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EXECUTIVE SUMMARY

In this report, Savannah River National Laboratory (SRNL) provides chemical analyses and Product Consistency Test (PCT) results for a series of simulated high-level waste (HLW) glass compositions fabricated at Pacific Northwest National Laboratory (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. A review of the individual glass composition measurements identified no analytical issues of concern. Minor differences between the targeted and measured concentrations of some of the baseline glass components were noted, including some high values for Fe_2O_3, and some low values for Al_2O_3, Li_2O, Na_2O and P_2O_5.

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. Some of the CCC versions of the study glasses have normalized concentration for boron (NC_B) values that are higher than the Environmental Assessment glass benchmark NC_B value of 16.695 g/L. For some of the study glasses, the NC_B values were higher after the CCC heat treatment. The normalized concentrations for lithium and sodium (NC_{Li} and NC_{Na}) followed this same trend. For many of these glasses, the changes in the normalized concentration for silicon (NC_{Si}) values were not congruent with the changes in NC_B, NC_{Li}, and NC_{Na} values.

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

ar	As received
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
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.[2] 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.[3] The propensity for nepheline crystallization in a HLW glass increases with increasing concentrations of Al_2O_3 and Na_2O in the glass.[4] 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.[5] The glasses are described as the Phase 6 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 C3489-00079-26.

2.2 Glasses Selected for Study

The glass compositions characterized in this report were selected and fabricated at PNNL.[a] Identifiers for the glasses are listed in Table 2-1. In the sections that follow, the methods used for

[a] Refer to: J. Kroll, "EWG – Nepheline Phase 6 Glass Characterization," PNNL document EWG-TI-0068 (2018).

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 6 ORP Nepheline Study Glasses

NP6-01	NP6-11
NP6-02	NP6-12
NP6-03	NP6-13
NP6-04	NP6-14
NP6-05	NP6-15
NP6-06	NP6-16
NP6-07	NP6-17
NP6-08	NP6-18
NP6-09	NP6-19
NP6-10	NP6-20

2.3 Glass Composition Analysis

Chemical analyses were performed under the auspices of an analytical plan[6] 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),[7] lithium metaborate fusion (LM),[8] and potassium hydroxide fusion (KH),[9] 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 Inductively Coupled Plasma – Atomic Emission Spectroscopy (ICP-AES)[10] or ion chromatography (IC),[11] 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)[12] 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.[12] The preparation and measurement methods used for each of the reported glass components are listed in Table 2-2.

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	LM	ICP-AES
Li	PF	ICP-AES
Mg	LM	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[13] was performed using three replicate samples of each of the quenched and WTP canister centerline cooled (CCC)[14] versions of the study glasses to assess chemical durability. Also included in the experimental test matrix was the Approved Reference Material (ARM-1) glass,[15] the Environmental Assessment (EA) benchmark glass,[16] and blanks from the vessel cleaning batch. Glass samples were ground, sieved, washed, and prepared according to the standard procedure.[13] 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[a]), then labeled and analyzed by ICP-AES under the auspices of analytical plans.[17] Samples of a multi-element, standard solution[b] were also included in the analytical plan as a check on the accuracy of the ICP-AES instrument used for these measurements. Due to the number of glasses in this study, the PCTs were divided into two groups, labelled as Group D and Group E. 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.

[a] The leachates were diluted by adding 4 mL of 0.4 M HNO_3 to 6 mL of the leachate (a 6:10 volume to volume, v:v, dilution). The leachates for EA were further diluted (1:10 v:v) with deionized water.
[b] ICP multi-element custom solution, product number SM-744-013, High Purity Standards, Charleston, SC.

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 in Appendix A provides the elemental concentration measurements in wt % for the study glasses as prepared by the PF method. Table A-3 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-3 of Appendix A were converted to oxide concentrations by multiplying the values for each element by the gravimetric factor for the corresponding oxide. An elemental concentration measurement that was reported to be below the detection limit of the analytical process used was set to the detection limit during the conversion to oxide concentration for the purposes of review and calculating a sum of oxides for each glass. Those oxides with one or more concentration measurement 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-3 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. 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, P_2O_5, SiO_2, and ZrO_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.[10] 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-3 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 Al_2O_3 are low for some of the study glasses.
- The measured concentrations of fluorine are low for most of the study glasses, perhaps due to volatility during melting.
- The measured Fe_2O_3 concentrations are higher than the targeted values for all the study glasses, but the measured concentration for the LRM glass is close to the target.
- The measured Li_2O and Na_2O values are lower than the targeted concentrations for some of the study glasses.
- The measured concentrations of NiO and RuO_2 are below the method detection limits.
- The measured concentrations of SO_3 are low for most of the study glasses, which again may be due to volatility during melting.
- The measured P_2O_5 concentrations are low for the study glasses.
- The measured ZrO_2 concentrations are low for some of the study glasses.

Table A-4 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 about 95 to 101 wt %, indicating acceptable recovery of the glass components. Entries in Table A-4 show the relative differences between the measured values and the targeted values for the oxides with targeted values above 5 wt %.

3.2 Review and Evaluation of PCT Measurements

Several observations of the glasses and leachates were made after the PCT vessels were removed from the oven. Some of the leachates were difficult to filter and required more than one filter to complete, including those from glasses NP6-10-Q, NP6-13-Q, and the EA glass. The triplicate vessels for glasses NP6-06-Q, NP6-10-Q, NP6-16-Q, and one vessel of NP6-14-Q had what appeared to be an oily layer on top of the leachates. This may be a reaction product that floated on the water. Photos are provided in Figure 3-1.

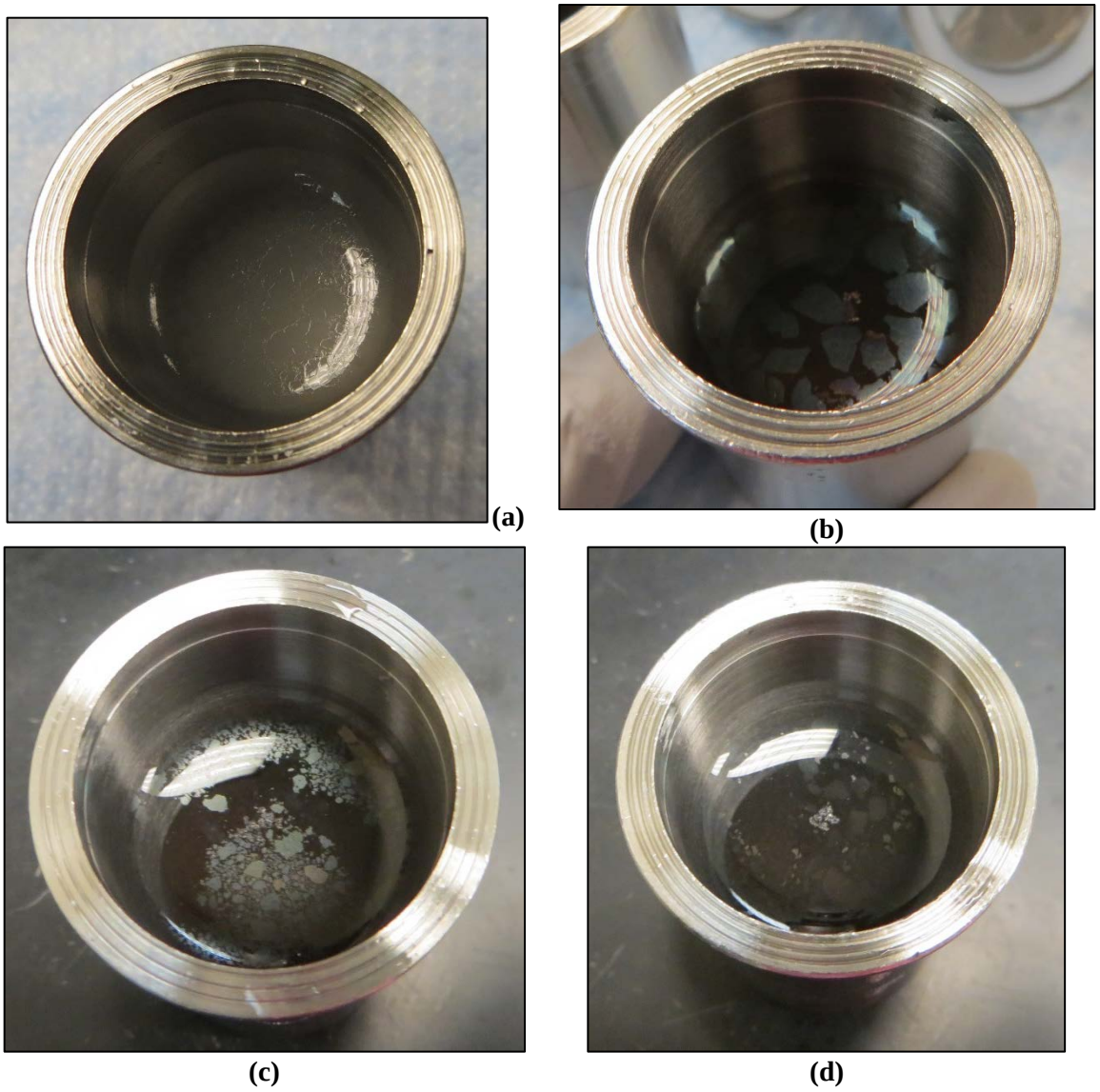

Figure 3-1. Photos of Potential Reaction Product Floating on PCT Leachates. Leachates are from the Quenched Versions of Glasses NP6-06 (a), NP6-10 (b), NP6-14 (c), and NP6-16 (d).

The CCC versions of these glasses also showed unusual behavior after the PCT. Glass NP6-06-CCC and its leachate were gel-like and white. There was a white gel-like layer visible on the surface of glass NP6-10-CCC. The layer did not uniformly cover the glass. The leachate for glass NP6-14-CCC had a thin layer of material floating on it, as did the leachate for glass NP6-16-CCC. Photos are provided in Figure 3-2.

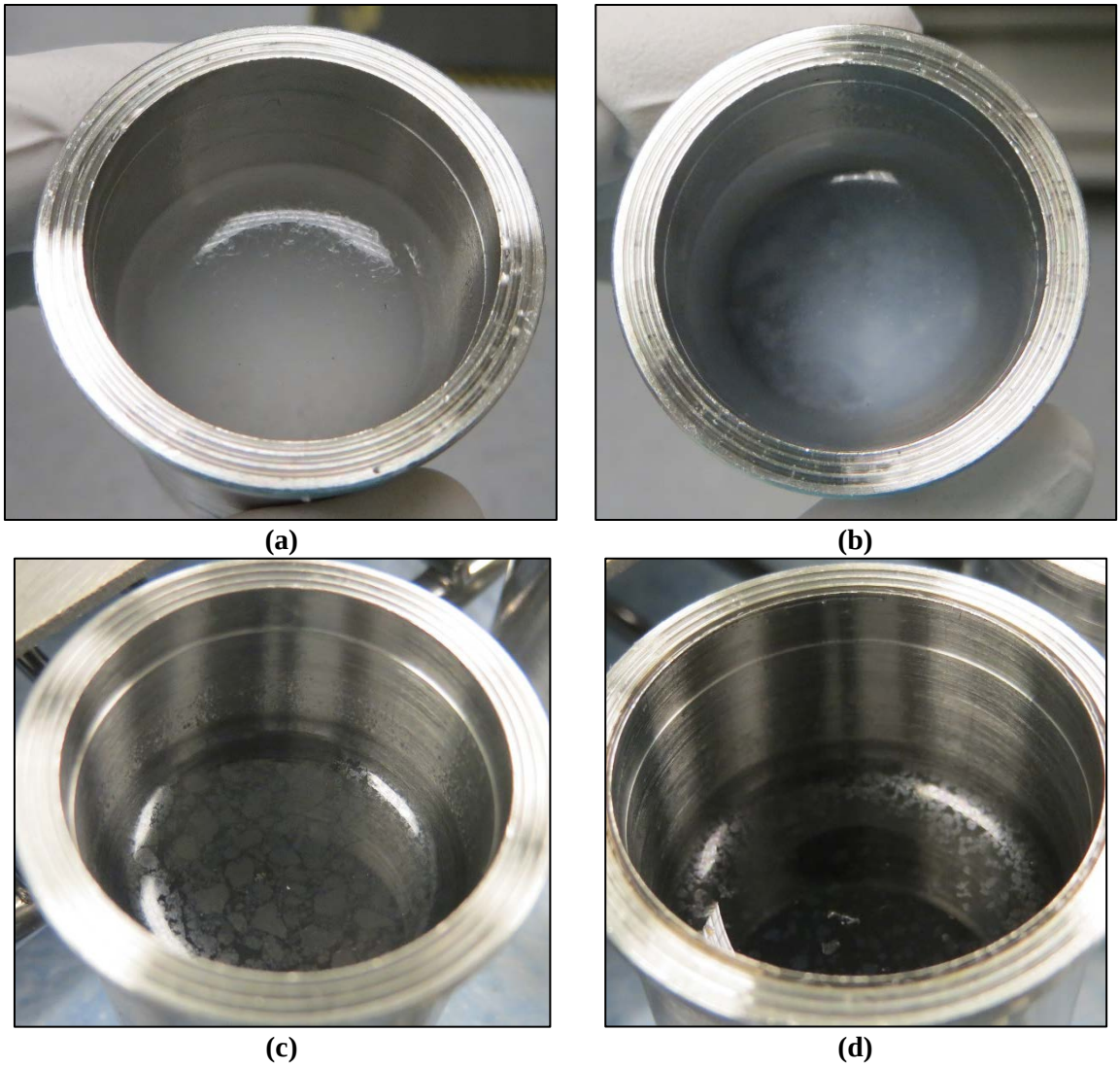

Figure 3-2. Photos of Glasses and Leachates after the PCT. Shown are the CCC Versions of Glasses NP6-06 (a), NP6-10 (b), NP6-14 (c), and NP6-16 (d).

The CCC versions of three other glasses in the study showed unusual behavior after the PCT. The quenched versions of these glasses were unremarkable after the PCT. The leachate for glass NP6-08-CCC was an opaque, whitish color. The glass was not visible below the leachate. There was a thin layer of opaque white material visible on glass NP6-13-CCC. The leachate for glass NP6-19-CCC had a thin layer of material floating on it. Photos are provided in Figure 3-3. Attempts were not made to further characterize these potential reaction products.

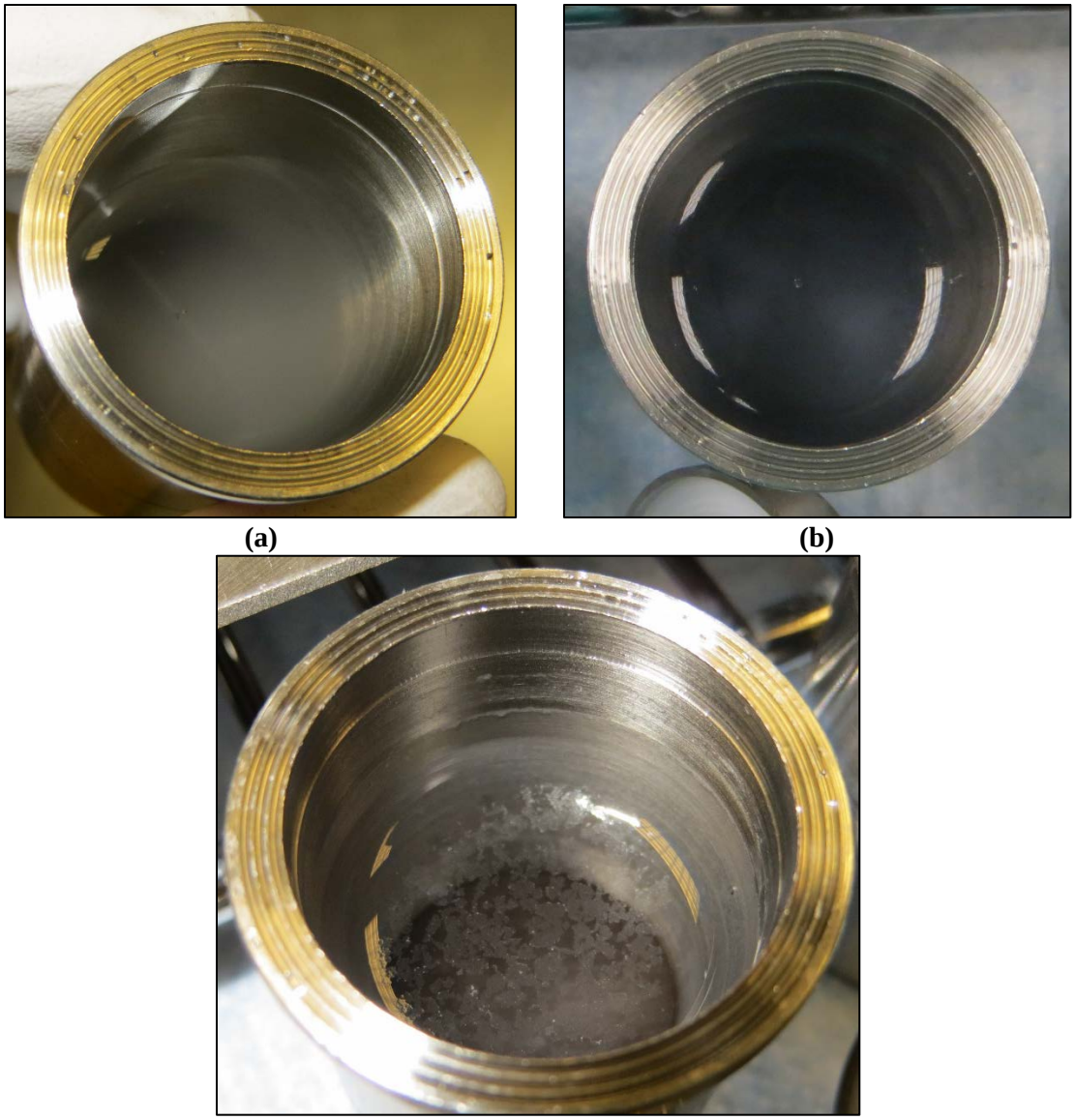

Figure 3-3. Photos of Glasses and Leachates after the PCT. Shown are the CCC Versions of Glasses NP6-08 (a), NP6-13 (b), and NP6-19 (c).

Based on the masses of the PCT vessels before and after the 7-day procedures, water was lost from one of the three triplicate vessels for glass NP6-13-Q. The leachate from this vessel was not measured. 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 other vessels during the PCTs.

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.

The ratio of leachant volume to the mass of ground glass was confirmed to be correct for each vessel. The measured concentrations of B, Li, Na, and Si in the leachates from the ARM glasses were compared to the control charts to demonstrate proper performance of the PCTs.[15] All the measured B, Li, Na, and Si concentrations in the ARM glass leachates fell within the limits of the control charts; thus, 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 and Table B-3 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-4 in Appendix B provides a review of the measurements of the solution standard samples that were included in the analytical blocks for the PCT analyses. For each analytical block, the mean, standard deviation, and percent relative standard deviation (%RSD) are determined for each element present in the standard. Following the guidance in ASTM C 1285, there were two primary evaluations conducted for these summary statistics: the mean value for each analytical block was found to be less than 10% from the reference value (i.e., a percent relative bias less than 10%) for the element in question, and the %RSD was less than 10% for the element in question. The results in Table B-4 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-4 of Appendix A). The calculated NC_i values are discussed further in the following sections.

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:

[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.

- 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.[16]
    - The CCC version of glass NP6-20 had the highest NC_B value, 62.2 g/L based on normalization to the measured composition.
- The effect of heat treatment on the PCT results can be generally divided into two 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 NP6-08, NP6-10, NP6-13, NP6-19, and NP6-20.
    - For several of the study glasses, heat treatment had little practical effect on the measured PCT responses. Examples include glasses NP6-01, NP6-02, and NP6-07.
- In general, the CCC versions of the glasses that were noted in Section 3.2 to have a visible reaction product after the PCT had higher NC_B values. Glass NP6-20 was an exception, with a relatively high NC_B of about 62 g/L but no visible reaction product.
- The release rates for boron, lithium, and sodium among the study glasses were generally congruent. The release rates for silicon for some of the study glasses lack congruence with the release rates of the other three analytes. This is shown visually for the quenched glass PCT results normalized to the measured compositions in Exhibit B-4 of Appendix B, and for the CCC glass PCT results normalized to the measured compositions in Exhibit B-5.

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)
D	ARM	ref	ref	0.450	0.524	0.476	0.262
E	ARM	ref	ref	0.511	0.537	0.505	0.273
D	EA	ref	ref	9.877	5.931	7.784	2.631
E	EA	ref	ref	12.917	7.036	9.603	3.069
D	NP6-01	Quenched	measured	0.901	0.943	0.801	0.249
D	NP6-01	Quenched	targeted	0.898	0.895	0.777	0.251
E	NP6-01	CCC	measured	0.853	0.780	0.604	0.146
E	NP6-01	CCC	targeted	0.850	0.740	0.586	0.146
D	NP6-02	Quenched	measured	1.081	1.258	0.830	0.378
D	NP6-02	Quenched	targeted	1.089	1.173	0.798	0.386
E	NP6-02	CCC	measured	1.446	1.509	1.061	0.445
E	NP6-02	CCC	targeted	1.457	1.407	1.021	0.455
D	NP6-03	Quenched	measured	0.907	1.107	0.747	0.262
D	NP6-03	Quenched	targeted	0.880	1.003	0.723	0.256
E	NP6-03	CCC	measured	0.784	0.714	0.486	0.118
E	NP6-03	CCC	targeted	0.760	0.646	0.471	0.116
D	NP6-04	Quenched	measured	0.284	0.402	0.354	0.167
D	NP6-04	Quenched	targeted	0.286	0.380	0.343	0.169
E	NP6-04	CCC	measured	7.995	6.100	2.430	0.122
E	NP6-04	CCC	targeted	8.027	5.763	2.353	0.123
D	NP6-05	Quenched	measured	4.550	< 3.765	3.608	0.200
D	NP6-05	Quenched	targeted	4.677	3.685	3.448	0.209
E	NP6-05	CCC	measured	6.573	< 5.268	4.620	0.219
E	NP6-05	CCC	targeted	6.756	5.155	4.416	0.228
D	NP6-06	Quenched	measured	12.485	7.775	8.892	< 0.016
D	NP6-06	Quenched	targeted	12.072	7.291	8.828	< 0.015
E	NP6-06	CCC	measured	11.226	7.203	7.747	< 0.016
E	NP6-06	CCC	targeted	10.855	6.754	7.691	< 0.015
D	NP6-07	Quenched	measured	2.138	1.912	1.444	0.292
D	NP6-07	Quenched	targeted	2.069	1.756	1.369	0.283
E	NP6-07	CCC	measured	2.136	1.979	1.121	0.193
E	NP6-07	CCC	targeted	2.068	1.817	1.062	0.187
D	NP6-08	Quenched	measured	0.429	0.469	0.473	0.218
D	NP6-08	Quenched	targeted	0.409	0.425	0.451	0.210
E	NP6-08	CCC	measured	50.500	58.376	15.477	0.045
E	NP6-08	CCC	targeted	48.206	52.870	14.762	0.044
D	NP6-09	Quenched	measured	1.285	1.436	0.828	0.544
D	NP6-09	Quenched	targeted	1.278	1.350	0.800	0.545
E	NP6-09	CCC	measured	2.919	2.131	1.112	0.447
E	NP6-09	CCC	targeted	2.901	2.003	1.074	0.448
D	NP6-10	Quenched	measured	2.717	2.628	2.147	0.102
D	NP6-10	Quenched	targeted	2.626	2.409	2.141	0.102
E	NP6-10	CCC	measured	20.454	8.298	14.449	0.041
E	NP6-10	CCC	targeted	19.769	7.608	14.410	0.040
D	NP6-11	Quenched	measured	1.460	1.467	1.008	0.425
D	NP6-11	Quenched	targeted	1.457	1.343	0.985	0.423

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	NP6-11	CCC	measured	4.065	3.020	1.467	0.227
E	NP6-11	CCC	targeted	4.058	2.766	1.433	0.226
D	NP6-12	Quenched	measured	1.244	1.317	0.908	0.386
D	NP6-12	Quenched	targeted	1.263	1.297	0.895	0.397
E	NP6-12	CCC	measured	1.344	1.226	0.857	0.383
E	NP6-12	CCC	targeted	1.364	1.208	0.845	0.394
D	NP6-13	Quenched	measured	5.996	5.443	4.595	< 0.016
D	NP6-13	Quenched	targeted	5.923	5.199	4.467	< 0.016
E	NP6-13	CCC	measured	20.418	8.892	14.841	< 0.016
E	NP6-13	CCC	targeted	20.172	8.493	14.427	< 0.016
D	NP6-14	Quenched	measured	2.057	2.081	1.568	0.313
D	NP6-14	Quenched	targeted	2.006	1.959	1.569	0.309
E	NP6-14	CCC	measured	2.540	1.940	1.873	< 0.014
E	NP6-14	CCC	targeted	2.477	1.826	1.874	< 0.014
D	NP6-15	Quenched	measured	0.892	0.942	0.845	0.169
D	NP6-15	Quenched	targeted	0.880	0.918	0.817	0.172
E	NP6-15	CCC	measured	1.266	1.256	1.086	0.246
E	NP6-15	CCC	targeted	1.250	1.223	1.049	0.249
D	NP6-16	Quenched	measured	2.618	2.628	1.659	0.411
D	NP6-16	Quenched	targeted	2.644	2.425	1.596	0.410
E	NP6-16	CCC	measured	3.337	2.913	2.021	< 0.014
E	NP6-16	CCC	targeted	3.371	2.688	1.944	< 0.014
D	NP6-17	Quenched	measured	0.777	< 1.533	0.757	0.255
D	NP6-17	Quenched	targeted	0.750	< 1.196	0.721	0.250
E	NP6-17	CCC	measured	1.586	2.049	1.257	0.311
E	NP6-17	CCC	targeted	1.533	1.599	1.197	0.305
D	NP6-18	Quenched	measured	0.260	0.377	0.304	0.112
D	NP6-18	Quenched	targeted	0.264	0.366	0.296	0.112
E	NP6-18	CCC	measured	1.826	1.380	0.799	0.053
E	NP6-18	CCC	targeted	1.853	1.341	0.780	0.053
D	NP6-19	Quenched	measured	1.965	2.046	1.846	0.234
D	NP6-19	Quenched	targeted	1.933	1.744	1.763	0.228
E	NP6-19	CCC	measured	61.840	4.618	40.680	0.073
E	NP6-19	CCC	targeted	60.847	3.937	38.852	0.071
D	NP6-20	Quenched	measured	0.996	1.018	0.740	0.413
D	NP6-20	Quenched	targeted	0.978	0.964	0.728	0.408
E	NP6-20	CCC	measured	62.224	36.252	17.877	0.117
E	NP6-20	CCC	targeted	61.083	34.349	17.575	0.116

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, P_2O_5, SiO_2, and ZrO_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 Fe_2O_3, and some low values for Al_2O_3, Li_2O, Na_2O and P_2O_5.

The PCT Method-A was performed in triplicate on each of the quenched and 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. 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. For some 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 many of these glasses, the changes in measured NC_{Si} values were not congruent with the changes in NC_B, NC_{Li}, and NC_{Na} values.

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.

5.0 References

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Appendix A Tables and Exhibits Supporting the Chemical Composition Measurements

Table A-1. LM Measurements of the Study Glasses

ID	Block	Sub-Blk	Sequence	Lab ID	Bi (wt%)	Fe (wt%)	Mg (wt%)	Na (wt%)	Pb (wt%)	Ru (wt%)	S (wt%)	Sr (wt%)
LRM	1	1	1	LRMLM111	<0.100	0.957	<0.100	14.8	0.0922	<0.0500	0.0941	<0.0500
NP6-17	1	1	2	Y13LM11	1.47	2.17	0.176	10.3	0.111	<0.0500	0.196	0.0962
NP6-14	1	1	3	Y16LM11	0.561	1.79	<0.100	8.27	0.0503	<0.0500	0.0959	<0.0500
NP6-17	1	1	4	Y13LM21	1.41	2.10	0.173	10.4	0.113	<0.0500	0.199	0.0968
NP6-03	1	1	5	Y07LM11	0.769	1.82	0.105	5.41	0.0562	<0.0500	0.123	<0.0500
NP6-08	1	1	6	Y10LM11	0.420	3.52	<0.100	10.3	0.0401	<0.0500	0.0704	<0.0500
NP6-20	1	1	7	Y04LM11	1.48	1.83	0.175	9.64	0.119	<0.0500	0.245	0.101
NP6-14	1	1	8	Y16LM21	0.558	1.84	<0.100	8.47	0.0488	<0.0500	0.0827	<0.0500
LRM	1	1	9	LRMLM112	<0.100	0.992	<0.100	14.6	0.0877	<0.0500	0.105	<0.0500
NP6-10	1	1	10	Y19LM11	0.419	3.22	<0.100	9.04	0.0336	<0.0500	0.0630	<0.0500
NP6-03	1	1	11	Y07LM21	0.768	1.81	0.104	5.37	0.0560	<0.0500	0.108	<0.0500
NP6-06	1	1	12	Y01LM11	0.809	3.15	<0.100	7.21	0.0714	<0.0500	0.114	<0.0500
NP6-10	1	1	13	Y19LM21	0.412	3.29	<0.100	9.09	0.0351	<0.0500	0.0645	<0.0500
NP6-08	1	1	14	Y10LM21	0.422	3.69	<0.100	10.2	0.0412	<0.0500	0.0752	<0.0500
NP6-20	1	1	15	Y04LM21	1.56	1.93	0.175	9.94	0.122	<0.0500	0.239	0.100
NP6-06	1	1	16	Y01LM21	0.779	3.04	<0.100	6.96	0.0719	<0.0500	0.115	<0.0500
LRM	1	1	17	LRMLM113	<0.100	0.932	<0.100	14.8	0.0899	<0.0500	0.0817	<0.0500
LRM	1	2	1	LRMLM121	<0.100	1.02	<0.100	15.0	0.0911	<0.0500	0.0876	<0.0500
NP6-14	1	2	2	Y16LM22	0.590	1.81	<0.100	8.47	0.0494	<0.0500	0.0958	<0.0500
NP6-20	1	2	3	Y04LM12	1.52	1.86	0.178	9.95	0.124	<0.0500	0.238	0.112
NP6-08	1	2	4	Y10LM22	0.434	3.59	<0.100	10.2	0.0405	<0.0500	0.0745	<0.0500
NP6-03	1	2	5	Y07LM22	0.777	1.78	0.106	5.42	0.0570	<0.0500	0.128	<0.0500
NP6-08	1	2	6	Y10LM12	0.419	3.45	<0.100	10.0	0.0409	<0.0500	0.0759	<0.0500
NP6-10	1	2	7	Y19LM22	0.414	3.27	<0.100	9.22	0.0313	<0.0500	0.0647	<0.0500
NP6-20	1	2	8	Y04LM22	1.50	1.87	0.170	10.0	0.120	<0.0500	0.239	0.107
LRM	1	2	9	LRMLM122	<0.100	1.01	<0.100	14.5	0.0937	<0.0500	0.0959	<0.0500
NP6-03	1	2	10	Y07LM12	0.766	1.80	0.107	5.46	0.0580	<0.0500	0.117	<0.0500
NP6-06	1	2	11	Y01LM12	0.810	3.20	<0.100	7.39	0.0679	<0.0500	0.122	<0.0500
NP6-06	1	2	12	Y01LM22	0.791	3.12	<0.100	7.31	0.0713	<0.0500	0.111	<0.0500
NP6-17	1	2	13	Y13LM12	1.41	2.16	0.175	10.6	0.108	<0.0500	0.195	0.101
NP6-14	1	2	14	Y16LM12	0.564	1.78	<0.100	8.49	0.0482	<0.0500	0.0900	<0.0500
NP6-17	1	2	15	Y13LM22	1.42	2.12	0.175	10.6	0.111	<0.0500	0.190	0.0994
NP6-10	1	2	16	Y19LM12	0.415	3.18	<0.100	9.08	0.0334	<0.0500	0.0620	<0.0500
LRM	1	2	17	LRMLM123	<0.100	1.02	<0.100	15.4	0.0929	<0.0500	0.0951	<0.0500
LRM	2	1	1	LRMLM211	<0.100	0.947	<0.100	14.8	0.0866	<0.0500	0.0916	<0.0500
NP6-04	2	1	2	Y05LM11	1.00	1.68	0.132	7.39	0.0801	<0.0500	0.156	0.0747
NP6-02	2	1	3	Y17LM11	1.28	3.58	0.158	6.10	0.107	<0.0500	0.187	0.102

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

ID	Block	Sub-Blk	Sequence	Lab ID	Bi (wt%)	Fe (wt%)	Mg (wt%)	Na (wt%)	Pb (wt%)	Ru (wt%)	S (wt%)	Sr (wt%)
NP6-04	2	1	4	Y05LM21	1.06	1.68	0.135	7.37	0.0811	<0.0500	0.160	0.0736
NP6-02	2	1	5	Y17LM21	1.27	3.50	0.166	6.01	0.109	<0.0500	0.212	0.101
NP6-12	2	1	6	Y02LM11	0.711	3.67	<0.100	8.58	0.0615	<0.0500	0.101	<0.0500
NP6-09	2	1	7	Y11LM11	0.404	3.37	<0.100	8.38	0.0318	<0.0500	0.0594	<0.0500
NP6-12	2	1	8	Y02LM21	0.701	3.51	<0.100	8.55	0.0582	<0.0500	0.112	<0.0500
LRM	2	1	9	LRMLM212	<0.100	0.945	<0.100	14.8	0.0863	<0.0500	0.0853	<0.0500
NP6-15	2	1	10	Y20LM11	1.23	3.23	0.162	6.19	0.101	<0.0500	0.193	0.0903
NP6-05	2	1	11	Y08LM11	1.44	3.38	0.165	11.2	0.117	<0.0500	0.205	0.108
NP6-15	2	1	12	Y20LM21	1.36	3.28	0.160	6.24	0.102	<0.0500	0.191	0.0913
NP6-09	2	1	13	Y11LM21	0.393	3.44	<0.100	8.24	0.0322	<0.0500	0.0612	<0.0500
NP6-01	2	1	14	Y14LM11	0.875	2.68	0.109	9.10	0.0740	<0.0500	0.133	0.0550
NP6-05	2	1	15	Y08LM21	1.23	3.52	0.162	11.2	0.118	<0.0500	0.197	0.107
NP6-01	2	1	16	Y14LM21	0.865	2.77	0.109	9.26	0.0728	<0.0500	0.132	0.0542
LRM	2	1	17	LRMLM213	<0.100	0.950	<0.100	15.3	0.0889	<0.0500	0.0809	<0.0500
LRM	2	2	1	LRMLM221	<0.100	0.943	<0.100	15.0	0.0849	<0.0500	0.0817	<0.0500
NP6-15	2	2	2	Y20LM22	1.33	3.34	0.154	6.28	0.0970	<0.0500	0.176	0.0940
NP6-12	2	2	3	Y02LM12	0.716	3.66	<0.100	8.44	0.0580	<0.0500	0.0998	<0.0500
NP6-09	2	2	4	Y11LM12	0.406	3.25	<0.100	7.88	0.0301	<0.0500	0.0566	<0.0500
NP6-02	2	2	5	Y17LM12	1.21	3.55	0.161	5.85	0.103	<0.0500	0.206	0.100
NP6-01	2	2	6	Y14LM12	0.901	2.75	0.108	9.15	0.0736	<0.0500	0.131	0.0554
NP6-02	2	2	7	Y17LM22	1.31	3.70	0.160	6.14	0.105	<0.0500	0.198	0.0991
NP6-09	2	2	8	Y11LM22	0.400	3.46	<0.100	8.24	0.0316	<0.0500	0.0610	<0.0500
LRM	2	2	9	LRMLM222	<0.100	0.953	<0.100	14.8	0.0856	<0.0500	0.0863	<0.0500
NP6-05	2	2	10	Y08LM12	1.50	3.54	0.154	11.3	0.112	<0.0500	0.182	0.110
NP6-01	2	2	11	Y14LM22	0.921	2.72	0.110	8.92	0.0736	<0.0500	0.130	0.0567
NP6-04	2	2	12	Y05LM22	1.11	1.74	0.134	7.31	0.0781	<0.0500	0.165	0.0735
NP6-05	2	2	13	Y08LM22	1.21	3.58	0.163	11.2	0.117	<0.0500	0.197	0.111
NP6-12	2	2	14	Y02LM22	0.712	3.71	<0.100	8.79	0.0616	<0.0500	0.109	<0.0500
NP6-15	2	2	15	Y20LM12	1.33	3.42	0.158	6.44	0.0987	<0.0500	0.187	0.0897
NP6-04	2	2	16	Y05LM12	1.08	1.78	0.133	7.55	0.0806	<0.0500	0.165	0.0743
LRM	2	2	17	LRMLM223	<0.100	0.943	<0.100	14.9	0.0873	<0.0500	0.0820	<0.0500
LRM	3	1	1	LRMLM311	<0.100	0.929	<0.100	14.9	0.0760	<0.0500	0.0894	<0.0500
NP6-19	3	1	2	Y09LM11	0.522	2.65	<0.100	10.9	0.0371	<0.0500	0.0550	<0.0500
NP6-13	3	1	3	Y12LM21	1.05	1.73	0.110	10.6	0.0694	<0.0500	0.139	0.0779
NP6-18	3	1	4	Y03LM21	1.27	2.94	0.148	7.41	0.0916	<0.0500	0.182	0.0890
NP6-19	3	1	5	Y09LM21	0.524	2.81	<0.100	10.8	0.0349	<0.0500	0.0640	<0.0500
NP6-11	3	1	6	Y15LM21	1.07	2.23	0.116	9.15	0.0713	<0.0500	0.152	0.0807
NP6-16	3	1	7	Y18LM11	1.35	1.95	0.137	7.04	0.0883	<0.0500	0.178	0.0961

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

ID	Block	Sub-Blk	Sequence	Lab ID	Bi (wt%)	Fe (wt%)	Mg (wt%)	Na (wt%)	Pb (wt%)	Ru (wt%)	S (wt%)	Sr (wt%)
NP6-18	3	1	8	Y03LM11	1.29	2.90	0.151	7.40	0.0913	<0.0500	0.173	0.0899
LRM	3	1	9	LRMLM312	<0.100	0.912	<0.100	14.9	0.0770	<0.0500	0.0798	<0.0500
NP6-07	3	1	10	Y06LM11	0.501	1.72	<0.100	10.9	0.0344	<0.0500	0.0743	<0.0500
NP6-13	3	1	11	Y12LM11	1.03	1.71	0.110	10.5	0.0708	<0.0500	0.140	0.0770
NP6-16	3	1	12	Y18LM21	1.28	1.90	0.132	6.97	0.0824	<0.0500	0.174	0.0966
NP6-11	3	1	13	Y15LM11	1.07	2.19	0.115	9.03	0.0696	<0.0500	0.150	0.0786
NP6-07	3	1	14	Y06LM21	0.502	1.79	<0.100	11.3	0.0307	<0.0500	0.0802	<0.0500
LRM	3	1	15	LRMLM313	<0.100	0.943	<0.100	14.6	0.0752	<0.0500	0.0812	<0.0500
LRM	3	2	1	LRMLM321	<0.100	0.951	<0.100	15.0	0.0831	<0.0500	0.0881	<0.0500
NP6-13	3	2	2	Y12LM22	1.09	1.78	0.115	10.5	0.0780	<0.0500	0.155	0.0732
NP6-18	3	2	3	Y03LM12	1.30	2.91	0.148	7.21	0.0912	<0.0500	0.183	0.0849
NP6-19	3	2	4	Y09LM22	0.508	2.82	<0.100	11.0	0.0381	<0.0500	0.0719	<0.0500
NP6-19	3	2	5	Y09LM12	0.508	2.80	<0.100	11.0	0.0343	<0.0500	0.0742	<0.0500
NP6-16	3	2	6	Y18LM22	1.28	1.88	0.134	6.65	0.0875	<0.0500	0.177	0.0919
NP6-16	3	2	7	Y18LM12	1.30	1.87	0.133	6.55	0.0894	<0.0500	0.179	0.0922
NP6-11	3	2	8	Y15LM22	1.09	2.22	0.110	8.71	0.0708	<0.0500	0.150	0.0752
LRM	3	2	9	LRMLM322	<0.100	0.953	<0.100	14.8	0.0823	<0.0500	0.0869	<0.0500
NP6-11	3	2	10	Y15LM12	1.06	2.22	0.116	8.85	0.0773	<0.0500	0.159	0.0740
NP6-18	3	2	11	Y03LM22	1.35	2.98	0.150	7.39	0.0958	<0.0500	0.182	0.0822
NP6-07	3	2	12	Y06LM22	0.477	1.88	<0.100	11.2	0.0349	<0.0500	0.0815	<0.0500
NP6-13	3	2	13	Y12LM12	1.11	1.76	0.113	10.4	0.0737	<0.0500	0.152	0.0693
NP6-07	3	2	14	Y06LM12	0.494	1.85	<0.100	11.1	0.0335	<0.0500	0.0760	<0.0500
LRM	3	2	15	LRMLM323	<0.100	0.955	<0.100	14.6	0.0824	<0.0500	0.0942	<0.0500

Table A-2. PF Measurements of the Study Glasses

ID	Block	Sub-Blk	Sequence	Lab ID	Al (wt%)	B (wt%)	Ca (wt%)	Cr (wt%)	Li (wt%)	Mn (wt%)	Ni (wt%)	P (wt%)	Si (wt%)	Zr (wt%)
LRM	1	1	1	LRMPF111	4.74	2.17	0.122	<0.100	<0.100	<0.100	<0.100	0.0873	25.7	0.594
NP6-06	1	1	2	Y01PF11	15.6	5.89	1.29	0.708	2.27	1.06	<0.100	0.378	10.6	0.225
NP6-20	1	1	3	Y04PF11	11.3	4.84	0.0597	1.42	1.63	2.18	<0.100	0.666	15.3	0.293
NP6-17	1	1	4	Y13PF11	11.4	5.52	3.22	1.30	0.104	1.98	<0.100	0.640	12.8	0.256
NP6-03	1	1	5	Y07PF11	16.3	5.05	3.06	0.685	2.40	1.05	<0.100	0.336	12.9	0.222
NP6-06	1	1	6	Y01PF21	15.1	5.61	1.25	0.686	2.19	1.05	<0.100	0.360	10.4	0.216
NP6-20	1	1	7	Y04PF21	10.6	4.39	<0.0500	1.31	1.52	2.01	<0.100	0.578	13.9	0.260
NP6-03	1	1	8	Y07PF21	14.9	4.48	2.79	0.609	2.24	0.952	<0.100	0.279	11.4	0.192
LRM	1	1	9	LRMPF112	4.99	2.34	0.153	<0.100	<0.100	<0.100	<0.100	0.101	26.5	0.640
NP6-17	1	1	10	Y13PF21	11.3	5.40	3.22	1.32	0.103	1.96	<0.100	0.617	12.3	0.215
NP6-10	1	1	11	Y19PF11	15.5	6.44	0.818	0.352	1.10	0.527	<0.100	0.137	10.3	0.0832
NP6-08	1	1	12	Y10PF11	10.6	4.90	2.79	0.331	1.01	0.543	<0.100	0.156	13.9	0.0791
NP6-14	1	1	13	Y16PF11	14.9	6.48	2.16	0.515	1.83	0.790	<0.100	0.254	11.9	0.145
NP6-08	1	1	14	Y10PF21	11.3	5.27	3.01	0.365	1.08	0.584	<0.100	0.119	15.1	0.110
NP6-14	1	1	15	Y16PF21	14.9	6.48	2.12	0.521	1.83	0.793	<0.100	0.232	11.9	0.138
NP6-10	1	1	16	Y19PF21	16.0	6.64	0.855	0.359	1.13	0.542	<0.100	0.180	10.6	0.0845
LRM	1	1	17	LRMPF113	4.81	2.22	0.125	<0.100	<0.100	<0.100	<0.100	0.0974	25.2	0.615
LRM	1	2	1	LRMPF121	5.18	2.48	0.191	<0.100	<0.100	<0.100	<0.100	0.119	24.6	0.690
NP6-10	1	2	2	Y19PF12	16.0	6.74	0.876	0.369	1.14	0.540	<0.100	0.102	10.7	0.131
NP6-06	1	2	3	Y01PF22	14.6	5.5	1.21	0.654	2.12	1.01	<0.100	0.305	10.3	0.245
NP6-08	1	2	4	Y10PF22	11.0	5.17	2.95	0.356	1.07	0.561	<0.100	0.157	14.7	0.145
NP6-10	1	2	5	Y19PF22	15.5	6.51	0.837	0.348	1.11	0.522	<0.100	0.200	10.3	0.116
NP6-08	1	2	6	Y10PF12	10.6	4.76	2.86	0.333	1.03	0.536	<0.100	0.117	13.7	0.122
NP6-03	1	2	7	Y07PF12	15.7	4.96	2.94	0.659	2.31	1.01	<0.100	0.36	12.5	0.254
NP6-20	1	2	8	Y04PF12	11.2	4.66	0.0874	1.41	1.62	2.10	<0.100	0.667	14.5	0.325
LRM	1	2	9	LRMPF122	4.99	2.32	0.167	<0.100	<0.100	<0.100	<0.100	0.142	26.2	0.668
NP6-20	1	2	10	Y04PF22	10.7	4.50	0.0679	1.33	1.55	2.02	<0.100	0.631	14.3	0.276
NP6-14	1	2	11	Y16PF12	13.7	5.78	1.96	0.465	1.70	0.714	<0.100	0.211	11.1	0.159
NP6-06	1	2	12	Y01PF12	15.6	6.04	1.35	0.719	2.27	1.07	<0.100	0.368	10.6	0.261
NP6-14	1	2	13	Y16PF22	14.7	6.45	2.12	0.515	1.81	0.779	<0.100	0.249	11.9	0.175
NP6-03	1	2	14	Y07PF22	15.8	4.93	2.98	0.660	2.32	1.01	<0.100	0.348	12.4	0.251
NP6-17	1	2	15	Y13PF22	11.2	5.30	3.22	1.32	0.117	1.92	<0.100	0.606	12.3	0.241
NP6-17	1	2	16	Y13PF12	10.8	4.99	3.03	1.22	0.111	1.83	<0.100	0.549	11.6	0.235
LRM	1	2	17	LRMPF123	5.03	2.36	0.179	<0.100	<0.100	<0.100	<0.100	0.161	23.8	0.674
LRM	2	1	1	LRMPF211	4.97	2.33	0.158	<0.100	<0.100	<0.100	<0.100	0.211	25.6	0.665
NP6-09	2	1	2	Y11PF11	14.9	4.91	<0.0500	0.365	2.40	0.534	<0.100	0.239	14.6	0.126
NP6-01	2	1	3	Y14PF11	13.2	6.19	2.79	0.881	0.903	1.26	<0.100	0.490	12.3	0.326

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

ID	Block	Sub-Blk	Sequence	Lab ID	Al (wt%)	B (wt%)	Ca (wt%)	Cr (wt%)	Li (wt%)	Mn (wt%)	Ni (wt%)	P (wt%)	Si (wt%)	Zr (wt%)
NP6-04	2	1	4	Y05PF11	11.2	4.53	3.38	1.02	2.59	1.55	<0.100	0.604	16.1	0.426
NP6-09	2	1	5	Y11PF21	14.9	5.02	<0.0500	0.384	2.40	0.539	<0.100	0.171	15.0	0.129
NP6-02	2	1	6	Y17PF11	13.4	4.59	1.36	1.39	2.45	2.10	<0.100	0.772	12.6	0.433
NP6-01	2	1	7	Y14PF21	13.0	6.00	2.79	0.874	0.884	1.23	<0.100	0.487	12.1	0.322
NP6-15	2	1	8	Y20PF11	14.6	5.23	3.37	1.27	1.57	1.90	<0.100	0.708	10.8	0.426
LRM	2	1	9	LRMPF212	4.93	2.31	0.159	<0.100	<0.100	<0.100	<0.100	0.187	25.5	0.667
NP6-05	2	1	10	Y08PF11	13.1	6.49	<0.0500	1.43	<0.100	2.22	<0.100	0.765	11.2	0.451
NP6-12	2	1	11	Y02PF11	13.3	5.88	0.850	0.684	1.83	1.01	<0.100	0.421	14.3	0.239
NP6-15	2	1	12	Y20PF21	14.9	5.45	3.43	1.30	1.62	1.96	<0.100	0.756	11.0	0.414
NP6-05	2	1	13	Y08PF21	13.1	6.46	<0.0500	1.43	<0.100	2.20	<0.100	0.815	10.9	0.458
NP6-12	2	1	14	Y02PF21	13.5	5.92	0.825	0.690	1.88	1.00	<0.100	0.391	14.2	0.247
NP6-04	2	1	15	Y05PF21	11.4	4.54	3.45	1.04	2.66	1.54	<0.100	0.642	15.8	0.414
NP6-02	2	1	16	Y17PF21	13.7	4.61	1.39	1.41	2.48	2.12	<0.100	0.703	12.9	0.423
LRM	2	1	17	LRMPF213	5.21	2.49	0.188	<0.100	<0.100	<0.100	<0.100	0.228	27.4	0.703
LRM	2	2	1	LRMPF221	4.81	2.23	0.130	<0.100	<0.100	<0.100	<0.100	0.179	25.8	0.647
NP6-15	2	2	2	Y20PF22	14.1	5.01	3.23	1.22	1.52	1.85	<0.100	0.663	10.5	0.419
NP6-09	2	2	3	Y11PF12	14.5	4.87	<0.0500	0.367	2.35	0.535	<0.100	0.175	14.6	0.130
NP6-04	2	2	4	Y05PF22	11.1	4.36	3.38	1.01	2.56	1.52	<0.100	0.536	15.7	0.412
NP6-12	2	2	5	Y02PF22	13.2	5.72	0.798	0.679	1.82	0.986	<0.100	0.328	13.9	0.250
NP6-04	2	2	6	Y05PF12	10.9	4.22	3.27	0.983	2.51	1.49	<0.100	0.528	15.2	0.422
NP6-05	2	2	7	Y08PF22	12.8	6.28	<0.0500	1.39	<0.100	2.16	<0.100	0.734	10.8	0.457
NP6-01	2	2	8	Y14PF22	13.1	6.10	2.80	0.889	0.895	1.27	<0.100	0.462	12.3	0.333
LRM	2	2	9	LRMPF222	4.88	2.24	0.130	<0.100	<0.100	<0.100	<0.100	0.145	26.5	0.671
NP6-02	2	2	10	Y17PF22	13.5	4.48	1.38	1.38	2.44	2.09	<0.100	0.685	12.7	0.467
NP6-05	2	2	11	Y08PF12	13.0	6.36	<0.0500	1.41	<0.100	2.17	<0.100	0.769	11.0	0.450
NP6-02	2	2	12	Y17PF12	13.5	4.58	1.34	1.39	2.45	2.11	<0.100	0.710	12.7	0.427
NP6-12	2	2	13	Y02PF12	13.0	5.60	0.822	0.657	1.79	0.981	<0.100	0.320	13.7	0.241
NP6-01	2	2	14	Y14PF12	13.1	6.06	2.75	0.869	0.897	1.25	<0.100	0.420	12.3	0.331
NP6-15	2	2	15	Y20PF12	14.6	5.36	3.35	1.27	1.57	1.94	<0.100	0.617	10.9	0.433
NP6-09	2	2	16	Y11PF22	14.6	4.75	<0.0500	0.378	2.35	0.535	<0.100	0.160	14.4	0.132
LRM	2	2	17	LRMPF223	4.99	2.31	0.151	<0.100	<0.100	<0.100	<0.100	0.138	26.2	0.682
LRM	3	1	1	LRMPF311	5.03	2.38	0.143	<0.100	<0.100	<0.100	<0.100	0.145	24.6	0.732
NP6-13	3	1	2	Y12PF11	12.7	6.54	0.347	0.950	0.958	1.34	<0.100	0.439	9.76	0.391
NP6-19	3	1	3	Y09PF21	13.1	6.40	2.43	0.399	0.157	0.607	<0.100	0.147	10.3	0.190
NP6-07	3	1	4	Y06PF11	11.0	5.21	0.885	0.389	0.653	0.569	<0.100	0.173	13.7	0.183
NP6-07	3	1	5	Y06PF21	12.0	6.09	1.03	0.440	0.699	0.640	<0.100	0.189	15.1	0.197
NP6-18	3	1	6	Y03PF21	12.8	4.80	3.75	1.15	1.41	1.72	<0.100	0.595	12.9	0.498
NP6-11	3	1	7	Y15PF11	11.8	5.03	0.450	0.922	2.24	1.35	<0.100	0.481	13.6	0.406

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

ID	Block	Sub-Blk	Sequence	Lab ID	Al (wt%)	B (wt%)	Ca (wt%)	Cr (wt%)	Li (wt%)	Mn (wt%)	Ni (wt%)	P (wt%)	Si (wt%)	Zr (wt%)
NP6-18	3	1	8	Y03PF11	12.9	4.83	3.78	1.17	1.42	1.71	<0.100	0.570	13.0	0.445
LRM	3	1	9	LRMPF312	4.85	2.25	0.123	<0.100	<0.100	<0.100	<0.100	0.092	23.7	0.712
NP6-11	3	1	10	Y15PF21	12.0	5.36	0.479	0.948	2.24	1.41	<0.100	0.480	14.3	0.405
NP6-16	3	1	11	Y18PF11	14.3	5.95	<0.0500	1.17	2.49	1.78	<0.100	0.590	12.2	0.380
NP6-19	3	1	12	Y09PF11	13.8	7.10	2.65	0.450	0.166	0.655	<0.100	0.194	10.7	0.203
NP6-16	3	1	13	Y18PF21	14.2	5.96	<0.0500	1.17	2.48	1.77	<0.100	0.564	12.0	0.370
NP6-13	3	1	14	Y12PF21	13.7	7.32	0.280	0.984	1.08	1.47	<0.100	0.480	10.5	0.427
LRM	3	1	15	LRMPF313	4.94	2.33	0.128	<0.100	<0.100	<0.100	<0.100	0.137	23.9	0.724
LRM	3	2	1	LRMPF321	4.78	2.20	0.147	<0.100	<0.100	<0.100	<0.100	0.181	26.1	0.734
NP6-11	3	2	2	Y15PF12	12.1	5.25	0.513	0.993	2.31	1.48	<0.100	0.516	14.5	0.457
NP6-19	3	2	3	Y09PF12	13.7	6.92	2.64	0.499	0.178	0.708	<0.100	0.234	11.2	0.255
NP6-18	3	2	4	Y03PF22	13.1	4.86	3.86	1.24	1.49	1.78	<0.100	0.679	13.1	0.547
NP6-13	3	2	5	Y12PF22	13.9	7.37	0.341	1.06	1.12	1.55	<0.100	0.579	10.9	0.485
NP6-11	3	2	6	Y15PF22	12.0	5.24	0.513	1.00	2.28	1.45	<0.100	0.547	14.1	0.459
NP6-13	3	2	7	Y12PF12	13.2	7.01	0.434	1.07	1.03	1.48	<0.100	0.545	10.5	0.466
NP6-07	3	2	8	Y06PF22	11.6	5.82	1.03	0.485	0.700	0.672	<0.100	0.227	15.0	0.245
LRM	3	2	9	LRMPF322	4.92	2.29	0.172	<0.100	<0.100	<0.100	<0.100	0.198	26.4	0.768
NP6-19	3	2	10	Y09PF22	13.7	6.85	2.61	0.487	0.180	0.703	<0.100	0.218	11.0	0.251
NP6-16	3	2	11	Y18PF12	14.1	5.78	<0.0500	1.21	2.53	1.79	<0.100	0.646	11.9	0.418
NP6-16	3	2	12	Y18PF22	14.1	5.81	<0.0500	1.21	2.53	1.80	<0.100	0.596	12.1	0.408
NP6-07	3	2	13	Y06PF12	12.0	6.03	1.07	0.501	0.729	0.692	<0.100	0.187	15.4	0.248
NP6-18	3	2	14	Y03PF12	13.0	4.80	3.85	1.23	1.46	1.78	<0.100	0.589	13.0	0.445
LRM	3	2	15	LRMPF323	5.05	2.38	0.198	<0.100	<0.100	<0.100	<0.100	0.171	26.6	0.777

Table A-3. KH Measurements of the Study Glasses

ID	Block	Sub-Blk	Sequence	Lab ID	F (wt%)
LRM	1	1	1	LRMKH111	0.939
NP6-10	1	1	2	Y19KH11	0.122
NP6-08	1	1	3	Y10KH11	0.188
NP6-03	1	1	4	Y07KH11	0.274
NP6-14	1	1	5	Y16KH11	0.197
NP6-17	1	1	6	Y13KH11	0.444
NP6-03	1	1	7	Y07KH21	0.244
NP6-10	1	1	8	Y19KH21	0.177
LRM	1	1	9	LRMKH112	0.907
NP6-20	1	1	10	Y04KH11	0.517
NP6-17	1	1	11	Y13KH21	0.522
NP6-06	1	1	12	Y01KH11	0.221
NP6-08	1	1	13	Y10KH21	0.133
NP6-20	1	1	14	Y04KH21	0.524
NP6-06	1	1	15	Y01KH21	0.219
NP6-14	1	1	16	Y16KH21	0.222
LRM	1	1	17	LRMKH113	0.958
LRM	1	2	1	LRMKH121	0.958
NP6-08	1	2	2	Y10KH12	0.178
NP6-14	1	2	3	Y16KH22	0.151
NP6-10	1	2	4	Y19KH22	0.117
NP6-20	1	2	5	Y04KH22	0.510
NP6-17	1	2	6	Y13KH12	0.442
NP6-06	1	2	7	Y01KH12	0.235
NP6-14	1	2	8	Y16KH12	0.223
LRM	1	2	9	LRMKH122	0.881
NP6-10	1	2	10	Y19KH12	0.184
NP6-03	1	2	11	Y07KH12	0.317
NP6-06	1	2	12	Y01KH22	0.305
NP6-08	1	2	13	Y10KH22	0.146
NP6-03	1	2	14	Y07KH22	0.243
NP6-17	1	2	15	Y13KH22	0.419
NP6-20	1	2	16	Y04KH12	0.509
LRM	1	2	17	LRMKH123	0.943
LRM	2	1	1	LRMKH211	0.863
NP6-01	2	1	2	Y14KH11	0.263
NP6-04	2	1	3	Y05KH11	0.338
NP6-02	2	1	4	Y17KH11	0.453
NP6-05	2	1	5	Y08KH11	0.481
NP6-15	2	1	6	Y20KH11	0.360
NP6-09	2	1	7	Y11KH11	0.116
NP6-04	2	1	8	Y05KH21	0.426
LRM	2	1	9	LRMKH212	0.819
NP6-02	2	1	10	Y17KH21	0.457
NP6-12	2	1	11	Y02KH11	0.215
NP6-01	2	1	12	Y14KH21	0.250
NP6-05	2	1	13	Y08KH21	0.496
NP6-12	2	1	14	Y02KH21	0.214
NP6-15	2	1	15	Y20KH21	0.367
NP6-09	2	1	16	Y11KH21	0.116
LRM	2	1	17	LRMKH213	0.882
LRM	2	2	1	LRMKH221	0.884
NP6-15	2	2	2	Y20KH12	0.339
NP6-15	2	2	3	Y20KH22	0.347
NP6-04	2	2	4	Y05KH22	0.360
NP6-05	2	2	5	Y08KH22	0.492
NP6-02	2	2	6	Y17KH22	0.458
NP6-05	2	2	7	Y08KH12	0.484
NP6-01	2	2	8	Y14KH12	0.235

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

ID	Block	Sub-Blk	Sequence	Lab ID	F (wt%)
LRM	2	2	9	LRMKH222	0.898
NP6-04	2	2	10	Y05KH12	0.356
NP6-12	2	2	11	Y02KH12	0.223
NP6-09	2	2	12	Y11KH12	0.117
NP6-09	2	2	13	Y11KH22	0.121
NP6-12	2	2	14	Y02KH22	0.223
NP6-02	2	2	15	Y17KH12	0.476
NP6-01	2	2	16	Y14KH22	0.259
LRM	2	2	17	LRMKH223	0.905
LRM	3	1	1	LRMKH311	0.861
NP6-19	3	1	2	Y09KH11	0.128
NP6-13	3	1	3	Y12KH11	0.320
NP6-11	3	1	4	Y15KH11	0.356
NP6-18	3	1	5	Y03KH11	0.423
NP6-11	3	1	6	Y15KH21	0.359
NP6-19	3	1	7	Y09KH21	0.133
NP6-07	3	1	8	Y06KH11	0.147
LRM	3	1	9	LRMKH312	0.914
NP6-16	3	1	10	Y18KH11	0.416
NP6-13	3	1	11	Y12KH21	0.366
NP6-07	3	1	12	Y06KH21	0.178
NP6-18	3	1	13	Y03KH21	0.425
NP6-16	3	1	14	Y18KH21	0.409
LRM	3	1	15	LRMKH313	0.947
LRM	3	2	1	LRMKH321	0.904
NP6-11	3	2	2	Y15KH22	0.352
NP6-19	3	2	3	Y09KH12	0.135
NP6-13	3	2	4	Y12KH12	0.324
NP6-13	3	2	5	Y12KH22	0.382
NP6-07	3	2	6	Y06KH22	0.197
NP6-18	3	2	7	Y03KH12	0.484
NP6-16	3	2	8	Y18KH12	0.505
LRM	3	2	9	LRMKH322	0.981
NP6-07	3	2	10	Y06KH12	0.149
NP6-16	3	2	11	Y18KH22	0.452
NP6-19	3	2	12	Y09KH22	0.138
NP6-18	3	2	13	Y03KH22	0.420
NP6-11	3	2	14	Y15KH12	0.352
LRM	3	2	15	LRMKH323	0.942

Table A-4. Comparison of Targeted and Measured Glass Compositions

Glass ID	Oxide	BDL (<)	Measured (wt %)	Targeted (wt %)	Difference of Measured versus Targeted	% Difference of Measured versus Targeted
LRM	Al_2O_3		9.353	9.510	-0.157	-1.7%
LRM	B_2O_3		7.447	7.850	-0.403	-5.1%
LRM	Bi_2O_3	<	0.112	0.000	0.112	
LRM	CaO		0.215	0.540	-0.325	
LRM	Cr_2O_3	<	0.146	0.190	-0.044	
LRM	F		0.910	0.860	0.050	
LRM	Fe_2O_3		1.371	1.380	-0.009	
LRM	Li_2O	<	0.215	0.110	0.105	
LRM	MgO	<	0.166	0.100	0.066	
LRM	MnO	<	0.129	0.080	0.049	
LRM	Na_2O		20.033	20.030	0.003	0.0%
LRM	NiO	<	0.127	0.190	-0.063	
LRM	P_2O_5		0.346	0.540	-0.194	
LRM	PbO		0.092	0.100	-0.008	
LRM	RuO_2	<	0.066	0.000	0.066	
LRM	SiO_2		54.707	54.200	0.507	0.9%
LRM	SO_3		0.220	0.300	-0.080	
LRM	SrO	<	0.059	0.000	0.059	
LRM	ZrO_2		0.928	0.930	-0.002	
LRM	Sum		96.642	96.910	-0.268	-0.3%
NP6-01	Al_2O_3		24.753	25.500	-0.747	-2.9%
NP6-01	B_2O_3		19.601	19.660	-0.059	-0.3%
NP6-01	Bi_2O_3		0.993	1.040	-0.047	
NP6-01	CaO		3.893	3.710	0.183	
NP6-01	Cr_2O_3		1.284	1.280	0.004	
NP6-01	F		0.252	0.410	-0.158	
NP6-01	Fe_2O_3		3.903	3.370	0.533	
NP6-01	Li_2O		1.926	2.030	-0.104	
NP6-01	MgO		0.181	0.160	0.021	
NP6-01	MnO		1.617	1.650	-0.033	
NP6-01	Na_2O		12.277	12.660	-0.383	-3.0%
NP6-01	NiO	<	0.127	0.150	-0.023	
NP6-01	P_2O_5		1.065	1.200	-0.135	
NP6-01	PbO		0.079	0.080	-0.001	
NP6-01	RuO_2	<	0.066	0.050	0.016	
NP6-01	SiO_2		26.206	26.080	0.126	0.5%
NP6-01	SO_3		0.328	0.380	-0.052	
NP6-01	SrO		0.065	0.070	-0.005	
NP6-01	ZrO_2		0.443	0.490	-0.047	
NP6-01	Sum		99.060	99.970	-0.910	-0.9%
NP6-02	Al_2O_3		25.556	26.300	-0.745	-2.8%
NP6-02	B_2O_3		14.699	14.580	0.119	0.8%
NP6-02	Bi_2O_3		1.413	1.730	-0.317	
NP6-02	CaO		1.913	1.900	0.013	
NP6-02	Cr_2O_3		2.035	2.120	-0.085	
NP6-02	F		0.461	0.680	-0.219	
NP6-02	Fe_2O_3		5.122	4.980	0.142	
NP6-02	Li_2O		5.285	5.670	-0.385	-6.8%
NP6-02	MgO		0.267	0.270	-0.003	
NP6-02	MnO		2.718	2.740	-0.022	
NP6-02	Na_2O		8.122	8.440	-0.318	-3.8%

Table A-4. Comparison of Targeted and Measured Glass Compositions (continued)

Glass ID	Oxide	BDL (<)	Measured (wt %)	Targeted (wt %)	Difference of Measured versus Targeted	% Difference of Measured versus Targeted
NP6-02	NiO	<	0.127	0.250	-0.123	
NP6-02	P_2O_5		1.644	1.990	-0.346	
NP6-02	PbO		0.114	0.120	-0.006	
NP6-02	RuO_2	<	0.066	0.080	-0.014	
NP6-02	SiO_2		27.223	26.640	0.583	2.2%
NP6-02	SO_3		0.501	0.620	-0.119	
NP6-02	SrO		0.119	0.120	-0.001	
NP6-02	ZrO_2		0.591	0.810	-0.219	
NP6-02	Sum		97.976	100.040	-2.064	-2.1%
NP6-03	Al_2O_3		29.618	31.700	-2.082	-6.6%
NP6-03	B_2O_3		15.633	16.120	-0.487	-3.0%
NP6-03	Bi_2O_3		0.858	0.880	-0.022	
NP6-03	CaO		4.117	4.150	-0.033	
NP6-03	Cr_2O_3		0.955	1.070	-0.115	
NP6-03	F		0.270	0.340	-0.071	
NP6-03	Fe_2O_3		2.577	2.220	0.357	
NP6-03	Li_2O		4.989	5.510	-0.521	-9.5%
NP6-03	MgO		0.175	0.140	0.035	
NP6-03	MnO		1.298	1.390	-0.092	
NP6-03	Na_2O		7.299	7.540	-0.241	-3.2%
NP6-03	NiO	<	0.127	0.130	-0.003	
NP6-03	P_2O_5		0.758	1.010	-0.252	
NP6-03	PbO		0.061	0.060	0.001	
NP6-03	RuO_2	<	0.066	0.040	0.026	
NP6-03	SiO_2		26.313	26.930	-0.617	-2.3%
NP6-03	SO_3		0.297	0.320	-0.023	
NP6-03	SrO	<	0.059	0.060	-0.001	
NP6-03	ZrO_2		0.310	0.410	-0.100	
NP6-03	Sum		95.782	100.020	-4.238	-4.2%
NP6-04	Al_2O_3		21.068	21.600	-0.532	-2.5%
NP6-04	B_2O_3		14.208	14.150	0.058	0.4%
NP6-04	Bi_2O_3		1.185	1.260	-0.075	
NP6-04	CaO		4.715	4.410	0.305	
NP6-04	Cr_2O_3		1.481	1.550	-0.069	
NP6-04	F		0.370	0.500	-0.130	
NP6-04	Fe_2O_3		2.459	2.040	0.419	
NP6-04	Li_2O		5.555	5.880	-0.326	-5.5%
NP6-04	MgO		0.221	0.200	0.021	
NP6-04	MnO		1.969	2.000	-0.031	
NP6-04	Na_2O		9.982	10.310	-0.328	-3.2%
NP6-04	NiO	<	0.127	0.180	-0.053	
NP6-04	P_2O_5		1.323	1.460	-0.137	
NP6-04	PbO		0.086	0.090	-0.004	
NP6-04	RuO_2	<	0.066	0.060	0.006	
NP6-04	SiO_2		33.587	33.190	0.397	1.2%
NP6-04	SO_3		0.403	0.460	-0.057	
NP6-04	SrO		0.088	0.090	-0.003	
NP6-04	ZrO_2		0.565	0.590	-0.025	
NP6-04	Sum		99.458	100.020	-0.562	-0.6%
NP6-05	Al_2O_3		24.564	24.600	-0.037	-0.1%
NP6-05	B_2O_3		20.599	20.040	0.559	2.8%

Table A-4. Comparison of Targeted and Measured Glass Compositions (continued)

