5-11	Quenched	1	14	S47	10.3	6.36	31.5	20.1	17.167	10.600	52.501	33.501
S	ARM	NA	1	15	S50	10.2	8.72	24.0	35.7	17.000	14.534	40.001	59.501
S	NP5-11	CCC	1	16	S42	2210	1070	910	33.6	3683.407	1783.369	1516.697	56.001
S	NP5-09	Quenched	1	17	S48	70.5	21.0	82.4	22.6	117.502	35.001	137.336	37.667
S	blank	NA	1	18	S35	4.39	<1.00	<1.00	<1.00	7.317	<1.667	<1.667	<1.667
S	NP5-14	Quenched	1	19	S49	105	23.8	126	24.1	175.004	39.667	210.004	40.167
S	Soln Std	NA	1	20	std-S1-3	18.7	9.63	83.0	45.4	18.700	9.630	83.000	45.400
S	Soln Std	NA	2	1	std-S2-1	20.6	9.65	81.1	47.7	20.600	9.650	81.100	47.700
S	EA2	NA	2	2	S36	37.4	10.8	99.2	50.8	623.335	180.000	1653.337	846.668
S	NP5-13	Quenched	2	3	S09	17.2	1.44	40.6	11.7	28.667	2.400	67.668	19.500
S	NP5-09	Quenched	2	4	S28	62.8	20.4	75.6	21.4	104.669	34.001	126.003	35.667
S	NP5-12	Quenched	2	5	S37	7.19	2.43	11.9	7.6	11.984	4.050	19.834	12.667
S	NP5-14	Quenched	2	6	S40	98.6	22.2	119	22.2	164.337	37.001	198.337	37.001
S	NP5-15	CCC	2	7	S10	34.1	17.8	31.4	43.0	56.834	29.667	52.334	71.668
S	NP5-11	CCC	2	8	S04	2130	1040	880	33.0	3550.071	1733.368	1466.696	55.001
S	NP5-09	CCC	2	9	S14	92.8	26.0	89.4	21.4	154.670	43.334	149.003	35.667
S	NP5-11	Quenched	2	10	S21	16.3	6.11	28.6	19.9	27.167	10.184	47.668	33.167
S	Soln Std	NA	2	11	std-S2-2	18.8	9.58	76.2	48.7	18.800	9.580	76.200	48.700
S	blank	NA	2	12	S51	2.61	<1.00	<1.00	<1.00	4.350	<1.667	<1.667	<1.667
S	NP5-15	Quenched	2	13	S46	34.6	17.0	28.4	37.6	57.668	28.334	47.334	62.668

(ar – as received)

Table B-1. PCT Measurements for the Nepheline Study Glasses (continued)

Group	Glass ID	Heat Treatment	Block	Seq	Lab ID	B ar	Li ar	Na ar	Si ar	B (mg/L)	Li (mg/L)	Na (mg/L)	Si (mg/L)
S	ARM	NA	2	14	S39	12.0	7.72	20.6	32.7	20.000	12.867	34.334	54.501
S	NP5-10	Quenched	2	15	S33	11.7	5.49	24.3	12.4	19.500	9.150	40.501	20.667
S	NP5-14	CCC	2	16	S06	114	24.7	123	26.1	190.004	41.167	205.004	43.501
S	NP5-12	CCC	2	17	S34	9.49	2.55	10.0	6.21	15.817	4.250	16.667	10.350
S	NP5-13	CCC	2	18	S44	52.1	4.28	53.8	<1.00	86.835	7.133	89.668	<1.667
S	blank	NA	2	19	S52	<1.00	<1.00	<1.00	<1.00	<1.667	<1.667	<1.667	<1.667
S	NP5-10	CCC	2	20	S41	1260	626	325	1.5	2100.042	1043.354	541.678	2.500
S	Soln Std	NA	2	21	std-S2-3	19.8	9.81	79.3	48.1	19.800	9.810	79.300	48.100
S	Soln Std	NA	3	1	std-S3-1	19.3	9.37	82.1	46.2	19.300	9.370	82.100	46.200
S	EA2	NA	3	2	S15	35.8	10.6	101	48.9	596.668	176.667	1683.337	815.002
S	NP5-14	CCC	3	3	S43	109	24.1	134	25.5	181.670	40.167	223.338	42.501
S	NP5-12	Quenched	3	4	S32	7.25	2.56	12.7	8.34	12.084	4.267	21.167	13.900
S	NP5-15	Quenched	3	5	S20	34.1	18.1	31.9	37.8	56.834	30.167	53.168	63.001
S	NP5-10	Quenched	3	6	S18	9.54	5.47	24.6	12.6	15.900	9.117	41.001	21.000
S	NP5-14	Quenched	3	7	S25	97.2	21.7	122	23.7	162.003	36.167	203.337	39.501
S	NP5-11	CCC	3	8	S02	2170	1100	943	32.4	3616.739	1833.370	1571.698	54.001
S	ARM	NA	3	9	S29	17.9	8.31	23.2	34.9	29.834	13.850	38.667	58.168
S	NP5-10	CCC	3	10	S24	1260	651	352	2.78	2100.042	1085.022	586.678	4.633
S	Soln Std	NA	3	11	std-S3-2	21.8	9.87	82.6	45.5	21.800	9.870	82.600	45.500
S	NP5-13	Quenched	3	12	S07	18.9	1.55	42.3	11.3	31.501	2.583	70.501	18.834
S	NP5-09	CCC	3	13	S16	82.1	25.8	94.1	21.6	136.836	43.001	156.836	36.001
S	blank	NA	3	14	S13	1.27	<1.00	<1.00	<1.00	2.117	<1.667	<1.667	<1.667
S	NP5-13	CCC	3	15	S30	47.8	4.26	55.7	1.68	79.668	7.100	92.835	2.800
S	NP5-12	CCC	3	16	S03	8.63	2.62	10.3	6.75	14.384	4.367	17.167	11.250
S	NP5-15	CCC	3	17	S38	30.2	15.7	30.6	41.4	50.334	26.167	51.001	69.001
S	NP5-09	Quenched	3	18	S01	62.9	19.9	77.4	21.7	104.835	33.167	129.003	36.167
S	NP5-11	Quenched	3	19	S23	12.4	6.07	30.7	21.4	20.667	10.117	51.168	35.667
S	Soln Std	NA	3	20	std-S3-3	20.3	9.41	82.4	45.4	20.300	9.410	82.400	45.400
Z	Soln Std	NA	1	1	std-Z1-1	18.4	9.50	79.5	48.0	18.400	9.500	79.500	48.000
Z	NP5-26	CCC	1	2	Z25	127	4.57	149	18.3	211.671	7.617	248.338	30.501
Z	NP5-23	CCC	1	3	Z44	412	88.3	374	<1.00	686.680	147.170	623.346	<1.667
Z	NP5-27	CCC	1	4	Z32	79.5	26.0	37.8	1.65	132.503	43.334	63.001	2.750
Z	NP5-25	Quenched	1	5	Z41	53.6	31.7	97.2	31.8	89.335	52.834	162.003	53.001
Z	NP5-24	Quenched	1	6	Z04	19.0	3.44	37.4	25.6	31.667	5.733	62.335	42.668
Z	NP5-24	CCC	1	7	Z29	208	31.0	164	<1.00	346.674	51.668	273.339	<1.667
Z	NP5-23	Quenched	1	8	Z08	31.6	8.9	51.9	11.0	52.668	14.834	86.502	18.334
Z	NP5-27	Quenched	1	9	Z26	16.8	10.2	24.3	20.7	28.001	17.000	40.501	34.501

(ar – as received)

Table B-1. PCT Measurements for the Nepheline Study Glasses (continued)

Group	Glass ID	Heat Treatment	Block	Seq	Lab ID	B ar	Li ar	Na ar	Si ar	B (mg/L)	Li (mg/L)	Na (mg/L)	Si (mg/L)
Z	Soln Std	NA	1	10	std-Z1-2	19.9	9.89	83.3	52.4	19.900	9.890	83.300	52.400
Z	ARM	NA	1	11	Z11	10.9	8.26	21.8	38.4	18.167	13.767	36.334	64.001
Z	blank	NA	1	12	Z07	<1.00	<1.00	<1.00	<1.00	<1.667	<1.667	<1.667	<1.667
Z	EA2	NA	1	13	Z37	34.4	10.6	97.6	54.3	573.334	176.667	1626.670	905.002
Z	NP5-22	Quenched	1	14	Z31	15.2	1.84	22.6	9.44	25.334	3.067	37.667	15.734
Z	NP5-22	CCC	1	15	Z03	20.2	2.35	27.8	14.3	33.667	3.917	46.334	23.834
Z	NP5-25	CCC	1	16	Z23	2030	1030	854	4.48	3383.401	1716.701	1423.362	7.467
Z	NP5-26	Quenched	1	17	Z05	142	4.41	154	17.2	236.671	7.350	256.672	28.667
Z	Soln Std	NA	1	18	std-Z1-3	21.0	9.80	81.5	53.6	21.000	9.800	81.500	53.600
Z	Soln Std	NA	2	1	std-Z2-1	20.0	9.84	85.6	52.6	20.000	9.840	85.600	52.600
Z	NP5-23	Quenched	2	2	Z13	35.2	9.55	57.7	11.6	58.668	15.917	96.169	19.334
Z	NP5-25	CCC	2	3	Z18	1920	994	837	4.53	3200.064	1656.700	1395.028	7.550
Z	EA2	NA	2	4	Z28	39.7	10.9	103	53.5	661.668	181.667	1716.670	891.668
Z	NP5-24	Quenched	2	5	Z02	19.7	3.47	39.0	25.8	32.834	5.783	65.001	43.001
Z	blank	NA	2	6	Z45	<1.00	<1.00	<1.00	<1.00	<1.667	<1.667	<1.667	<1.667
Z	NP5-22	CCC	2	7	Z15	19.7	2.18	26.9	13.5	32.834	3.633	44.834	22.500
Z	NP5-27	Quenched	2	8	Z27	18.7	10.2	24.9	21.3	31.167	17.000	41.501	35.501
Z	blank	NA	2	9	Z46	<1.00	<1.00	<1.00	<1.00	<1.667	<1.667	<1.667	<1.667
Z	Soln Std	NA	2	10	std-Z2-2	20.3	9.84	85.1	51.4	20.300	9.840	85.100	51.400
Z	NP5-24	CCC	2	11	Z19	222	32.0	170	1.28	370.007	53.334	283.339	2.133
Z	NP5-23	CCC	2	12	Z43	411	87.1	365	<1.00	685.014	145.170	608.346	<1.667
Z	NP5-22	Quenched	2	13	Z39	17.4	1.79	23.5	10.2	29.001	2.983	39.167	17.000
Z	NP5-26	CCC	2	14	Z17	129	4.34	149	16.5	215.004	7.233	248.338	27.501
Z	NP5-26	Quenched	2	15	Z24	118	4.16	144	16.5	196.671	6.933	240.005	27.501
Z	NP5-25	Quenched	2	16	Z38	55.4	32.0	100	31.6	92.335	53.334	166.670	52.668
Z	ARM	NA	2	17	Z06	11.0	8.11	22.1	37.9	18.334	13.517	36.834	63.168
Z	NP5-27	CCC	2	18	Z35	83.0	26.9	39.7	1.92	138.336	44.834	66.168	3.200
Z	Soln Std	NA	2	19	std-Z2-3	19.9	9.83	84.2	51.8	19.900	9.830	84.200	51.800
Z	Soln Std	NA	3	1	std-Z3-1	18.2	9.46	79.0	47.1	18.200	9.460	79.000	47.100
Z	NP5-27	Quenched	3	2	Z09	16.7	10.0	23.9	19.3	27.834	16.667	39.834	32.167
Z	EA2	NA	3	3	Z40	31.3	10.4	93.6	49.1	521.668	173.334	1560.003	818.335
Z	NP5-25	Quenched	3	4	Z20	53.6	32.2	99.1	29.3	89.335	53.668	165.170	48.834
Z	NP5-22	CCC	3	5	Z12	20.9	2.37	27.8	14.6	34.834	3.950	46.334	24.334
Z	NP5-24	CCC	3	6	Z36	222	31.1	170	1.57	370.007	51.834	283.339	2.617
Z	NP5-26	CCC	3	7	Z30	129	4.60	146	17.4	215.004	7.667	243.338	29.001
Z	NP5-25	CCC	3	8	Z01	1940	1010	775	4.59	3233.398	1683.367	1291.693	7.650
Z	blank	NA	3	9	Z42	4.66	<1.00	<1.00	<1.00	7.767	<1.667	<1.667	<1.667

(ar – as received)

Table B-1. PCT Measurements for the Nepheline Study Glasses (continued)

Group	Glass ID	Heat Treatment	Block	Seq	Lab ID	B ar	Li ar	Na ar	Si ar	B (mg/L)	Li (mg/L)	Na (mg/L)	Si (mg/L)
Z	Soln Std	NA	3	10	std-Z3-2	19.7	9.24	75.5	46.0	19.700	9.240	75.500	46.000
Z	NP5-24	Quenched	3	11	Z22	19.8	3.56	37.8	25.3	33.001	5.933	63.001	42.168
Z	NP5-23	Quenched	3	12	Z33	35.1	9.28	54.5	11.3	58.501	15.467	90.835	18.834
Z	ARM	NA	3	13	Z34	12.5	8.63	22.9	38.9	20.834	14.384	38.167	64.835
Z	NP5-26	Quenched	3	14	Z16	122	4.43	141	16.6	203.337	7.383	235.005	27.667
Z	NP5-23	CCC	3	15	Z10	393	84.3	361	<1.00	655.013	140.503	601.679	<1.667
Z	NP5-22	Quenched	3	16	Z21	17.1	1.91	22.9	9.74	28.501	3.183	38.167	16.234
Z	NP5-27	CCC	3	17	Z14	72.7	24.7	35.4	1.96	121.169	41.167	59.001	3.267
Z	Soln Std	NA	3	18	std-Z3-3	18.6	9.35	77.0	46.5	18.600	9.350	77.000	46.500

Table B-2. Ambient Temperature PCT Leachate pH Values for the Group E Glasses

Identifier	pH		Identifier	pH
blank-1	7.81		NP5-04-Q-3	9.37
blank-2	7.38		NP5-05-CCC-1	9.40
ARM-1-1	10.31		NP5-05-CCC-2	9.40
ARM-1-2	10.41		NP5-05-CCC-3	9.37
ARM-1-3	10.40		NP5-05-Q-1	9.44
EA1-1	11.67		NP5-05-Q-2	9.50
EA1-2	11.72		NP5-05-Q-3	9.27
EA1-3	11.71		NP5-06-CCC-1	9.06
BL3-CCC-1	9.36		NP5-06-CCC-2	9.09
BL3-CCC-2	9.35		NP5-06-CCC-3	9.11
BL3-CCC-3	9.30		NP5-06-Q-1	9.26
BL3-Q-1	9.49		NP5-06-Q-2	9.13
BL3-Q-2	9.46		NP5-06-Q-3	9.17
BL3-Q-3	9.55		NP5-07-CCC-1	9.28
NP5-01-CCC-1	9.13		NP5-07-CCC-2	9.15
NP5-01-CCC-2	8.96		NP5-07-CCC-3	9.22
NP5-01-CCC-3	9.03		NP5-07-Q-1	9.35
NP5-01-Q-1	9.10		NP5-07-Q-2	9.43
NP5-01-Q-2	9.17		NP5-07-Q-3	9.40
NP5-01-Q-3	9.01		NP5-08-CCC-1	9.85
NP5-04-CCC-1	9.35		NP5-08-CCC-2	9.87
NP5-04-CCC-2	9.34		NP5-08-CCC-3	9.86
NP5-04-CCC-3	9.30		NP5-08-Q-1	9.79
NP5-04-Q-1	9.35		NP5-08-Q-2	9.90
NP5-04-Q-2	9.41		NP5-08-Q-3	9.89

Table B-3. Ambient Temperature PCT Leachate pH Values for the Group N Glasses

Identifier	pH		Identifier	pH
Blank-A-1	7.69		NP5-11-Q-2	10.59
Blank-A-2	7.13		NP5-11-Q-3	10.67
ARM-1-1	10.28		NP5-12-CCC-1	9.37
ARM-1-2	10.49		NP5-12-CCC-2	9.78
ARM-1-3	10.41		NP5-12-CCC-3	9.64
EA2-1	11.94		NP5-12-Q-1	9.23
EA2-2	12.05		NP5-12-Q-2	9.23
EA2-3	12.15		NP5-12-Q-3	9.23
NP5-09-CCC-1	9.59		NP5-13-CCC-1	9.25
NP5-09-CCC-2	9.69		NP5-13-CCC-2	9.41
NP5-09-CCC-3	9.63		NP5-13-CCC-3	9.52
Blank-B-1	7.79		NP5-13-Q-1	9.53
Blank-B-2	6.98		NP5-13-Q-2	9.59
NP5-09-Q-1	9.70		NP5-13-Q-3	9.77
NP5-09-Q-2	9.72		NP5-14-CCC-1	9.71
NP5-09-Q-3	9.50		NP5-14-CCC-2	9.68
NP5-10-CCC-1	9.97		NP5-14-CCC-3	10.06
NP5-10-CCC-2	10.33		NP5-14-Q-1	10.01
NP5-10-CCC-3	10.30		NP5-14-Q-2	9.96
NP5-10-Q-1	10.26		NP5-14-Q-3	10.07
NP5-10-Q-2	10.15		NP5-15-CCC-1	9.93
NP5-10-Q-3	10.24		NP5-15-CCC-2	9.65
NP5-11-CCC-1	10.21		NP5-15-CCC-3	9.81
NP5-11-CCC-2	10.38		NP5-15-Q-1	9.80
NP5-11-CCC-3	10.26		NP5-15-Q-2	9.79
NP5-11-Q-1	10.42		NP5-15-Q-3	9.59

Table B-4. Ambient Temperature PCT Leachate pH Values for the Group S Glasses

Identifier	pH		Identifier	pH
Blank-A-1	7.72		NP5-18-Q-1	9.29
Blank-A-2	6.97		NP5-18-Q-2	9.21
ARM-1-1	10.19		NP5-18-Q-3	9.30
ARM-1-2	10.20		NP5-19-CCC-1	9.44
ARM-1-3	10.23		NP5-19-CCC-2	9.45
EA1-1	11.66		NP5-19-CCC-3	9.49
EA1-2	11.74		NP5-19-Q-1	9.71
EA1-3	11.77		NP5-19-Q-2	9.74
NP5-16-CCC-1	10.90		NP5-19-Q-3	9.72
NP5-16-CCC-2	10.77		NP5-20-CCC-1	9.34
NP5-16-CCC-3	10.78		NP5-20-CCC-2	9.10
NP5-16-Q-1	9.86		NP5-20-CCC-3	9.27
NP5-16-Q-2	9.94		NP5-20-Q-1	9.21
NP5-16-Q-3	10.01		NP5-20-Q-2	9.29
NP5-17-CCC-1	8.72		NP5-20-Q-3	9.24
NP5-17-CCC-2	8.76		NP5-21-CCC-1	9.73
NP5-17-CCC-3	8.76		NP5-21-CCC-2	9.66
NP5-17-Q-1	8.68		NP5-21-CCC-3	9.69
NP5-17-Q-2	8.66		Blank-B-1	8.96
NP5-17-Q-3	8.70		Blank-B-2	7.97
NP5-18-CCC-1	9.23		NP5-21-Q-1	9.64
NP5-18-CCC-2	9.29		NP5-21-Q-2	9.55
NP5-18-CCC-3	9.22		NP5-21-Q-3	9.63

