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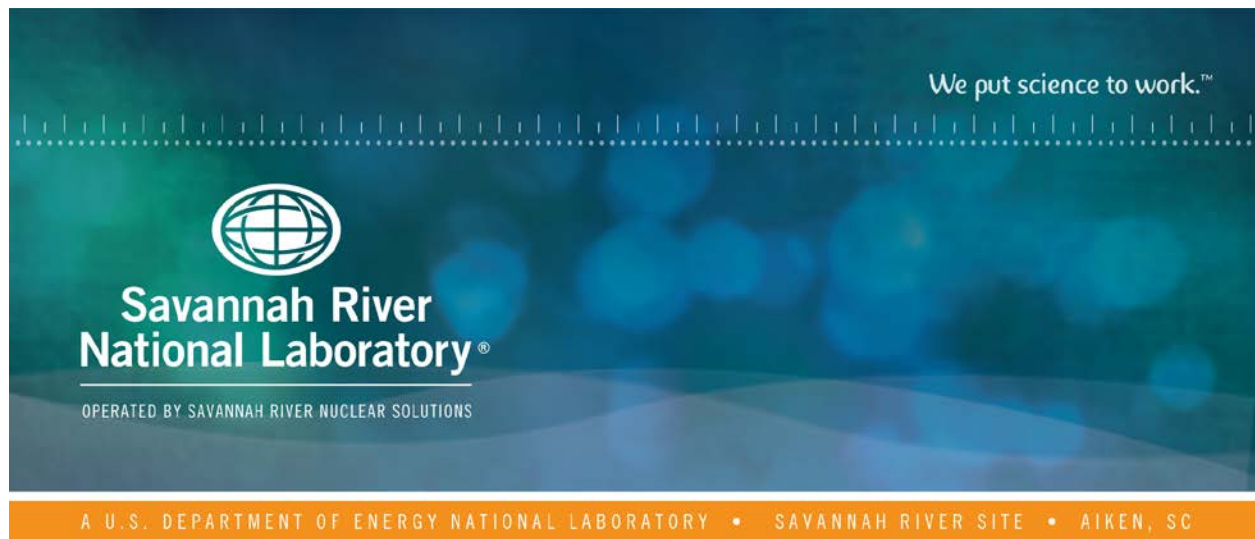
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# Composition Measurements of the Quenched, High-Chromium Matrix Glasses

**K. M. Fox**

**T. B. Edwards**

March 2020

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## EXECUTIVE SUMMARY

In this report, the Savannah River National Laboratory provides analyses of glass compositions for a series of simulated Direct Feed High-Level Waste glasses fabricated at the Pacific Northwest National Laboratory. The series included quenched versions of the glasses. These data will be used in the development of improved property/composition models for waste vitrification at Hanford.

Chemical analyses were performed on a representative sample of each of the quenched glasses to allow for comparisons with the targeted compositions. For some of the quenched glasses, measured concentrations of  $B_2O_3$ ,  $Cr_2O_3$ ,  $K_2O$ ,  $Li_2O$ , and  $Na_2O$  were below the targeted values. Measured concentrations of  $CaO$  were higher than the targeted values for some of the glasses. The measured concentrations of chlorine, fluorine, and  $SO_3$  were below the targeted values for most of the study glasses, likely because of volatility during melting. Overall, there were no indications of errors in batching of the simulated waste glasses. These results can be used in further characterization of this series of glasses, including the normalization of Product Consistency Test results.

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## LIST OF ABBREVIATIONS

AD	Acid Dissolution
ARG-1	Analytical Reference Glass-1
BDL	Below Detection Limit
DOE	U.S. Department of Energy
IC	Ion Chromatography
ICP-OES	Inductively Coupled Plasma – Optical Emission Spectroscopy
HLW	High Level Waste
KH	Potassium Hydroxide fusion
LAW	Low Activity Waste
LRM	Low-level Reference Material
ORP	Office of River Protection
PF	Sodium 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

## 1.0 Introduction

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

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).<sup>1</sup> Two of these areas are enhancing waste glass property/composition models and broadening the compositional regions over which those models are applicable.

In this report, SRNL provides chemical analysis of a series of simulated nuclear waste glasses. The glasses were selected as part of a broader study of the influence of glass composition on chemical durability, sulfur retention, and other properties.<sup>2,3</sup> The glasses were designated the DHW19M-series glasses. The resulting data will be used in the development of improved property/composition models for nuclear waste 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 C3489-00079-29. The glasses provided by PNNL were fabricated following a Task Plan.<sup>4</sup>

### 2.2 Glasses Selected for Study

The baseline (quenched) glass compositions in this study were selected and fabricated at the Pacific Northwest National Laboratory (PNNL). The glasses were received and subsequently analyzed in two groups. Identifiers for the glasses are listed in Table 2-1.

In the sections that follow, the methods used for measuring the chemical compositions of the study glasses 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 High-Chromium DFHLW Matrix Glasses**

<b>Group 1</b>	<b>Group 2</b>
DHW19M-1-2-Q	DHW19M-1-3-Q
DHW19M-2-3-Q	DHW19M-17-1-Q
DHW19M-3-1-Q	DHW19M-18-Q
DHW19M-4-Q	DHW19M-19-Q
DHW19M-5-Q	DHW19M-20-Q
DHW19M-6-1-Q	DHW19M-21-Q
DHW19M-7-1-Q	DHW19M-22-1-Q
DHW19M-8-Q	DHW19M-23-Q
DHW19M-9-Q	DHW19M-24-Q
DHW19M-10-Q	DHW19M-25-Q
DHW19M-11-Q	DHW19M-26-Q
DHW19M-12-Q	DHW19M-27-Q
DHW19M-13-Q	DHW19M-28-Q
DHW19M-14-Q	DHW19M-29-Q
DHW19M-15-Q	DHW19M-30-Q
DHW19M-16-Q	DHW19M-31-Q
	DHW19M-32-Q
	DHW19M-33-Q

### 2.3 Glass Composition Analysis

Chemical analyses were performed under the auspices of two analytical plans<sup>5,6</sup> on a representative sample of each of the quenched glasses listed in Table 2-1 to allow for comparisons with the targeted compositions. Three dissolution techniques, sodium peroxide fusion (PF),<sup>7</sup> acid dissolution (AD),<sup>8</sup> and potassium hydroxide fusion (KH),<sup>9</sup> were used for preparing each of the glass samples, in duplicate, for analysis. Note that for some analytes, the analytical plans specified more than one preparation method for analyses. The results were reviewed, and in general, the method that provided better recovery of the analyte was selected for reporting.

Each of the duplicate samples was analyzed twice for each element of interest by Inductively Coupled Plasma – Optical Emission Spectroscopy (ICP-OES)<sup>10</sup> or ion chromatography (IC),<sup>11</sup> for a total of four measurements per element per glass. Glass standards were also intermittently measured to assess the performance of the ICP-OES and IC instruments over the course of these analyses. Specifically, several samples of the Analytical Reference Glass-1 (ARG-1)<sup>12</sup> and several samples of the Low-level Reference Material (LRM)<sup>13</sup> were included as part of the analytical plans. The set of Corning, Inc., Glass Composition Mean wt% measurements of the ARG-1 standard glass<sup>12</sup> is considered to be the reference composition for this glass. The LRM composition reported as the “Consensus Average” is used as the reference composition of this glass.<sup>13</sup> 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-OES
B	PF	ICP-OES
Ca	PF	ICP-OES
Cl	KH	IC
Cr	PF	ICP-OES
F	KH	IC
Fe	PF	ICP-OES
K	AD	ICP-OES
Li	PF	ICP-OES
Mn	PF	ICP-OES
Na	AD	ICP-OES
Ni	PF	ICP-OES
P	AD	ICP-OES
Pb	AD	ICP-OES
S	AD	ICP-OES
Si	PF	ICP-OES
Zr	AD	ICP-OES

### 3.0 Results and Discussion

#### 3.1 Review and Evaluation of the Group 1 Quenched Glass Composition Measurements

Table A-1 in Appendix A provides the elemental concentration measurements in weight percent (wt %) for the glasses as prepared by the PF method. Table A-2 in Appendix A provides the elemental concentration measurements in wt % for the glasses as prepared by the AD method. Table A-3 in Appendix A provides the elemental concentration measurements in wt % for the glasses as prepared by the KH method. Elemental measurements for samples of the ARG-1 and LRM reference glasses 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 reviewed, 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.)<sup>14</sup> 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. Some of the elemental concentration measurements were reported as being below the detection limit of the analytical processes used. In these cases, the value of the detection limit was considered to be the measured value of the analyte during the process of converting to oxide concentrations. This approach was used for the purposes of data review and calculating a sum of oxides for each glass. Those oxides with one or more concentration measurements that were below the associated detection limit (BDL) will be denoted with a less than symbol (<) as the measured compositions are reported.

### 3.1.2 Measurements in Analytical Sequence

Exhibit A-1 in Appendix A provides plots of the wt % measurements generated for each sample by oxide and analytical block. The plots are in analytical sequence within each calibration block with different symbols and colors being used to represent each of the study and standard glasses. These plots include all of 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<sup>5</sup>). 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. In all cases, the instrument check standards were within specification. Any minor calibration effects typical of ICP-OES analyses 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 ARM-1 and LRM reference glasses) by Lab ID grouped by targeted concentration. Different symbols and colors are used to represent the different glasses. These plots show the individual measurements across the duplicates of each preparation method and the two instrument calibrations for each glass. Plotting the data in this format provides an opportunity to review the values for each individual glass as a function of the duplicate preparations and duplicate measurements. A review of the plots presented in these exhibits reveals the repeatability of the four individual values for each oxide for each glass. Some degree of scatter among the  $\text{Al}_2\text{O}_3$ ,  $\text{B}_2\text{O}_3$ ,  $\text{CaO}$ ,  $\text{Fe}_2\text{O}_3$ ,  $\text{Na}_2\text{O}$ , and  $\text{SiO}_2$  measurements was noted for the Group 1 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 shown in this exhibit 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.<sup>10</sup> 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

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  $\text{B}_2\text{O}_3$ ,  $\text{Cr}_2\text{O}_3$ , and  $\text{Na}_2\text{O}$  are below the targeted values for some of the glasses.
- The measured concentrations of  $\text{CaO}$  are higher than the targeted values for most of the glasses.
- The measured concentrations of chlorine, fluorine, and  $\text{SO}_3$  are below the targeted values for most of the study glasses, likely because of volatility during melting.

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. The measured sums of oxides for all but one of the glasses fall within the interval of 95 to 105 wt %, indicating acceptable recovery of the glass components.<sup>15</sup> 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 %. The relative differences are shaded if they are 10% or more.<sup>a</sup> The highlighted cells are consistent with the observations listed above.

### 3.2 Review and Evaluation of the Group 2 Quenched Glass Composition Measurements

Table B-1 in Appendix B provides the elemental concentration measurements in wt % for the glasses as prepared by the PF method. Table B-2 in Appendix B provides the elemental concentration measurements in wt % for the glasses as prepared by the AD method. Table B-3 in Appendix B provides the elemental concentration measurements in wt % for the glasses as prepared by the KH method. Elemental measurements for samples of the ARG-1 and LRM reference glasses are also included in the tables of Appendix B. These unprocessed data are provided so that the values are readily available should they be of interest for future reviews.

#### 3.2.1 Treatment of Detection Limits

Detection limits for the analyses of the Group 2 glasses were treated as described in Section 3.1.1.

#### 3.2.2 Measurements in Analytical Sequence

Exhibit B-1 in Appendix B provides plots of the wt % measurements generated for each sample by oxide and analytical block. The plots are in analytical sequence within each calibration block with different symbols and colors being used to represent each of the study and standard glasses. These plots include all of the measurement data from Table B-1 through Table B-3 in Appendix B, with each plotted point identified by its Lab ID (from the analytical study plan<sup>6</sup>). 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. In all cases, the instrument check standards were within specification. Any minor calibration effects typical of ICP-OES analyses are mitigated by taking the average of the measurements for each analyte.

#### 3.2.3 Composition Measurements by Glass Identifier

Exhibit B-2 in Appendix B provides plots of the oxide concentration measurements by the PNNL Glass ID (including the ARG-1 and LRM reference glasses) by Lab ID grouped by targeted concentration. Different symbols and colors are used to represent the different glasses. These plots show the individual measurements across the duplicates of each preparation method and the two instrument calibrations for each glass. Plotting the data in this format provides an opportunity to review the values for each individual glass as a function of the duplicate preparations and duplicate measurements. A review of the plots presented in these exhibits reveals the repeatability of the four individual values for each oxide for each glass. Some degree of scatter among the  $\text{Al}_2\text{O}_3$ ,  $\text{B}_2\text{O}_3$ ,  $\text{CaO}$ ,  $\text{Fe}_2\text{O}_3$ ,  $\text{K}_2\text{O}$ ,  $\text{Na}_2\text{O}$ , and  $\text{SiO}_2$  measurements was noted for the glasses. There is one low value for  $\text{K}_2\text{O}$  for the ARG-1 reference glass.

Initial calculations of the measured sums of oxides revealed low values for three of the study glasses: DHW19M-19-Q, DHW19M-25-Q, and DHW19M-29-Q. The PF preparations for these glasses were repeated, with smaller masses of glass being used in each preparation. This resulted in a more complete recovery of the analytes for these glasses. The supplemental measurements are shown in Table B-4. The values given in Table B-4 were substituted for the original values reported in Table B-1 for the remaining data review and for the calculation of averaged measured compositions for the study glasses.<sup>b</sup> There were

<sup>a</sup> These criteria were selected arbitrarily for the purpose of highlighting differences from targeted concentrations that may be of practical concern.

<sup>b</sup> Note that the original measurements for glasses DHW19M-19-Q, DHW19M-25-Q, and DHW19M-29-Q are displayed in Exhibits B-1 and B-2 for completeness; however, the revised measurements in Table B-4 were substituted for those original values as described above.

no other indications of errors in preparation or measurement that had to be addressed in treatment of the data.

### 3.2.4 Results for the LRM Standard

Exhibit B-3 in Appendix B provides a comparison of the LRM results to their acceptability limits utilized by SRNL.<sup>10</sup> 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.

An evaluation of the results for the LRM glass samples included in the re-analysis of the three glasses by the PF preparation method is shown in Table B-5. The results show that all the measurements for the elements present in the LRM standard glass were within the acceptability limits.

### 3.2.5 Measured versus Targeted Compositions

All of the measurements for each oxide for each glass (i.e., all of the measurements in Table B-1 through Table B-3 in Appendix B, with the substitutions shown in Table B-4) were averaged to determine a representative chemical composition for each glass. A sum of oxides was also computed for each glass based upon the averaged, measured values. Exhibit B-4 in Appendix B 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  $B_2O_3$ ,  $K_2O$ ,  $Li_2O$ , and  $Na_2O$  are low relative to the targeted values for most of the glasses.
- The measured concentrations of  $CaO$  are higher than the targeted values for some of the glasses.
- The measured concentrations of chlorine, fluorine, and  $SO_3$  are below the targeted values for most of the study glasses, likely because of volatility during melting.
- There are some deviations in the measured  $SiO_2$  concentrations, both above and below the targeted values for the study glasses.

Table B-6 in Appendix B provides a summary of the average compositions as well as the targeted compositions and some associated differences and relative differences. The measured sums of oxides for all but one of the glasses fall within the interval of 95 to 105 wt %, indicating acceptable recovery of the glass components.<sup>15</sup> Entries in Table B-6 show the relative differences between the measured values and the targeted values for the oxides with targeted values above 5 wt %. The relative differences are shaded if they are 10% or more.<sup>a</sup> The highlighted cells are consistent with the observations listed above.

## 4.0 Summary

In this report, SRNL provides analyses of glass compositions for a series of simulated nuclear waste glasses fabricated at PNNL. The series included quenched versions of the glasses. These data will be used in the development of improved property/composition models for waste vitrification at Hanford.

Chemical analyses were performed on a representative sample of each of the quenched glasses to allow for comparisons with the targeted compositions. For some of the quenched glasses, measured concentrations of  $B_2O_3$ ,  $Cr_2O_3$ ,  $K_2O$ ,  $Li_2O$ , and  $Na_2O$  were below the targeted values. Measured concentrations of  $CaO$  were higher than the targeted values for some of the glasses. The measured concentrations of chlorine, fluorine, and  $SO_3$  were below the targeted values for most of the study glasses, likely because of volatility

<sup>a</sup> These criteria were selected arbitrarily for the purpose of highlighting differences from targeted concentrations that may be of practical concern.



during melting. Overall, there were no indications of errors in batching of the simulated waste glasses. These results can be used in further characterization of this series of glasses, including the normalization of Product Consistency Test results.