Glass ID	Oxide	BDL (<)	Measured (wt %)	Targeted (wt %)	Difference of Measured versus Targeted	% Difference of Measured versus Targeted
NP6-05	Bi_2O_3		1.499	1.760	-0.261	
NP6-05	CaO	<	0.070	0.120	-0.050	
NP6-05	Cr_2O_3		2.068	2.160	-0.092	
NP6-05	F		0.488	0.690	-0.202	
NP6-05	Fe_2O_3		5.011	4.890	0.121	
NP6-05	Li_2O	<	0.215	0.220	-0.005	
NP6-05	MgO		0.267	0.280	-0.013	
NP6-05	MnO		2.825	2.800	0.025	
NP6-05	Na_2O		15.131	15.830	-0.699	-4.4%
NP6-05	NiO	<	0.127	0.250	-0.123	
NP6-05	P_2O_5		1.766	2.030	-0.264	
NP6-05	PbO		0.125	0.130	-0.005	
NP6-05	RuO_2	<	0.066	0.080	-0.014	
NP6-05	SiO_2		23.479	22.540	0.939	4.2%
NP6-05	SO_3		0.488	0.640	-0.153	
NP6-05	SrO		0.129	0.130	-0.001	
NP6-05	ZrO_2		0.613	0.830	-0.217	
NP6-05	Sum		99.530	100.020	-0.490	-0.5%
NP6-06	Al_2O_3		28.768	30.800	-2.032	-6.6%
NP6-06	B_2O_3		18.547	19.180	-0.633	-3.3%
NP6-06	Bi_2O_3		0.889	0.910	-0.021	
NP6-06	CaO		1.784	1.930	-0.146	
NP6-06	Cr_2O_3		1.011	1.110	-0.099	
NP6-06	F		0.245	0.360	-0.115	
NP6-06	Fe_2O_3		4.471	4.050	0.421	
NP6-06	Li_2O		4.763	5.080	-0.317	-6.2%
NP6-06	MgO	<	0.166	0.140	0.026	
NP6-06	MnO		1.353	1.440	-0.087	
NP6-06	Na_2O		9.729	9.800	-0.071	-0.7%
NP6-06	NiO	<	0.127	0.130	-0.003	
NP6-06	P_2O_5		0.808	1.050	-0.242	
NP6-06	PbO		0.076	0.070	0.006	
NP6-06	RuO_2	<	0.066	0.040	0.026	
NP6-06	SiO_2		22.409	23.130	-0.721	-3.1%
NP6-06	SO_3		0.288	0.330	-0.042	
NP6-06	SrO	<	0.059	0.060	-0.001	
NP6-06	ZrO_2		0.320	0.430	-0.110	
NP6-06	Sum		95.879	100.040	-4.161	-4.2%
NP6-07	Al_2O_3		22.013	23.300	-1.287	-5.5%
NP6-07	B_2O_3		18.635	19.250	-0.615	-3.2%
NP6-07	Bi_2O_3		0.550	0.560	-0.010	
NP6-07	CaO		1.404	1.570	-0.166	
NP6-07	Cr_2O_3		0.663	0.680	-0.017	
NP6-07	F		0.168	0.220	-0.052	
NP6-07	Fe_2O_3		2.588	2.140	0.448	
NP6-07	Li_2O		1.497	1.630	-0.133	
NP6-07	MgO	<	0.166	0.090	0.076	
NP6-07	MnO		0.831	0.890	-0.059	
NP6-07	Na_2O		14.997	15.820	-0.824	-5.2%
NP6-07	NiO	<	0.127	0.080	0.047	
NP6-07	P_2O_5		0.445	0.640	-0.196	

Table A-4. Comparison of Targeted and Measured Glass Compositions (continued)

Glass ID	Oxide	BDL (<)	Measured (wt %)	Targeted (wt %)	Difference of Measured versus Targeted	% Difference of Measured versus Targeted
NP6-07	PbO		0.036	0.040	-0.004	
NP6-07	RuO_2	<	0.066	0.030	0.036	
NP6-07	SiO_2		31.662	32.590	-0.928	-2.8%
NP6-07	SO_3		0.195	0.200	-0.005	
NP6-07	SrO	<	0.059	0.040	0.019	
NP6-07	ZrO_2		0.295	0.260	0.035	
NP6-07	Sum		96.395	100.030	-3.635	-3.6%
NP6-08	Al_2O_3		20.548	22.100	-1.552	-7.0%
NP6-08	B_2O_3		16.180	16.950	-0.770	-4.5%
NP6-08	Bi_2O_3		0.472	0.500	-0.028	
NP6-08	CaO		4.061	4.090	-0.029	
NP6-08	Cr_2O_3		0.506	0.610	-0.104	
NP6-08	F		0.161	0.200	-0.039	
NP6-08	Fe_2O_3		5.093	4.820	0.273	
NP6-08	Li_2O		2.255	2.490	-0.235	
NP6-08	MgO	<	0.166	0.080	0.086	
NP6-08	MnO		0.718	0.790	-0.072	
NP6-08	Na_2O		13.716	14.380	-0.664	-4.6%
NP6-08	NiO	<	0.127	0.070	0.057	
NP6-08	P_2O_5		0.315	0.580	-0.266	
NP6-08	PbO		0.044	0.040	0.004	
NP6-08	RuO_2	<	0.066	0.020	0.046	
NP6-08	SiO_2		30.699	31.800	-1.101	-3.5%
NP6-08	SO_3		0.185	0.180	0.005	
NP6-08	SrO	<	0.059	0.040	0.019	
NP6-08	ZrO_2		0.154	0.240	-0.086	
NP6-08	Sum		95.526	99.980	-4.454	-4.5%
NP6-09	Al_2O_3		27.823	28.400	-0.577	-2.0%
NP6-09	B_2O_3		15.737	15.830	-0.093	-0.6%
NP6-09	Bi_2O_3		0.447	0.460	-0.013	
NP6-09	CaO	<	0.070	0.070	0.000	
NP6-09	Cr_2O_3		0.546	0.560	-0.014	
NP6-09	F		0.118	0.180	-0.063	
NP6-09	Fe_2O_3		4.832	4.560	0.272	
NP6-09	Li_2O		5.113	5.440	-0.327	-6.0%
NP6-09	MgO	<	0.166	0.070	0.096	
NP6-09	MnO		0.692	0.720	-0.028	
NP6-09	Na_2O		11.033	11.420	-0.387	-3.4%
NP6-09	NiO	<	0.127	0.070	0.057	
NP6-09	P_2O_5		0.427	0.530	-0.103	
NP6-09	PbO		0.034	0.030	0.004	
NP6-09	RuO_2	<	0.066	0.020	0.046	
NP6-09	SiO_2		31.341	31.280	0.061	0.2%
NP6-09	SO_3		0.149	0.160	-0.011	
NP6-09	SrO	<	0.059	0.030	0.029	
NP6-09	ZrO_2		0.175	0.210	-0.035	
NP6-09	Sum		98.954	100.040	-1.086	-1.1%
NP6-10	Al_2O_3		29.760	31.700	-1.940	-6.1%
NP6-10	B_2O_3		21.195	21.930	-0.735	-3.4%
NP6-10	Bi_2O_3		0.463	0.470	-0.007	
NP6-10	CaO		1.184	1.390	-0.206	

Table A-4. Comparison of Targeted and Measured Glass Compositions (continued)

Glass ID	Oxide	BDL (<)	Measured (wt %)	Targeted (wt %)	Difference of Measured versus Targeted	% Difference of Measured versus Targeted
NP6-10	Cr_2O_3		0.522	0.580	-0.058	
NP6-10	F		0.150	0.190	-0.040	
NP6-10	Fe_2O_3		4.632	4.350	0.282	
NP6-10	Li_2O		2.411	2.630	-0.219	
NP6-10	MgO	<	0.166	0.070	0.096	
NP6-10	MnO		0.688	0.750	-0.062	
NP6-10	Na_2O		12.277	12.310	-0.033	-0.3%
NP6-10	NiO	<	0.127	0.070	0.057	
NP6-10	P_2O_5		0.355	0.540	-0.185	
NP6-10	PbO		0.036	0.030	0.006	
NP6-10	RuO_2	<	0.066	0.020	0.046	
NP6-10	SiO_2		22.409	22.580	-0.171	-0.8%
NP6-10	SO_3		0.159	0.170	-0.011	
NP6-10	SrO	<	0.059	0.030	0.029	
NP6-10	ZrO_2		0.140	0.220	-0.080	
NP6-10	Sum		96.798	100.030	-3.232	-3.2%
NP6-11	Al_2O_3		22.627	23.500	-0.873	-3.7%
NP6-11	B_2O_3		16.808	16.840	-0.032	-0.2%
NP6-11	Bi_2O_3		1.196	1.200	-0.004	
NP6-11	CaO		0.684	0.860	-0.176	
NP6-11	Cr_2O_3		1.412	1.470	-0.059	
NP6-11	F		0.355	0.470	-0.115	
NP6-11	Fe_2O_3		3.167	2.760	0.407	
NP6-11	Li_2O		4.882	5.330	-0.448	-8.4%
NP6-11	MgO		0.190	0.190	-0.001	
NP6-11	MnO		1.837	1.900	-0.063	
NP6-11	Na_2O		12.044	12.330	-0.286	-2.3%
NP6-11	NiO	<	0.127	0.170	-0.043	
NP6-11	P_2O_5		1.159	1.380	-0.221	
NP6-11	PbO		0.078	0.090	-0.012	
NP6-11	RuO_2	<	0.066	0.050	0.016	
NP6-11	SiO_2		30.218	30.380	-0.162	-0.5%
NP6-11	SO_3		0.381	0.430	-0.049	
NP6-11	SrO		0.091	0.090	0.001	
NP6-11	ZrO_2		0.583	0.560	0.023	
NP6-11	Sum		97.903	100.000	-2.097	-2.1%
NP6-12	Al_2O_3		25.036	25.300	-0.264	-1.0%
NP6-12	B_2O_3		18.611	18.340	0.271	1.5%
NP6-12	Bi_2O_3		0.792	0.800	-0.009	
NP6-12	CaO		1.153	1.240	-0.087	
NP6-12	Cr_2O_3		0.990	0.980	0.010	
NP6-12	F		0.219	0.320	-0.101	
NP6-12	Fe_2O_3		5.201	4.830	0.371	
NP6-12	Li_2O		3.940	4.000	-0.060	
NP6-12	MgO	<	0.166	0.120	0.046	
NP6-12	MnO		1.284	1.270	0.014	
NP6-12	Na_2O		11.579	11.740	-0.161	-1.4%
NP6-12	NiO	<	0.127	0.110	0.017	
NP6-12	P_2O_5		0.836	0.920	-0.084	
NP6-12	PbO		0.064	0.060	0.004	
NP6-12	RuO_2	<	0.066	0.040	0.026	

Table A-4. Comparison of Targeted and Measured Glass Compositions (continued)

Glass ID	Oxide	BDL (<)	Measured (wt %)	Targeted (wt %)	Difference of Measured versus Targeted	% Difference of Measured versus Targeted
NP6-12	SiO_2		30.004	29.170	0.834	2.9%
NP6-12	SO_3		0.263	0.290	-0.027	
NP6-12	SrO	<	0.059	0.060	-0.001	
NP6-12	ZrO_2		0.330	0.380	-0.050	
NP6-12	Sum		100.719	99.970	0.749	0.7%
NP6-13	Al_2O_3		25.272	26.300	-1.028	-3.9%
NP6-13	B_2O_3		22.733	23.010	-0.278	-1.2%
NP6-13	Bi_2O_3		1.193	1.230	-0.037	
NP6-13	CaO		0.490	0.790	-0.300	
NP6-13	Cr_2O_3		1.485	1.510	-0.025	
NP6-13	F		0.348	0.480	-0.132	
NP6-13	Fe_2O_3		2.495	2.020	0.475	
NP6-13	Li_2O		2.254	2.360	-0.106	
NP6-13	MgO		0.186	0.190	-0.004	
NP6-13	MnO		1.885	1.950	-0.065	
NP6-13	Na_2O		14.154	14.560	-0.406	-2.8%
NP6-13	NiO	<	0.127	0.180	-0.053	
NP6-13	P_2O_5		1.170	1.420	-0.250	
NP6-13	PbO		0.079	0.090	-0.011	
NP6-13	RuO_2	<	0.066	0.060	0.006	
NP6-13	SiO_2		22.281	22.710	-0.429	-1.9%
NP6-13	SO_3		0.366	0.440	-0.074	
NP6-13	SrO		0.088	0.090	-0.002	
NP6-13	ZrO_2		0.597	0.580	0.017	
NP6-13	Sum		97.269	99.970	-2.702	-2.7%
NP6-14	Al_2O_3		27.492	29.000	-1.508	-5.2%
NP6-14	B_2O_3		20.277	20.790	-0.513	-2.5%
NP6-14	Bi_2O_3		0.634	0.660	-0.027	
NP6-14	CaO		2.924	2.980	-0.056	
NP6-14	Cr_2O_3		0.737	0.810	-0.073	
NP6-14	F		0.198	0.260	-0.062	
NP6-14	Fe_2O_3		2.581	2.060	0.521	
NP6-14	Li_2O		3.859	4.100	-0.241	
NP6-14	MgO	<	0.166	0.100	0.066	
NP6-14	MnO		0.993	1.050	-0.057	
NP6-14	Na_2O		11.357	11.350	0.007	0.1%
NP6-14	NiO	<	0.127	0.090	0.037	
NP6-14	P_2O_5		0.542	0.760	-0.218	
NP6-14	PbO		0.053	0.050	0.003	
NP6-14	RuO_2	<	0.066	0.030	0.036	
NP6-14	SiO_2		25.030	25.300	-0.270	-1.1%
NP6-14	SO_3		0.228	0.240	-0.013	
NP6-14	SrO	<	0.059	0.050	0.009	
NP6-14	ZrO_2		0.208	0.310	-0.102	
NP6-14	Sum		97.530	99.990	-2.460	-2.5%
NP6-15	Al_2O_3		27.492	28.300	-0.808	-2.9%
NP6-15	B_2O_3		16.945	17.160	-0.215	-1.3%
NP6-15	Bi_2O_3		1.463	1.580	-0.117	
NP6-15	CaO		4.680	4.470	0.210	
NP6-15	Cr_2O_3		1.849	1.940	-0.091	
NP6-15	F		0.353	0.620	-0.267	

Table A-4. Comparison of Targeted and Measured Glass Compositions (continued)

Glass ID	Oxide	BDL (<)	Measured (wt %)	Targeted (wt %)	Difference of Measured versus Targeted	% Difference of Measured versus Targeted
NP6-15	Fe_2O_3		4.743	4.510	0.233	
NP6-15	Li_2O		3.380	3.470	-0.090	
NP6-15	MgO		0.263	0.250	0.013	
NP6-15	MnO		2.469	2.510	-0.041	
NP6-15	Na_2O		8.476	8.770	-0.294	-3.4%
NP6-15	NiO	<	0.127	0.230	-0.103	
NP6-15	P_2O_5		1.572	1.820	-0.248	
NP6-15	PbO		0.107	0.110	-0.003	
NP6-15	RuO_2	<	0.066	0.070	-0.004	
NP6-15	SiO_2		23.104	22.770	0.334	1.5%
NP6-15	SO_3		0.466	0.570	-0.104	
NP6-15	SrO		0.108	0.110	-0.002	
NP6-15	ZrO_2		0.571	0.750	-0.179	
NP6-15	Sum		98.236	100.010	-1.774	-1.8%
NP6-16	Al_2O_3		26.784	27.600	-0.816	-3.0%
NP6-16	B_2O_3		18.917	18.730	0.187	1.0%
NP6-16	Bi_2O_3		1.452	1.490	-0.038	
NP6-16	CaO	<	0.070	0.210	-0.140	
NP6-16	Cr_2O_3		1.739	1.820	-0.081	
NP6-16	F		0.446	0.580	-0.135	
NP6-16	Fe_2O_3		2.716	2.300	0.416	
NP6-16	Li_2O		5.398	5.850	-0.452	-7.7%
NP6-16	MgO		0.222	0.230	-0.008	
NP6-16	MnO		2.305	2.360	-0.055	
NP6-16	Na_2O		9.170	9.530	-0.360	-3.8%
NP6-16	NiO	<	0.127	0.210	-0.083	
NP6-16	P_2O_5		1.373	1.710	-0.338	
NP6-16	PbO		0.094	0.110	-0.016	
NP6-16	RuO_2	<	0.066	0.070	-0.004	
NP6-16	SiO_2		25.779	25.850	-0.071	-0.3%
NP6-16	SO_3		0.442	0.540	-0.098	
NP6-16	SrO		0.111	0.110	0.001	
NP6-16	ZrO_2		0.532	0.700	-0.168	
NP6-16	Sum		97.742	100.000	-2.258	-2.3%
NP6-17	Al_2O_3		21.115	22.300	-1.185	-5.3%
NP6-17	B_2O_3		17.074	17.670	-0.597	-3.4%
NP6-17	Bi_2O_3		1.591	1.670	-0.079	
NP6-17	CaO		4.439	4.380	0.059	
NP6-17	Cr_2O_3		1.886	2.040	-0.155	
NP6-17	F		0.457	0.660	-0.203	
NP6-17	Fe_2O_3		3.056	2.680	0.376	
NP6-17	Li_2O		0.234	0.300	-0.066	
NP6-17	MgO		0.290	0.260	0.030	
NP6-17	MnO		2.482	2.640	-0.158	
NP6-17	Na_2O		14.120	14.830	-0.710	-4.8%
NP6-17	NiO	<	0.127	0.240	-0.113	
NP6-17	P_2O_5		1.382	1.920	-0.538	
NP6-17	PbO		0.119	0.120	-0.001	
NP6-17	RuO_2	<	0.066	0.080	-0.014	
NP6-17	SiO_2		26.206	26.690	-0.484	-1.8%
NP6-17	SO_3		0.487	0.600	-0.113	

Table A-4. Comparison of Targeted and Measured Glass Compositions (continued)

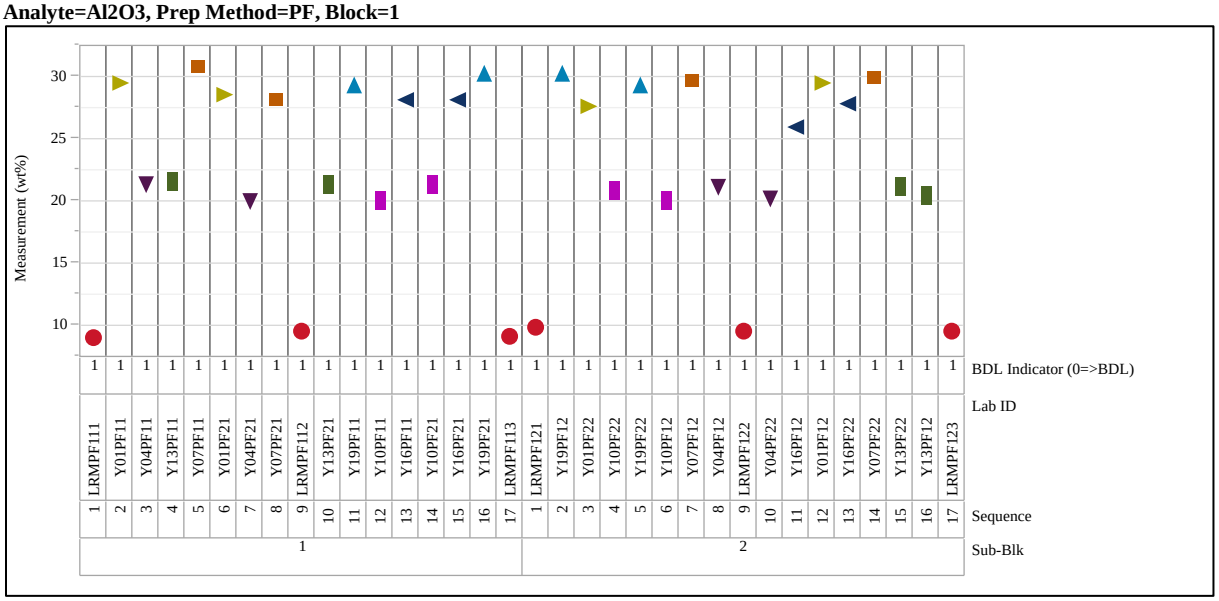
Glass ID	Oxide	BDL (<)	Measured (wt %)	Targeted (wt %)	Difference of Measured versus Targeted	% Difference of Measured versus Targeted
NP6-17	SrO		0.116	0.120	-0.004	
NP6-17	ZrO_2		0.320	0.780	-0.460	
NP6-17	Sum		95.567	99.980	-4.413	-4.4%
NP6-18	Al_2O_3		24.469	25.100	-0.631	-2.5%
NP6-18	B_2O_3		15.528	15.300	0.228	1.5%
NP6-18	Bi_2O_3		1.452	1.460	-0.008	
NP6-18	CaO		5.331	5.000	0.331	6.6%
NP6-18	Cr_2O_3		1.750	1.790	-0.040	
NP6-18	F		0.438	0.570	-0.132	
NP6-18	Fe_2O_3		4.193	3.750	0.443	
NP6-18	Li_2O		3.111	3.200	-0.089	
NP6-18	MgO		0.248	0.230	0.018	
NP6-18	MnO		2.256	2.320	-0.064	
NP6-18	Na_2O		9.911	10.160	-0.249	-2.4%
NP6-18	NiO	<	0.127	0.210	-0.083	
NP6-18	P_2O_5		1.394	1.680	-0.286	
NP6-18	PbO		0.100	0.110	-0.010	
NP6-18	RuO_2	<	0.066	0.070	-0.004	
NP6-18	SiO_2		27.811	27.780	0.031	0.1%
NP6-18	SO_3		0.449	0.530	-0.081	
NP6-18	SrO		0.102	0.100	0.002	
NP6-18	ZrO_2		0.653	0.690	-0.037	
NP6-18	Sum		99.389	100.050	-0.661	-0.7%
NP6-19	Al_2O_3		25.650	27.000	-1.350	-5.0%
NP6-19	B_2O_3		21.952	22.310	-0.358	-1.6%
NP6-19	Bi_2O_3		0.575	0.580	-0.005	
NP6-19	CaO		3.613	3.560	0.053	
NP6-19	Cr_2O_3		0.671	0.710	-0.040	
NP6-19	F		0.134	0.230	-0.097	
NP6-19	Fe_2O_3		3.960	3.620	0.340	
NP6-19	Li_2O		0.367	0.430	-0.064	
NP6-19	MgO	<	0.166	0.090	0.076	
NP6-19	MnO		0.863	0.920	-0.057	
NP6-19	Na_2O		14.727	15.420	-0.693	-4.5%
NP6-19	NiO	<	0.127	0.080	0.047	
NP6-19	P_2O_5		0.454	0.670	-0.216	
NP6-19	PbO		0.039	0.040	-0.001	
NP6-19	RuO_2	<	0.066	0.030	0.036	
NP6-19	SiO_2		23.104	23.750	-0.646	-2.7%
NP6-19	SO_3		0.166	0.210	-0.045	
NP6-19	SrO	<	0.059	0.040	0.019	
NP6-19	ZrO_2		0.304	0.270	0.034	
NP6-19	Sum		96.995	99.960	-2.965	-3.0%
NP6-20	Al_2O_3		20.690	21.700	-1.010	-4.7%
NP6-20	B_2O_3		14.804	15.080	-0.277	-1.8%
NP6-20	Bi_2O_3		1.689	1.790	-0.101	
NP6-20	CaO	<	0.093	0.350	-0.257	
NP6-20	Cr_2O_3		1.999	2.190	-0.191	
NP6-20	F		0.515	0.700	-0.185	
NP6-20	Fe_2O_3		2.677	2.360	0.317	
NP6-20	Li_2O		3.402	3.590	-0.188	

Table A-4. Comparison of Targeted and Measured Glass Compositions (continued)

Glass ID	Oxide	BDL (<)	Measured (wt %)	Targeted (wt %)	Difference of Measured versus Targeted	% Difference of Measured versus Targeted
NP6-20	MgO		0.289	0.280	0.009	
NP6-20	MnO		2.683	2.840	-0.158	
NP6-20	Na_2O		13.322	13.550	-0.228	-1.7%
NP6-20	NiO	<	0.127	0.260	-0.133	
NP6-20	P_2O_5		1.456	2.060	-0.604	
NP6-20	PbO		0.131	0.130	0.001	
NP6-20	RuO_2	<	0.066	0.080	-0.014	
NP6-20	SiO_2		31.020	31.420	-0.400	-1.3%
NP6-20	SO_3		0.600	0.650	-0.050	
NP6-20	SrO		0.124	0.130	-0.006	
NP6-20	ZrO_2		0.390	0.840	-0.450	
NP6-20	Sum		96.075	100.000	-3.926	-3.9%

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

Analyte=Al2O3, Prep Method=PF, Block=1



Analyte=Al2O3, Prep Method=PF, Block=2

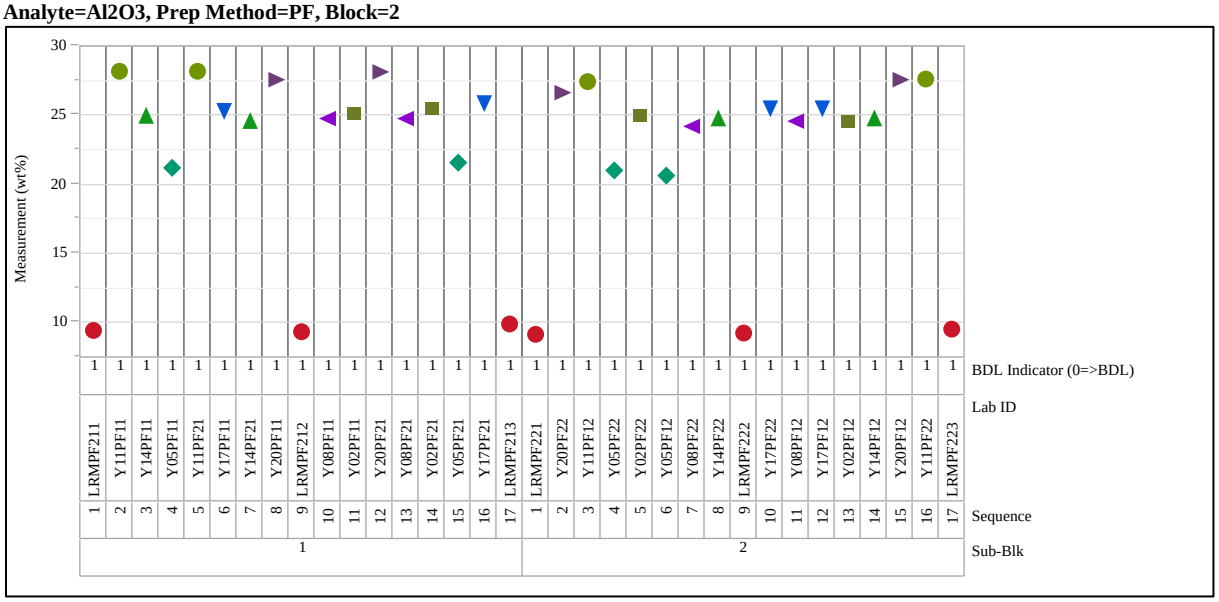
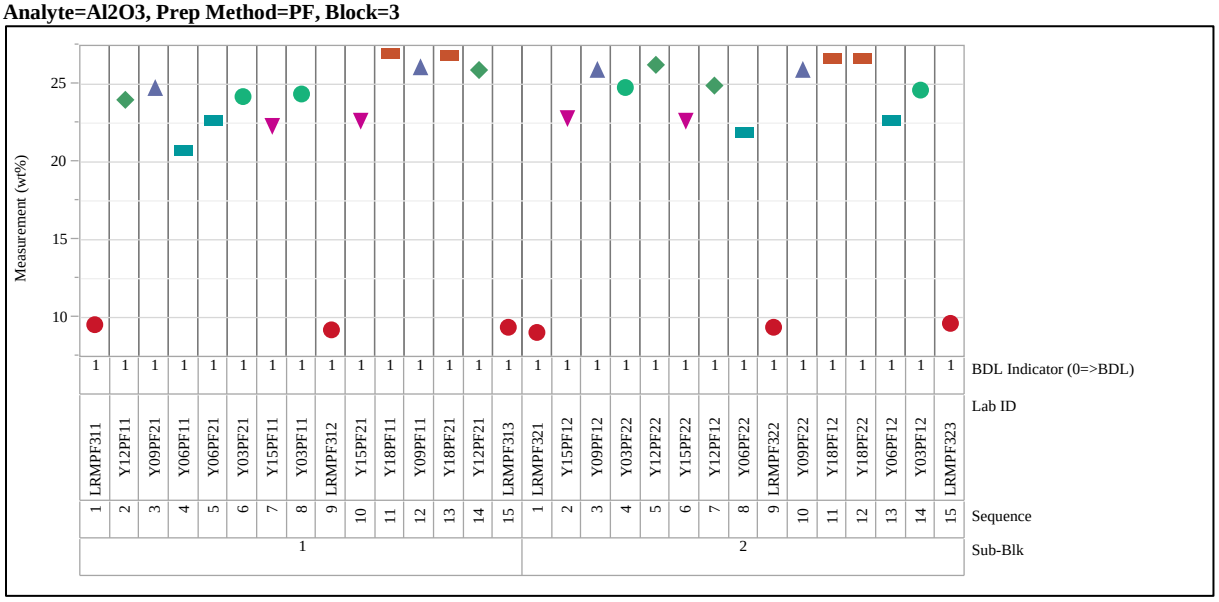


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=Al2O3, Prep Method=PF, Block=3



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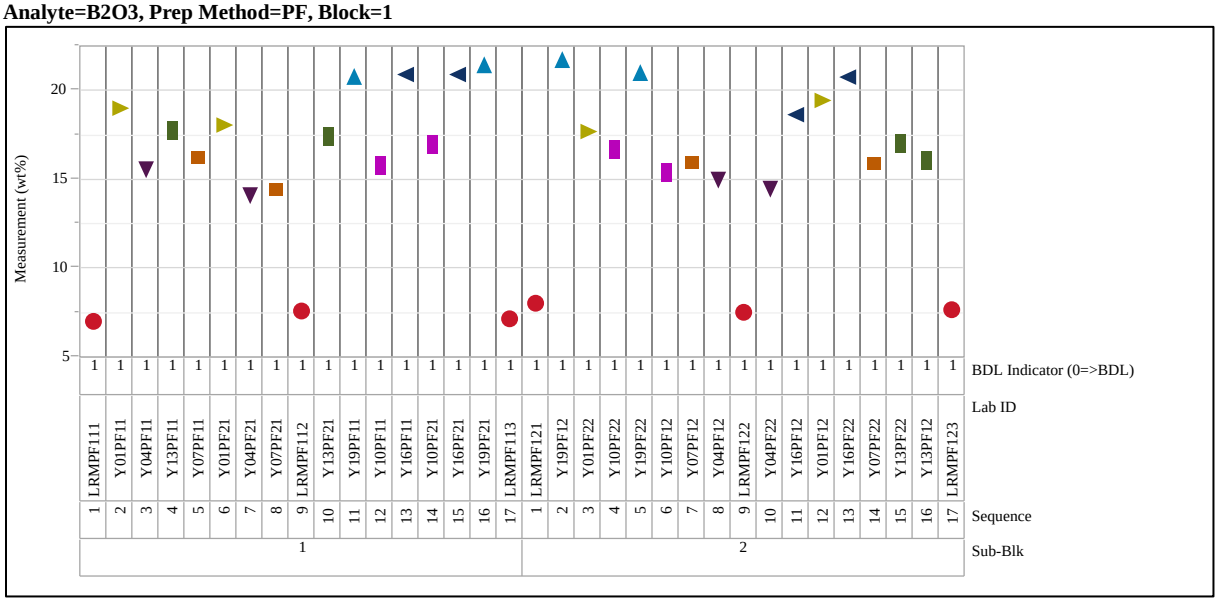
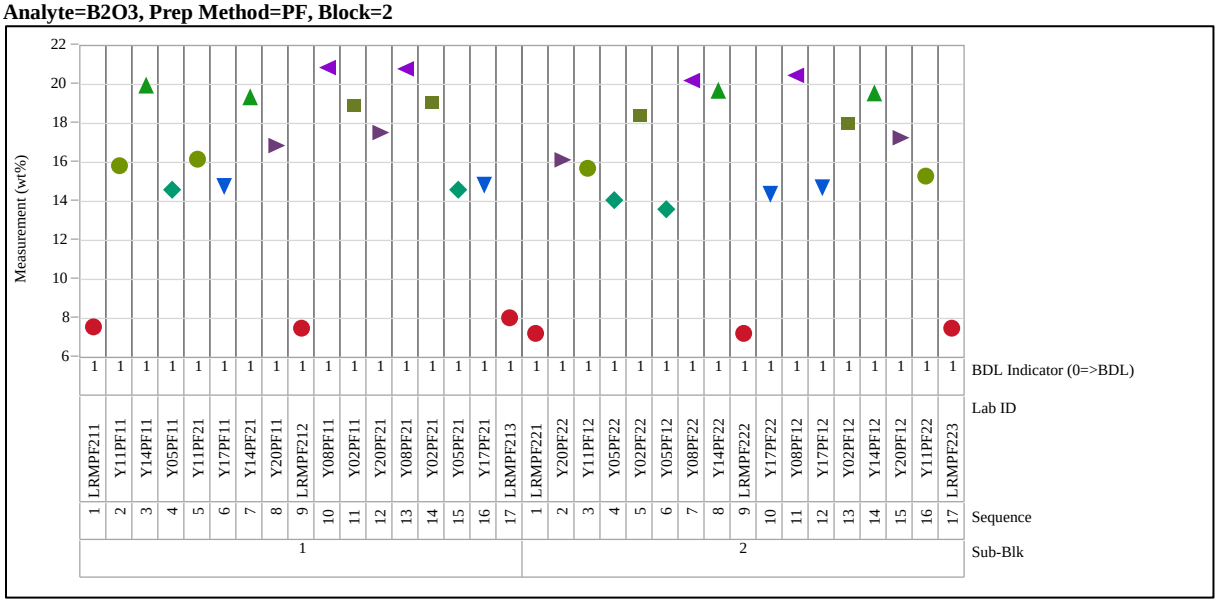


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=B2O3, Prep Method=PF, Block=2



Analyte=B2O3, Prep Method=PF, Block=3

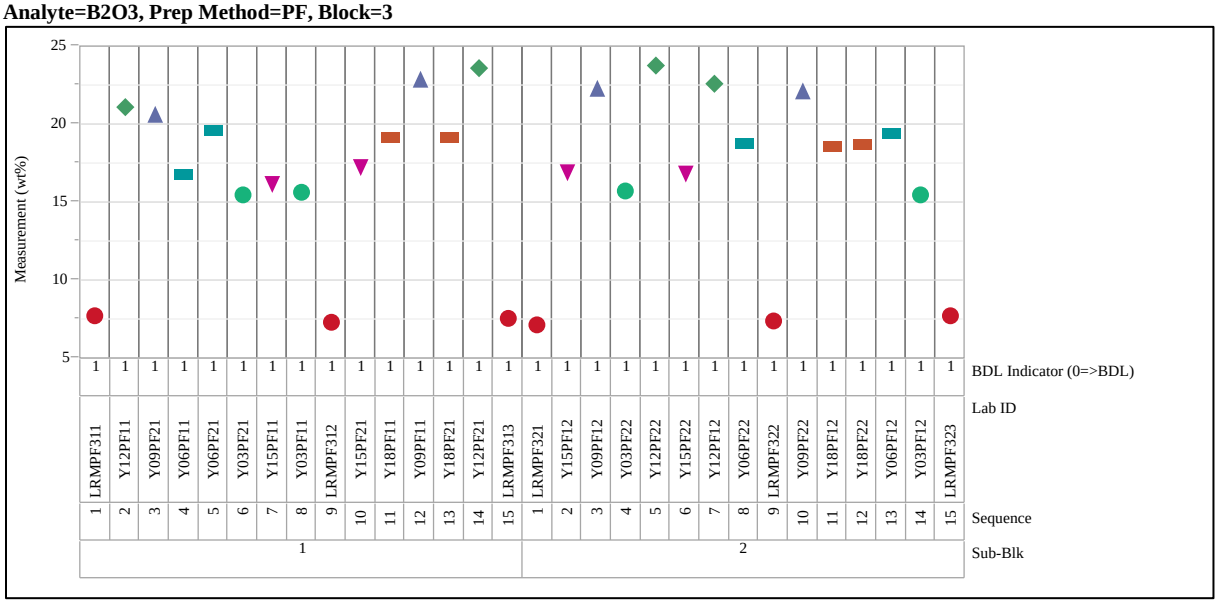
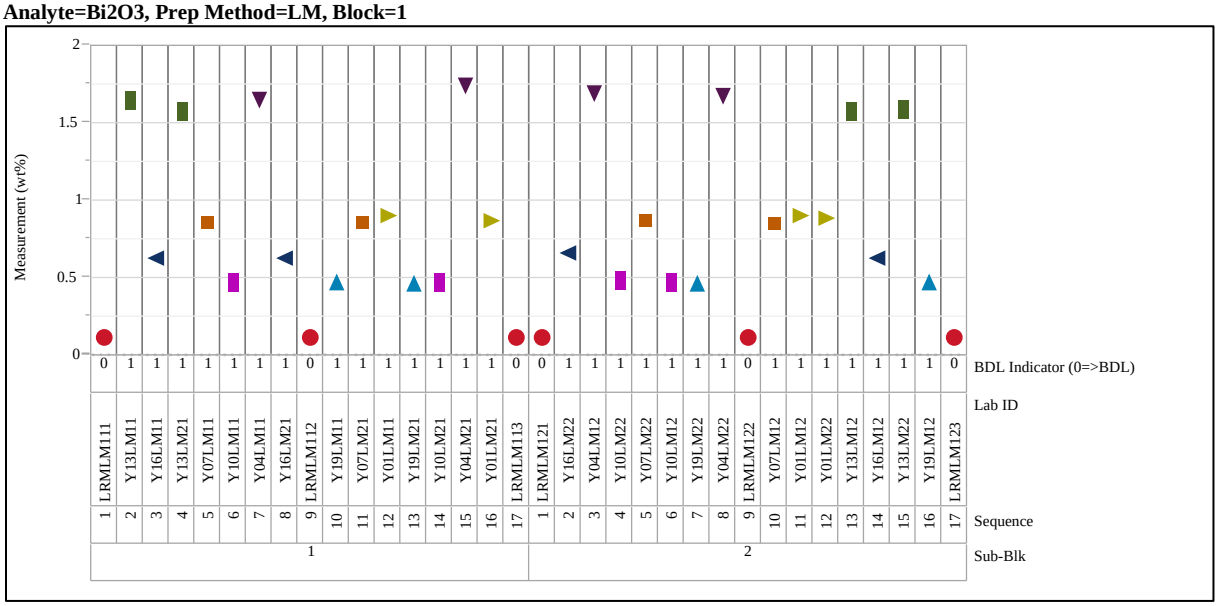


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=Bi2O3, Prep Method=LM, Block=1



Analyte=Bi2O3, Prep Method=LM, Block=2

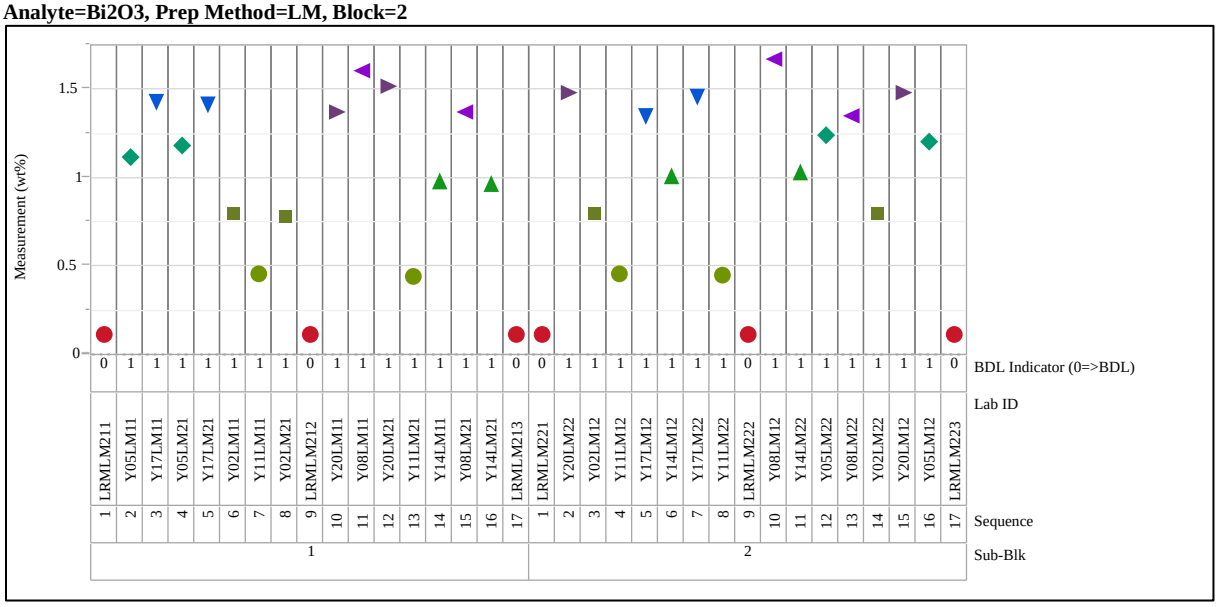
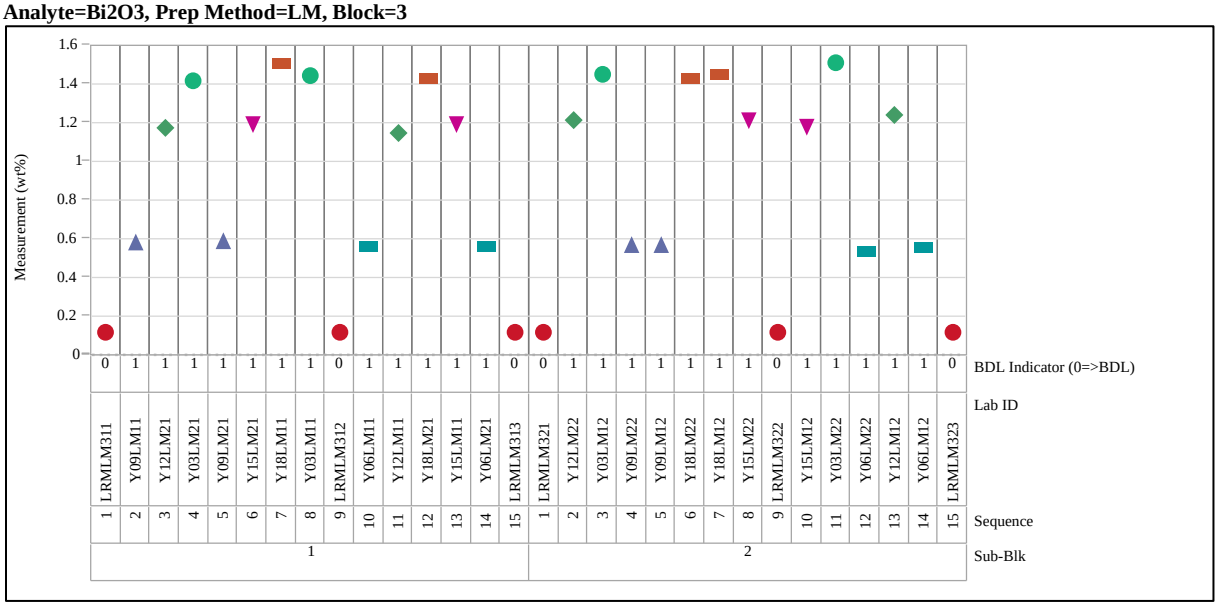


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=Bi2O3, Prep Method=LM, Block=3



Analyte=CaO, Prep Method=PF, Block=1

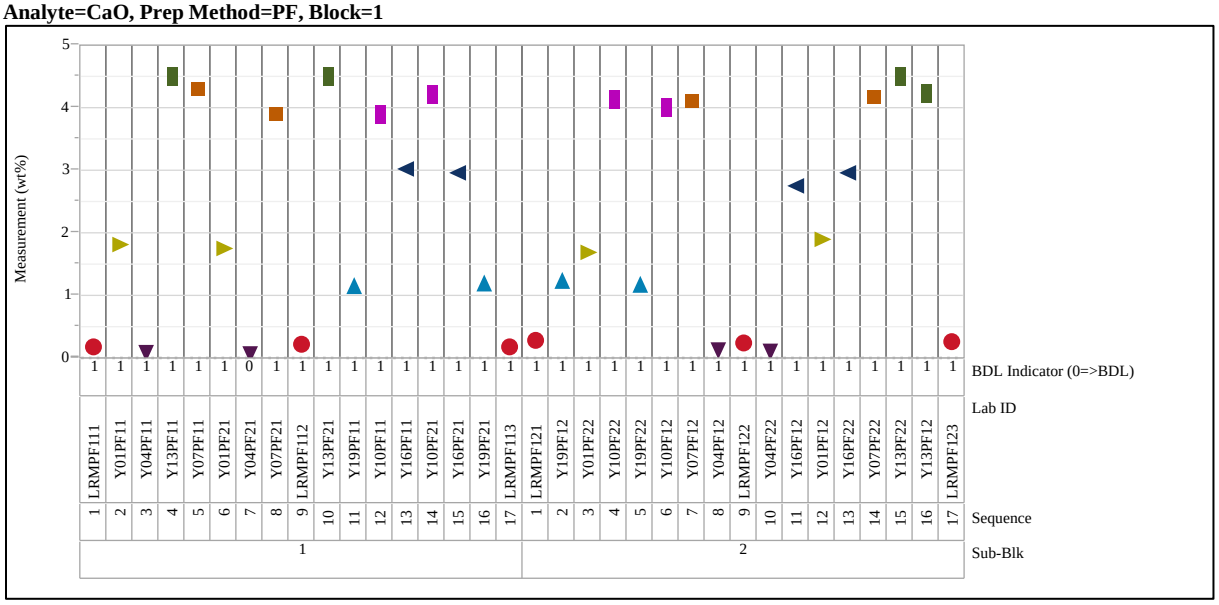
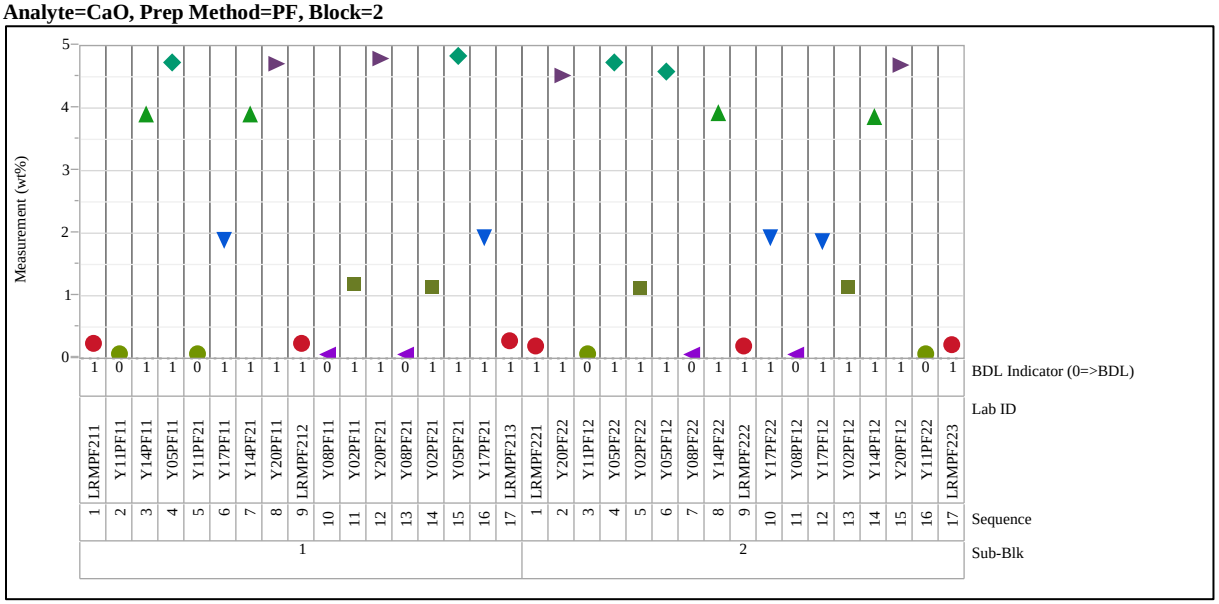


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=CaO, Prep Method=PF, Block=2



Analyte=CaO, Prep Method=PF, Block=3

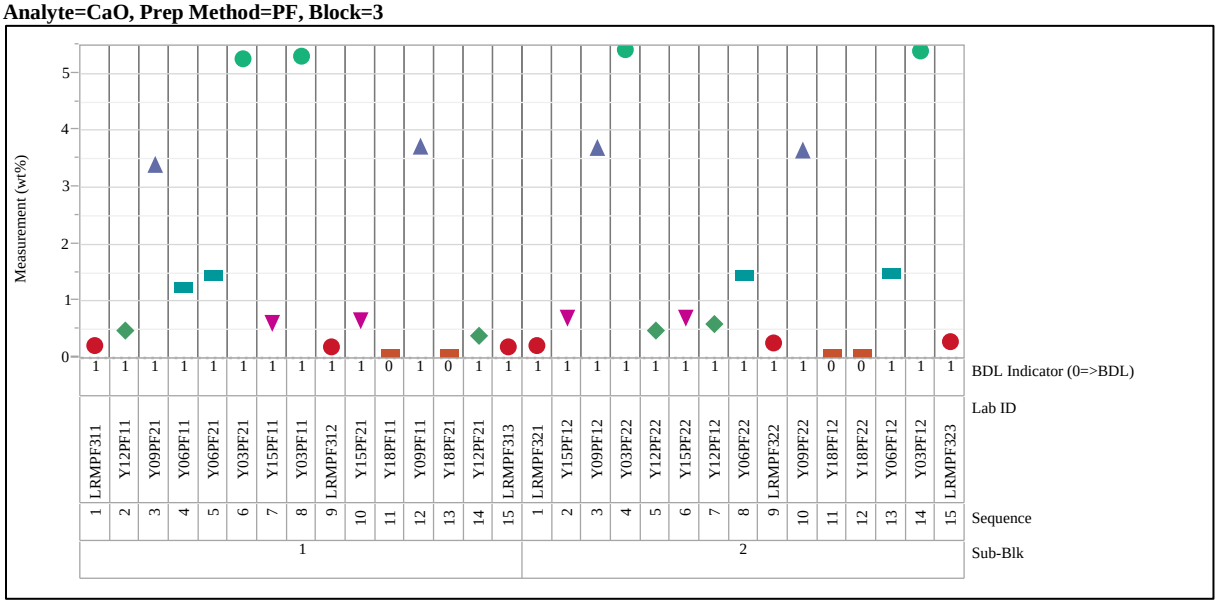
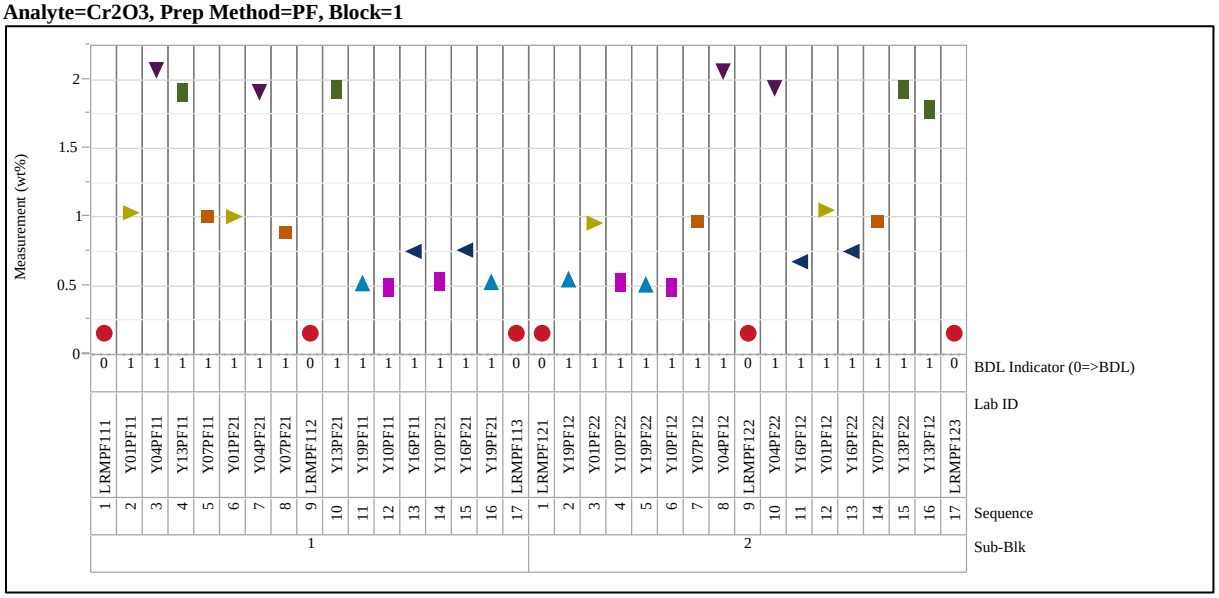


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=Cr2O3, Prep Method=PF, Block=1



Analyte=Cr2O3, Prep Method=PF, Block=2

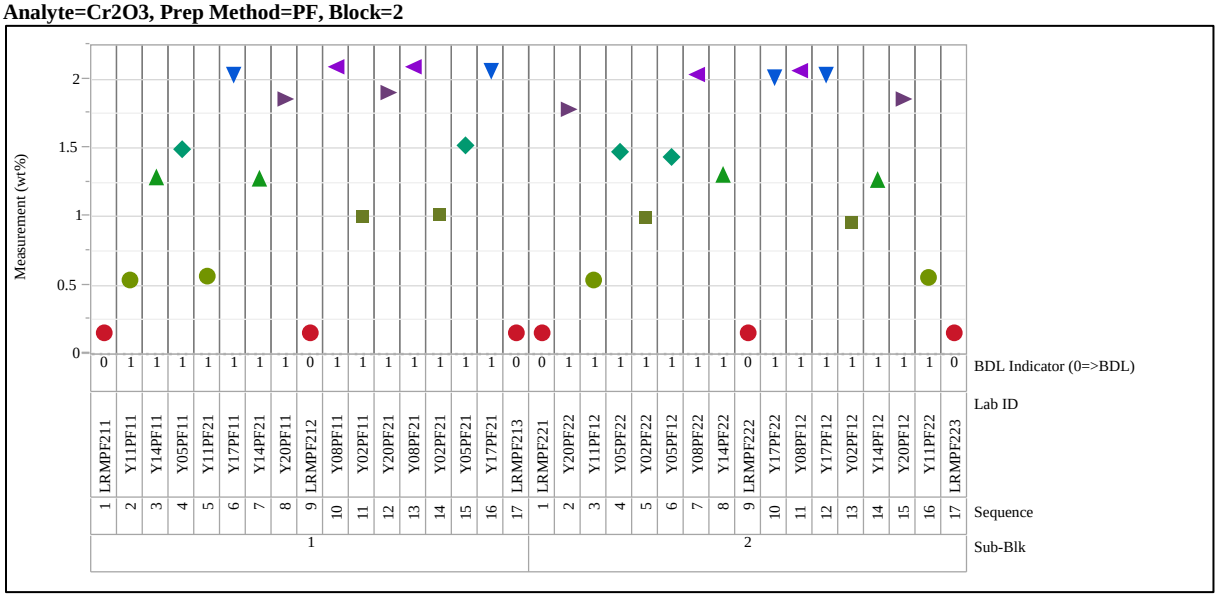
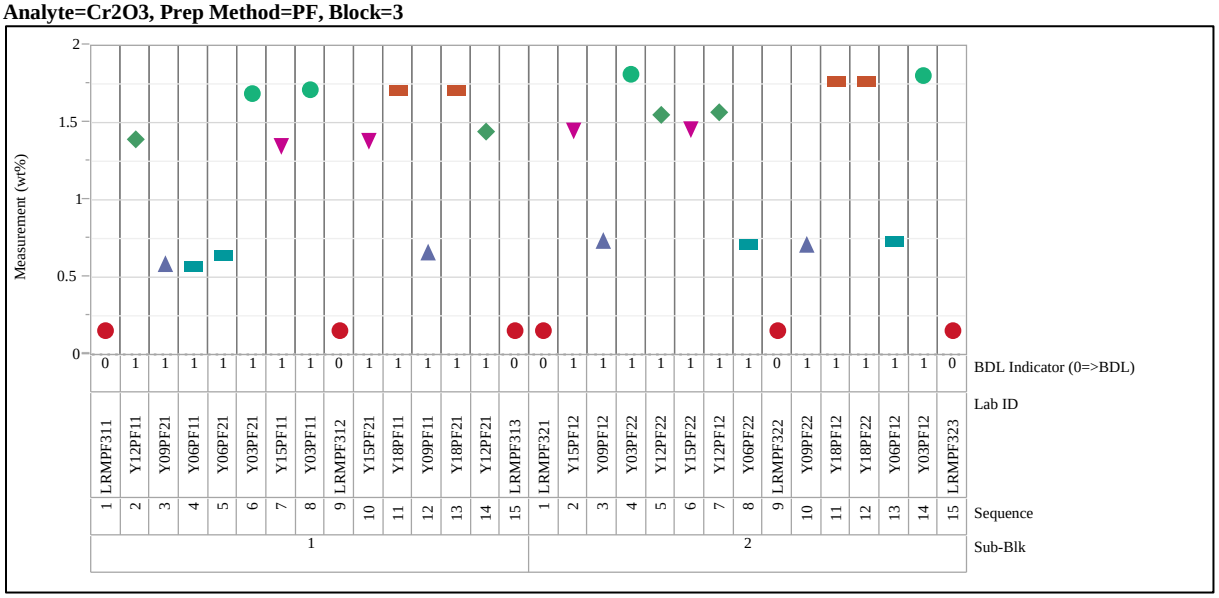


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=Cr2O3, Prep Method=PF, Block=3



Analyte=F, Prep Method=KH, Block=1

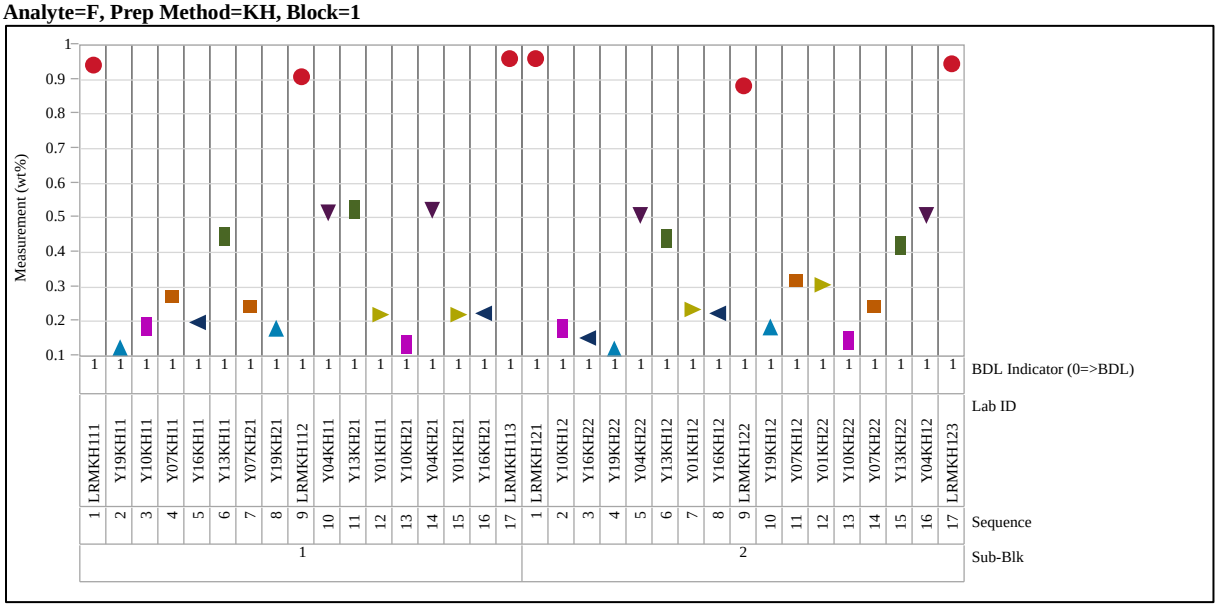
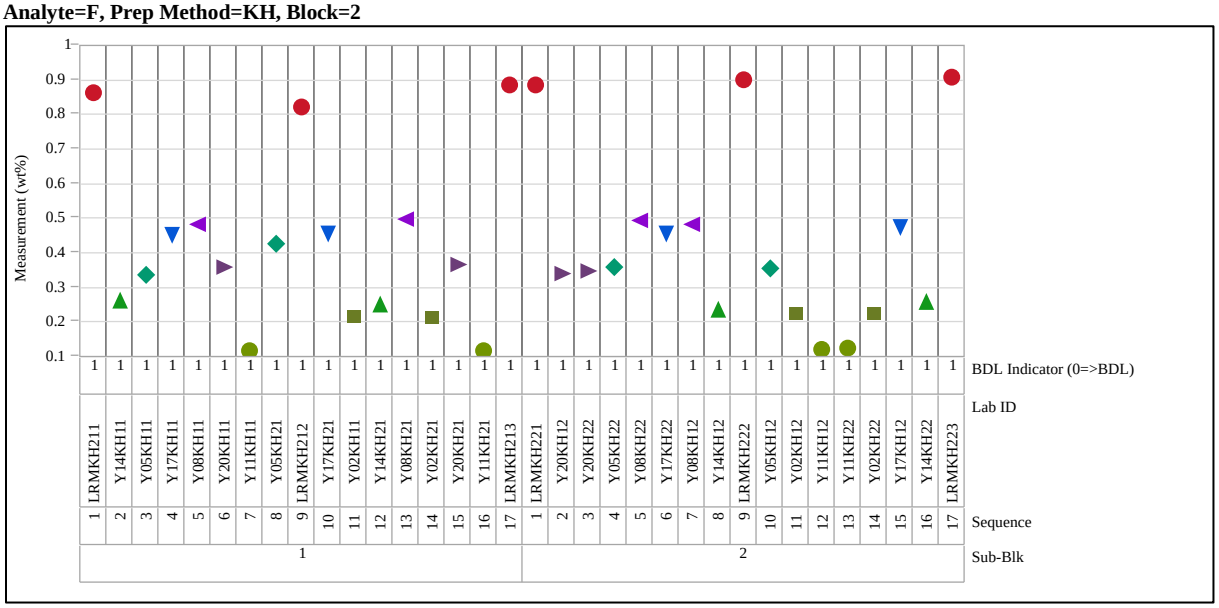


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=F, Prep Method=KH, Block=2



Analyte=F, Prep Method=KH, Block=3

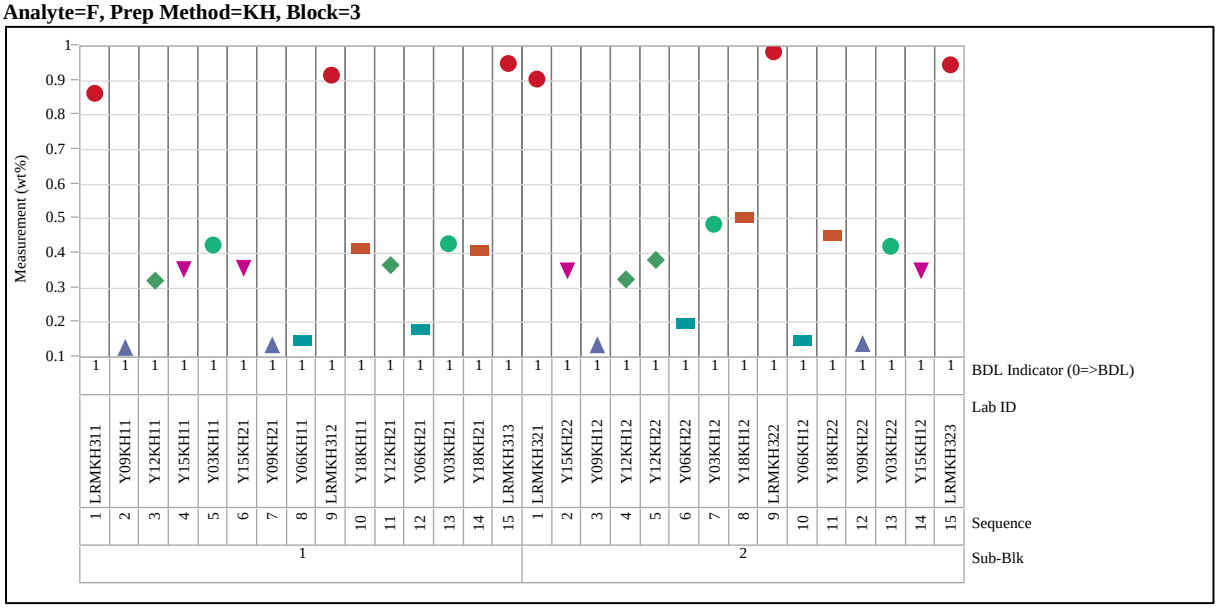
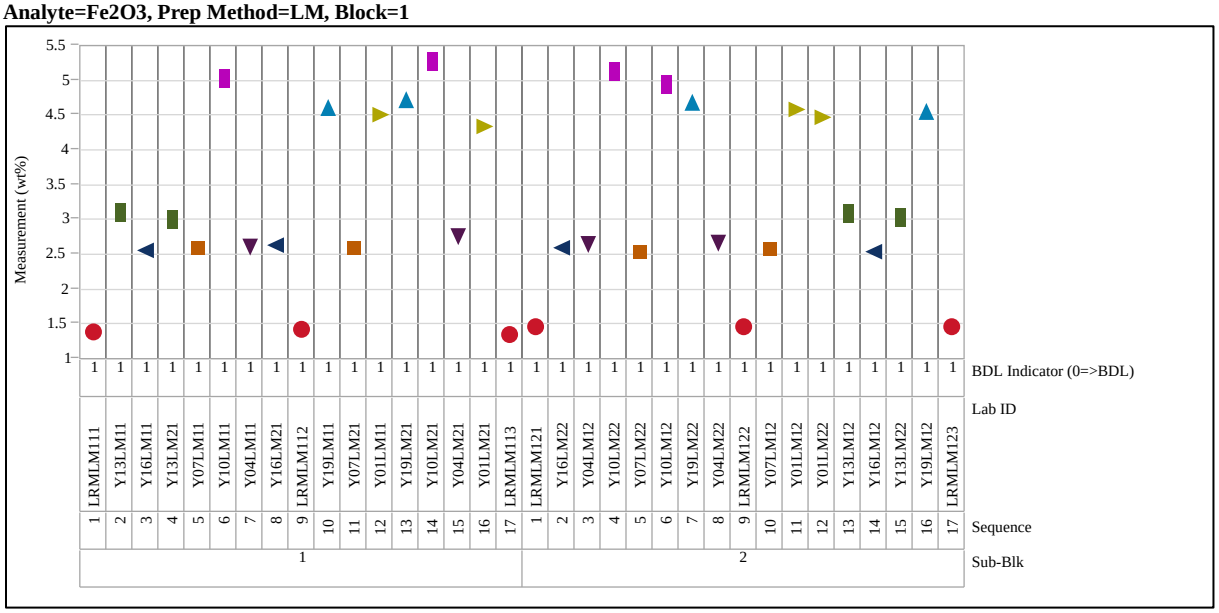


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=Fe2O3, Prep Method=LM, Block=1