Table B-5. Ambient Temperature PCT Leachate pH Values for the Group Z Glasses

Identifier	pH		Identifier	pH
Blank-A-1	5.27		NP5-24-Q-1	9.54
Blank-A-2	5.27		NP5-24-Q-2	9.35
ARM-1-1	10.33		NP5-24-Q-3	9.62
ARM-1-2	10.44		NP5-25-CCC-1	11.09
ARM-1-3	10.33		NP5-25-CCC-2	11.08
EA2-1	11.97		NP5-25-CCC-3	11.32
EA2-2	11.78		NP5-25-Q-1	10.40
EA2-3	11.95		NP5-25-Q-2	10.38
NP5-22-CCC-1	9.15		NP5-25-Q-3	10.33
NP5-22-CCC-2	8.92		NP5-26-CCC-1	9.09
NP5-22-CCC-3	8.88		NP5-26-CCC-2	9.26
NP5-22-Q-1	8.82		NP5-26-CCC-3	9.23
NP5-22-Q-2	8.98		NP5-26-Q-1	9.33
NP5-22-Q-3	8.96		NP5-26-Q-2	9.42
NP5-23-CCC-1	9.68		NP5-26-Q-3	9.27
NP5-23-CCC-2	9.75		Blank-B-1	8.66
NP5-23-CCC-3	9.60		Blank-B-2	7.68
NP5-23-Q-1	9.56		NP5-27-CCC-1	9.51
NP5-23-Q-2	9.56		NP5-27-CCC-2	9.48
NP5-23-Q-3	9.55		NP5-27-CCC-3	9.41
NP5-24-CCC-1	9.25		NP5-27-Q-1	9.65
NP5-24-CCC-2	9.32		NP5-27-Q-2	9.73
NP5-24-CCC-3	9.19		NP5-27-Q-3	9.70

Table B-6. Results from Samples of the Multi-Element Solution Standard for the Group E and Group N PCTs

PCT Group	E			N			Reference Values (mg/L)
Block	1	2	3	1	2	3	
Mean (B (mg/L))	20.80	19.33	21.33	18.87	19.73	20.47	20
Mean (Li (mg/L))	9.61	9.23	9.63	9.68	9.68	9.55	10
Mean (Na (mg/L))	79.53	78.80	81.90	82.10	78.87	82.37	81
Mean (Si (mg/L))	45.40	47.60	48.03	45.50	48.17	45.70	50
% relative bias, B	4.0%	-3.3%	6.7%	-5.7%	-1.3%	2.3%	<10% per ASTM C 1285
% relative bias, Li	-3.9%	-7.7%	-3.7%	-3.2%	-3.2%	-4.5%	
% relative bias, Na	-1.8%	-2.7%	1.1%	1.4%	-2.6%	1.7%	
% relative bias, Si	-9.2%	-4.8%	-3.9%	-9.0%	-3.7%	-8.6%	
Std Dev (B (mg/L))	1.058	1.102	1.155	0.379	0.902	1.258	
Std Dev (Li (mg/L))	0.258	0.168	0.105	0.044	0.118	0.278	
Std Dev (Na (mg/L))	3.252	1.873	0.954	0.819	2.479	0.252	
Std Dev (Si (mg/L))	0.361	2.326	0.451	0.361	0.503	0.436	
%RSD, B	5.1%	5.7%	5.4%	2.0%	4.6%	6.1%	<10% per ASTM C 1285
%RSD, Li	2.7%	1.8%	1.1%	0.5%	1.2%	2.9%	
%RSD, Na	4.1%	2.4%	1.2%	1.0%	3.1%	0.3%	
%RSD, Si	0.8%	4.9%	0.9%	0.8%	1.0%	1.0%	

Table B-7. Results from Samples of the Multi-Element Solution Standard for the Group S and Group Z PCTs

PCT Group	S			Z			Reference Values (mg/L)
Block	1	2	3	1	2	3	
Mean (B (mg/L))	21.60	19.50	20.03	19.77	20.07	18.83	20
Mean (Li (mg/L))	10.00	9.44	9.24	9.73	9.84	9.35	10
Mean (Na (mg/L))	80.60	80.53	76.27	81.43	84.97	77.17	81
Mean (Si (mg/L))	49.53	51.50	50.33	51.33	51.93	46.53	50
% relative bias, B	8.0%	-2.5%	0.2%	-1.2%	0.3%	-5.8%	<10% per ASTM C 1285
% relative bias, Li	0.0%	-5.6%	-7.6%	-2.7%	-1.6%	-6.5%	
% relative bias, Na	-0.5%	-0.6%	-5.8%	0.5%	4.9%	-4.7%	
% relative bias, Si	-0.9%	3.0%	0.7%	2.7%	3.9%	-6.9%	
Std Dev (B (mg/L))	0.346	1.114	0.929	1.305	0.208	0.777	
Std Dev (Li (mg/L))	0.173	0.320	0.095	0.204	0.006	0.110	
Std Dev (Na (mg/L))	2.166	3.742	2.178	1.901	0.709	1.756	
Std Dev (Si (mg/L))	2.155	1.353	0.586	2.948	0.611	0.551	
%RSD, B	1.6%	5.7%	4.6%	6.6%	1.0%	4.1%	<10% per ASTM C 1285
%RSD, Li	1.7%	3.4%	1.0%	2.1%	0.1%	1.2%	
%RSD, Na	2.7%	4.6%	2.9%	2.3%	0.8%	2.3%	
%RSD, Si	4.4%	2.6%	1.2%	5.7%	1.2%	1.2%	

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

Group=E, Analyte=B
Variability Chart for log[Measured (mg/L)]

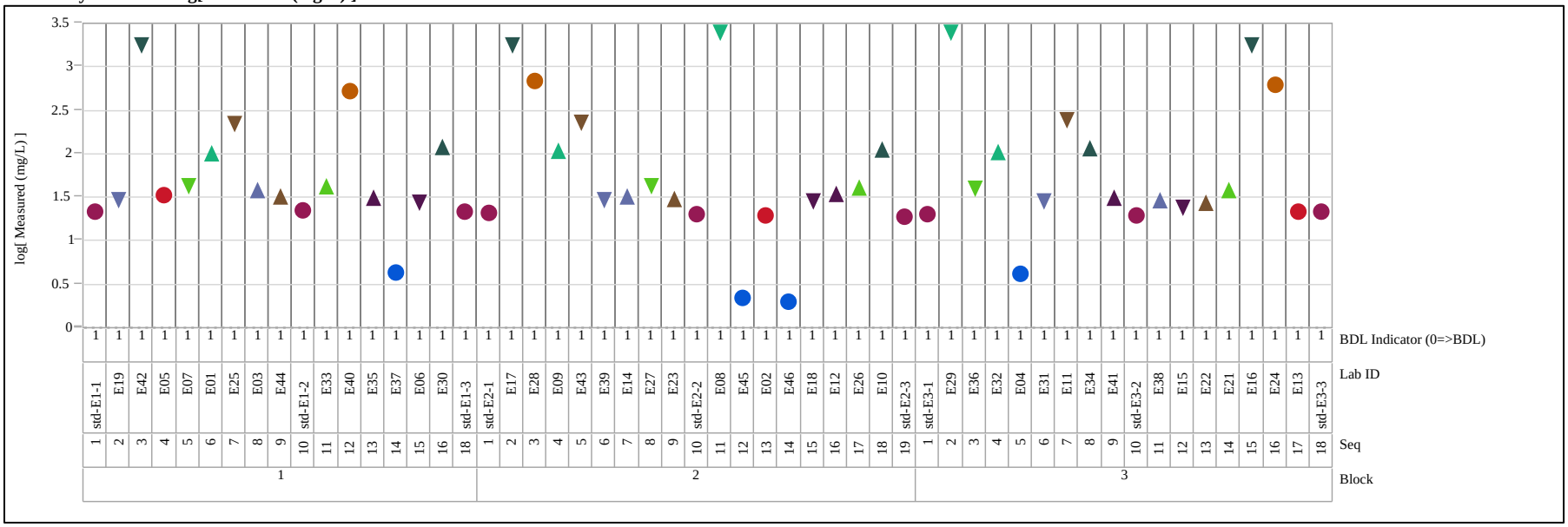


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

Group=E, Analyte=Li
Variability Chart for log[Measured (mg/L)]

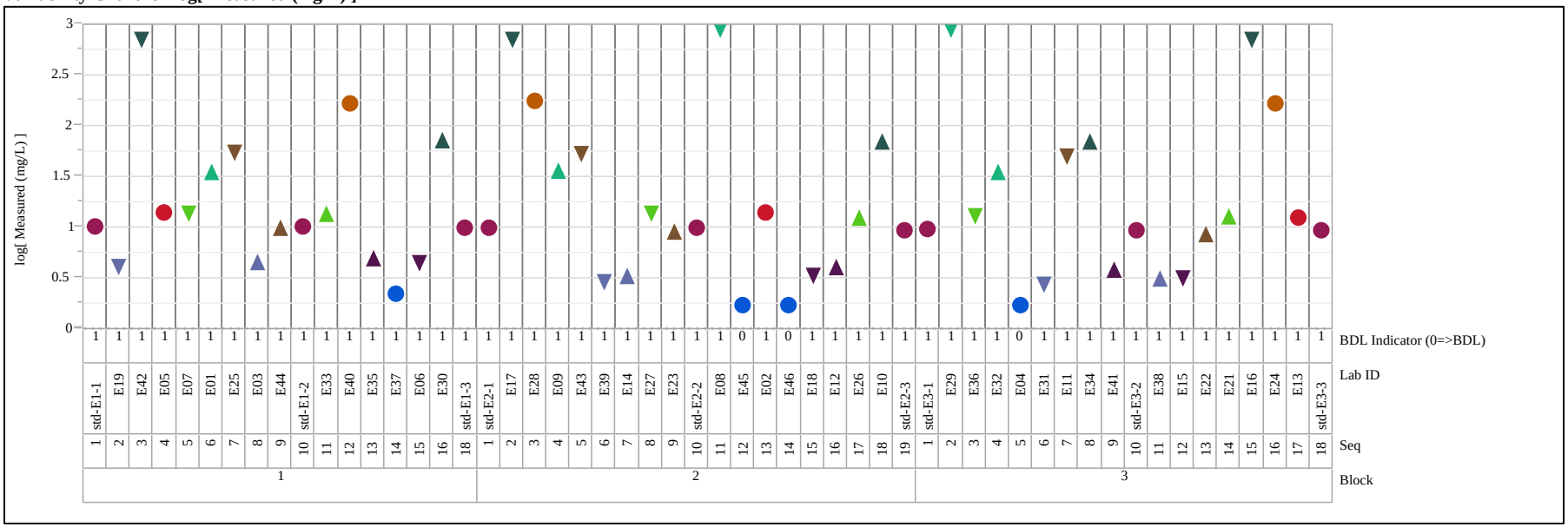


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

Group=E, Analyte=Na
Variability Chart for log[Measured (mg/L)]

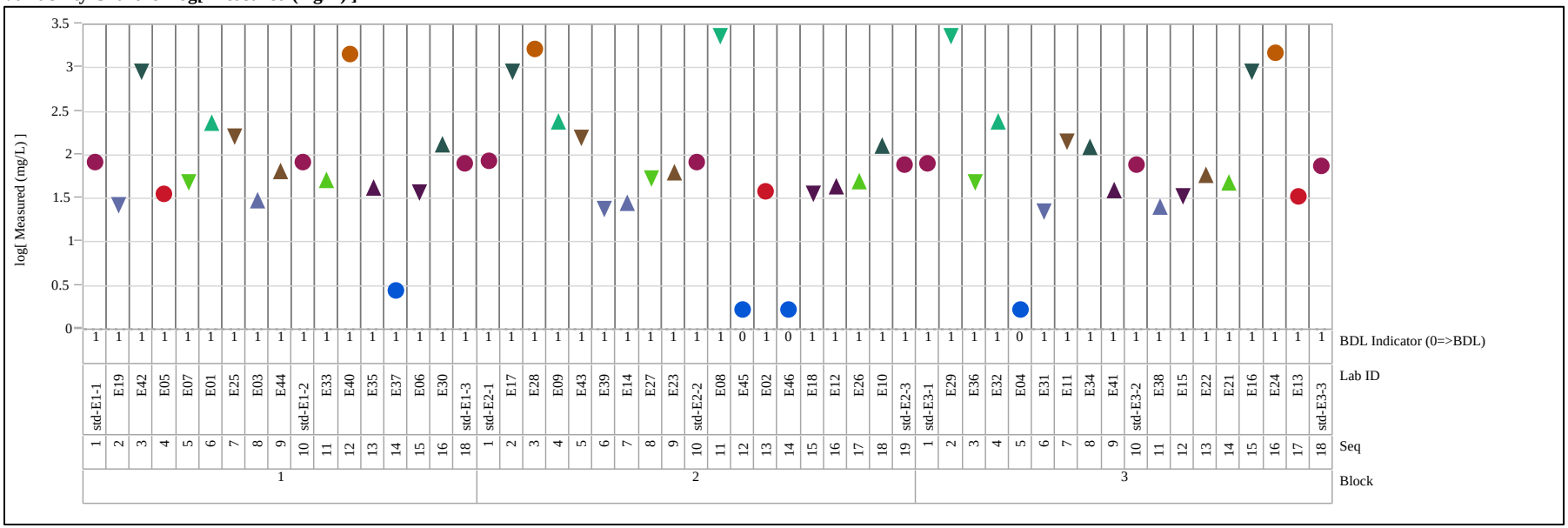


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

Group=E, Analyte=Si
Variability Chart for log[Measured (mg/L)]

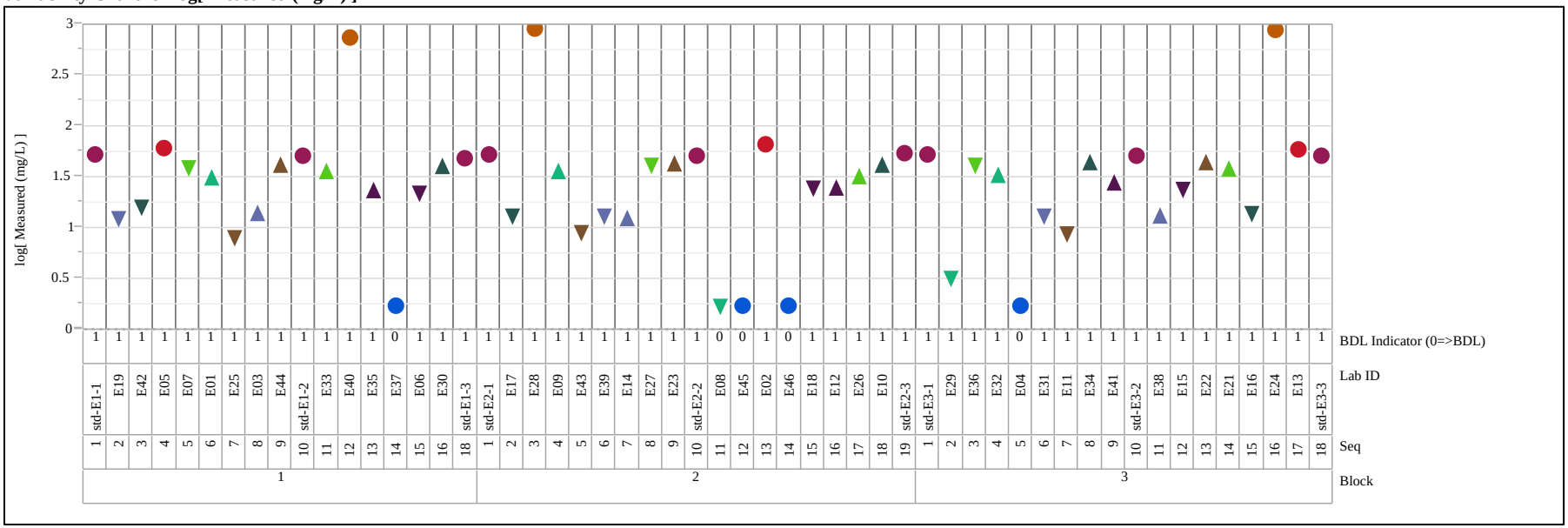


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

Group=N, Analyte=B
Variability Chart for log[Measured (mg/L)]

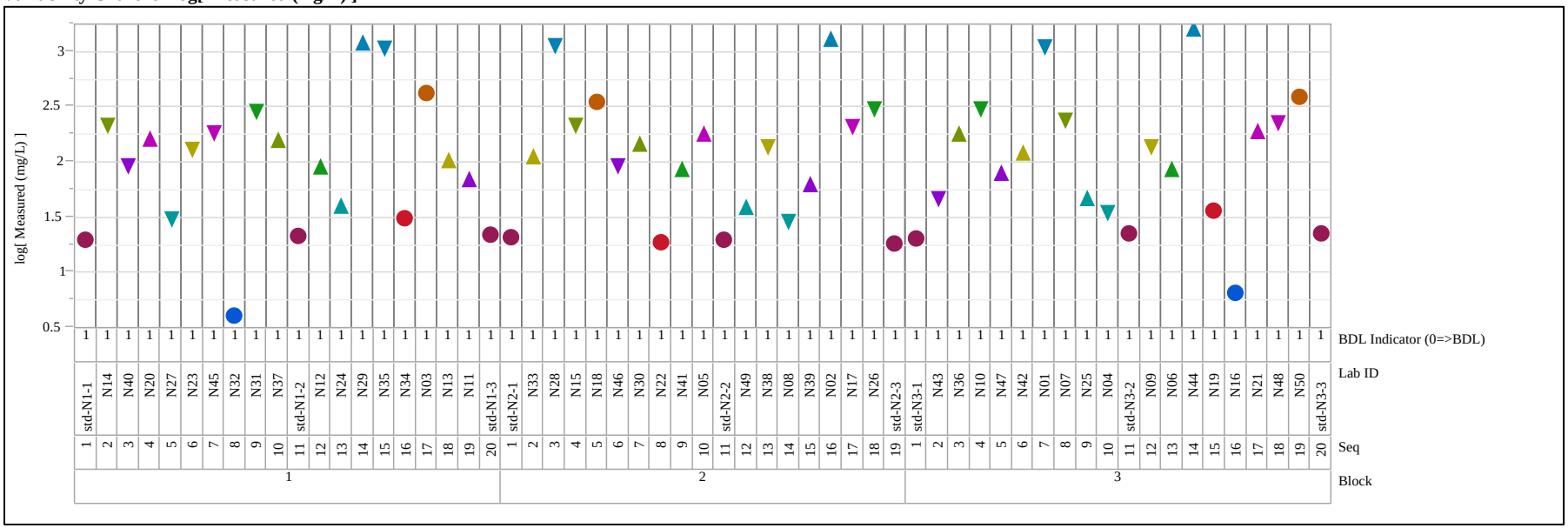


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

Group=N, Analyte=Li
Variability Chart for log[Measured (mg/L)]