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## **Appendix A   Tables and Exhibits Supporting the Group 1 Glass Composition Measurements**

**Table A-1. PF Measurements of the Group 1 Glasses**

Glass ID	Block	Sub-Blk	Sequence	Lab ID	Al (wt%)	B (wt%)	Ca (wt%)	Cr (wt%)	Fe (wt%)	Li (wt%)	Mn (wt%)	Ni (wt%)	Si (wt%)
LRM	1	1	1	LRMPF111	5.22	2.21	0.520	0.124	0.912	<0.100	<0.100	0.123	24.8
ARG-1	1	1	2	ARG1PF111	2.58	2.42	1.33	<0.100	8.72	1.51	1.32	0.723	21.7
DHW19M-1	1	1	3	S-09995PF21	3.00	3.54	2.96	1.55	3.50	1.61	<0.100	0.212	20.6
DHW19M-7	1	1	4	S-10001PF11	3.20	3.98	0.285	0.633	3.86	1.84	<0.100	0.108	20.8
DHW19M-5	1	1	5	S-09999PF11	3.34	5.04	1.85	0.938	3.19	1.30	0.129	0.145	19.5
DHW19M-3	1	1	6	S-09997PF11	2.11	2.94	0.234	0.822	2.85	0.222	0.177	0.177	23.4
DHW19M-13	1	1	7	S-10007PF21	3.50	4.48	3.95	0.624	1.68	1.34	0.196	0.200	20.0
DHW19M-15	1	1	8	S-10009PF21	1.85	5.13	3.56	1.01	0.661	1.83	0.101	0.127	22.4
DHW19M-7	1	1	9	S-10001PF21	3.27	4.01	0.325	0.642	3.80	1.86	<0.100	<0.100	20.8
DHW19M-5	1	1	10	S-09999PF21	3.36	5.05	1.87	0.921	3.26	1.30	0.134	0.204	19.6
LRM	1	1	11	LRMPF112	5.42	2.31	0.567	0.115	0.894	<0.100	<0.100	0.117	24.9
ARG-1	1	1	12	ARG1PF112	2.69	2.56	1.42	<0.100	8.63	1.57	1.32	0.712	21.8
DHW19M-11	1	1	13	S-10005PF11	2.74	5.78	0.694	0.920	1.04	1.71	0.171	0.179	20.7
DHW19M-9	1	1	14	S-10003PF21	3.84	4.86	0.467	1.44	3.26	0.186	0.190	0.177	17.9
DHW19M-3	1	1	15	S-09997PF21	2.48	2.90	0.290	0.808	2.70	0.228	0.169	0.157	23.4
DHW19M-13	1	1	16	S-10007PF11	3.54	4.49	4.03	0.616	1.69	1.34	0.194	0.223	20.3
DHW19M-11	1	1	17	S-10005PF21	2.76	5.73	0.698	0.866	1.02	1.73	0.171	0.169	21.1
DHW19M-15	1	1	18	S-10009PF11	1.86	5.34	3.64	1.01	0.679	1.82	0.102	<0.100	23.0
DHW19M-9	1	1	19	S-10003PF11	3.92	5.01	0.438	1.48	3.27	0.190	0.175	0.172	17.9
DHW19M-1	1	1	20	S-09995PF11	3.15	3.81	3.18	1.51	3.47	1.67	<0.100	<0.100	21.1
LRM	1	1	21	LRMPF113	5.47	2.35	0.584	0.117	0.889	<0.100	<0.100	0.118	24.9
ARG-1	1	1	22	ARG1PF113	2.71	2.58	1.45	<0.100	8.51	1.57	1.31	0.702	21.8
LRM	1	2	1	LRMPF121	5.19	2.22	0.539	0.118	0.892	<0.100	<0.100	0.101	24.9
ARG-1	1	2	2	ARG1PF121	2.56	2.41	1.36	<0.100	8.46	1.51	1.29	0.679	21.9
DHW19M-5	1	2	3	S-09999PF12	3.27	4.99	1.86	0.927	3.27	1.29	0.133	0.125	20.0
DHW19M-9	1	2	4	S-10003PF12	3.74	4.89	0.405	1.56	3.51	0.182	0.184	0.164	18.2
DHW19M-11	1	2	5	S-10005PF22	2.71	5.86	0.680	0.937	1.12	1.69	0.185	0.172	21.3
DHW19M-5	1	2	6	S-09999PF22	3.29	5.19	1.87	0.978	3.53	1.29	0.144	0.199	19.7
DHW19M-13	1	2	7	S-10007PF22	3.47	4.64	4.02	0.654	1.82	1.33	0.210	0.205	20.2
DHW19M-1	1	2	8	S-09995PF12	3.01	3.71	3.07	1.56	3.71	1.60	<0.100	<0.100	21.6
DHW19M-3	1	2	9	S-09997PF22	2.42	2.96	0.275	0.869	2.95	0.225	0.184	0.158	23.5
DHW19M-9	1	2	10	S-10003PF22	3.75	4.87	0.449	1.58	3.55	0.181	0.206	0.174	18.3
LRM	1	2	11	LRMPF122	5.41	2.39	0.571	0.122	0.983	<0.100	<0.100	0.121	25.1
ARG-1	1	2	12	ARG1PF122	2.65	2.61	1.42	<0.100	9.36	1.54	1.42	0.764	22.0
DHW19M-13	1	2	13	S-10007PF12	3.48	4.60	4.00	0.660	1.86	1.33	0.212	0.235	20.5
DHW19M-15	1	2	14	S-10009PF12	1.80	5.35	3.57	1.07	0.739	1.82	0.108	<0.100	23.6

**Table A-1. PF Measurements of the Group 1 Glasses (continued)**

Glass ID	Block	Sub-Blk	Sequence	Lab ID	Al (wt%)	B (wt%)	Ca (wt%)	Cr (wt%)	Fe (wt%)	Li (wt%)	Mn (wt%)	Ni (wt%)	Si (wt%)
DHW19M-11	1	2	15	S-10005PF12	2.69	5.83	0.681	0.929	1.12	1.69	0.185	0.185	21.4
DHW19M-1	1	2	16	S-09995PF22	3.05	3.79	3.13	1.64	3.77	1.63	<0.100	0.207	21.2
DHW19M-7	1	2	17	S-10001PF22	3.28	4.23	0.326	0.693	4.17	1.86	<0.100	<0.100	21.2
DHW19M-3	1	2	18	S-09997PF12	2.08	3.02	0.235	0.873	3.01	0.220	0.188	0.171	23.9
DHW19M-15	1	2	19	S-10009PF22	1.81	5.27	3.59	1.05	0.714	1.80	0.109	0.116	23.1
DHW19M-7	1	2	20	S-10001PF12	3.22	4.19	0.298	0.700	4.17	1.88	<0.100	<0.100	21.2
LRM	1	2	21	LRMPF123	5.42	2.42	0.573	0.133	0.991	<0.100	<0.100	0.115	24.8
ARG-1	1	2	22	ARG1PF123	2.64	2.63	1.42	<0.100	9.36	1.55	1.42	0.758	21.9
LRM	2	1	1	LRMPF211	5.20	2.26	0.540	0.123	0.946	<0.100	<0.100	0.115	25.7
ARG-1	2	1	2	ARG1PF211	2.57	2.48	1.36	<0.100	9.05	1.53	1.37	0.746	22.5
DHW19M-12	2	1	3	S-10006PF11	2.38	3.33	3.33	1.21	2.14	0.675	<0.100	<0.100	23.5
DHW19M-14	2	1	4	S-10008PF21	1.16	3.02	1.82	0.995	2.15	1.40	0.161	0.145	23.2
DHW19M-4	2	1	5	S-09998PF21	3.11	2.97	2.12	0.787	4.57	0.392	0.204	0.186	20.8
DHW19M-10	2	1	6	S-10004PF21	2.66	5.31	4.13	1.18	2.77	0.435	0.178	0.183	18.8
DHW19M-6	2	1	7	S-10000PF21	3.02	2.84	1.44	0.826	0.678	<0.100	<0.100	<0.100	24.3
DHW19M-2	2	1	8	S-09996PF21	3.67	3.24	1.67	1.42	1.54	0.339	0.198	0.179	23.4
DHW19M-12	2	1	9	S-10006PF21	2.38	3.38	3.33	1.22	2.16	0.669	<0.100	<0.100	25.3
DHW19M-16	2	1	10	S-10010PF21	3.52	3.53	0.588	1.14	4.56	1.60	<0.100	<0.100	22.4
LRM	2	1	11	LRMPF212	5.24	2.30	0.546	0.143	0.959	<0.100	<0.100	0.122	25.5
ARG-1	2	1	12	ARG1PF212	2.60	2.51	1.37	<0.100	9.14	1.54	1.38	0.746	22.4
DHW19M-14	2	1	13	S-10008PF11	1.16	3.05	1.83	1.01	2.17	1.39	0.163	0.142	23.8
DHW19M-4	2	1	14	S-09998PF11	3.12	3.03	2.13	0.785	4.64	0.392	0.209	0.180	20.3
DHW19M-2	2	1	15	S-09996PF11	3.70	3.30	1.63	1.43	1.55	0.340	0.200	0.189	22.1
DHW19M-10	2	1	16	S-10004PF11	2.65	5.29	4.10	1.17	2.76	0.433	0.179	0.159	18.6
DHW19M-6	2	1	17	S-10000PF11	3.03	2.86	1.50	0.828	0.691	<0.100	<0.100	<0.100	24.6
DHW19M-8	2	1	18	S-10002PF11	2.31	3.97	1.39	1.46	2.44	0.807	<0.100	<0.100	21.6
DHW19M-16	2	1	19	S-10010PF11	3.52	3.49	0.591	1.14	4.51	1.62	<0.100	<0.100	22.5
DHW19M-8	2	1	20	S-10002PF21	2.33	4.09	1.37	1.50	2.51	0.810	<0.100	<0.100	21.6
LRM	2	1	21	LRMPF213	5.28	2.34	0.552	0.136	0.966	<0.100	<0.100	0.127	24.1
ARG-1	2	1	22	ARG1PF213	2.60	2.54	1.38	<0.100	9.18	1.54	1.39	0.751	21.1
LRM	2	2	1	LRMPF221	5.20	2.27	0.525	0.120	0.953	<0.100	<0.100	0.126	24.9
ARG-1	2	2	2	ARG1PF221	2.53	2.39	1.30	<0.100	8.42	1.50	1.28	0.694	21.8
DHW19M-16	2	2	3	S-10010PF22	3.47	3.36	0.559	1.05	4.2	1.59	<0.100	<0.100	21.3
DHW19M-8	2	2	4	S-10002PF12	2.27	3.85	1.34	1.35	2.27	0.801	<0.100	<0.100	22.4
DHW19M-12	2	2	5	S-10006PF12	2.39	3.34	3.25	1.21	2.13	0.676	<0.100	<0.100	24.9
DHW19M-6	2	2	6	S-10000PF12	3.00	2.87	1.44	0.826	0.683	<0.100	<0.100	<0.100	26.0
DHW19M-12	2	2	7	S-10006PF22	2.36	3.34	3.22	1.20	2.14	0.667	<0.100	<0.100	26.4

**Table A-1. PF Measurements of the Group 1 Glasses (continued)**

Glass ID	Block	Sub-Blk	Sequence	Lab ID	Al (wt%)	B (wt%)	Ca (wt%)	Cr (wt%)	Fe (wt%)	Li (wt%)	Mn (wt%)	Ni (wt%)	Si (wt%)
DHW19M-14	2	2	8	S-10008PF12	1.16	3.06	1.77	0.984	2.17	1.39	0.161	0.146	26.9
DHW19M-2	2	2	9	S-09996PF12	3.69	3.31	1.58	1.42	1.55	0.338	0.198	0.187	24.9
DHW19M-4	2	2	10	S-09998PF12	3.14	3.04	2.09	0.791	4.66	0.397	0.208	0.197	22.5
LRM	2	2	11	LRMPF222	4.98	2.27	0.457	0.124	1.04	<0.100	<0.100	0.146	24.9
ARG-1	2	2	12	ARG1PF222	2.45	2.48	1.18	<0.100	9.89	1.47	1.46	0.830	22.0
DHW19M-10	2	2	13	S-10004PF22	2.60	5.05	3.92	1.06	2.56	0.426	0.165	0.171	18.8
DHW19M-14	2	2	14	S-10008PF22	1.13	2.87	1.71	0.939	1.99	1.37	0.148	0.139	24.5
DHW19M-2	2	2	15	S-09996PF22	3.60	3.08	1.58	1.29	1.41	0.336	0.182	0.171	23.4
DHW19M-16	2	2	16	S-10010PF12	3.41	3.28	0.553	1.04	4.14	1.58	<0.100	<0.100	22.4
DHW19M-6	2	2	17	S-10000PF22	2.99	2.84	1.39	0.804	0.684	<0.100	<0.100	<0.100	24.5
DHW19M-8	2	2	18	S-10002PF22	2.30	4.05	1.31	1.46	2.48	0.798	<0.100	<0.100	22.8
DHW19M-10	2	2	19	S-10004PF12	2.64	5.33	3.97	1.19	2.78	0.430	0.178	0.169	20.0
DHW19M-4	2	2	20	S-09998PF22	3.10	2.99	2.07	0.760	4.62	0.391	0.205	0.193	22.4
LRM	2	2	21	LRMPF223	5.07	2.32	0.472	0.115	1.04	<0.100	<0.100	0.144	25.0
ARG-1	2	2	22	ARG1PF223	2.51	2.56	1.22	<0.100	9.91	1.50	1.47	0.826	21.9