Analyte=Fe2O3, Prep Method=LM, Block=2

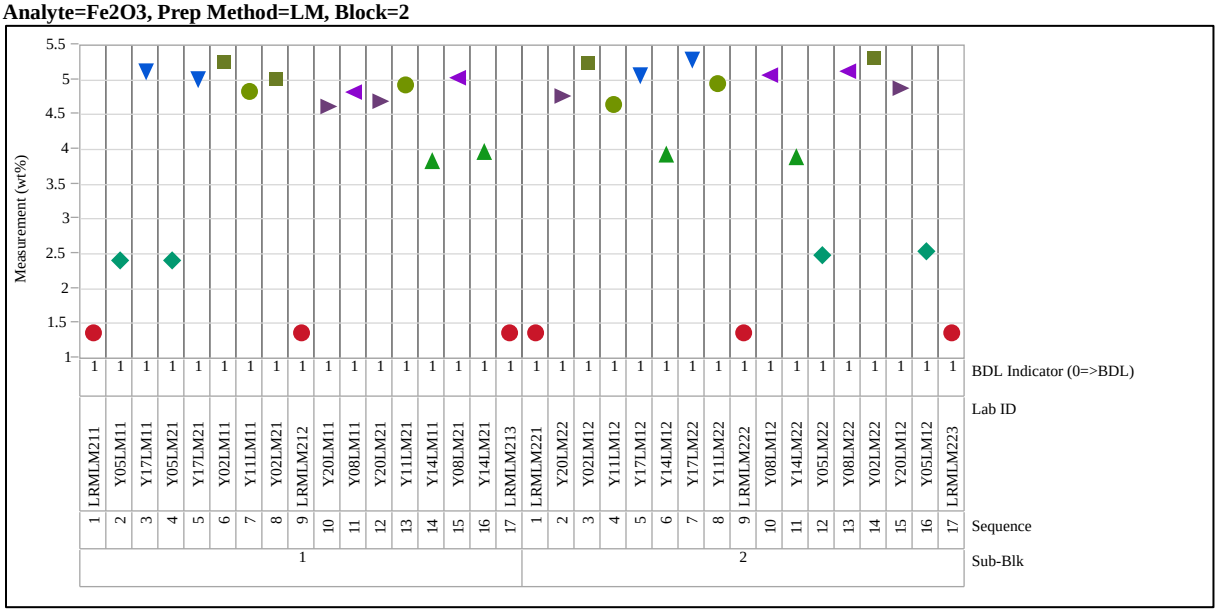
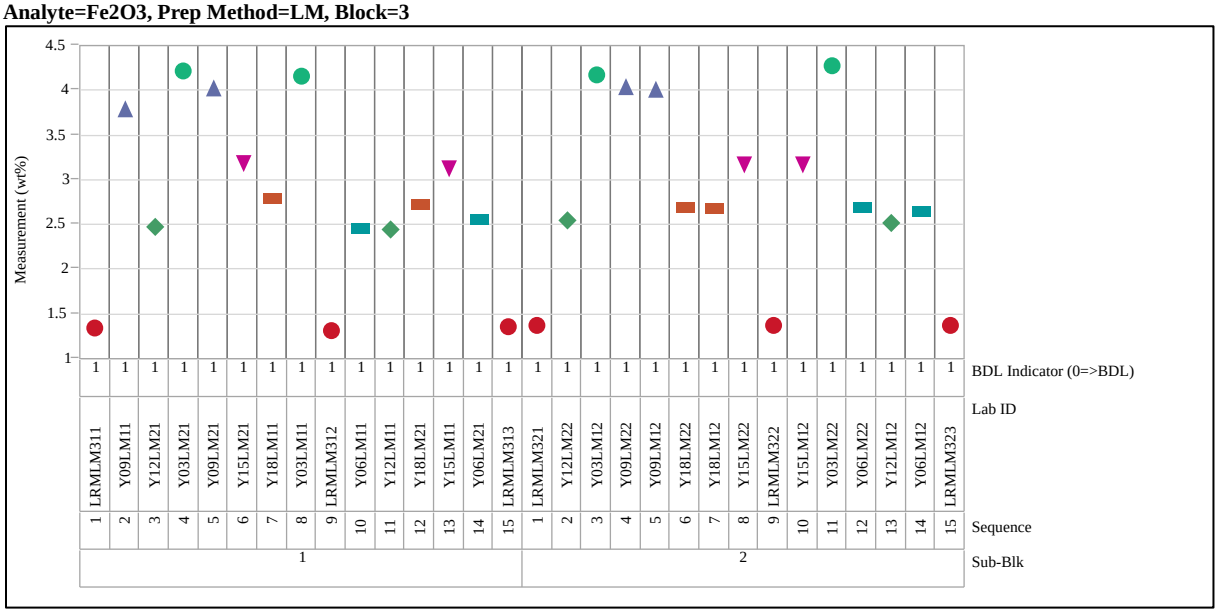


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=Fe2O3, Prep Method=LM, Block=3



Analyte=Li2O, Prep Method=PF, Block=1

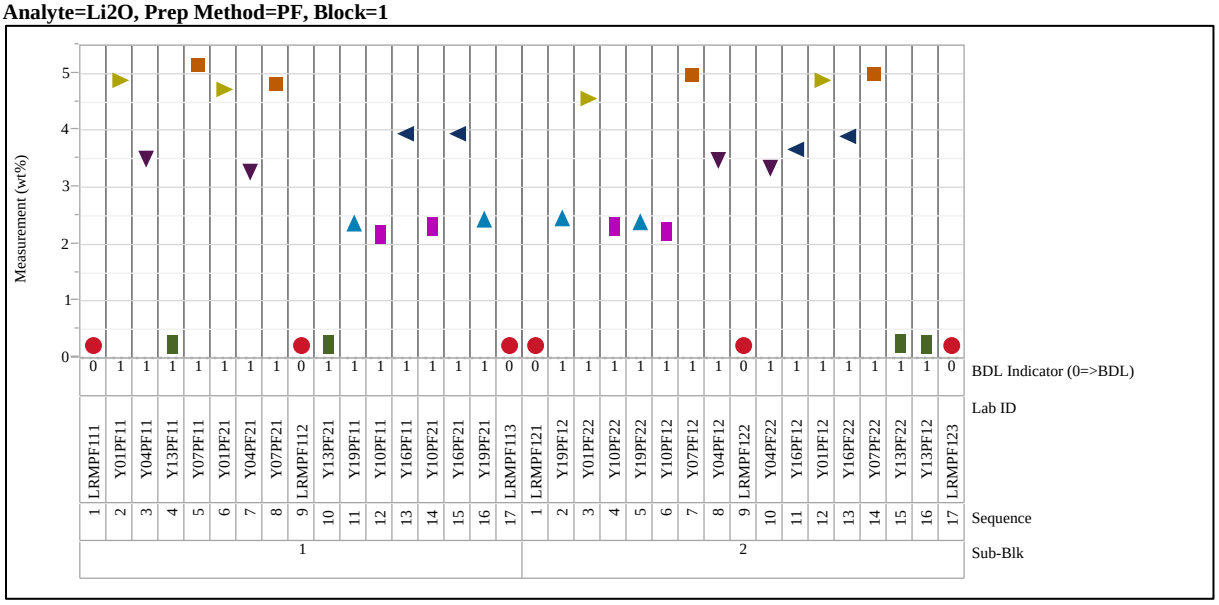
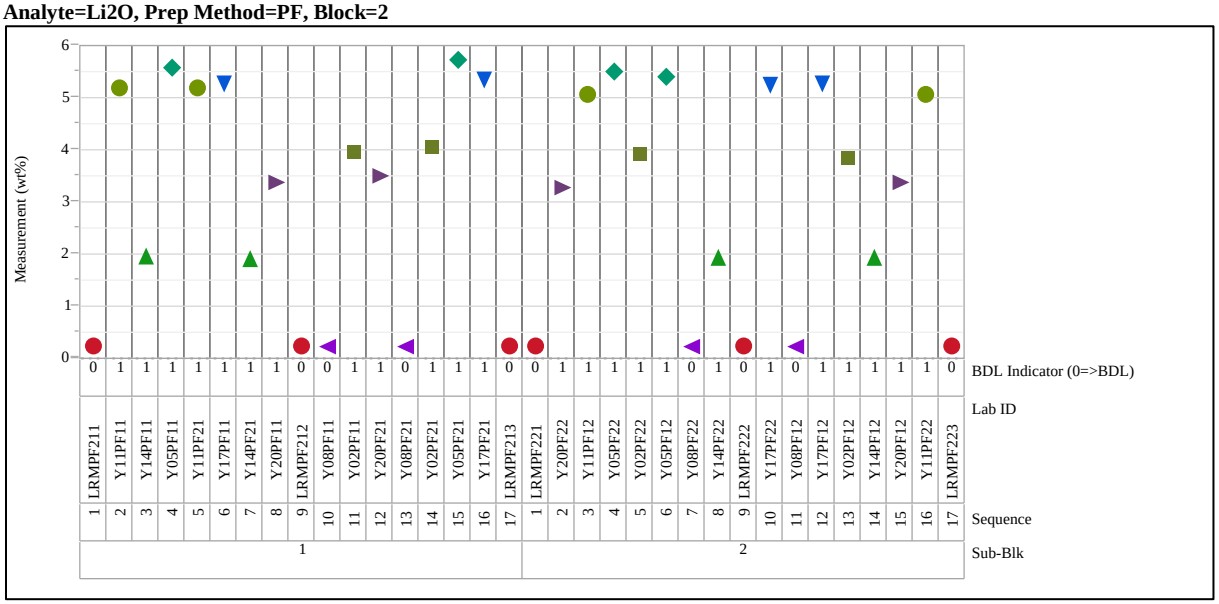


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=Li2O, Prep Method=PF, Block=2



Analyte=Li2O, Prep Method=PF, Block=3

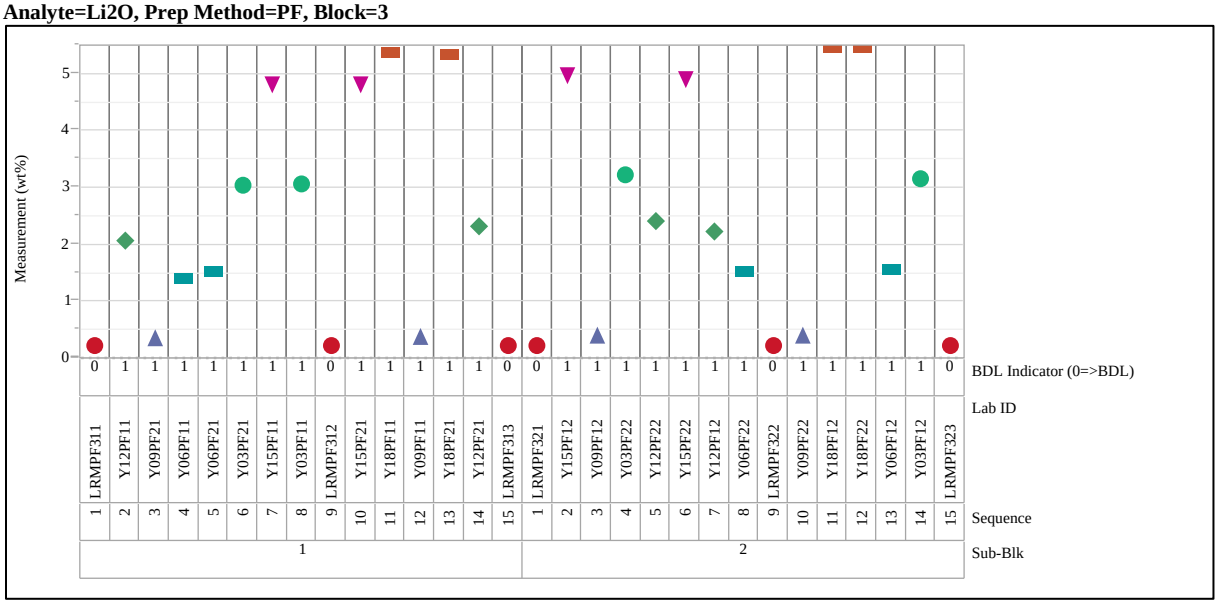
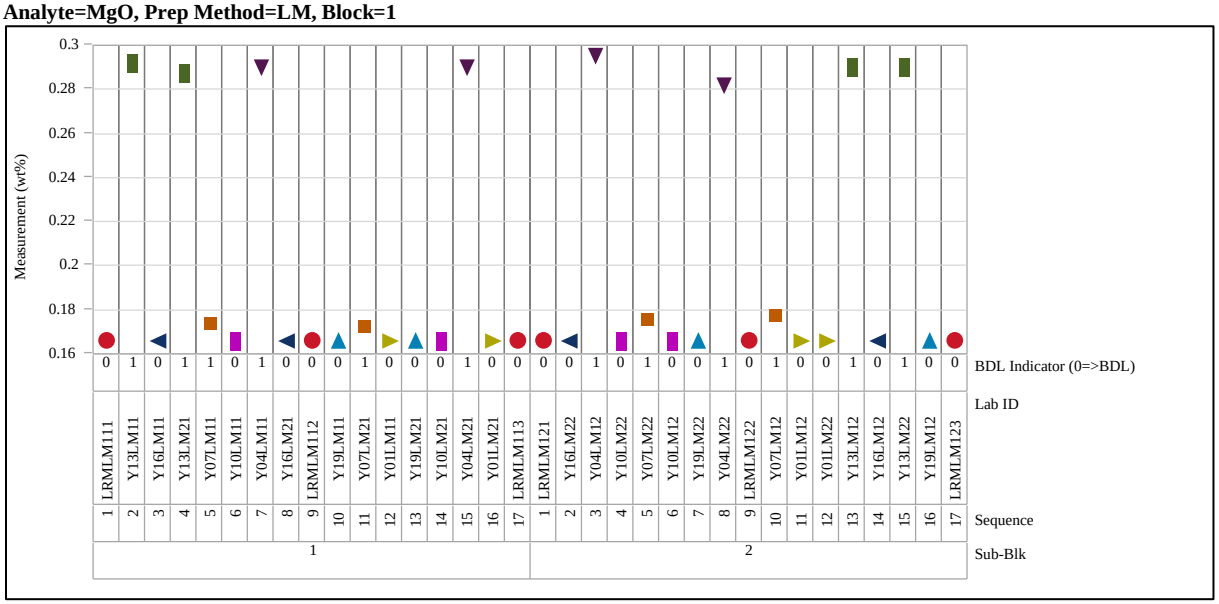


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=MgO, Prep Method=LM, Block=1



Analyte=MgO, Prep Method=LM, Block=2

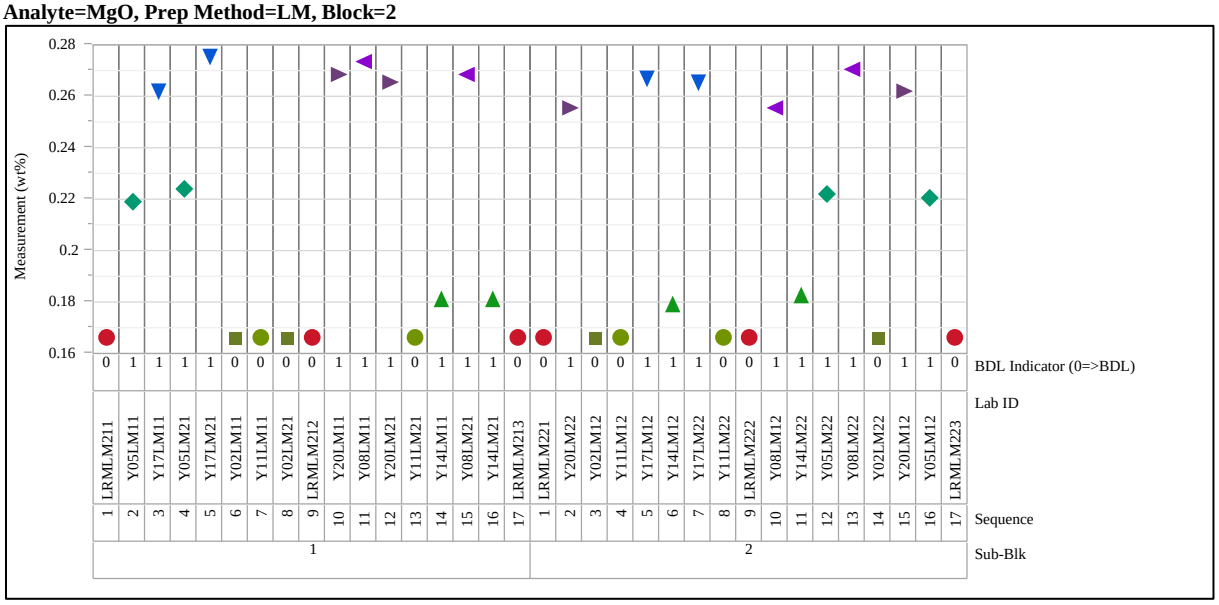
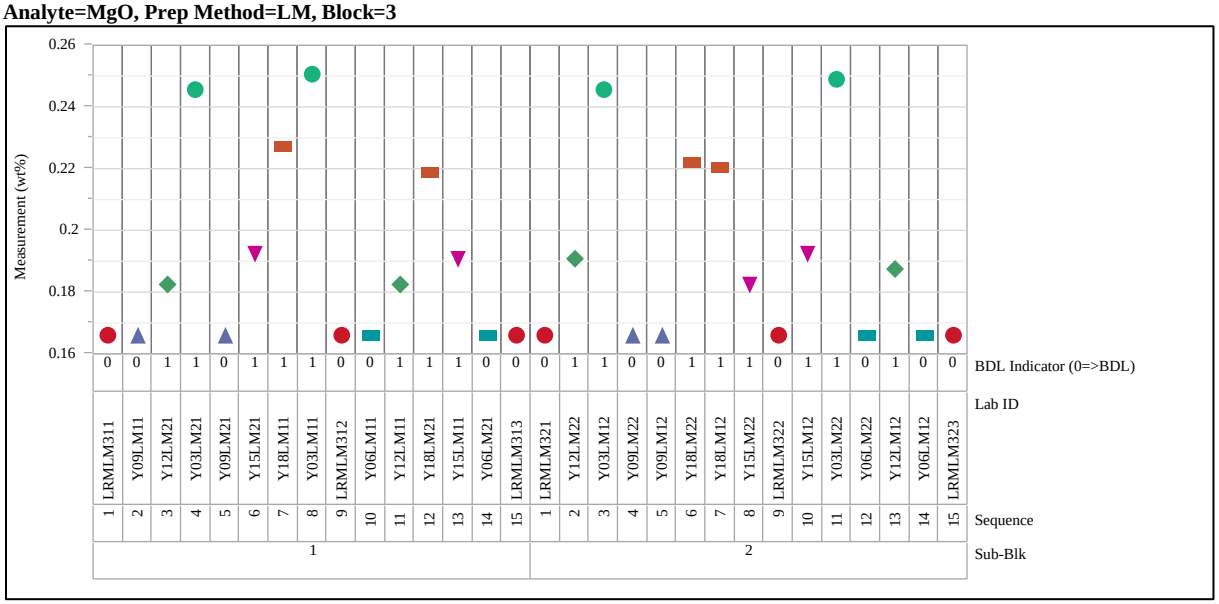


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=MgO, Prep Method=LM, Block=3



Analyte=MnO, Prep Method=PF, Block=1

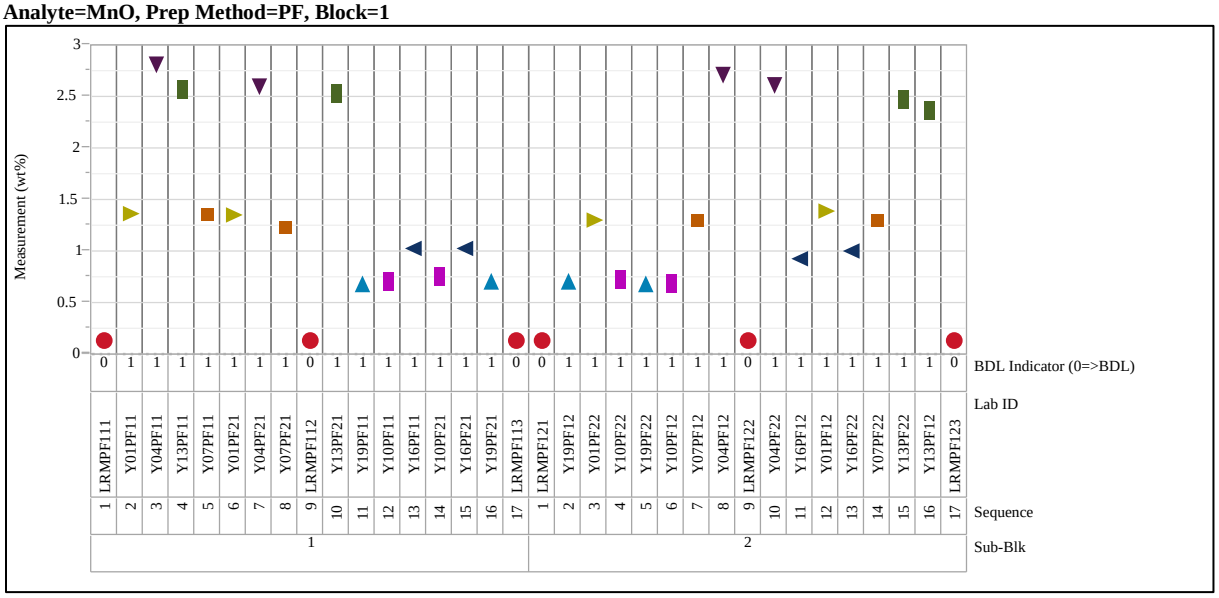
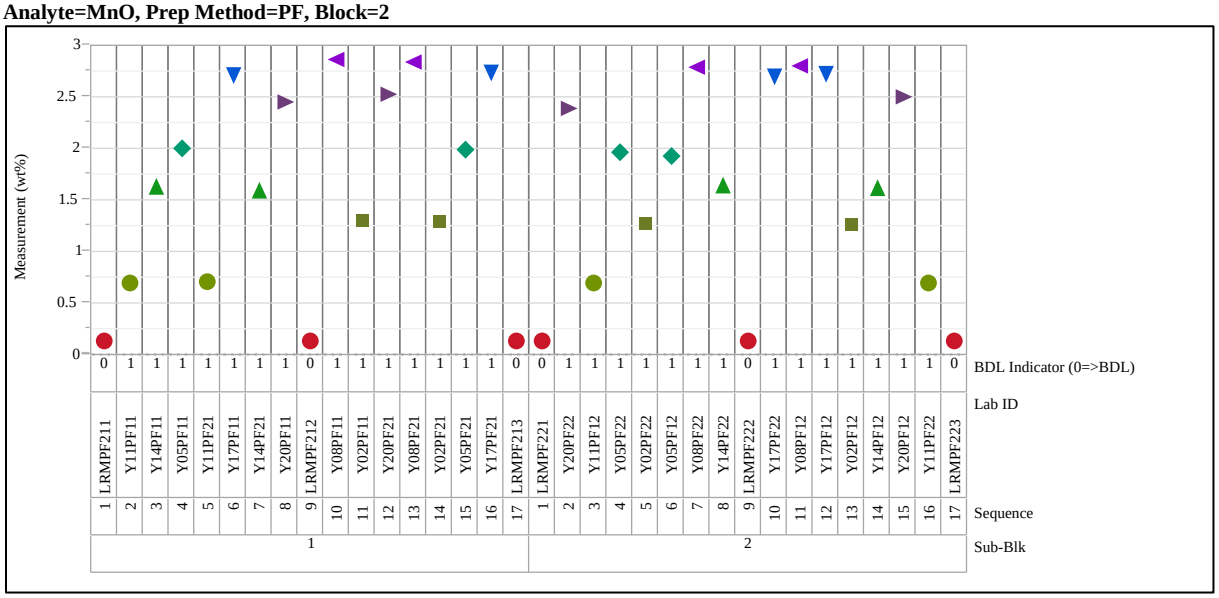


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=MnO, Prep Method=PF, Block=2



Analyte=MnO, Prep Method=PF, Block=3

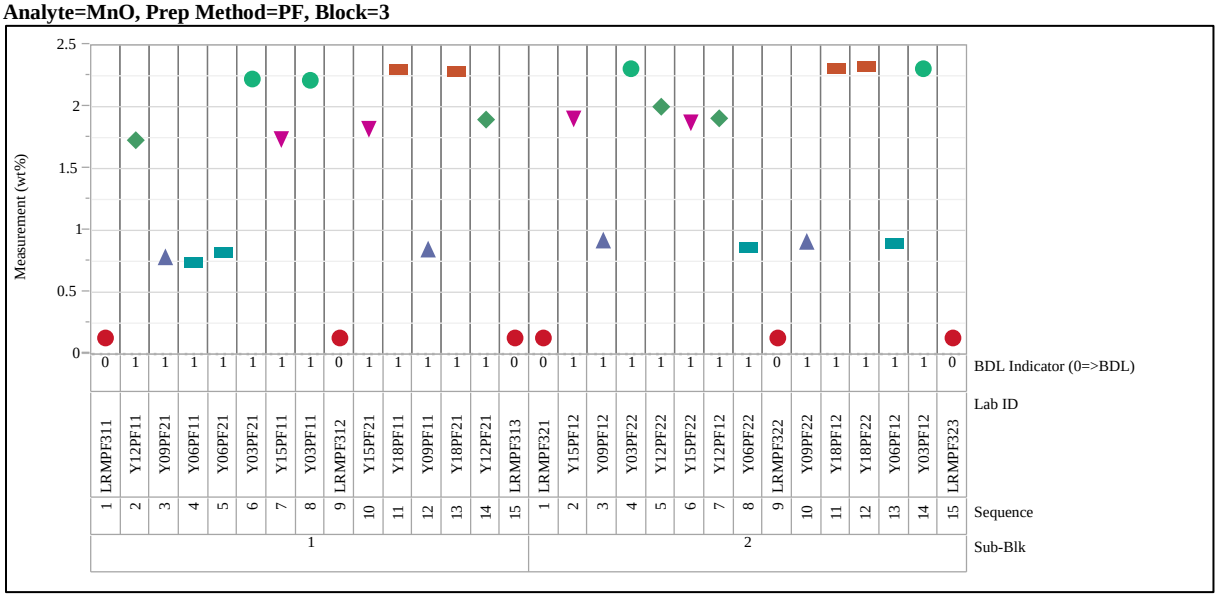
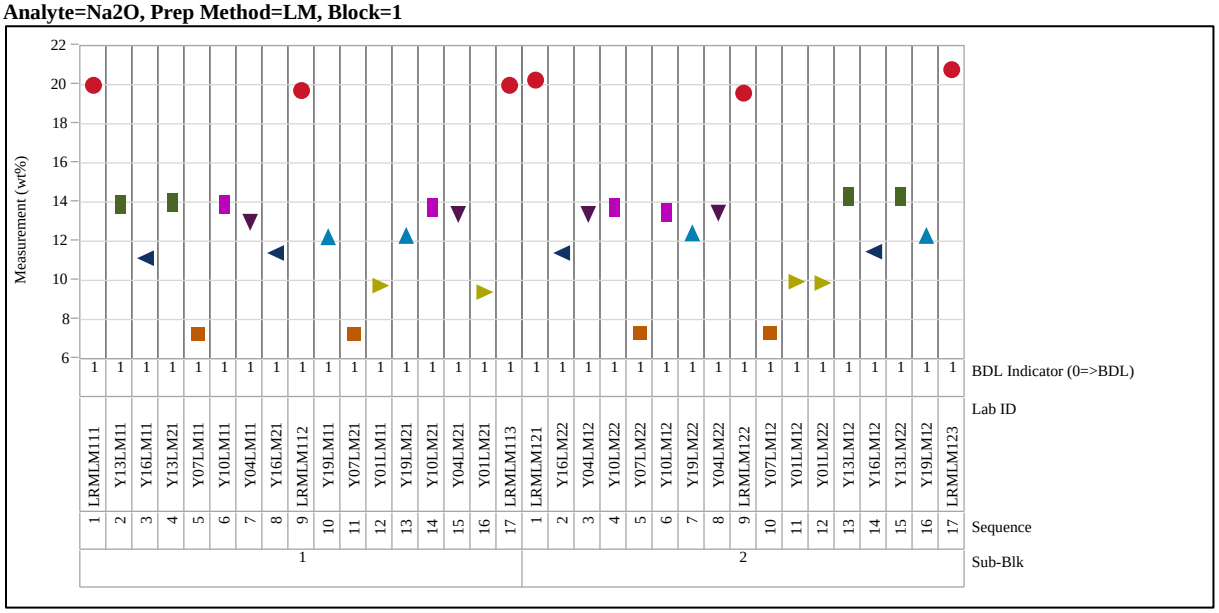


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=Na2O, Prep Method=LM, Block=1



Analyte=Na2O, Prep Method=LM, Block=2

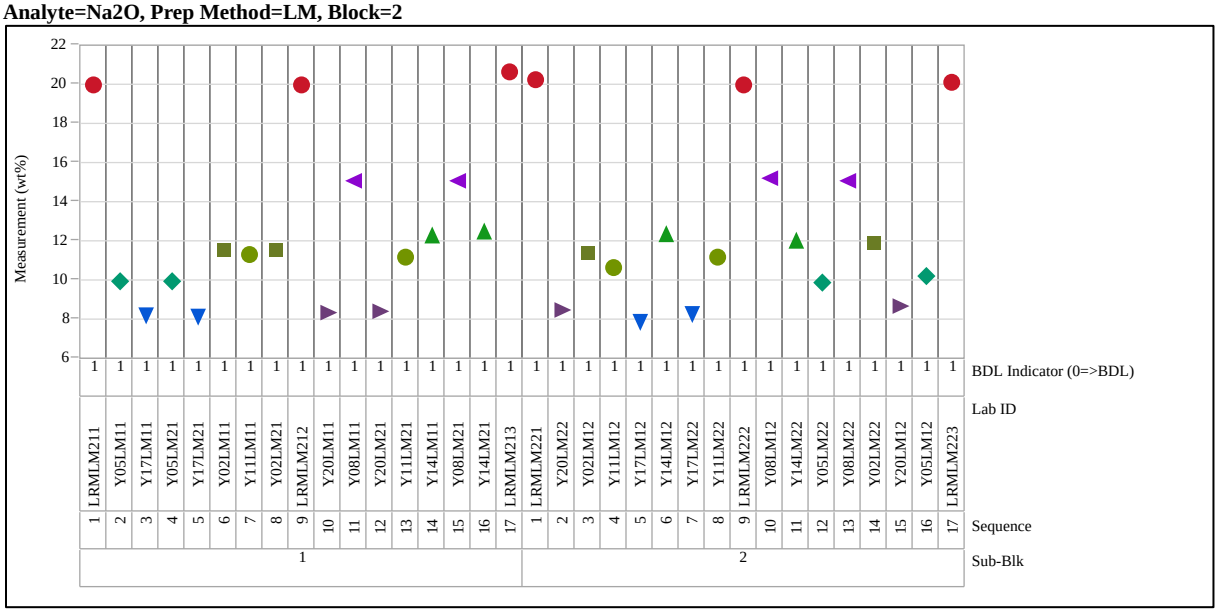
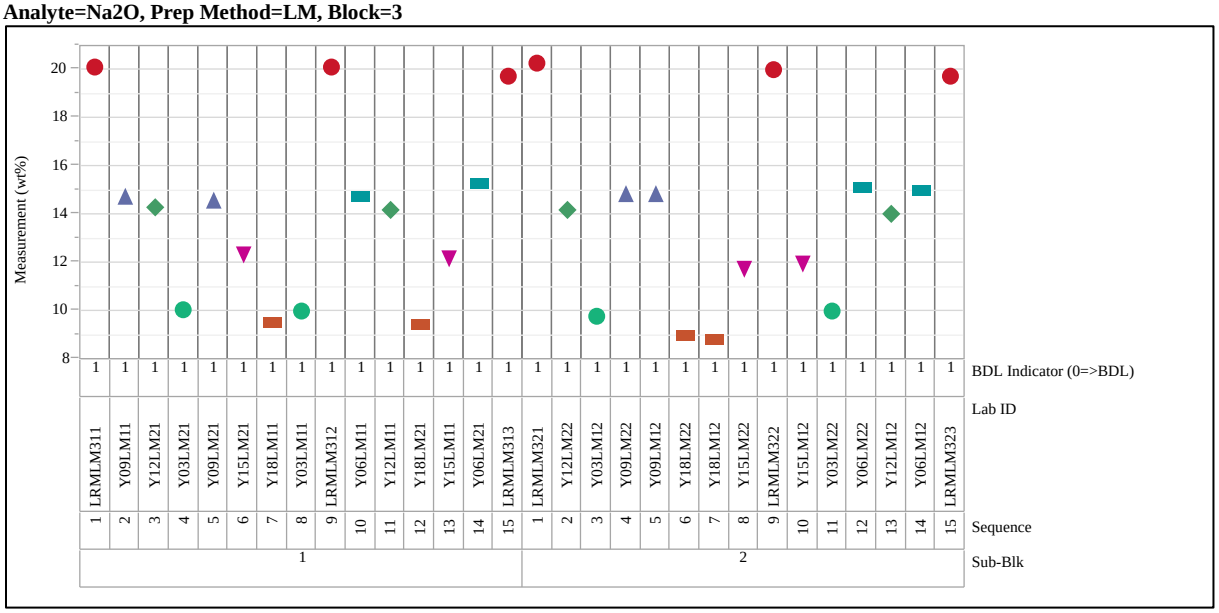


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=Na2O, Prep Method=LM, Block=3



Analyte=NiO, Prep Method=PF, Block=1

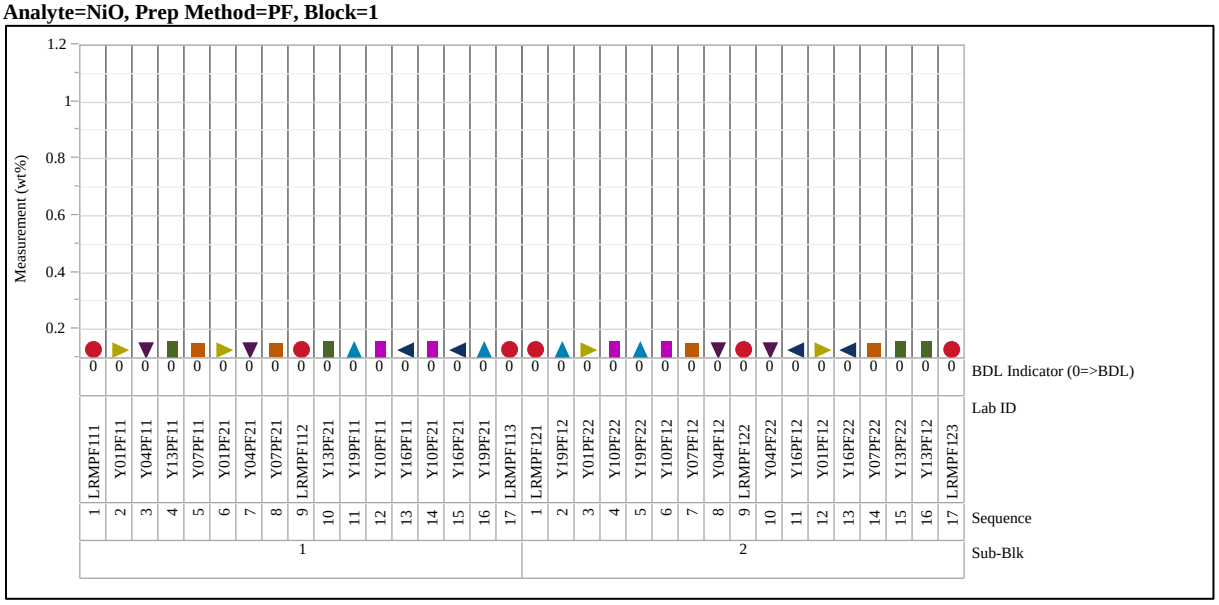
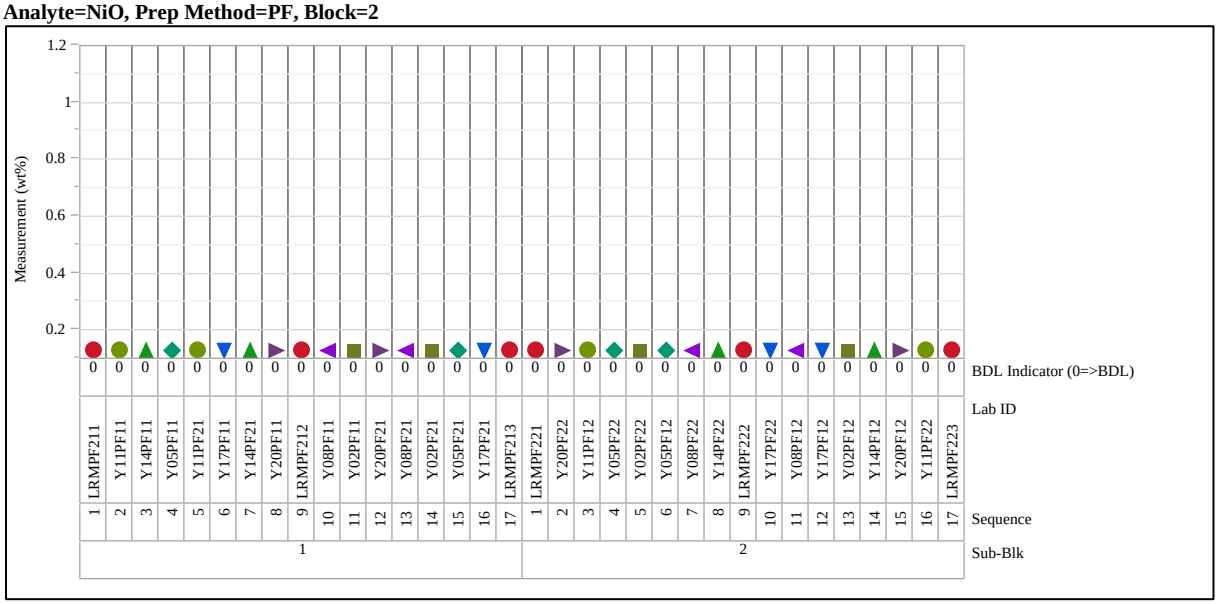


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=NiO, Prep Method=PF, Block=2



Analyte=NiO, Prep Method=PF, Block=3

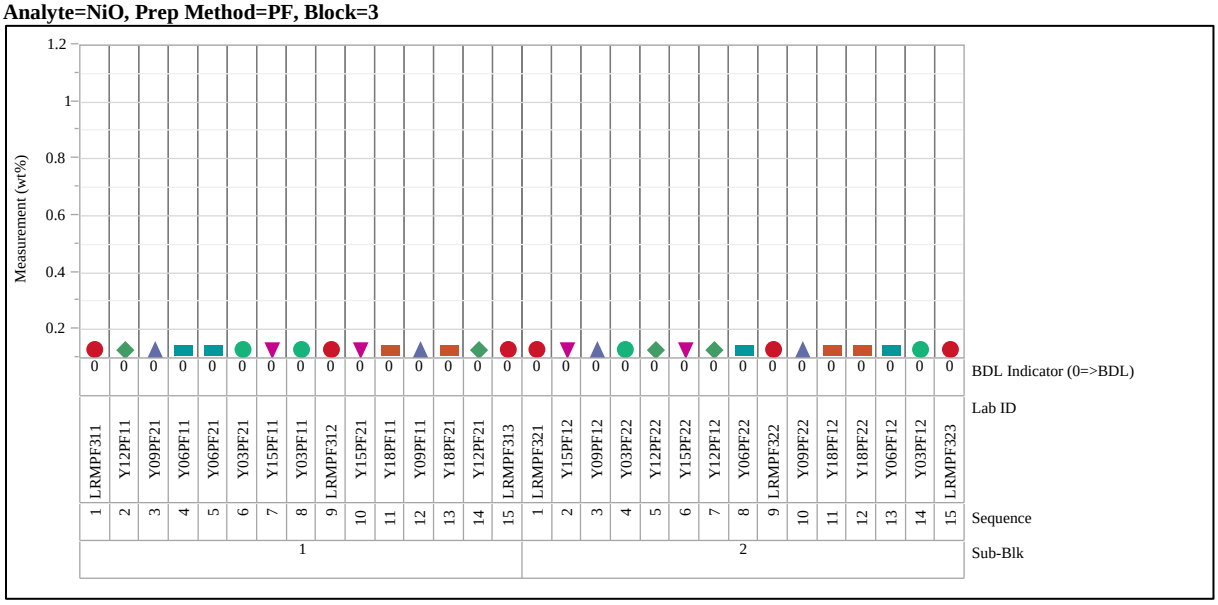
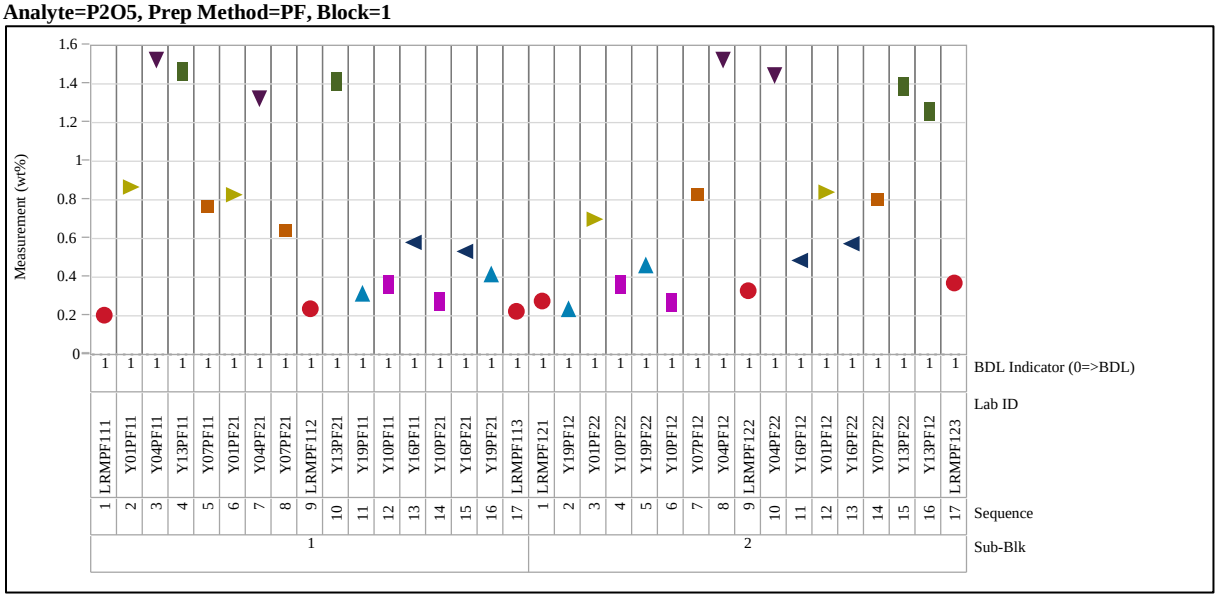


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=P2O5, Prep Method=PF, Block=1



Analyte=P2O5, Prep Method=PF, Block=2

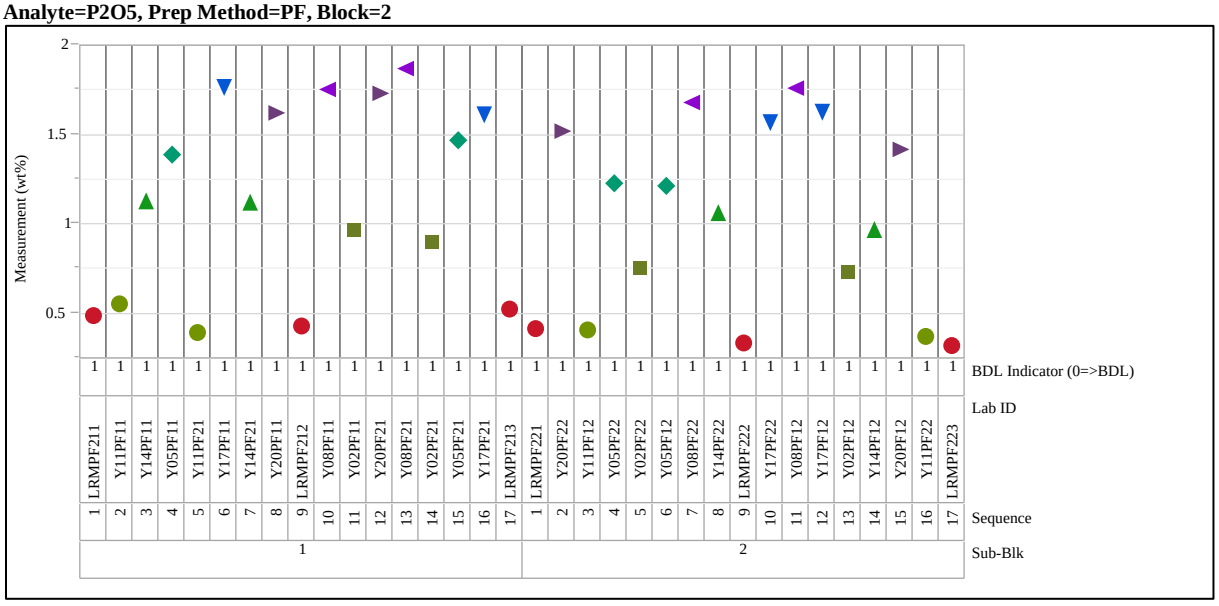
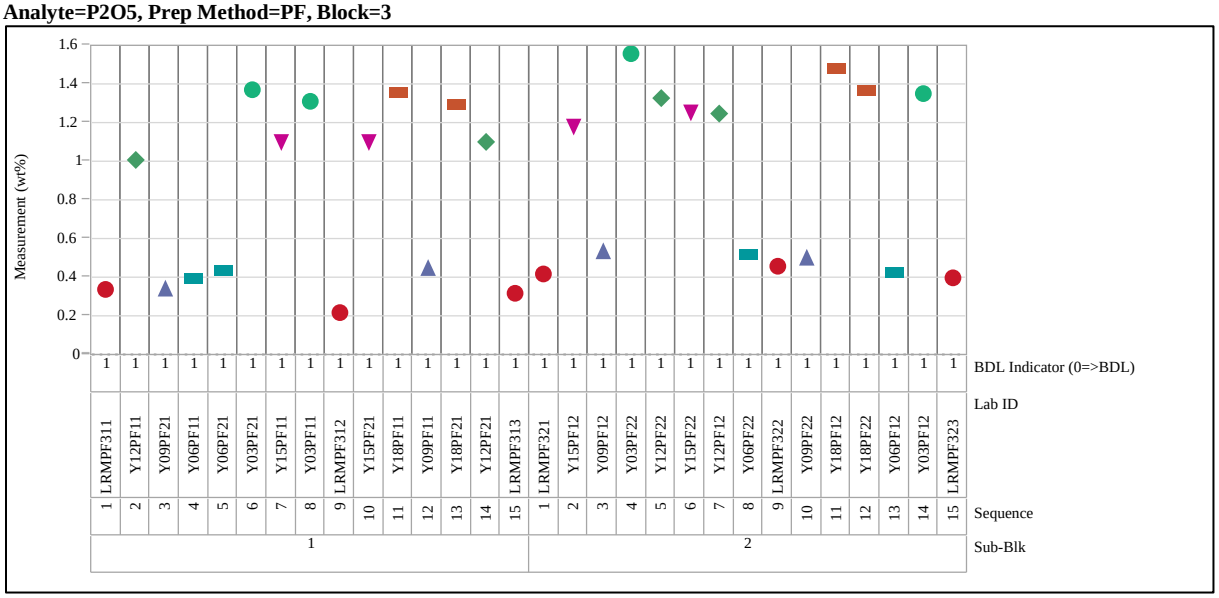


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=P2O5, Prep Method=PF, Block=3



Analyte=PbO, Prep Method=LM, Block=1

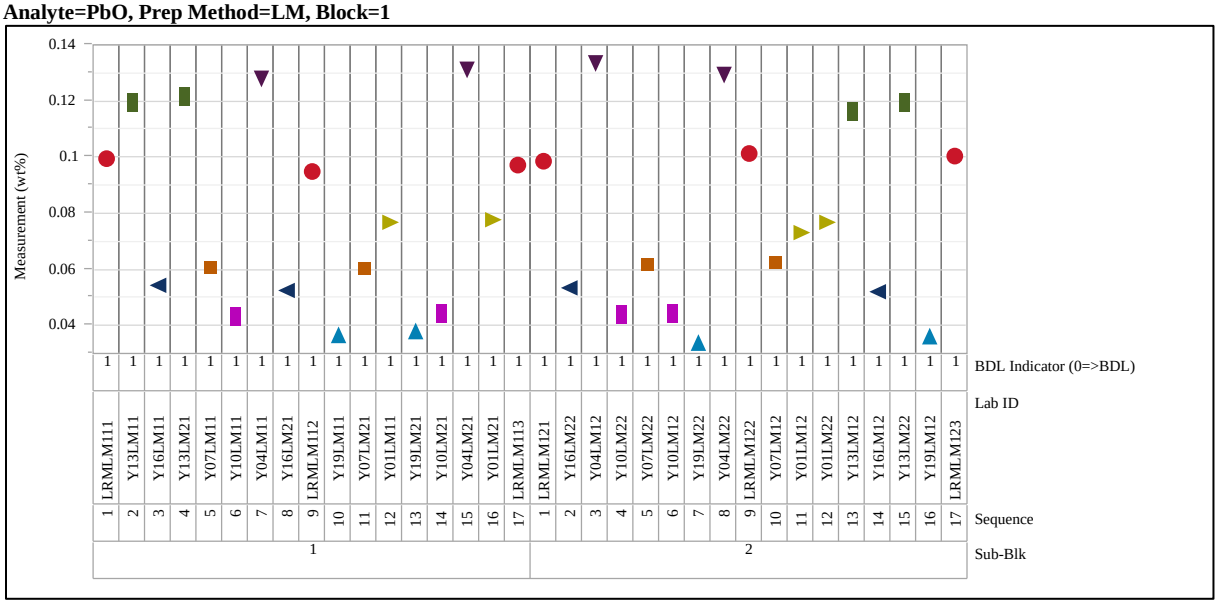
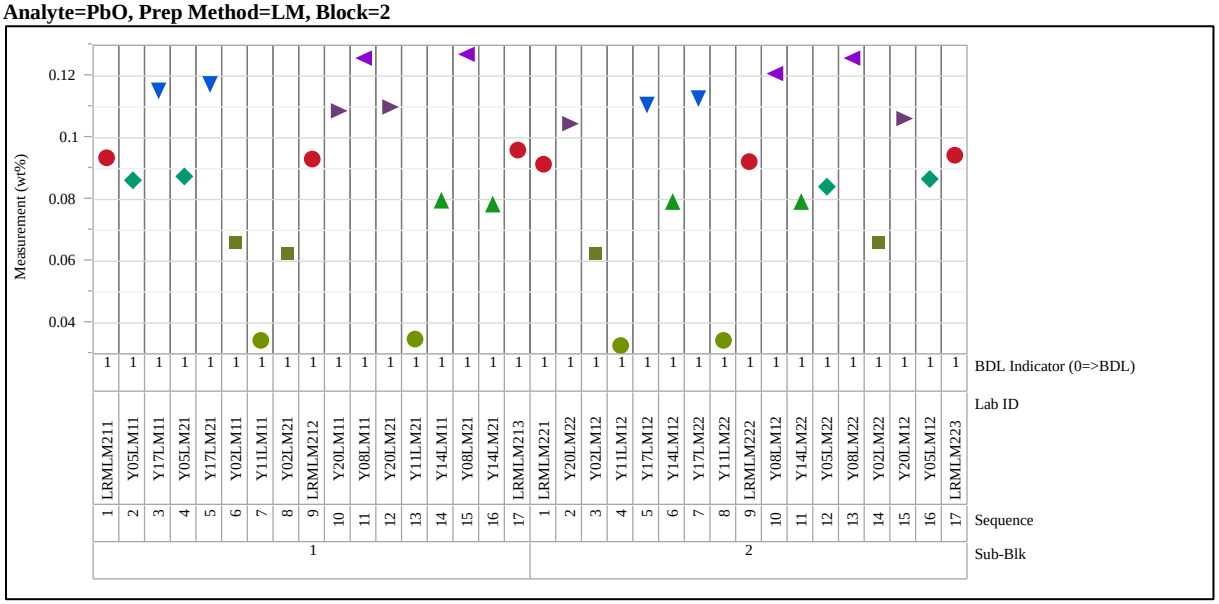


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=PbO, Prep Method=LM, Block=2



Analyte=PbO, Prep Method=LM, Block=3

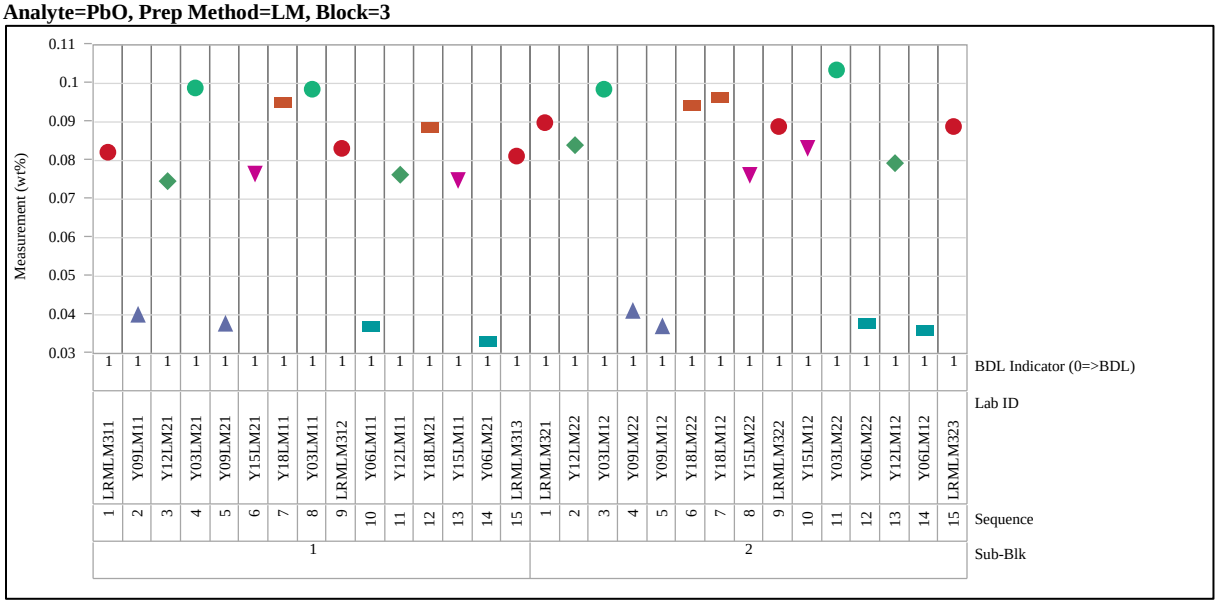
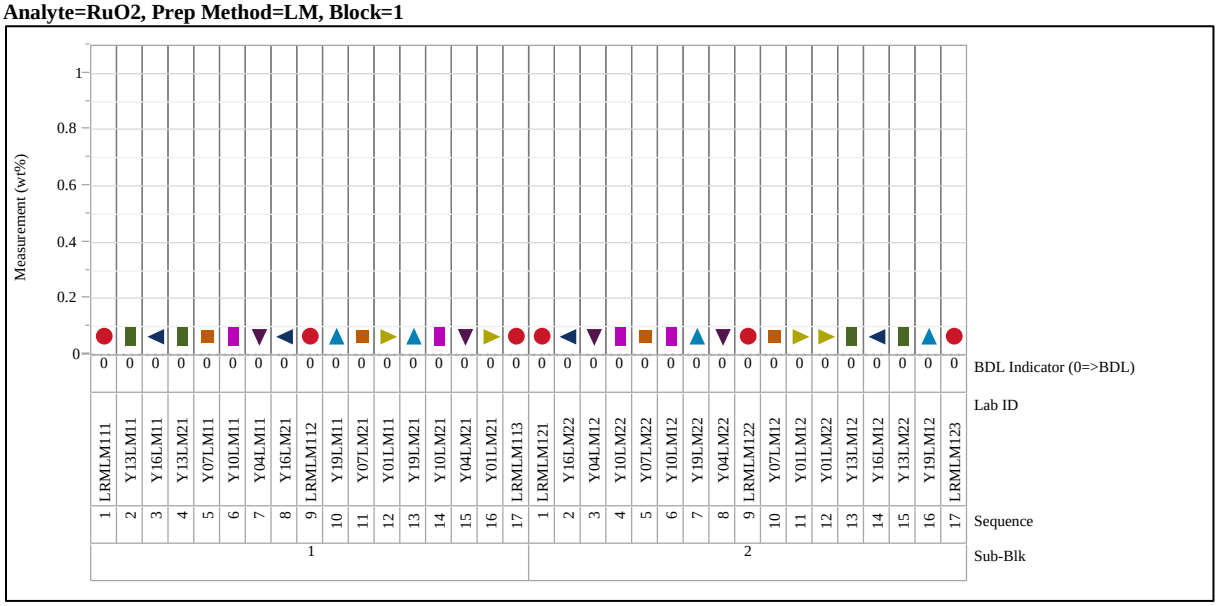


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=RuO2, Prep Method=LM, Block=1



Analyte=RuO2, Prep Method=LM, Block=2

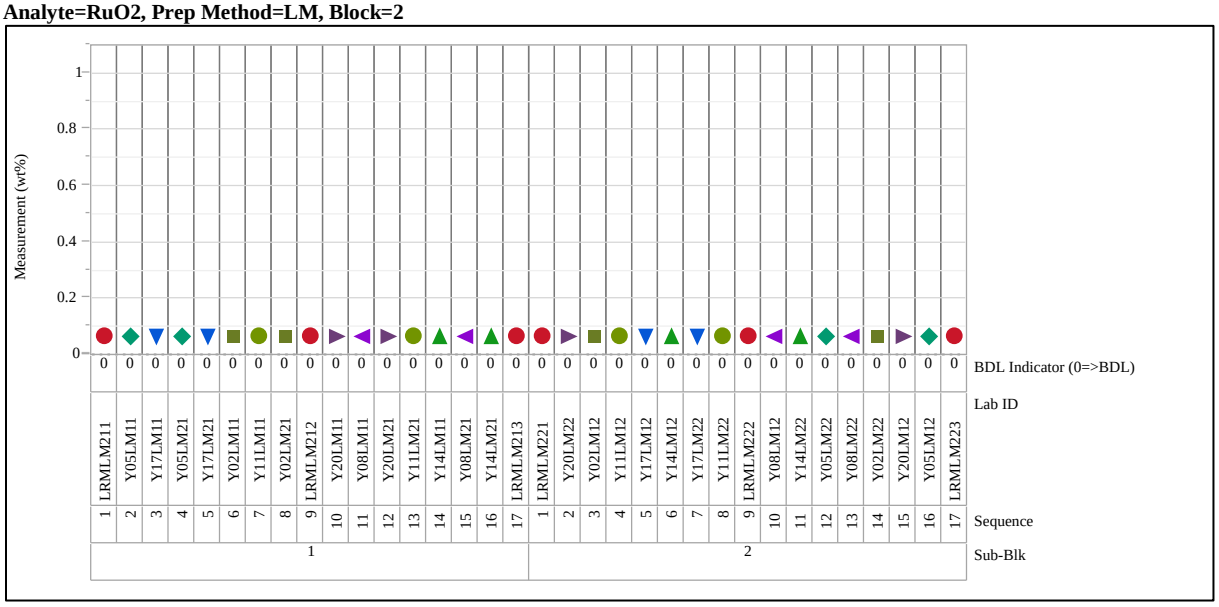
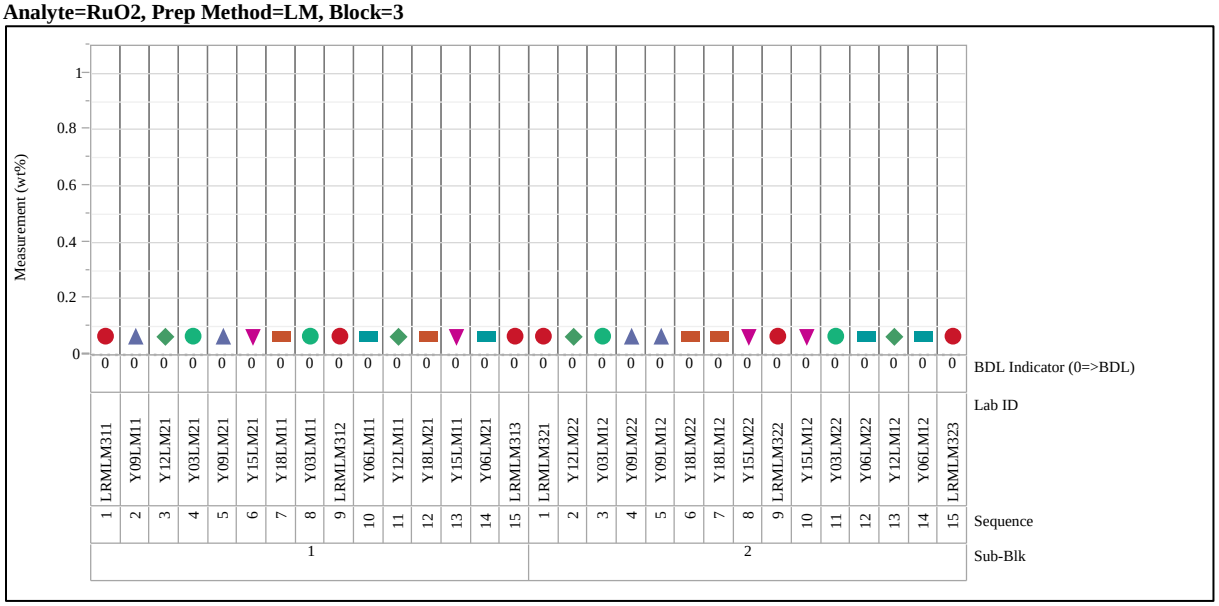


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=RuO2, Prep Method=LM, Block=3



Analyte=SiO2, Prep Method=PF, Block=1

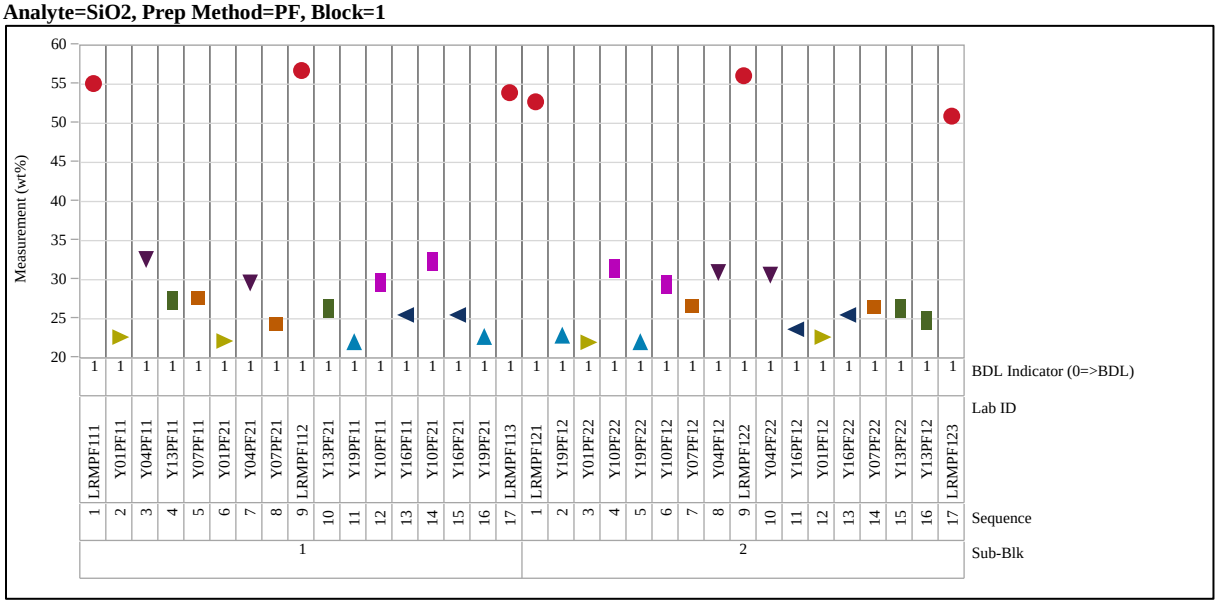
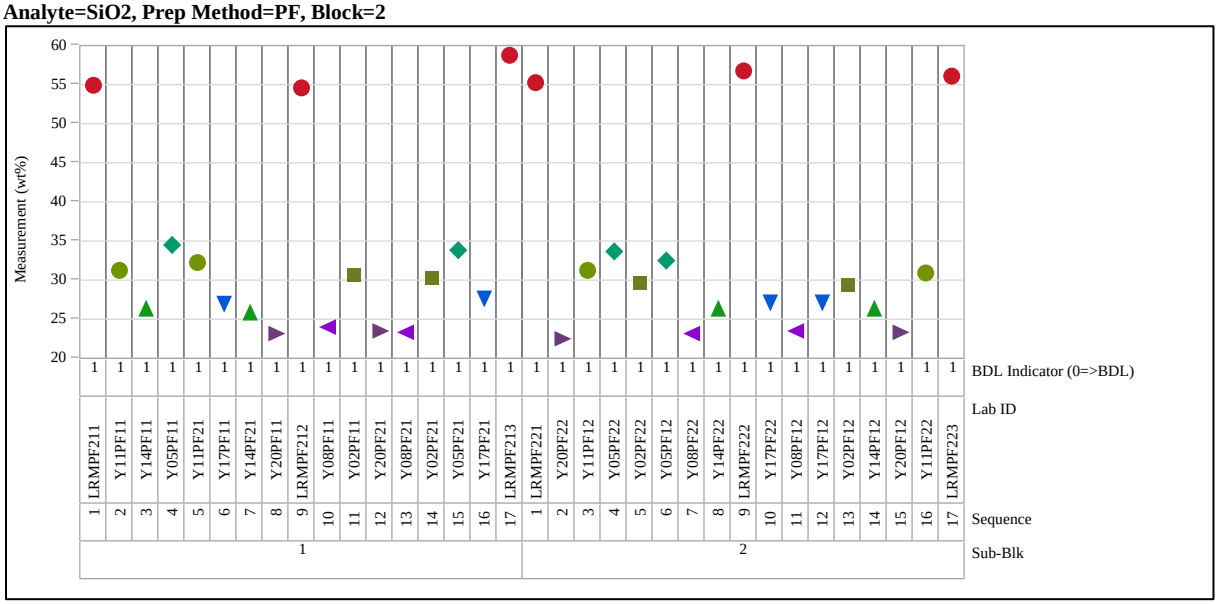


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=SiO2, Prep Method=PF, Block=2



Analyte=SiO2, Prep Method=PF, Block=3

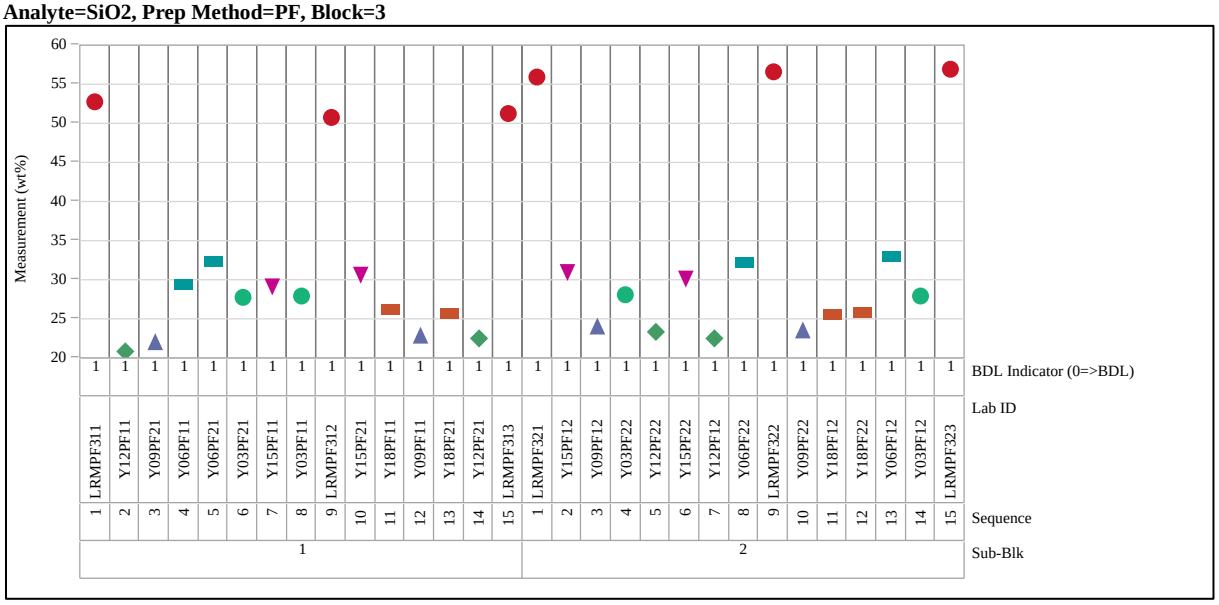
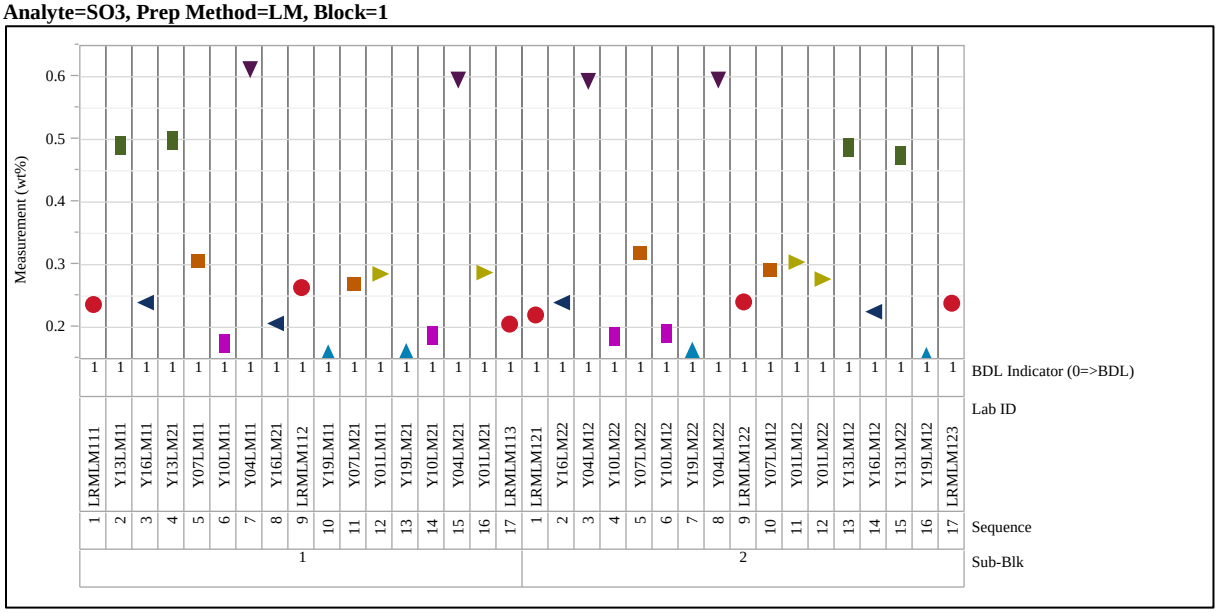