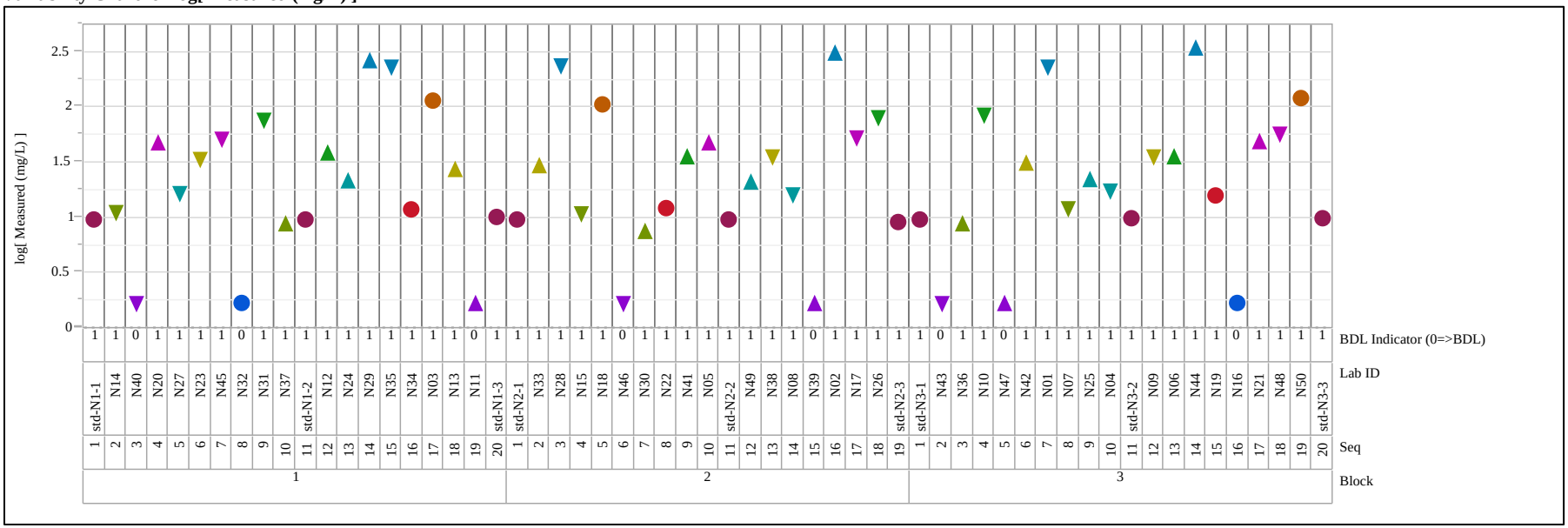


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

Group=N, Analyte=Na
Variability Chart for log[Measured (mg/L)]

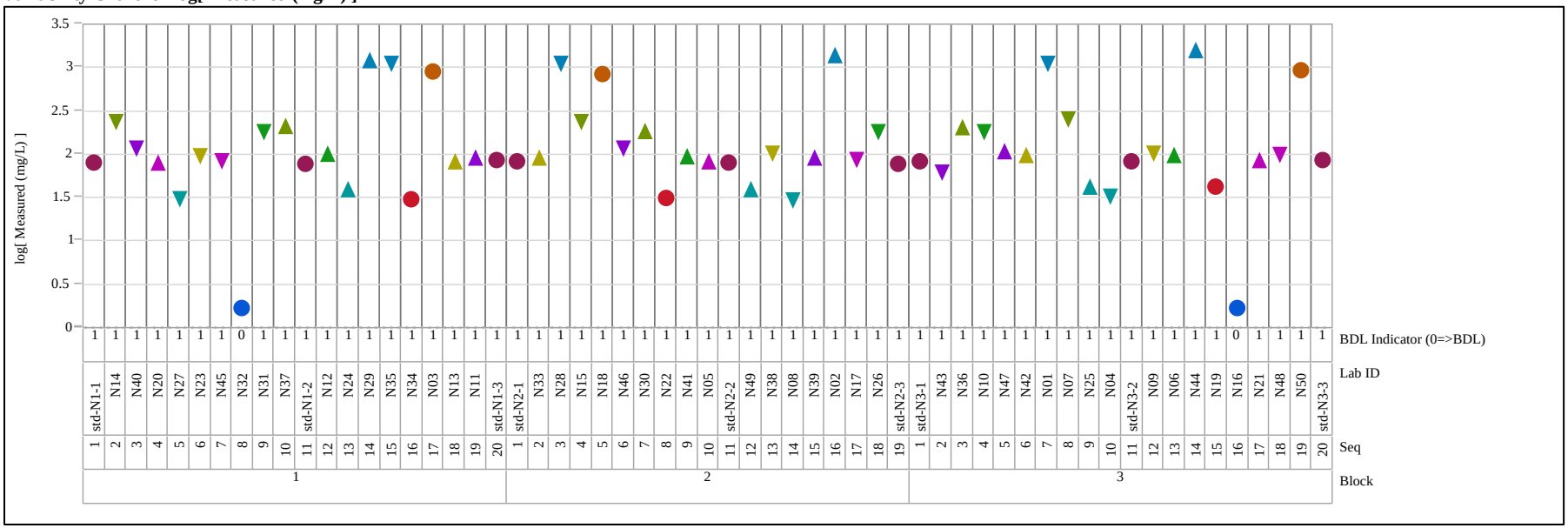


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

Group=N, Analyte=Si
Variability Chart for log[Measured (mg/L)]

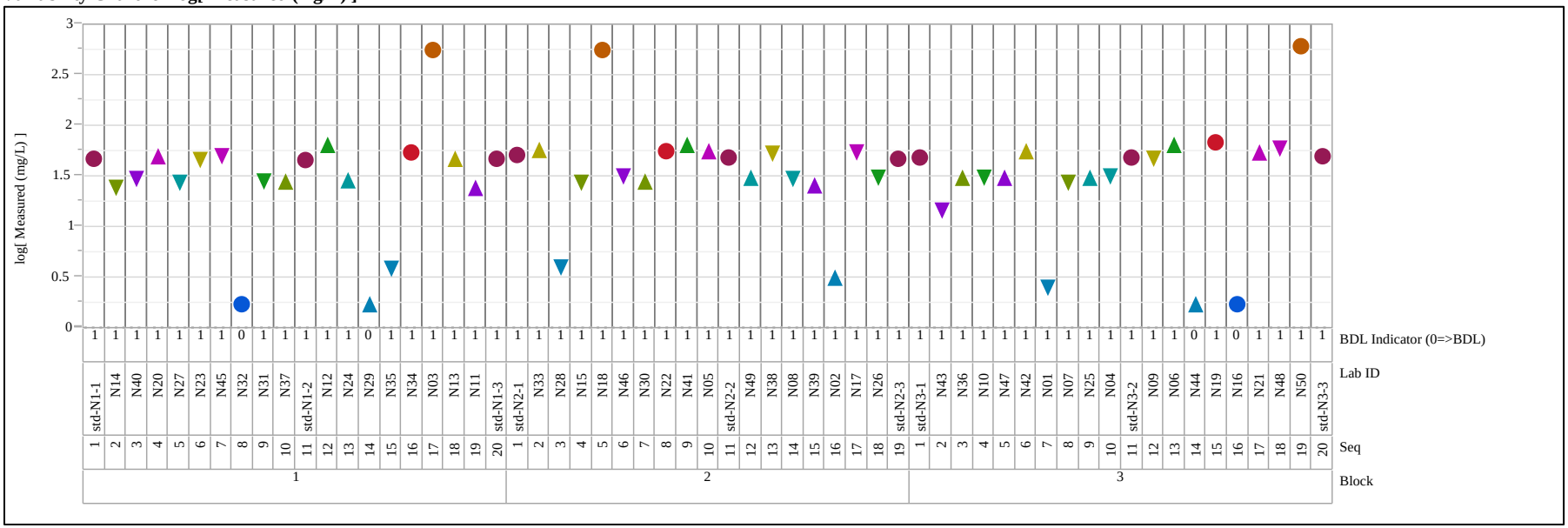


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

Group=S, Analyte=B
Variability Chart for log[Measured (mg/L)]

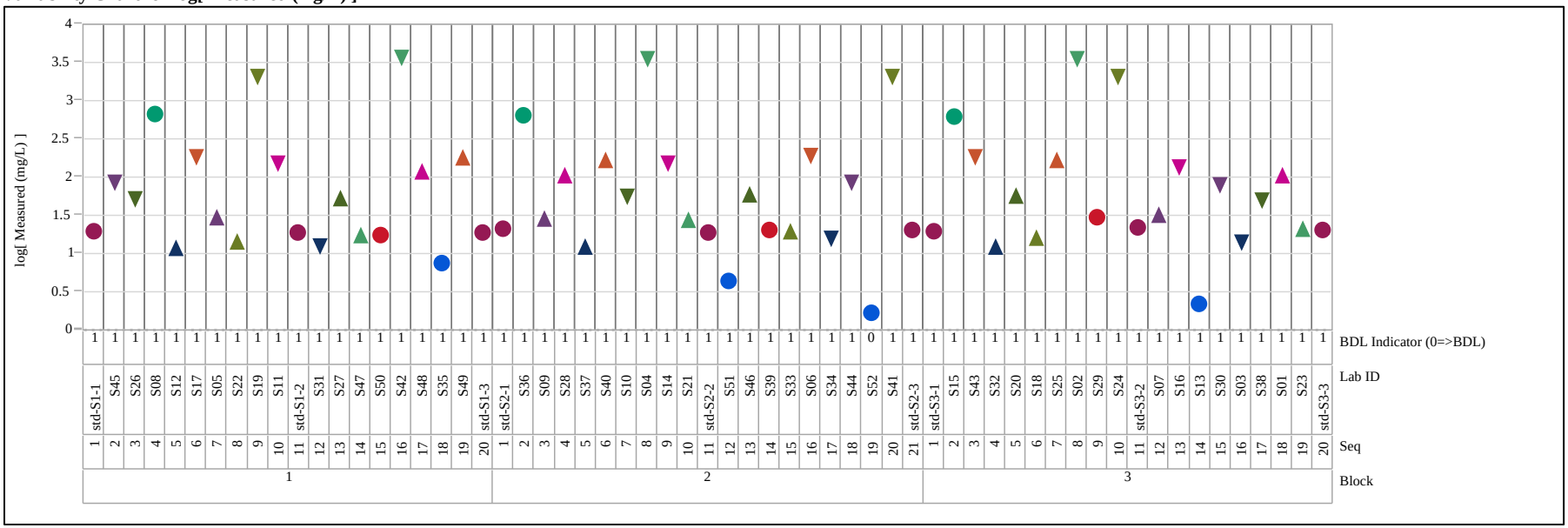


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

Group=S, Analyte=Li
Variability Chart for log[Measured (mg/L)]

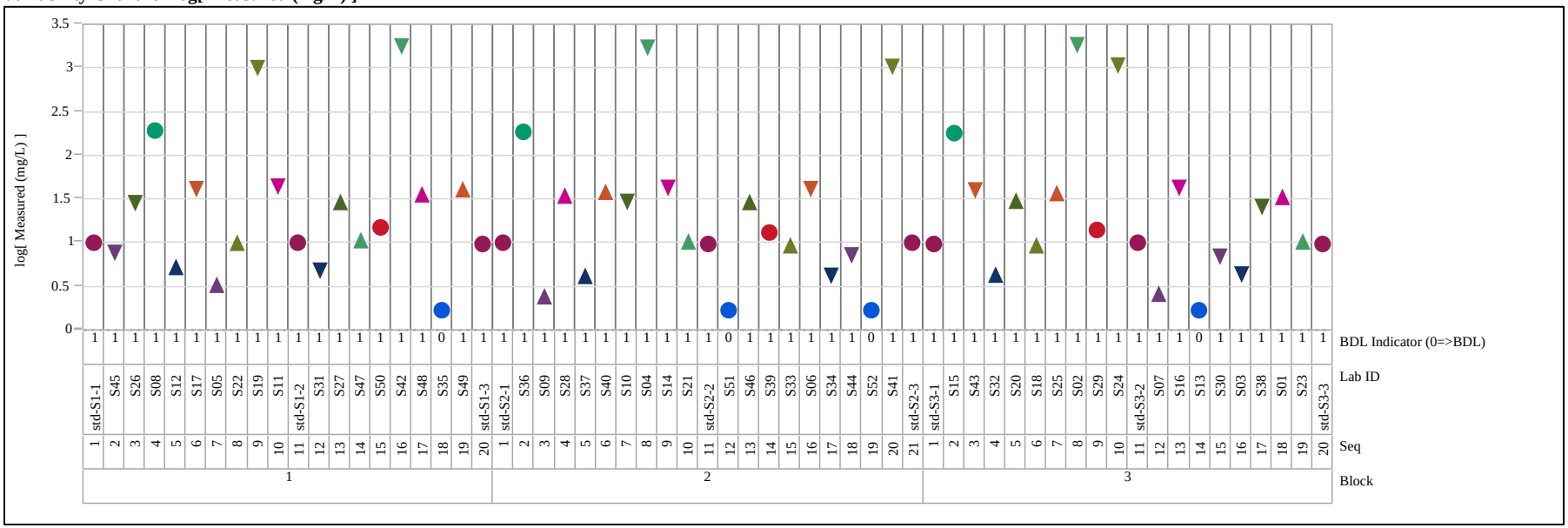


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

Group=S, Analyte=Na
Variability Chart for log[Measured (mg/L)]

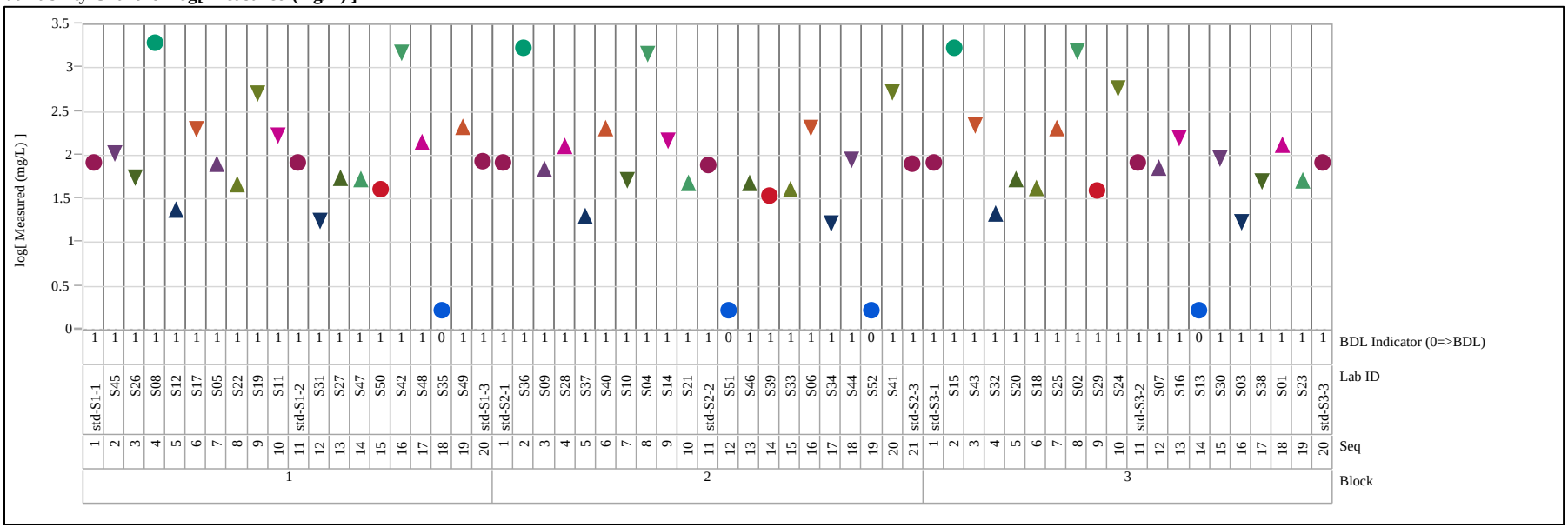


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

Group=S, Analyte=Si
Variability Chart for log[Measured (mg/L)]

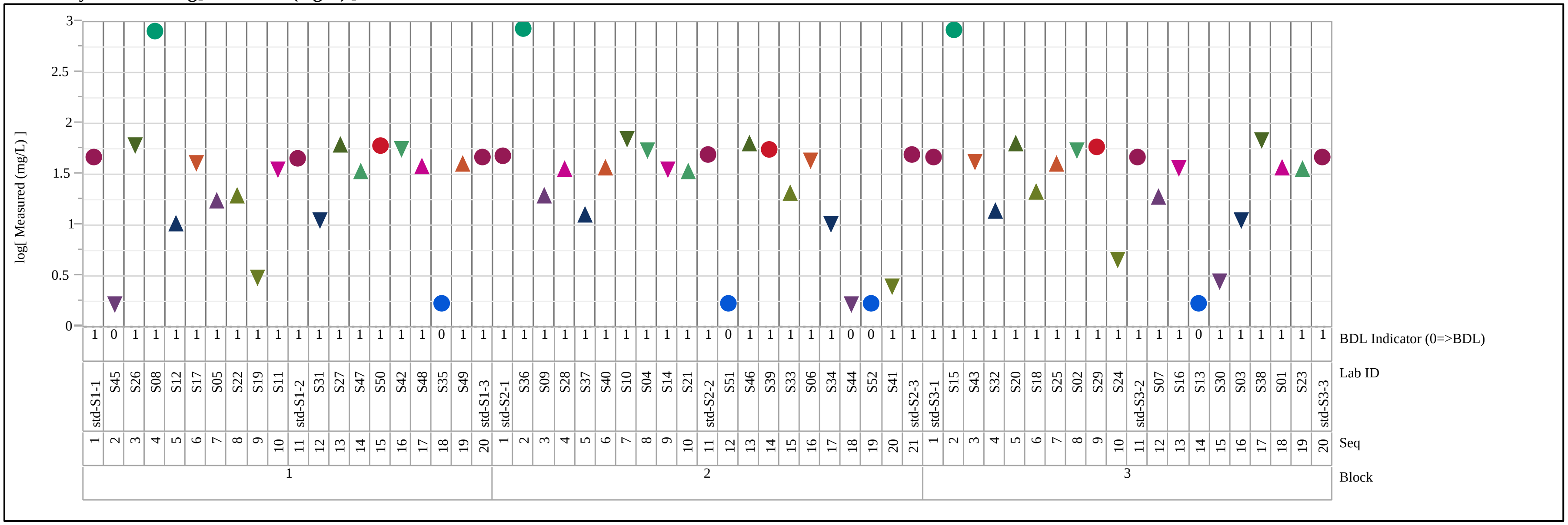


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

Group=Z, Analyte=B
Variability Chart for log[Measured (mg/L)]