**Table A-2. AD Measurements of the Group 1 Glasses**

ID	Block	Sub-Blk	Sequence	Lab ID	K (wt%)	Na (wt%)	P (wt%)	Pb (wt%)	S (wt%)	Zr (wt%)
LRM	1	1	1	LRMAD111	1.28	14.2	0.230	0.0993	0.0821	0.766
ARG-1	1	1	2	ARG1AD111	2.36	8.06	0.122	<0.0500	0.0629	0.108
DHW19M-5-Q	1	1	3	S-09999AD21	3.52	11.5	0.105	0.160	<0.0500	0.0567
DHW19M-5-Q	1	1	4	S-09999AD11	3.56	11.6	0.109	0.151	<0.0500	0.0568
DHW19M-13-Q	1	1	5	S-10007AD11	1.23	12.9	0.158	0.236	0.113	0.0918
DHW19M-13-Q	1	1	6	S-10007AD21	1.26	13.1	0.167	0.240	0.0700	0.0918
DHW19M-11-Q	1	1	7	S-10005AD11	3.06	10.5	0.165	0.232	<0.0500	0.0867
DHW19M-15-Q	1	1	8	S-10009AD11	<0.0500	11.1	0.0869	0.131	0.128	<0.0500
DHW19M-7-1-Q	1	1	9	S-10001AD21	5.13	10.8	0.0627	0.0901	<0.0500	<0.0500
DHW19M-11-Q	1	1	10	S-10005AD21	3.07	10.5	0.148	0.211	<0.0500	0.0841
LRM	1	1	11	LRMAD112	1.24	14.3	0.217	0.0862	0.106	0.731
ARG-1	1	1	12	ARG1AD112	2.29	8.18	0.112	<0.0500	<0.0500	0.0997
DHW19M-9-Q	1	1	13	S-10003AD21	4.82	13.3	0.159	0.222	<0.0500	0.0886
DHW19M-3-1-Q	1	1	14	S-09997AD11	6.54	11.2	0.158	0.227	0.215	0.0893
DHW19M-9-Q	1	1	15	S-10003AD11	4.80	13.2	0.150	0.211	<0.0500	0.0838
DHW19M-1-2-Q	1	1	16	S-09995AD11	0.521	12.6	0.0515	0.0809	0.158	<0.0500
DHW19M-1-2-Q	1	1	17	S-09995AD21	0.513	12.5	0.0598	0.0782	0.160	<0.0500
DHW19M-7-1-Q	1	1	18	S-10001AD11	5.13	10.7	0.0651	0.0822	0.0788	<0.0500
DHW19M-15-Q	1	1	19	S-10009AD21	<0.0500	11.0	0.100	0.130	0.125	<0.0500
DHW19M-3-1-Q	1	1	20	S-09997AD21	6.41	11.2	0.161	0.221	0.214	0.0875
LRM	1	1	21	LRMAD113	1.26	14.1	0.224	0.0990	0.115	0.748
ARG-1	1	1	22	ARG1AD113	2.33	8.09	0.109	<0.0500	<0.0500	0.104
LRM	1	2	1	LRMAD121	1.27	14.4	0.215	0.0862	0.0840	0.703
ARG-1	1	2	2	ARG1AD121	2.29	8.29	0.106	<0.0500	0.0800	0.100
DHW19M-3-1-Q	1	2	3	S-09997AD12	6.30	11.4	0.157	0.226	0.221	0.0866
DHW19M-13-Q	1	2	4	S-10007AD12	1.21	13.1	0.156	0.221	0.0867	0.0862
DHW19M-1-2-Q	1	2	5	S-09995AD12	0.503	13.0	<0.0500	0.0723	0.160	<0.0500
DHW19M-5-Q	1	2	6	S-09999AD22	3.48	11.7	0.108	0.147	<0.0500	0.0539
DHW19M-7-1-Q	1	2	7	S-10001AD22	5.15	11.3	0.0652	0.0816	<0.0500	<0.0500
DHW19M-3-1-Q	1	2	8	S-09997AD22	6.35	11.5	0.144	0.212	0.191	0.0859
DHW19M-13-Q	1	2	9	S-10007AD22	1.22	13.4	0.162	0.240	0.0682	0.0925
DHW19M-15-Q	1	2	10	S-10009AD22	<0.0500	11.2	0.0700	0.111	0.106	<0.0500
LRM	1	2	11	LRMAD122	1.26	14.7	0.207	0.0754	0.0909	0.684
ARG-1	1	2	12	ARG1AD122	2.32	8.42	0.118	<0.0500	0.0914	0.0967
DHW19M-5-Q	1	2	13	S-09999AD12	3.57	11.8	0.100	0.150	0.0665	0.0575
DHW19M-9-Q	1	2	14	S-10003AD12	4.73	13.6	0.159	0.207	<0.0500	0.0851
DHW19M-7-1-Q	1	2	15	S-10001AD12	5.00	11.0	0.0625	0.0883	<0.0500	<0.0500
DHW19M-11-Q	1	2	16	S-10005AD22	3.05	10.8	0.136	0.201	<0.0500	0.0802
DHW19M-9-Q	1	2	17	S-10003AD22	4.72	13.7	0.142	0.195	<0.0500	0.0819
DHW19M-11-Q	1	2	18	S-10005AD12	3.03	10.9	0.136	0.197	0.0859	0.0794
DHW19M-1-2-Q	1	2	19	S-09995AD22	0.517	12.8	<0.0500	0.0632	0.126	<0.0500
DHW19M-15-Q	1	2	20	S-10009AD12	<0.0500	11.3	0.0940	0.121	0.117	<0.0500
LRM	1	2	21	LRMAD123	1.24	14.7	0.217	0.0785	0.103	0.699
ARG-1	1	2	22	ARG1AD123	2.30	8.42	0.117	<0.0500	<0.0500	0.0991
LRM	2	1	1	LRMAD211	1.17	14.6	0.263	0.0961	0.123	0.757
ARG-1	2	1	2	ARG1AD211	2.15	8.44	0.137	<0.0500	0.0869	0.112
DHW19M-8-Q	2	1	3	S-10002AD21	2.86	14.2	0.0799	0.105	0.114	<0.0500
DHW19M-14-Q	2	1	4	S-10008AD21	0.112	13.8	0.129	0.176	0.0574	0.0745
DHW19M-8-Q	2	1	5	S-10002AD11	2.86	14.2	0.0750	0.105	0.118	<0.0500
DHW19M-6-1-Q	2	1	6	S-10000AD11	5.63	12.6	0.0610	0.0877	0.128	<0.0500
DHW19M-4-Q	2	1	7	S-09998AD21	3.52	13.8	0.157	0.221	0.141	0.0966
DHW19M-12-Q	2	1	8	S-10006AD21	1.45	10.7	0.0594	0.0916	0.106	<0.0500



**Table A-2. AD Measurements of the Group 1 Glasses (continued)**

ID	Block	Sub-Blk	Sequence	Lab ID	K (wt%)	Na (wt%)	P (wt%)	Pb (wt%)	S (wt%)	Zr (wt%)
DHW19M-10-Q	2	1	9	S-10004AD11	1.83	13.8	0.144	0.199	0.138	0.0835
DHW19M-14-Q	2	1	10	S-10008AD11	0.112	13.8	0.122	0.180	0.0797	0.0750
LRM	2	1	11	LRMAD212	1.15	14.8	0.261	0.0942	0.132	0.757
ARG-1	2	1	12	ARG1AD212	2.17	8.39	0.136	<0.0500	0.0907	0.113
DHW19M-16-Q	2	1	13	S-10010AD21	1.84	12.2	0.0752	0.109	0.0561	<0.0500
DHW19M-16-Q	2	1	14	S-10010AD11	1.84	12.4	0.0754	0.102	0.103	<0.0500
DHW19M-2-3-Q	2	1	15	S-09996AD11	0.524	14.3	0.159	0.223	0.204	0.101
DHW19M-10-Q	2	1	16	S-10004AD21	1.80	14.0	0.147	0.197	0.142	0.0837
DHW19M-2-3-Q	2	1	17	S-09996AD21	0.525	14.4	0.148	0.218	0.207	0.100
DHW19M-4-Q	2	1	18	S-09998AD11	3.50	14.0	0.163	0.224	0.136	0.0946
DHW19M-12-Q	2	1	19	S-10006AD11	1.44	10.9	0.0574	0.0849	0.0797	0.0395
DHW19M-6-1-Q	2	1	20	S-10000AD21	5.47	12.6	0.0627	0.0907	0.143	0.0380
LRM	2	1	21	LRMAD213	1.16	14.7	0.262	0.0983	0.133	0.754
ARG-1	2	1	22	ARG1AD213	2.10	8.42	0.137	<0.0500	0.0665	0.112
LRM	2	2	1	LRMAD221	1.21	14.8	0.232	0.105	0.102	0.699
ARG-1	2	2	2	ARG1AD221	2.21	8.49	0.112	<0.0500	<0.0500	0.0997
DHW19M-12-Q	2	2	3	S-10006AD22	1.51	11.0	0.0675	0.101	0.120	<0.0500
DHW19M-6-1-Q	2	2	4	S-10000AD12	5.69	12.7	0.0609	0.097	0.126	<0.0500
DHW19M-14-Q	2	2	5	S-10008AD22	0.119	13.9	0.130	0.182	0.112	0.0667
DHW19M-16-Q	2	2	6	S-10010AD22	1.96	12.5	0.0757	0.115	0.0667	<0.0500
DHW19M-16-Q	2	2	7	S-10010AD12	1.92	12.4	0.0798	0.119	0.0912	<0.0500
DHW19M-2-3-Q	2	2	8	S-09996AD22	0.551	14.3	0.182	0.231	0.231	0.0971
DHW19M-4-Q	2	2	9	S-09998AD12	3.62	14.0	0.158	0.238	0.145	0.0909
DHW19M-14-Q	2	2	10	S-10008AD12	0.117	13.9	0.126	0.184	0.109	0.0670
LRM	2	2	11	LRMAD222	1.21	14.8	0.209	0.0981	0.114	0.683
ARG-1	2	2	12	ARG1AD222	2.21	8.45	0.106	<0.0500	<0.0500	0.0959
DHW19M-6-1-Q	2	2	13	S-10000AD22	5.82	12.7	0.0604	0.100	0.138	<0.0500
DHW19M-8-Q	2	2	14	S-10002AD12	2.91	14.5	0.0794	0.121	0.136	<0.0500
DHW19M-12-Q	2	2	15	S-10006AD12	1.49	11.0	0.0621	0.101	0.0920	<0.0500
DHW19M-10-Q	2	2	16	S-10004AD12	1.83	14.2	0.140	0.203	0.132	0.0750
DHW19M-2-3-Q	2	2	17	S-09996AD12	0.547	14.6	0.161	0.221	0.210	0.0920
DHW19M-8-Q	2	2	18	S-10002AD22	2.91	14.4	0.0771	0.118	0.137	<0.0500
DHW19M-4-Q	2	2	19	S-09998AD22	3.60	14.0	0.166	0.235	0.139	0.0899
DHW19M-10-Q	2	2	20	S-10004AD22	1.88	14.1	0.152	0.208	0.133	0.0778
LRM	2	2	21	LRMAD223	1.18	14.8	0.206	0.0945	0.0895	0.679
ARG-1	2	2	22	ARG1AD223	2.19	8.51	0.110	<0.0500	<0.0500	0.0961

**Table A-3. KH Measurements of the Group 1 Glasses**

Glass ID	Block	Sub-Blk	Sequence	Lab ID	Cl (wt%)	F (wt%)
LRM	1	1	1	LRMKH111	<0.0500	0.896
ARG-1	1	1	2	ARG1KH111	<0.0500	<0.0500
DHW19M-3	1	1	3	S-09997KH21	0.0672	0.0712
DHW19M-1	1	1	4	S-09995KH21	<0.0500	<0.0500
DHW19M-13	1	1	5	S-10007KH11	<0.0500	0.0825
DHW19M-11	1	1	6	S-10005KH21	0.0593	0.0712
DHW19M-9	1	1	7	S-10003KH21	0.0537	0.0751
DHW19M-9	1	1	8	S-10003KH11	0.0552	0.0746
DHW19M-11	1	1	9	S-10005KH11	0.0568	0.0710
DHW19M-13	1	1	10	S-10007KH21	<0.0500	0.0825
LRM	1	1	11	LRMKH112	<0.0500	0.888
ARG-1	1	1	12	ARG1KH112	<0.0500	<0.0500
DHW19M-7	1	1	13	S-10001KH21	<0.0500	<0.0500
DHW19M-7	1	1	14	S-10001KH11	<0.0500	<0.0500
DHW19M-15	1	1	15	S-10009KH11	<0.0500	<0.0500
DHW19M-1	1	1	16	S-09995KH11	<0.0500	<0.0500
DHW19M-5	1	1	17	S-09999KH21	<0.0500	0.0515
DHW19M-15	1	1	18	S-10009KH21	0.0574	<0.0500
DHW19M-3	1	1	19	S-09997KH11	<0.0500	<0.0500
DHW19M-5	1	1	20	S-09999KH11	<0.0500	<0.0500
LRM	1	1	21	LRMKH113	<0.0500	0.891
ARG-1	1	1	22	ARG1KH113	<0.0500	<0.0500
LRM	1	2	1	LRMKH121	<0.0500	0.901
ARG-1	1	2	2	ARG1KH121	<0.0500	<0.0500
DHW19M-5	1	2	3	S-09999KH22	<0.0500	0.0519
DHW19M-15	1	2	4	S-10009KH12	<0.0500	<0.0500
DHW19M-3	1	2	5	S-09997KH22	0.0665	0.0714
DHW19M-5	1	2	6	S-09999KH12	<0.0500	0.0522
DHW19M-3	1	2	7	S-09997KH12	0.0744	0.0733
DHW19M-7	1	2	8	S-10001KH12	<0.0500	<0.0500
DHW19M-9	1	2	9	S-10003KH12	0.0551	0.0753
DHW19M-7	1	2	10	S-10001KH22	<0.0500	<0.0500
LRM	1	2	11	LRMKH122	<0.0500	0.896
ARG-1	1	2	12	ARG1KH122	<0.0500	<0.0500
DHW19M-1	1	2	13	S-09995KH12	<0.0500	<0.0500
DHW19M-15	1	2	14	S-10009KH22	0.0572	<0.0500
DHW19M-13	1	2	15	S-10007KH22	<0.0500	0.0829
DHW19M-11	1	2	16	S-10005KH12	0.0569	0.0713
DHW19M-11	1	2	17	S-10005KH22	0.0592	0.0712
DHW19M-9	1	2	18	S-10003KH22	0.0535	0.0753
DHW19M-1	1	2	19	S-09995KH22	<0.0500	<0.0500
DHW19M-13	1	2	20	S-10007KH12	<0.0500	0.0832
LRM	1	2	21	LRMKH123	<0.0500	0.895
ARG-1	1	2	22	ARG1KH123	<0.0500	<0.0500
LRM	2	1	1	LRMKH211	<0.0500	0.869
ARG-1	2	1	2	ARG1KH211	<0.0500	<0.0500
DHW19M-6	2	1	3	S-10000KH11	<0.0500	<0.0500
DHW19M-6	2	1	4	S-10000KH21	<0.0500	<0.0500

**Table A-3. KH Measurements of the Group 1 Glasses (continued)**

Glass ID	Block	Sub-Blk	Sequence	Lab ID	Cl (wt%)	F (wt%)
DHW19M-16	2	1	5	S-10010KH11	<0.0500	<0.0500
DHW19M-2	2	1	6	S-09996KH21	0.0807	0.0894
DHW19M-2	2	1	7	S-09996KH11	0.0815	0.0912
DHW19M-10	2	1	8	S-10004KH21	0.0541	0.0713
DHW19M-8	2	1	9	S-10002KH21	<0.0500	<0.0500
DHW19M-12	2	1	10	S-10006KH21	<0.0500	<0.0500
LRM	2	1	11	LRMKH212	<0.0500	0.877
ARG-1	2	1	12	ARG1KH212	<0.0500	<0.0500
DHW19M-14	2	1	13	S-10008KH11	0.0555	0.0649
DHW19M-4	2	1	14	S-09998KH11	0.0552	0.0894
DHW19M-8	2	1	15	S-10002KH11	<0.0500	<0.0500
DHW19M-16	2	1	16	S-10010KH21	<0.0500	<0.0500
DHW19M-10	2	1	17	S-10004KH11	0.0549	0.0716
DHW19M-14	2	1	18	S-10008KH21	0.0545	0.0643
DHW19M-12	2	1	19	S-10006KH11	<0.0500	<0.0500
DHW19M-4	2	1	20	S-09998KH21	0.0546	0.0889
LRM	2	1	21	LRMKH213	<0.0500	0.880
ARG-1	2	1	22	ARG1KH213	<0.0500	<0.0500
LRM	2	2	1	LRMKH221	<0.0500	0.888
ARG-1	2	2	2	ARG1KH221	<0.0500	<0.0500
DHW19M-12	2	2	3	S-10006KH12	<0.0500	<0.0500
DHW19M-8	2	2	4	S-10002KH22	<0.0500	<0.0500
DHW19M-2	2	2	5	S-09996KH22	0.0828	0.0914
DHW19M-12	2	2	6	S-10006KH22	<0.0500	<0.0500
DHW19M-8	2	2	7	S-10002KH12	<0.0500	<0.0500
DHW19M-6	2	2	8	S-10000KH22	<0.0500	<0.0500
DHW19M-2	2	2	9	S-09996KH12	0.0838	0.0943
DHW19M-16	2	2	10	S-10010KH22	<0.0500	<0.0500
LRM	2	2	11	LRMKH222	<0.0500	0.892
ARG-1	2	2	12	ARG1KH222	<0.0500	<0.0500
DHW19M-10	2	2	13	S-10004KH22	0.0552	0.0734
DHW19M-14	2	2	14	S-10008KH12	0.0560	0.0666
DHW19M-6	2	2	15	S-10000KH12	<0.0500	<0.0500
DHW19M-16	2	2	16	S-10010KH12	<0.0500	<0.0500
DHW19M-4	2	2	17	S-09998KH12	0.0559	0.0918
DHW19M-4	2	2	18	S-09998KH22	0.0553	0.0910
DHW19M-10	2	2	19	S-10004KH12	0.0559	0.0732
DHW19M-14	2	2	20	S-10008KH22	0.0548	0.0658
LRM	2	2	21	LRMKH223	<0.0500	0.893
ARG-1	2	2	22	ARG1KH223	<0.0500	<0.0500