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=SO3, Prep Method=LM, Block=1



Analyte=SO3, Prep Method=LM, Block=2

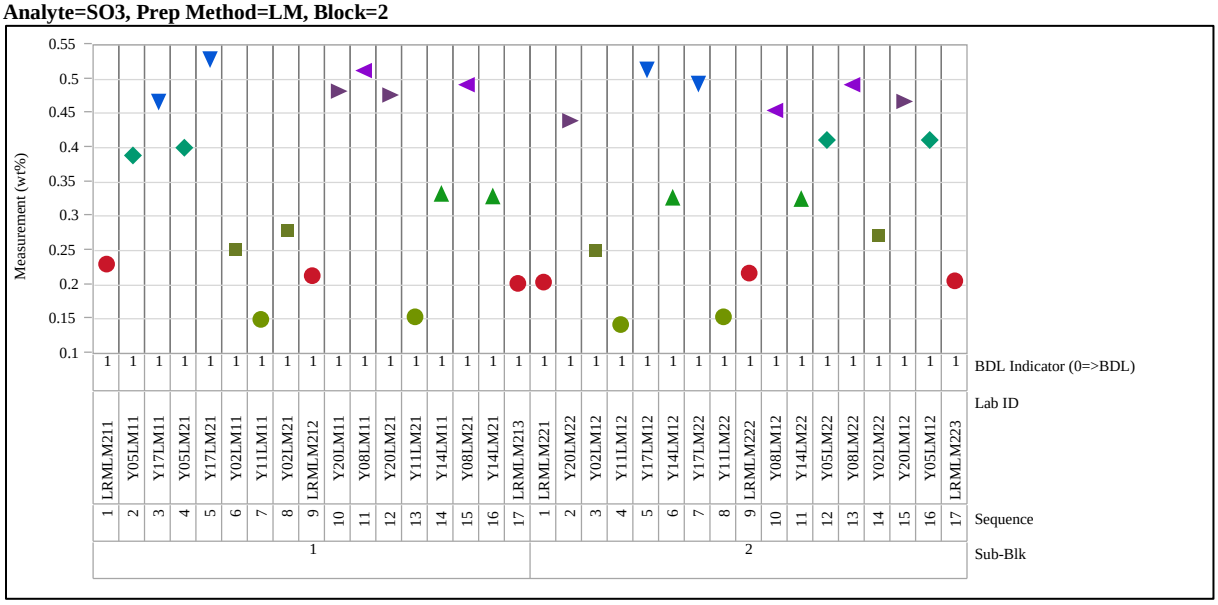
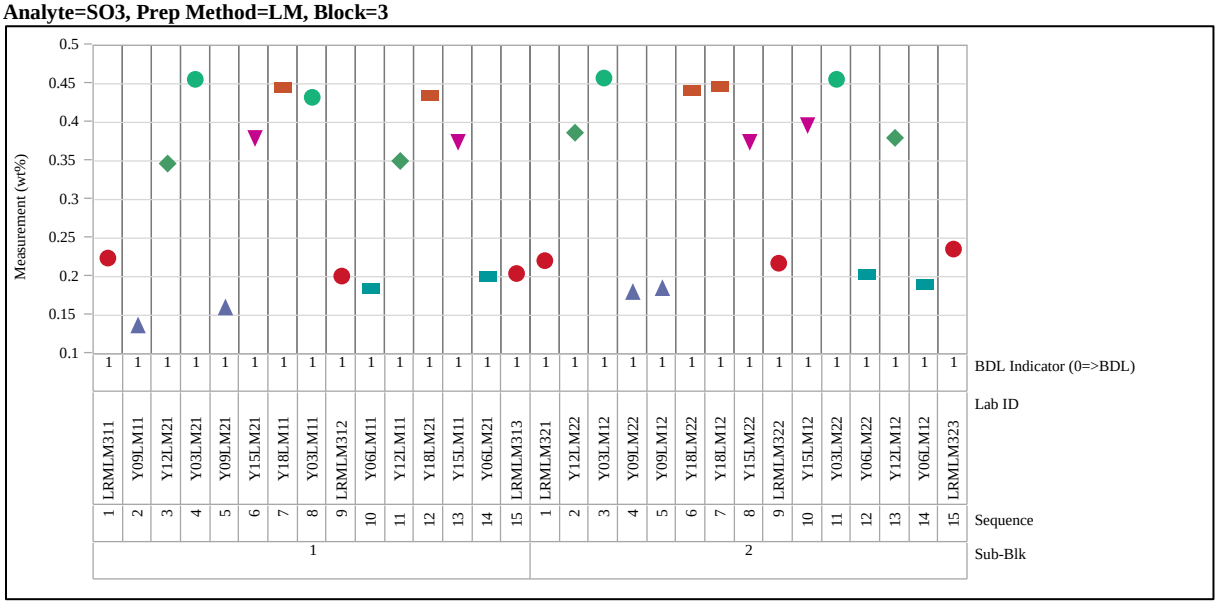


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=SO3, Prep Method=LM, Block=3



Analyte=SrO, Prep Method=LM, Block=1

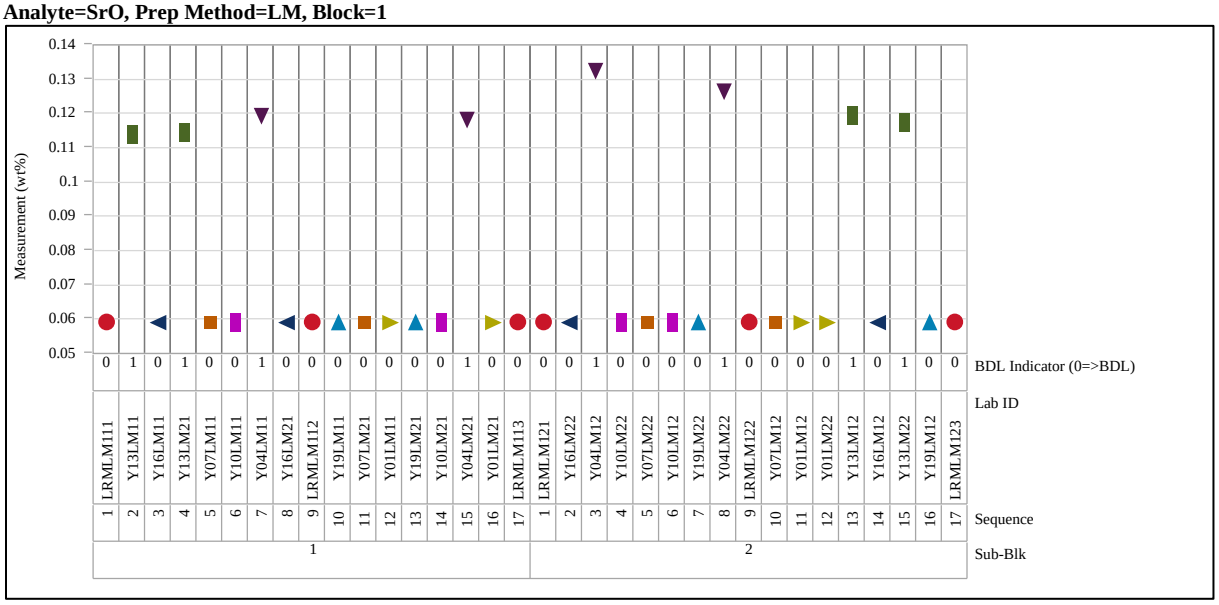
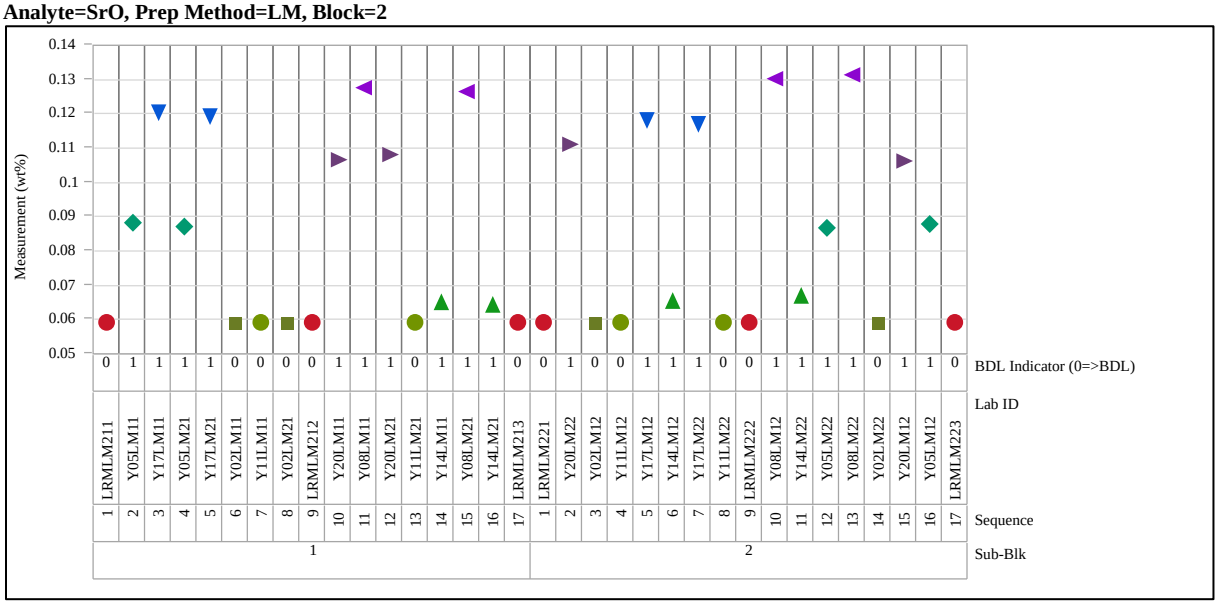


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=SrO, Prep Method=LM, Block=2



Analyte=SrO, Prep Method=LM, Block=3

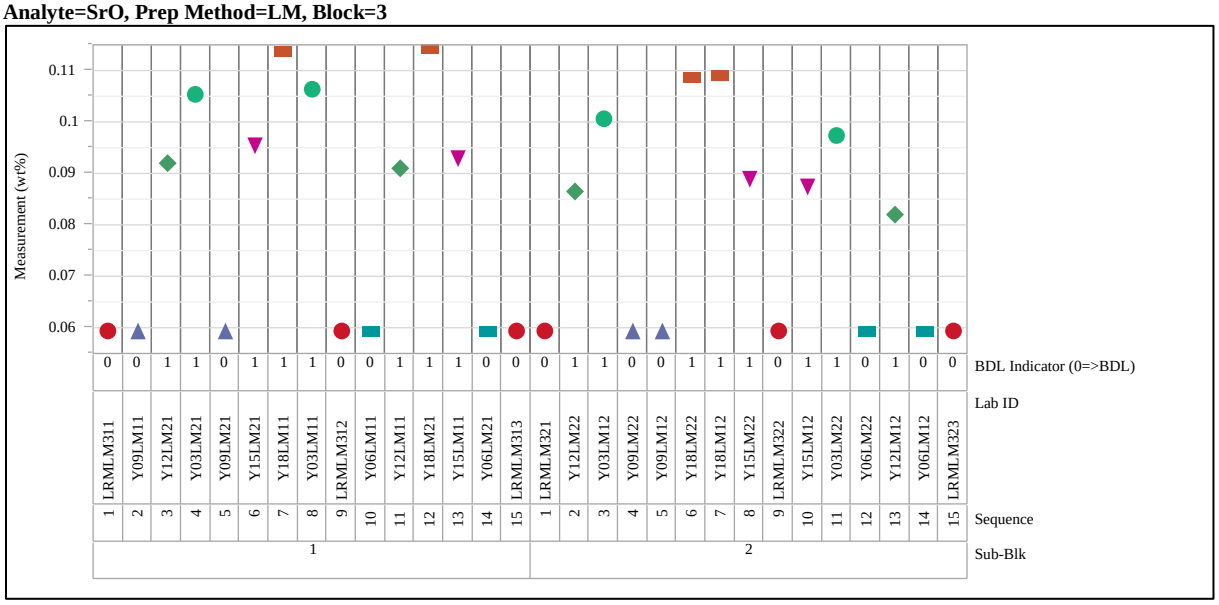
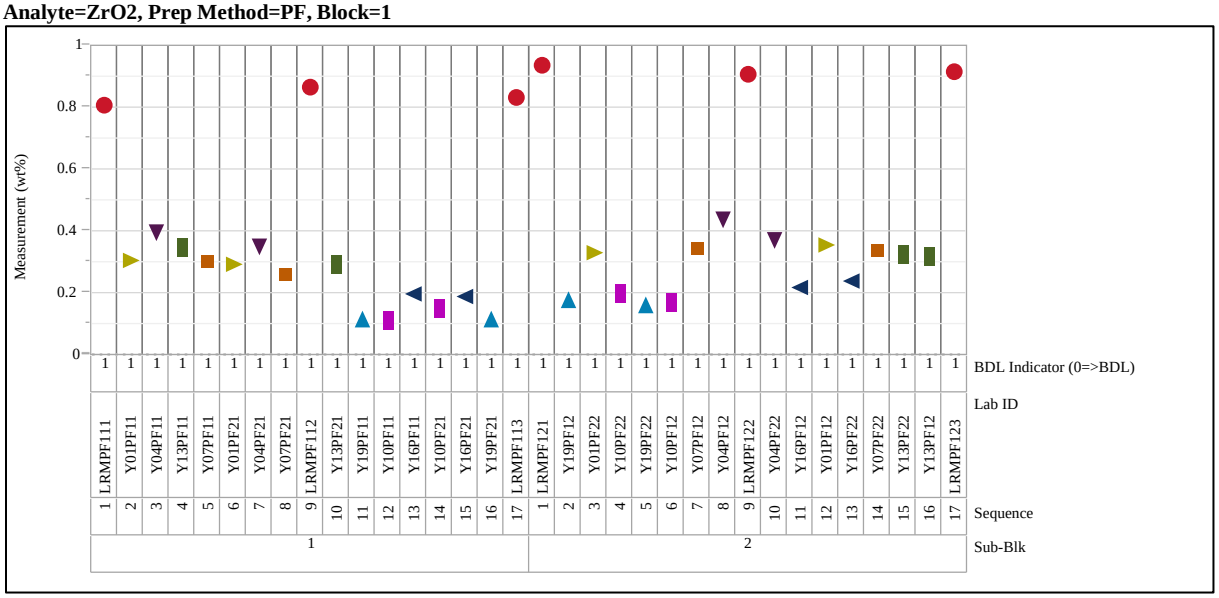


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=ZrO2, Prep Method=PF, Block=1



Analyte=ZrO2, Prep Method=PF, Block=2

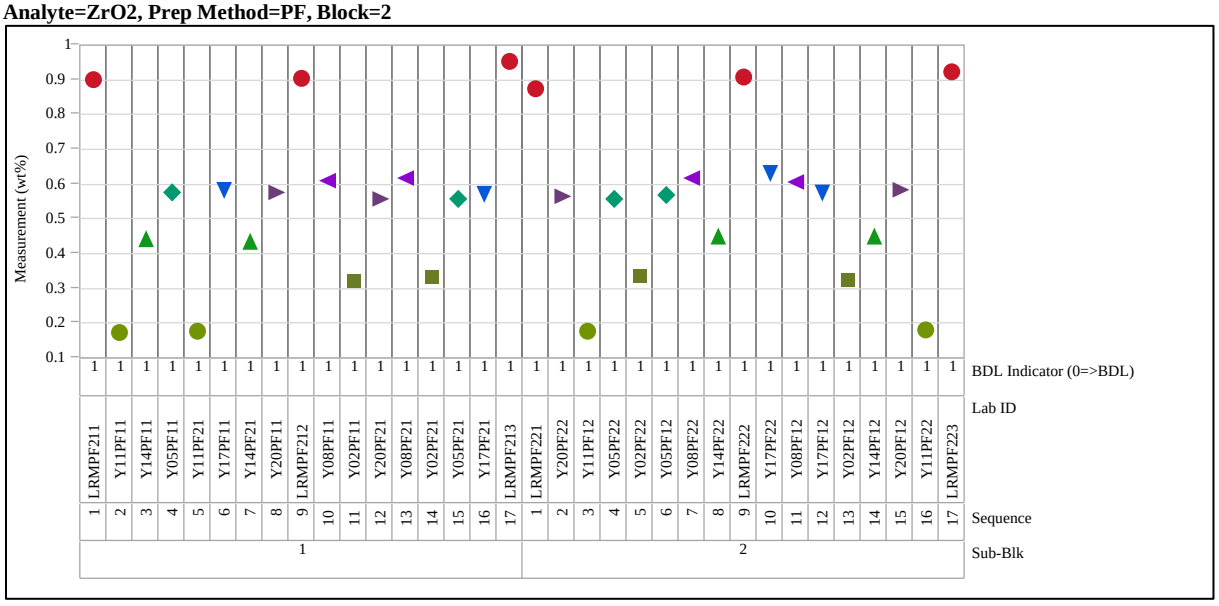


Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence by Block (continued)

Analyte=ZrO2, Prep Method=PF, Block=3

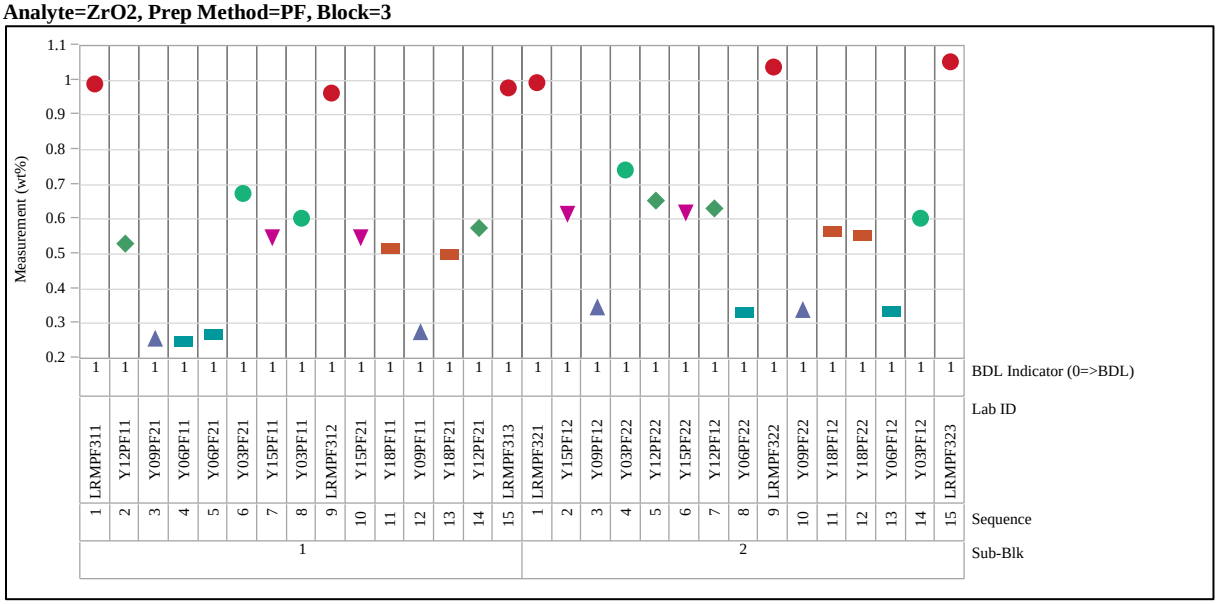
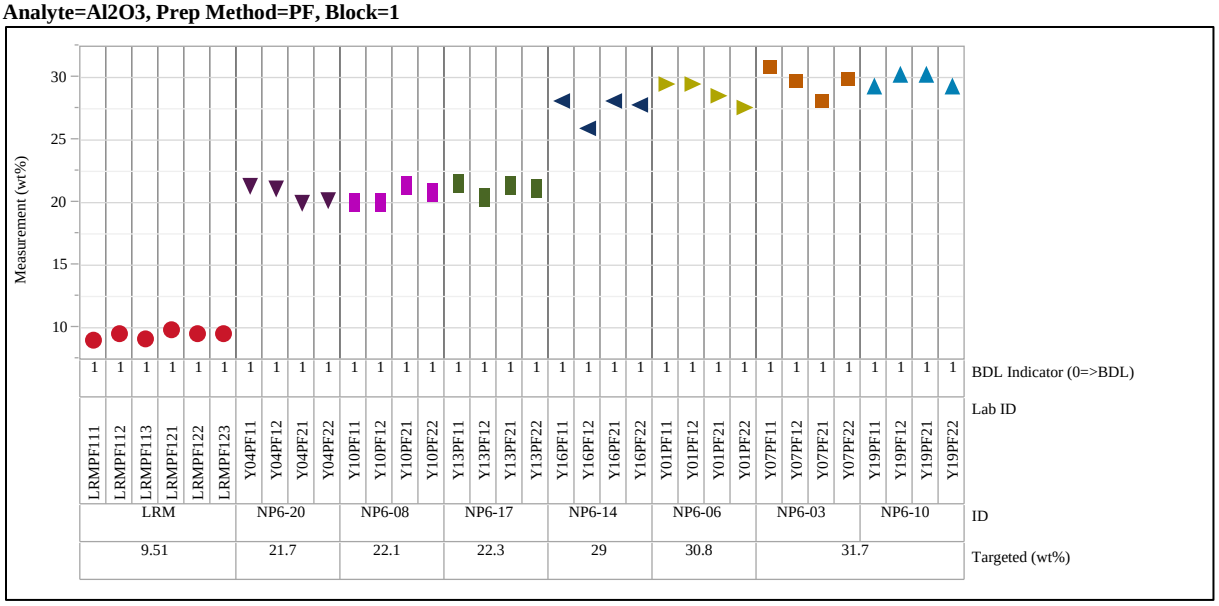


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block

Analyte=Al2O3, Prep Method=PF, Block=1



Analyte=Al2O3, Prep Method=PF, Block=2

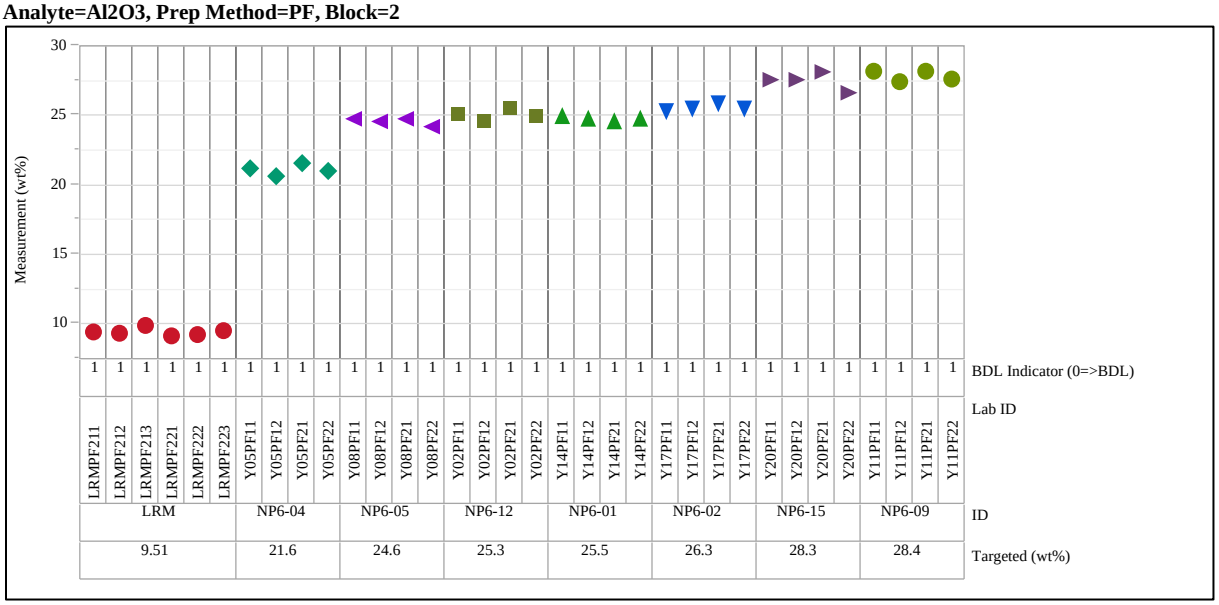
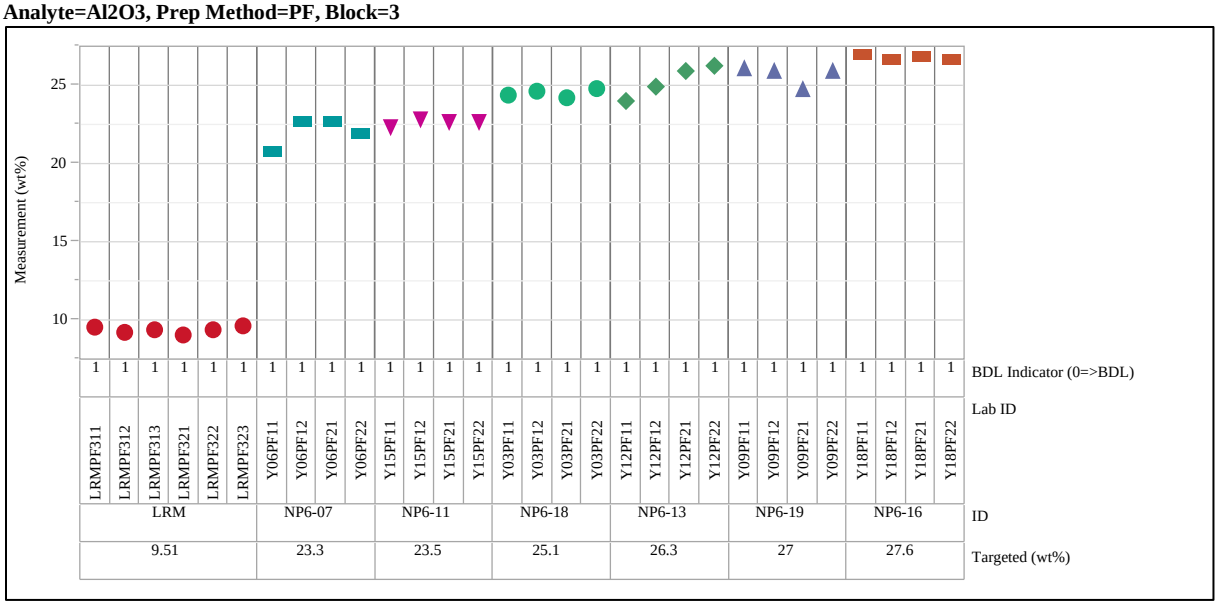


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=Al2O3, Prep Method=PF, Block=3



Analyte=B2O3, Prep Method=PF, Block=1

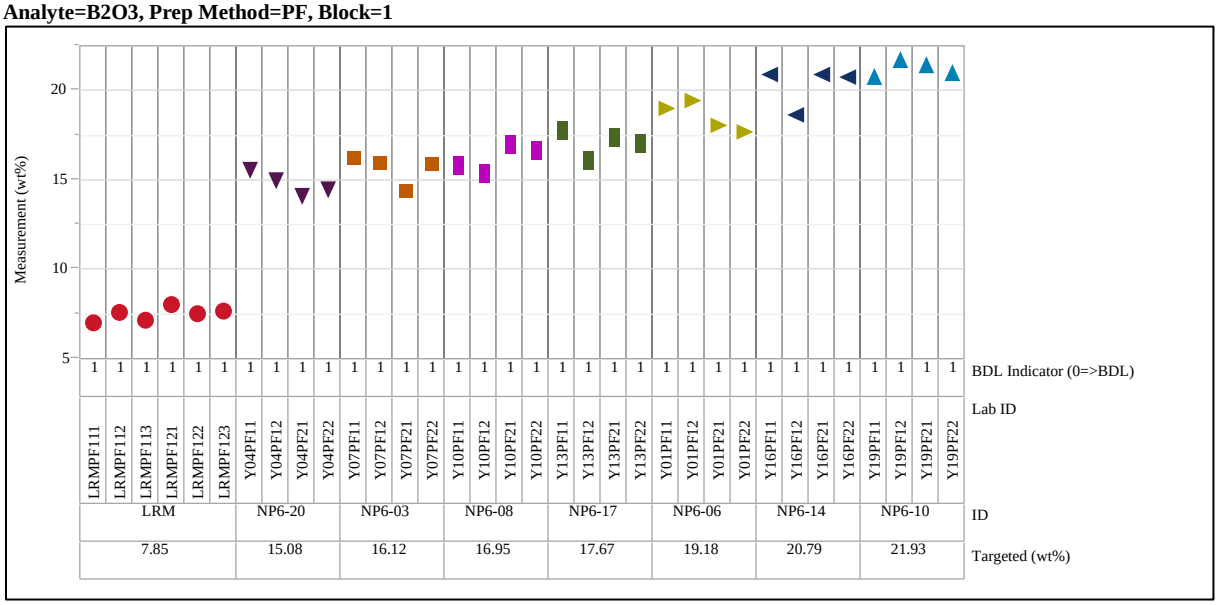
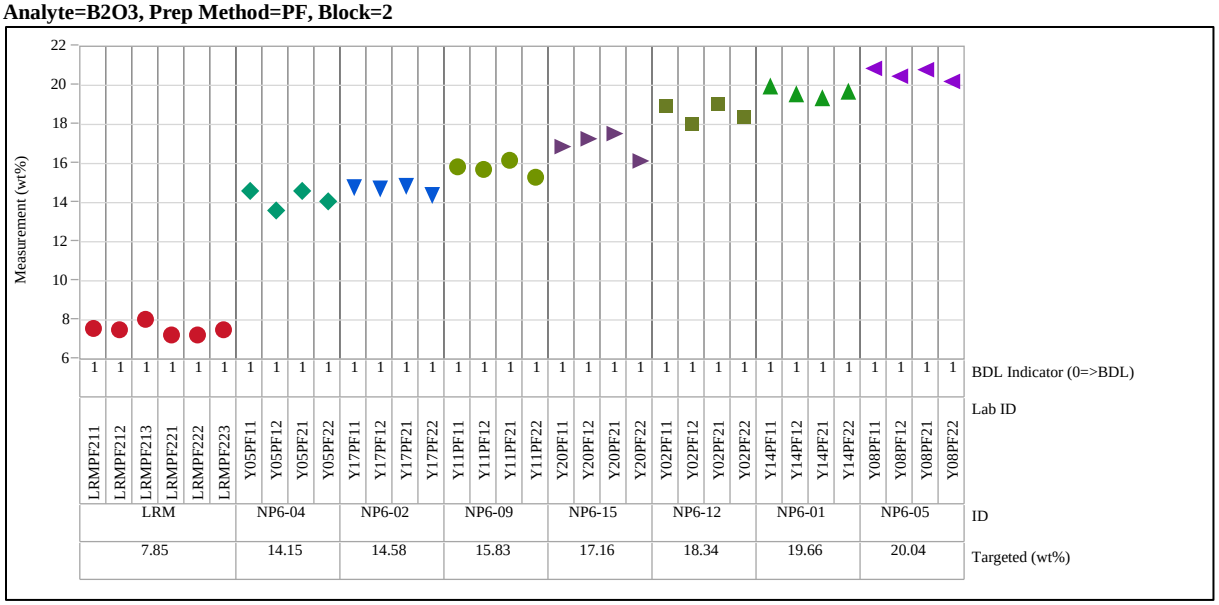


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=B2O3, Prep Method=PF, Block=2



Analyte=B2O3, Prep Method=PF, Block=3

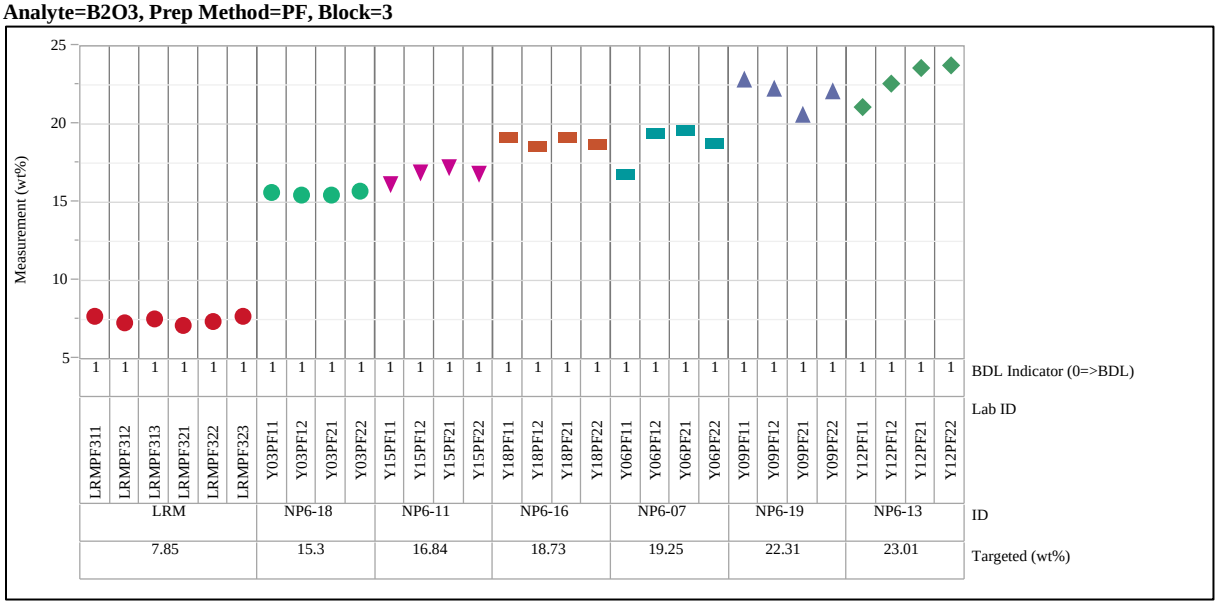
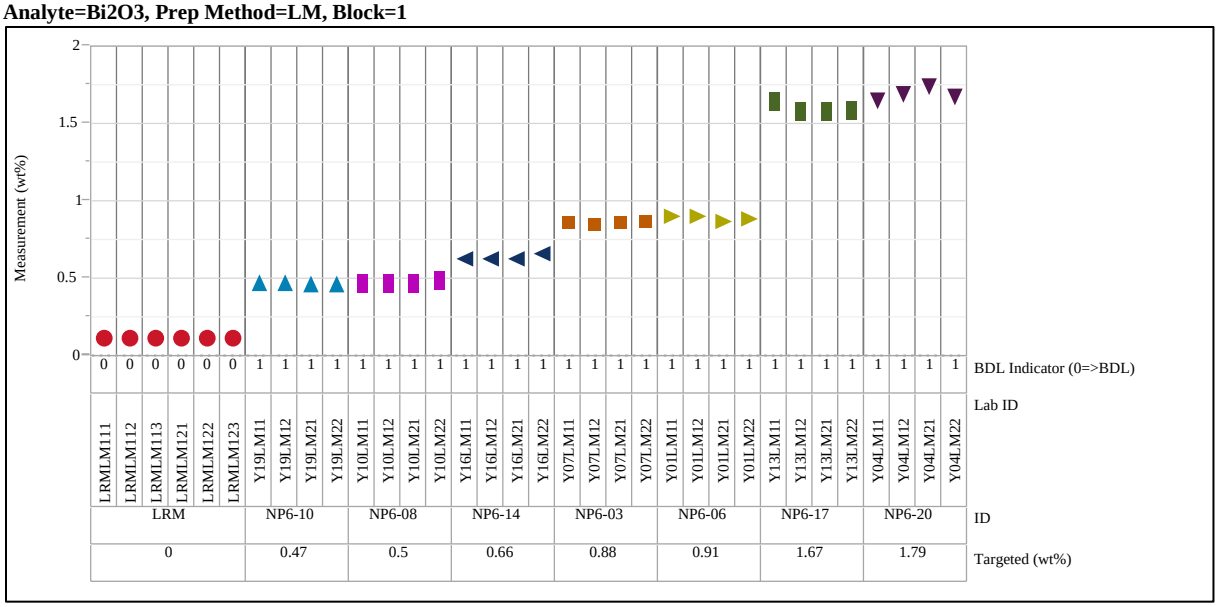


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=Bi2O3, Prep Method=LM, Block=1



Analyte=Bi2O3, Prep Method=LM, Block=2

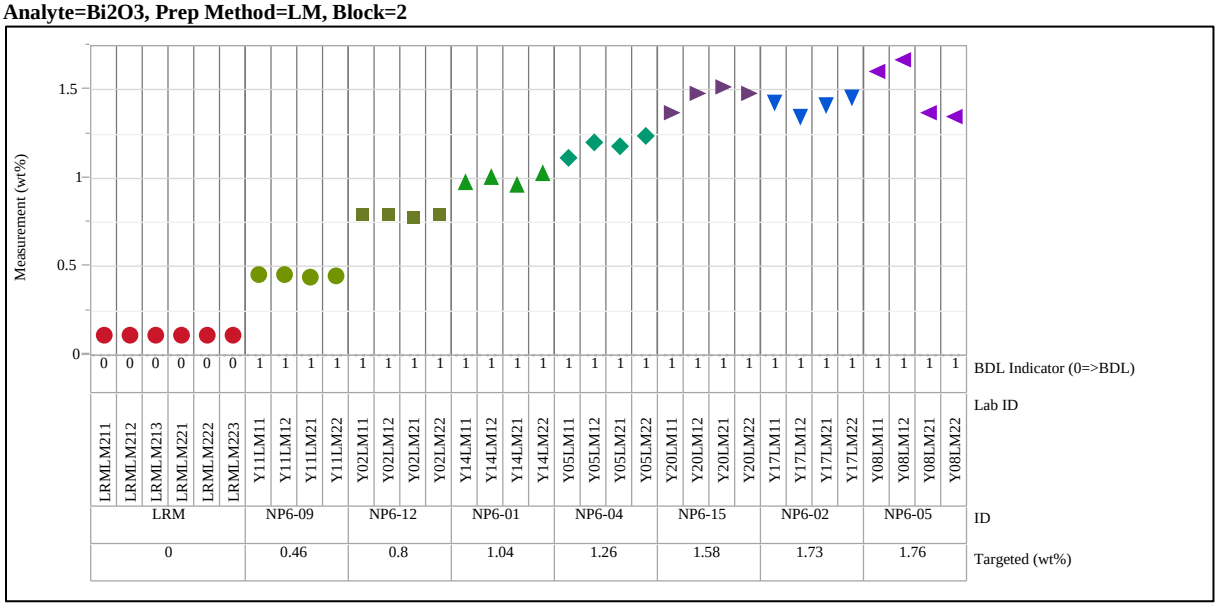
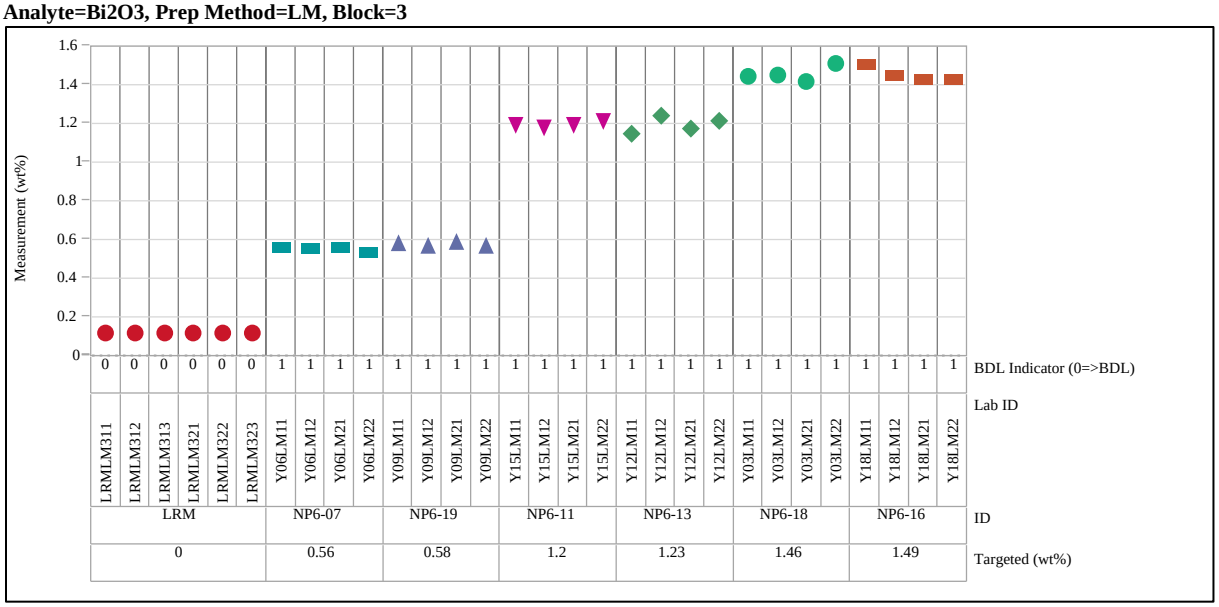


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=Bi2O3, Prep Method=LM, Block=3



Analyte=CaO, Prep Method=PF, Block=1

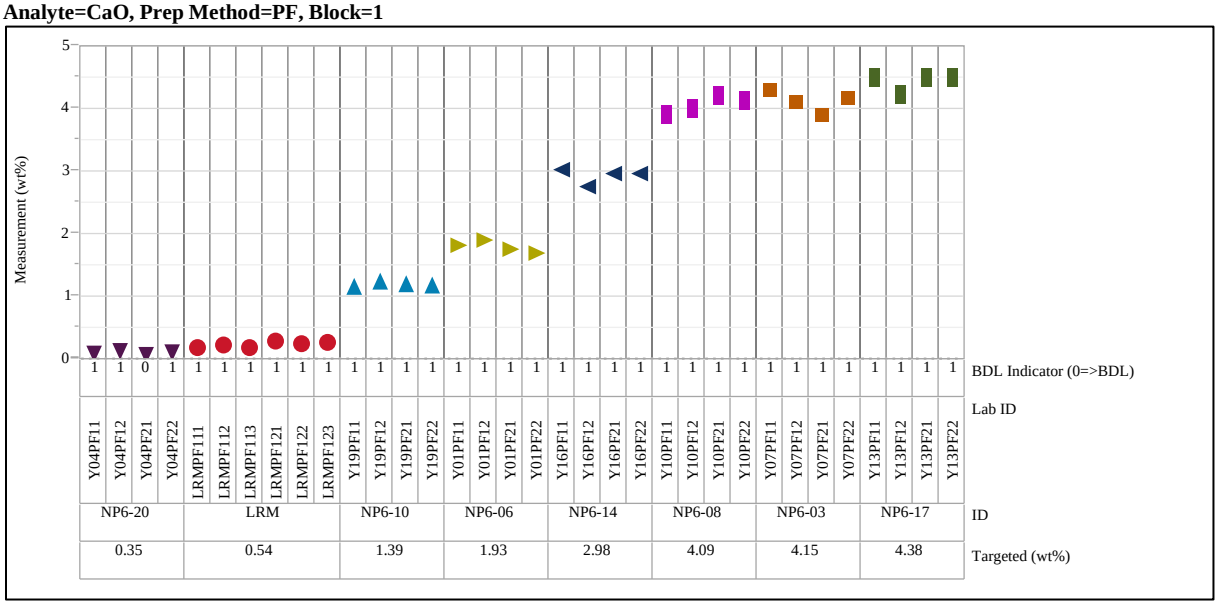
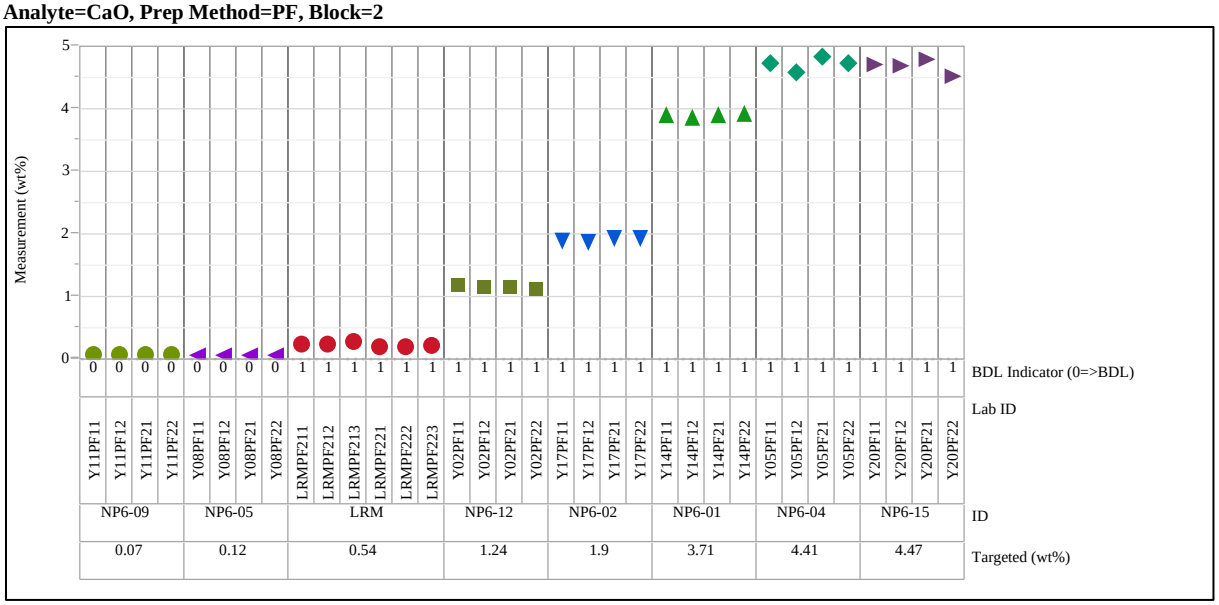


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=CaO, Prep Method=PF, Block=2



Analyte=CaO, Prep Method=PF, Block=3

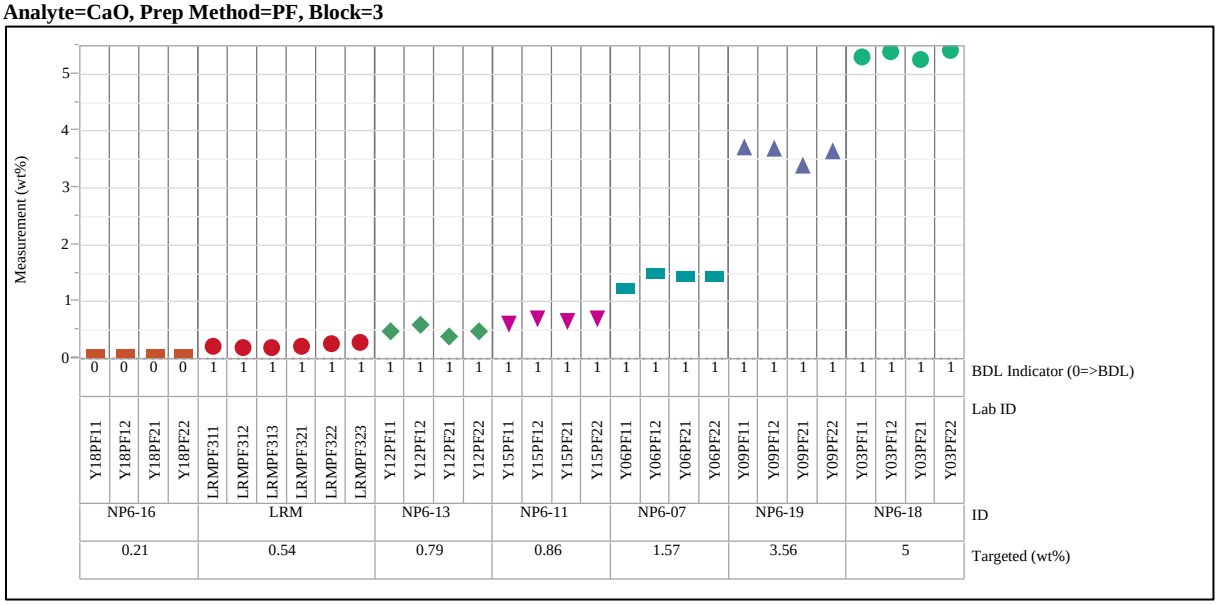
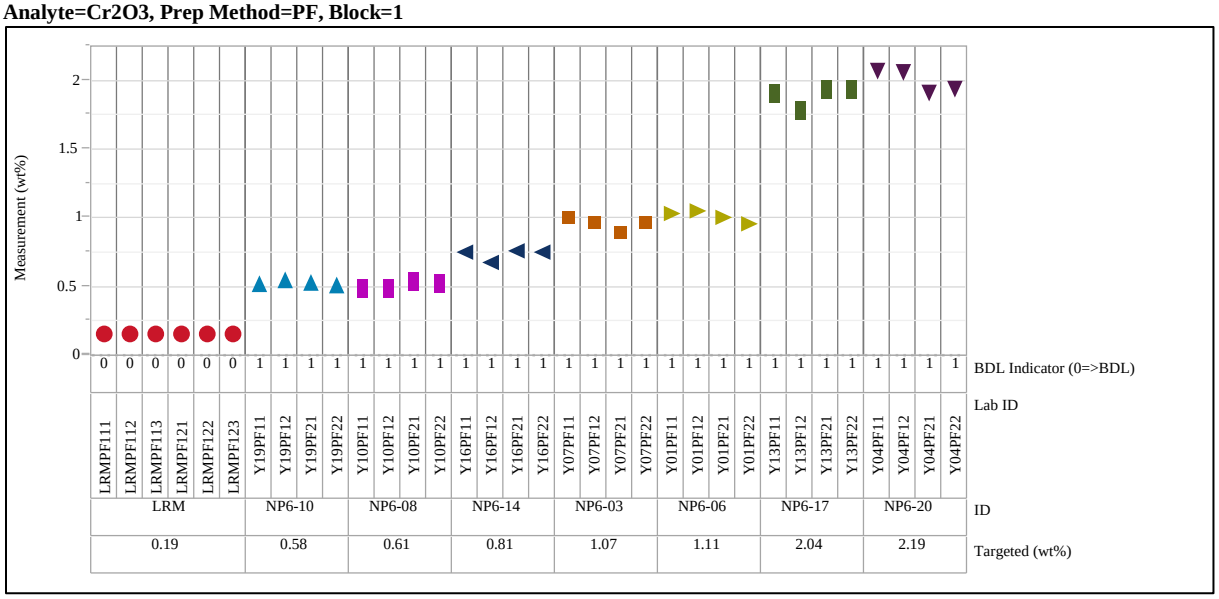


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=Cr2O3, Prep Method=PF, Block=1



Analyte=Cr2O3, Prep Method=PF, Block=2

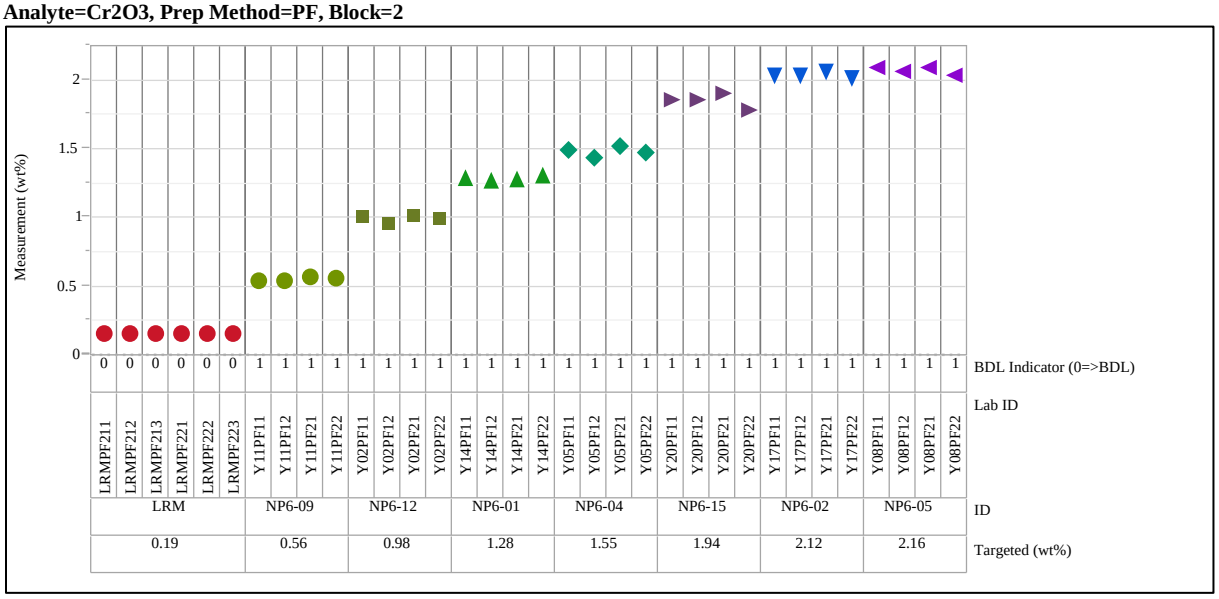
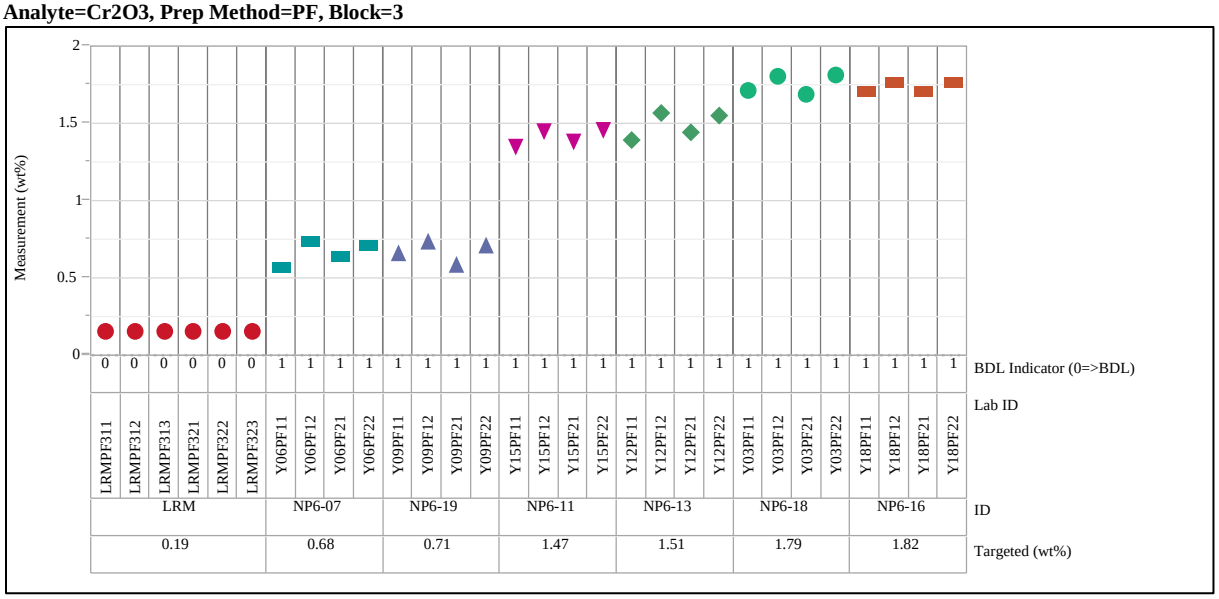


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=Cr2O3, Prep Method=PF, Block=3



Analyte=F, Prep Method=KH, Block=1

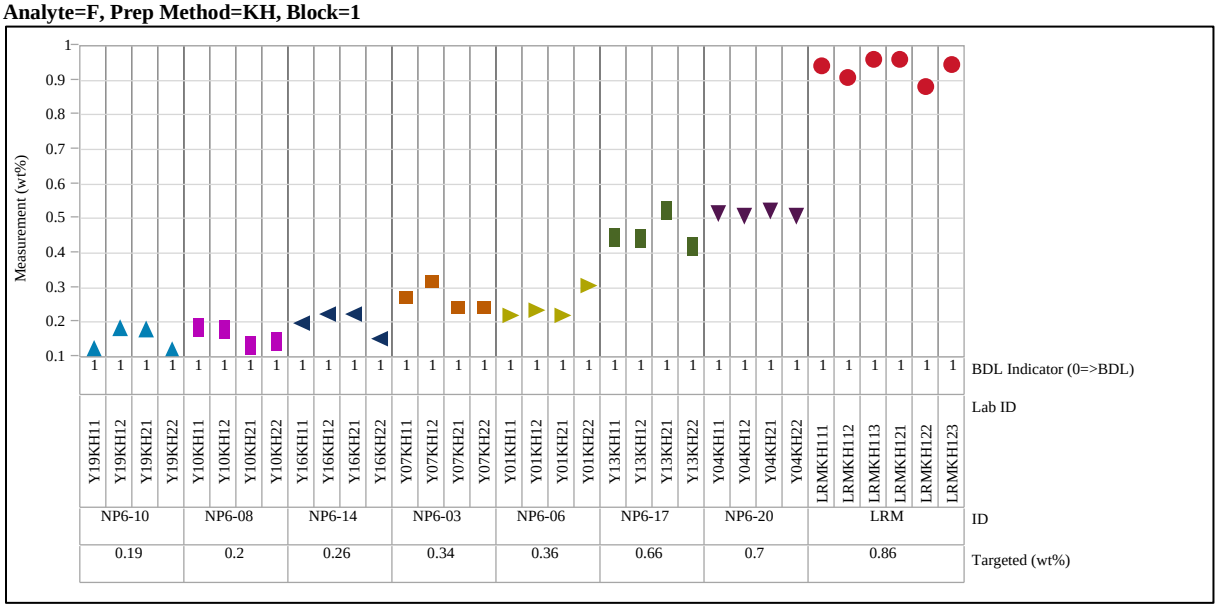
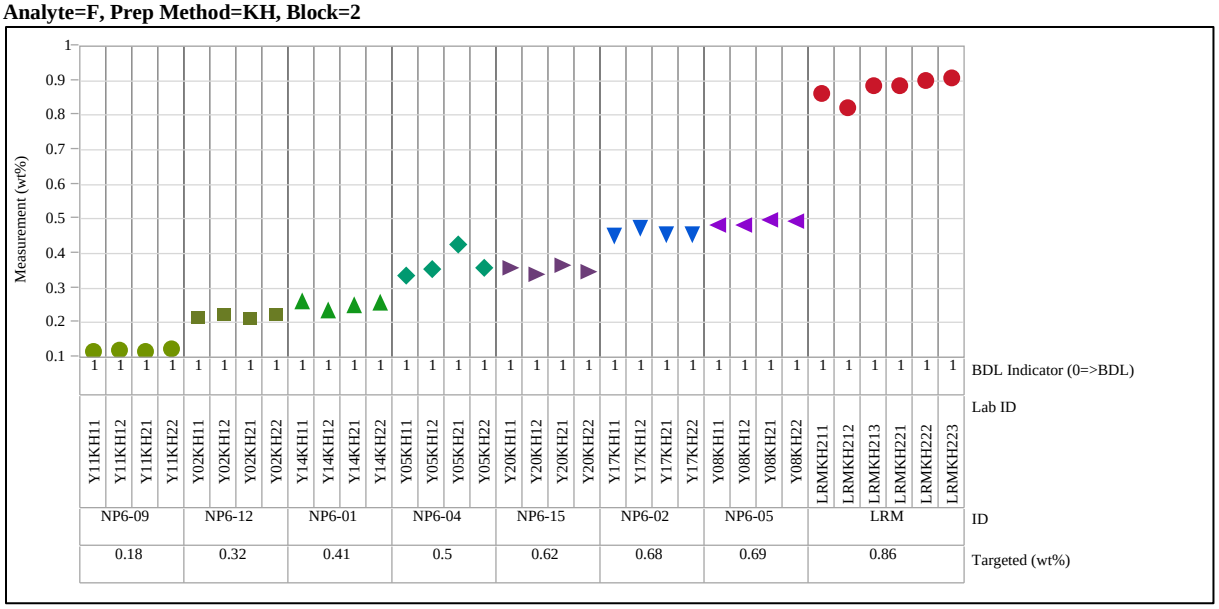


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=F, Prep Method=KH, Block=2



Analyte=F, Prep Method=KH, Block=3

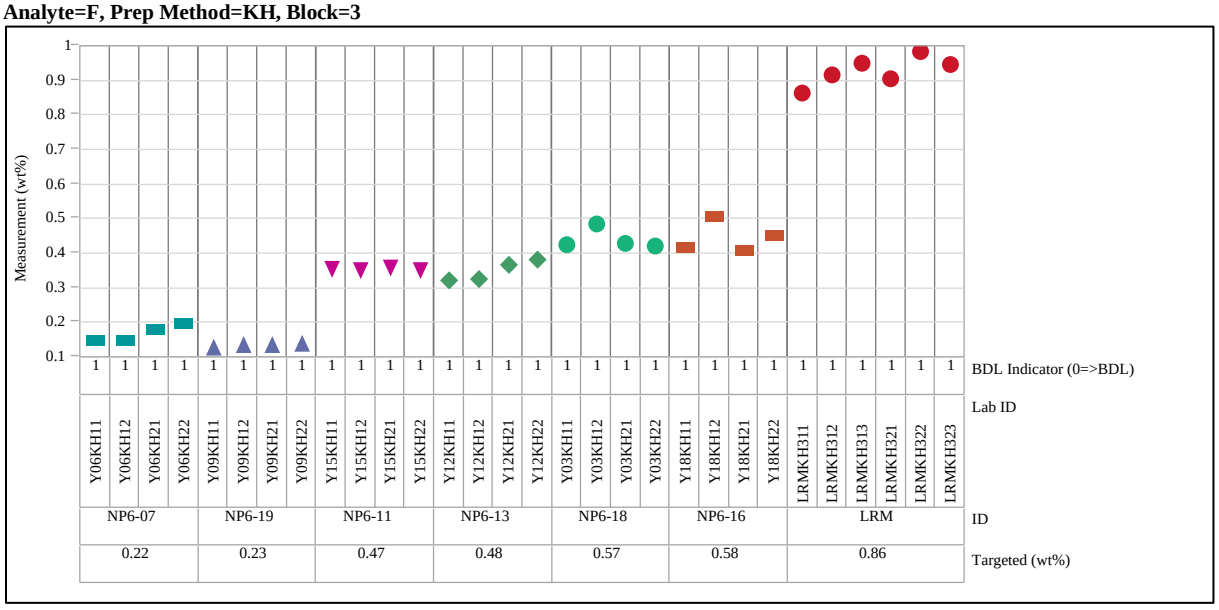
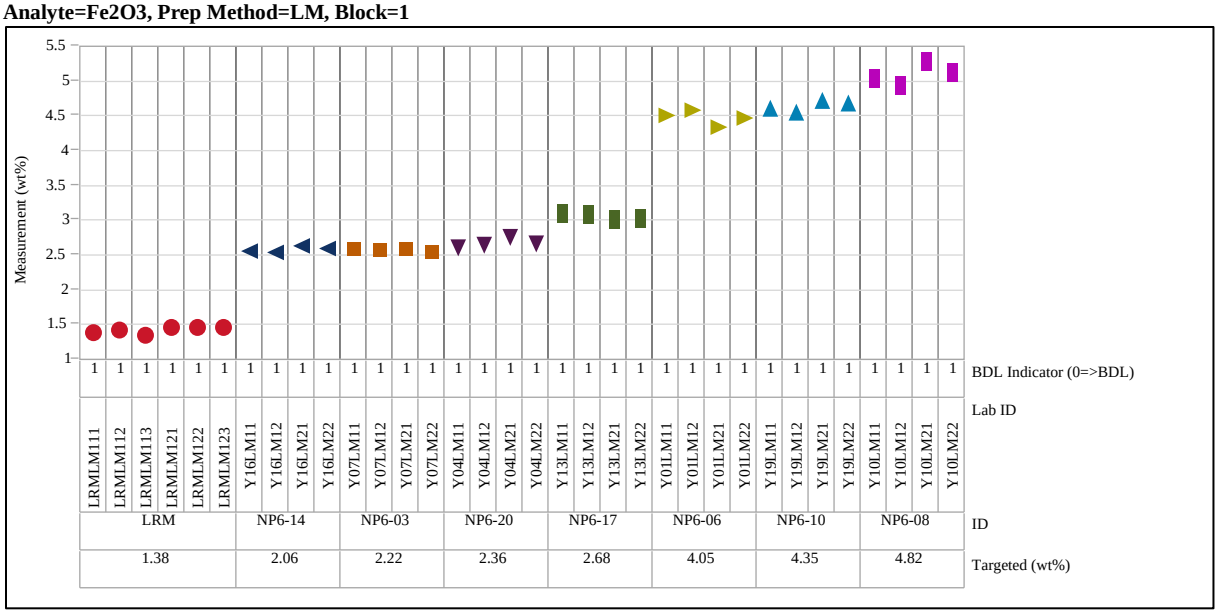


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=Fe2O3, Prep Method=LM, Block=1



Analyte=Fe2O3, Prep Method=LM, Block=2

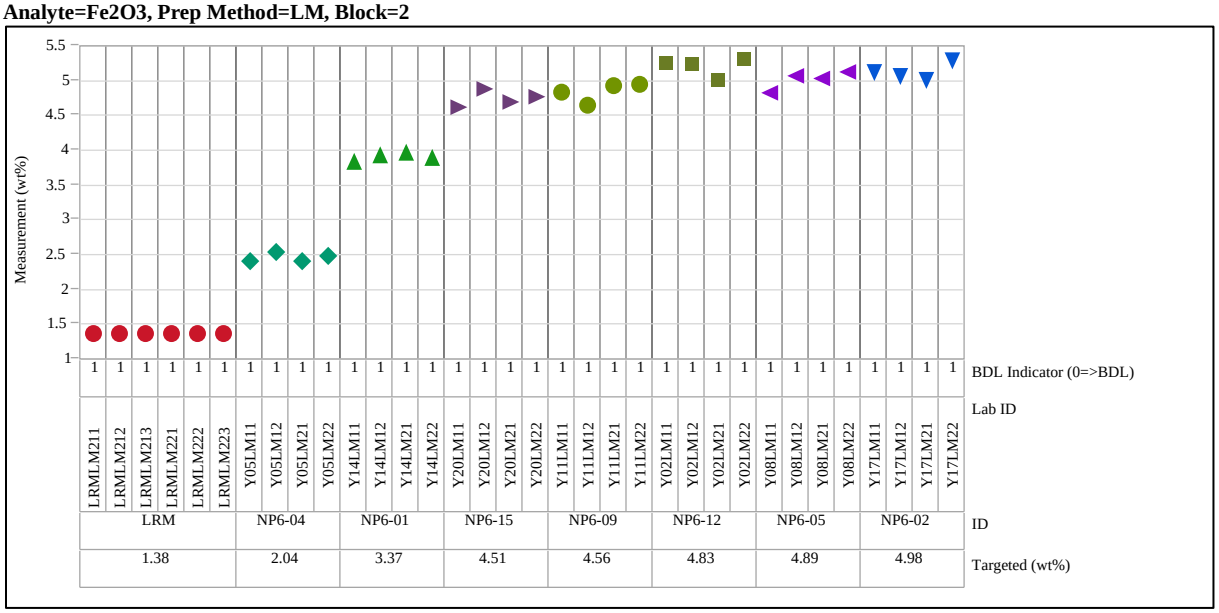
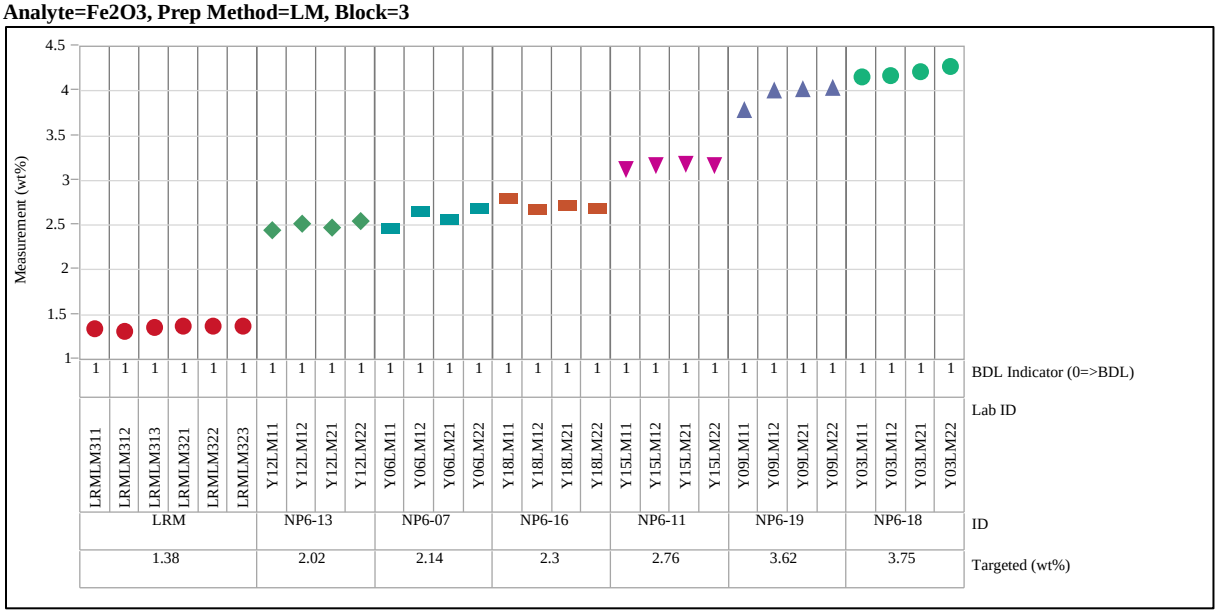