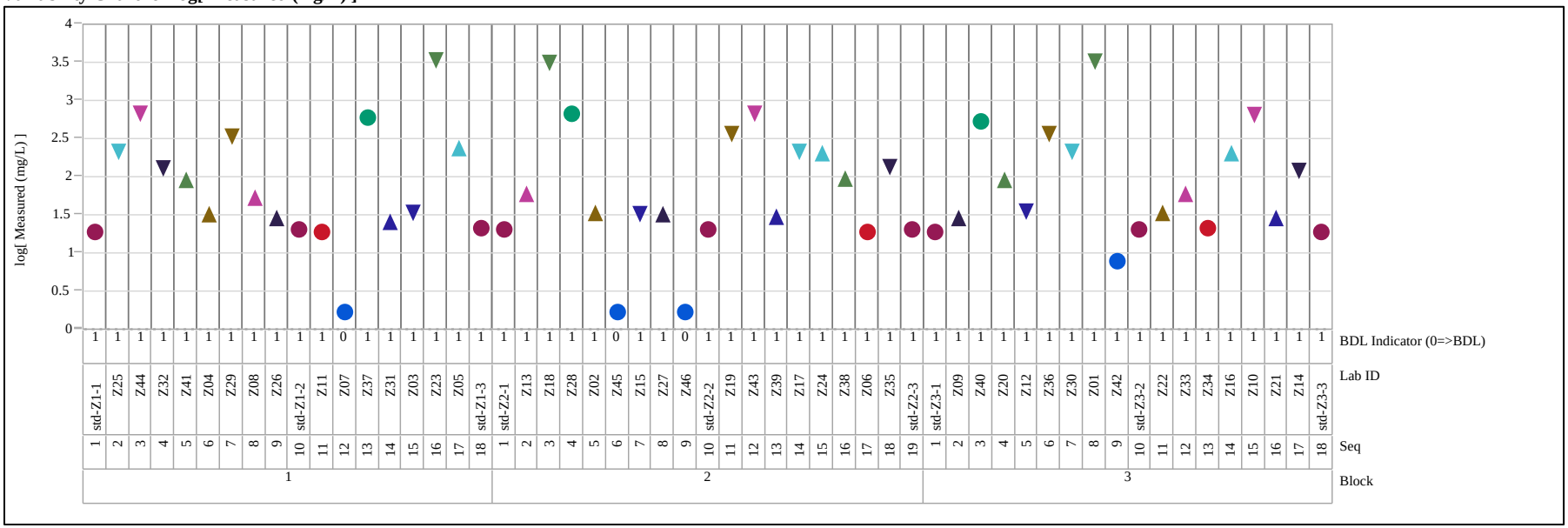


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

Group=Z, Analyte=Li
Variability Chart for log[Measured (mg/L)]

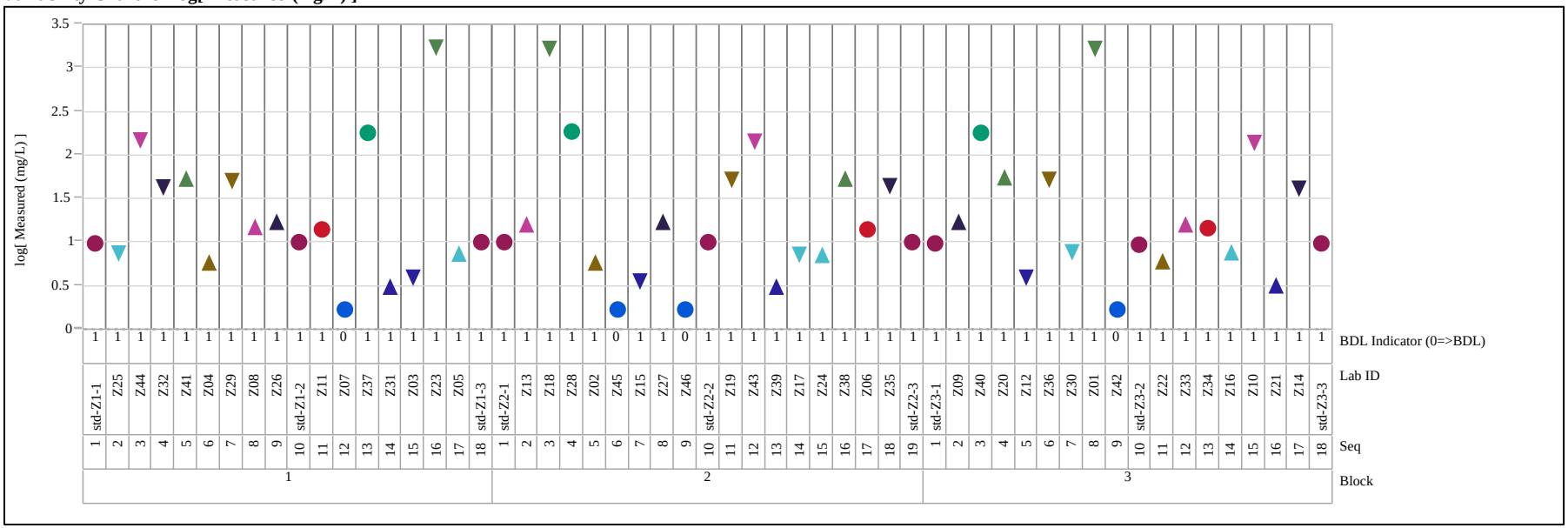


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

Group=Z, Analyte=Na
Variability Chart for log[Measured (mg/L)]

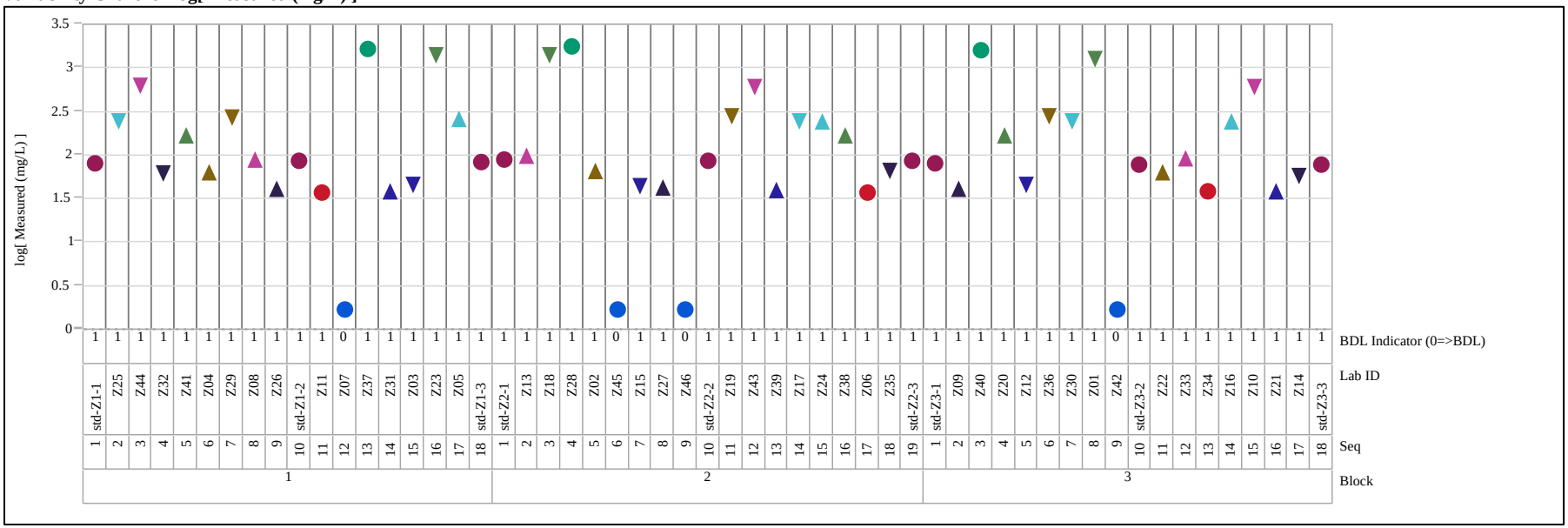


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

Group=Z, Analyte=Si
Variability Chart for log[Measured (mg/L)]

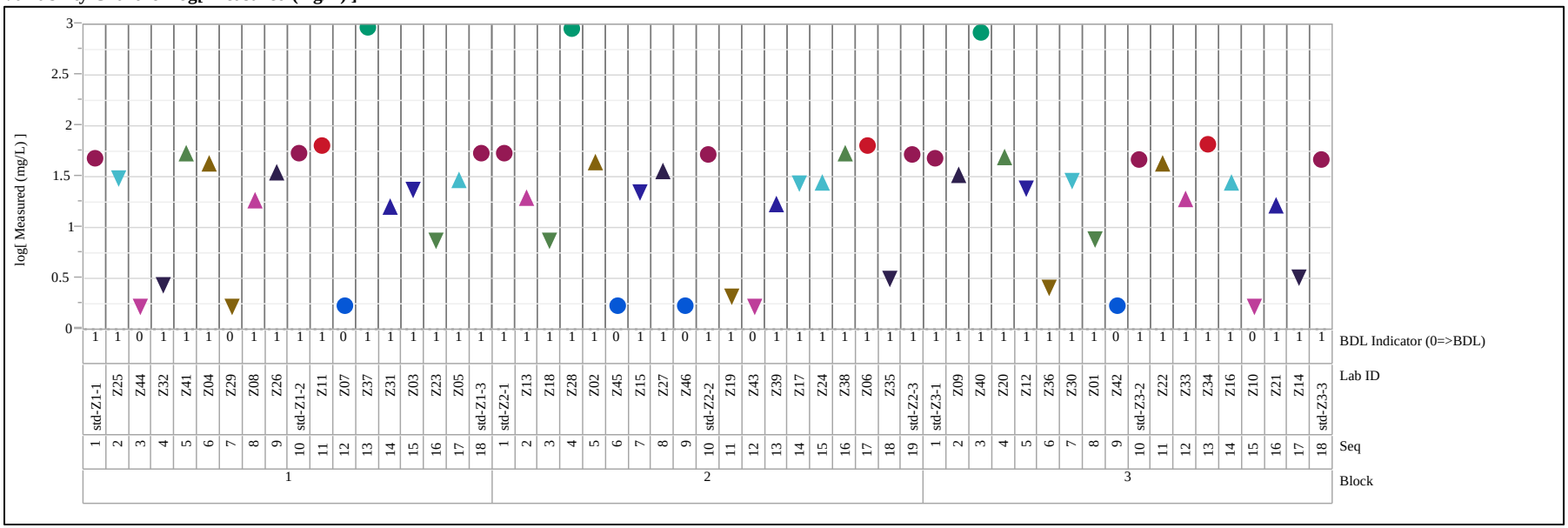


Exhibit B-2. PCT Measurements by Glass ID and Heat Treatment for Each Set

Group=E, Analyte=B
Variability Chart for log[Measured (mg/L)]

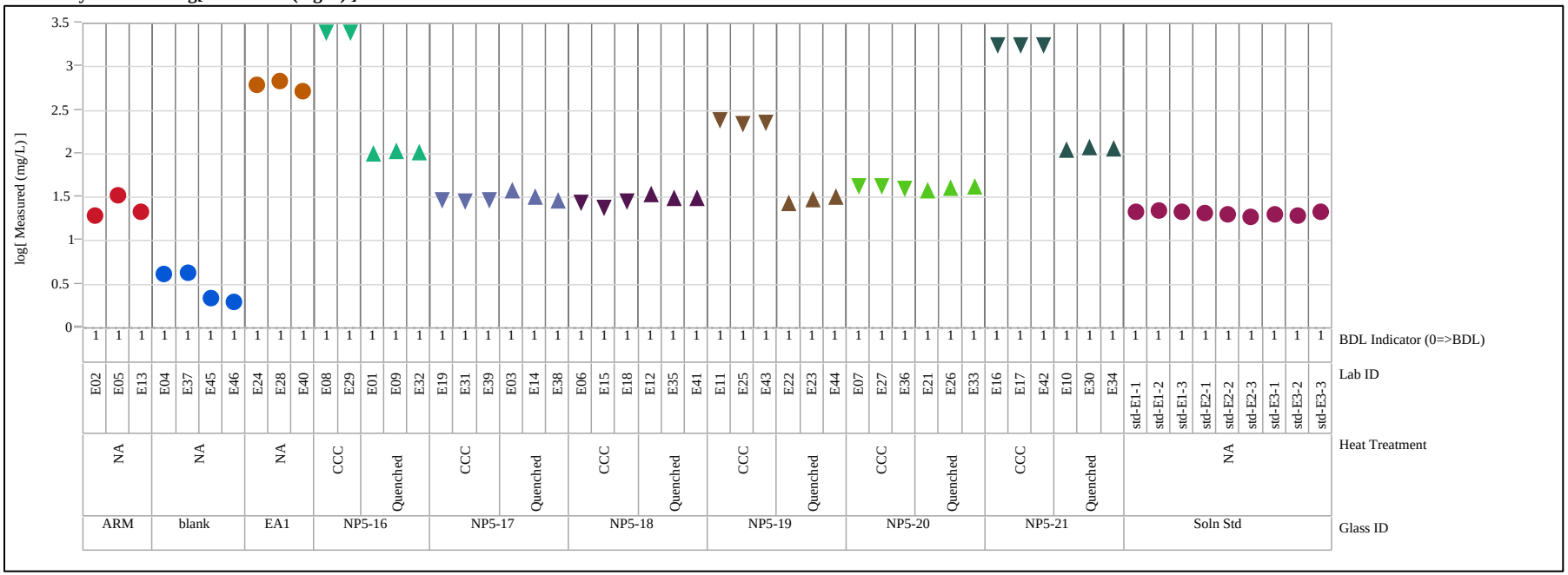


Exhibit B-2. PCT Measurements by Glass ID and Heat Treatment for Each Set (continued)

Group=E, Analyte=Li
Variability Chart for log[Measured (mg/L)]

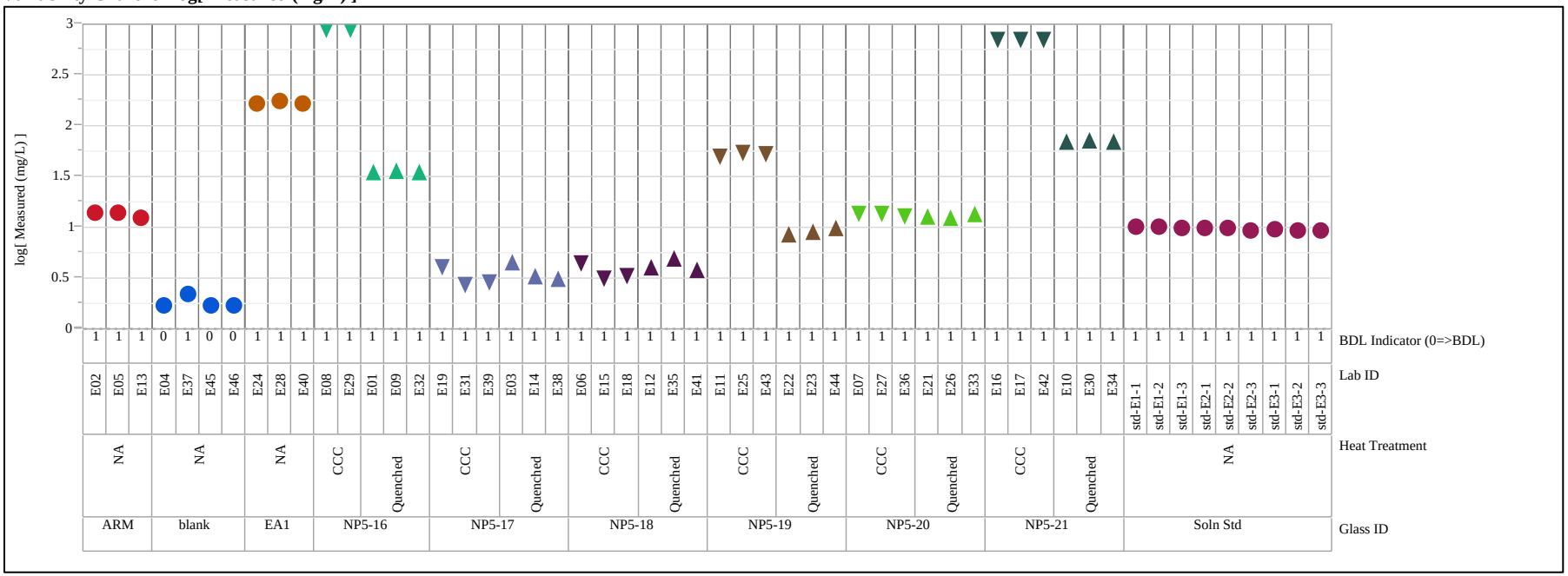


Exhibit B-2. PCT Measurements by Glass ID and Heat Treatment for Each Set (continued)

Group=E, Analyte=Na
Variability Chart for log[Measured (mg/L)]

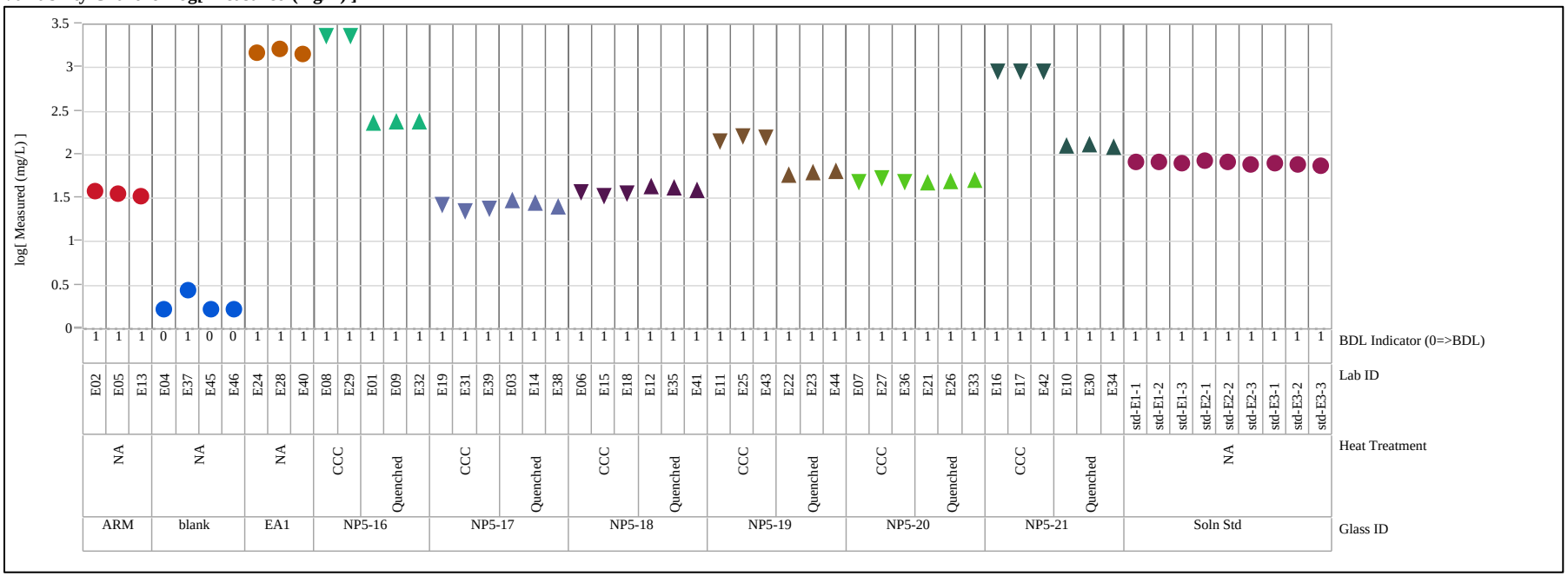


Exhibit B-2. PCT Measurements by Glass ID and Heat Treatment for Each Set (continued)