**Table A-4. Comparison of Measured and Targeted Compositions of the Group 1 Glasses**

Glass ID	Oxide	BDL ( $<$ )	Measured (wt %)	Targeted (wt %)	Difference of Measured versus Targeted	% Difference of Measured versus Targeted
DHW19M-1-2-Q	Al <sub>2</sub> O <sub>3</sub>		5.768	5.600	0.168	3.0%
DHW19M-1-2-Q	B <sub>2</sub> O <sub>3</sub>		11.954	12.530	-0.576	-4.6%
DHW19M-1-2-Q	CaO		4.317	3.610	0.707	
DHW19M-1-2-Q	Cl	$<$	0.050	0.040	0.010	
DHW19M-1-2-Q	Cr <sub>2</sub> O <sub>3</sub>		2.287	2.460	-0.173	
DHW19M-1-2-Q	F	$<$	0.050	0.040	0.010	
DHW19M-1-2-Q	Fe <sub>2</sub> O <sub>3</sub>		5.165	5.640	-0.475	-8.4%
DHW19M-1-2-Q	K <sub>2</sub> O		0.619	0.620	-0.001	
DHW19M-1-2-Q	Li <sub>2</sub> O		3.504	3.470	0.034	
DHW19M-1-2-Q	MnO	$<$	0.129	0.090	0.039	
DHW19M-1-2-Q	Na <sub>2</sub> O		17.153	19.370	-2.217	-11.4%
DHW19M-1-2-Q	NiO	$<$	0.197	0.090	0.107	
DHW19M-1-2-Q	P <sub>2</sub> O <sub>5</sub>	$<$	0.121	0.130	-0.009	
DHW19M-1-2-Q	PbO		0.079	0.090	-0.011	
DHW19M-1-2-Q	SiO <sub>2</sub>		45.193	45.640	-0.447	-1.0%
DHW19M-1-2-Q	SO <sub>3</sub>		0.377	0.570	-0.193	
DHW19M-1-2-Q	ZrO <sub>2</sub>	$<$	0.068	0.040	0.028	
DHW19M-1-2-Q	sum		97.030	100.030	-3.000	-3.0%
DHW19M-2-3-Q	Al <sub>2</sub> O <sub>3</sub>		6.925	6.700	0.225	3.4%
DHW19M-2-3-Q	B <sub>2</sub> O <sub>3</sub>		10.408	10.940	-0.532	-4.9%
DHW19M-2-3-Q	CaO		2.260	1.790	0.470	
DHW19M-2-3-Q	Cl		0.082	0.130	-0.048	
DHW19M-2-3-Q	Cr <sub>2</sub> O <sub>3</sub>		2.032	2.170	-0.138	
DHW19M-2-3-Q	F		0.092	0.130	-0.038	
DHW19M-2-3-Q	Fe <sub>2</sub> O <sub>3</sub>		2.162	2.300	-0.138	
DHW19M-2-3-Q	K <sub>2</sub> O		0.647	0.670	-0.023	
DHW19M-2-3-Q	Li <sub>2</sub> O		0.728	0.750	-0.022	
DHW19M-2-3-Q	MnO		0.251	0.260	-0.009	
DHW19M-2-3-Q	Na <sub>2</sub> O		19.411	21.470	-2.059	-9.6%
DHW19M-2-3-Q	NiO		0.231	0.260	-0.029	
DHW19M-2-3-Q	P <sub>2</sub> O <sub>5</sub>		0.372	0.390	-0.018	
DHW19M-2-3-Q	PbO		0.240	0.260	-0.020	
DHW19M-2-3-Q	SiO <sub>2</sub>		50.167	50.870	-0.703	-1.4%
DHW19M-2-3-Q	SO <sub>3</sub>		0.532	0.740	-0.208	
DHW19M-2-3-Q	ZrO <sub>2</sub>		0.132	0.130	0.002	
DHW19M-2-3-Q	sum		96.672	99.960	-3.288	-3.3%
DHW19M-3-1-Q	Al <sub>2</sub> O <sub>3</sub>		4.294	3.800	0.494	
DHW19M-3-1-Q	B <sub>2</sub> O <sub>3</sub>		9.515	10.380	-0.865	-8.3%
DHW19M-3-1-Q	CaO		0.362	0.180	0.182	
DHW19M-3-1-Q	Cl	$<$	0.065	0.120	-0.055	
DHW19M-3-1-Q	Cr <sub>2</sub> O <sub>3</sub>		1.232	1.320	-0.088	
DHW19M-3-1-Q	F	$<$	0.066	0.120	-0.054	
DHW19M-3-1-Q	Fe <sub>2</sub> O <sub>3</sub>		4.114	4.520	-0.406	
DHW19M-3-1-Q	K <sub>2</sub> O		7.709	8.640	-0.931	-10.8%
DHW19M-3-1-Q	Li <sub>2</sub> O		0.482	0.520	-0.038	
DHW19M-3-1-Q	MnO		0.232	0.240	-0.008	
DHW19M-3-1-Q	Na <sub>2</sub> O		15.266	17.020	-1.754	-10.3%
DHW19M-3-1-Q	NiO		0.211	0.240	-0.029	
DHW19M-3-1-Q	P <sub>2</sub> O <sub>5</sub>		0.355	0.360	-0.005	
DHW19M-3-1-Q	PbO		0.239	0.240	-0.001	
DHW19M-3-1-Q	SiO <sub>2</sub>		50.381	51.410	-1.029	-2.0%
DHW19M-3-1-Q	SO <sub>3</sub>		0.525	0.800	-0.275	
DHW19M-3-1-Q	ZrO <sub>2</sub>		0.118	0.120	-0.002	
DHW19M-3-1-Q	sum		95.165	100.030	-4.865	-4.9%
DHW19M-4-Q	Al <sub>2</sub> O <sub>3</sub>		5.891	5.600	0.291	5.2%
DHW19M-4-Q	B <sub>2</sub> O <sub>3</sub>		9.684	10.270	-0.586	-5.7%
DHW19M-4-Q	CaO		2.942	2.400	0.542	
DHW19M-4-Q	Cl		0.055	0.130	-0.075	

**Table A-4. Comparison of Measured and Targeted Compositions of the Group 1 Glasses  
(continued)**

Glass ID	Oxide	BDL (<)	Measured (wt %)	Targeted (wt %)	Difference of Measured versus Targeted	% Difference of Measured versus Targeted
DHW19M-4-Q	Cr <sub>2</sub> O <sub>3</sub>		1.141	1.150	-0.009	
DHW19M-4-Q	F		0.090	0.130	-0.040	
DHW19M-4-Q	Fe <sub>2</sub> O <sub>3</sub>		6.609	6.880	-0.271	-3.9%
DHW19M-4-Q	K <sub>2</sub> O		4.288	4.890	-0.602	
DHW19M-4-Q	Li <sub>2</sub> O		0.846	0.850	-0.004	
DHW19M-4-Q	MnO		0.267	0.260	0.007	
DHW19M-4-Q	Na <sub>2</sub> O		18.805	20.600	-1.795	-8.7%
DHW19M-4-Q	NiO		0.241	0.260	-0.019	
DHW19M-4-Q	P <sub>2</sub> O <sub>5</sub>		0.369	0.400	-0.031	
DHW19M-4-Q	PbO		0.247	0.260	-0.013	
DHW19M-4-Q	SiO <sub>2</sub>		45.995	45.250	0.745	1.6%
DHW19M-4-Q	SO <sub>3</sub>		0.350	0.560	-0.210	
DHW19M-4-Q	ZrO <sub>2</sub>		0.126	0.130	-0.004	
DHW19M-4-Q	sum		97.945	100.020	-2.075	-2.1%
DHW19M-5-Q	Al <sub>2</sub> O <sub>3</sub>		6.264	5.900	0.364	6.2%
DHW19M-5-Q	B <sub>2</sub> O <sub>3</sub>		16.317	17.600	-1.283	-7.3%
DHW19M-5-Q	CaO		2.606	2.010	0.596	
DHW19M-5-Q	Cl	<	0.050	0.080	-0.030	
DHW19M-5-Q	Cr <sub>2</sub> O <sub>3</sub>		1.375	1.480	-0.105	
DHW19M-5-Q	F	<	0.051	0.080	-0.029	
DHW19M-5-Q	Fe <sub>2</sub> O <sub>3</sub>		4.736	4.940	-0.204	
DHW19M-5-Q	K <sub>2</sub> O		4.255	4.770	-0.515	
DHW19M-5-Q	Li <sub>2</sub> O		2.788	2.740	0.048	
DHW19M-5-Q	MnO		0.174	0.170	0.004	
DHW19M-5-Q	Na <sub>2</sub> O		15.704	17.340	-1.636	-9.4%
DHW19M-5-Q	NiO		0.214	0.170	0.044	
DHW19M-5-Q	P <sub>2</sub> O <sub>5</sub>		0.242	0.250	-0.008	
DHW19M-5-Q	PbO		0.164	0.170	-0.006	
DHW19M-5-Q	SiO <sub>2</sub>		42.144	41.500	0.644	1.6%
DHW19M-5-Q	SO <sub>3</sub>	<	0.135	0.680	-0.545	
DHW19M-5-Q	ZrO <sub>2</sub>		0.076	0.080	-0.004	
DHW19M-5-Q	sum		97.296	99.960	-2.664	-2.7%
DHW19M-6-1-Q	Al <sub>2</sub> O <sub>3</sub>		5.687	5.500	0.187	3.4%
DHW19M-6-1-Q	B <sub>2</sub> O <sub>3</sub>		9.185	10.000	-0.815	-8.2%
DHW19M-6-1-Q	CaO		2.018	1.560	0.458	
DHW19M-6-1-Q	Cl	<	0.050	0.050	0.000	
DHW19M-6-1-Q	Cr <sub>2</sub> O <sub>3</sub>		1.200	1.230	-0.030	
DHW19M-6-1-Q	F	<	0.050	0.050	0.000	
DHW19M-6-1-Q	Fe <sub>2</sub> O <sub>3</sub>		0.978	1.010	-0.032	
DHW19M-6-1-Q	K <sub>2</sub> O		6.809	7.970	-1.161	-14.6%
DHW19M-6-1-Q	Li <sub>2</sub> O	<	0.215	0.060	0.155	
DHW19M-6-1-Q	MnO	<	0.129	0.100	0.029	
DHW19M-6-1-Q	Na <sub>2</sub> O		17.052	18.600	-1.548	-8.3%
DHW19M-6-1-Q	NiO	<	0.127	0.100	0.027	
DHW19M-6-1-Q	P <sub>2</sub> O <sub>5</sub>		0.140	0.150	-0.010	
DHW19M-6-1-Q	PbO		0.101	0.100	0.001	
DHW19M-6-1-Q	SiO <sub>2</sub>		53.162	53.120	0.042	0.1%
DHW19M-6-1-Q	SO <sub>3</sub>		0.334	0.390	-0.056	
DHW19M-6-1-Q	ZrO <sub>2</sub>	<	0.063	0.050	0.013	
DHW19M-6-1-Q	sum		97.302	100.040	-2.738	-2.7%
DHW19M-7-1-Q	Al <sub>2</sub> O <sub>3</sub>		6.127	5.800	0.327	5.6%
DHW19M-7-1-Q	B <sub>2</sub> O <sub>3</sub>		13.210	14.260	-1.050	-7.4%
DHW19M-7-1-Q	CaO		0.432	0.180	0.252	
DHW19M-7-1-Q	Cl	<	0.050	0.050	0.000	
DHW19M-7-1-Q	Cr <sub>2</sub> O <sub>3</sub>		0.975	1.030	-0.055	
DHW19M-7-1-Q	F	<	0.050	0.050	0.000	

**Table A-4. Comparison of Measured and Targeted Compositions of the Group 1 Glasses  
(continued)**

Glass ID	Oxide	BDL ( $<$ )	Measured (wt %)	Targeted (wt %)	Difference of Measured versus Targeted	% Difference of Measured versus Targeted
DHW19M-7-1-Q	Fe <sub>2</sub> O <sub>3</sub>		5.719	6.160	-0.441	-7.2%
DHW19M-7-1-Q	K <sub>2</sub> O		6.146	6.920	-0.774	-11.2%
DHW19M-7-1-Q	Li <sub>2</sub> O		4.004	3.930	0.074	
DHW19M-7-1-Q	MnO	$<$	0.129	0.100	0.029	
DHW19M-7-1-Q	Na <sub>2</sub> O		14.761	16.340	-1.579	-9.7%
DHW19M-7-1-Q	NiO	$<$	0.130	0.100	0.030	
DHW19M-7-1-Q	P <sub>2</sub> O <sub>5</sub>		0.146	0.150	-0.004	
DHW19M-7-1-Q	PbO		0.092	0.100	-0.008	
DHW19M-7-1-Q	SiO <sub>2</sub>		44.925	44.610	0.315	0.7%
DHW19M-7-1-Q	SO <sub>3</sub>	$<$	0.143	0.130	0.013	
DHW19M-7-1-Q	ZrO <sub>2</sub>	$<$	0.068	0.050	0.018	
DHW19M-7-1-Q	sum		97.106	99.960	-2.854	-2.9%
DHW19M-8-Q	Al <sub>2</sub> O <sub>3</sub>		4.351	4.200	0.151	
DHW19M-8-Q	B <sub>2</sub> O <sub>3</sub>		12.847	13.750	-0.903	-6.6%
DHW19M-8-Q	CaO		1.892	1.450	0.442	
DHW19M-8-Q	Cl	$<$	0.050	0.060	-0.010	
DHW19M-8-Q	Cr <sub>2</sub> O <sub>3</sub>		2.108	2.240	-0.132	
DHW19M-8-Q	F	$<$	0.050	0.060	-0.010	
DHW19M-8-Q	Fe <sub>2</sub> O <sub>3</sub>		3.467	3.710	-0.243	
DHW19M-8-Q	K <sub>2</sub> O		3.475	3.920	-0.445	
DHW19M-8-Q	Li <sub>2</sub> O		1.731	1.690	0.041	
DHW19M-8-Q	MnO	$<$	0.129	0.120	0.009	
DHW19M-8-Q	Na <sub>2</sub> O		19.310	21.190	-1.880	-8.9%
DHW19M-8-Q	NiO	$<$	0.127	0.120	0.007	
DHW19M-8-Q	P <sub>2</sub> O <sub>5</sub>		0.178	0.180	-0.002	
DHW19M-8-Q	PbO		0.121	0.120	0.001	
DHW19M-8-Q	SiO <sub>2</sub>		47.279	46.480	0.799	1.7%
DHW19M-8-Q	SO <sub>3</sub>		0.315	0.700	-0.385	
DHW19M-8-Q	ZrO <sub>2</sub>	$<$	0.068	0.060	0.008	
DHW19M-8-Q	sum		97.499	100.050	-2.551	-2.5%
DHW19M-9-Q	Al <sub>2</sub> O <sub>3</sub>		7.204	6.800	0.404	5.9%
DHW19M-9-Q	B <sub>2</sub> O <sub>3</sub>		15.802	17.040	-1.238	-7.3%
DHW19M-9-Q	CaO		0.615	0.260	0.355	
DHW19M-9-Q	Cl		0.054	0.120	-0.066	
DHW19M-9-Q	Cr <sub>2</sub> O <sub>3</sub>		2.214	2.430	-0.216	
DHW19M-9-Q	F		0.075	0.120	-0.045	
DHW19M-9-Q	Fe <sub>2</sub> O <sub>3</sub>		4.857	5.400	-0.543	-10.0%
DHW19M-9-Q	K <sub>2</sub> O		5.743	6.540	-0.797	-12.2%
DHW19M-9-Q	Li <sub>2</sub> O		0.398	0.420	-0.022	
DHW19M-9-Q	MnO		0.244	0.240	0.004	
DHW19M-9-Q	Na <sub>2</sub> O		18.131	20.600	-2.469	-12.0%
DHW19M-9-Q	NiO		0.219	0.240	-0.021	
DHW19M-9-Q	P <sub>2</sub> O <sub>5</sub>		0.349	0.360	-0.011	
DHW19M-9-Q	PbO		0.225	0.240	-0.015	
DHW19M-9-Q	SiO <sub>2</sub>		38.668	38.940	-0.272	-0.7%
DHW19M-9-Q	SO <sub>3</sub>	$<$	0.125	0.130	-0.005	
DHW19M-9-Q	ZrO <sub>2</sub>		0.115	0.120	-0.005	
DHW19M-9-Q	sum		95.037	100.000	-4.963	-5.0%
DHW19M-10-Q	Al <sub>2</sub> O <sub>3</sub>		4.984	4.800	0.184	
DHW19M-10-Q	B <sub>2</sub> O <sub>3</sub>		16.888	17.680	-0.792	-4.5%
DHW19M-10-Q	CaO		5.639	4.880	0.759	
DHW19M-10-Q	Cl		0.055	0.110	-0.055	
DHW19M-10-Q	Cr <sub>2</sub> O <sub>3</sub>		1.681	1.790	-0.109	
DHW19M-10-Q	F		0.072	0.110	-0.038	
DHW19M-10-Q	Fe <sub>2</sub> O <sub>3</sub>		3.885	4.170	-0.285	
DHW19M-10-Q	K <sub>2</sub> O		2.210	2.460	-0.250	