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=Fe2O3, Prep Method=LM, Block=3



Analyte=Li2O, Prep Method=PF, Block=1

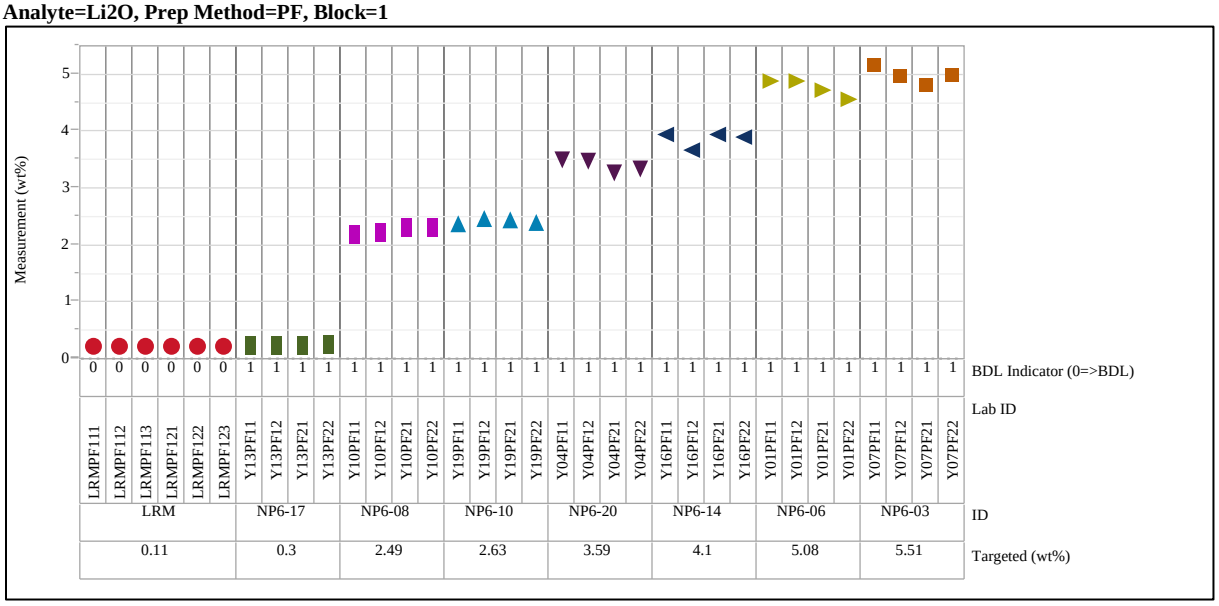
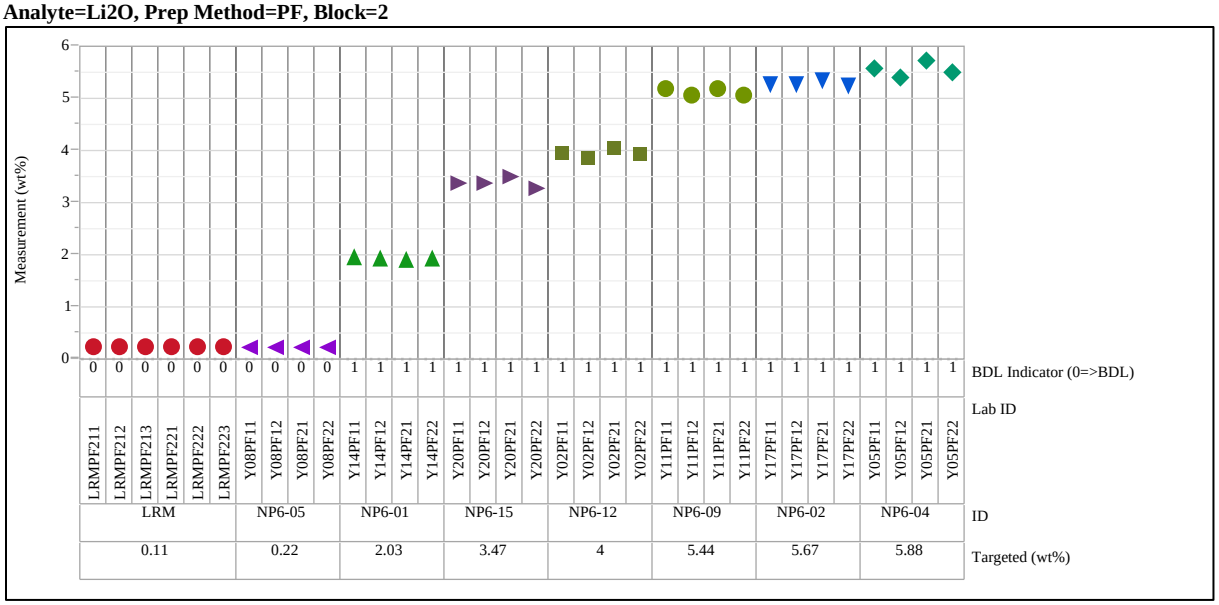


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=Li2O, Prep Method=PF, Block=2



Analyte=Li2O, Prep Method=PF, Block=3

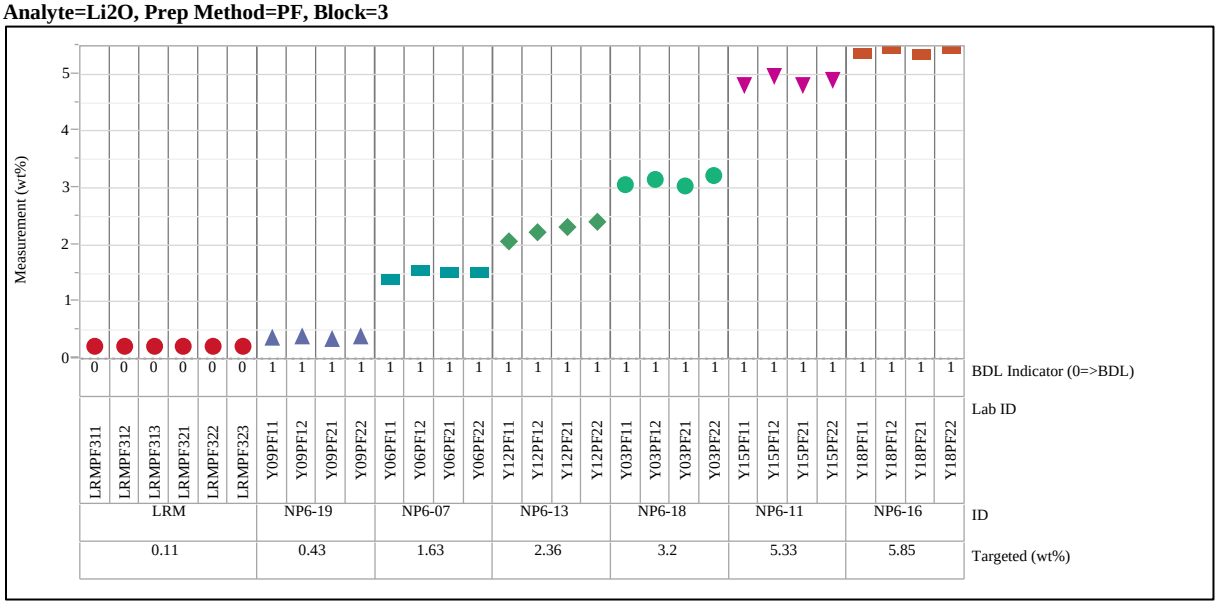
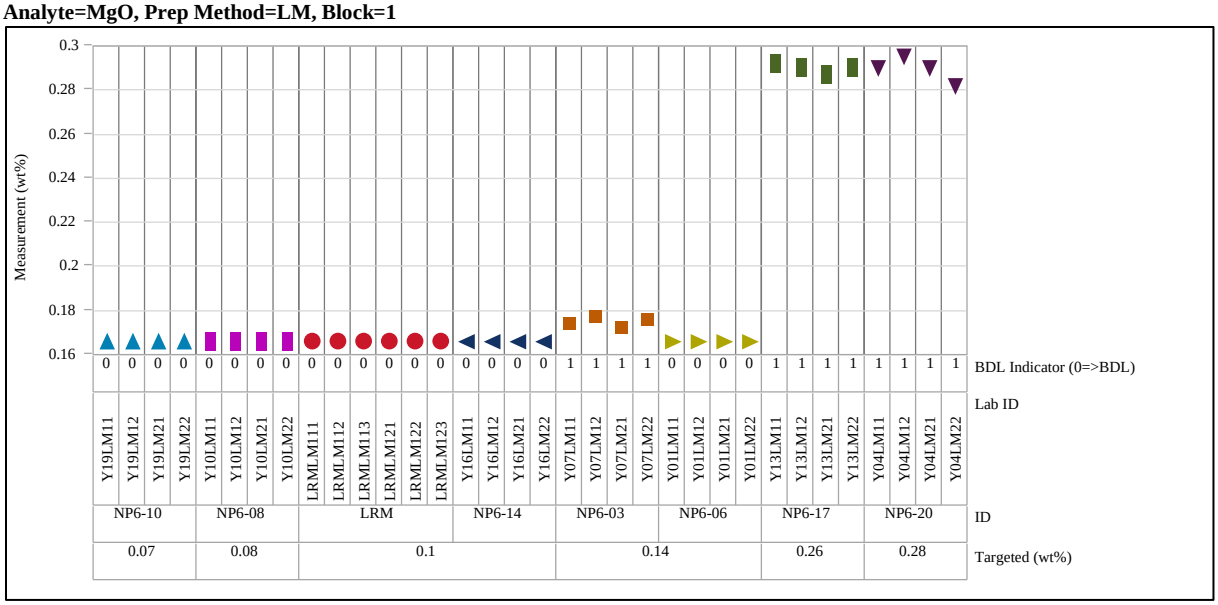


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=MgO, Prep Method=LM, Block=1



Analyte=MgO, Prep Method=LM, Block=2

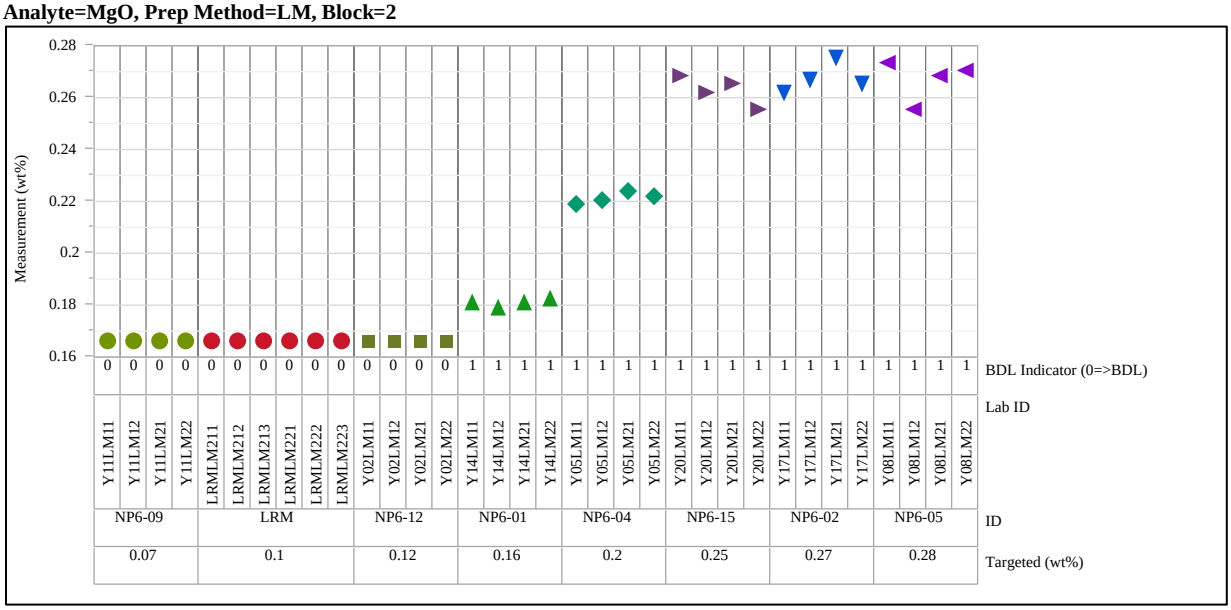
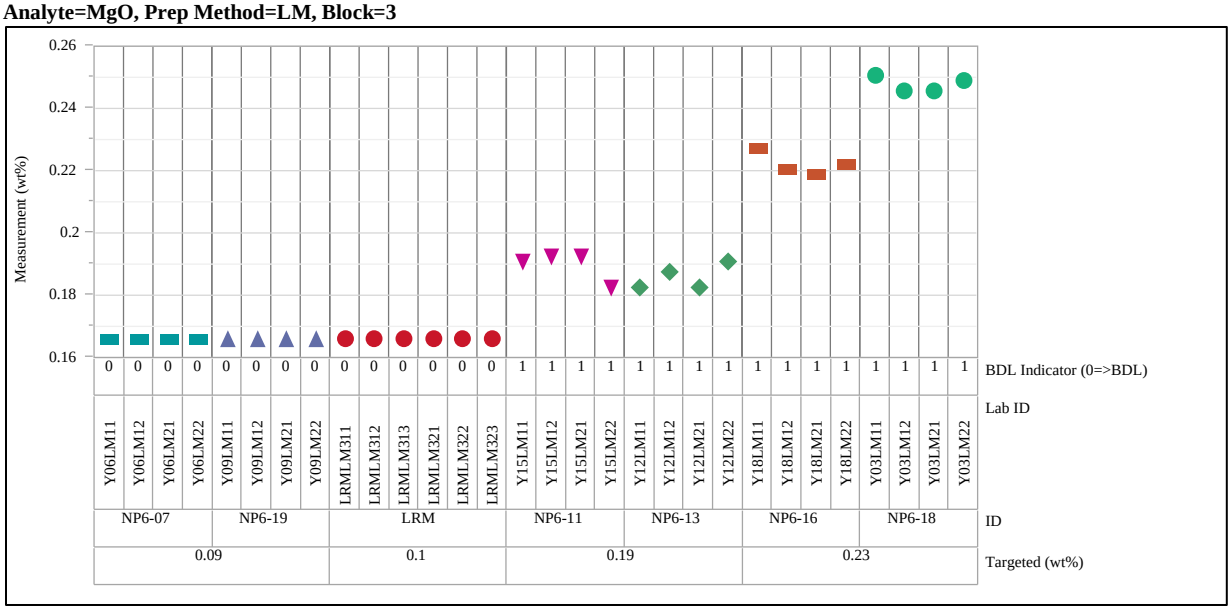


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=MgO, Prep Method=LM, Block=3



Analyte=MnO, Prep Method=PF, Block=1

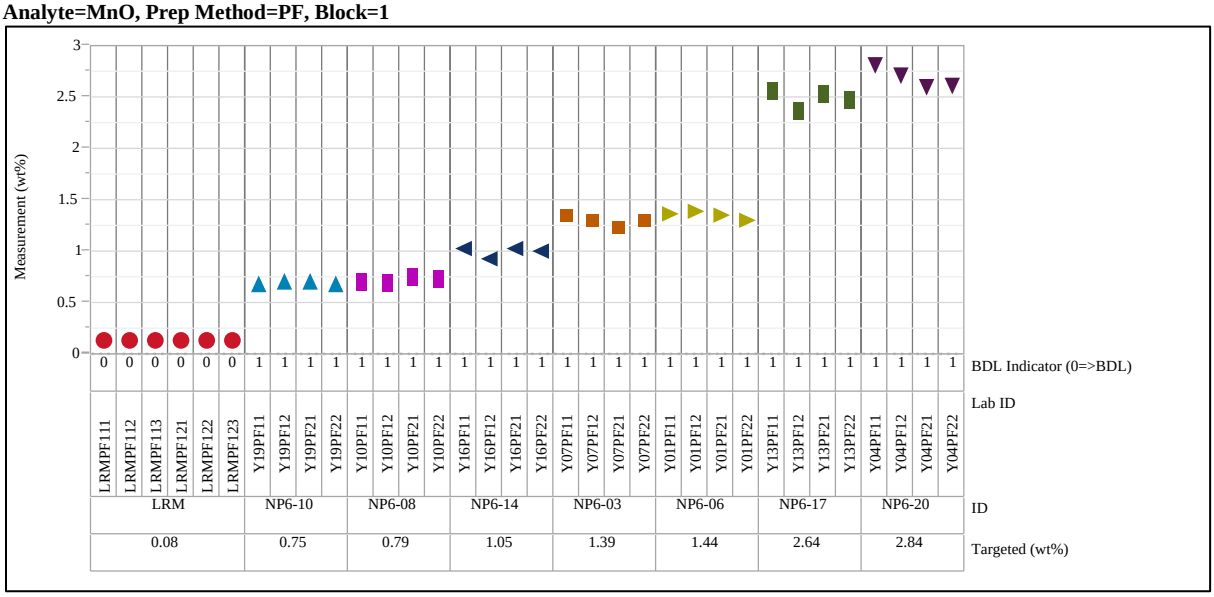
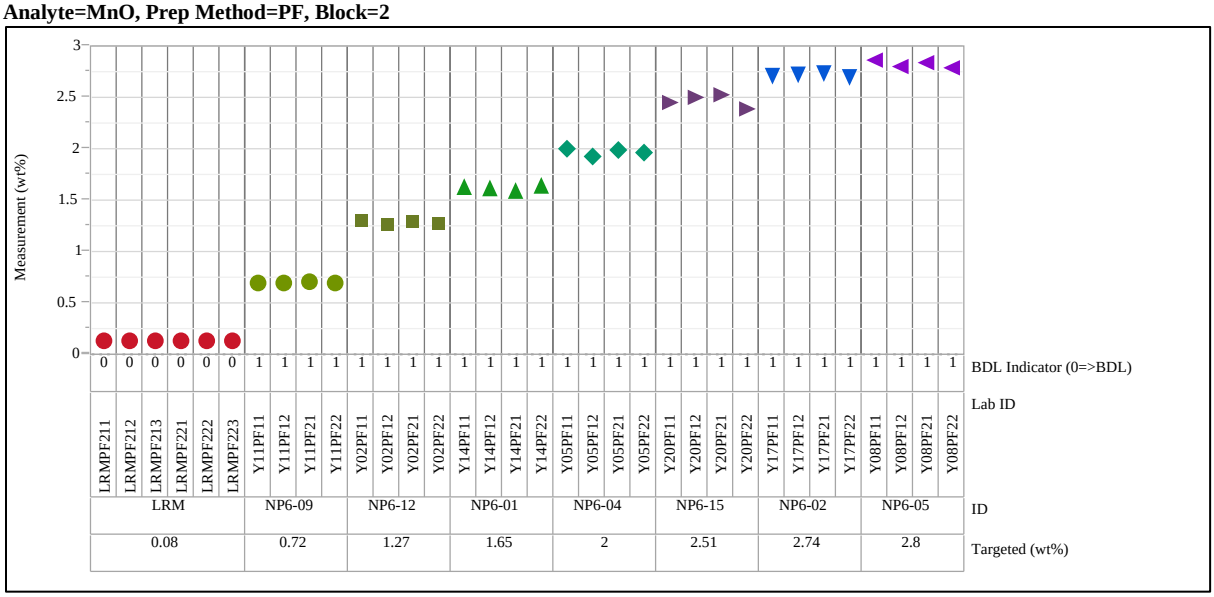


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=MnO, Prep Method=PF, Block=2



Analyte=MnO, Prep Method=PF, Block=3

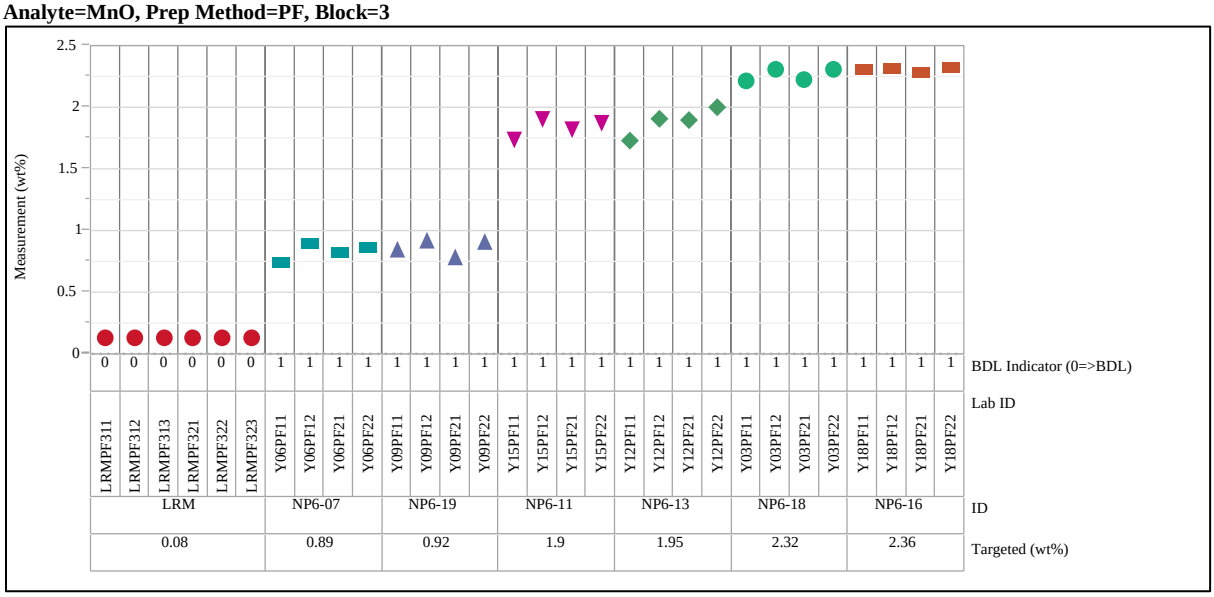
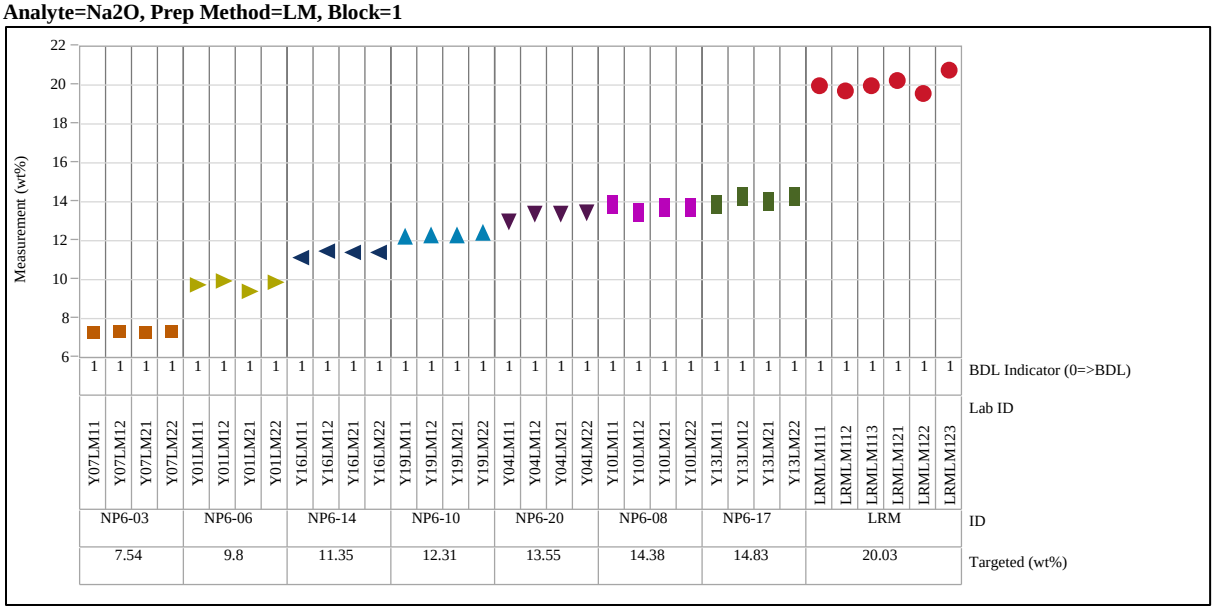


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=Na2O, Prep Method=LM, Block=1



Analyte=Na2O, Prep Method=LM, Block=2

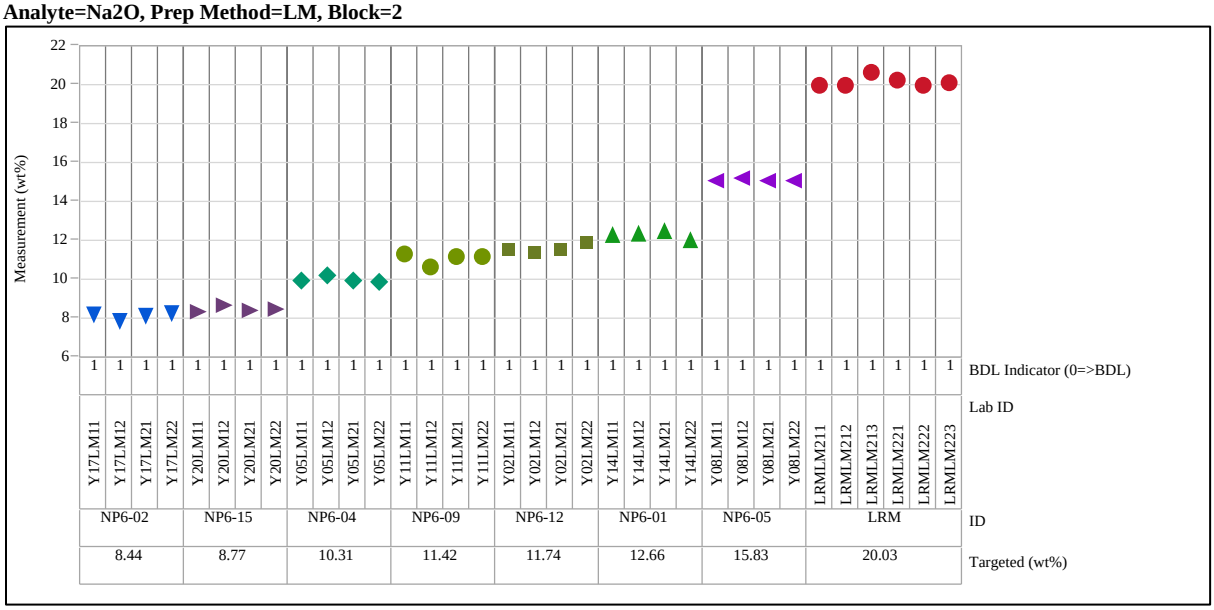
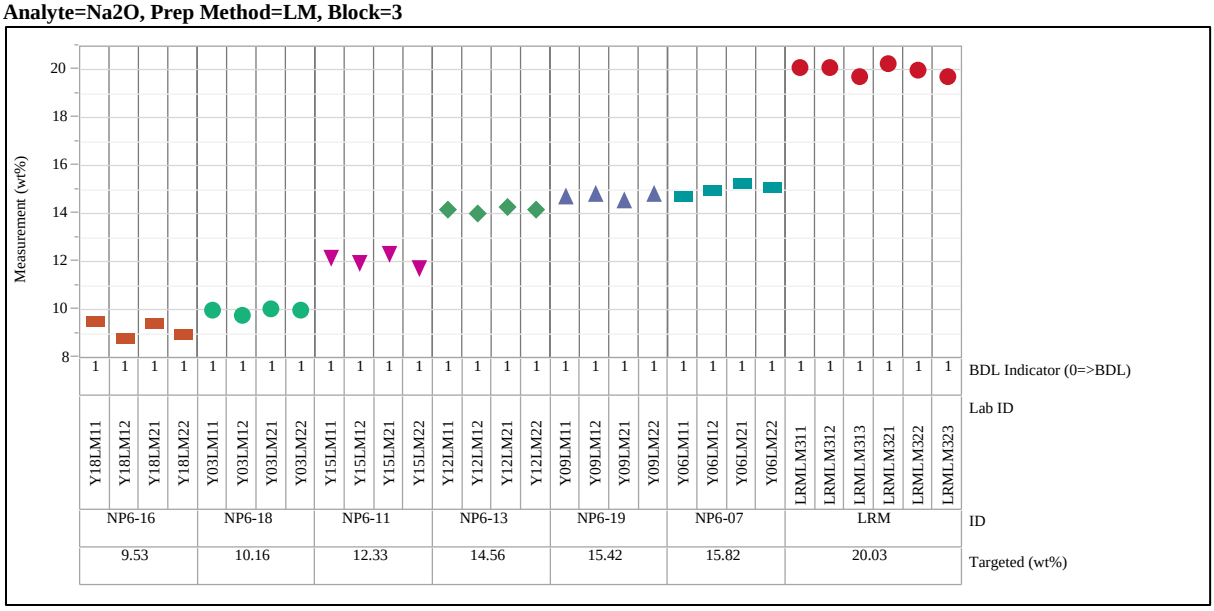


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=Na2O, Prep Method=LM, Block=3



Analyte=NiO, Prep Method=PF, Block=1

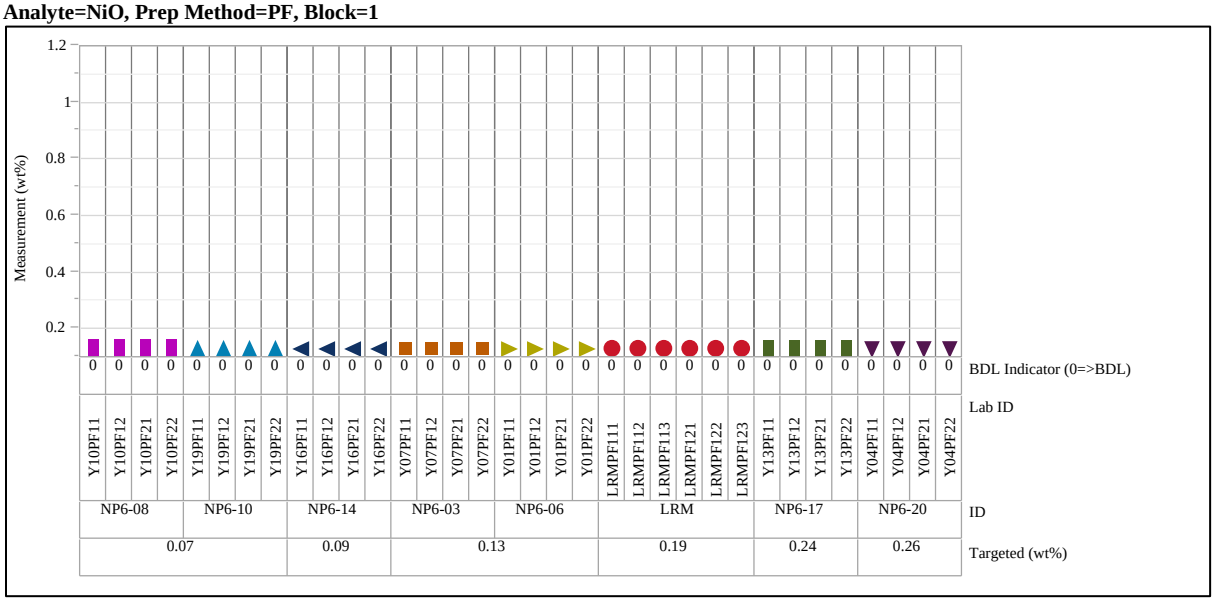
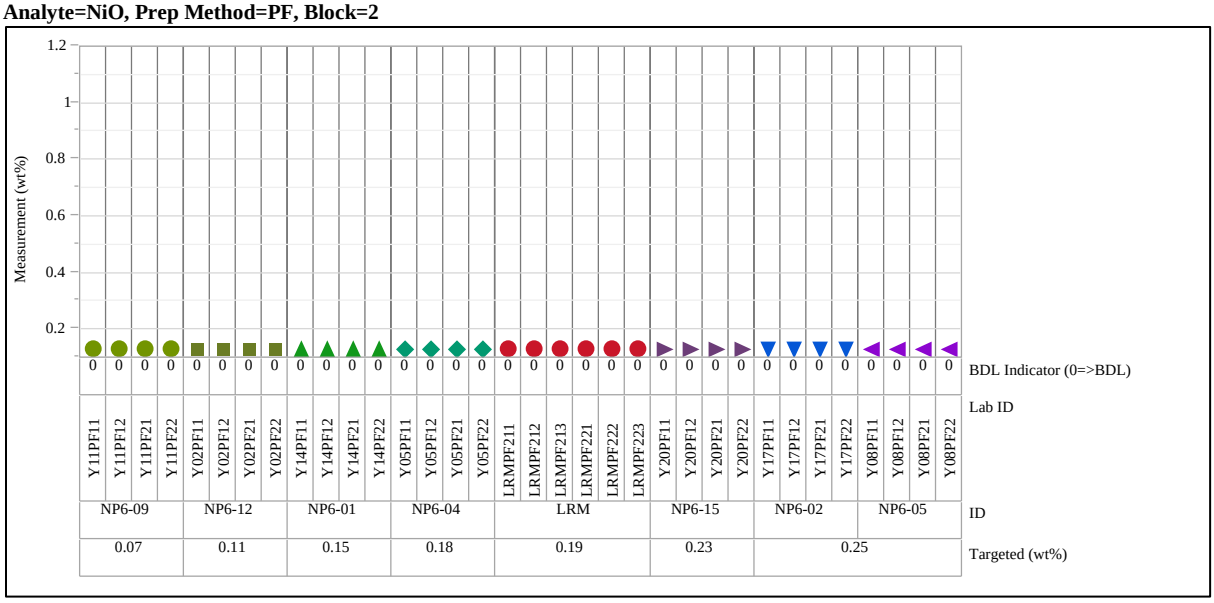


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=NiO, Prep Method=PF, Block=2



Analyte=NiO, Prep Method=PF, Block=3

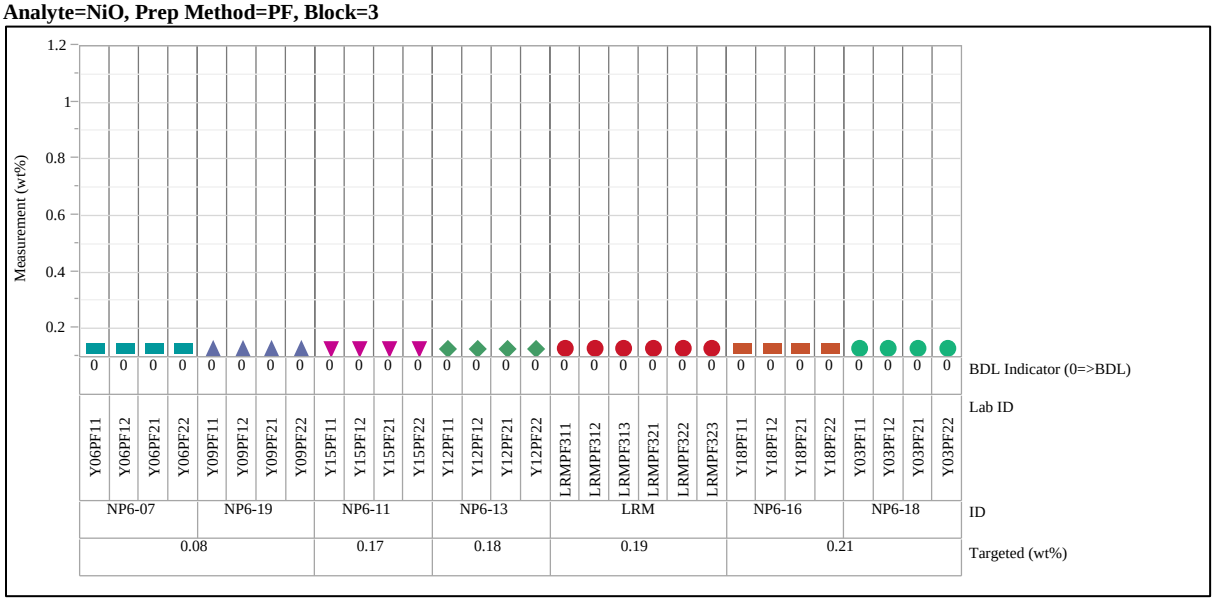
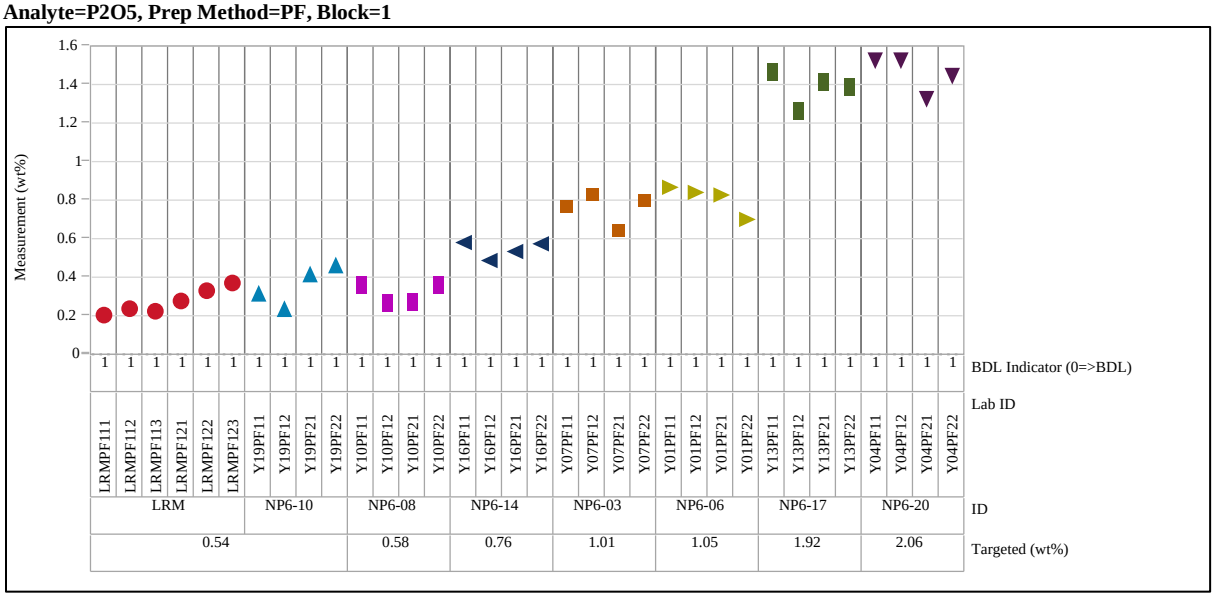


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=P2O5, Prep Method=PF, Block=1



Analyte=P2O5, Prep Method=PF, Block=2

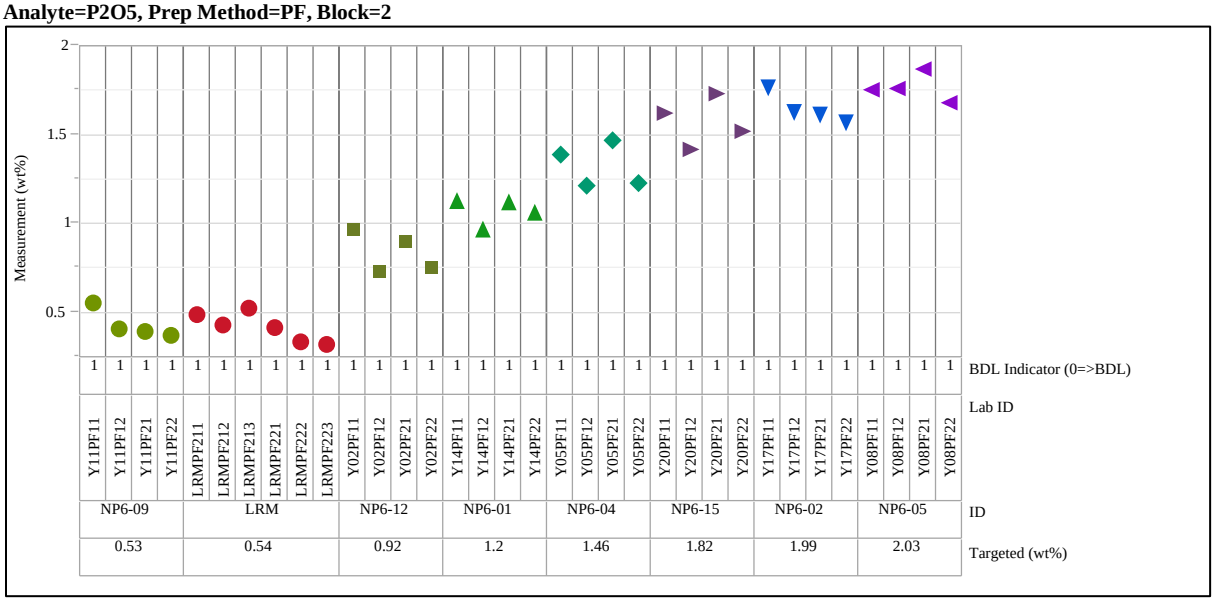
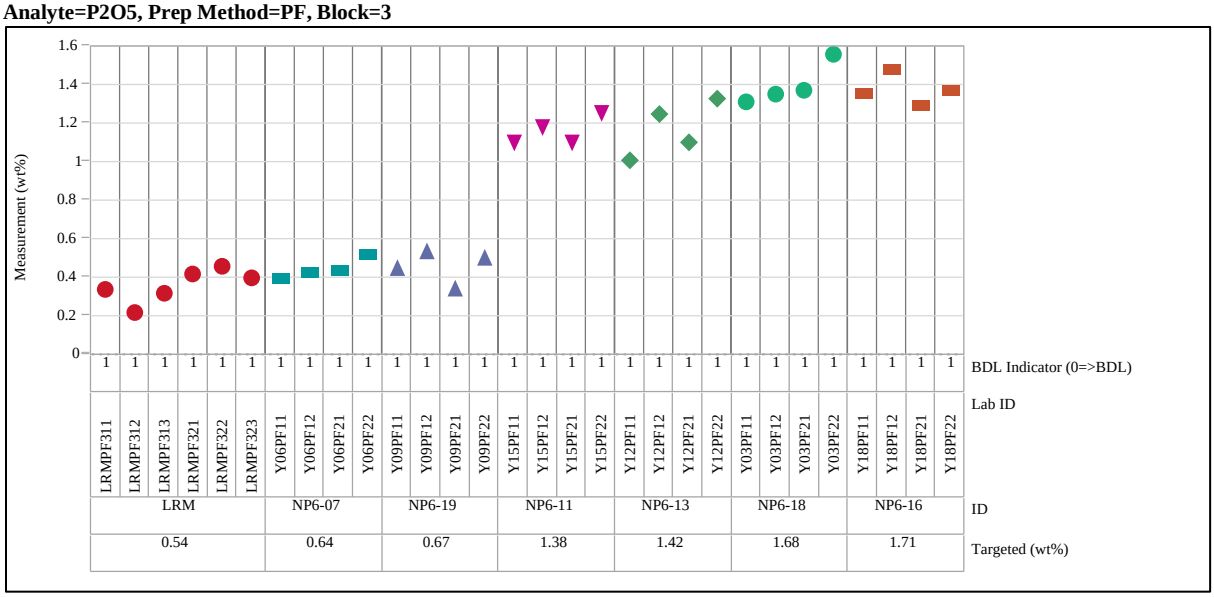


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=P2O5, Prep Method=PF, Block=3



Analyte=PbO, Prep Method=LM, Block=1

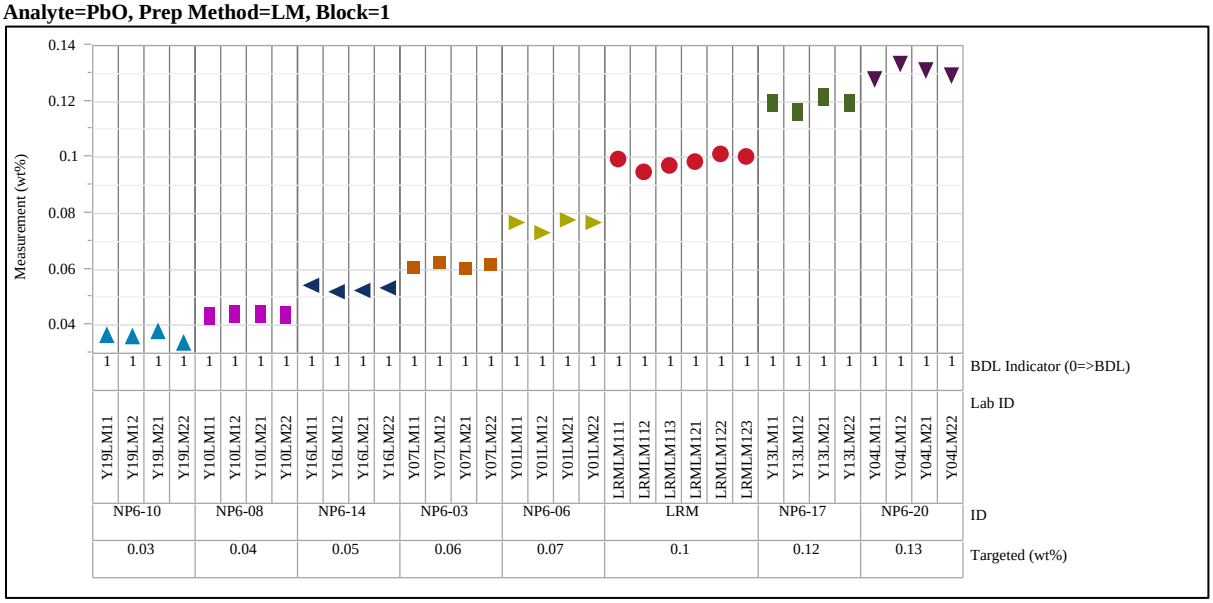
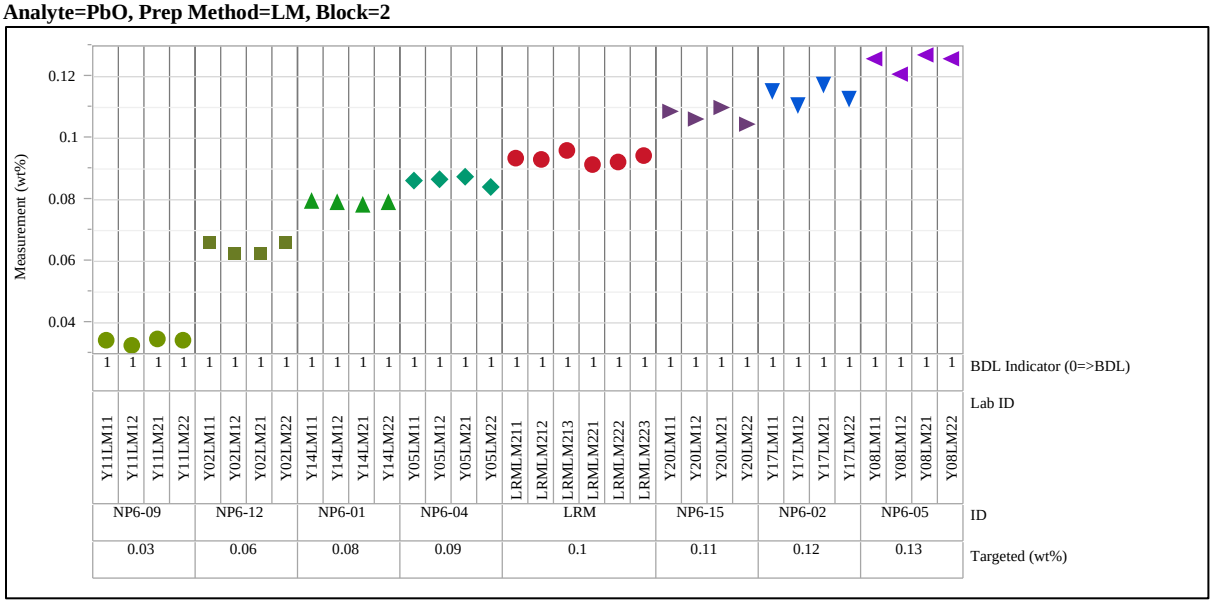


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=PbO, Prep Method=LM, Block=2



Analyte=PbO, Prep Method=LM, Block=3

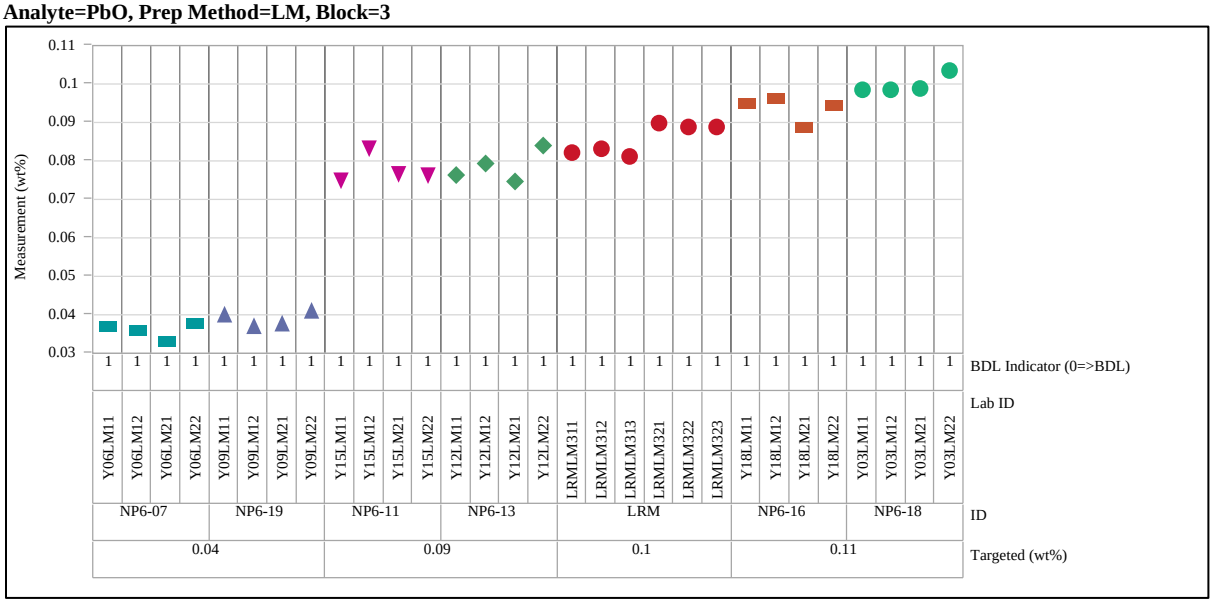
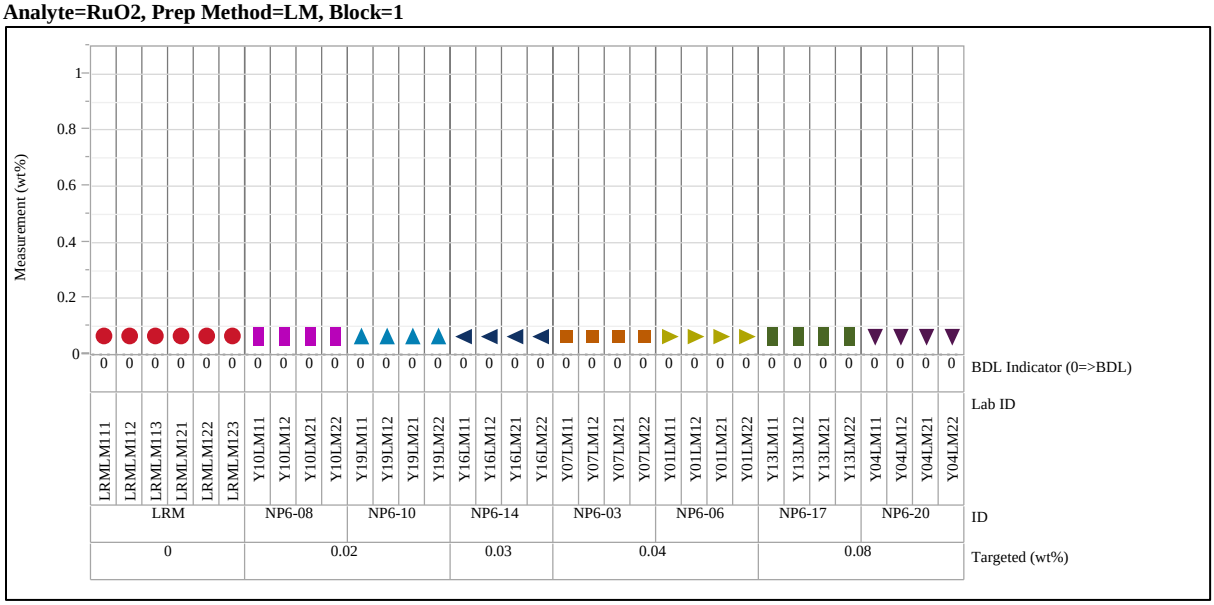


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=RuO2, Prep Method=LM, Block=1



Analyte=RuO2, Prep Method=LM, Block=2

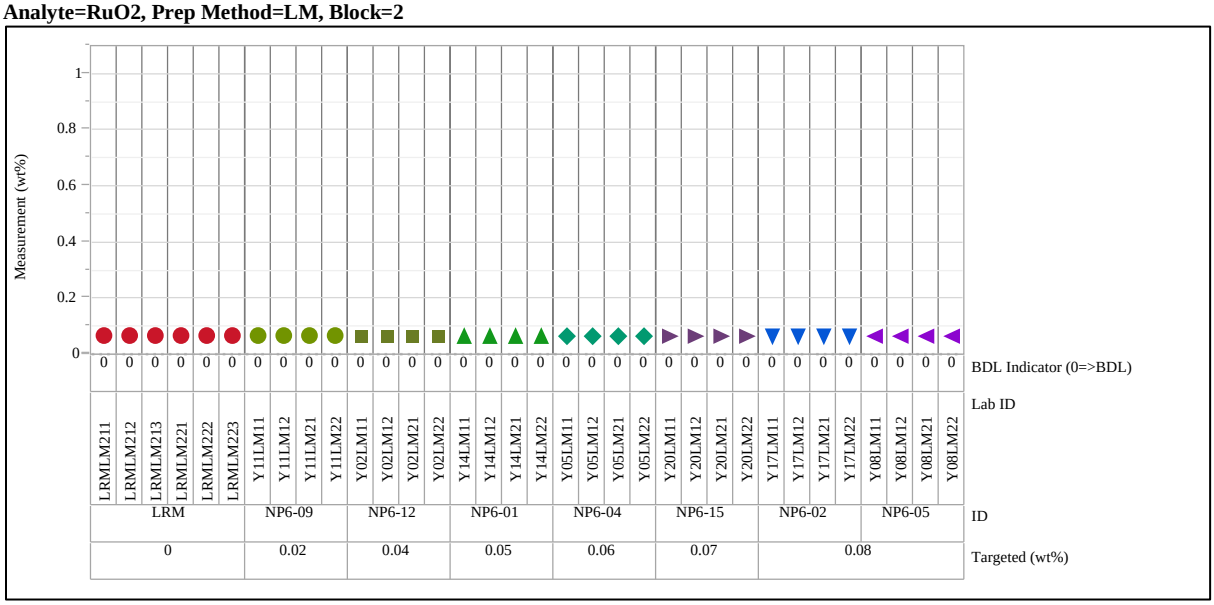
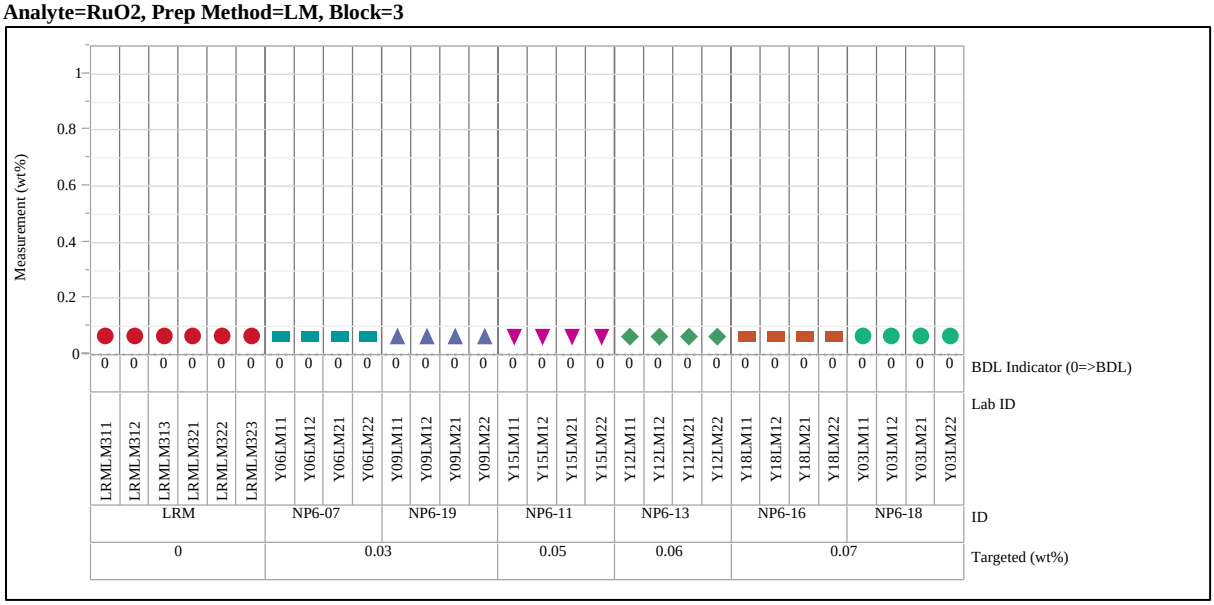


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=RuO2, Prep Method=LM, Block=3



Analyte=SiO2, Prep Method=PF, Block=1

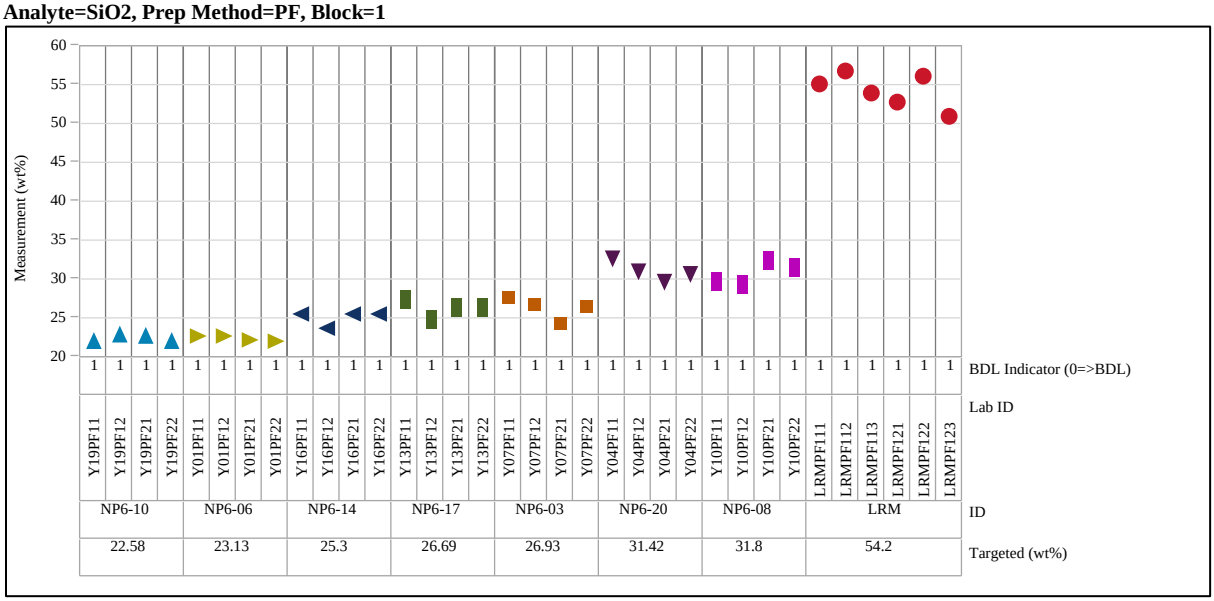
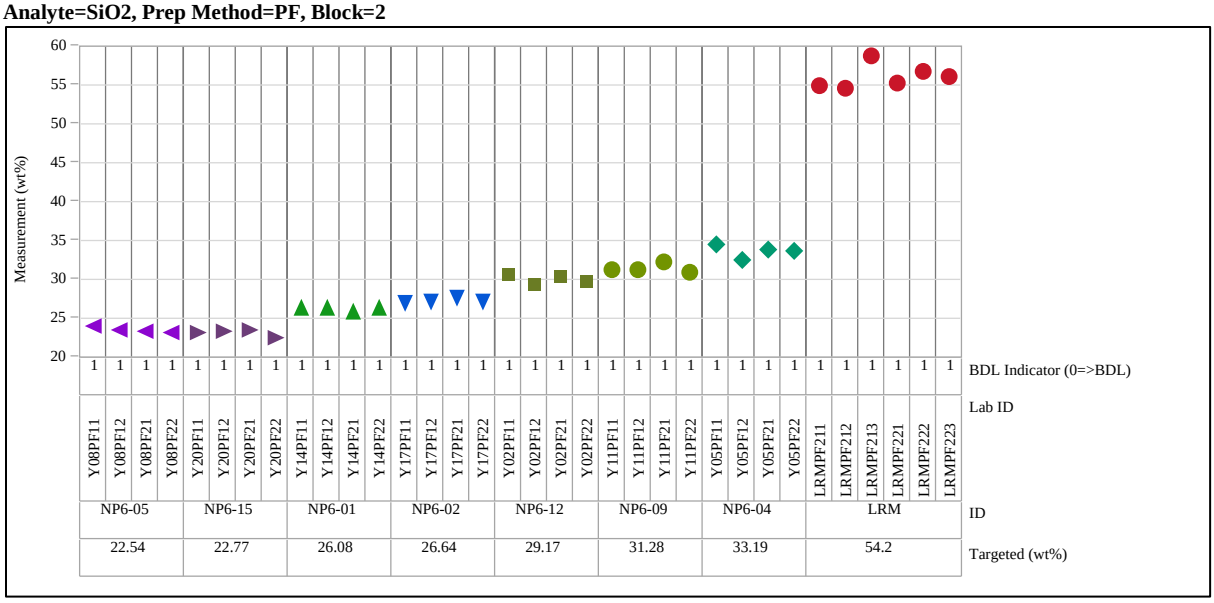


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=SiO2, Prep Method=PF, Block=2



Analyte=SiO2, Prep Method=PF, Block=3

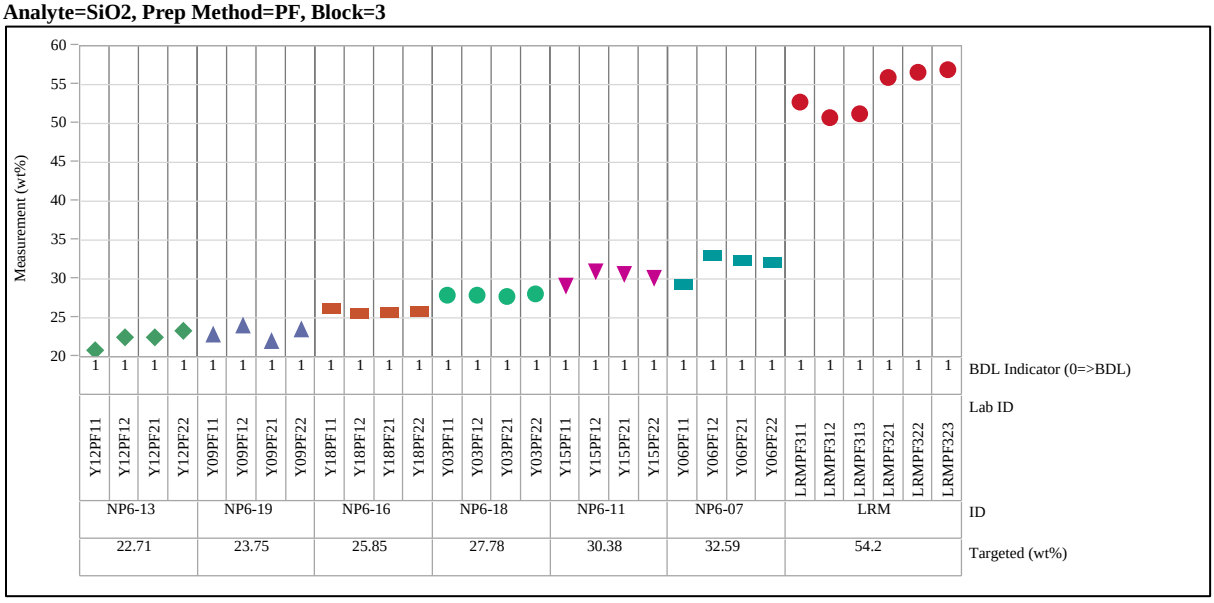
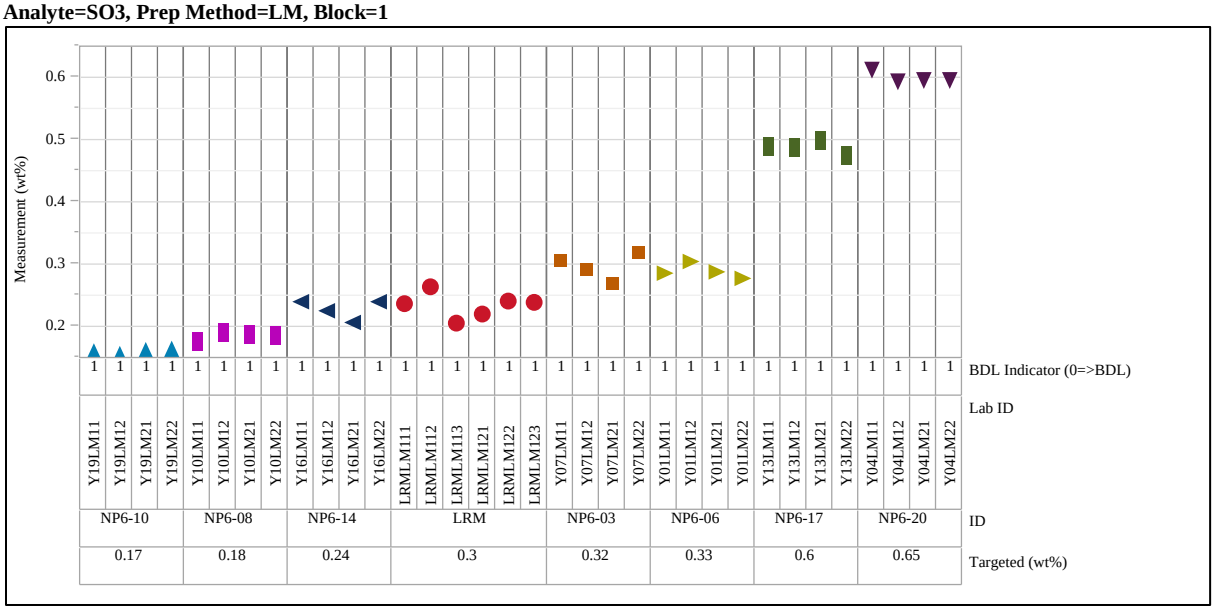


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=SO3, Prep Method=LM, Block=1