Group=E, Analyte=Si
Variability Chart for log[Measured (mg/L)]

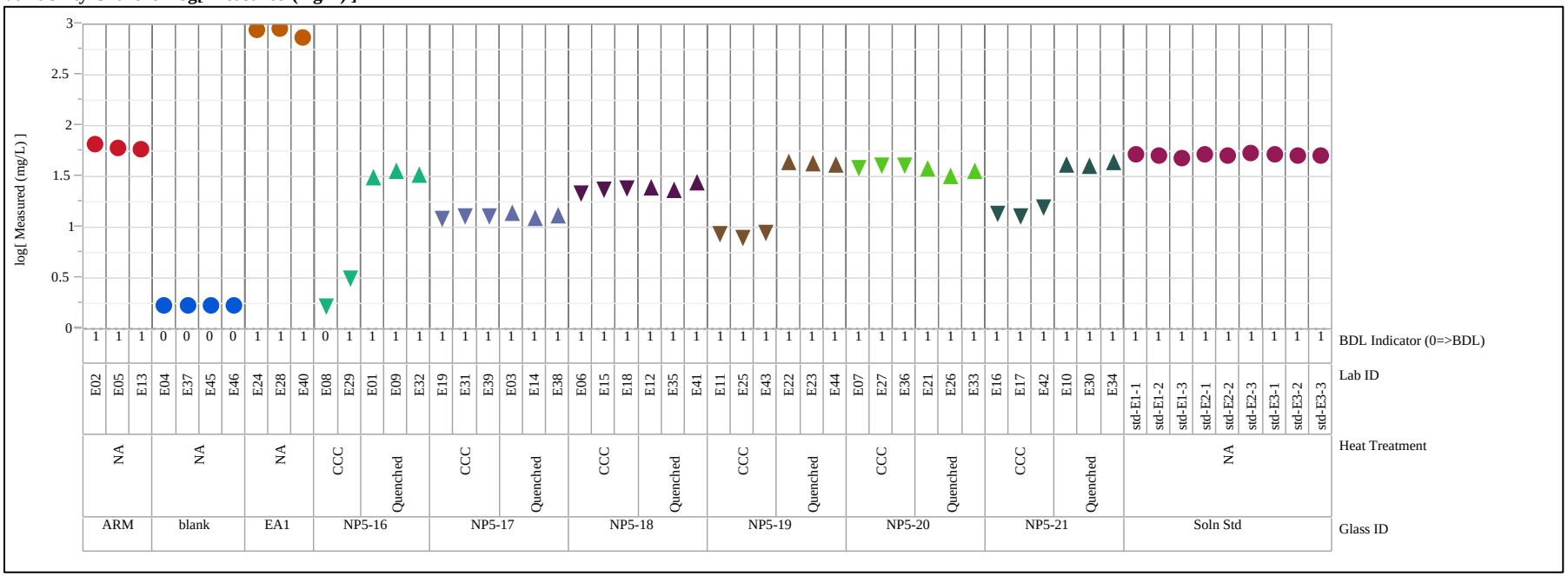


Exhibit B-2. PCT Measurements by Glass ID and Heat Treatment for Each Set (continued)

Group=N, Analyte=B
Variability Chart for log[Measured (mg/L)]

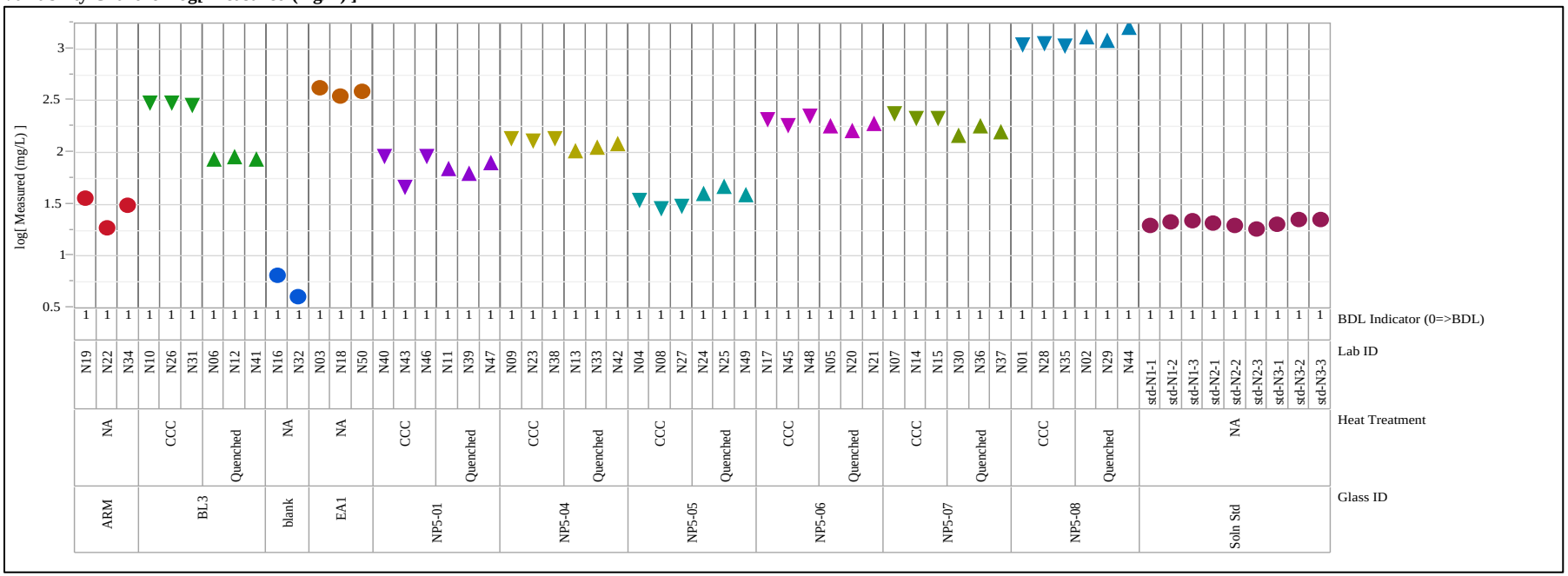


Exhibit B-2. PCT Measurements by Glass ID and Heat Treatment for Each Set (continued)

Group=N, Analyte=Li
Variability Chart for log[Measured (mg/L)]

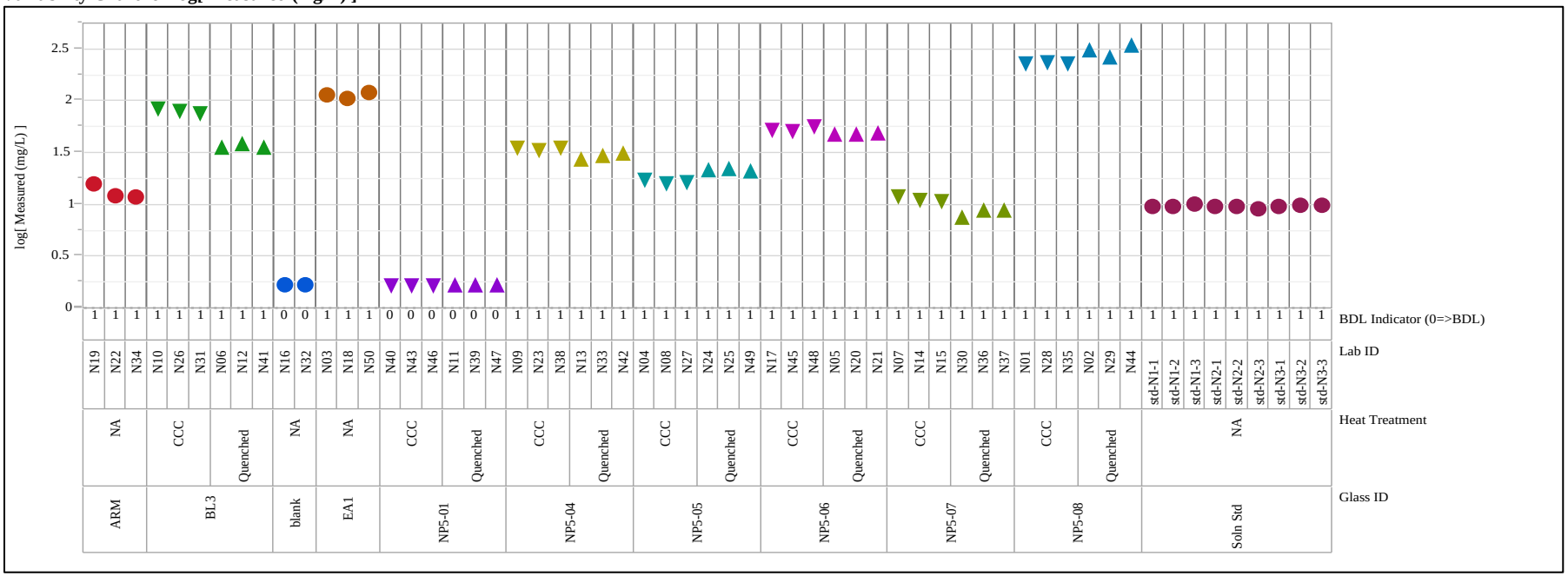


Exhibit B-2. PCT Measurements by Glass ID and Heat Treatment for Each Set (continued)

Group=N, Analyte=Na
Variability Chart for log[Measured (mg/L)]

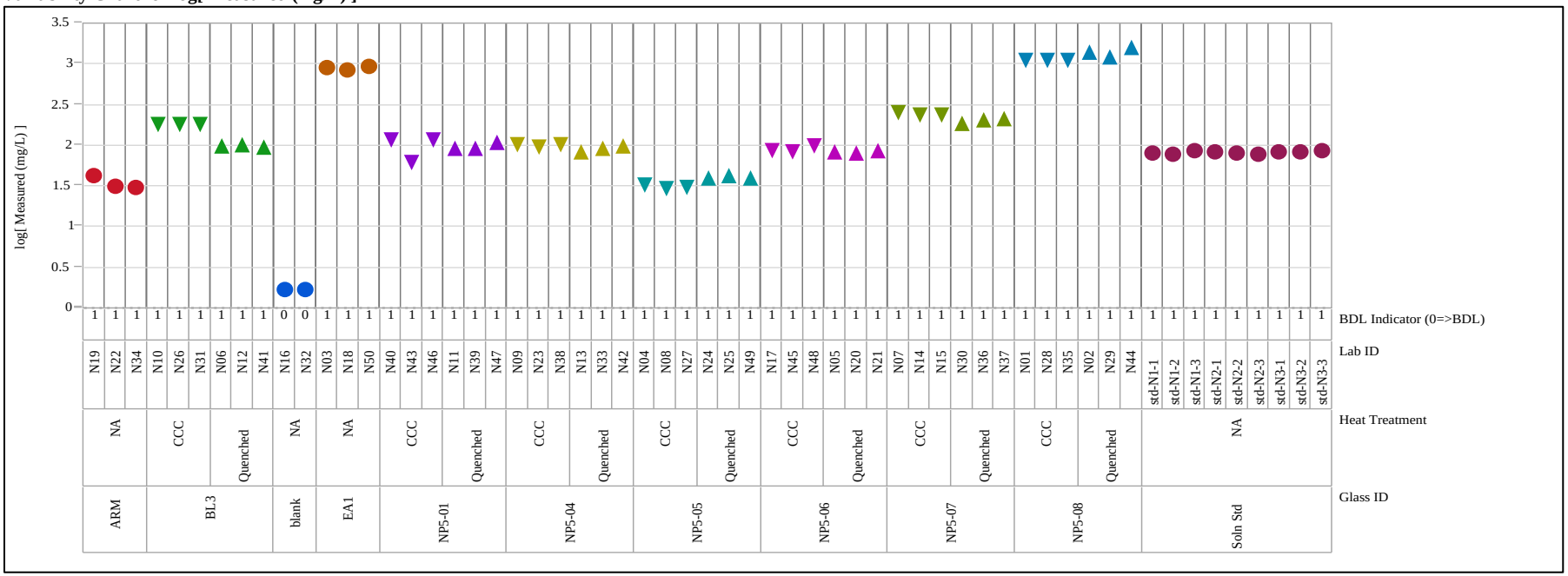


Exhibit B-2. PCT Measurements by Glass ID and Heat Treatment for Each Set (continued)

Group=N, Analyte=Si
Variability Chart for log[Measured (mg/L)]

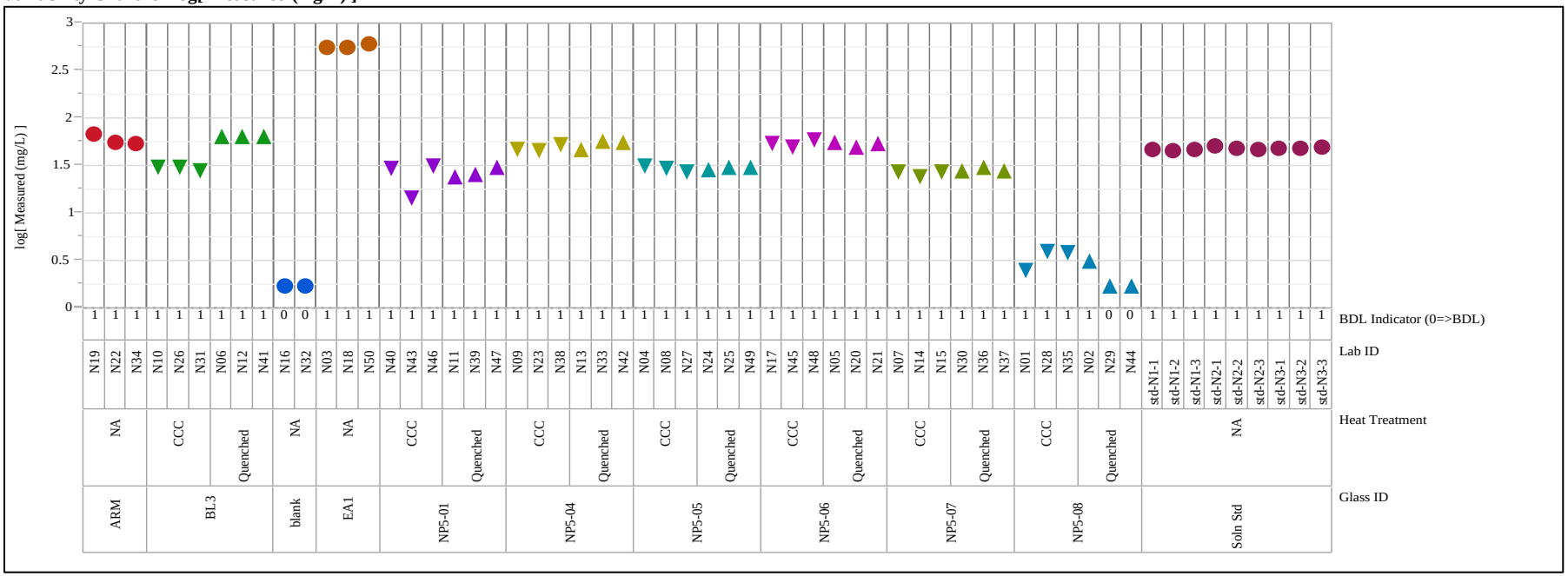


Exhibit B-2. PCT Measurements by Glass ID and Heat Treatment for Each Set (continued)

Group=S, Analyte=B
Variability Chart for log[Measured (mg/L)]

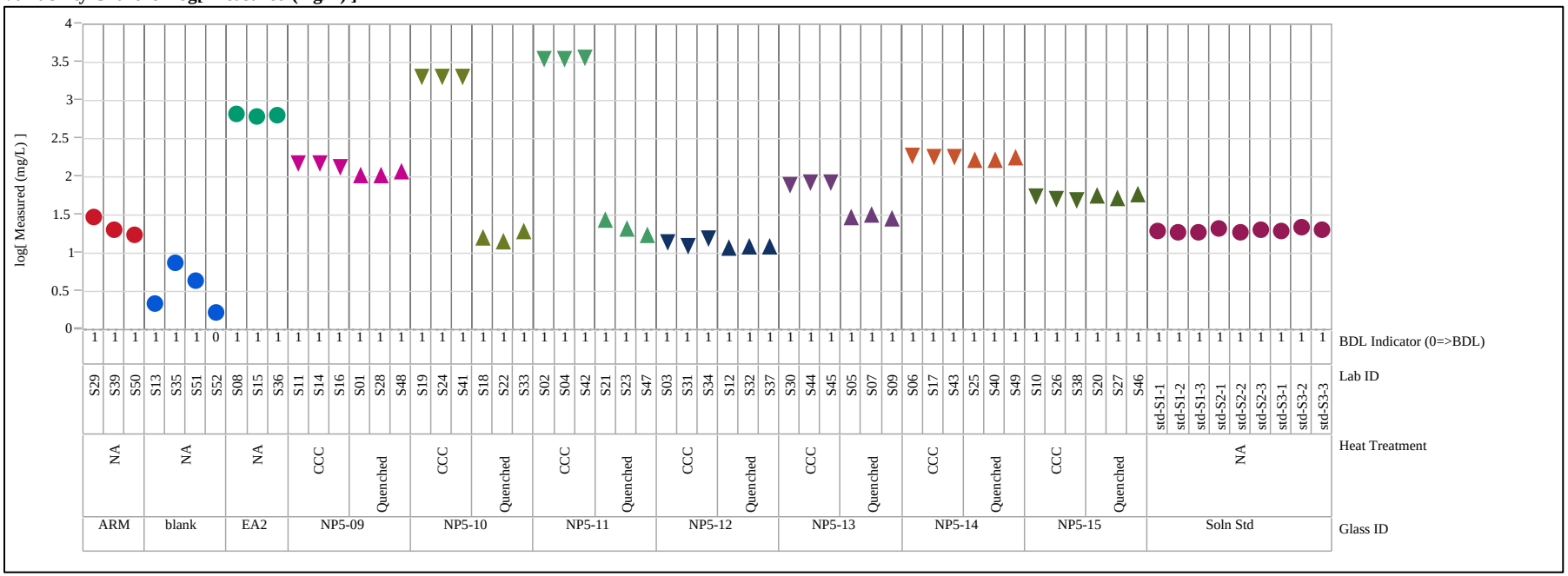


Exhibit B-2. PCT Measurements by Glass ID and Heat Treatment for Each Set (continued)

Group=S, Analyte=Li
Variability Chart for log[Measured (mg/L)]

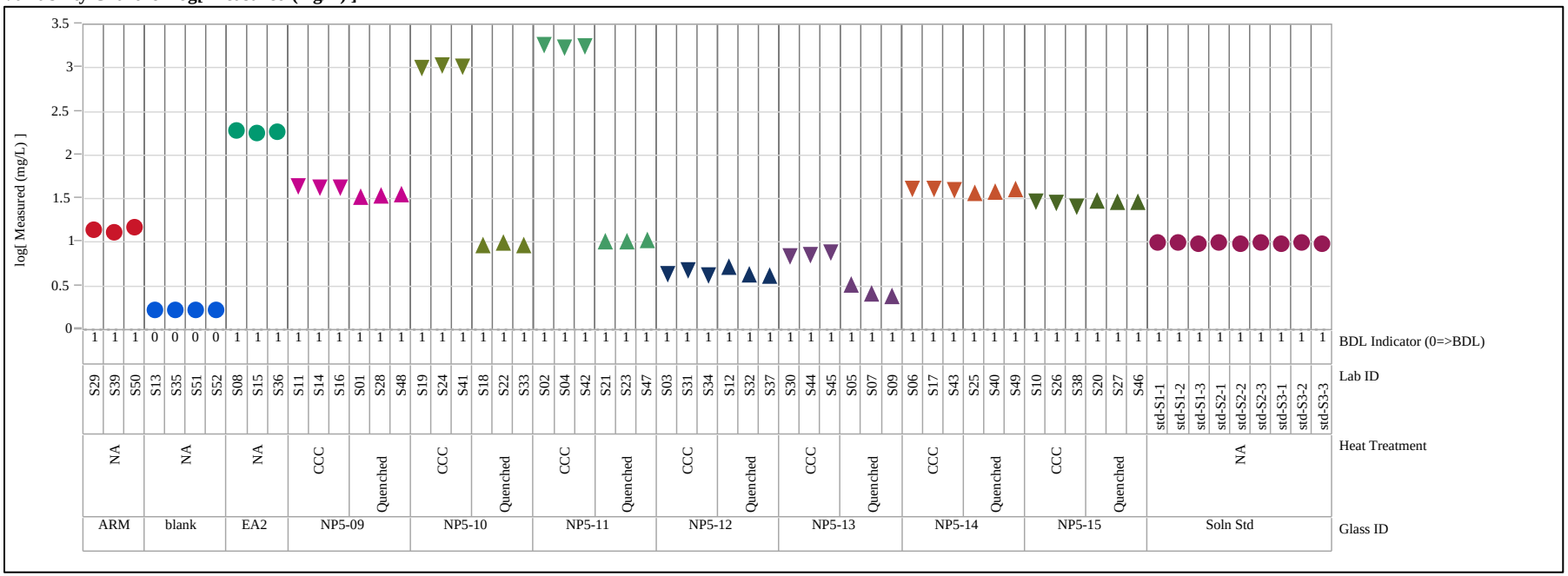


Exhibit B-2. PCT Measurements by Glass ID and Heat Treatment for Each Set (continued)

Group=S, Analyte=Na
Variability Chart for log[Measured (mg/L)]

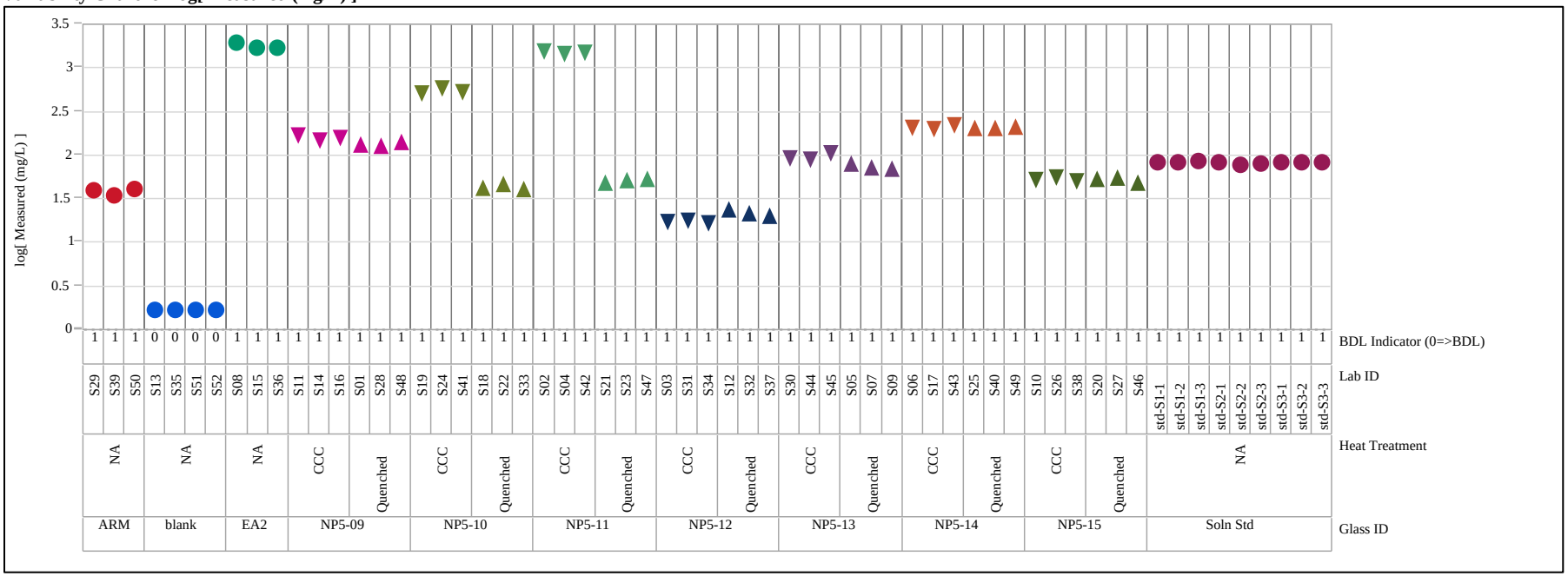


Exhibit B-2. PCT Measurements by Glass ID and Heat Treatment for Each Set (continued)

Group=S, Analyte=Si
Variability Chart for log[Measured (mg/L)]

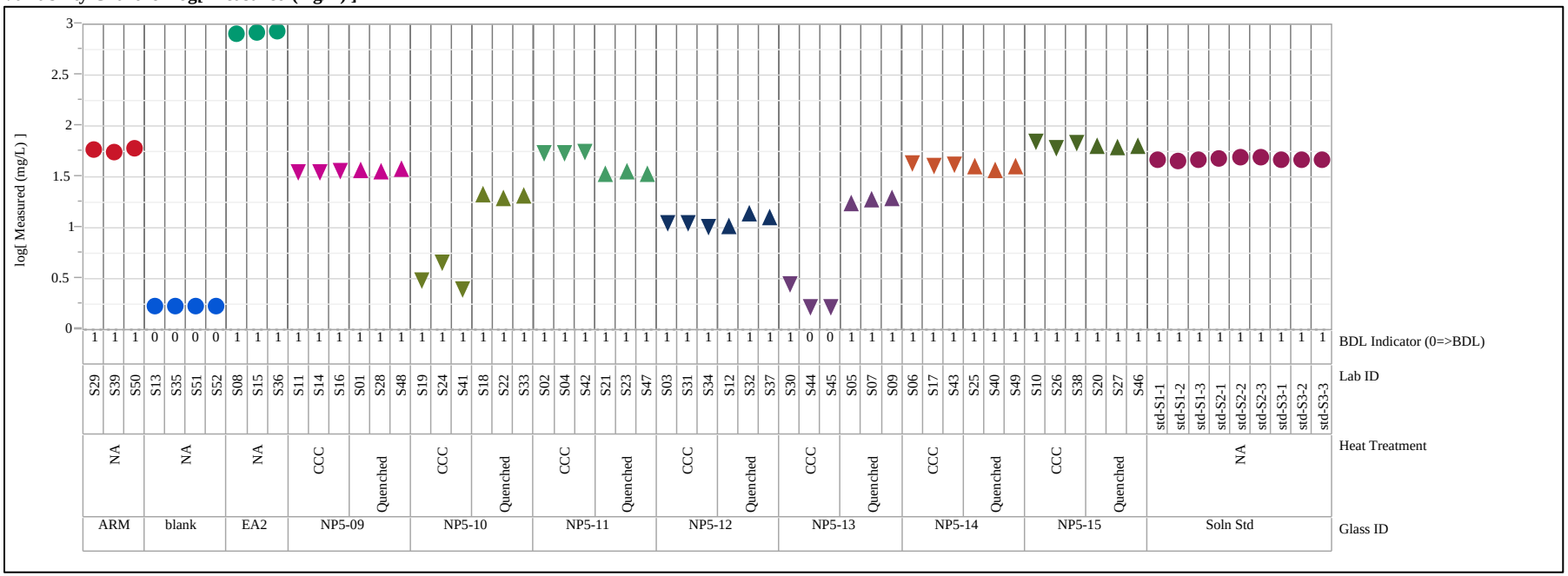


Exhibit B-2. PCT Measurements by Glass ID and Heat Treatment for Each Set (continued)

Group=Z, Analyte=B
Variability Chart for log[Measured (mg/L)]

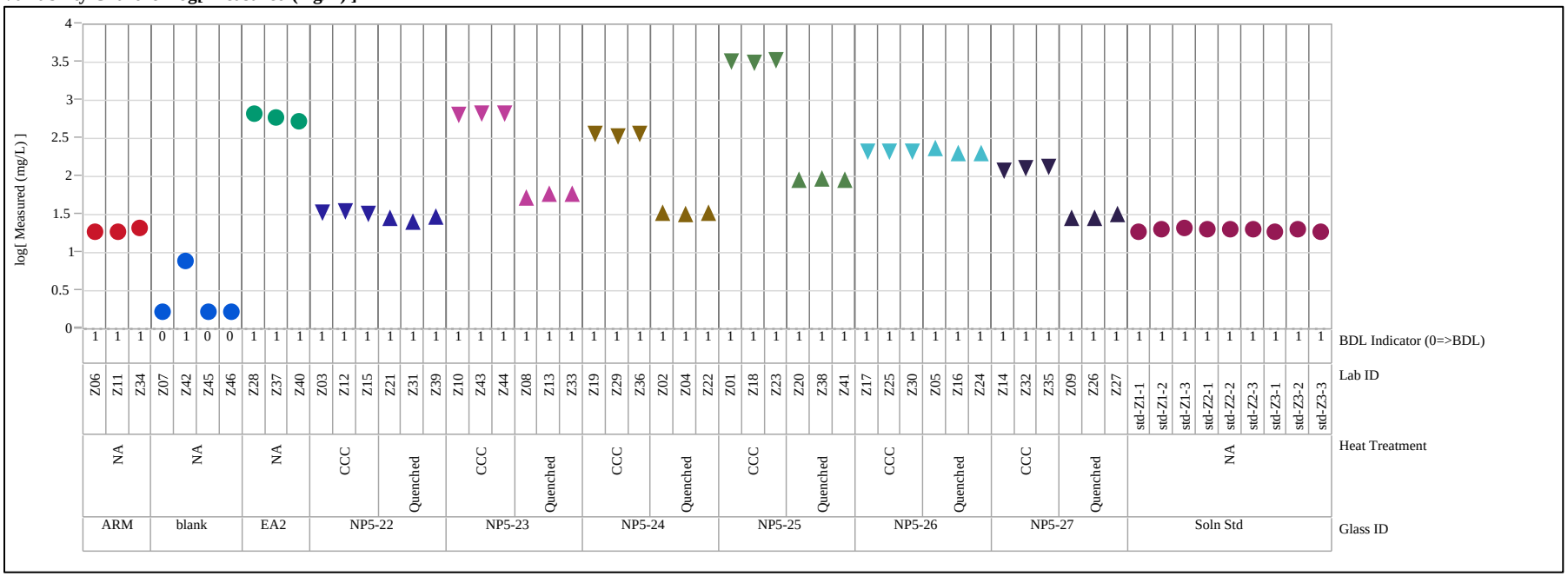


Exhibit B-2. PCT Measurements by Glass ID and Heat Treatment for Each Set (continued)

Group=Z, Analyte=Li
Variability Chart for log[Measured (mg/L)]

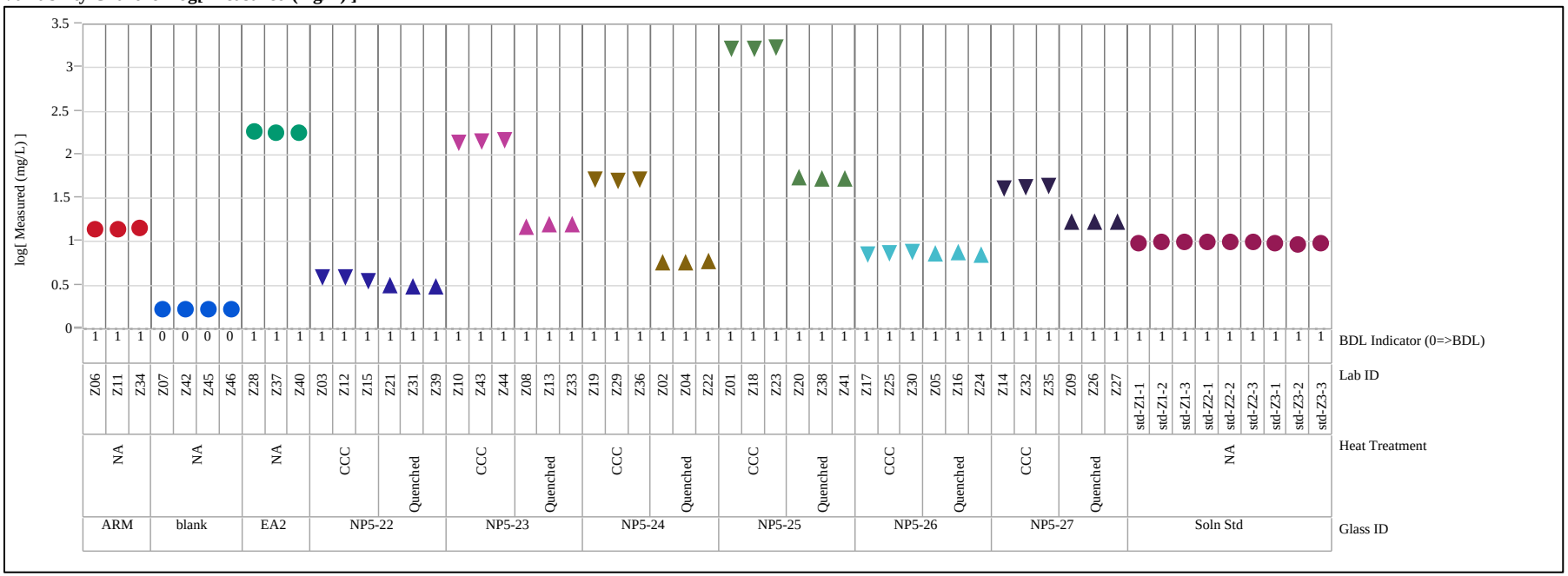


Exhibit B-2. PCT Measurements by Glass ID and Heat Treatment for Each Set (continued)

Group=Z, Analyte=Na
Variability Chart for log[Measured (mg/L)]

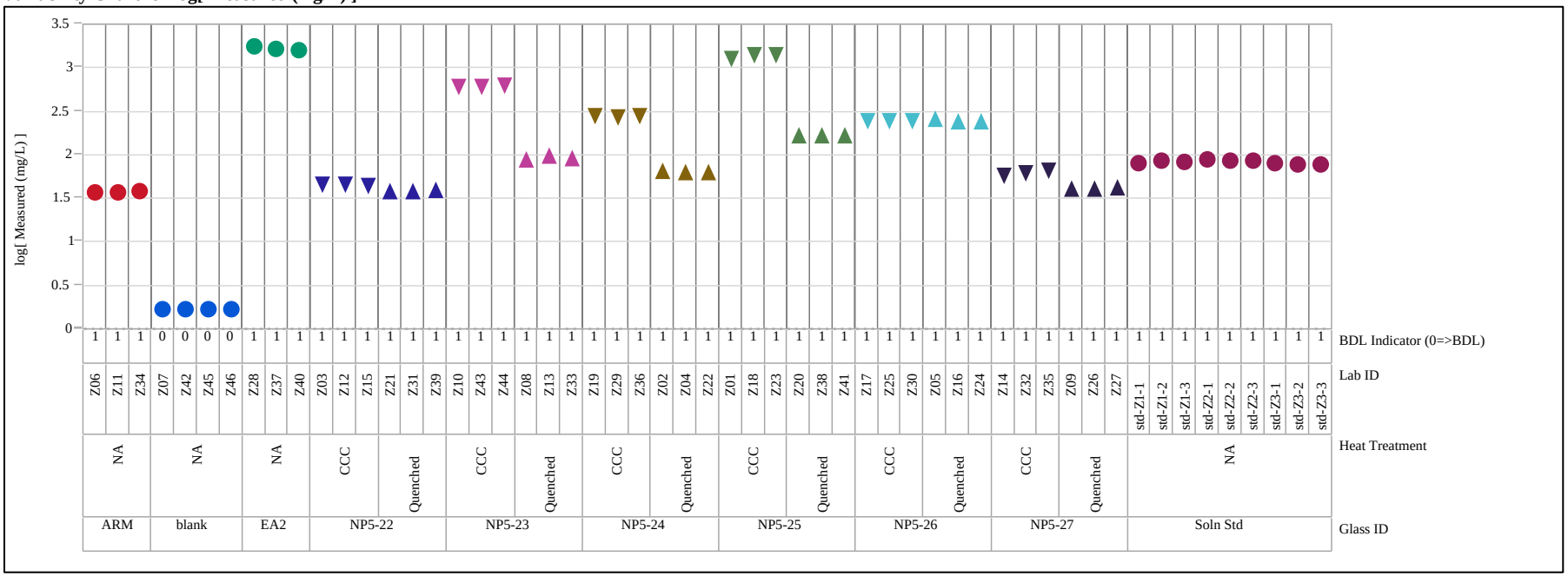


Exhibit B-2. PCT Measurements by Glass ID and Heat Treatment for Each Set (continued)

Group=Z, Analyte=Si
Variability Chart for log[Measured (mg/L)]