Analyte=SO3, Prep Method=LM, Block=2

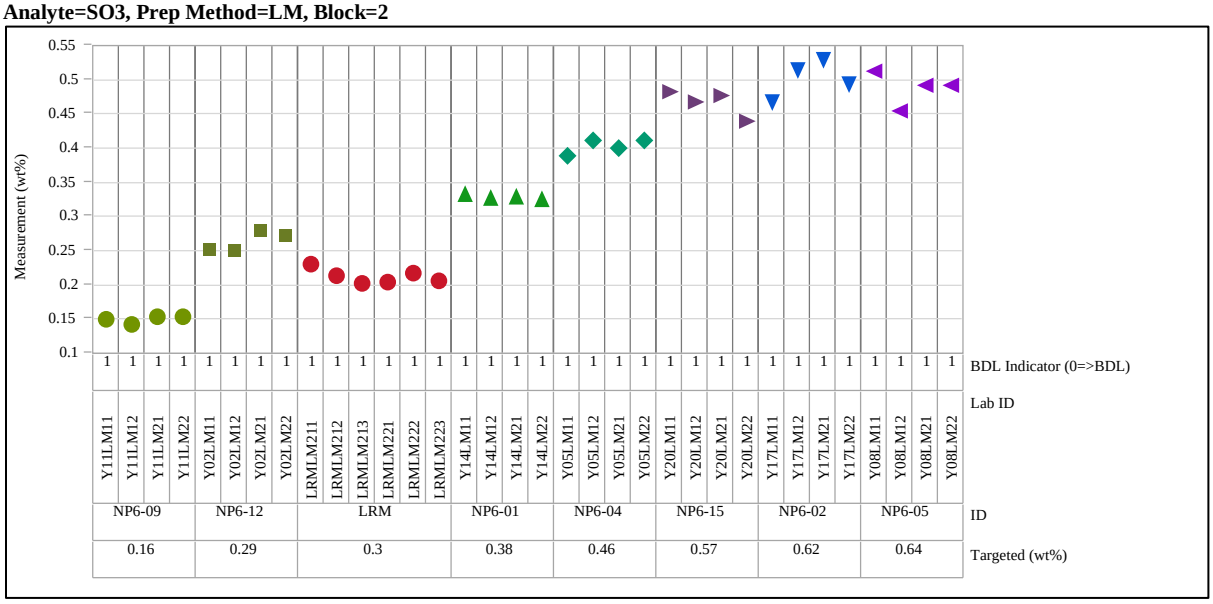
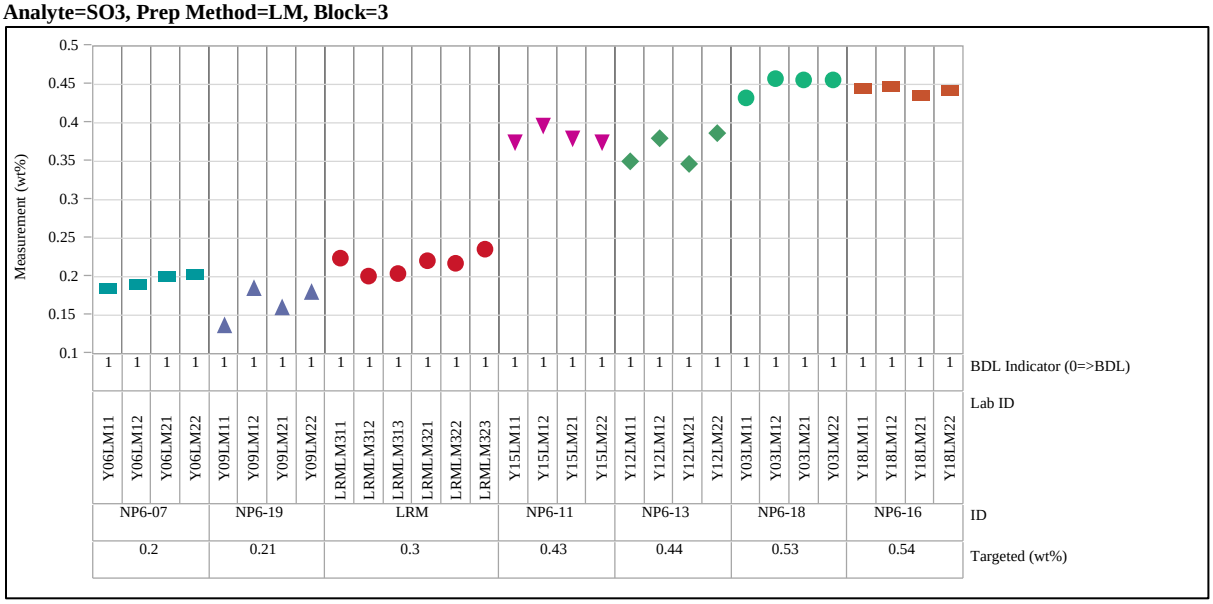


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=SO3, Prep Method=LM, Block=3



Analyte=SrO, Prep Method=LM, Block=1

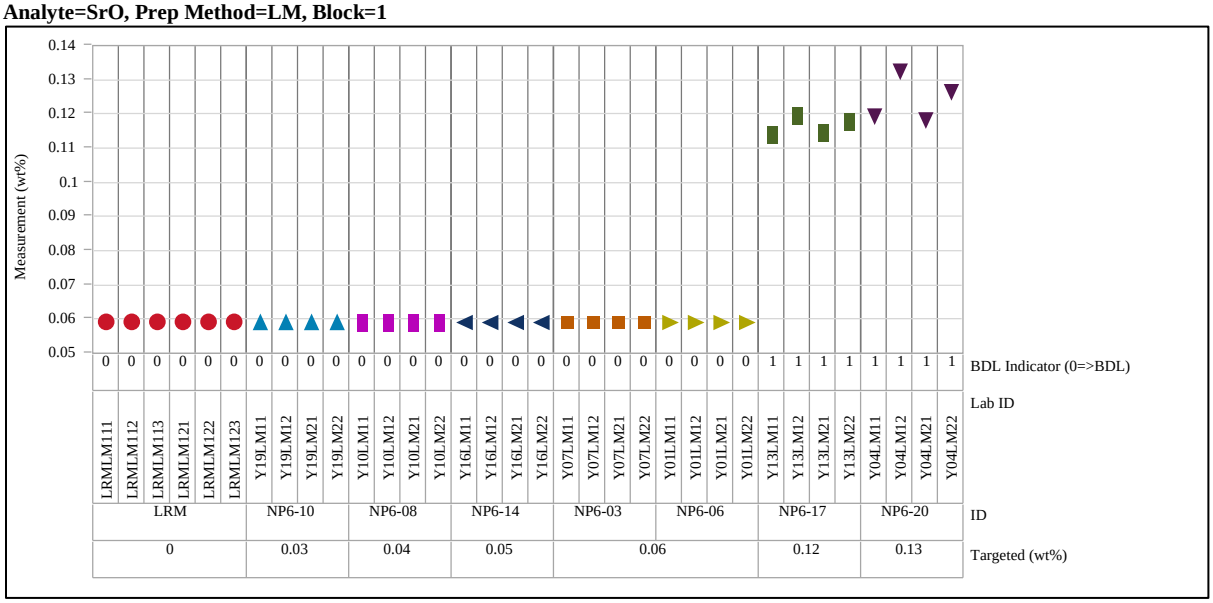
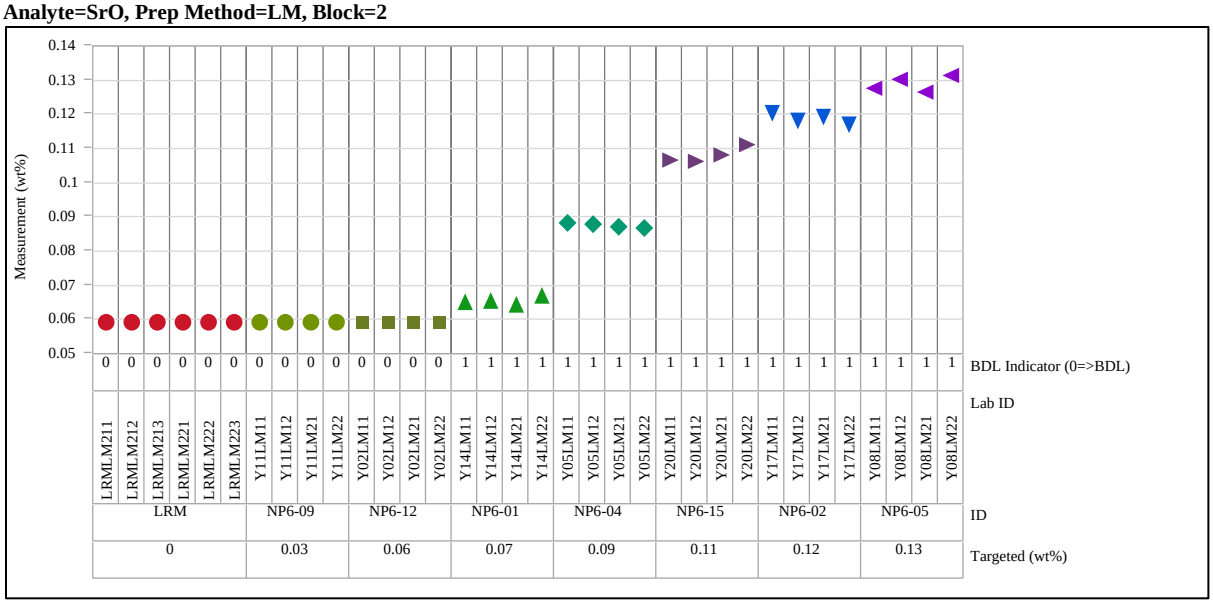


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=SrO, Prep Method=LM, Block=2



Analyte=SrO, Prep Method=LM, Block=3

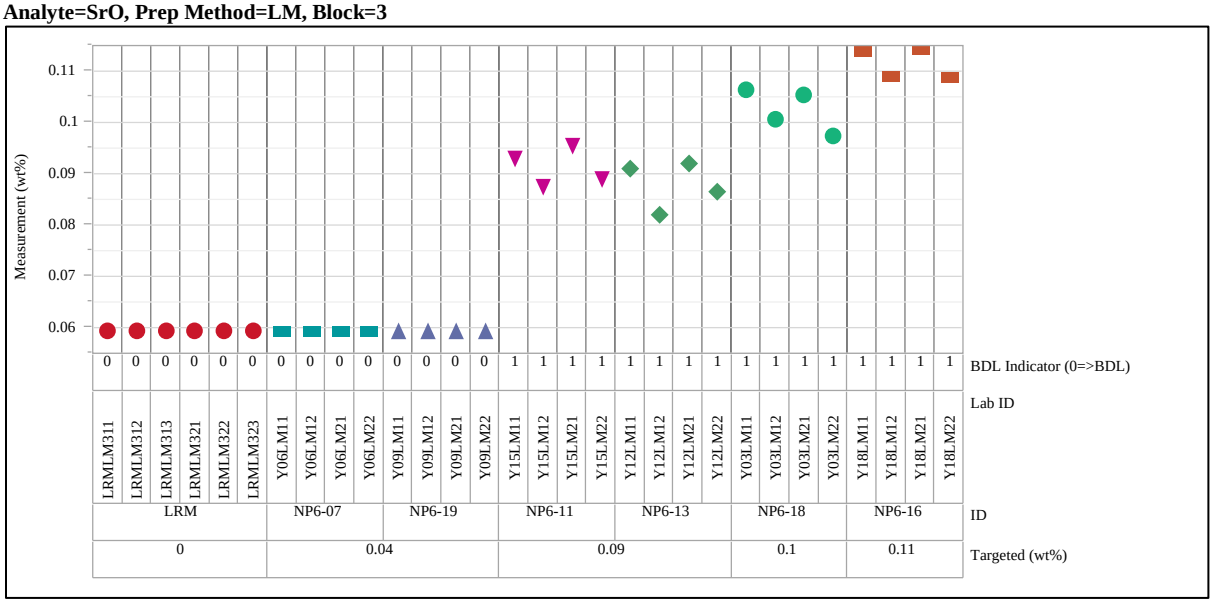
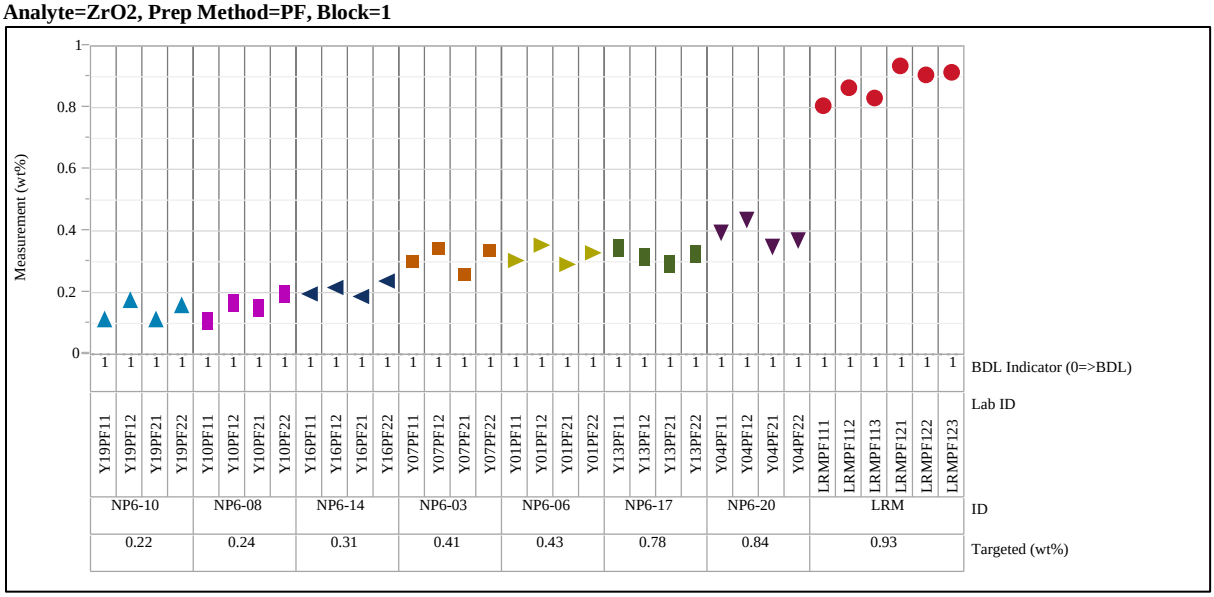


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=ZrO2, Prep Method=PF, Block=1



Analyte=ZrO2, Prep Method=PF, Block=2

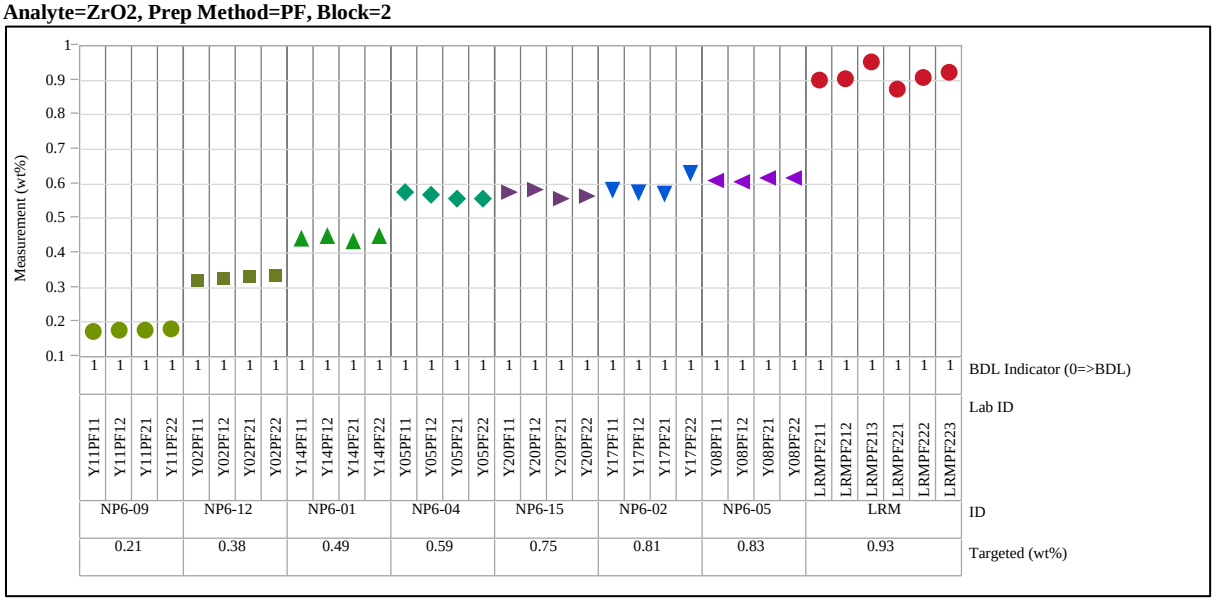


Exhibit A-2. Plots of Oxide Measurements by Glass Identifier Grouped by Targeted Concentrations and Analytical Block (continued)

Analyte=ZrO2, Prep Method=PF, Block=3

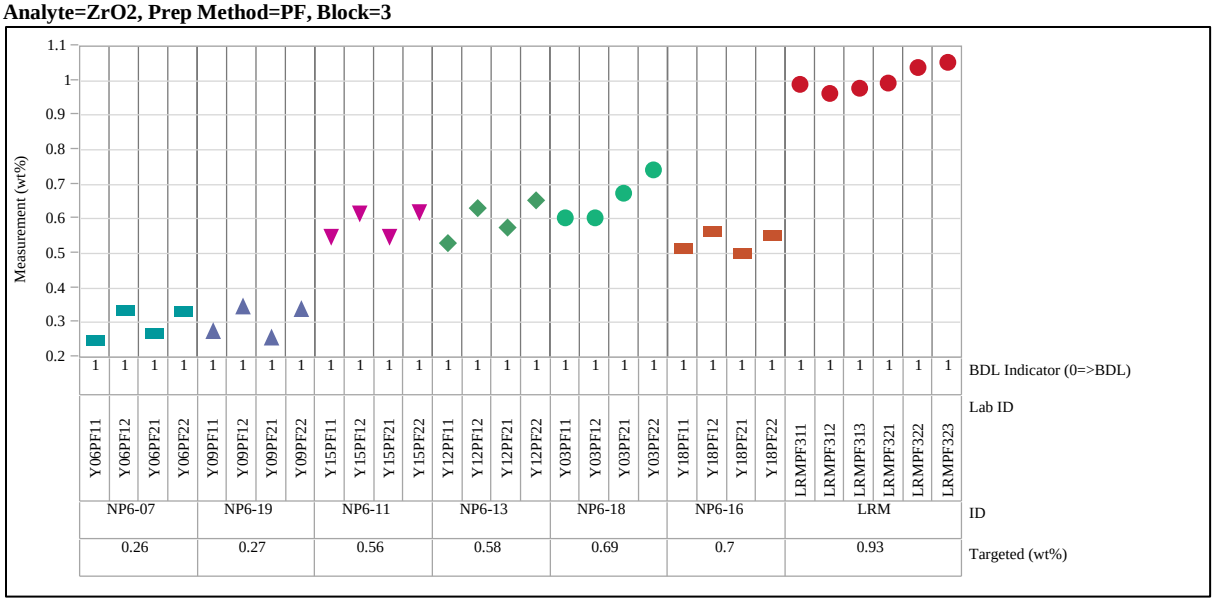
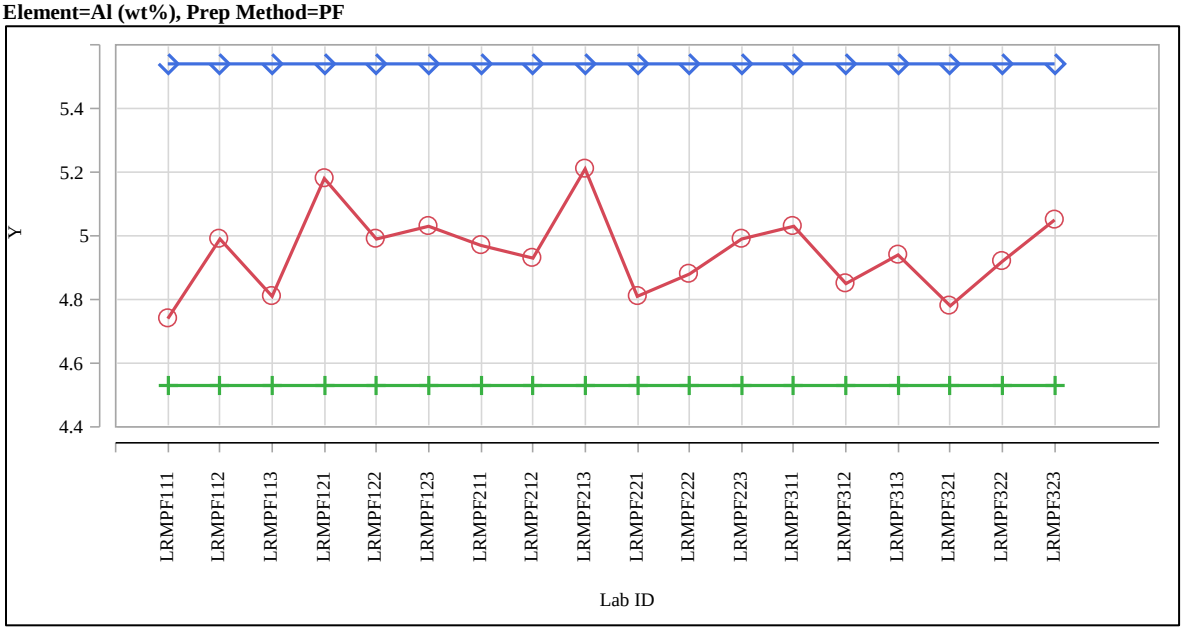
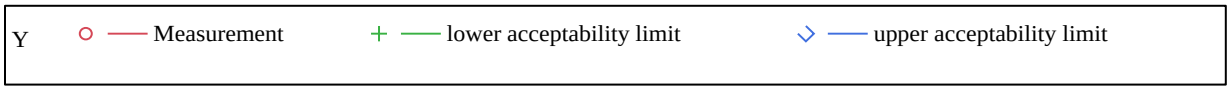


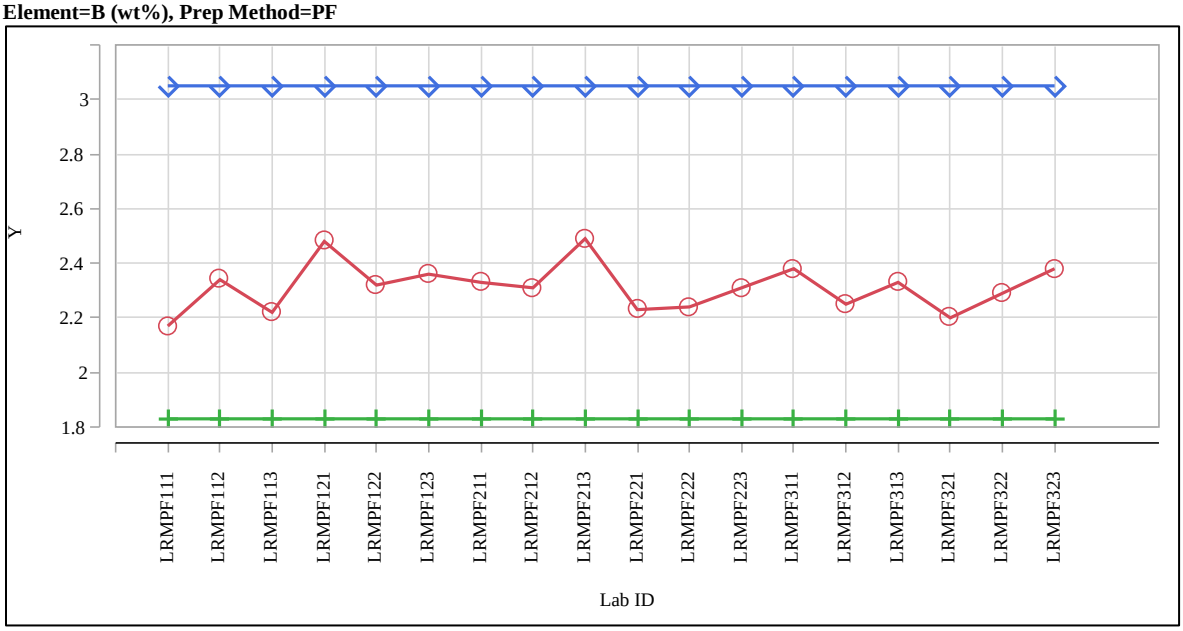
Exhibit A-3. Acceptability Evaluation for Measurements of the LRM Glass

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





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



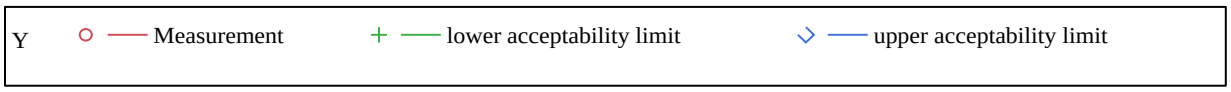
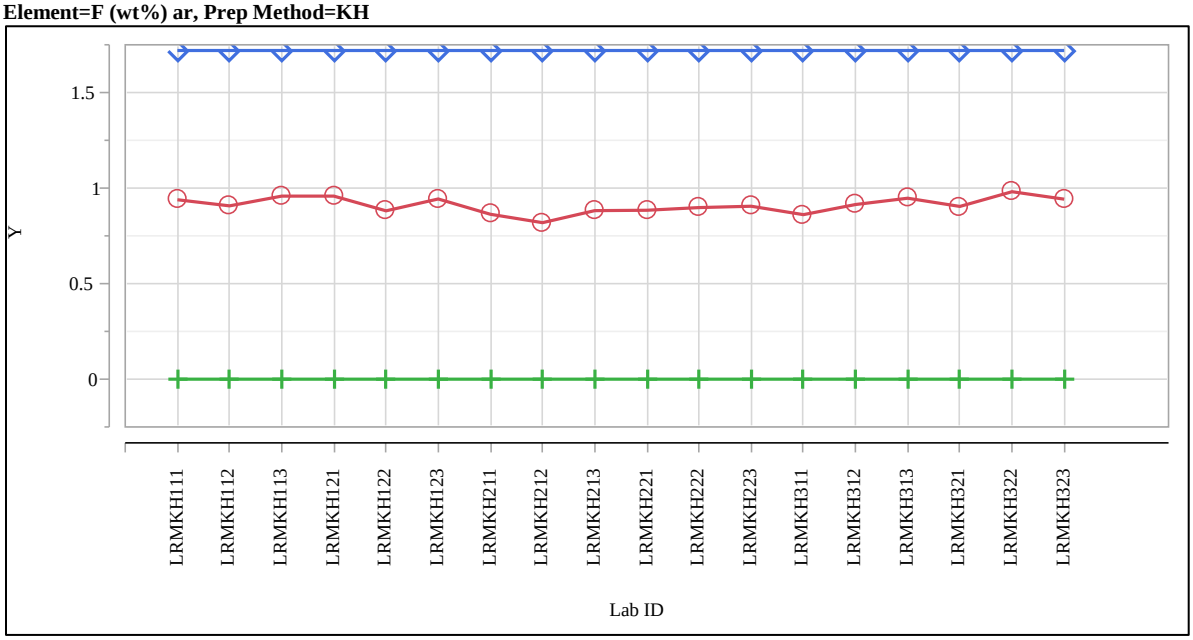
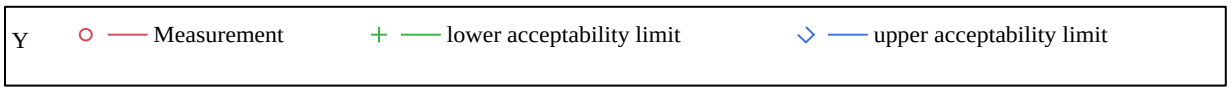


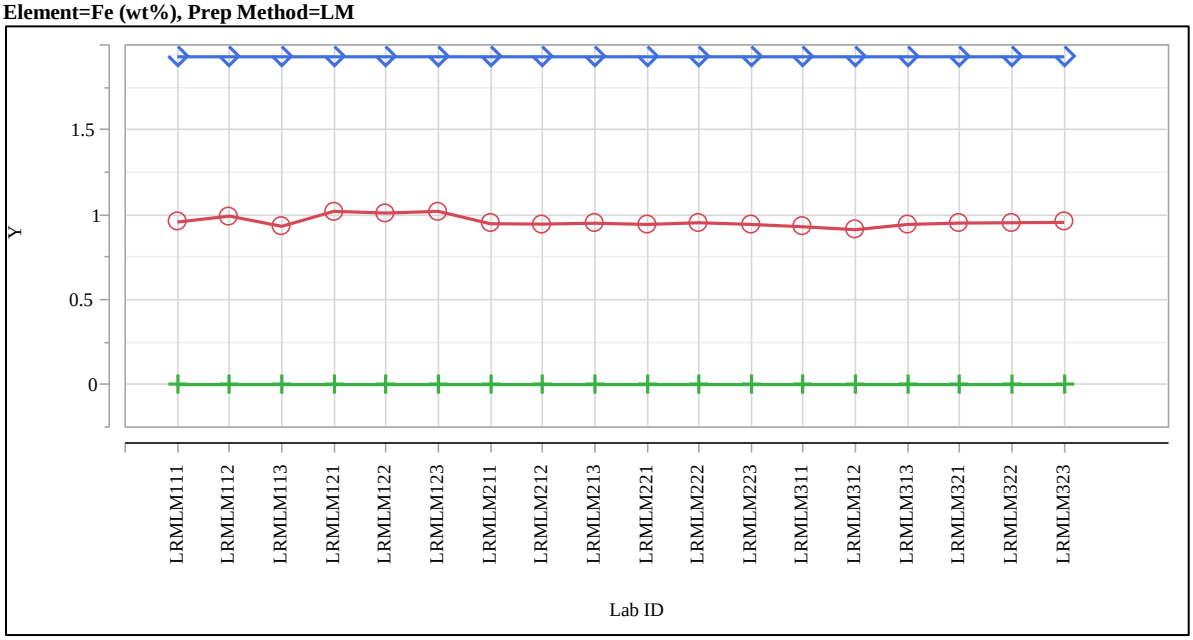
Exhibit A-3. Acceptability Evaluation for Measurements of the LRM Glass (continued)

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





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



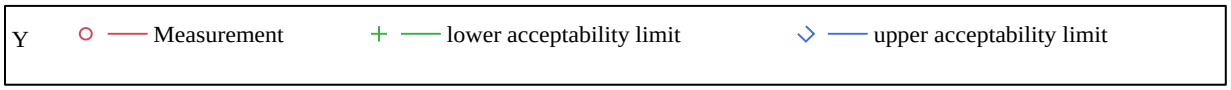
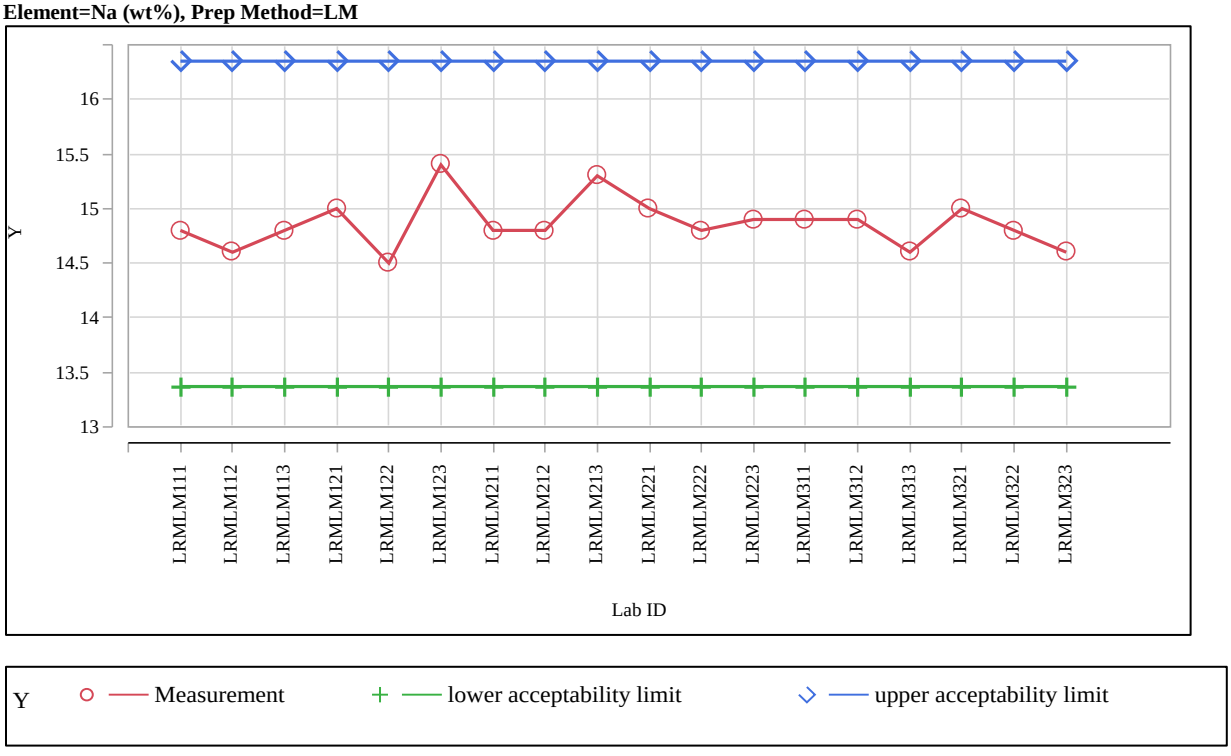
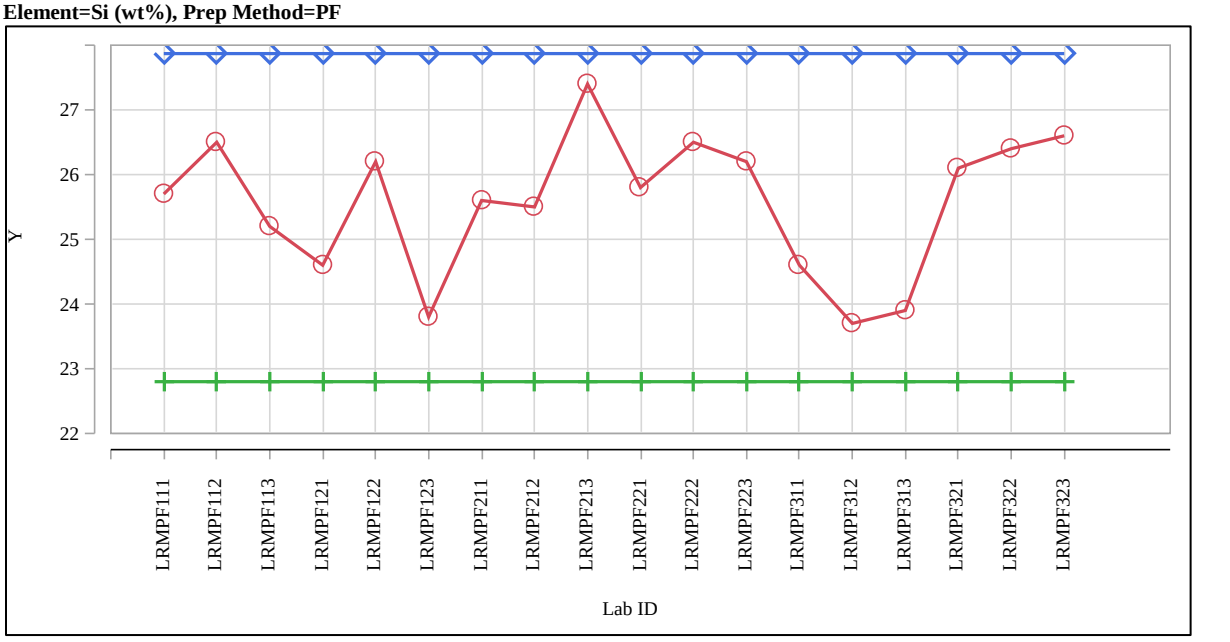


Exhibit A-3. Acceptability Evaluation for Measurements of the LRM Glass (continued)

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



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



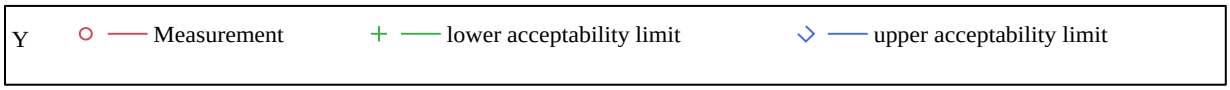


Exhibit A-3. Acceptability Evaluation for Measurements of the LRM Glass (continued)

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

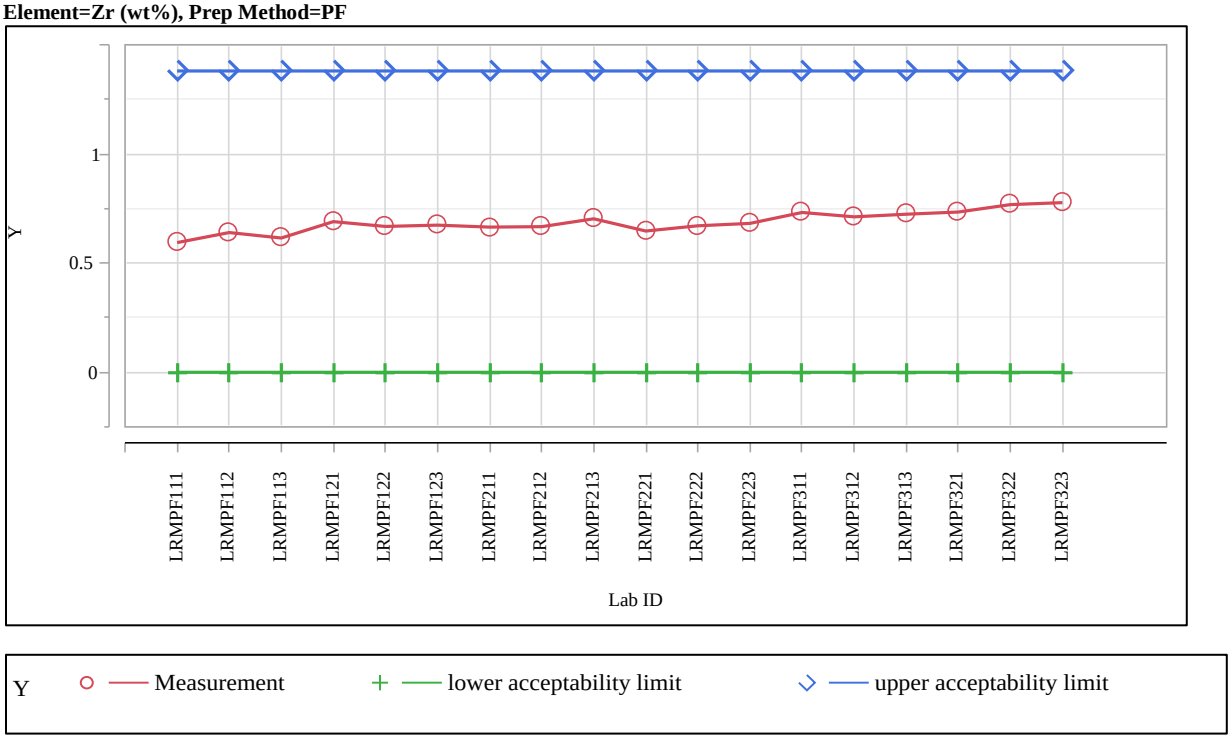


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide

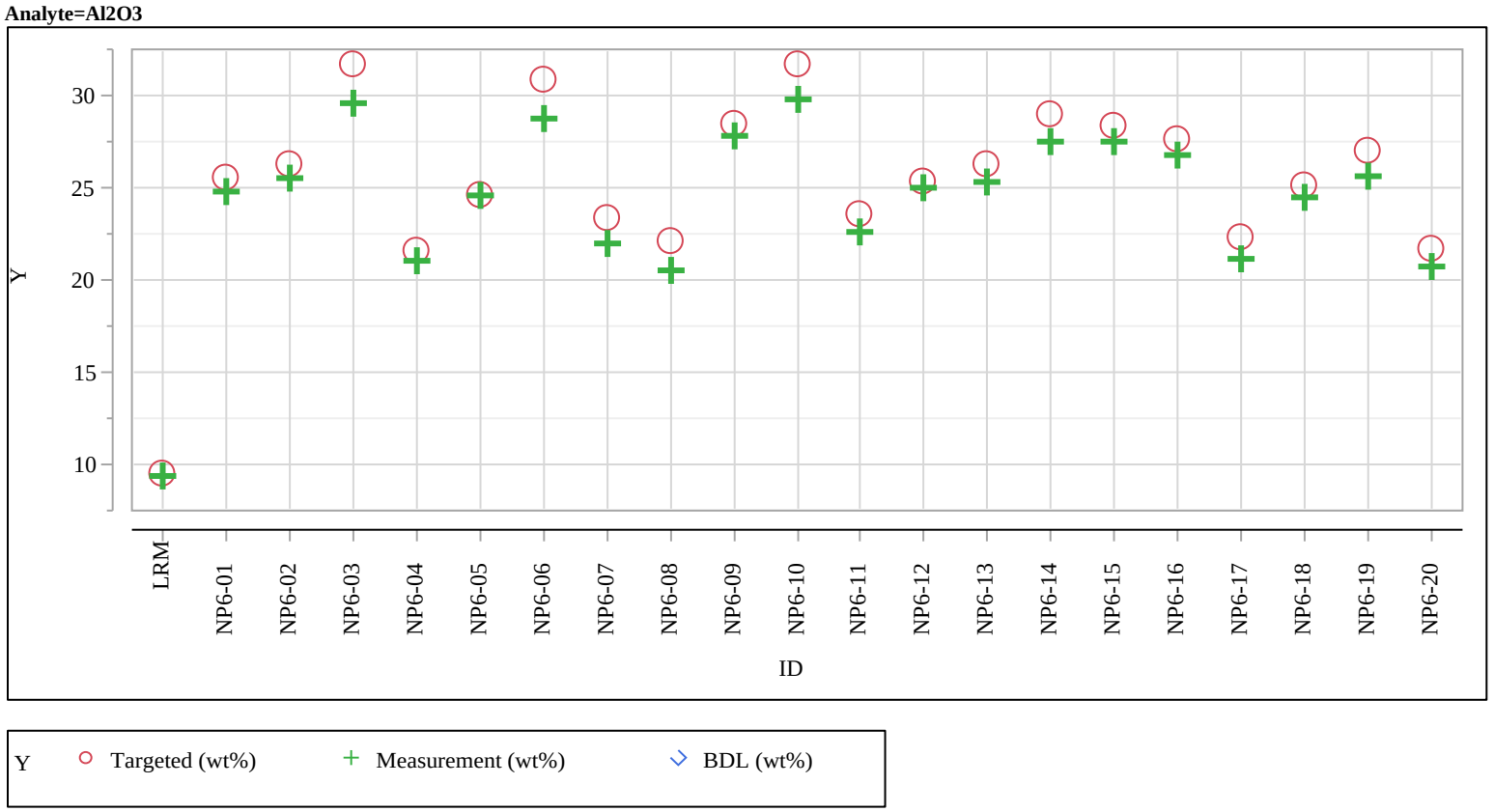


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

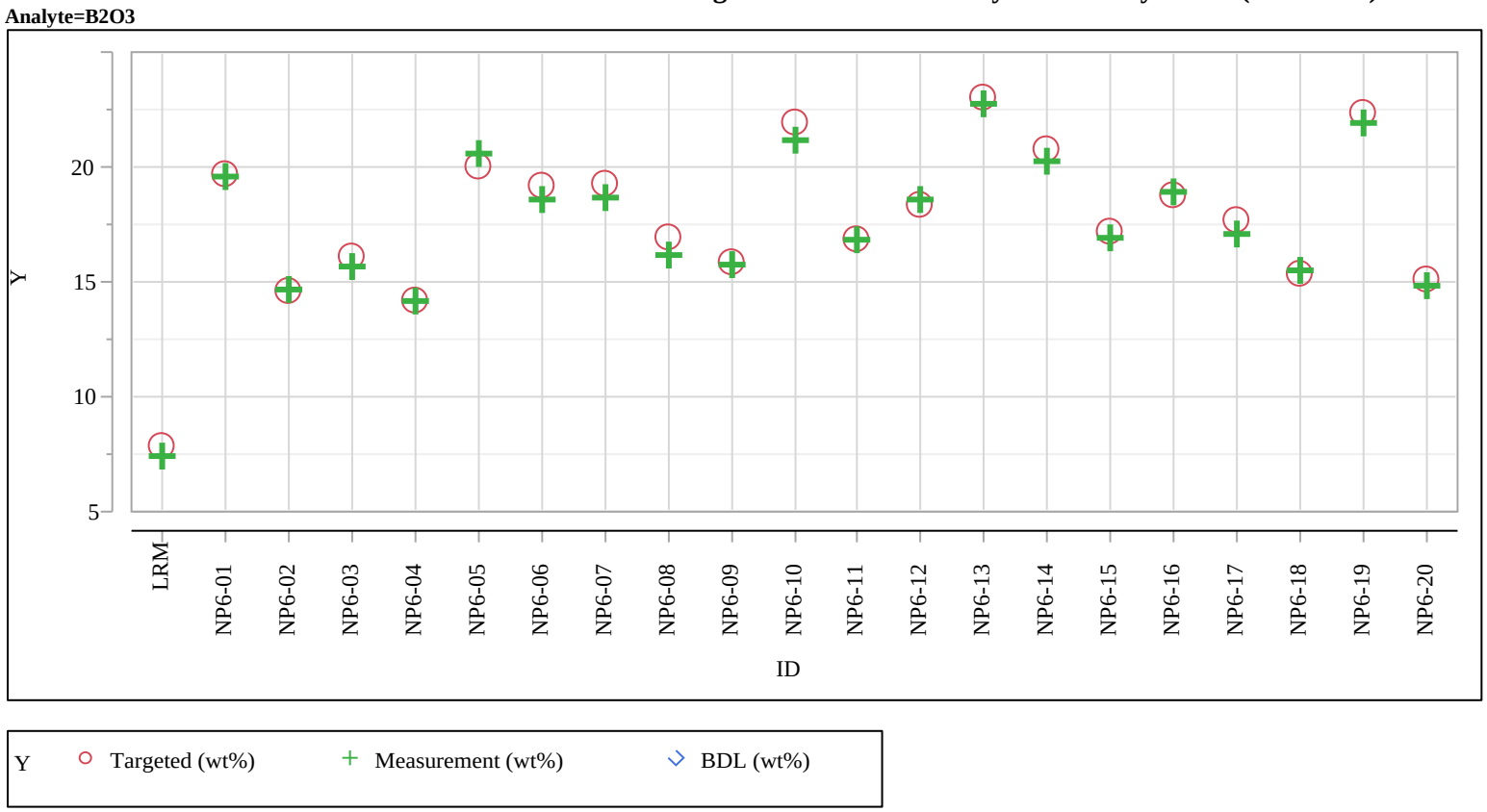


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

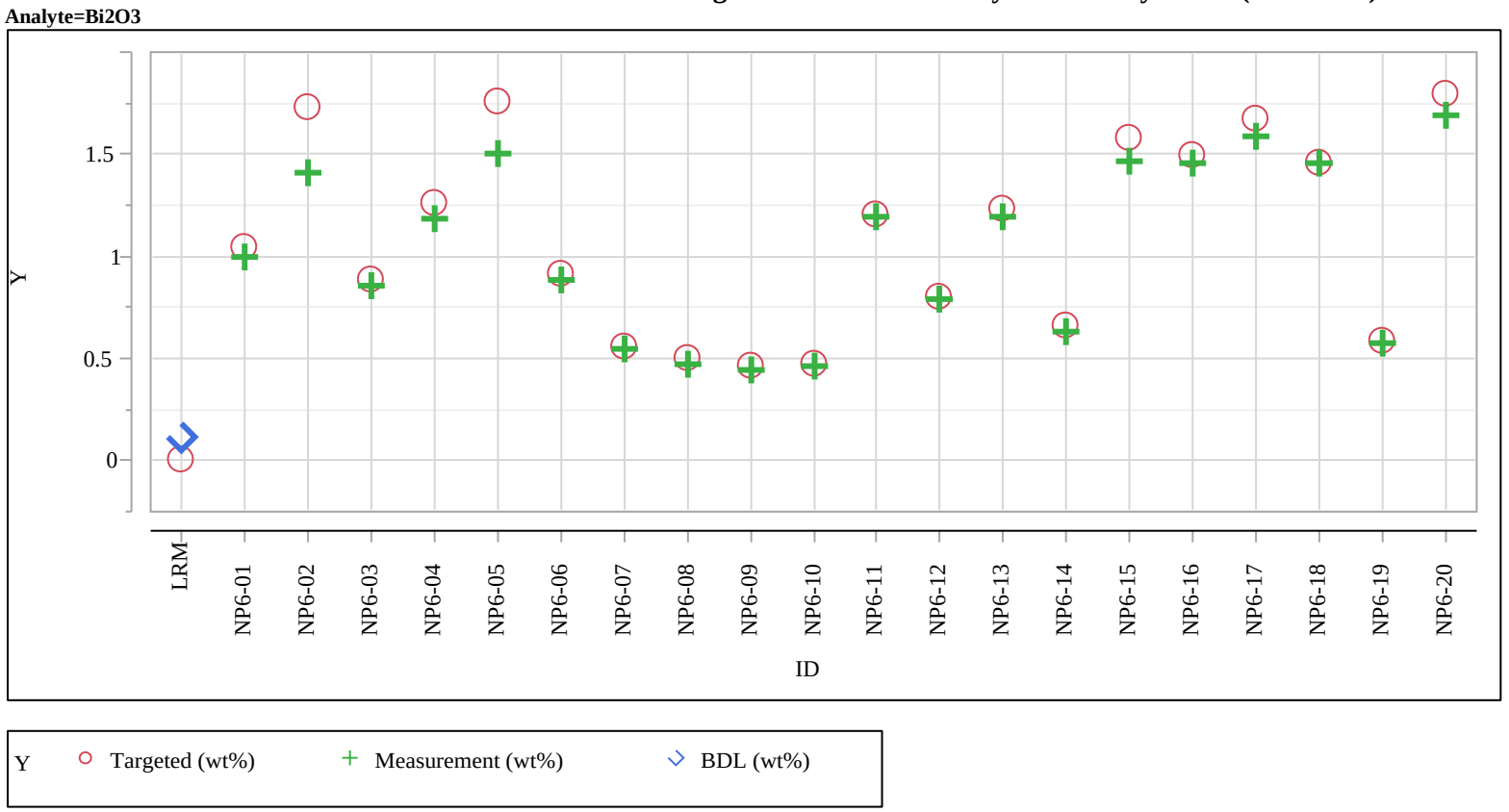


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

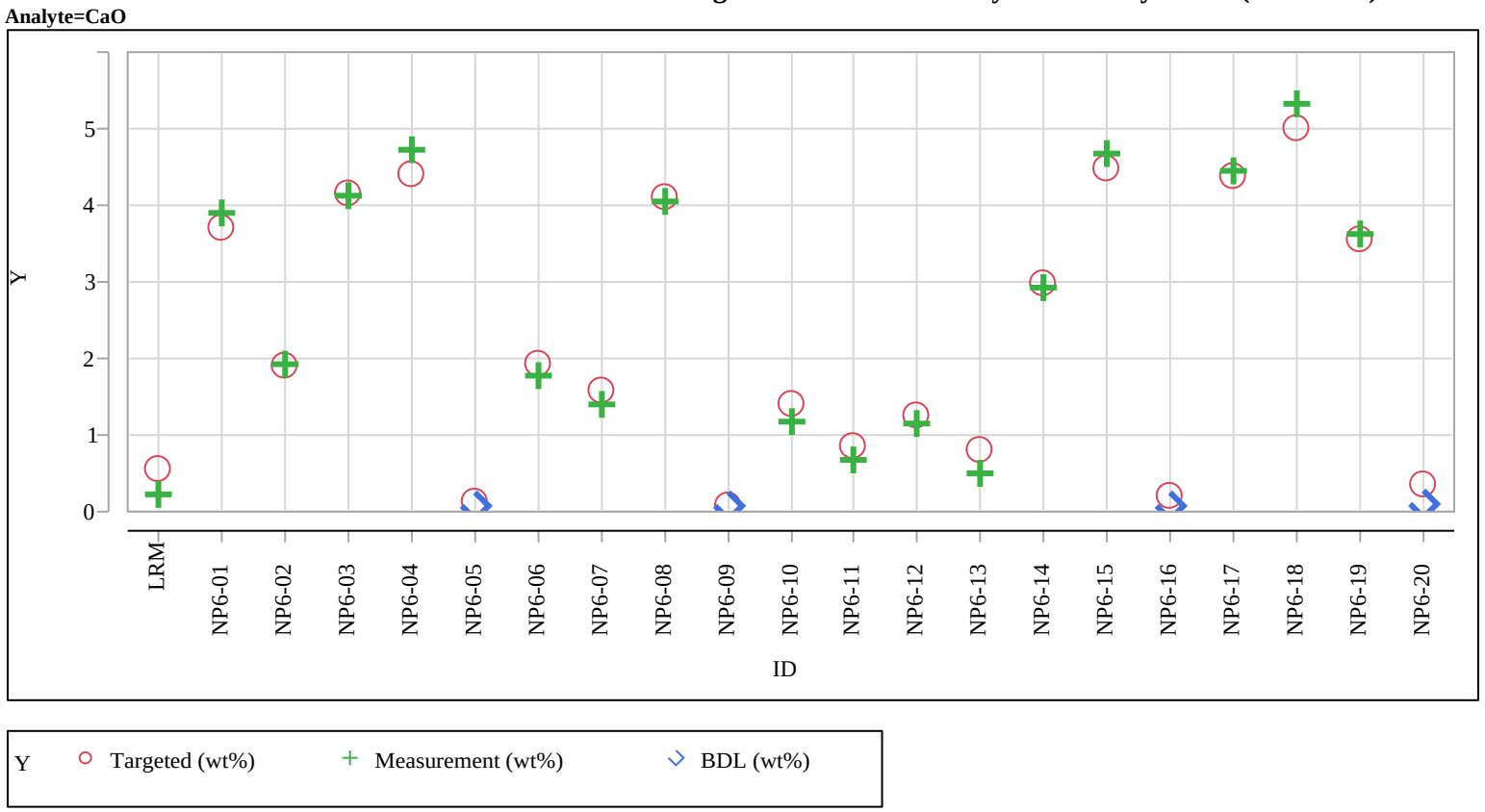


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

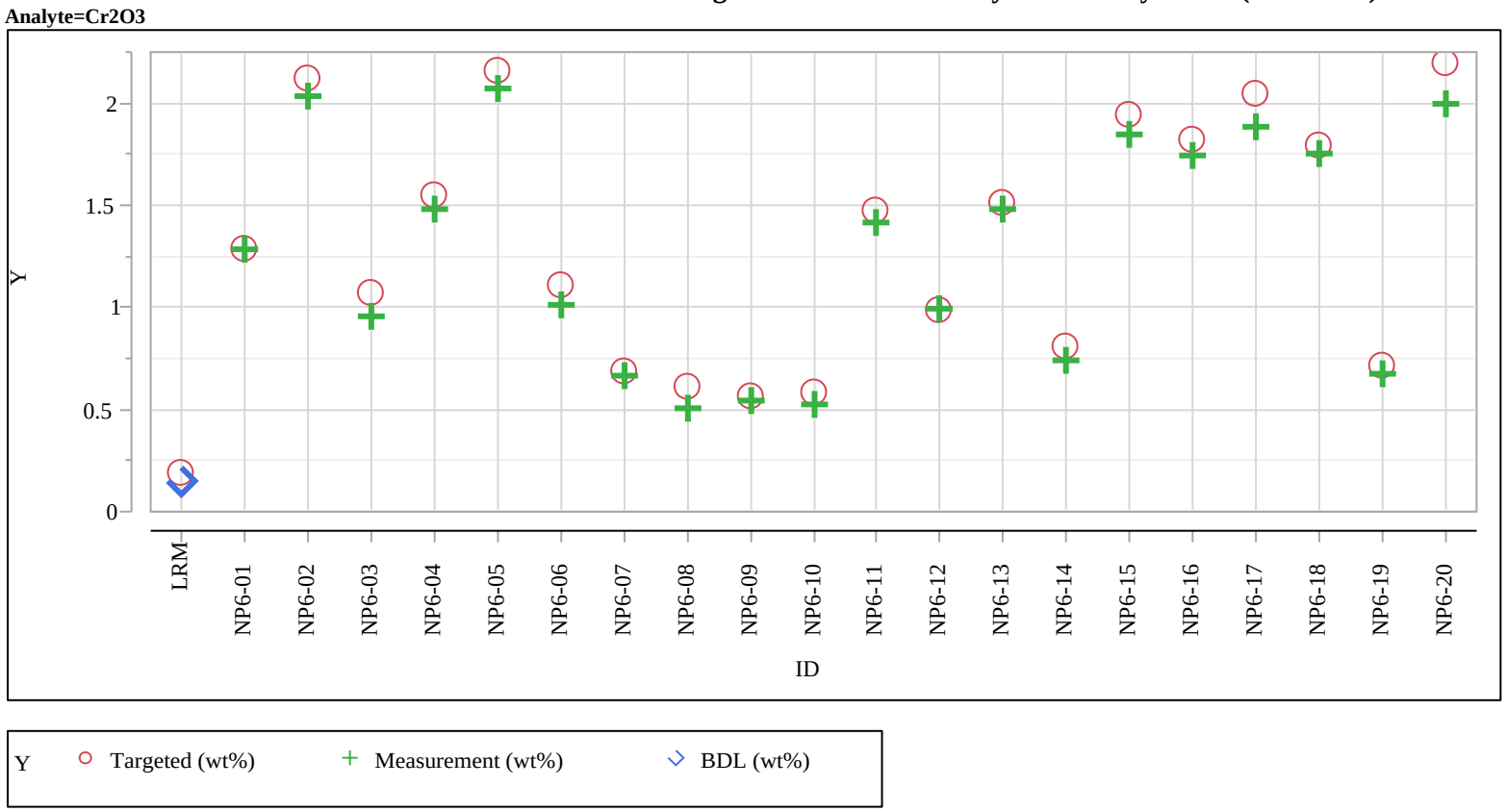


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

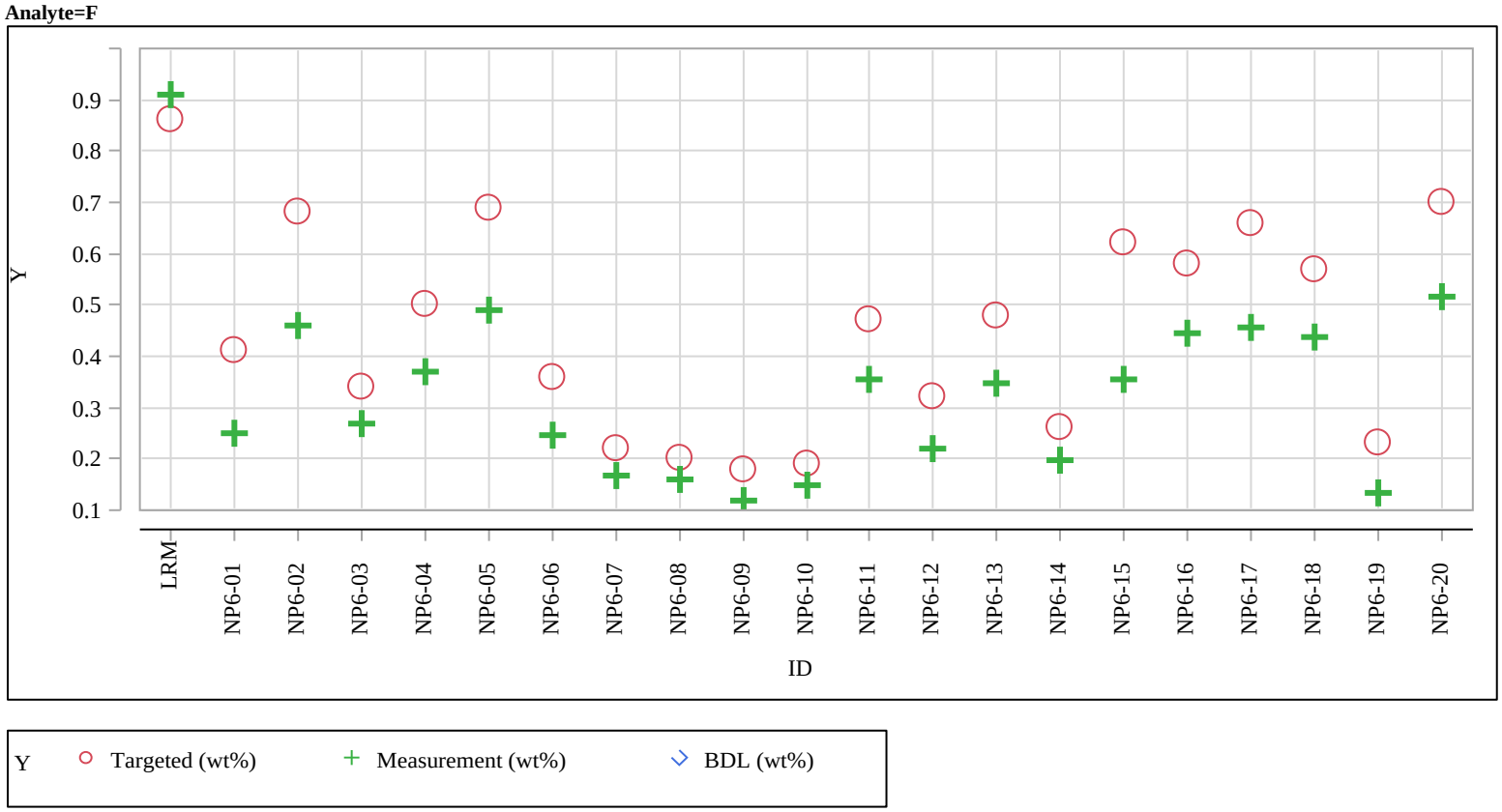


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

Analyte=Fe2O3

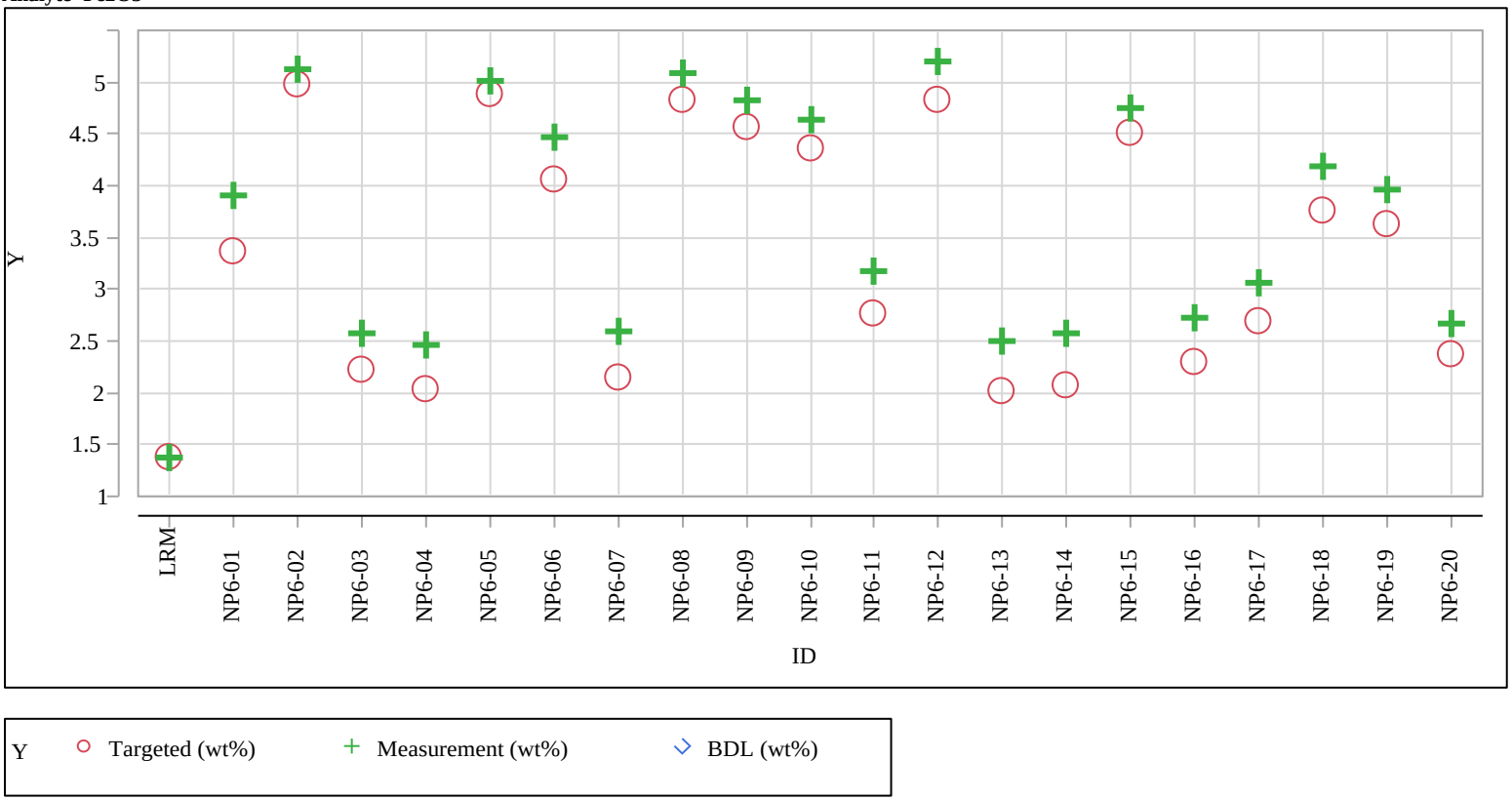


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

Analyte=Li2O

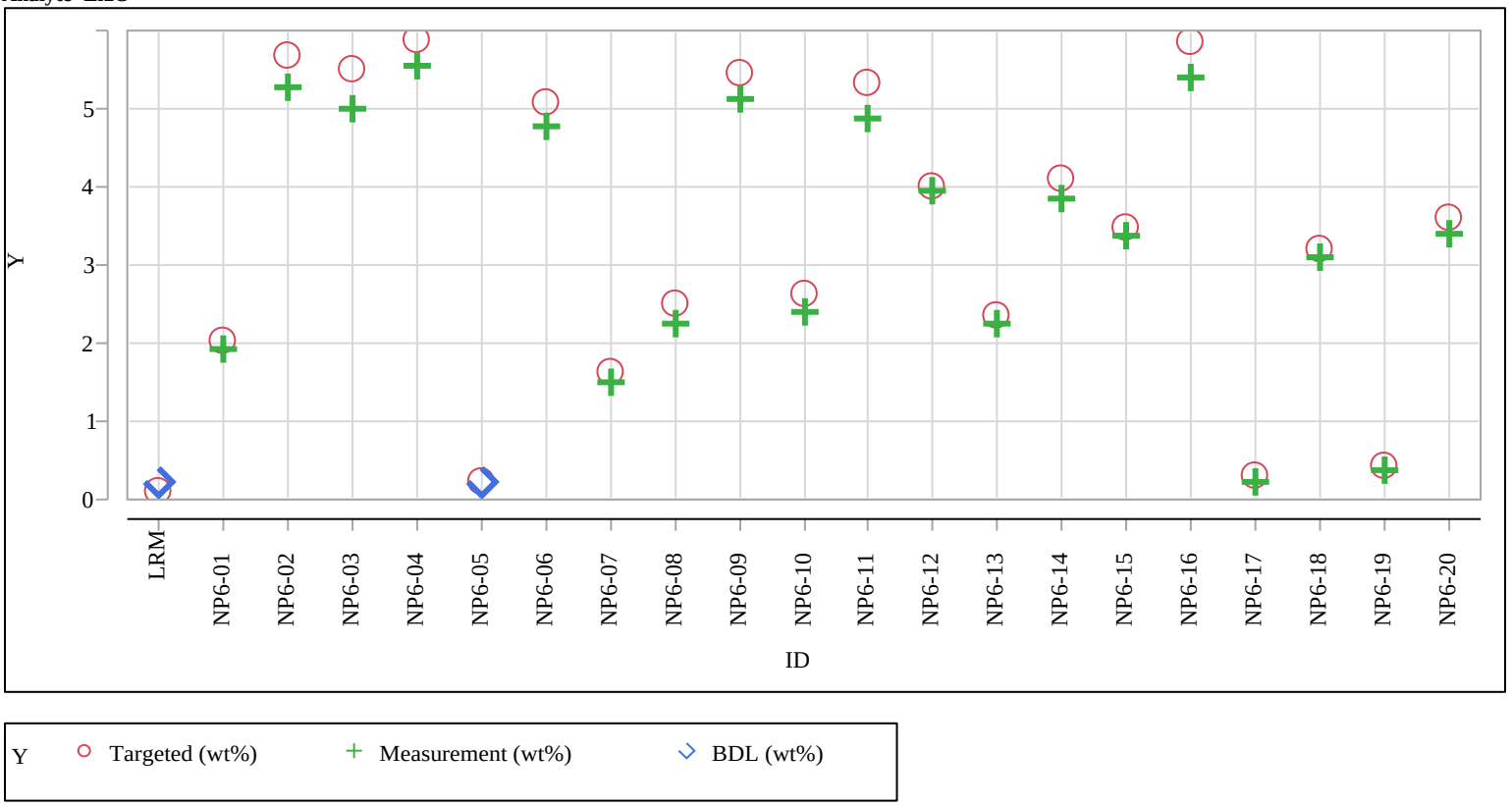


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

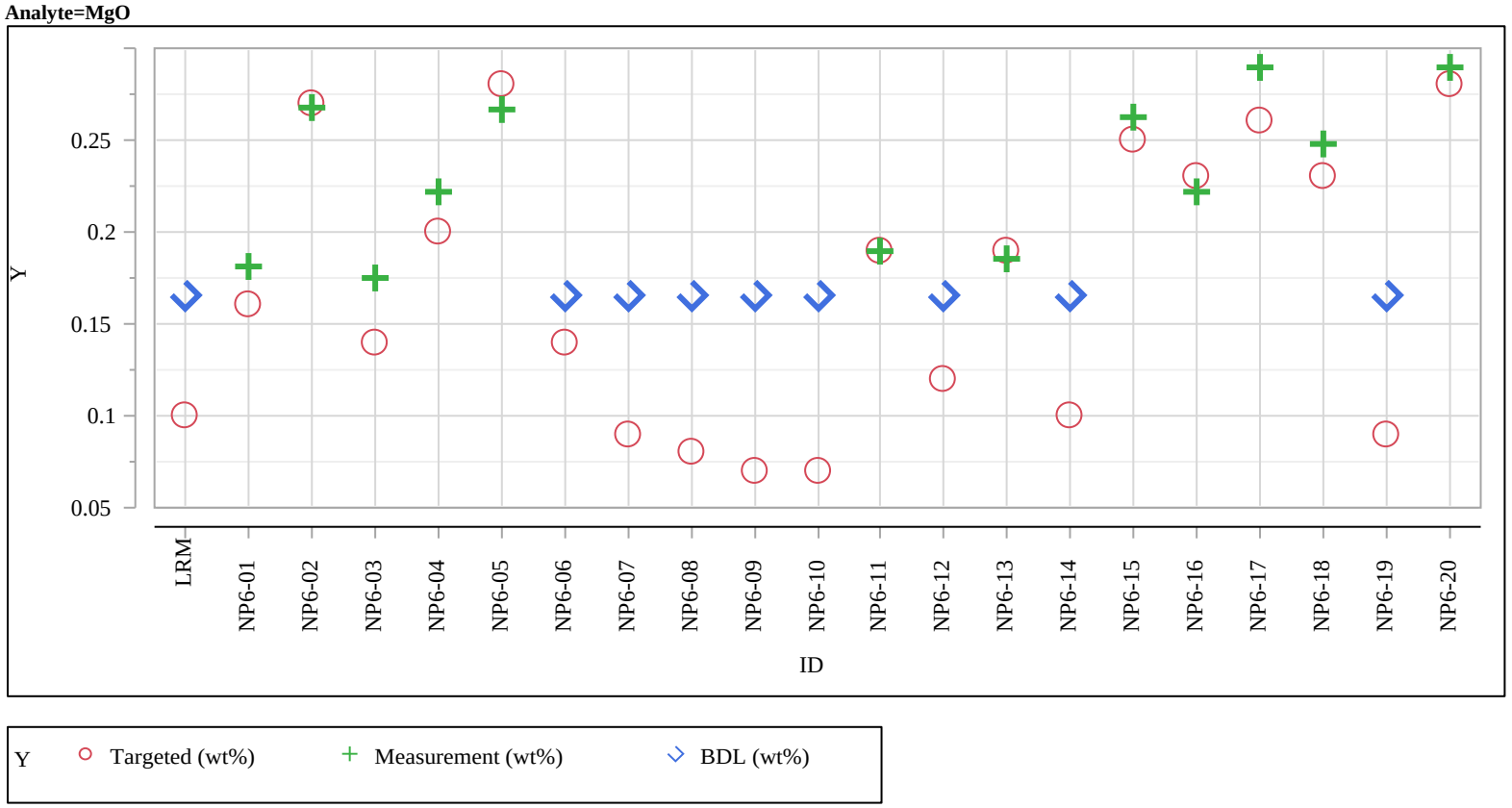


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

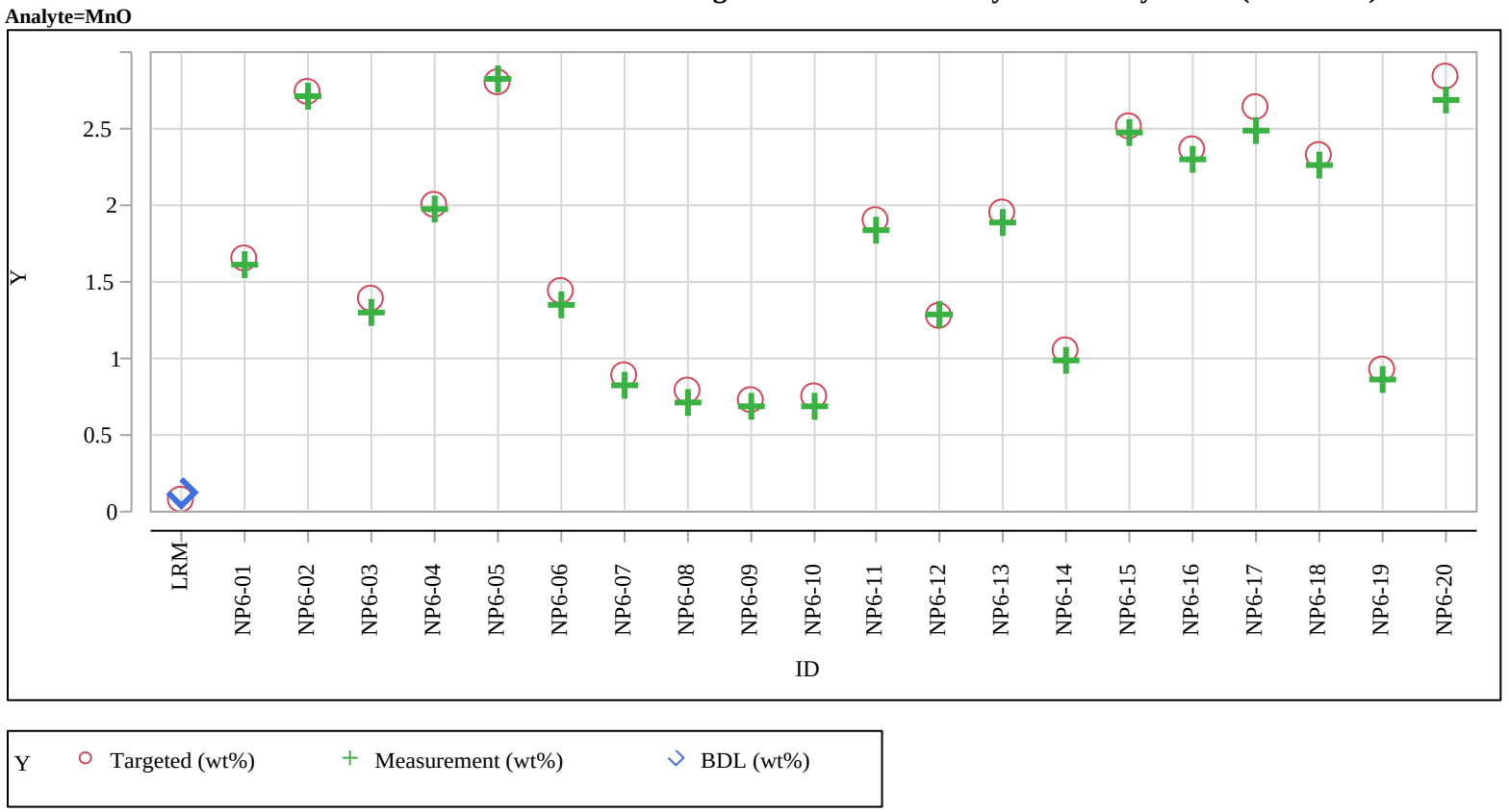


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

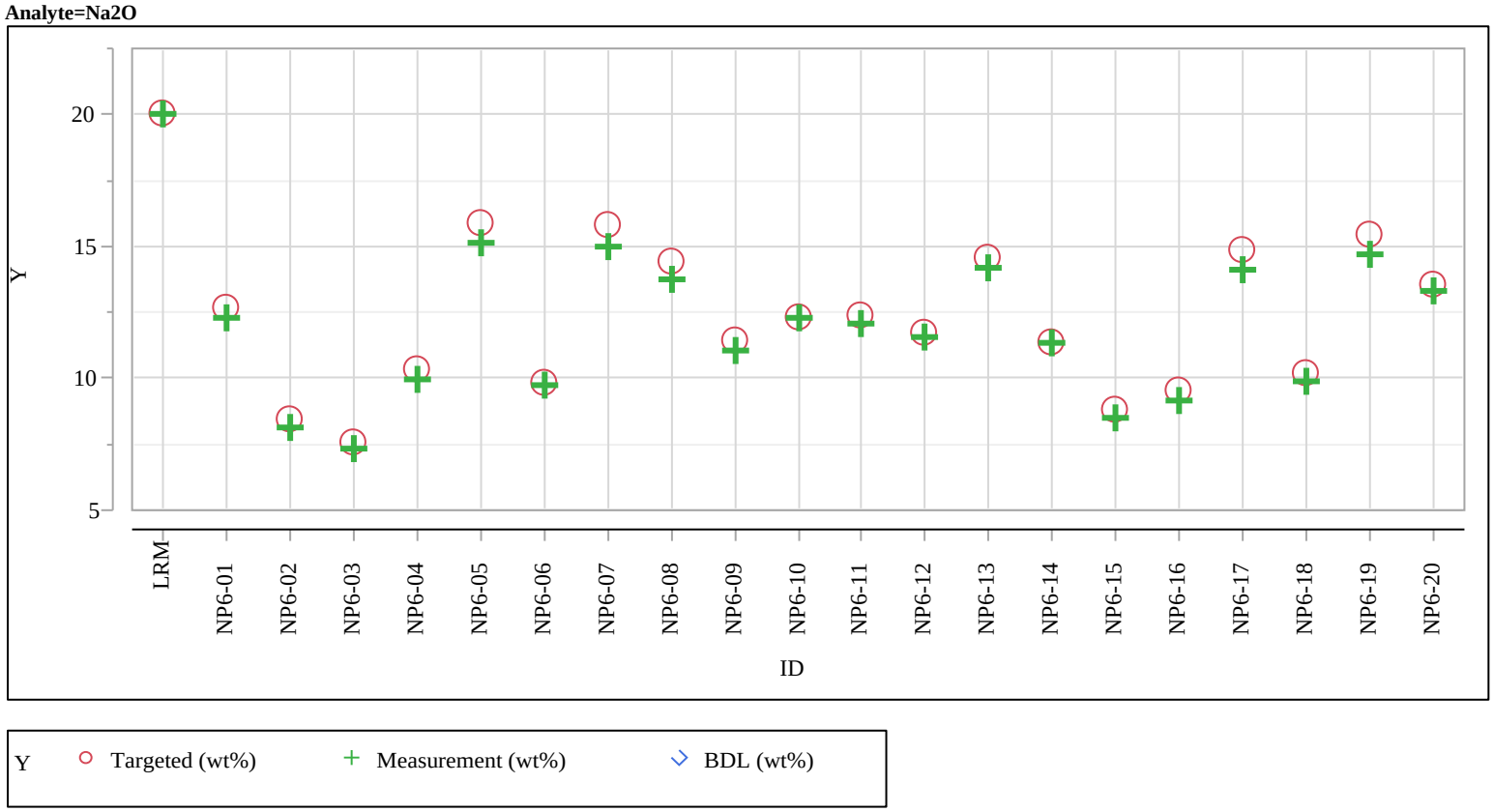


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

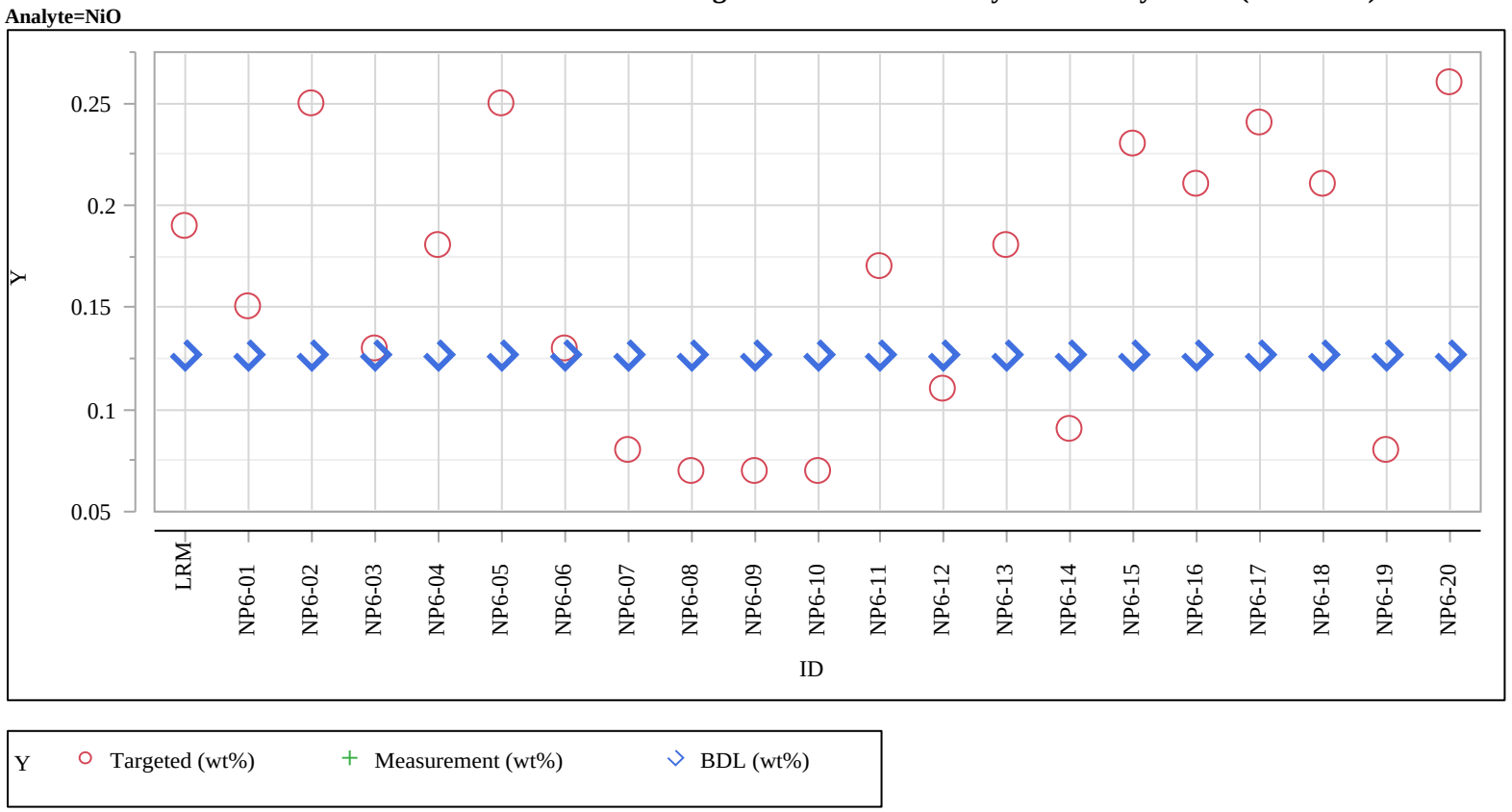


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

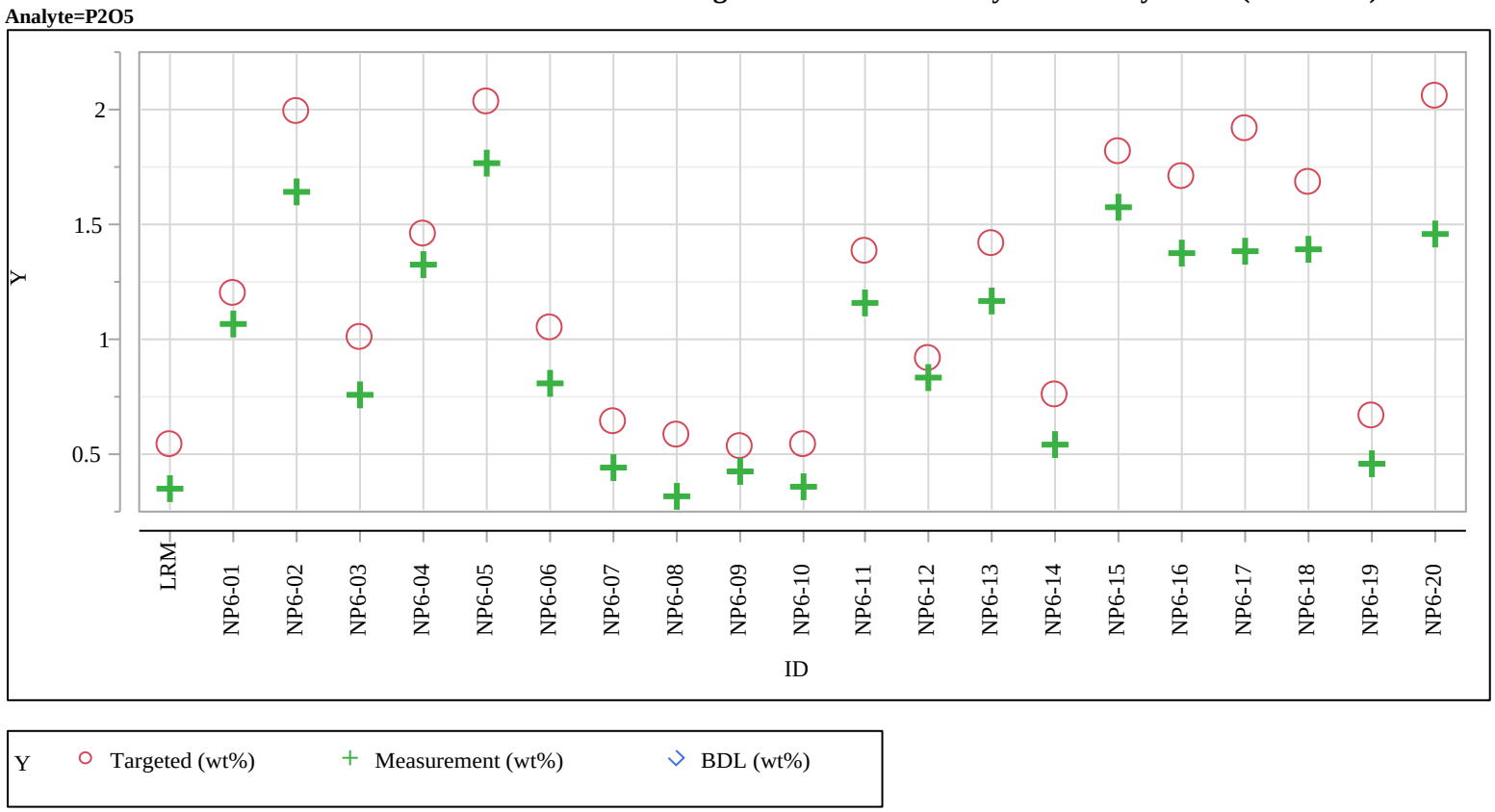


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

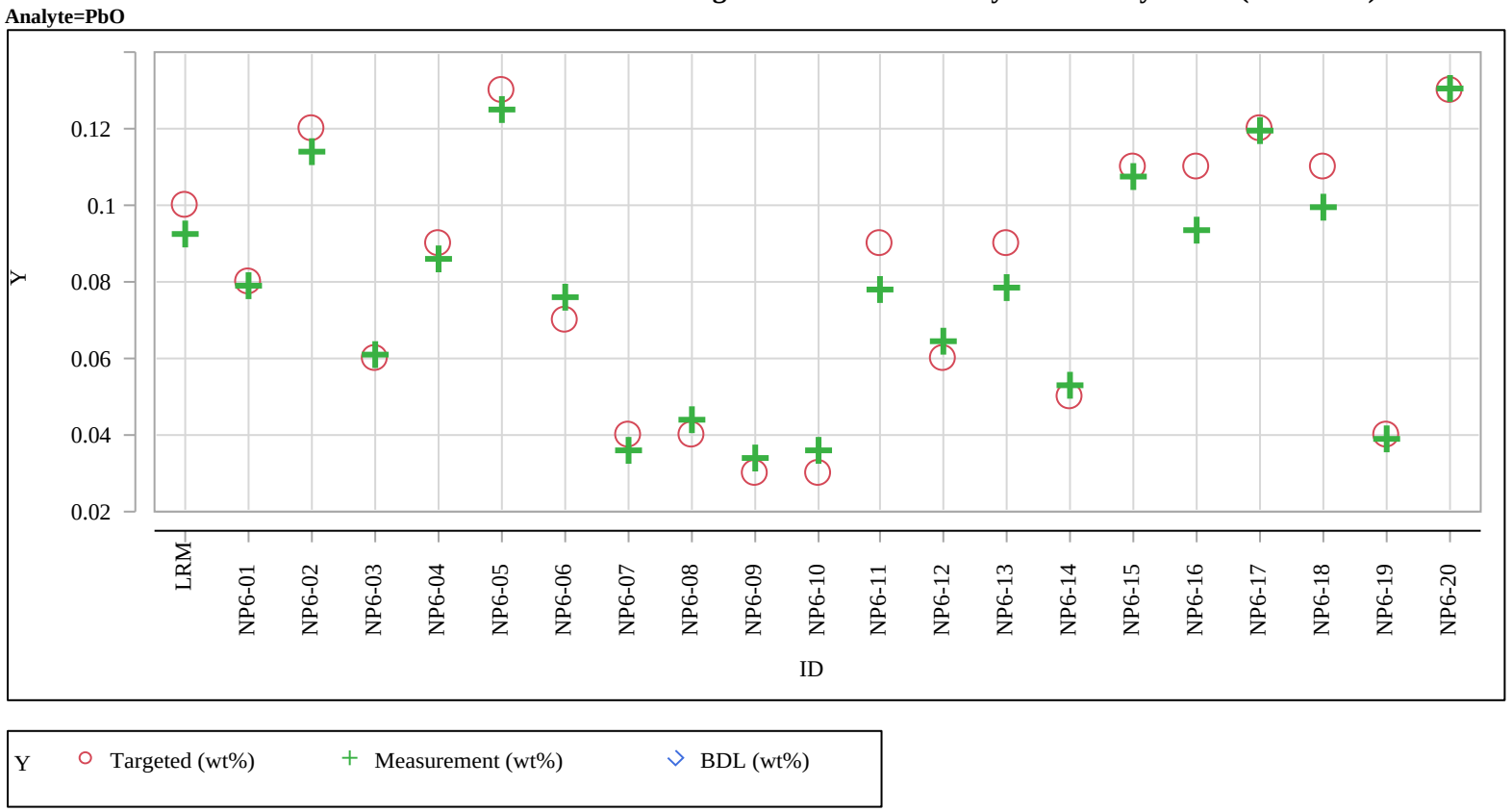


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

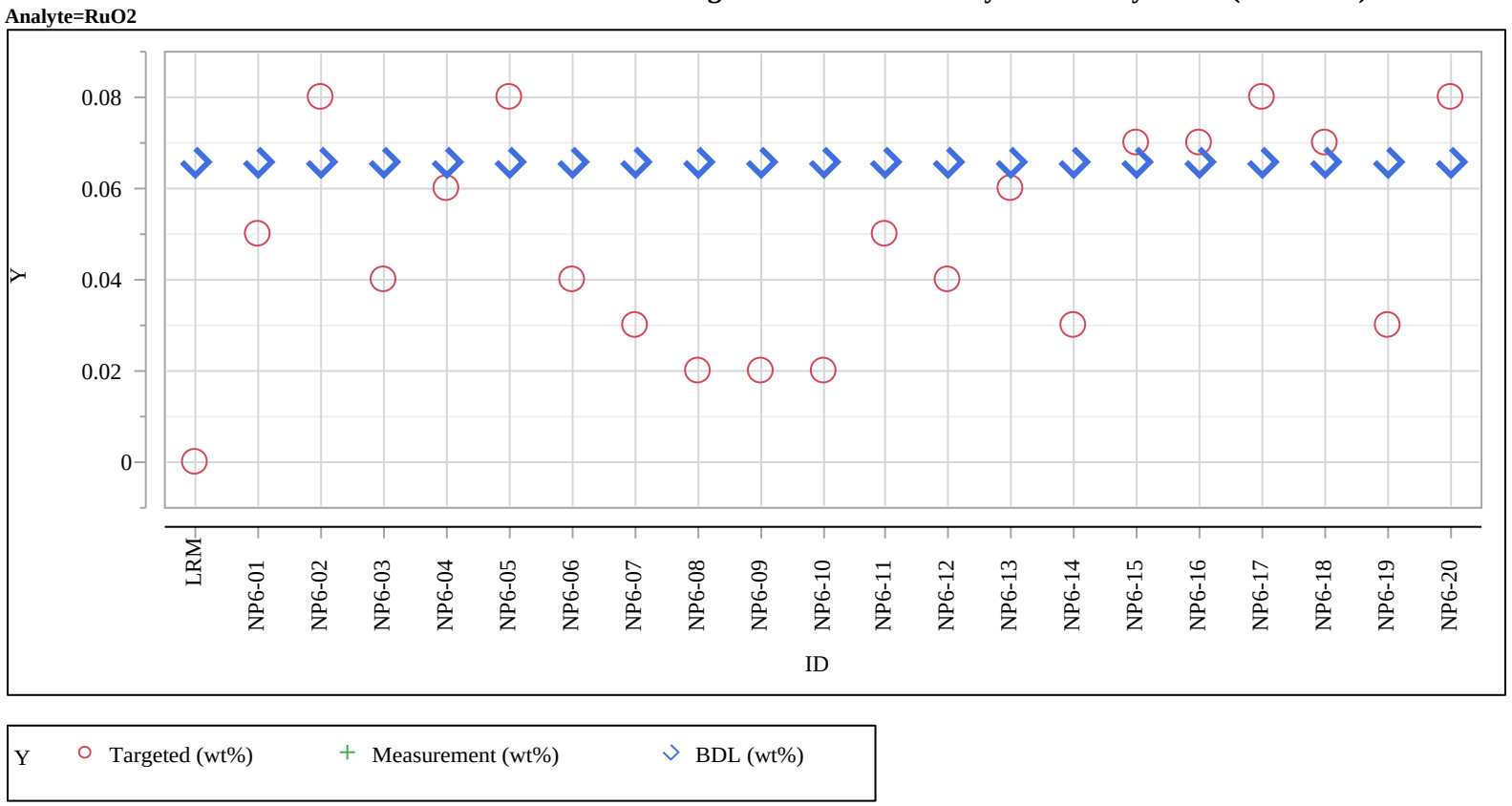


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

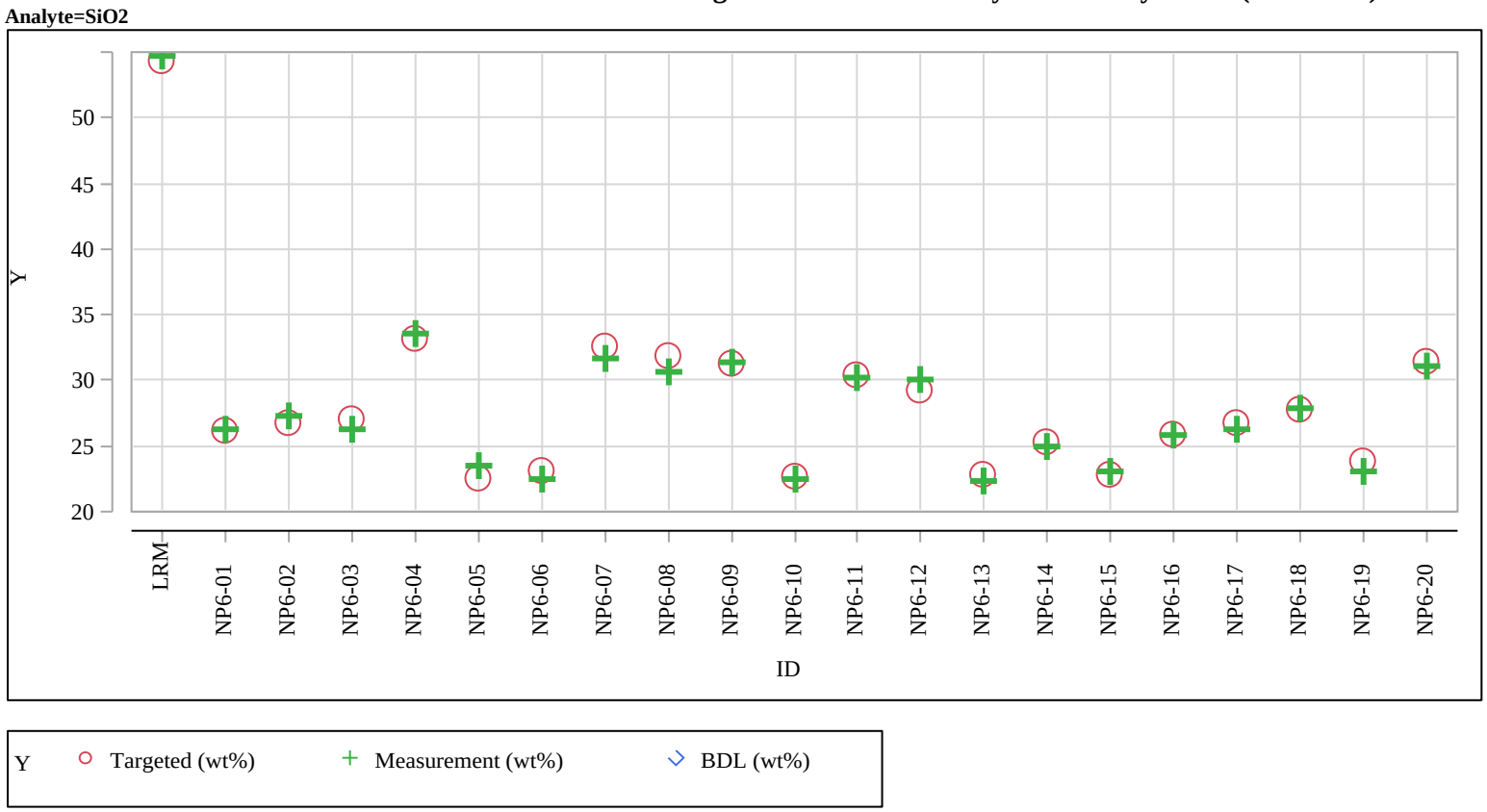


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

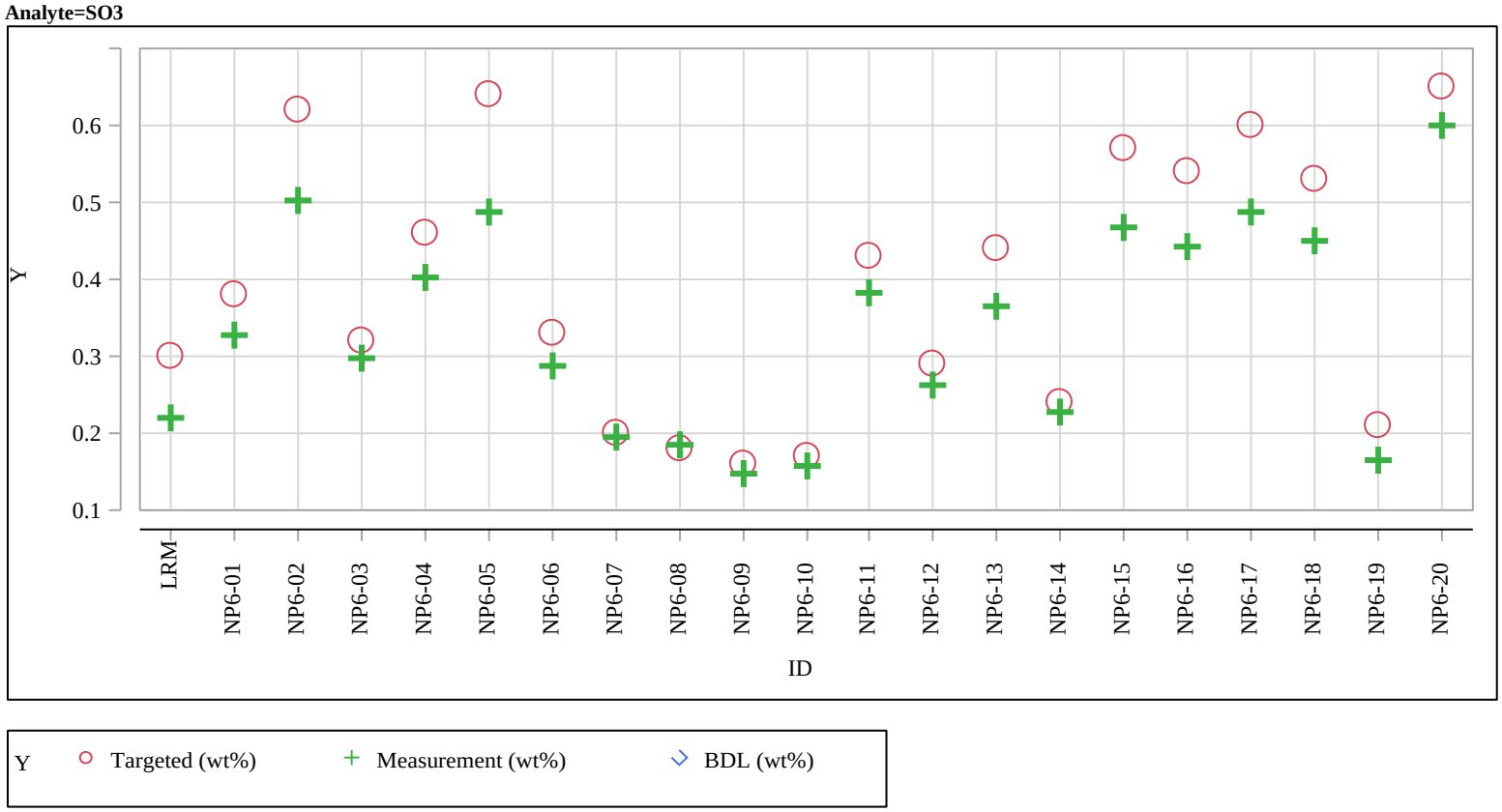


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

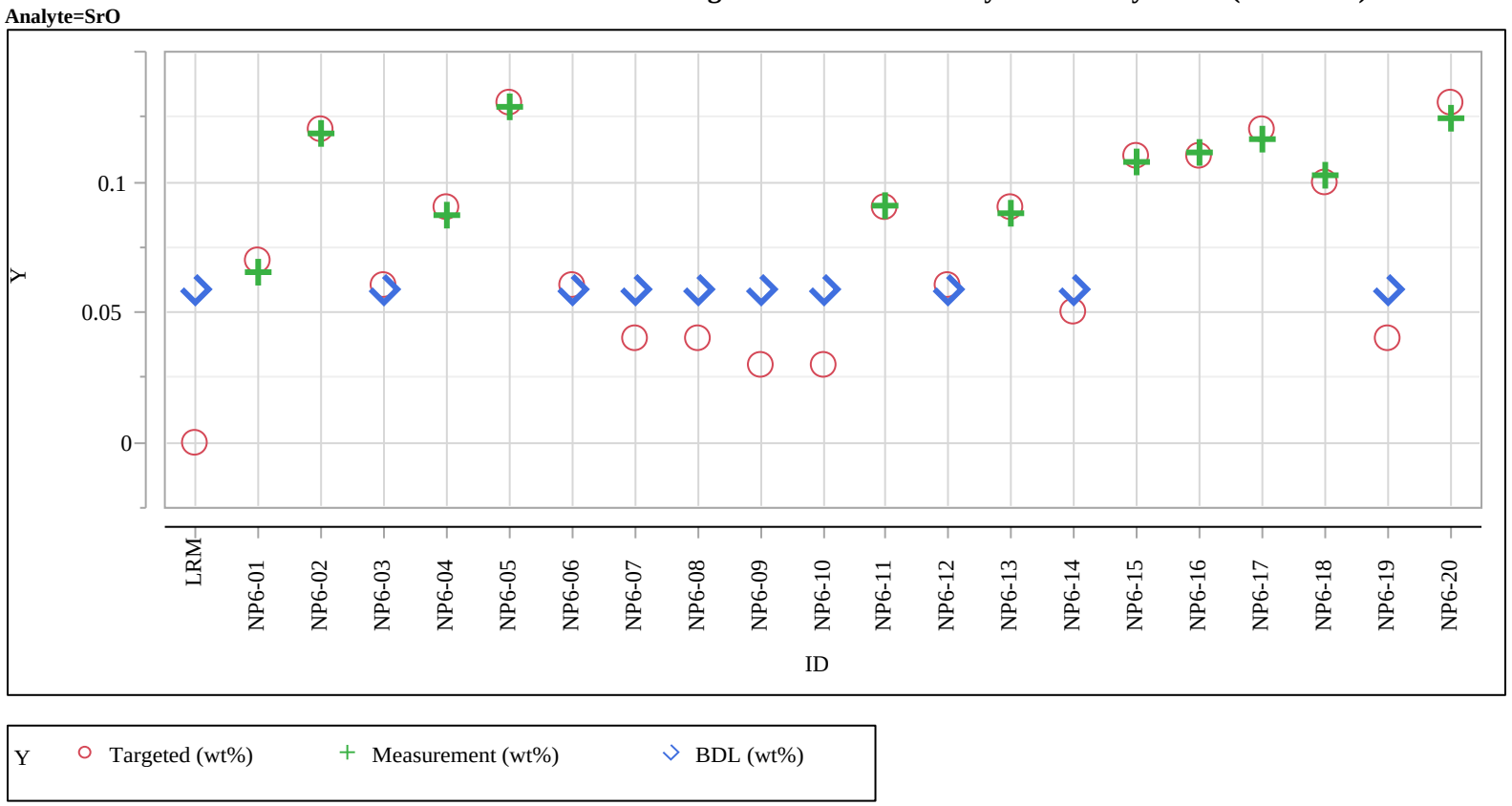


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

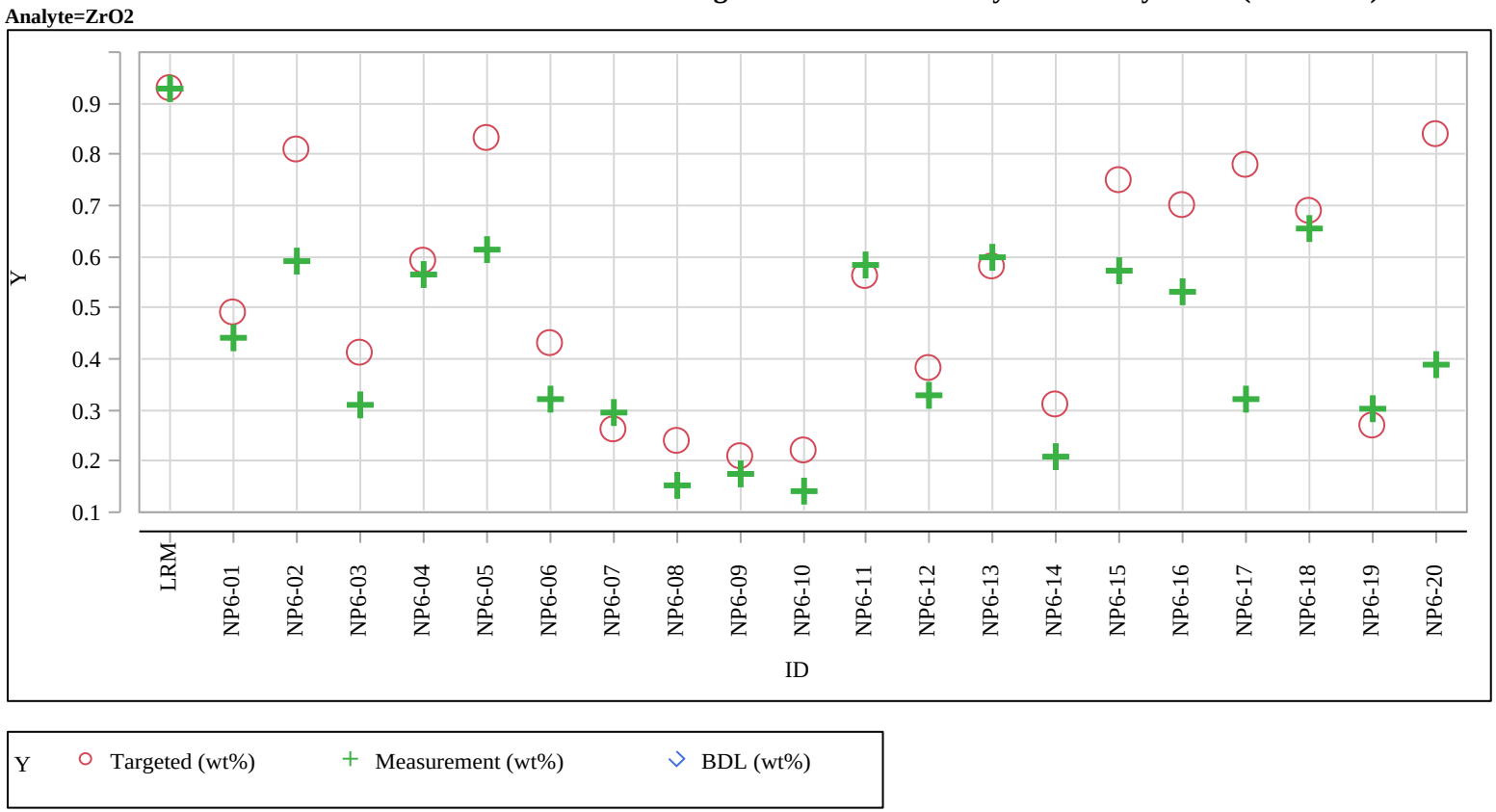
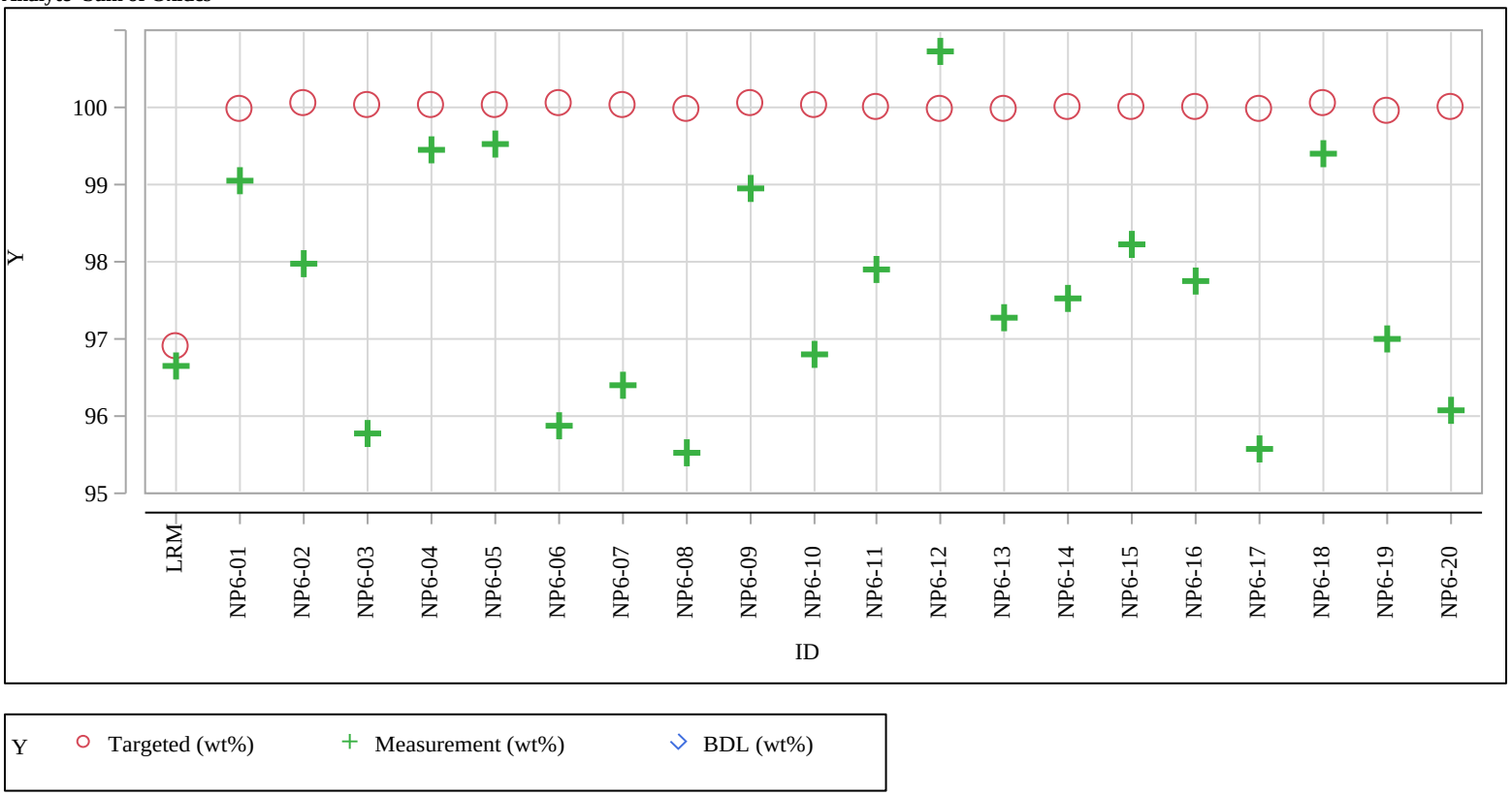


Exhibit A-4. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

Analyte=Sum of Oxides



Appendix B Tables and Exhibits Supporting the PCT Results

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

Set	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)
D	soln std	NA	1	1	std-D1-1	19.8	9.61	81.1	51.1	19.800	9.610	81.100	51.100
D	NP6-12	Quenched	1	2	D39	45.0	15.0	48.6	33.7	75.002	25.001	81.002	56.168
D	NP6-06	Quenched	1	3	D30	438	104	386	<1.00	730.015	173.337	643.346	<1.667
D	NP6-10	Quenched	1	4	D33	104	17.0	114	1.07	173.337	28.334	190.004	1.783
D	NP6-17	Quenched	1	5	D38	26.3	<1.00	49.1	19.8	43.834	<1.667	81.835	33.001
D	NP6-02	Quenched	1	6	D62	30.3	18.8	30.7	29.4	50.501	31.334	51.168	49.001
D	EA	NA	1	7	D24	18.4	6.59	52.9	33.4	306.667	109.834	881.668	556.668
D	NP6-05	Quenched	1	8	D56	176	2.35	244	13.5	293.339	3.917	406.675	22.500
D	NP6-08	Quenched	1	9	D54	13.6	3.04	29.5	18.8	22.667	5.067	49.168	31.334
D	NP6-03	Quenched	1	10	D26	27.5	15.8	25.8	20.1	45.834	26.334	43.001	33.501
D	NP6-01	Quenched	1	11	D35	32.0	5.05	43.5	18.9	53.334	8.417	72.501	31.501
D	NP6-04	Quenched	1	12	D52	8.22	6.44	23.8	16.4	13.700	10.734	39.667	27.334
D	NP6-16	Quenched	1	13	D17	93.5	40.1	69.0	30.5	155.836	66.835	115.002	50.834
D	soln std	NA	1	14	std-D1-2	20.7	9.75	83.3	50.8	20.700	9.750	83.300	50.800
D	ARM-1	NA	1	15	D13	10.2	7.71	21.7	35.7	17.000	12.850	36.167	59.501
D	NP6-20	Quenched	1	16	D03	28.7	9.94	45.6	37.1	47.834	16.567	76.002	61.835
D	NP6-09	Quenched	1	17	D01	38.8	20.7	41.3	49.6	64.668	34.501	68.835	82.668
D	blank	NA	1	18	D46	<1.00	<1.00	<1.00	<1.00	<1.667	<1.667	<1.667	<1.667
D	NP6-18	Quenched	1	19	D27	7.87	3.40	14.0	9.17	13.117	5.667	23.334	15.284
D	NP6-11	Quenched	1	20	D60	47.2	20.7	56.5	37.3	78.668	34.501	94.169	62.168
D	NP6-14	Quenched	1	21	D55	78.0	22.1	79.5	21.5	130.003	36.834	132.503	35.834
D	NP6-19	Quenched	1	22	D05	82.0	2.21	121	14.4	136.669	3.683	201.671	24.000
D	NP6-13	Quenched	1	23	D48	258	34.9	293	<1.00	430.009	58.168	488.343	<1.667
D	NP6-15	Quenched	1	24	D28	29.4	9.27	33.7	11.6	49.001	15.450	56.168	19.334
D	NP6-07	Quenched	1	25	D43	75.0	8.11	98.9	27.5	125.003	13.517	164.837	45.834
D	soln std	NA	1	26	std-D1-3	21.0	9.75	83.2	51.3	21.000	9.750	83.200	51.300
D	soln std	NA	2	1	std-D2-1	18.9	9.40	79.4	49.3	18.900	9.400	79.400	49.300
D	NP6-02	Quenched	2	2	D10	29.0	18.4	29.7	28.8	48.334	30.667	49.501	48.001
D	NP6-13	Quenched	2	3	D08								
D	NP6-06	Quenched	2	4	D15	469	112	419	<1.00	781.682	186.670	698.347	<1.667
D	NP6-01	Quenched	2	5	D25	33.3	5.00	42.4	18.2	55.501	8.334	70.668	30.334
D	NP6-19	Quenched	2	6	D34	83.7	2.15	123	14.2	139.503	3.583	205.004	23.667
D	NP6-15	Quenched	2	7	D40	27.1	8.65	30.9	10.7	45.168	14.417	51.501	17.834
D	NP6-08	Quenched	2	8	D22	12.5	2.91	28.4	18.6	20.834	4.850	47.334	31.001
D	NP6-04	Quenched	2	9	D06	7.12	6.04	12.8	15.4	11.867	10.067	21.334	25.667
D	NP6-12	Quenched	2	10	D68	41.7	14.0	45.0	32.1	69.501	23.334	75.002	53.501

(ar – as received)

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

Set	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)
D	NP6-20	Quenched	2	11	D20	26.1	9.37	42.3	35.3	43.501	15.617	70.501	58.835
D	NP6-05	Quenched	2	12	D31	170	2.24	238	12.9	283.339	3.733	396.675	21.500
D	EA	NA	2	13	D32	19.1	6.39	52.5	33.0	318.334	106.500	875.002	550.001
D	soln std	NA	2	14	std-D2-2	19.2	9.43	79.7	48.6	19.200	9.430	79.700	48.600
D	NP6-10	Quenched	2	15	D07	110	18.2	120	15.1	183.337	30.334	200.004	25.167
D	NP6-18	Quenched	2	16	D47	7.63	3.25	13.2	8.19	12.717	5.417	22.000	13.650
D	NP6-14	Quenched	2	17	D63	73.6	21.6	75.8	20.9	122.669	36.001	126.336	34.834
D	NP6-16	Quenched	2	18	D44	89.6	39.0	66.7	28.6	149.336	65.001	111.169	47.668
D	NP6-07	Quenched	2	19	D18	73.0	7.87	95.0	24.6	121.669	13.117	158.337	41.001
D	NP6-11	Quenched	2	20	D37	42.4	19.0	51.3	33.8	70.668	31.667	85.502	56.334
D	NP6-03	Quenched	2	21	D12	26.1	15.1	23.5	18.3	43.501	25.167	39.167	30.501
D	NP6-09	Quenched	2	22	D65	37.5	20.4	40.5	46.6	62.501	34.001	67.501	77.668
D	ARM-1	NA	2	23	D23	9.25	7.30	20.0	33.3	15.417	12.167	33.334	55.501
D	NP6-17	Quenched	2	24	D51	24.0	<1.00	47.0	18.0	40.001	<1.667	78.335	30.001
D	soln std	NA	2	25	std-D2-3	19.0	9.40	79.4	48.4	19.000	9.400	79.400	48.400
D	soln std	NA	3	1	std-D3-1	19.5	9.55	81.3	50.8	19.500	9.550	81.300	50.800
D	NP6-05	Quenched	3	2	D19	178	2.19	247	13.2	296.673	3.650	411.675	22.000
D	NP6-14	Quenched	3	3	D59	81.8	23.5	82.7	23.5	136.336	39.167	137.836	39.167
D	NP6-08	Quenched	3	4	D29	12.7	2.90	28.8	18.8	21.167	4.833	48.001	31.334
D	NP6-09	Quenched	3	5	D66	36.8	20.3	40.2	47.3	61.335	33.834	67.001	78.835
D	NP6-18	Quenched	3	6	D53	7.10	3.15	13.0	8.82	11.834	5.250	21.667	14.700
D	NP6-06	Quenched	3	7	D09	391	94.4	353	<1.00	651.680	157.336	588.345	<1.667
D	NP6-11	Quenched	3	8	D11	47.8	20.2	54.5	37.1	79.668	33.667	90.835	61.835
D	NP6-16	Quenched	3	9	D45	93.8	39.5	67.4	30.0	156.336	65.835	112.336	50.001
D	NP6-07	Quenched	3	10	D67	74.7	7.95	95.4	25.7	124.502	13.250	159.003	42.834
D	NP6-19	Quenched	3	11	D02	75.6	1.92	119	17.1	126.003	3.200	198.337	28.501
D	NP6-01	Quenched	3	12	D57	33.4	5.14	45.5	17.9	55.668	8.567	75.835	29.834
D	NP6-20	Quenched	3	13	D58	27.7	9.64	43.8	35.5	46.168	16.067	73.001	59.168
D	soln std	NA	3	14	std-D3-2	20.1	9.48	80.8	49.9	20.100	9.480	80.800	49.900
D	EA	NA	3	15	D36	25.6	8.29	71.0	42.2	426.668	138.167	1183.336	703.335
D	NP6-17	Quenched	3	16	D16	23.9	<1.00	46.7	18.4	39.834	<1.667	77.835	30.667
D	NP6-02	Quenched	3	17	D64	29.5	18.4	29.6	28.3	49.168	30.667	49.334	47.168
D	NP6-03	Quenched	3	18	D41	25.7	15.3	23.6	19.7	42.834	25.501	39.334	32.834
D	NP6-12	Quenched	3	19	D61	42.8	14.4	46.8	31.6	71.335	24.000	78.002	52.668
D	NP6-10	Quenched	3	20	D04	108	17.8	118	16.5	180.004	29.667	196.671	27.501
D	NP6-13	Quenched	3	21	D49	250	33.5	286	<1.00	416.675	55.834	476.676	<1.667
D	NP6-15	Quenched	3	22	D14	28.0	8.72	31.1	10.6	46.668	14.534	51.834	17.667
D	blank	NA	3	23	D50	<1.00	<1.00	<1.00	<1.00	<1.667	<1.667	<1.667	<1.667

(ar – as received)

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

Set	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)
D	ARM-1	NA	3	24	D42	9.02	7.24	19.8	33.4	15.034	12.067	33.001	55.668
D	NP6-04	Quenched	3	25	D21	7.30	6.19	12.8	15.4	12.167	10.317	21.334	25.667
D	soln std	NA	3	26	std-D3-3	19.1	9.38	79.8	48.7	19.100	9.380	79.800	48.700
E	soln std	NA	1	1	std-E1-1	18.5	9.66	79.8	50.1	18.500	9.660	79.800	50.100
E	NP6-09	CCC	1	2	E28	81.6	29.7	53.1	39.6	136.003	49.501	88.502	66.001
E	NP6-20	CCC	1	3	E53	1680	342	1050	10.5	2800.056	570.011	1750.035	17.500
E	NP6-13	CCC	1	4	E30	849	54.8	928	<1.00	1415.028	91.335	1546.698	<1.667
E	NP6-05	CCC	1	5	E27	245	2.98	305	13.6	408.342	4.967	508.344	22.667
E	blank	NA	1	6	E24	<1.00	<1.00	1.27	<1.00	<1.667	<1.667	2.117	<1.667
E	NP6-11	CCC	1	7	E42	127	40.0	75.7	18.9	211.671	66.668	126.169	31.501
E	NP6-06	CCC	1	8	E10	348	85.4	301	<1.00	580.012	142.336	501.677	<1.667
E	NP6-15	CCC	1	9	E19	39.7	11.9	40.7	16.3	66.168	19.834	67.835	27.167
E	NP6-10	CCC	1	10	E67	732	52.3	728	2.66	1220.024	87.168	1213.358	4.433
E	NP6-04	CCC	1	11	E12	209	94.0	111	11.9	348.340	156.670	185.004	19.834
E	ARM-1	NA	1	12	E05	10.8	7.40	20.8	34.5	18.000	12.334	34.667	57.501
E	NP6-12	CCC	1	13	E65	44.4	13.4	43.4	32.1	74.001	22.334	72.335	53.501
E	soln std	NA	1	14	std-E1-2	18.8	9.41	77.7	49.4	18.800	9.410	77.700	49.400
E	NP6-17	CCC	1	15	E60	45.6	1.26	75.7	22.7	76.002	2.100	126.169	37.834
E	NP6-14	CCC	1	16	E25	90.8	20.6	93.0	<1.00	151.336	34.334	155.003	<1.667
E	blank	NA	1	17	E02	<1.00	<1.00	1.33	<1.00	<1.667	<1.667	2.217	<1.667
E	EA	NA	1	18	E17	32.3	10.5	94.5	52.1	538.334	175.000	1575.003	868.335
E	NP6-03	CCC	1	19	E23	20.7	9.75	15.1	8.45	34.501	16.250	25.167	14.084
E	NP6-01	CCC	1	20	E14	26.1	4.07	32.1	10.6	43.501	6.783	53.501	17.667
E	NP6-08	CCC	1	21	E07	1580	380	971	3.86	2633.386	633.346	1618.366	6.433
E	NP6-07	CCC	1	22	E09	72.5	8.14	73.5	17.1	120.836	13.567	122.502	28.501
E	NP6-18	CCC	1	23	E56	49.1	11.7	34.0	4.32	81.835	19.500	56.668	7.200
E	NP6-02	CCC	1	24	E34	39.0	22.0	37.4	33.6	65.001	36.667	62.335	56.001
E	NP6-19	CCC	1	25	E38	2600	3.23	2700	3.79	4333.420	5.383	4500.090	6.317
E	NP6-16	CCC	1	26	E57	121	43.4	79.6	<1.00	201.671	72.335	132.669	<1.667
E	soln std	NA	1	27	std-E1-3	20.7	9.43	77.6	51.0	20.700	9.430	77.600	51.000
E	soln std	NA	2	1	std-E2-1	19.6	9.57	80.7	50.4	19.600	9.570	80.700	50.400
E	NP6-11	CCC	2	2	E59	129	41.6	80.3	19.8	215.004	69.335	133.836	33.001
E	NP6-05	CCC	2	3	E18	241	2.96	303	14.7	401.675	4.933	505.010	24.500
E	ARM-1	NA	2	4	E35	9.85	7.47	22.0	36.0	16.417	12.450	36.667	60.001
E	NP6-02	CCC	2	5	E43	39.5	21.9	38.1	33.9	65.835	36.501	63.501	56.501
E	NP6-03	CCC	2	6	E61	23.0	9.92	16.1	9.08	38.334	16.534	26.834	15.134
E	NP6-06	CCC	2	7	E70	595	143	512	<1.00	991.687	238.338	853.350	<1.667
E	NP6-09	CCC	2	8	E01	88.2	30.3	54.5	39.3	147.003	50.501	90.835	65.501

(ar – as received)

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

Set	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	NP6-10	CCC	2	9	E46	802	55.9	787	2.28	1336.693	93.169	1311.693	3.800
E	NP6-12	CCC	2	10	E68	48.5	13.5	44.8	32.4	80.835	22.500	74.668	54.001
E	NP6-13	CCC	2	11	E54	865	55.9	946	<1.00	1441.696	93.169	1576.698	<1.667
E	NP6-07	CCC	2	12	E66	77.5	8.16	76.0	17.0	129.169	13.600	126.669	28.334
E	NP6-08	CCC	2	13	E11	1530	360	933	3.63	2550.051	600.012	1555.031	6.050
E	soln std	NA	2	14	std-E2-2	18.7	9.74	83.4	50.6	18.700	9.740	83.400	50.600
E	NP6-17	CCC	2	15	E44	53.9	1.17	80.4	22.9	89.835	1.950	134.003	38.167
E	NP6-19	CCC	2	16	E58	2500	4.83	2640	4.75	4166.750	8.050	4400.088	7.917
E	NP6-01	CCC	2	17	E08	38.3	4.09	33.8	10.8	63.835	6.817	56.334	18.000
E	NP6-14	CCC	2	18	E06	97.3	20.9	95.9	<1.00	162.170	34.834	159.837	<1.667
E	NP6-04	CCC	2	19	E63	211	94.2	107	10.0	351.674	157.003	178.337	16.667
E	NP6-20	CCC	2	20	E20	1750	347	1070	8.91	2916.725	578.345	1783.369	14.850
E	NP6-16	CCC	2	21	E62	117	43.1	83.1	<1.00	195.004	71.835	138.503	<1.667
E	NP6-18	CCC	2	22	E31	56.7	11.7	35.2	3.30	94.502	19.500	58.668	5.500
E	EA	NA	2	23	E48	27.2	7.69	65.2	38.7	453.334	128.167	1086.669	645.001
E	NP6-15	CCC	2	24	E36	42.3	11.5	40.5	14.8	70.501	19.167	67.501	24.667
E	soln std	NA	2	25	std-E2-3	18.1	9.51	80.2	48.2	18.100	9.510	80.200	48.200
E	soln std	NA	3	1	std-E3-1	19.5	10.0	81.4	51.2	19.500	10.000	81.400	51.200
E	NP6-10	CCC	3	2	E51	898	59.3	859	2.72	1496.697	98.835	1431.695	4.533
E	NP6-20	CCC	3	3	E64	1720	342	1060	11.3	2866.724	570.011	1766.702	18.834
E	ARM-1	NA	3	4	E33	11.7	7.96	22.4	36.5	19.500	13.267	37.334	60.835
E	blank	NA	3	5	E52	1.01	<1.00	2.20	<1.00	1.683	<1.667	3.667	<1.667
E	NP6-15	CCC	3	6	E26	38.0	12.1	41.7	16.7	63.335	20.167	69.501	27.834
E	NP6-13	CCC	3	7	E39	881	56.9	931	1.02	1468.363	94.835	1551.698	1.700
E	blank	NA	3	8	E04	<1.00	<1.00	2.32	<1.00	<1.667	<1.667	3.867	<1.667
E	NP6-02	CCC	3	9	E69	40.3	22.8	39.6	34.4	67.168	38.001	66.001	57.334
E	NP6-04	CCC	3	10	E41	215	95.1	106	12.7	358.341	158.503	176.670	21.167
E	NP6-08	CCC	3	11	E16	1460	361	931	4.18	2433.382	601.679	1551.698	6.967
E	NP6-17	CCC	3	12	E49	52.3	1.62	81.0	22.9	87.168	2.700	135.003	38.167
E	NP6-06	CCC	3	13	E03	282	71.6	245	<1.00	470.009	119.336	408.342	<1.667
E	soln std	NA	3	14	std-E3-2	19.9	10.0	81.7	51.1	19.900	10.000	81.700	51.100
E	NP6-19	CCC	3	15	E47	2490	6.73	2660	5.84	4150.083	11.217	4433.422	9.734
E	NP6-12	CCC	3	16	E40	47.0	13.5	44.3	32.2	78.335	22.500	73.835	53.668
E	NP6-05	CCC	3	17	E50	272	3.58	326	15.0	453.342	5.967	543.344	25.001
E	NP6-14	CCC	3	18	E21	100	21.1	95.2	<1.00	166.670	35.167	158.670	<1.667
E	NP6-18	CCC	3	19	E29	53.0	12.5	36.6	4.99	88.335	20.834	61.001	8.317
E	NP6-16	CCC	3	20	E32	115	45.0	84.8	<1.00	191.671	75.002	141.336	<1.667
E	EA	NA	3	21	E55	22.9	7.22	60.1	36.6	381.667	120.334	1001.669	610.001

(ar – as received)

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

Set	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	NP6-11	CCC	3	22	E22	126	41.7	80.0	19.1	210.004	69.501	133.336	31.834
E	NP6-03	CCC	3	23	E13	25.0	10.1	16.2	8.67	41.668	16.834	27.001	14.450
E	NP6-07	CCC	3	24	E37	72.6	8.47	74.9	17.2	121.002	14.117	124.836	28.667
E	NP6-01	CCC	3	25	E15	30.2	4.41	33.1	10.7	50.334	7.350	55.168	17.834
E	NP6-09	CCC	3	26	E45	87.1	31.1	56.2	39.0	145.170	51.834	93.669	65.001
E	soln std	NA	3	27	std-E3-3	21.3	10.1	82.0	51.2	21.300	10.100	82.000	51.200

Table B-2. Ambient Temperature PCT Leachate pH Values for the Set D Glasses

Identifier	pH		Identifier	pH
ARM-1-1	9.98		NP6-09-Q-3	9.28
ARM-1-2	10.1		NP6-10-Q-1	9.23
ARM-1-3	10.07		NP6-10-Q-2	9.32
blank-1	7.39		NP6-10-Q-3	9.3
blank-2	6.47		NP6-11-Q-1	9.64
EA-1	11.52		NP6-11-Q-2	9.74
EA-2	11.48		NP6-11-Q-3	9.69
EA-3	11.68		NP6-12-Q-1	9.33
NP6-01-Q-1	9.18		NP6-12-Q-2	9.25
NP6-01-Q-2	8.98		NP6-12-Q-3	9.31
NP6-01-Q-3	8.91		NP6-13-Q-1	9.33
NP6-02-Q-1	9.58		NP6-13-Q-2	not meas.
NP6-02-Q-2	9.48		NP6-13-Q-3	9.43
NP6-02-Q-3	9.31		NP6-14-Q-1	9.41
NP6-03-Q-1	9.24		NP6-14-Q-2	9.38
NP6-03-Q-2	9.17		NP6-14-Q-3	9.38
NP6-03-Q-3	9.23		NP6-15-Q-1	9.28
NP6-04-Q-1	10.05		NP6-15-Q-2	9.35
NP6-04-Q-2	9.98		NP6-15-Q-3	9.26
NP6-04-Q-3	9.92		NP6-16-Q-1	9.52
NP6-05-Q-1	9.07		NP6-16-Q-2	9.51
NP6-05-Q-2	9.1		NP6-16-Q-3	9.5
NP6-05-Q-3	9.05		NP6-17-Q-1	8.94
NP6-06-Q-1	9.56		NP6-17-Q-2	9.08
NP6-06-Q-2	9.63		NP6-17-Q-3	9.1
NP6-06-Q-3	9.65		NP6-18-Q-1	9.26
NP6-07-Q-1	9.3		NP6-18-Q-2	9.19
NP6-07-Q-2	9.2		NP6-18-Q-3	9.26
NP6-07-Q-3	9.22		NP6-19-Q-1	9.18
NP6-08-Q-1	9.34		NP6-19-Q-2	9.24
NP6-08-Q-2	9.31		NP6-19-Q-3	9.2
NP6-08-Q-3	9.49		NP6-20-Q-1	9.35
NP6-09-Q-1	9.16		NP6-20-Q-2	9.41
NP6-09-Q-2	9.29		NP6-20-Q-3	9.41

Table B-3. Ambient Temperature PCT Leachate pH Values for the Set E Glasses

Identifier	pH		Identifier	pH
ARM-1-1	10.18		NP6-09-CCC-2	9.51
ARM-1-2	10.39		NP6-09-CCC-3	9.59
ARM-1-3	10.44		NP6-10-CCC-1	9.34
blank-1	7.73		NP6-10-CCC-2	9.36
blank-2	6.9		NP6-10-CCC-3	9.31
blank-3	6.37		NP6-11-CCC-1	9.37
blank-4	6.16		NP6-11-CCC-2	9.43
EA-1	11.55		NP6-11-CCC-3	9.52
EA-2	11.52		NP6-12-CCC-1	9.45
EA-3	11.53		NP6-12-CCC-2	9.49
NP6-01-CCC-1	9.18		NP6-12-CCC-3	9.42
NP6-01-CCC-2	9.21		NP6-13-CCC-1	9.43
NP6-01-CCC-3	9.23		NP6-13-CCC-2	9.31
NP6-02-CCC-1	9.64		NP6-13-CCC-3	9.11
NP6-02-CCC-2	9.64		NP6-14-CCC-1	9.92
NP6-02-CCC-3	9.65		NP6-14-CCC-2	9.65
NP6-03-CCC-1	9.33		NP6-14-CCC-3	9.72
NP6-03-CCC-2	9.24		NP6-15-CCC-1	9.32
NP6-03-CCC-3	9.19		NP6-15-CCC-2	9.33
NP6-04-CCC-1	9.95		NP6-15-CCC-3	9.36
NP6-04-CCC-2	9.96		NP6-16-CCC-1	9.2
NP6-04-CCC-3	9.96		NP6-16-CCC-2	9.48
NP6-05-CCC-1	9.33		NP6-16-CCC-3	9.44
NP6-05-CCC-2	9.31		NP6-17-CCC-1	9.46
NP6-05-CCC-3	9.28		NP6-17-CCC-2	9.31
NP6-06-CCC-1	9.65		NP6-17-CCC-3	9.19
NP6-06-CCC-2	9.63		NP6-18-CCC-1	9.48
NP6-06-CCC-3	9.74		NP6-18-CCC-2	9.29
NP6-07-CCC-1	9.12		NP6-18-CCC-3	9.07
NP6-07-CCC-2	9.33		NP6-19-CCC-1	9.08
NP6-07-CCC-3	9.32		NP6-19-CCC-2	9.31
NP6-08-CCC-1	9.51		NP6-19-CCC-3	9.37
NP6-08-CCC-2	9.45		NP6-20-CCC-1	8.94
NP6-08-CCC-3	9.58		NP6-20-CCC-2	9.32
NP6-09-CCC-1	9.6		NP6-20-CCC-3	9.07

Table B-4. Results from Samples of the Multi-Element Solution Standard for the Group D and Group E PCTs