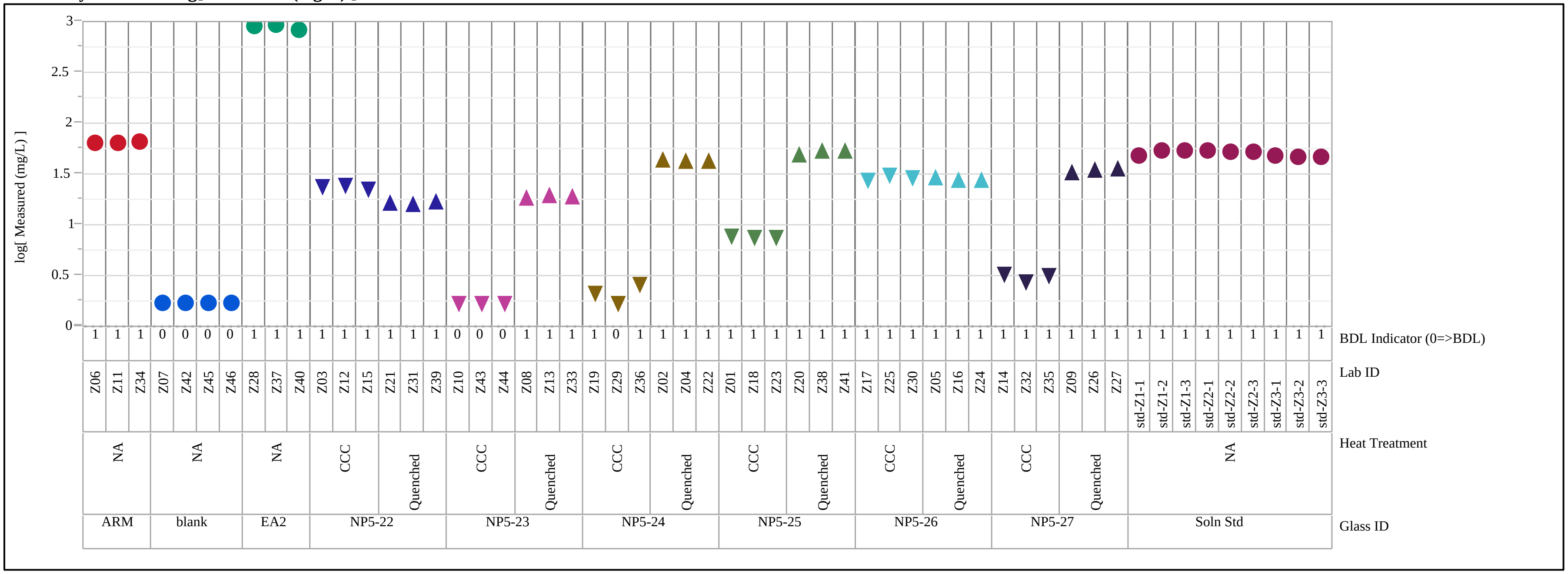


Exhibit B-3. Normalized PCT Results by Heat Treatment by Compositional View for Each Glass

Comp View=measured
Variability Chart for log NC_B (g/L)

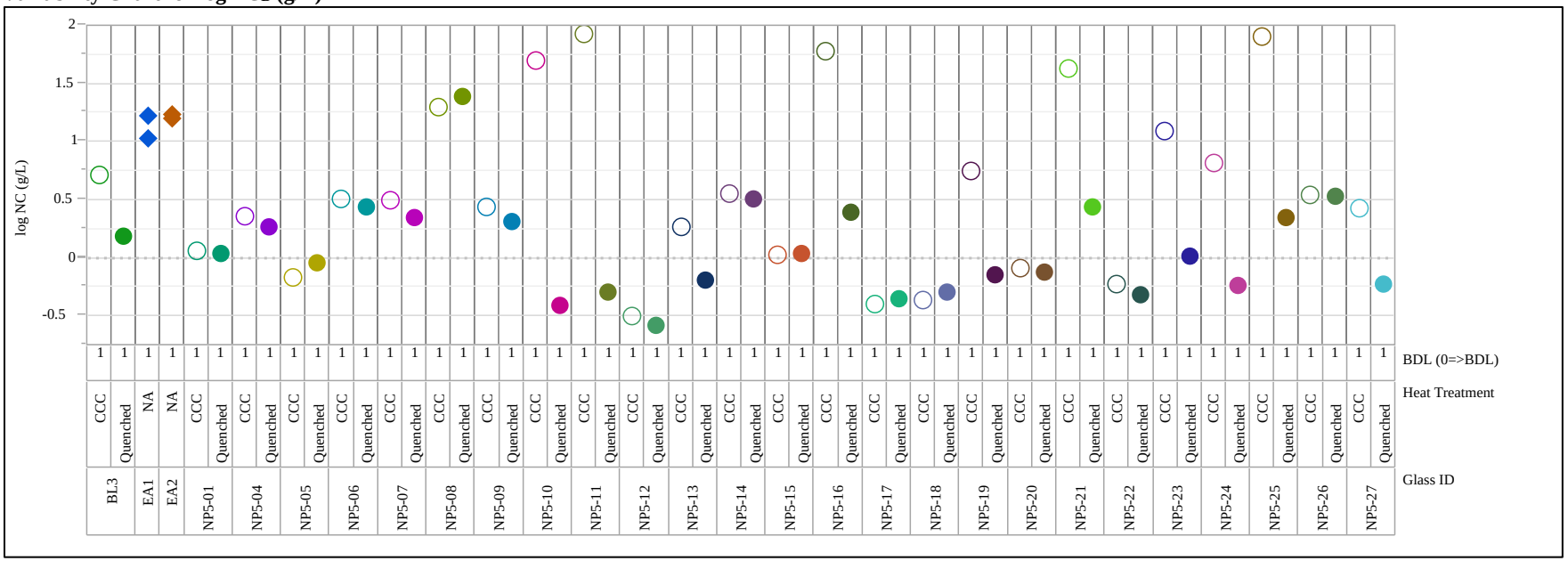


Exhibit B-3. Normalized PCT Results by Heat Treatment by Compositional View for Each Glass (continued)

Comp View=reference
Variability Chart for log NC_B (g/L)

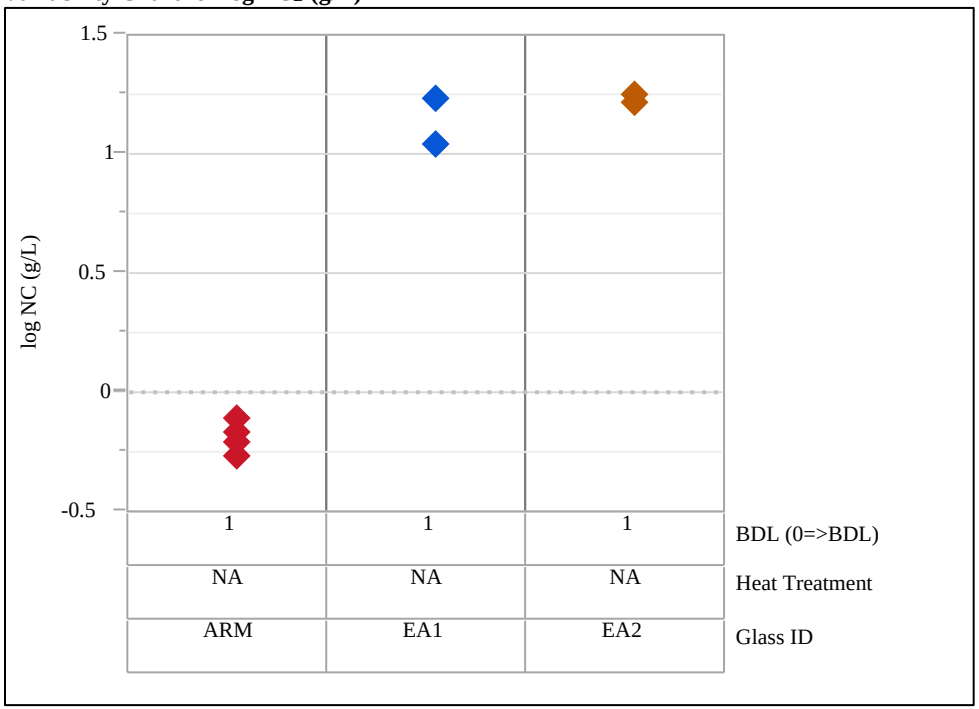


Exhibit B-3. Normalized PCT Results by Heat Treatment by Compositional View for Each Glass (continued)

Comp View=targeted
Variability Chart for log NC_B (g/L)

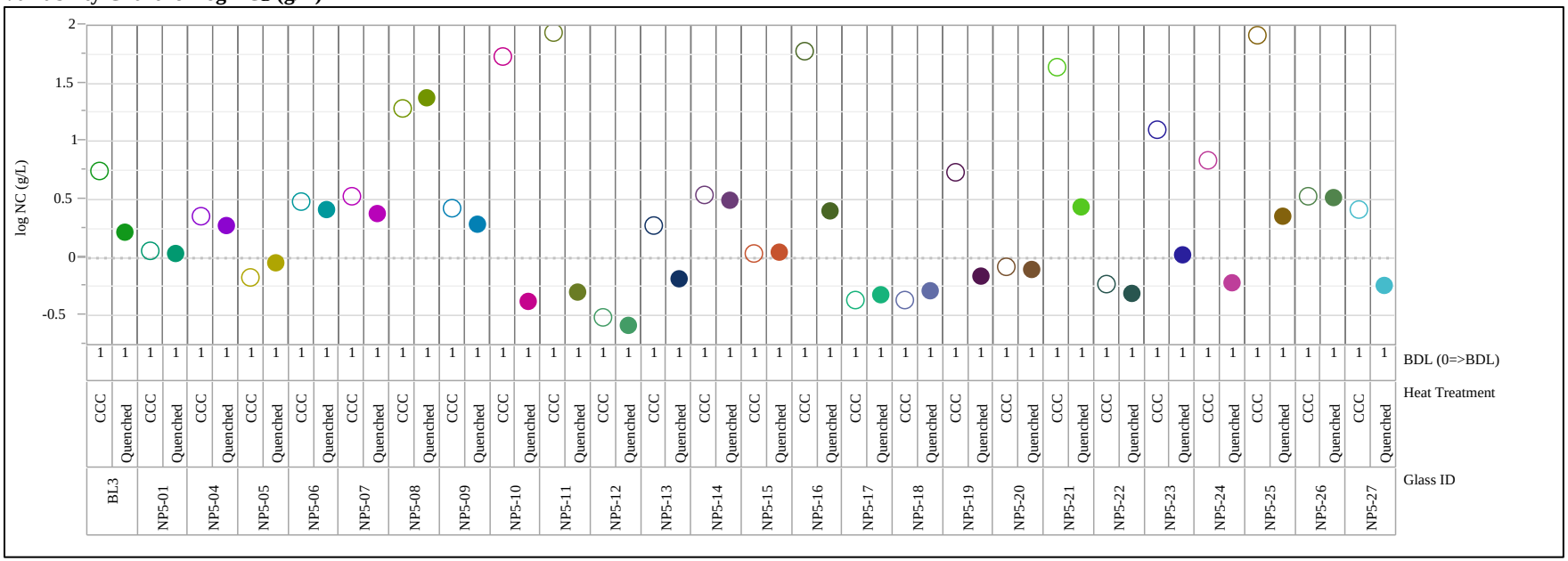


Exhibit B-3. Normalized PCT Results by Heat Treatment by Compositional View for Each Glass (continued)

Comp View=measured
Variability Chart for log NC_{Li} (g/L)

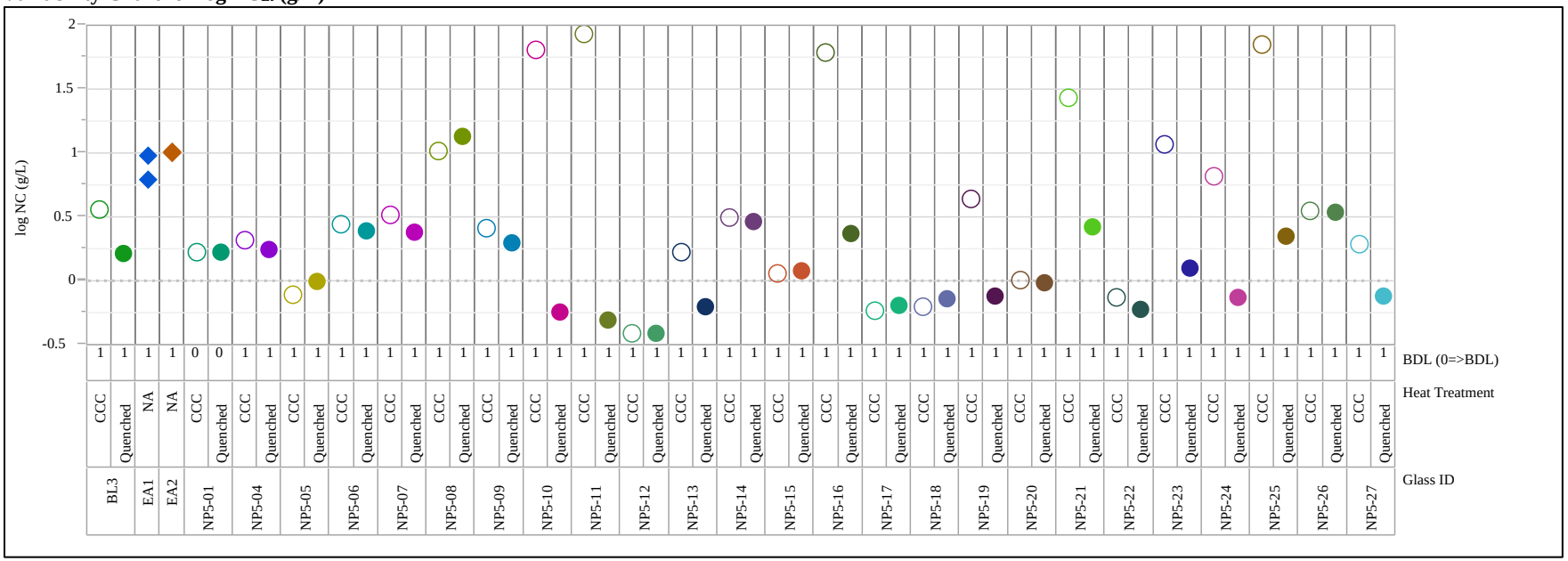


Exhibit B-3. Normalized PCT Results by Heat Treatment by Compositional View for Each Glass (continued)

Analyte=Li, Comp View=reference
Variability Chart for log NC_{Li} (g/L)

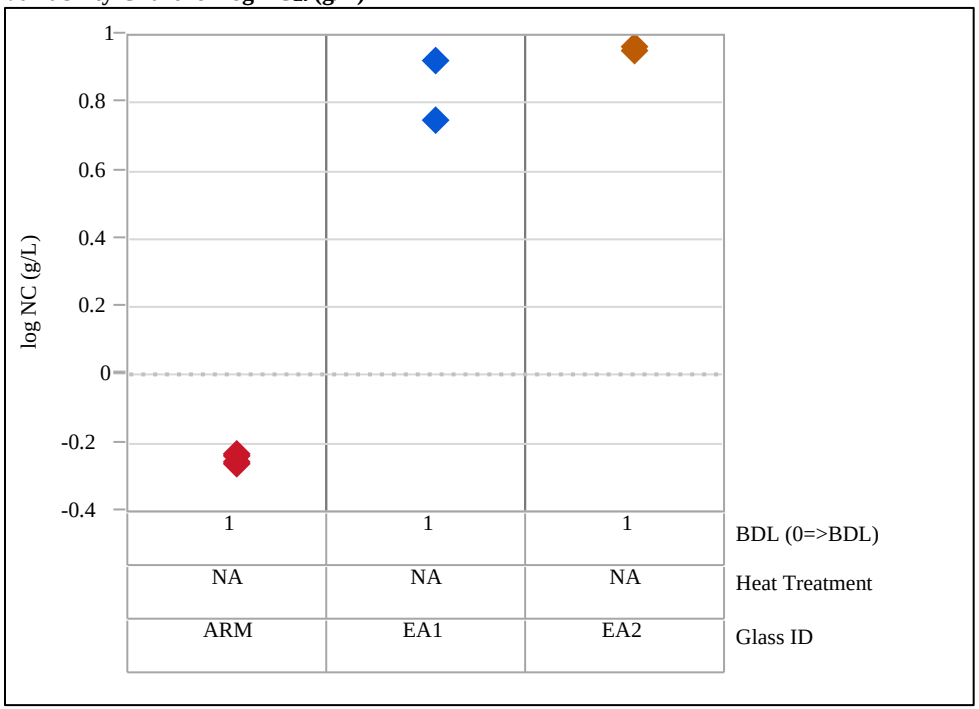


Exhibit B-3. Normalized PCT Results by Heat Treatment by Compositional View for Each Glass (continued)

Comp View=targeted
Variability Chart for log NC_{Li} (g/L)

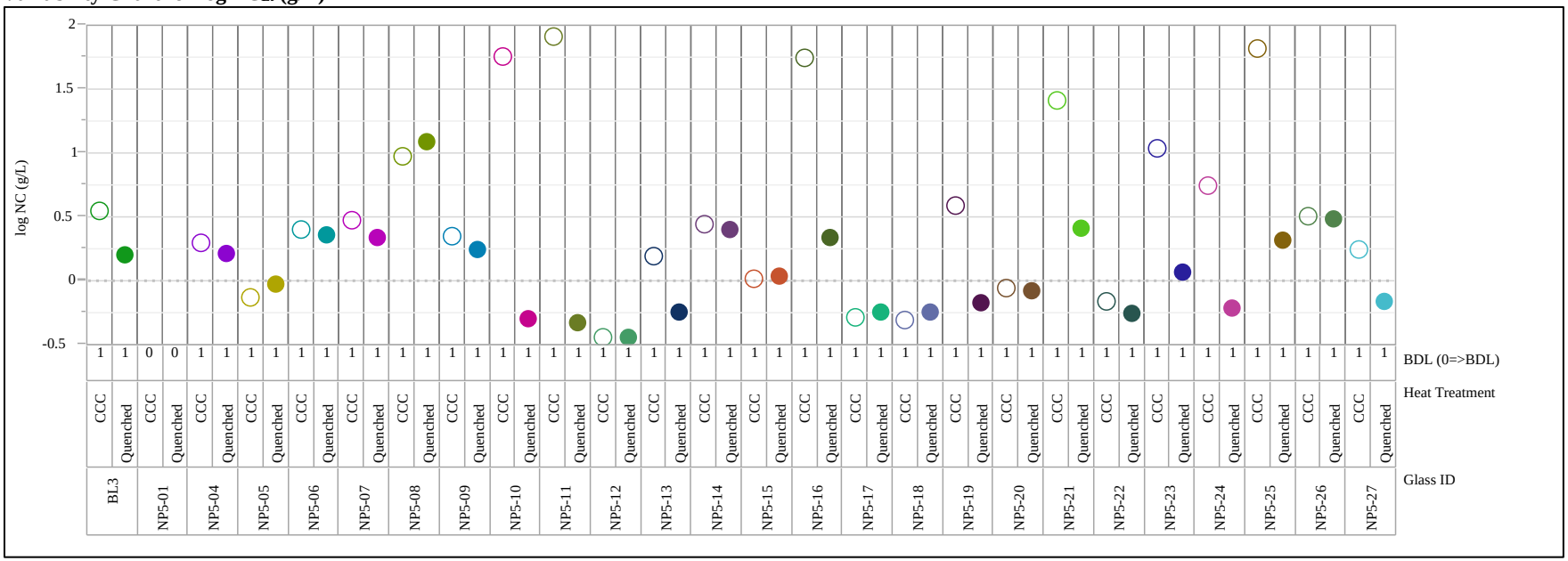


Exhibit B-3. Normalized PCT Results by Heat Treatment by Compositional View for Each Glass (continued)

Comp View=measured
Variability Chart for log NC_{Na} (g/L)

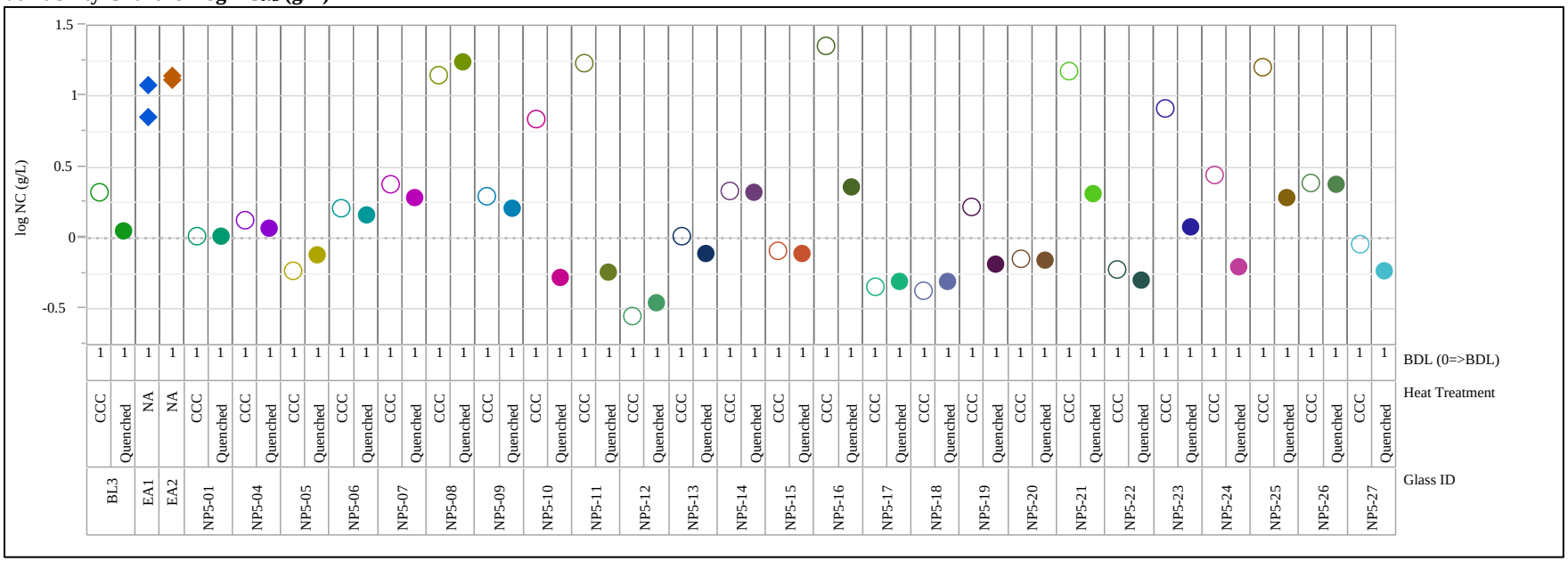


Exhibit B-3. Normalized PCT Results by Heat Treatment by Compositional View for Each Glass (continued)

Comp View=reference
Variability Chart for log NC_{Na} (g/L)

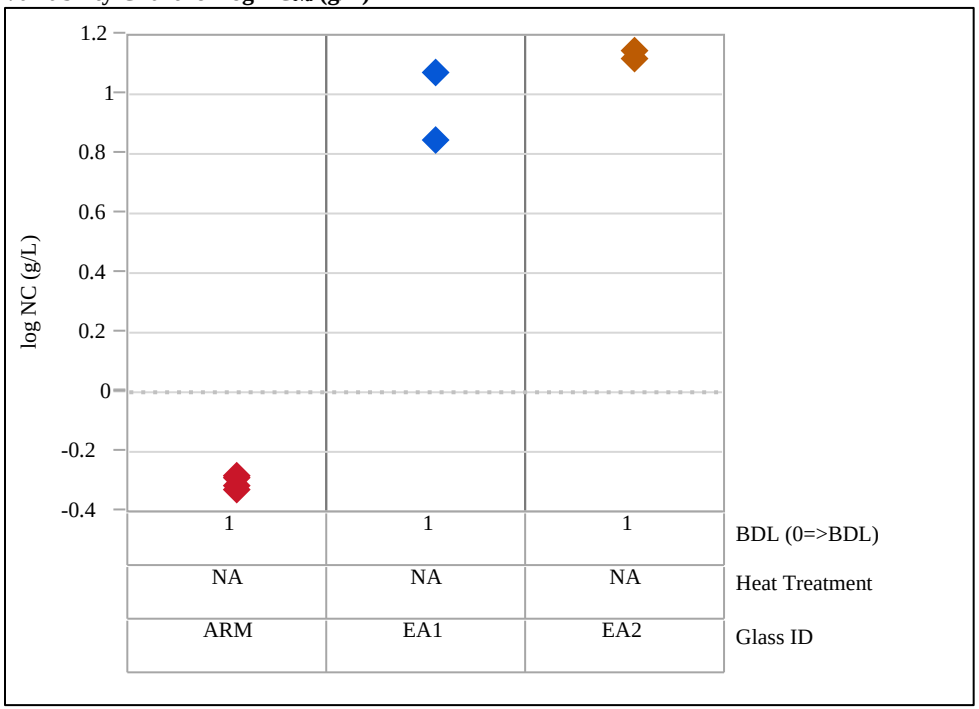


Exhibit B-3. Normalized PCT Results by Heat Treatment by Compositional View for Each Glass (continued)

Comp View=targeted
Variability Chart for log NC_{Na} (g/L)

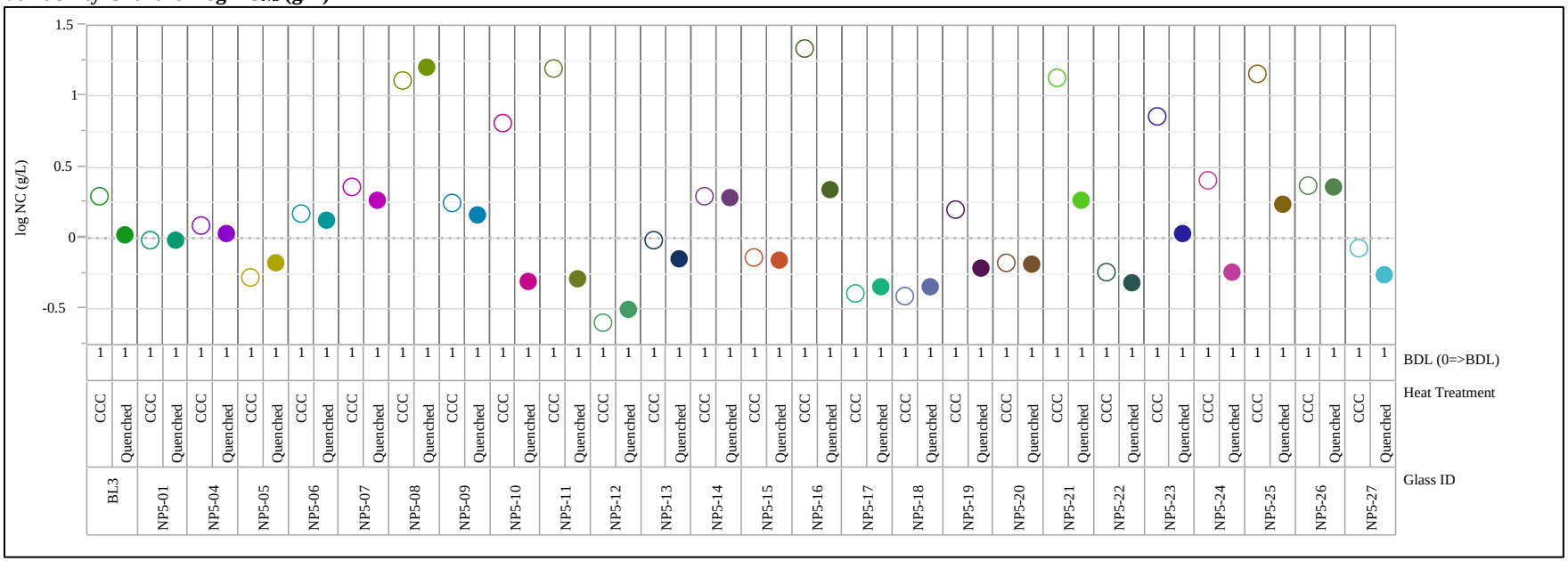


Exhibit B-3. Normalized PCT Results by Heat Treatment by Compositional View for Each Glass (continued)

Comp View=measured
Variability Chart for log NC_{Si} (g/L)

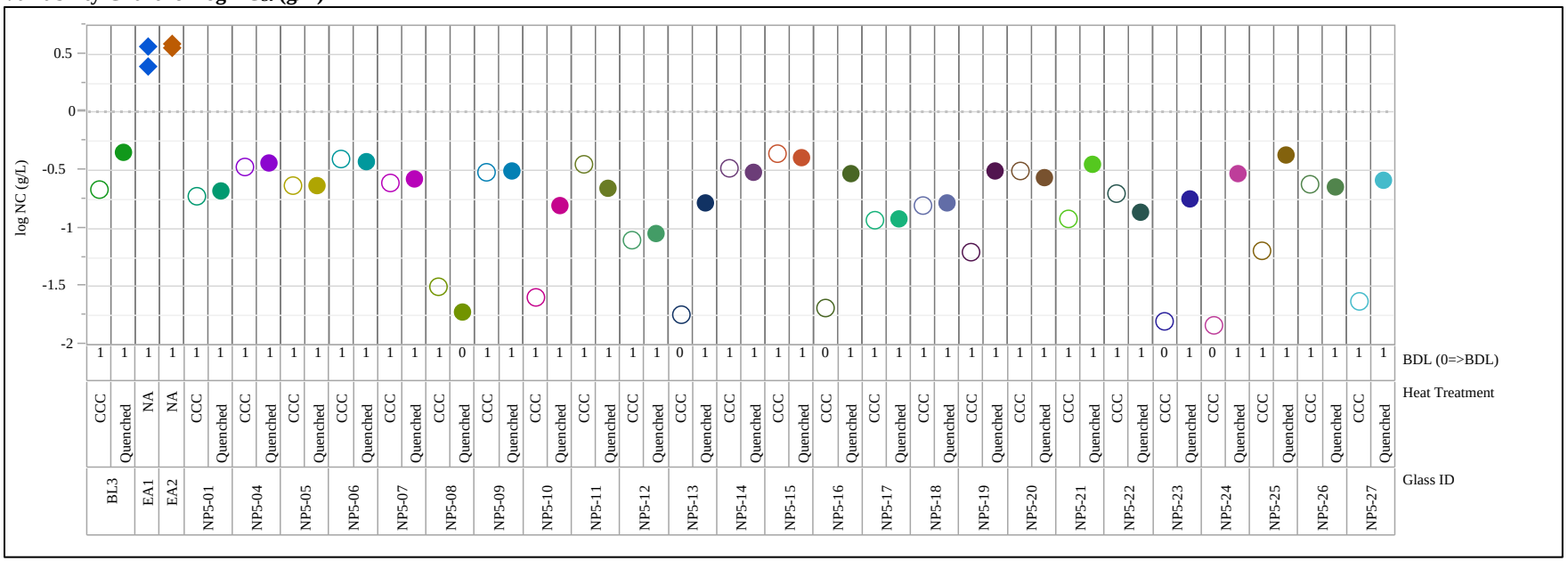


Exhibit B-3. Normalized PCT Results by Heat Treatment by Compositional View for Each Glass (continued)

Comp View=reference
Variability Chart for log NC_{Si} (g/L)

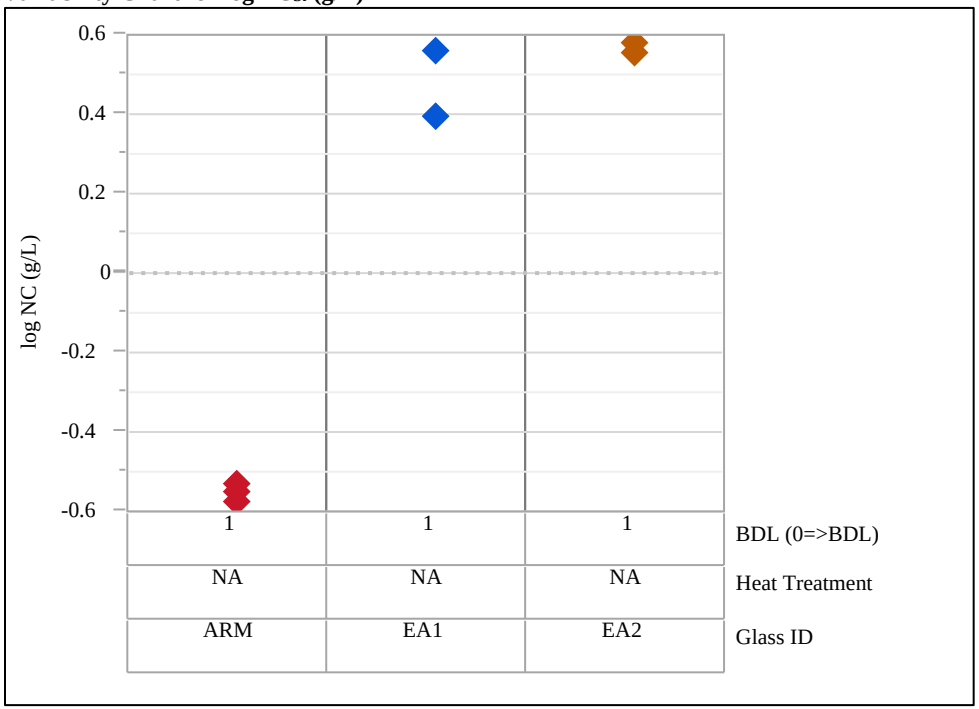
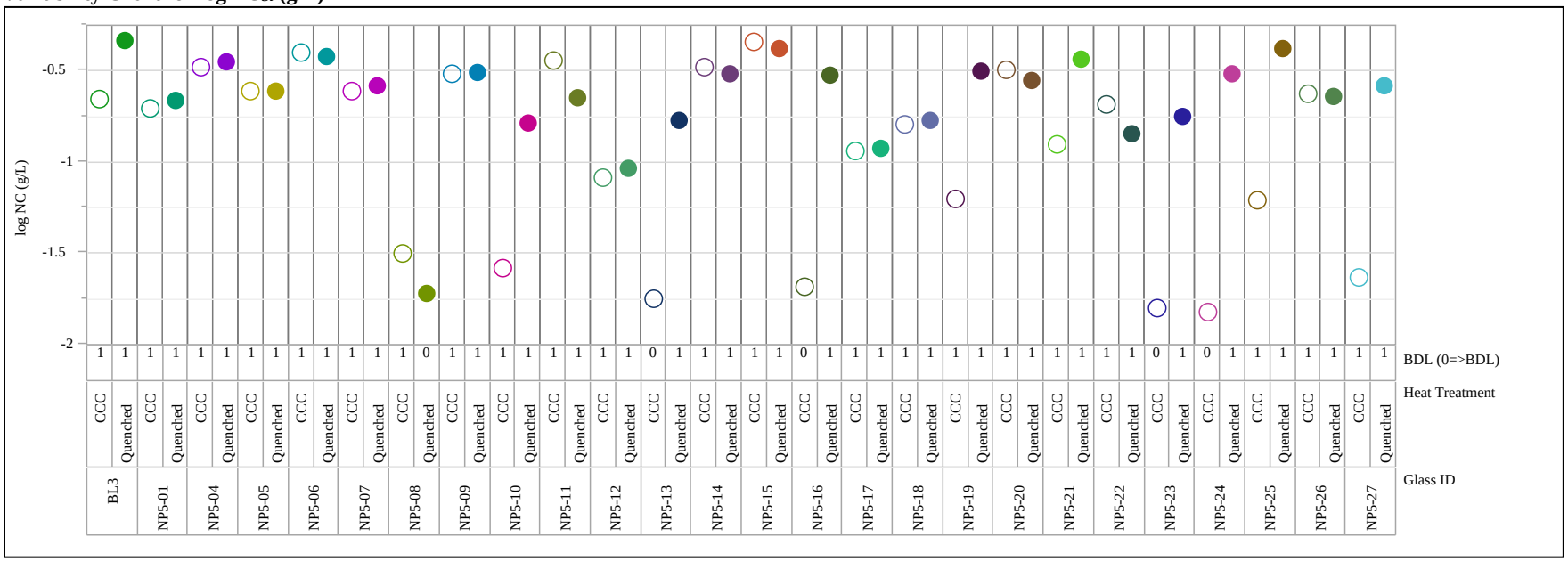


Exhibit B-3. Normalized PCT Results by Heat Treatment by Compositional View for Each Glass (continued)

Comp View=targeted
Variability Chart for log NC_{Si} (g/L)



Distribution:

J. W. Amoroso, 999-W
T. B. Brown, 773-A
M. E. Caldwell, 999-W
A. D. Cozzi, 999-W
C. L. Crawford, 773-42A
D. E. Dooley, 773-A
W. C. Eaton, PNNL
T. B. Edwards, 999-W
A. P. Fellinger, 773-42A
S. D. Fink, 773-A
K. M. Fox, 999-W
C. C. Herman, 773-A
A. M. Howe, 999-W
C. M. Jantzen, 773-A
T. Jin, PNNL
F. C. Johnson, 999-W
D. S. Kim, PNNL
A. A. Kruger, DOE-ORP
J. Matyáš, PNNL
D. J. McCabe, 773-42A
D. L. McClane, 999-W
G. A. Morgan, 999-W
F. M. Pennebaker, 773-42A
A. A. Ramsey, 999-W
W. G. Ramsey, 999-W
W. T. Riley, 999-1W
R. L. Russell, PNNL
M. J. Schweiger, PNNL
G. N. Smoland, 999-1W
C. L. Trivelpiece, 999-W
J. D. Vienna, PNNL
B. J. Wiedenman, 773-42A
W. R. Wilmarth, 773-A
Records Administration (EDWS)