PCT Set	D			E			Reference
Block	1	2	3	1	2	3	Values (mg/L)
Mean (B (mg/L))	20.50	19.03	19.57	19.33	18.80	20.23	20
Mean (Li (mg/L))	9.70	9.41	9.47	9.50	9.61	10.03	10
Mean (Na (mg/L))	82.53	79.50	80.63	78.37	81.43	81.70	81
Mean (Si (mg/L))	51.07	48.77	49.80	50.17	49.73	51.17	50
% relative bias, B	2.5%	-4.8%	-2.2%	-3.3%	-6.0%	1.2%	
% relative bias, Li	-3.0%	-5.9%	-5.3%	-5.0%	-3.9%	0.3%	<10% per
% relative bias, Na	1.9%	-1.9%	-0.5%	-3.3%	0.5%	0.9%	ASTM C 1285
% relative bias, Si	2.1%	-2.5%	-0.4%	0.3%	-0.5%	2.3%	
Std Dev (B (mg/L))	0.624	0.153	0.503	1.193	0.755	0.945	
Std Dev (Li (mg/L))	0.081	0.017	0.085	0.139	0.119	0.058	
Std Dev (Na (mg/L))	1.242	0.173	0.764	1.242	1.721	0.300	
Std Dev (Si (mg/L))	0.252	0.473	1.054	0.802	1.332	0.058	
%RSD, B	3.0%	0.8%	2.6%	6.2%	4.0%	4.7%	
%RSD, Li	0.8%	0.2%	0.9%	1.5%	1.2%	0.6%	<10% per
%RSD, Na	1.5%	0.2%	0.9%	1.6%	2.1%	0.4%	ASTM C 1285
%RSD, Si	0.5%	1.0%	2.1%	1.6%	2.7%	0.1%	

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

Set=D, Analyte=B
Variability Chart for log [Measurement (mg/L)]

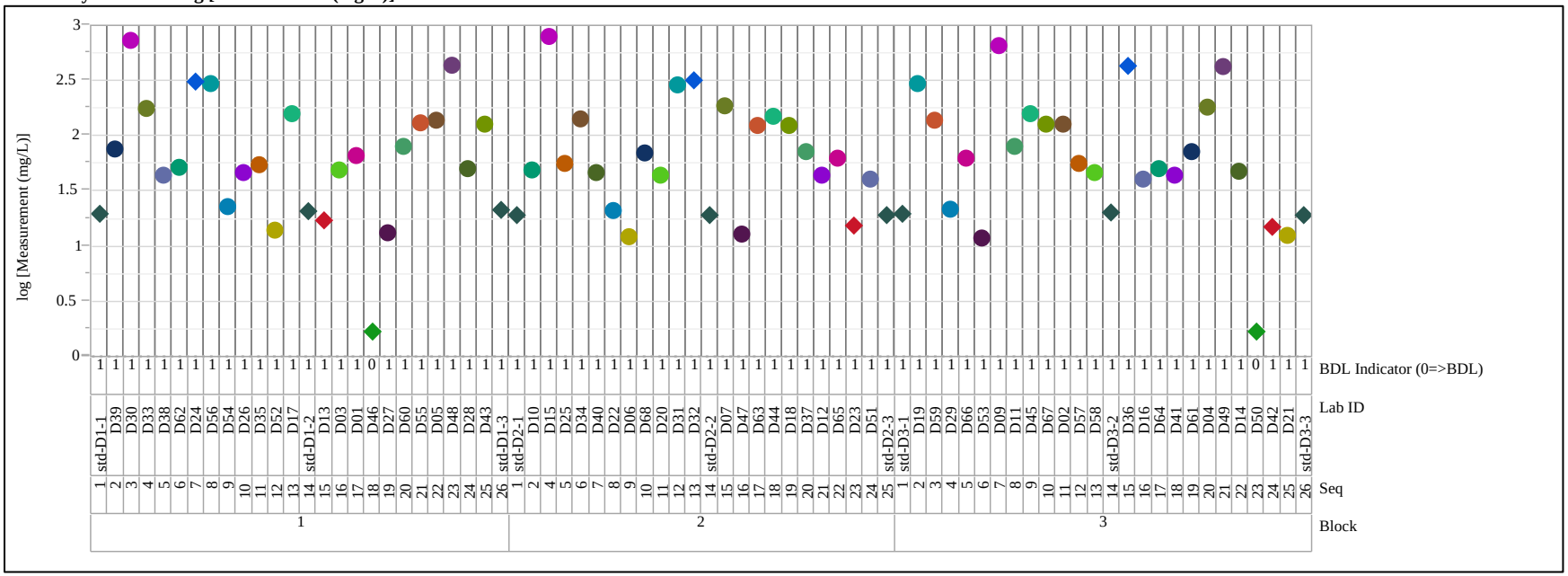


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

Set=D, Analyte=Li
Variability Chart for log [Measurement (mg/L)]

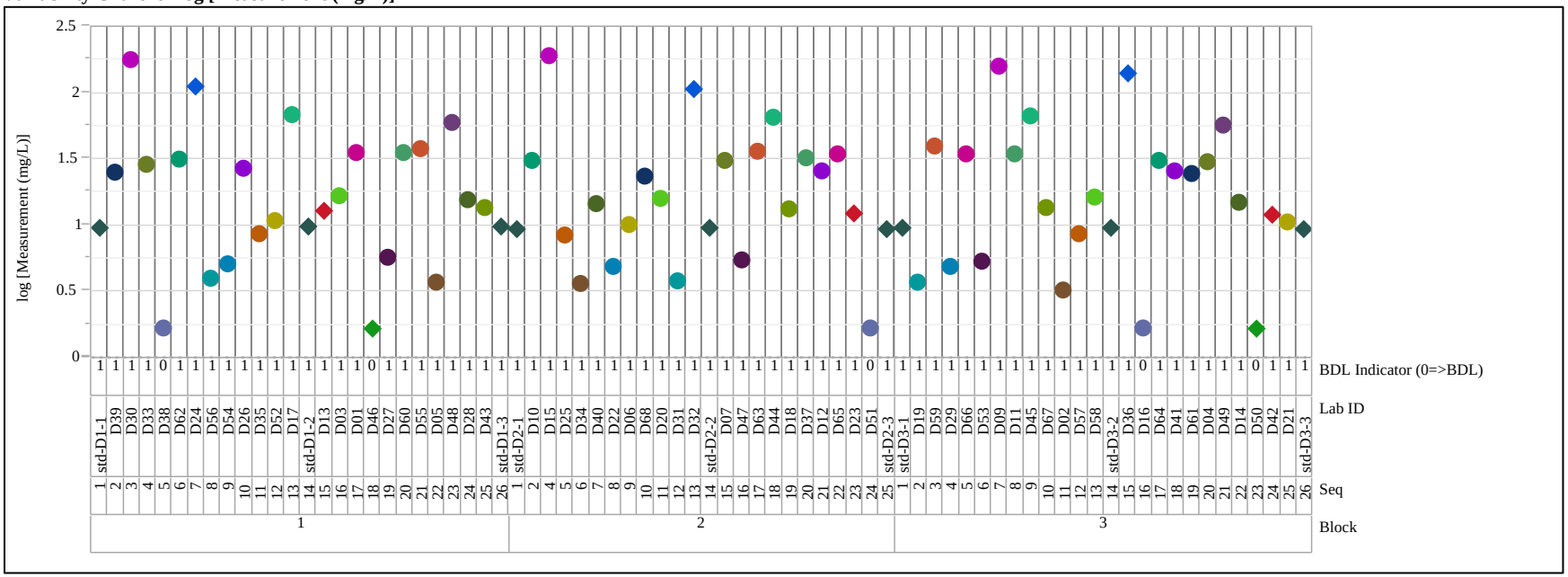


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

Set=D, Analyte=Na
Variability Chart for log [Measurement (mg/L)]

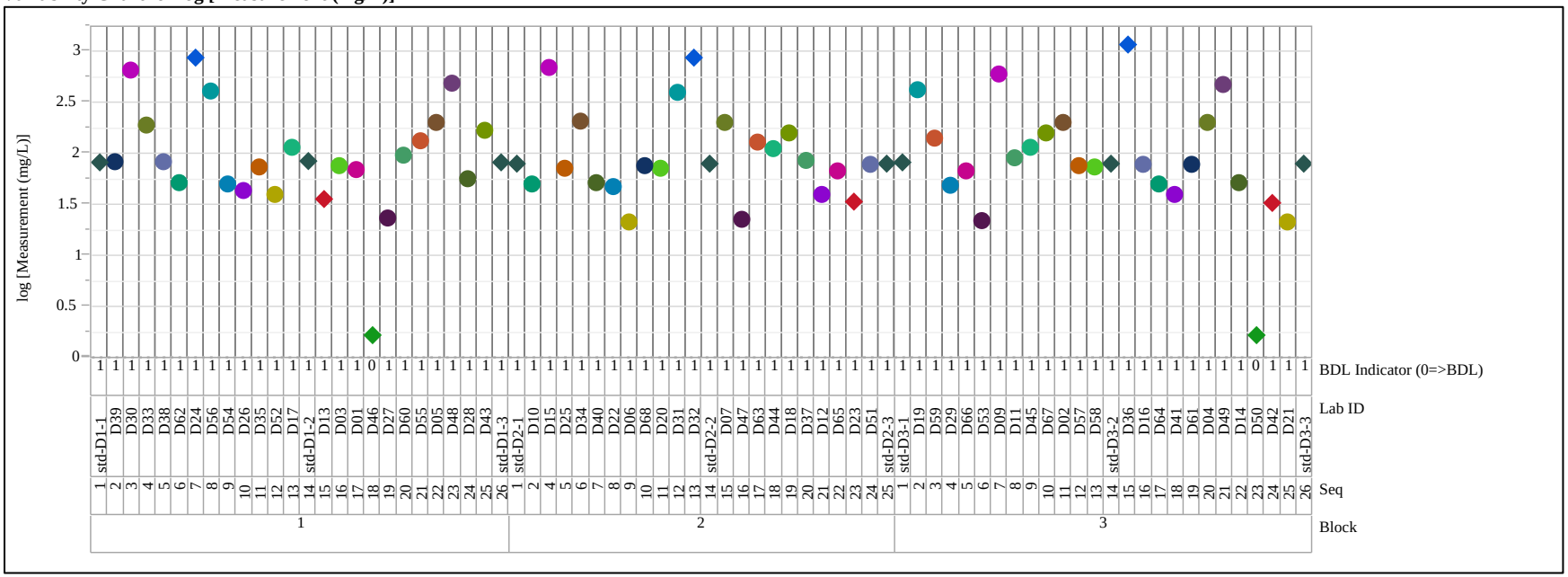


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

Set=D, Analyte=Si
Variability Chart for log [Measurement (mg/L)]

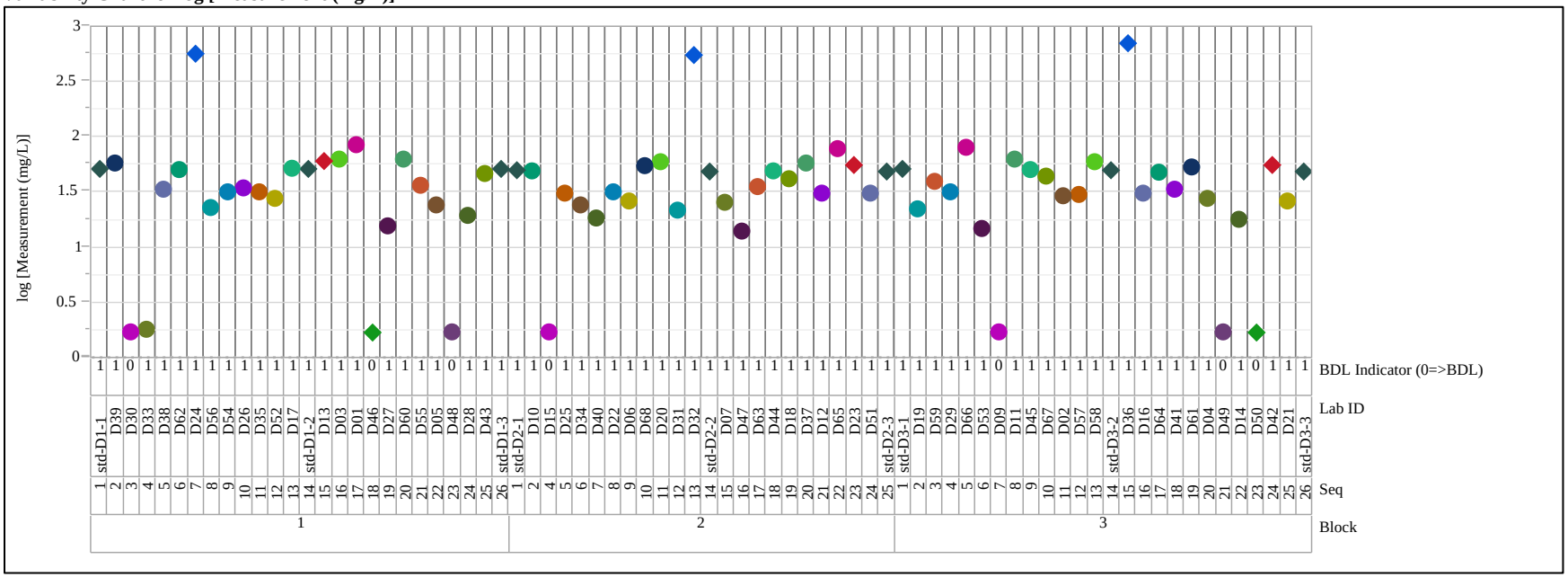


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

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

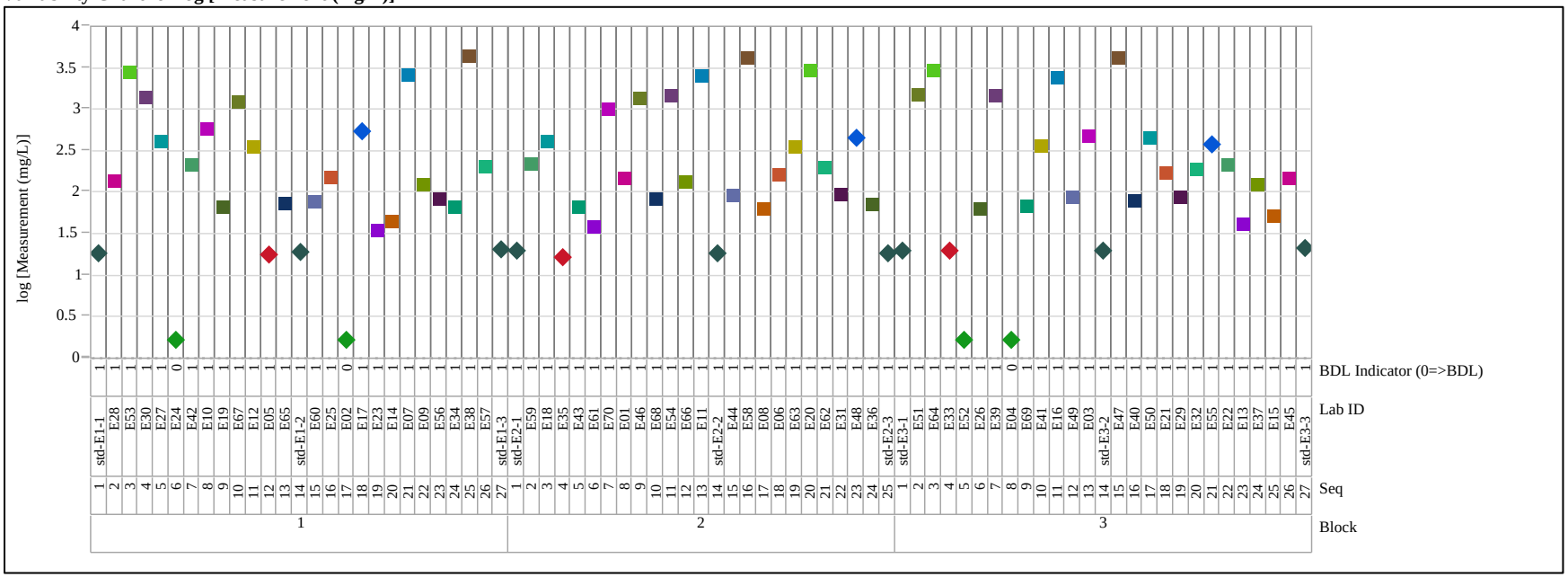


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

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

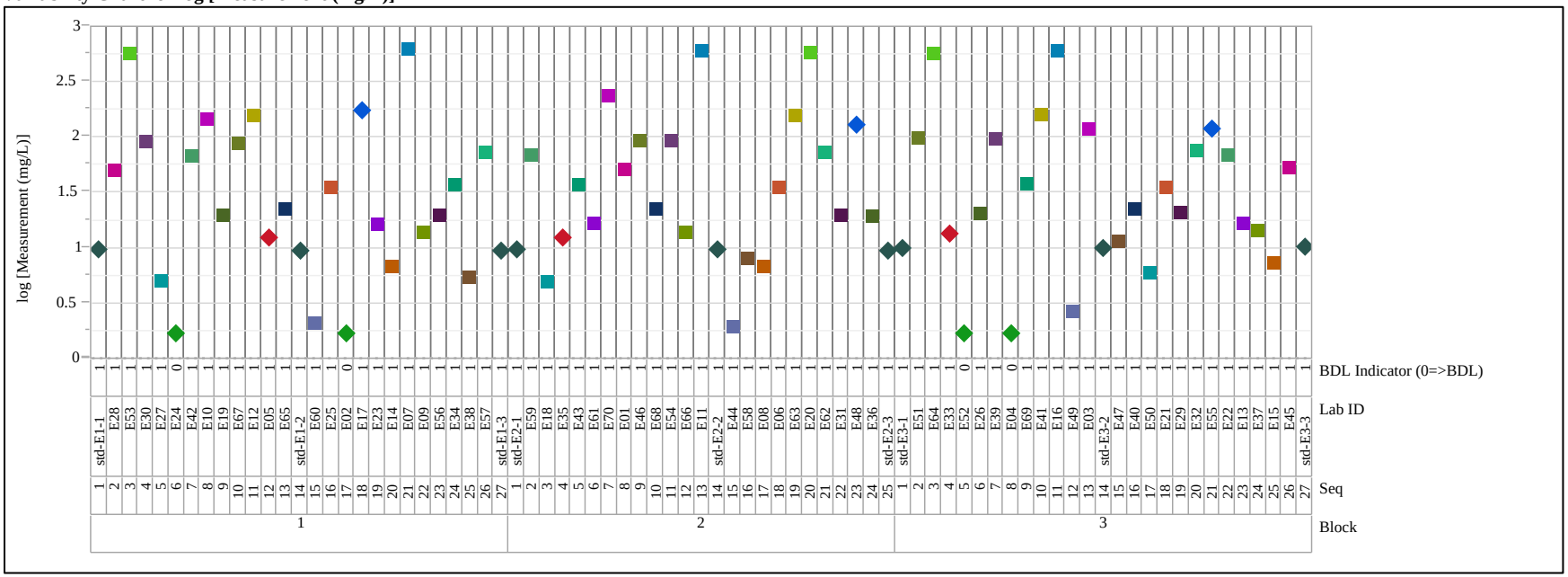


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

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

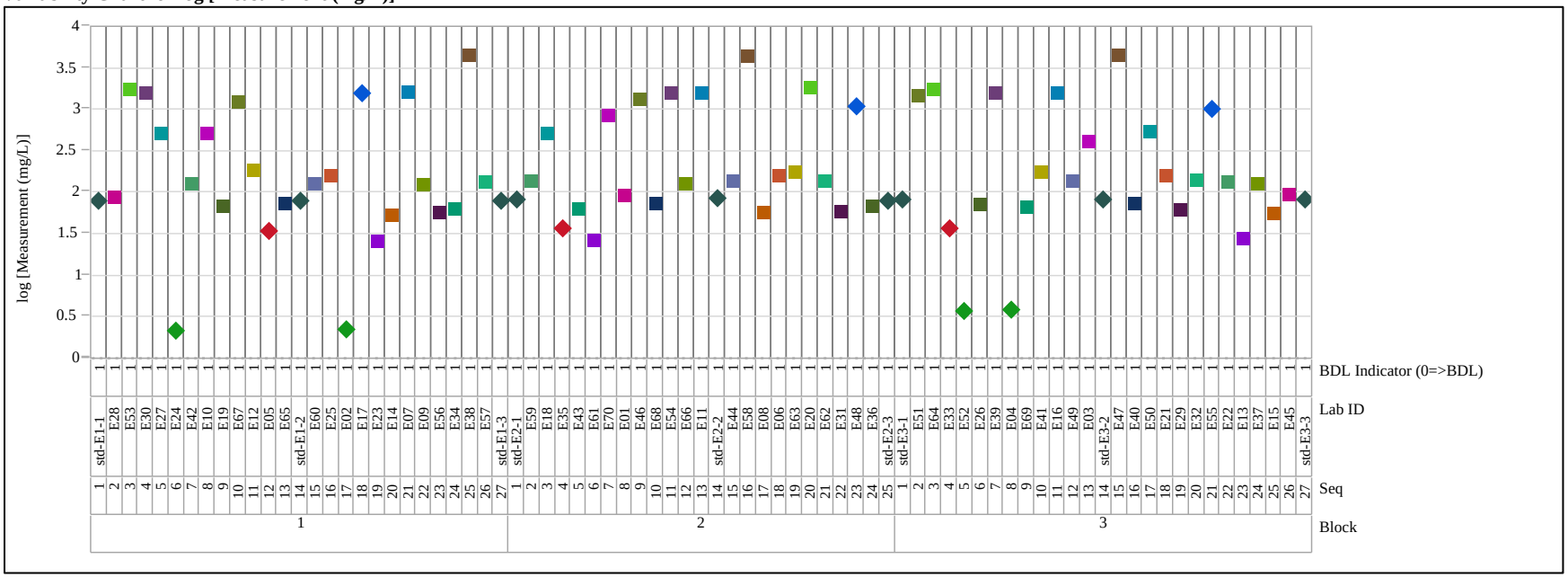


Exhibit B-1. PCT Measurements in Analytical Sequence by Analytical Set (continued)

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

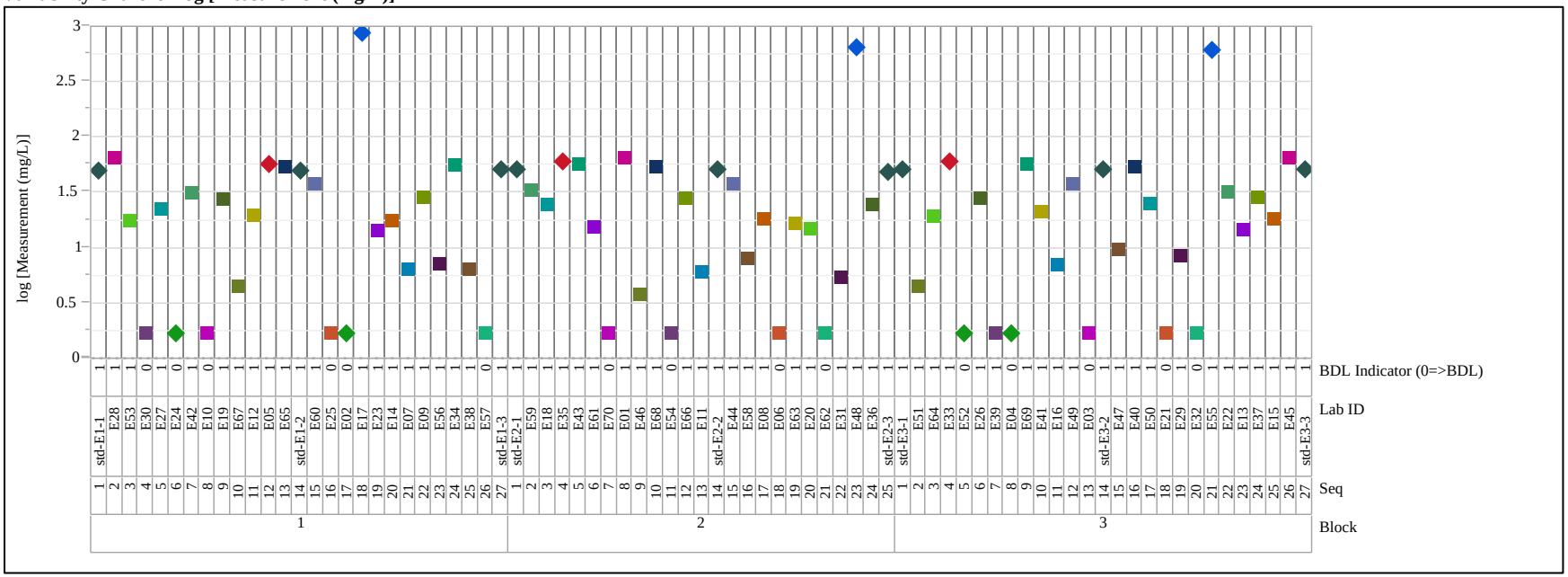


Exhibit B-2. PCT Measurements by Glass ID and Heat Treatment for Each Set

Set=D, Analyte=B
Variability Chart for log [Measurement (mg/L)]

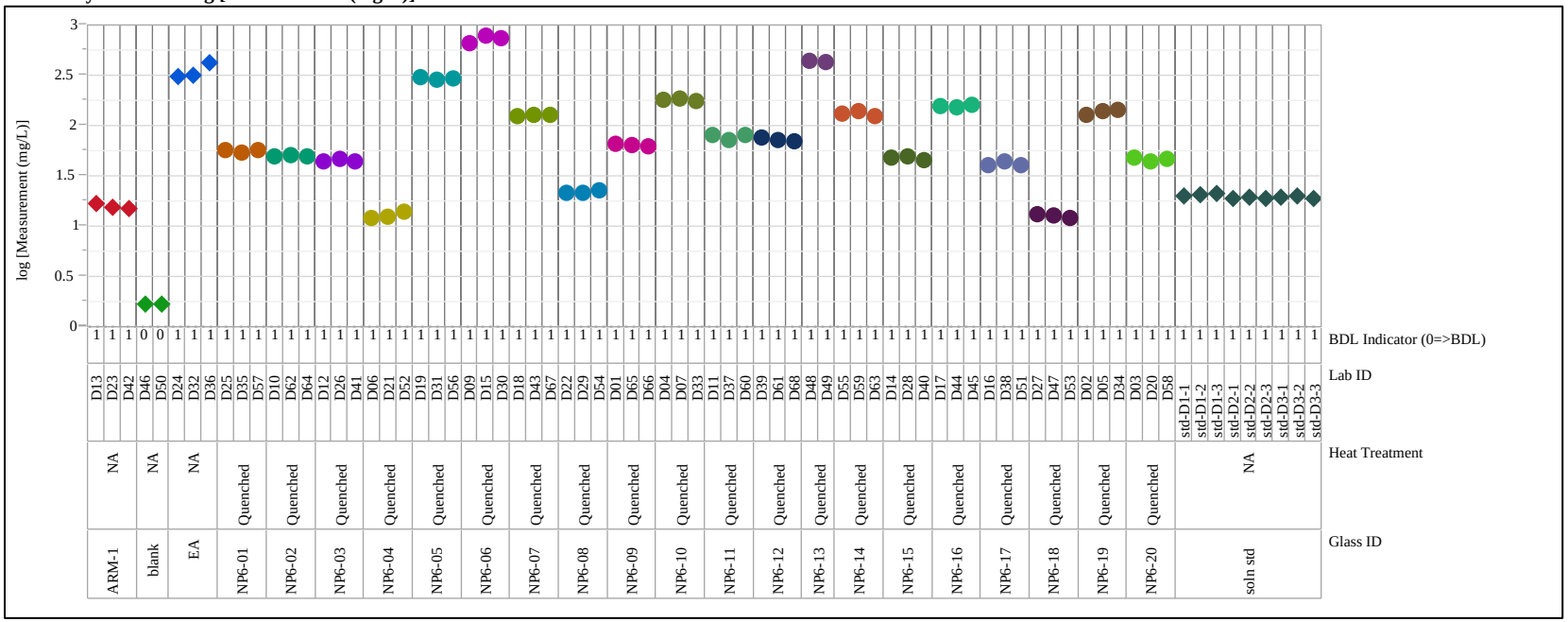


Exhibit B-2. PCT Measurements by Glass ID and Heat Treatment for Each Set (continued)

Set=D, Analyte=Li
Variability Chart for log [Measurement (mg/L)]

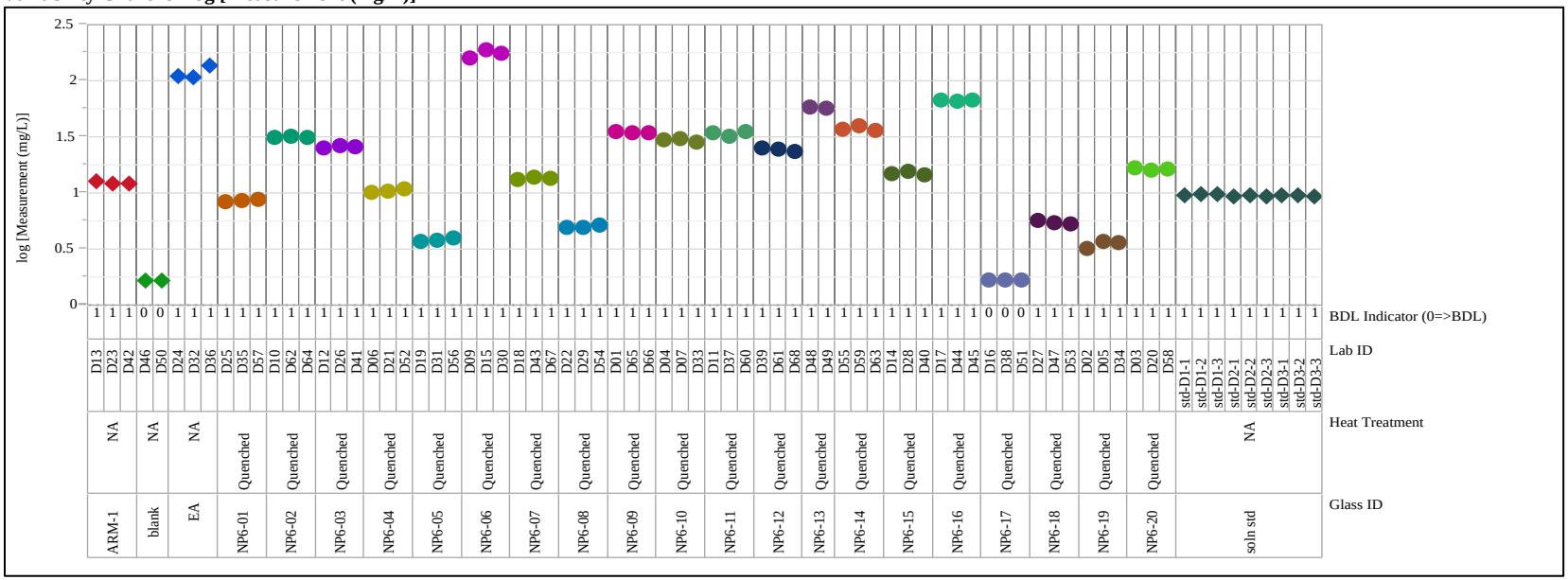


Exhibit B-2. PCT Measurements by Glass ID and Heat Treatment for Each Set (continued)

Set=D, Analyte=Na
Variability Chart for log [Measurement (mg/L)]

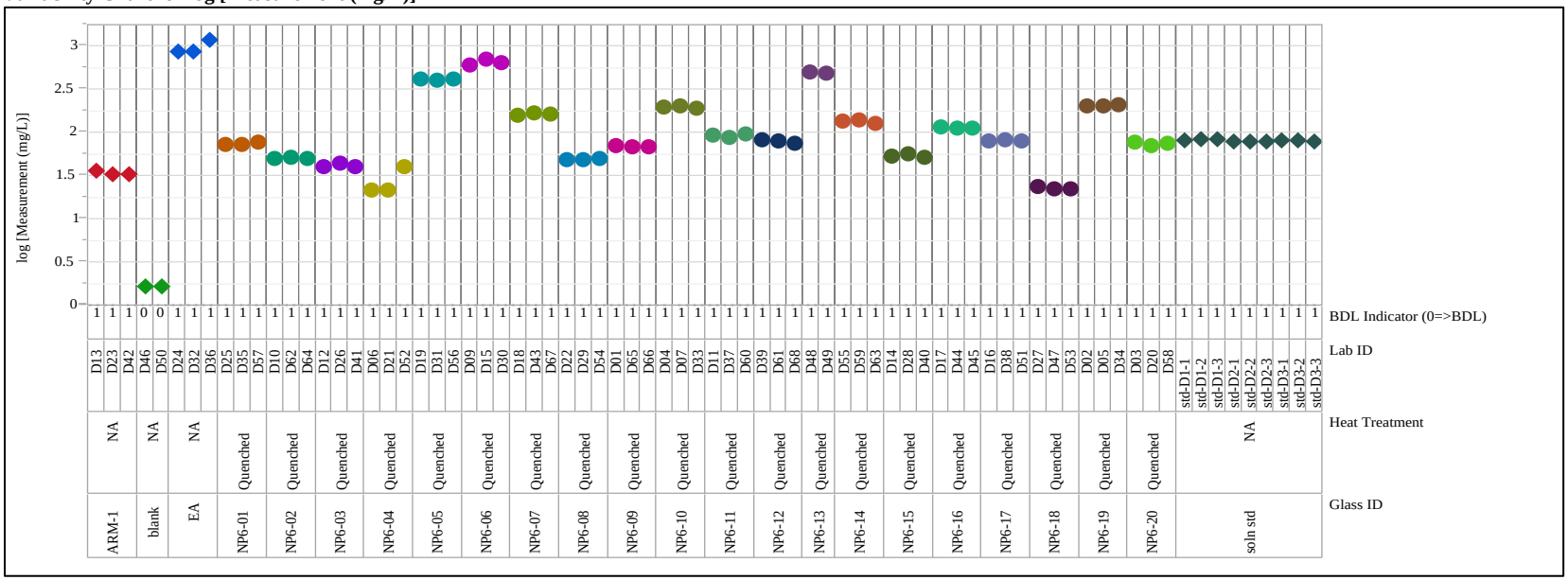


Exhibit B-2. PCT Measurements by Glass ID and Heat Treatment for Each Set (continued)

Set=D, Analyte=Si
Variability Chart for log [Measurement (mg/L)]

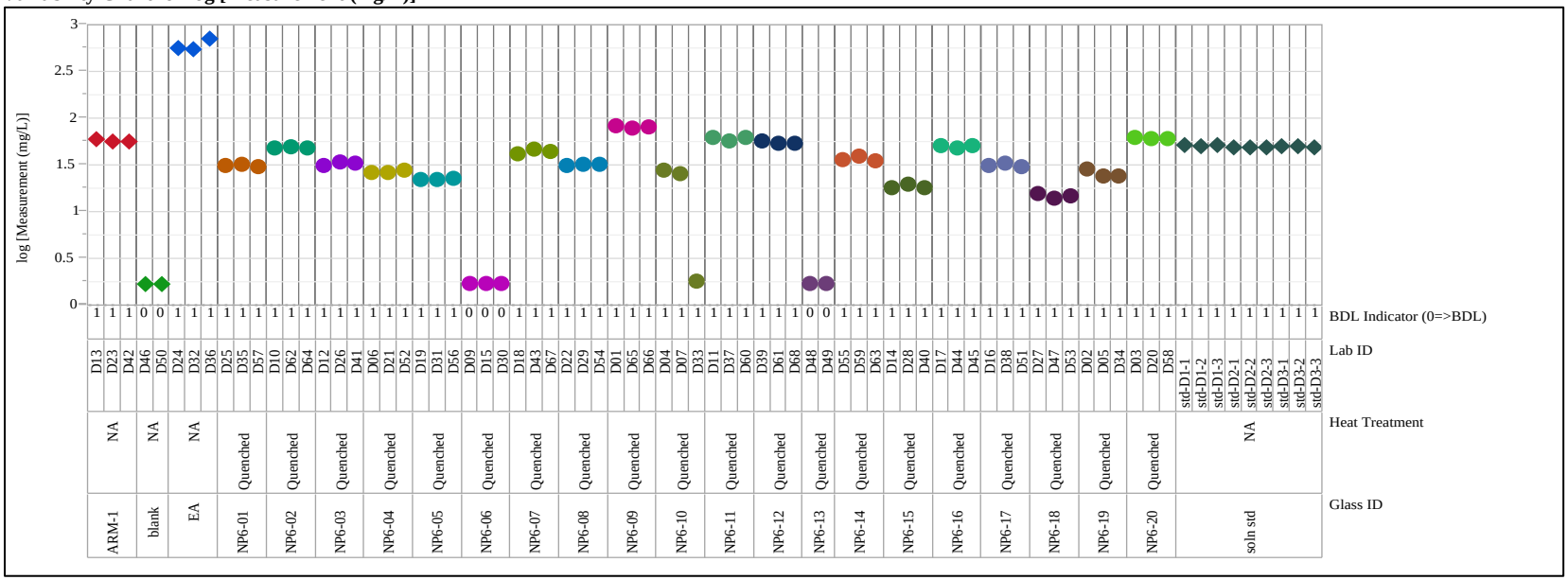


Exhibit B-2. PCT Measurements by Glass ID and Heat Treatment for Each Set (continued)

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

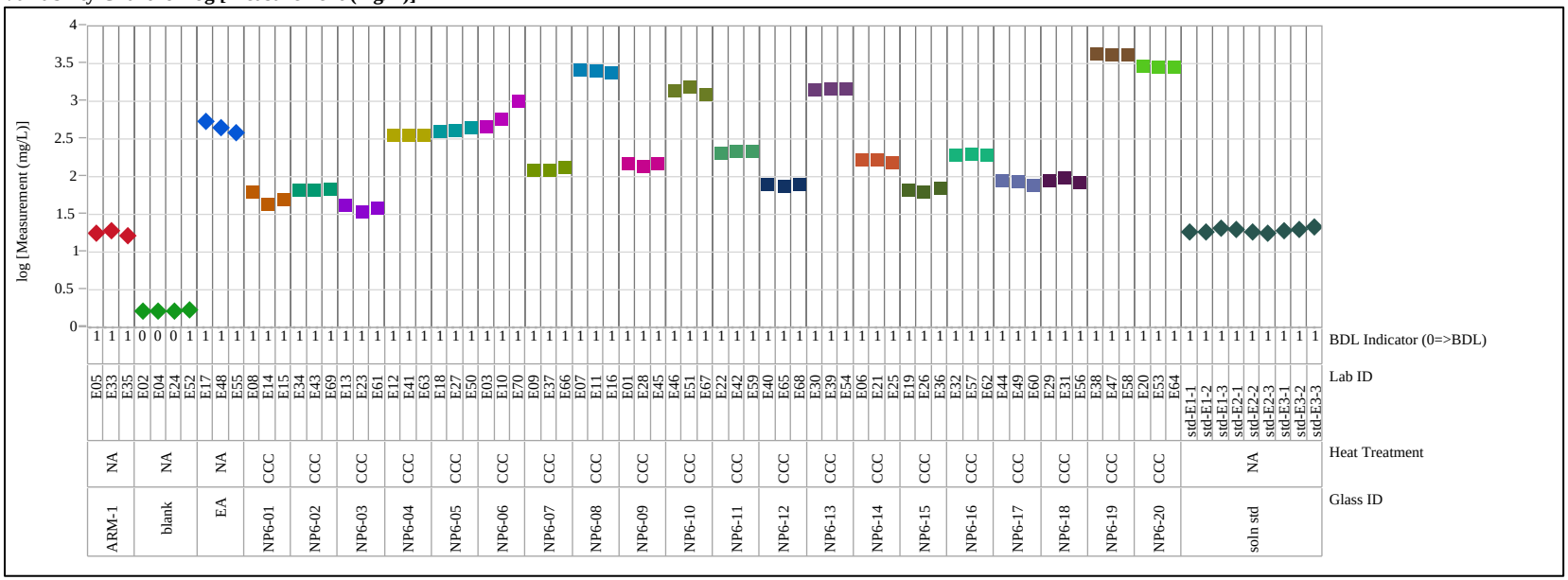


Exhibit B-2. PCT Measurements by Glass ID and Heat Treatment for Each Set (continued)

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

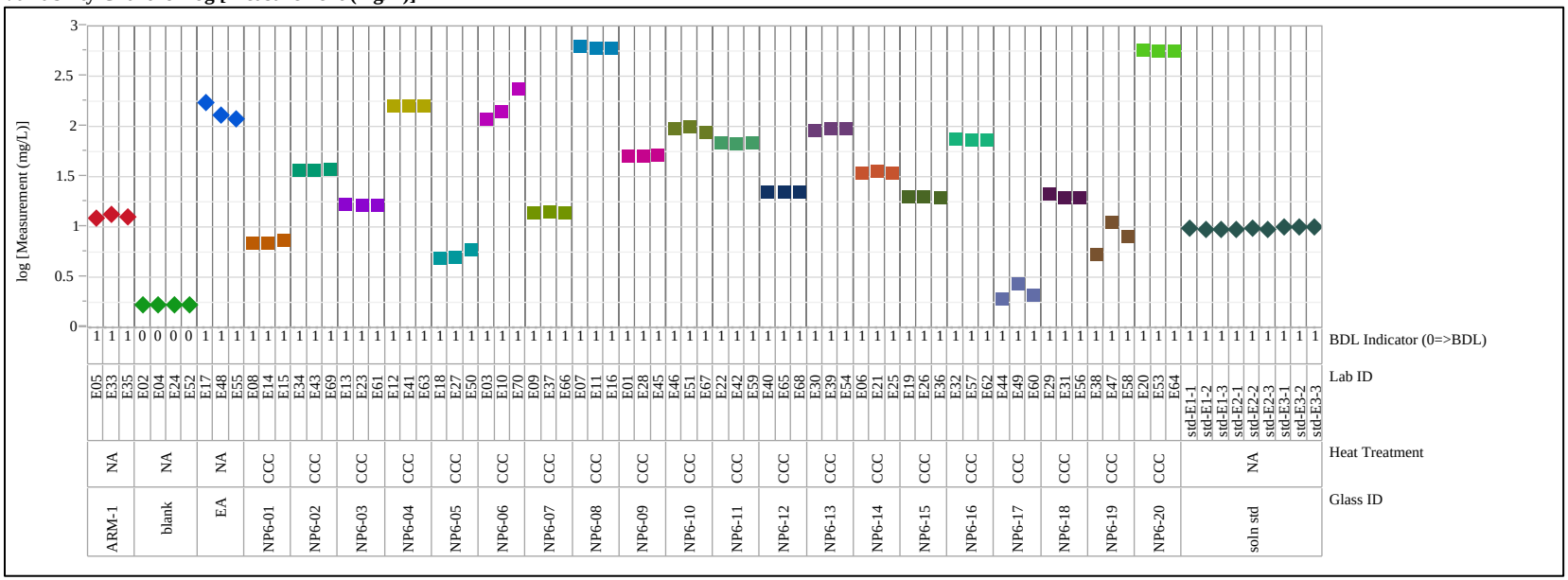


Exhibit B-2. PCT Measurements by Glass ID and Heat Treatment for Each Set (continued)

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

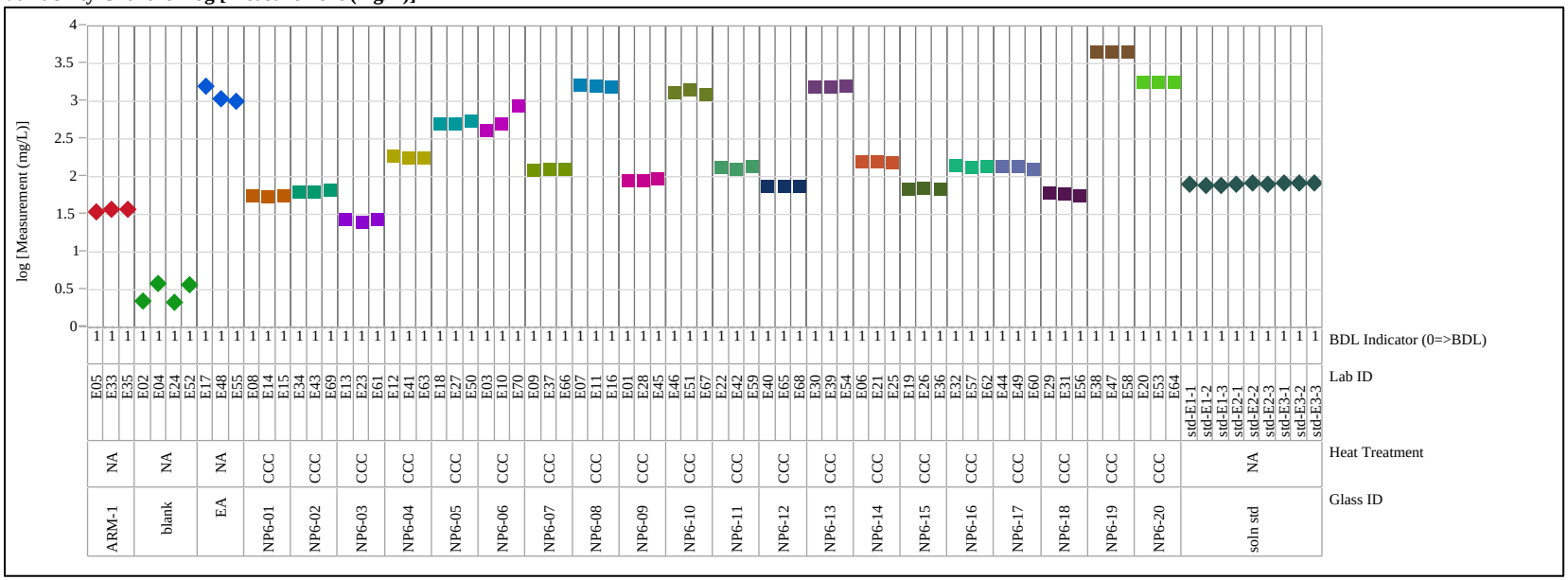


Exhibit B-2. PCT Measurements by Glass ID and Heat Treatment for Each Set (continued)

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

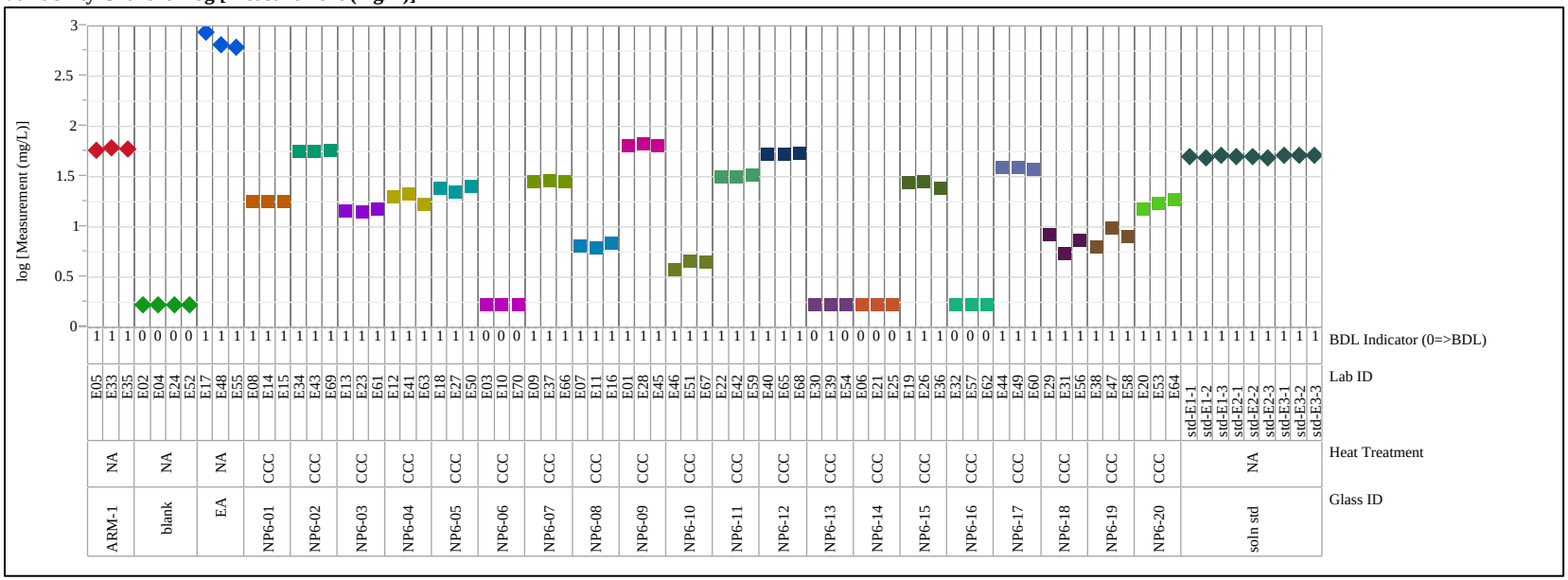


Exhibit B-3. Normalized PCT Results by Heat Treatment by Compositional View for Each Glass

Analyte=B
Variability Chart for log {NC[B (g/L)]}

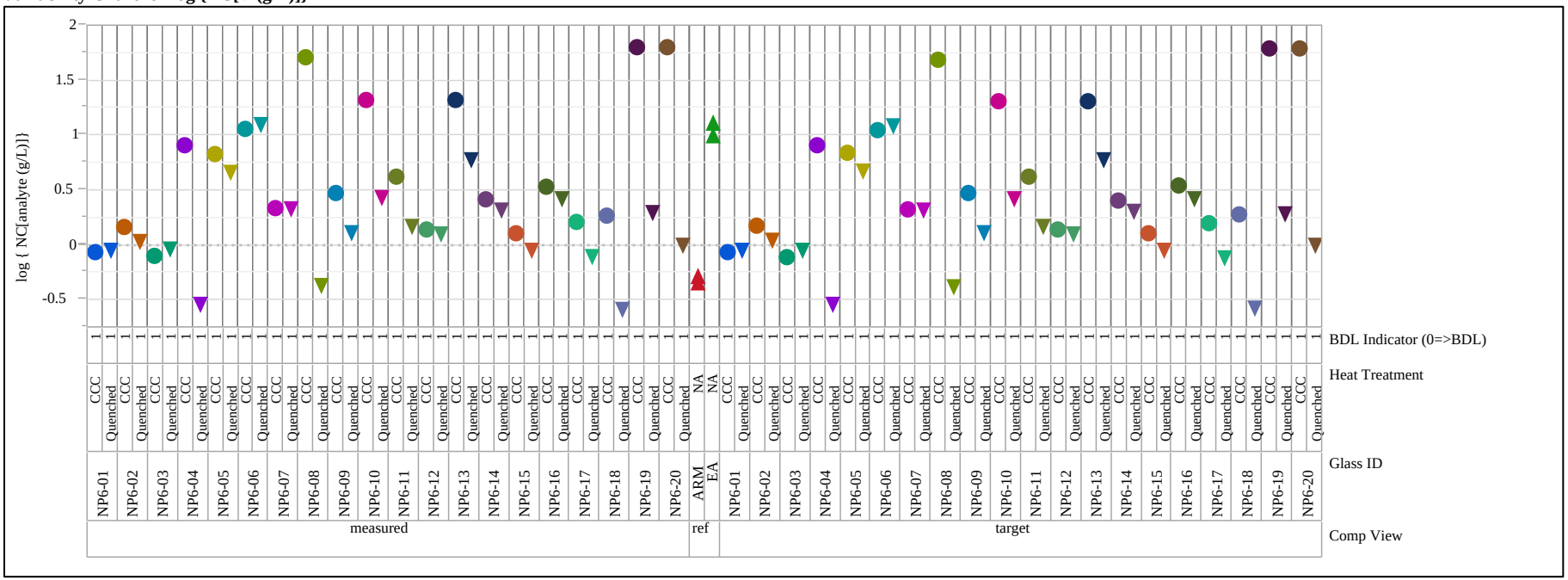


Exhibit B-3. Normalized PCT Results by Heat Treatment by Compositional View for Each Glass (continued)

Analyte=Li
Variability Chart for log {NC[Li (g/L)]}

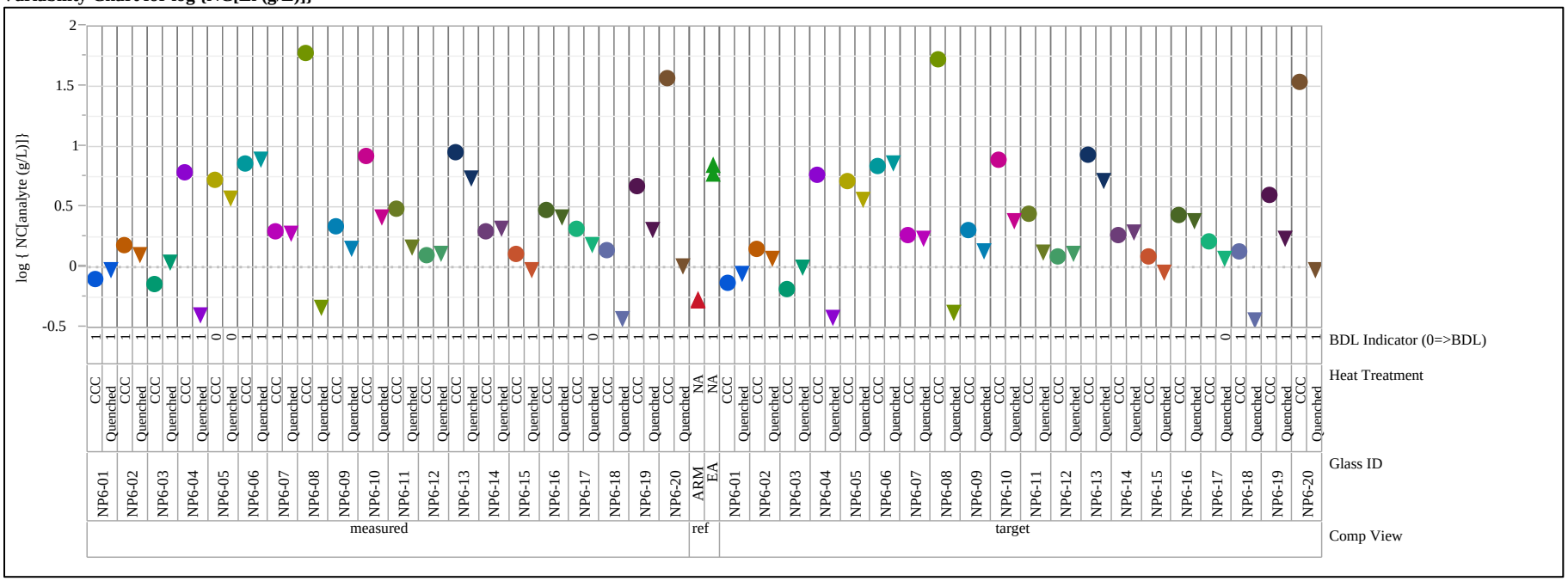


Exhibit B-3. Normalized PCT Results by Heat Treatment by Compositional View for Each Glass (continued)

Analyte=Na
Variability Chart for log {NC[Na (g/L)]}

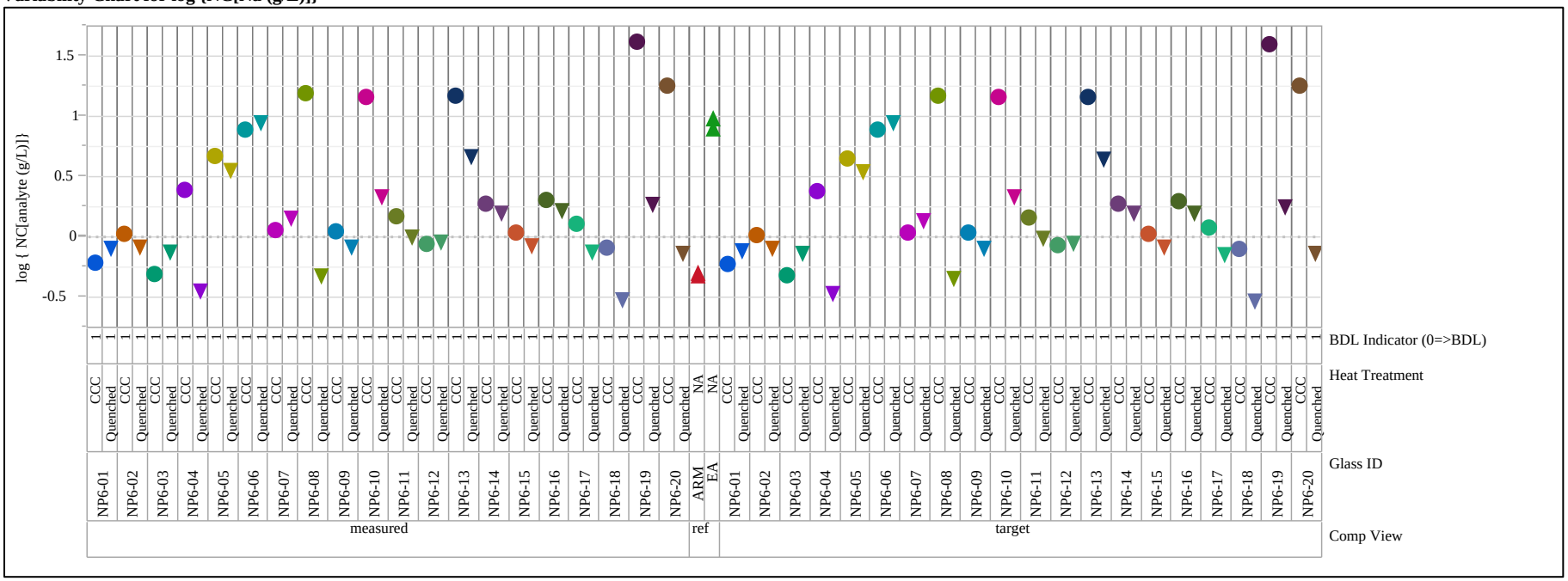


Exhibit B-3. Normalized PCT Results by Heat Treatment by Compositional View for Each Glass (continued)

Analyte=Si
Variability Chart for log {NC[Si (g/L)]}

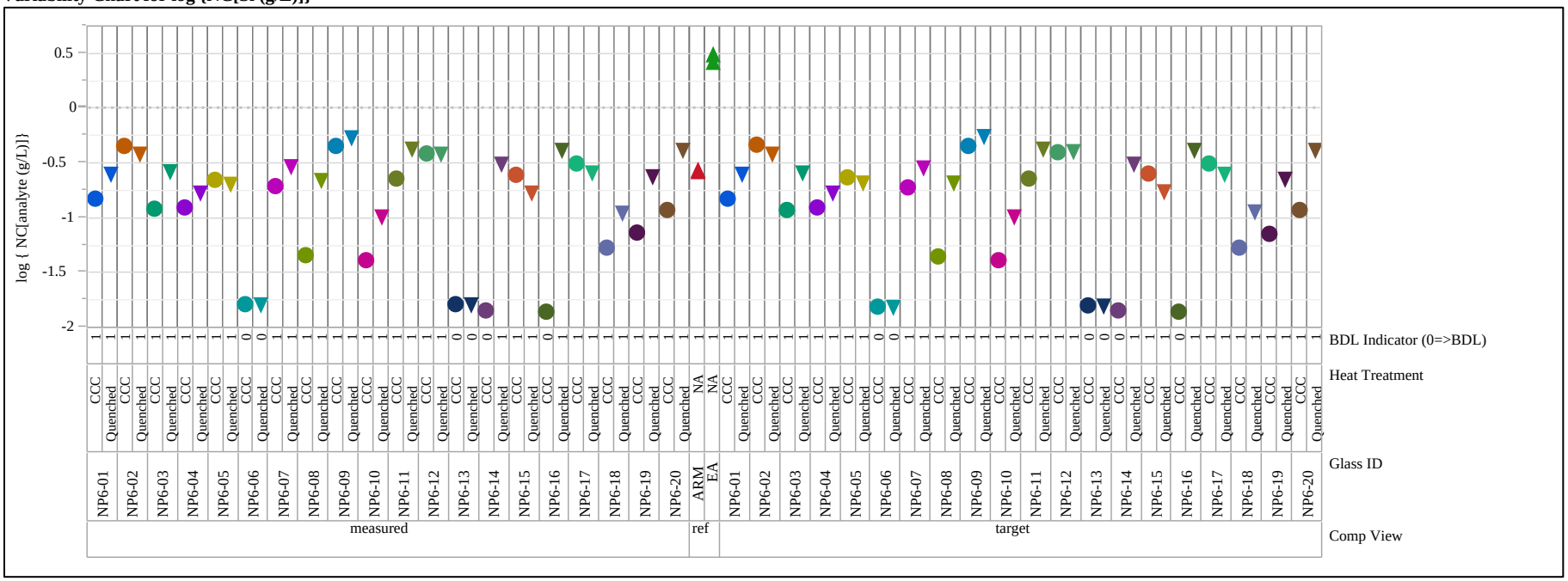


Exhibit B-4. Congruent Leaching Analysis for the Quenched Versions of the Nepheline Glasses, Normalized to the Measured Compositions

Correlations

	log NC[B (g/L)]	log NC[Li(g/L)]	log NC[Na (g/L)]	log NC[Si (g/L)]
log NC[B (g/L)]	1.0000	0.9839	0.9858	-0.4827
log NC[Li(g/L)]	0.9839	1.0000	0.9716	-0.4709
log NC[Na (g/L)]	0.9858	0.9716	1.0000	-0.5852
log NC[Si (g/L)]	-0.4827	-0.4709	-0.5852	1.0000

Scatterplot Matrix

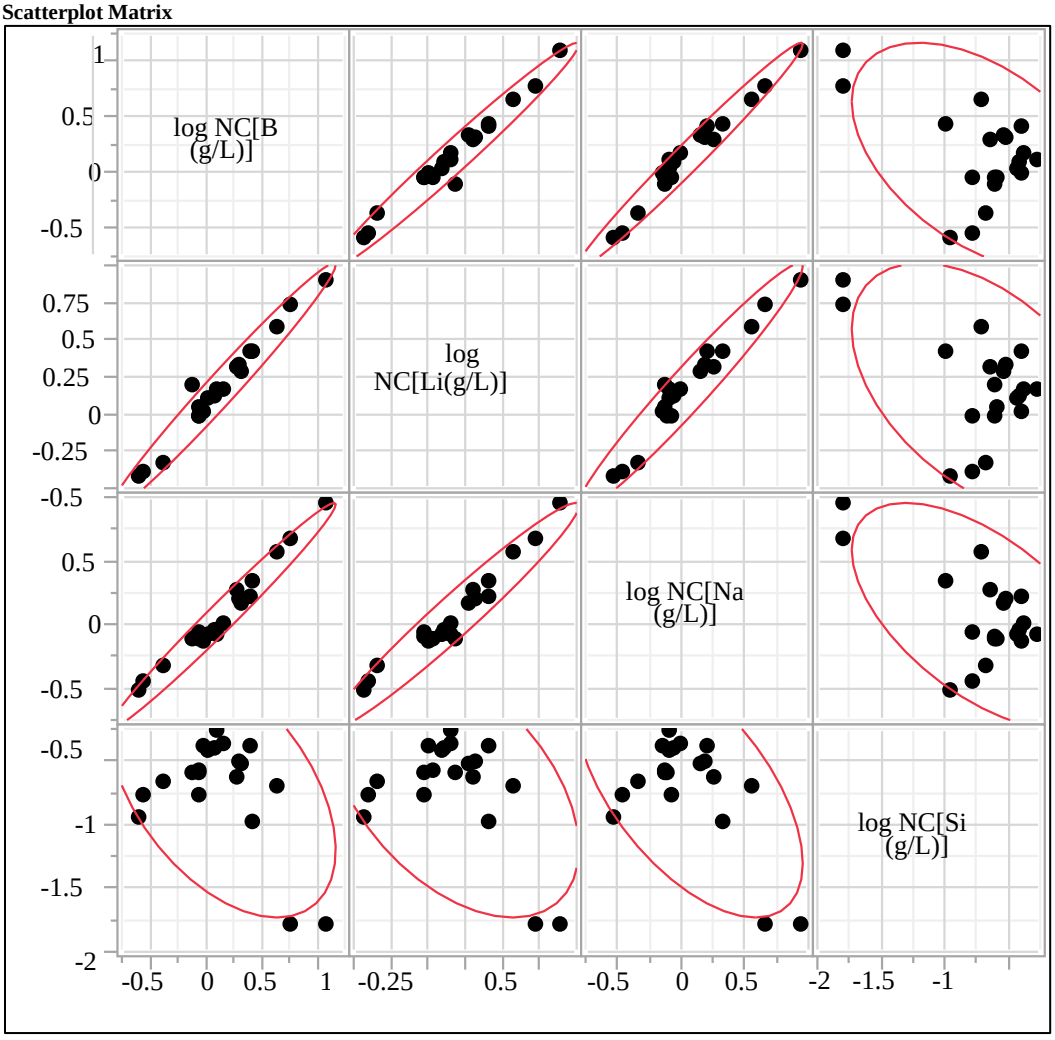
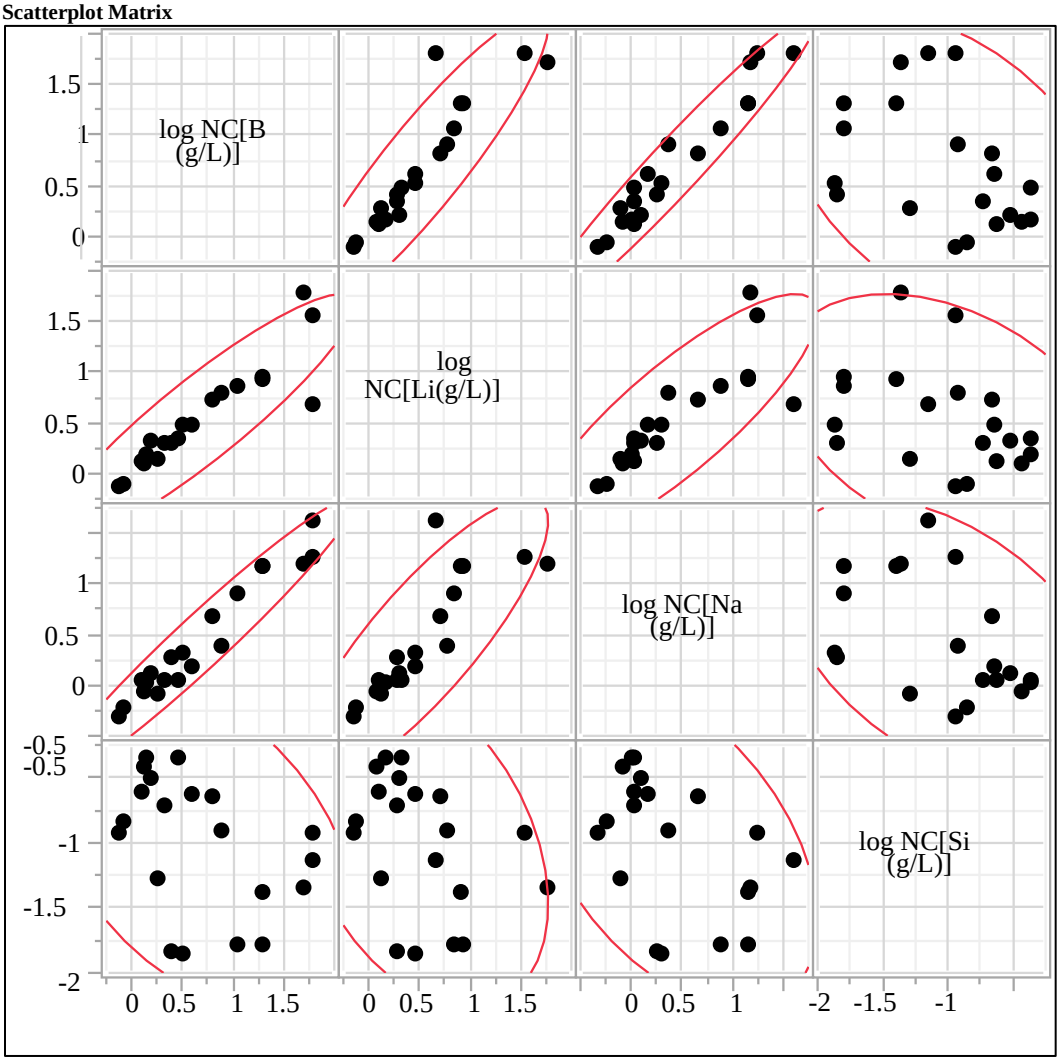


Exhibit B-5. Congruent Leaching Analysis for the CCC Versions of the Nepheline Glasses, Normalized to the Measured Compositions

Correlations

	log NC[B (g/L)]	log NC[Li(g/L)]	log NC[Na (g/L)]	log NC[Si (g/L)]
log NC[B (g/L)]	1.0000	0.9118	0.9696	-0.4109
log NC[Li(g/L)]	0.9118	1.0000	0.8423	-0.3626
log NC[Na (g/L)]	0.9696	0.8423	1.0000	-0.4661
log NC[Si (g/L)]	-0.4109	-0.3626	-0.4661	1.0000

Scatterplot Matrix



Distribution:

J. W. Amoroso, 999-W
T. B. Brown, 773-A
A. D. Cozzi, 999-W
C. L. Crawford, 773-42A
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
M. C. Hsieh, 999-W
C. M. Jantzen, 773-A
T. Jin, PNNL
F. C. Johnson, 999-W
D. S. Kim, PNNL
A. A. Kruger, DOE-ORP
C. E. Lonergan, PNNL
D. J. McCabe, 773-42A
D. L. McClane, 999-W
G. A. Morgan, 999-W
F. M. Pennebaker, 773-42A
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)