**Table A-4. Comparison of Measured and Targeted Compositions of the Group 1 Glasses  
(continued)**

Glass ID	Oxide	BDL (<)	Measured (wt %)	Targeted (wt %)	Difference of Measured versus Targeted	% Difference of Measured versus Targeted
DHW19M-10-Q	Li <sub>2</sub> O		0.928	0.940	-0.012	
DHW19M-10-Q	MnO		0.226	0.230	-0.004	
DHW19M-10-Q	Na <sub>2</sub> O		18.906	20.970	-2.064	-9.8%
DHW19M-10-Q	NiO		0.217	0.230	-0.013	
DHW19M-10-Q	P <sub>2</sub> O <sub>5</sub>		0.334	0.340	-0.006	
DHW19M-10-Q	PbO		0.217	0.230	-0.013	
DHW19M-10-Q	SiO <sub>2</sub>		40.754	40.230	0.524	1.3%
DHW19M-10-Q	SO <sub>3</sub>		0.340	0.730	-0.390	
DHW19M-10-Q	ZrO <sub>2</sub>		0.108	0.110	-0.002	
DHW19M-10-Q	sum		97.444	100.010	-2.566	-2.6%
DHW19M-11-Q	Al <sub>2</sub> O <sub>3</sub>		5.149	4.900	0.249	
DHW19M-11-Q	B <sub>2</sub> O <sub>3</sub>		18.675	19.890	-1.215	-6.1%
DHW19M-11-Q	CaO		0.963	0.570	0.393	
DHW19M-11-Q	Cl		0.058	0.120	-0.062	
DHW19M-11-Q	Cr <sub>2</sub> O <sub>3</sub>		1.334	1.450	-0.116	
DHW19M-11-Q	F		0.071	0.120	-0.049	
DHW19M-11-Q	Fe <sub>2</sub> O <sub>3</sub>		1.537	1.590	-0.053	
DHW19M-11-Q	K <sub>2</sub> O		3.677	4.050	-0.373	
DHW19M-11-Q	Li <sub>2</sub> O		3.671	3.570	0.101	
DHW19M-11-Q	MnO		0.230	0.240	-0.010	
DHW19M-11-Q	Na <sub>2</sub> O		14.390	16.090	-1.700	-10.6%
DHW19M-11-Q	NiO		0.224	0.240	-0.016	
DHW19M-11-Q	P <sub>2</sub> O <sub>5</sub>		0.335	0.360	-0.025	
DHW19M-11-Q	PbO		0.226	0.240	-0.014	
DHW19M-11-Q	SiO <sub>2</sub>		45.193	46.250	-1.057	-2.3%
DHW19M-11-Q	SO <sub>3</sub>	<	0.147	0.240	-0.093	
DHW19M-11-Q	ZrO <sub>2</sub>		0.112	0.120	-0.008	
DHW19M-11-Q	sum		95.993	100.040	-4.047	-4.0%
DHW19M-12-Q	Al <sub>2</sub> O <sub>3</sub>		4.492	4.300	0.192	
DHW19M-12-Q	B <sub>2</sub> O <sub>3</sub>		10.779	11.310	-0.531	-4.7%
DHW19M-12-Q	CaO		4.593	3.970	0.623	
DHW19M-12-Q	Cl	<	0.050	0.050	0.000	
DHW19M-12-Q	Cr <sub>2</sub> O <sub>3</sub>		1.769	1.870	-0.101	
DHW19M-12-Q	F	<	0.050	0.050	0.000	
DHW19M-12-Q	Fe <sub>2</sub> O <sub>3</sub>		3.063	3.230	-0.167	
DHW19M-12-Q	K <sub>2</sub> O		1.774	1.940	-0.166	
DHW19M-12-Q	Li <sub>2</sub> O		1.446	1.450	-0.004	
DHW19M-12-Q	MnO	<	0.129	0.100	0.029	
DHW19M-12-Q	Na <sub>2</sub> O		14.693	16.010	-1.317	-8.2%
DHW19M-12-Q	NiO	<	0.127	0.100	0.027	
DHW19M-12-Q	P <sub>2</sub> O <sub>5</sub>		0.141	0.150	-0.009	
DHW19M-12-Q	PbO		0.102	0.100	0.002	
DHW19M-12-Q	SiO <sub>2</sub>		53.536	55.100	-1.564	-2.8%
DHW19M-12-Q	SO <sub>3</sub>		0.248	0.220	0.028	
DHW19M-12-Q	ZrO <sub>2</sub>	<	0.064	0.050	0.014	
DHW19M-12-Q	sum		97.056	100.000	-2.944	-2.9%
DHW19M-13-Q	Al <sub>2</sub> O <sub>3</sub>		6.609	6.300	0.309	4.9%
DHW19M-13-Q	B <sub>2</sub> O <sub>3</sub>		14.659	15.720	-1.061	-6.8%
DHW19M-13-Q	CaO		5.597	4.670	0.927	
DHW19M-13-Q	Cl	<	0.050	0.130	-0.080	
DHW19M-13-Q	Cr <sub>2</sub> O <sub>3</sub>		0.933	1.020	-0.087	
DHW19M-13-Q	F		0.083	0.130	-0.047	
DHW19M-13-Q	Fe <sub>2</sub> O <sub>3</sub>		2.520	2.590	-0.070	
DHW19M-13-Q	K <sub>2</sub> O		1.482	1.630	-0.148	
DHW19M-13-Q	Li <sub>2</sub> O		2.874	2.830	0.044	
DHW19M-13-Q	MnO		0.262	0.270	-0.008	

**Table A-4. Comparison of Measured and Targeted Compositions of the Group 1 Glasses  
(continued)**

Glass ID	Oxide	BDL ( $<$ )	Measured (wt %)	Targeted (wt %)	Difference of Measured versus Targeted	% Difference of Measured versus Targeted
DHW19M-13-Q	Na <sub>2</sub> O		17.693	20.070	-2.378	-11.8%
DHW19M-13-Q	NiO		0.275	0.270	0.005	
DHW19M-13-Q	P <sub>2</sub> O <sub>5</sub>		0.368	0.400	-0.032	
DHW19M-13-Q	PbO		0.252	0.270	-0.018	
DHW19M-13-Q	SiO <sub>2</sub>		43.321	43.150	0.171	0.4%
DHW19M-13-Q	SO <sub>3</sub>		0.211	0.450	-0.239	
DHW19M-13-Q	ZrO <sub>2</sub>		0.122	0.130	-0.008	
DHW19M-13-Q	sum		97.309	100.030	-2.721	-2.7%
DHW19M-14-Q	Al <sub>2</sub> O <sub>3</sub>		2.178	2.000	0.178	
DHW19M-14-Q	B <sub>2</sub> O <sub>3</sub>		9.660	10.190	-0.530	-5.2%
DHW19M-14-Q	CaO		2.494	1.930	0.564	
DHW19M-14-Q	Cl		0.055	0.100	-0.045	
DHW19M-14-Q	Cr <sub>2</sub> O <sub>3</sub>		1.435	1.540	-0.105	
DHW19M-14-Q	F		0.065	0.100	-0.035	
DHW19M-14-Q	Fe <sub>2</sub> O <sub>3</sub>		3.031	3.270	-0.239	
DHW19M-14-Q	K <sub>2</sub> O		0.139	0.120	0.019	
DHW19M-14-Q	Li <sub>2</sub> O		2.987	2.890	0.097	
DHW19M-14-Q	MnO		0.204	0.210	-0.006	
DHW19M-14-Q	Na <sub>2</sub> O		18.670	20.870	-2.200	-10.5%
DHW19M-14-Q	NiO		0.182	0.210	-0.028	
DHW19M-14-Q	P <sub>2</sub> O <sub>5</sub>		0.290	0.310	-0.020	
DHW19M-14-Q	PbO		0.194	0.210	-0.016	
DHW19M-14-Q	SiO <sub>2</sub>		52.627	55.600	-2.973	-5.3%
DHW19M-14-Q	SO <sub>3</sub>		0.224	0.350	-0.126	
DHW19M-14-Q	ZrO <sub>2</sub>		0.096	0.100	-0.004	
DHW19M-14-Q	sum		94.531	100.000	-5.469	-5.5%
DHW19M-15-Q	Al <sub>2</sub> O <sub>3</sub>		3.458	3.200	0.258	
DHW19M-15-Q	B <sub>2</sub> O <sub>3</sub>		16.977	17.890	-0.913	-5.1%
DHW19M-15-Q	CaO		5.023	4.190	0.833	
DHW19M-15-Q	Cl	$<$	0.054	0.070	-0.016	
DHW19M-15-Q	Cr <sub>2</sub> O <sub>3</sub>		1.513	1.640	-0.127	
DHW19M-15-Q	F	$<$	0.050	0.070	-0.020	
DHW19M-15-Q	Fe <sub>2</sub> O <sub>3</sub>		0.998	1.010	-0.012	
DHW19M-15-Q	K <sub>2</sub> O	$<$	0.060	0.010	0.050	
DHW19M-15-Q	Li <sub>2</sub> O		3.913	3.860	0.053	
DHW19M-15-Q	MnO		0.136	0.140	-0.004	
DHW19M-15-Q	Na <sub>2</sub> O		15.030	16.800	-1.770	-10.5%
DHW19M-15-Q	NiO	$<$	0.141	0.140	0.001	
DHW19M-15-Q	P <sub>2</sub> O <sub>5</sub>		0.201	0.210	-0.009	
DHW19M-15-Q	PbO		0.133	0.140	-0.007	
DHW19M-15-Q	SiO <sub>2</sub>		49.257	49.930	-0.673	-1.3%
DHW19M-15-Q	SO <sub>3</sub>		0.297	0.600	-0.303	
DHW19M-15-Q	ZrO <sub>2</sub>	$<$	0.068	0.070	-0.002	
DHW19M-15-Q	sum		97.308	99.970	-2.662	-2.7%
DHW19M-16-Q	Al <sub>2</sub> O <sub>3</sub>		6.575	6.400	0.175	2.7%
DHW19M-16-Q	B <sub>2</sub> O <sub>3</sub>		10.996	11.730	-0.734	-6.3%
DHW19M-16-Q	CaO		0.801	0.550	0.251	
DHW19M-16-Q	Cl	$<$	0.050	0.060	-0.010	
DHW19M-16-Q	Cr <sub>2</sub> O <sub>3</sub>		1.597	1.690	-0.093	
DHW19M-16-Q	F	$<$	0.050	0.060	-0.010	
DHW19M-16-Q	Fe <sub>2</sub> O <sub>3</sub>		6.223	6.770	-0.547	-8.1%
DHW19M-16-Q	K <sub>2</sub> O		2.277	2.470	-0.193	
DHW19M-16-Q	Li <sub>2</sub> O		3.439	3.360	0.079	
DHW19M-16-Q	MnO	$<$	0.129	0.120	0.009	
DHW19M-16-Q	Na <sub>2</sub> O		16.682	18.080	-1.399	-7.7%
DHW19M-16-Q	NiO	$<$	0.127	0.120	0.007	

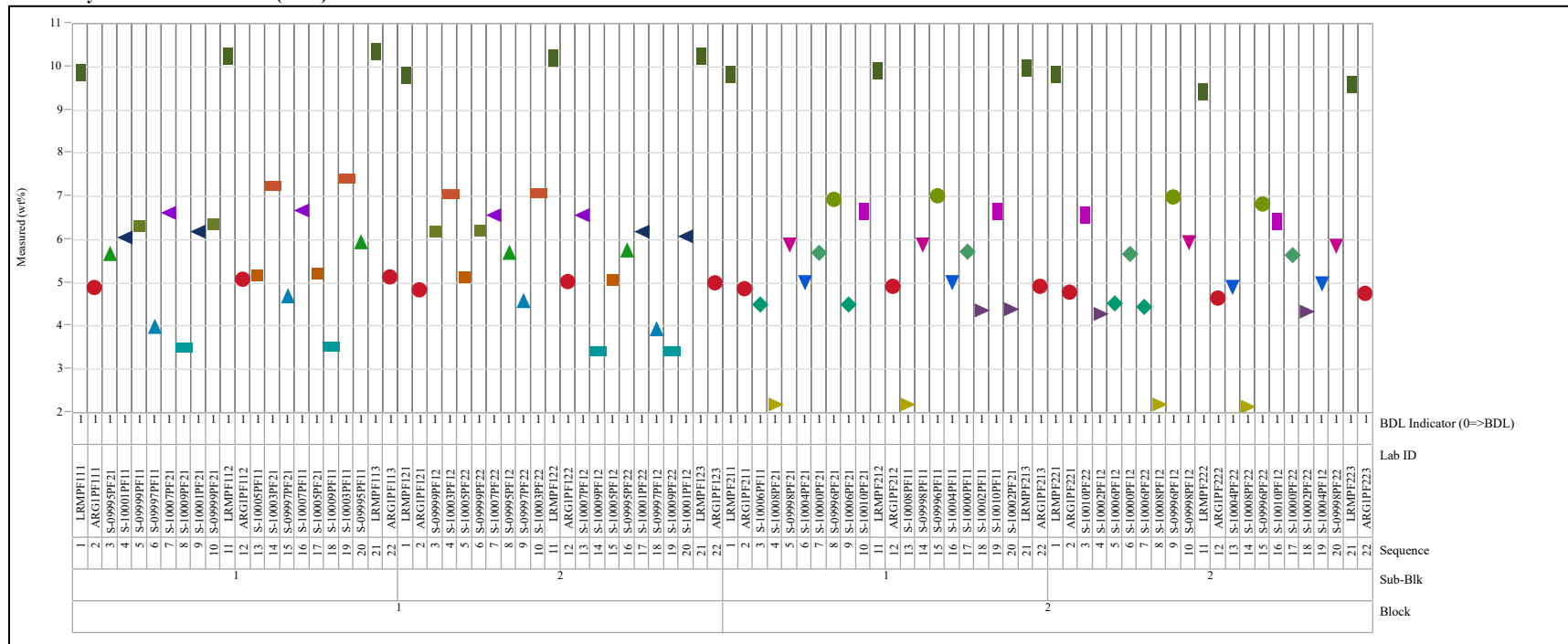


**Table A-4. Comparison of Measured and Targeted Compositions of the Group 1 Glasses  
(continued)**

Glass ID	Oxide	BDL (<)	Measured (wt %)	Targeted (wt %)	Difference of Measured versus Targeted	% Difference of Measured versus Targeted
DHW19M-16-Q	P <sub>2</sub> O <sub>5</sub>		0.175	0.180	-0.005	
DHW19M-16-Q	PbO		0.120	0.120	0.000	
DHW19M-16-Q	SiO <sub>2</sub>		47.385	47.900	-0.515	-1.1%
DHW19M-16-Q	SO <sub>3</sub>		0.198	0.380	-0.182	
DHW19M-16-Q	ZrO <sub>2</sub>	<	0.068	0.060	0.008	
DHW19M-16-Q	sum		96.892	100.050	-3.158	-3.2%
ARG-1	Al <sub>2</sub> O <sub>3</sub>		4.895	4.730	0.165	
ARG-1	B <sub>2</sub> O <sub>3</sub>		8.095	8.670	-0.575	-6.6%
ARG-1	CaO		1.890	1.430	0.460	
ARG-1	Cl	<	0.050	0.000	0.050	
ARG-1	Cr <sub>2</sub> O <sub>3</sub>	<	0.146	0.093	0.053	
ARG-1	F	<	0.050	0.000	0.050	
ARG-1	Fe <sub>2</sub> O <sub>3</sub>		12.942	14.000	-1.058	-7.6%
ARG-1	K <sub>2</sub> O		2.702	2.710	-0.008	
ARG-1	Li <sub>2</sub> O		3.289	3.210	0.079	
ARG-1	MnO		1.768	1.880	-0.112	
ARG-1	Na <sub>2</sub> O		11.251	11.500	-0.249	-2.2%
ARG-1	NiO		0.947	1.050	-0.103	
ARG-1	P <sub>2</sub> O <sub>5</sub>		0.272	0.220	0.052	
ARG-1	PbO	<	0.054	0.000	0.054	
ARG-1	SiO <sub>2</sub>		46.851	47.900	-1.049	-2.2%
ARG-1	SO <sub>3</sub>	<	0.162	0.000	0.162	
ARG-1	ZrO <sub>2</sub>		0.139	0.130	0.009	
ARG-1	sum		95.504	97.523	-2.019	-2.1%
LRM	Al <sub>2</sub> O <sub>3</sub>		9.936	9.510	0.426	4.5%
LRM	B <sub>2</sub> O <sub>3</sub>		7.422	7.850	-0.428	-5.5%
LRM	CaO		0.752	0.540	0.212	
LRM	Cl	<	0.050	0.000	0.050	
LRM	Cr <sub>2</sub> O <sub>3</sub>		0.181	0.190	-0.009	
LRM	F		0.889	0.860	0.029	
LRM	Fe <sub>2</sub> O <sub>3</sub>		1.366	1.380	-0.014	
LRM	K <sub>2</sub> O		1.469	1.480	-0.011	
LRM	Li <sub>2</sub> O	<	0.215	0.110	0.105	
LRM	MnO	<	0.129	0.080	0.049	
LRM	Na <sub>2</sub> O		19.647	20.030	-0.383	-1.9%
LRM	NiO		0.156	0.190	-0.034	
LRM	P <sub>2</sub> O <sub>5</sub>		0.524	0.540	-0.016	
LRM	PbO		0.100	0.100	0.000	
LRM	SiO <sub>2</sub>		53.393	54.200	-0.807	-1.5%
LRM	SO <sub>3</sub>		0.265	0.300	-0.035	
LRM	ZrO <sub>2</sub>		0.975	0.930	0.045	
LRM	sum		97.469	98.290	-0.821	-0.8%

# Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence for the Group 1 Glasses

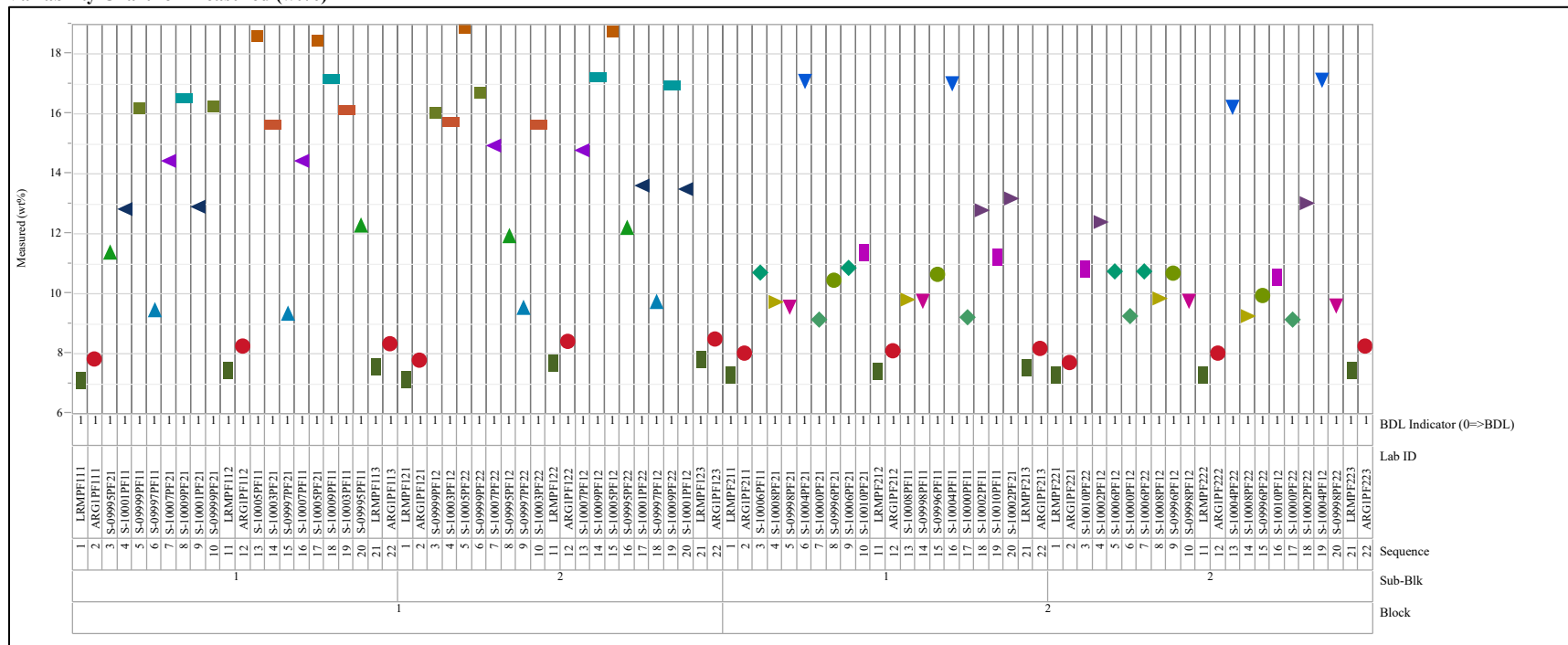
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Variability Chart for Measured (wt%)



## Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence for the Group 1 Glasses (continued)

Analyte=B2O3, Prep Method=PF

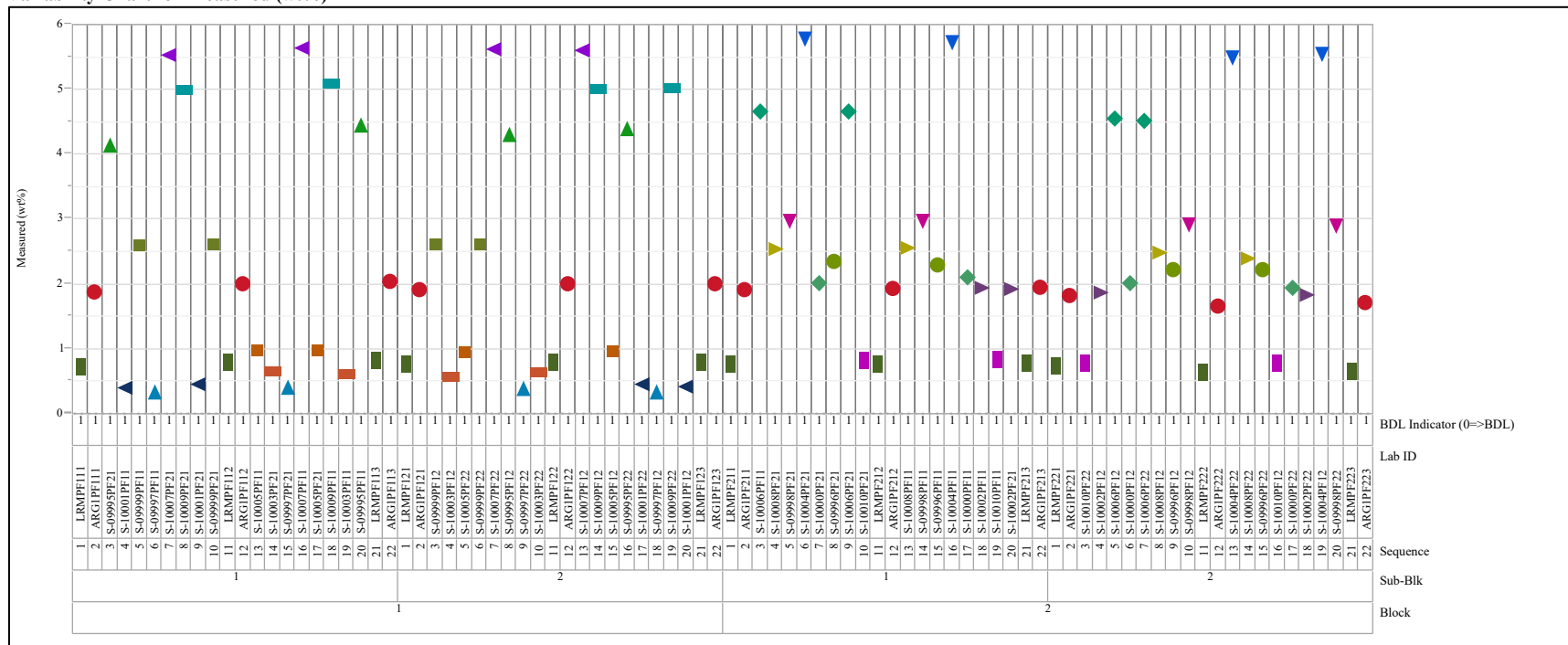
Variability Chart for Measured (wt%)



**Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence for the Group 1 Glasses (continued)**

Analyte=CaO, Prep Method=PF

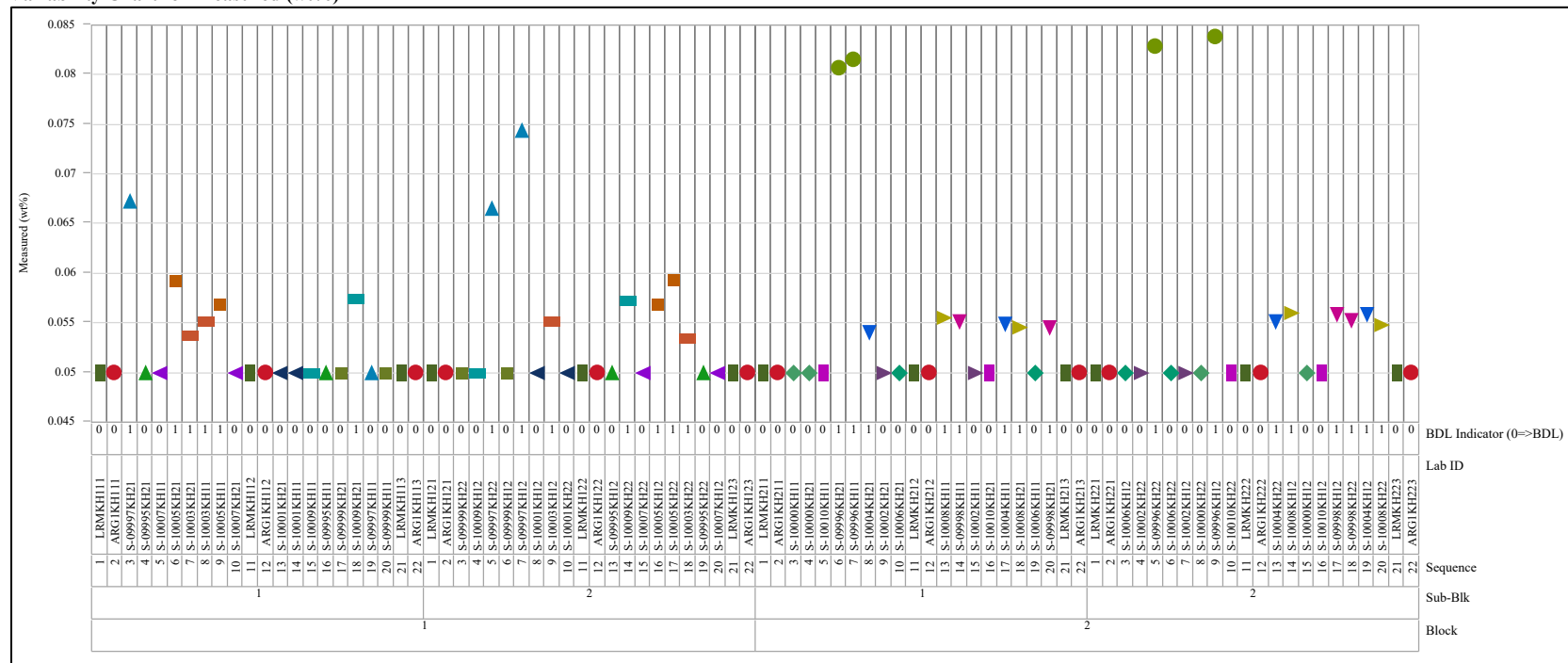
Variability Chart for Measured (wt%)



**Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence for the Group 1 Glasses (continued)**

Analyte=Cl, Prep Method=KH

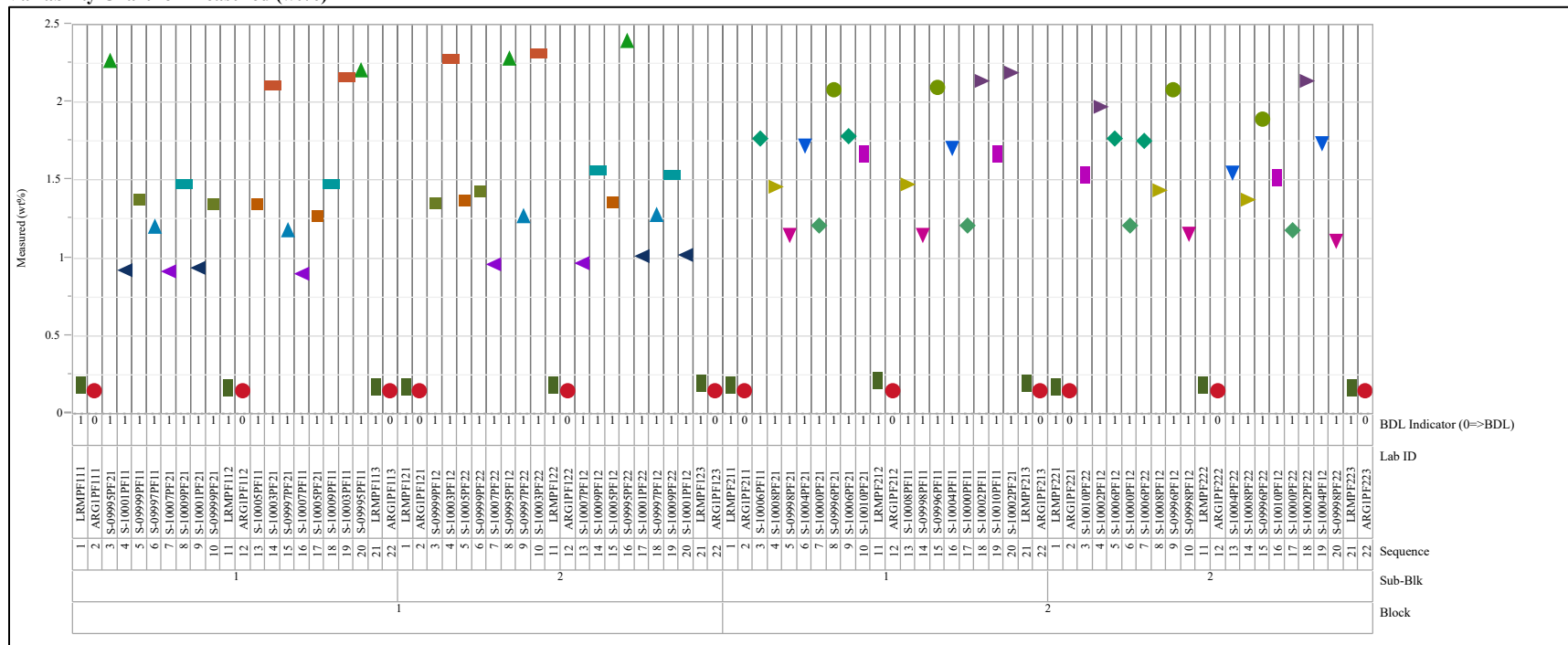
Variability Chart for Measured (wt%)



**Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence for the Group 1 Glasses (continued)**

Analyte=Cr2O3, Prep Method=PF

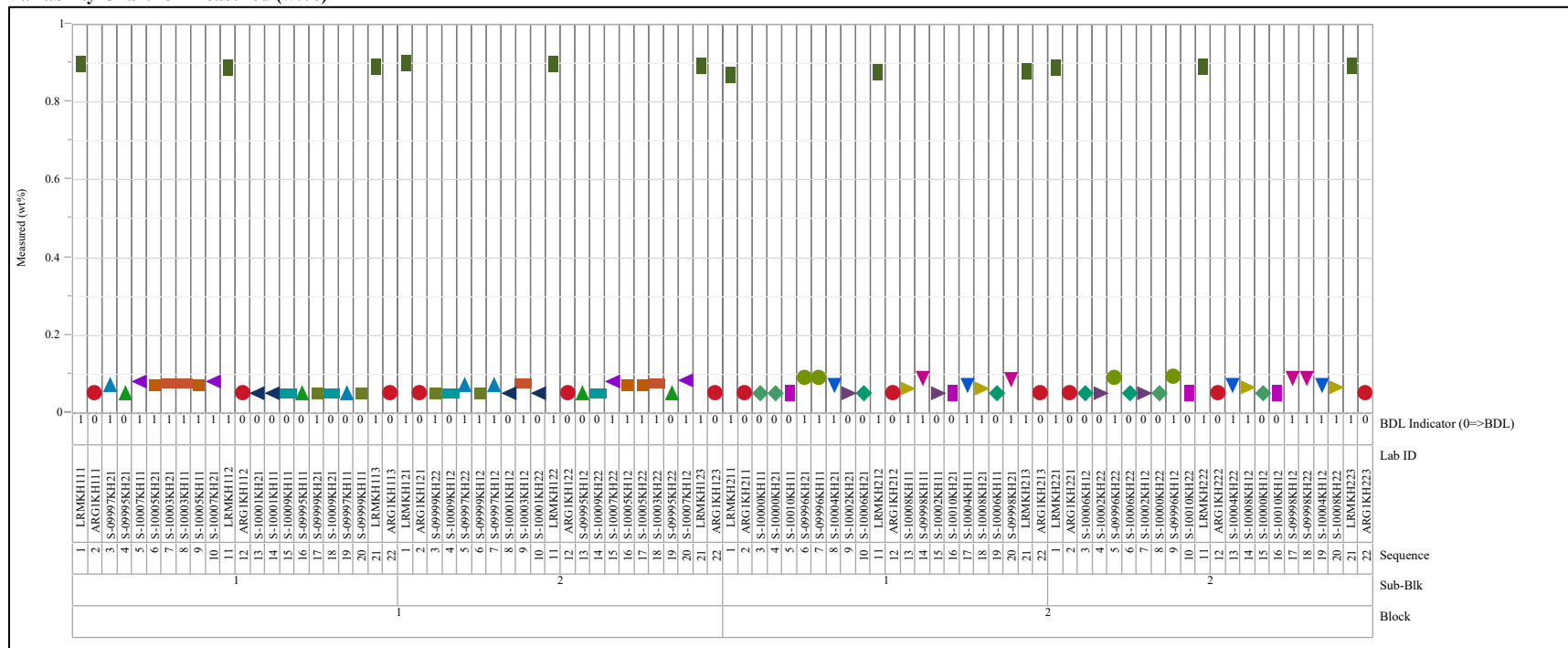
Variability Chart for Measured (wt%)



**Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence for the Group 1 Glasses (continued)**

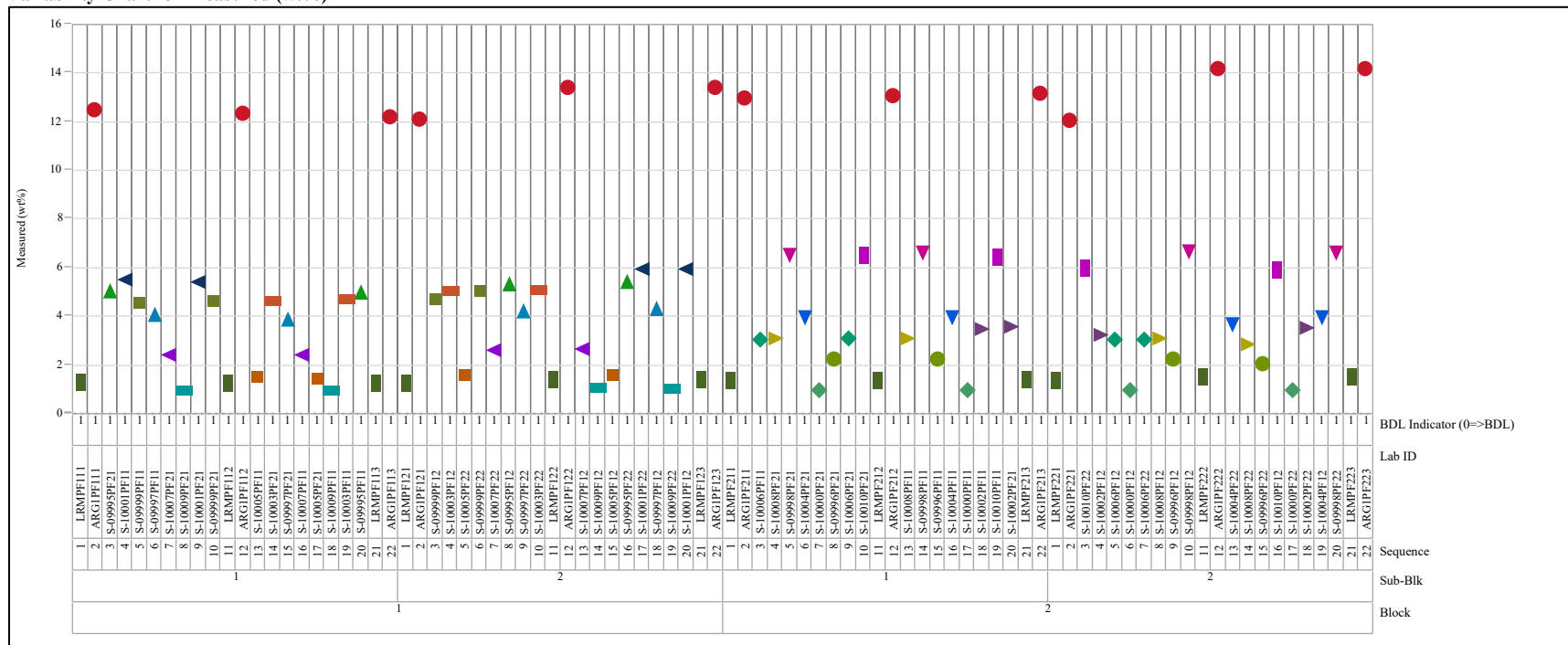
Analyte=F, Prep Method=KH

Variability Chart for Measured (wt%)



**Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence for the Group 1 Glasses (continued)**Analyte=Fe<sub>2</sub>O<sub>3</sub>, Prep Method=PF

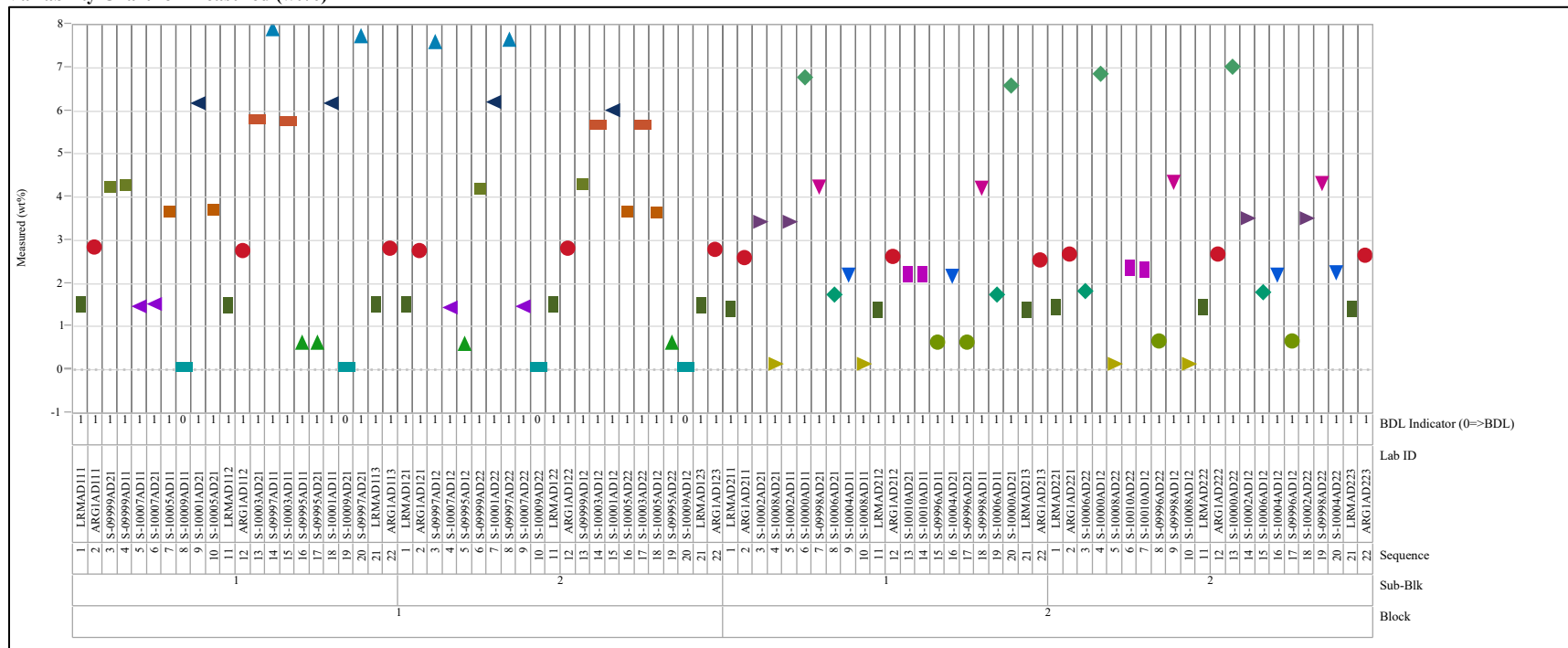
Variability Chart for Measured (wt%)





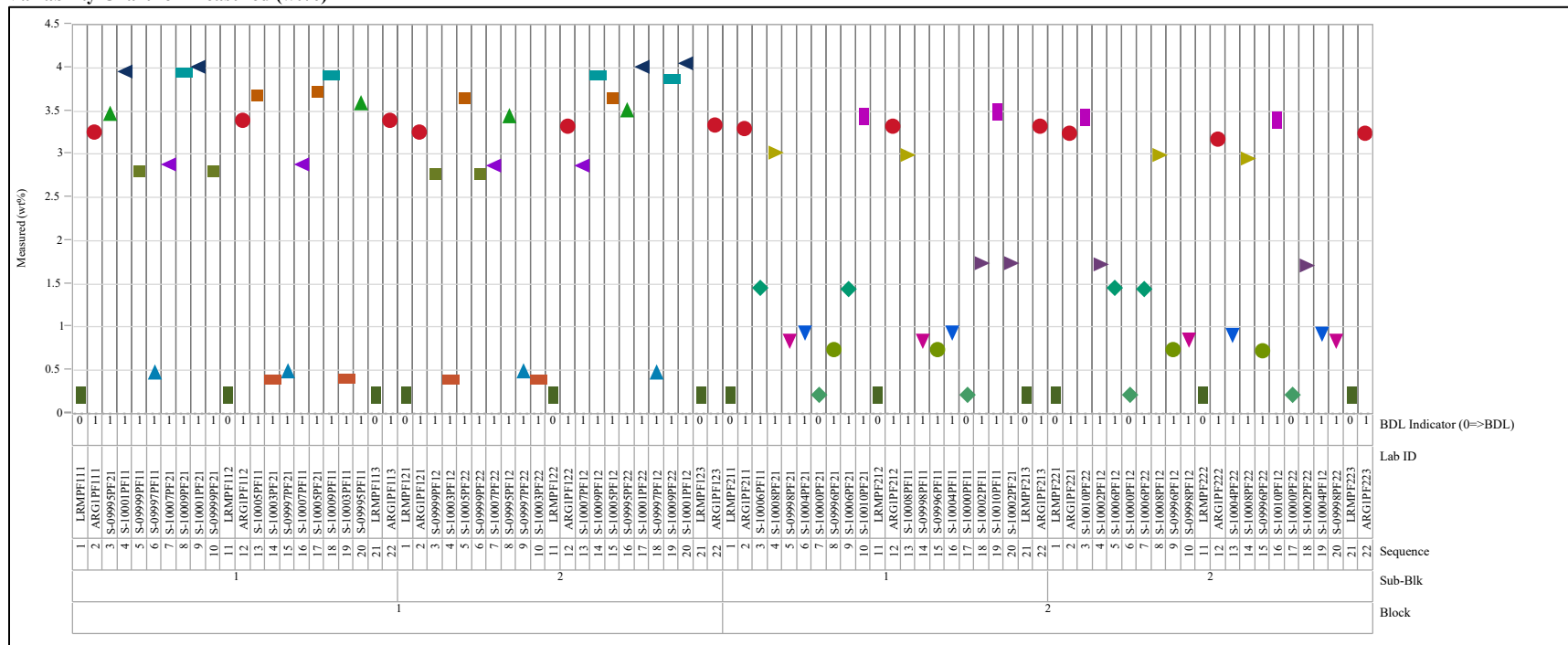
**Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence for the Group 1 Glasses (continued)**Analyte=K<sub>2</sub>O, Prep Method=AD

Variability Chart for Measured (wt%)



**Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence for the Group 1 Glasses (continued)**Analyte=Li<sub>2</sub>O, Prep Method=PF

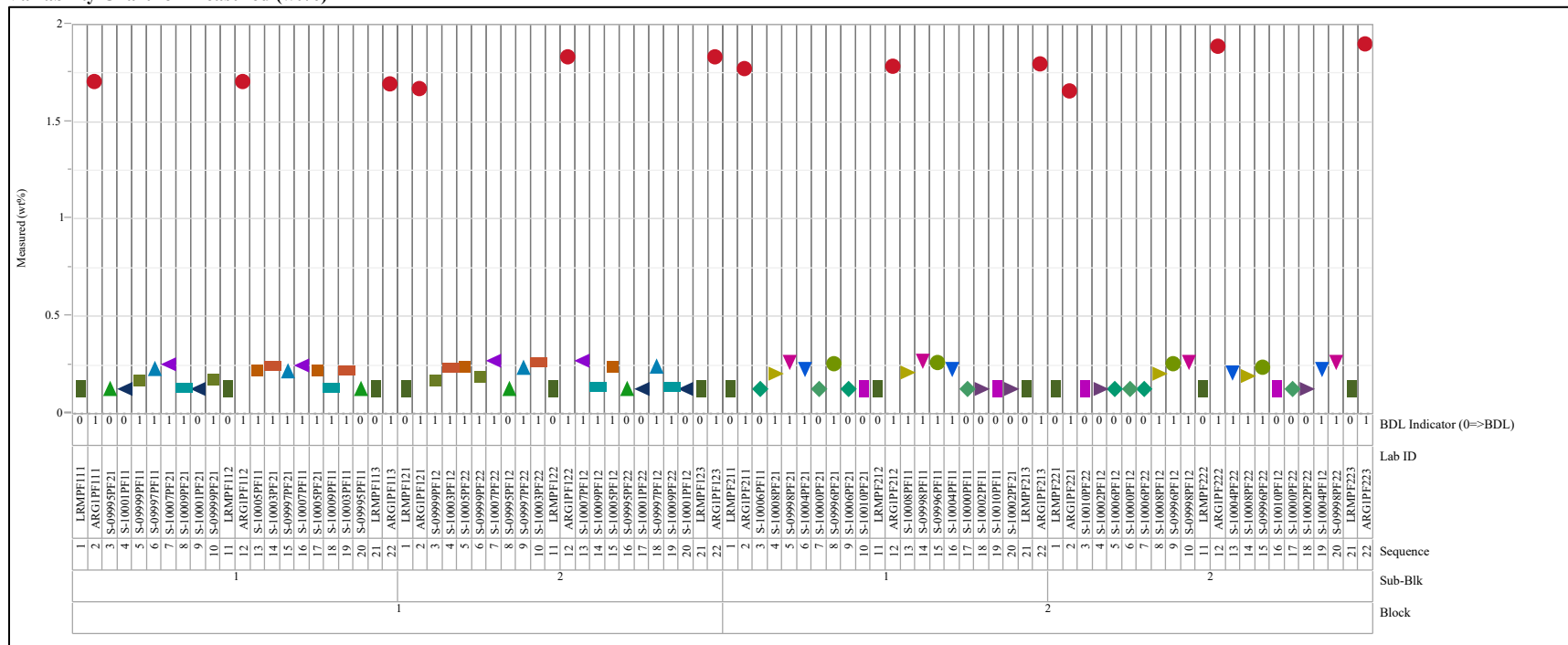
Variability Chart for Measured (wt%)



**Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence for the Group 1 Glasses (continued)**

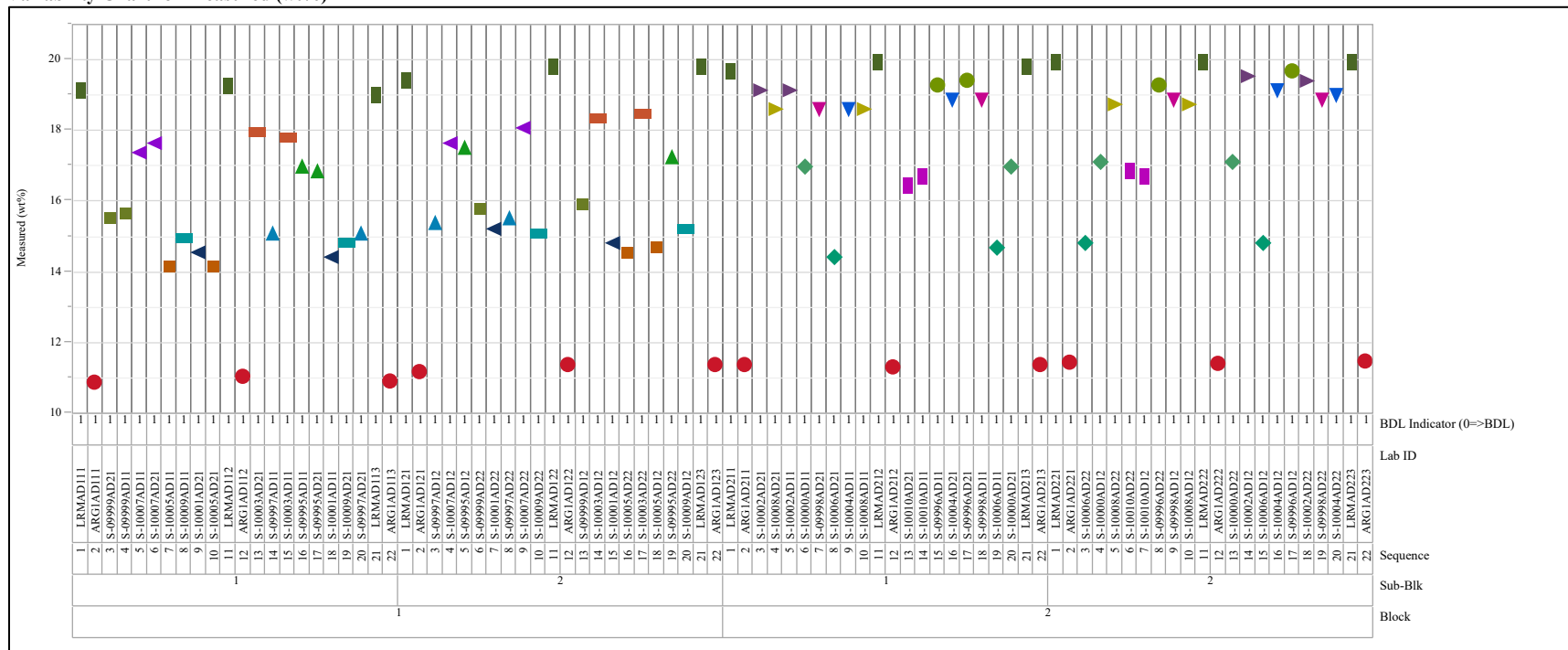
Analyte=MnO, Prep Method=PF

Variability Chart for Measured (wt%)



**Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence for the Group 1 Glasses (continued)**

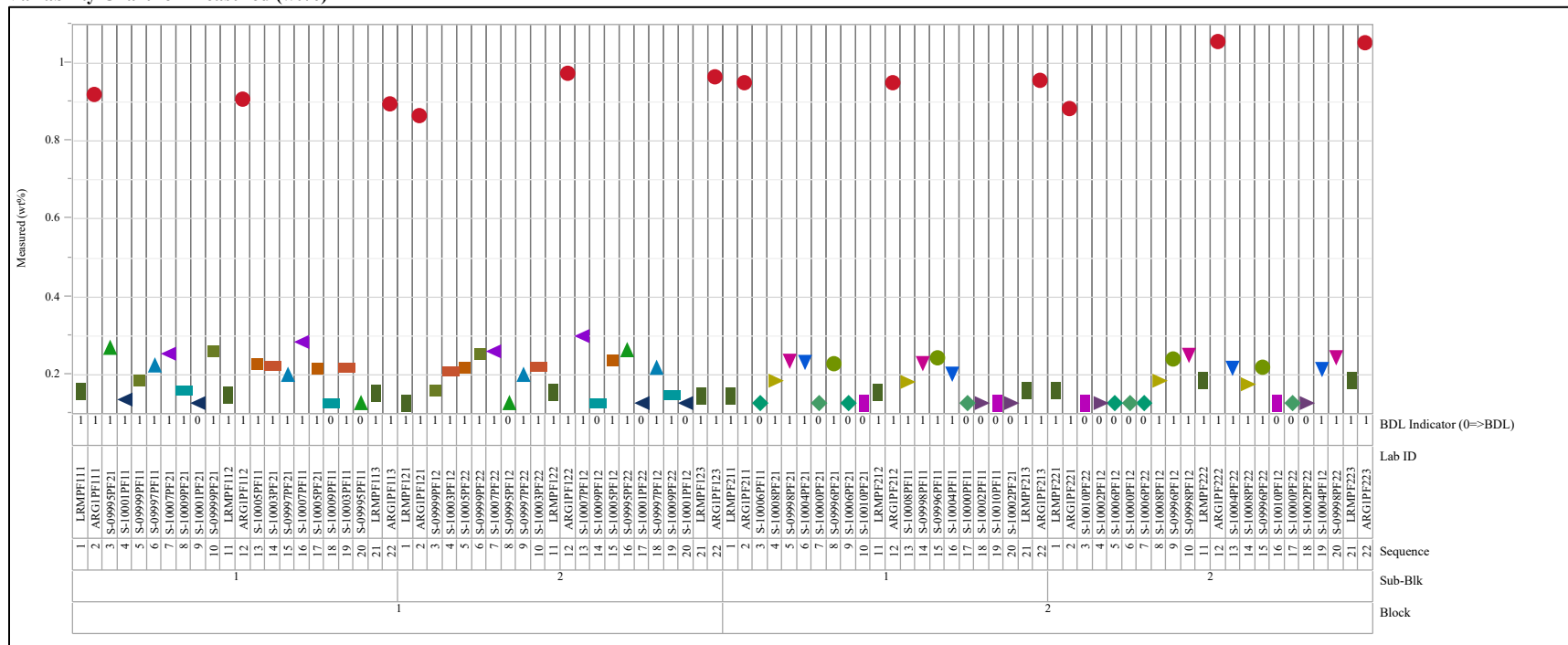
Analyte=Na<sub>2</sub>O, Prep Method=AD  
 Variability Chart for Measured (wt%)



**Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence for the Group 1 Glasses (continued)**

Analyte=NiO, Prep Method=PF

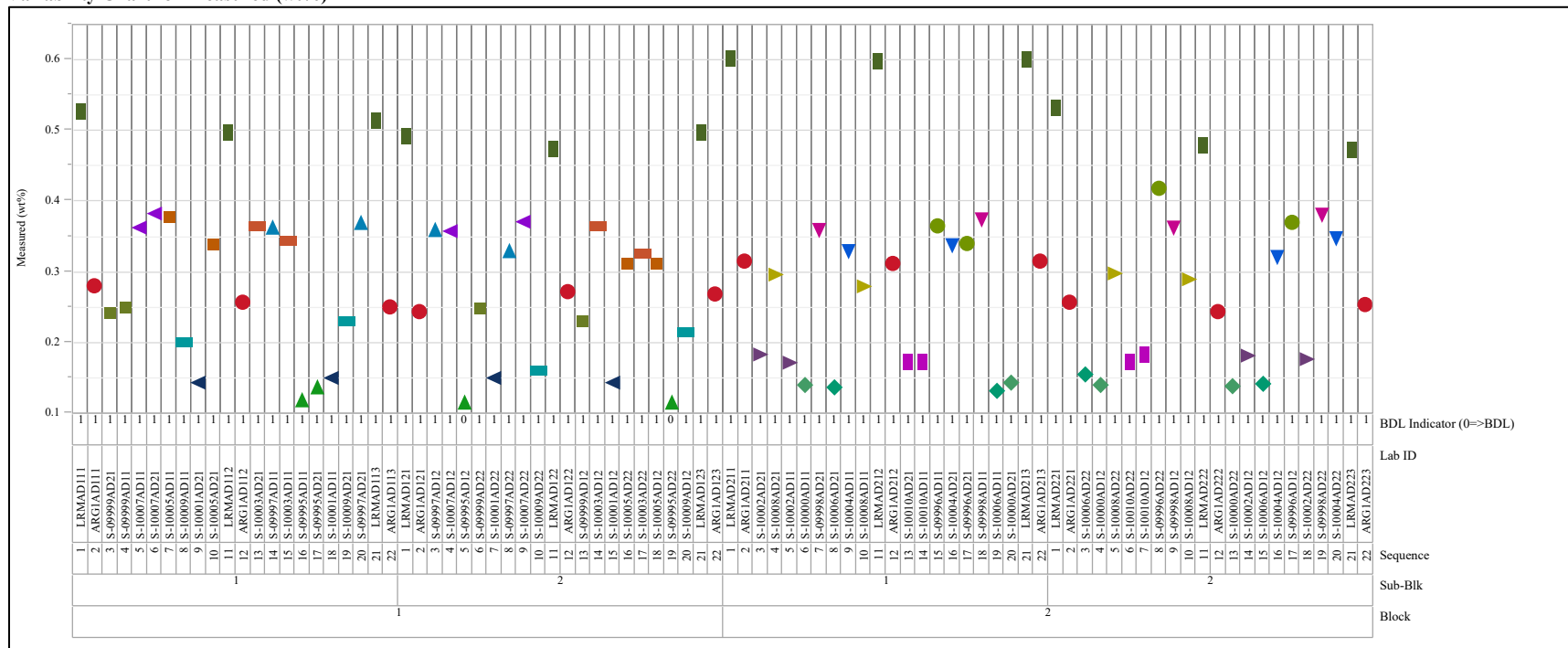
Variability Chart for Measured (wt%)



**Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence for the Group 1 Glasses (continued)**

Analyte=P2O5, Prep Method=AD

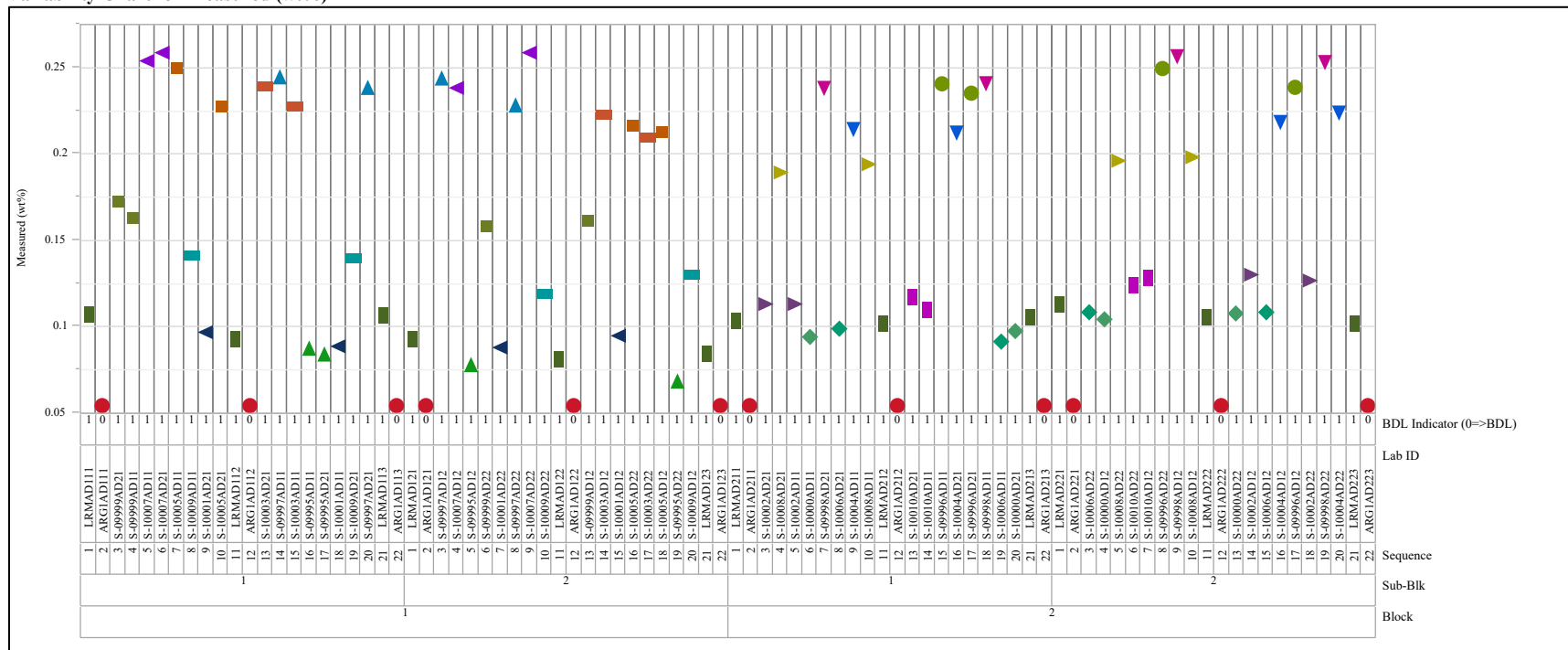
Variability Chart for Measured (wt%)



## Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence for the Group 1 Glasses (continued)

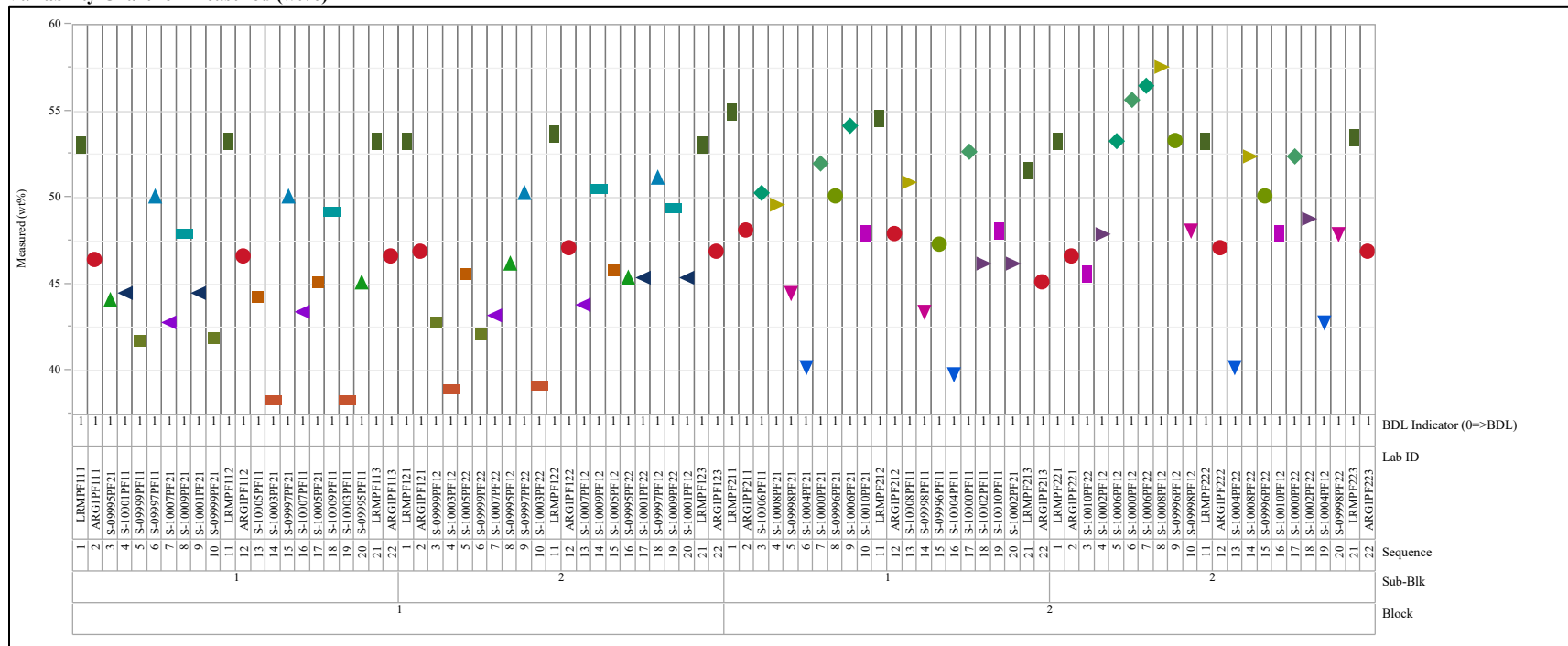
Analyte=PbO, Prep Method=AD

Variability Chart for Measured (wt%)



**Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence for the Group 1 Glasses (continued)**Analyte=SiO<sub>2</sub>, Prep Method=PF

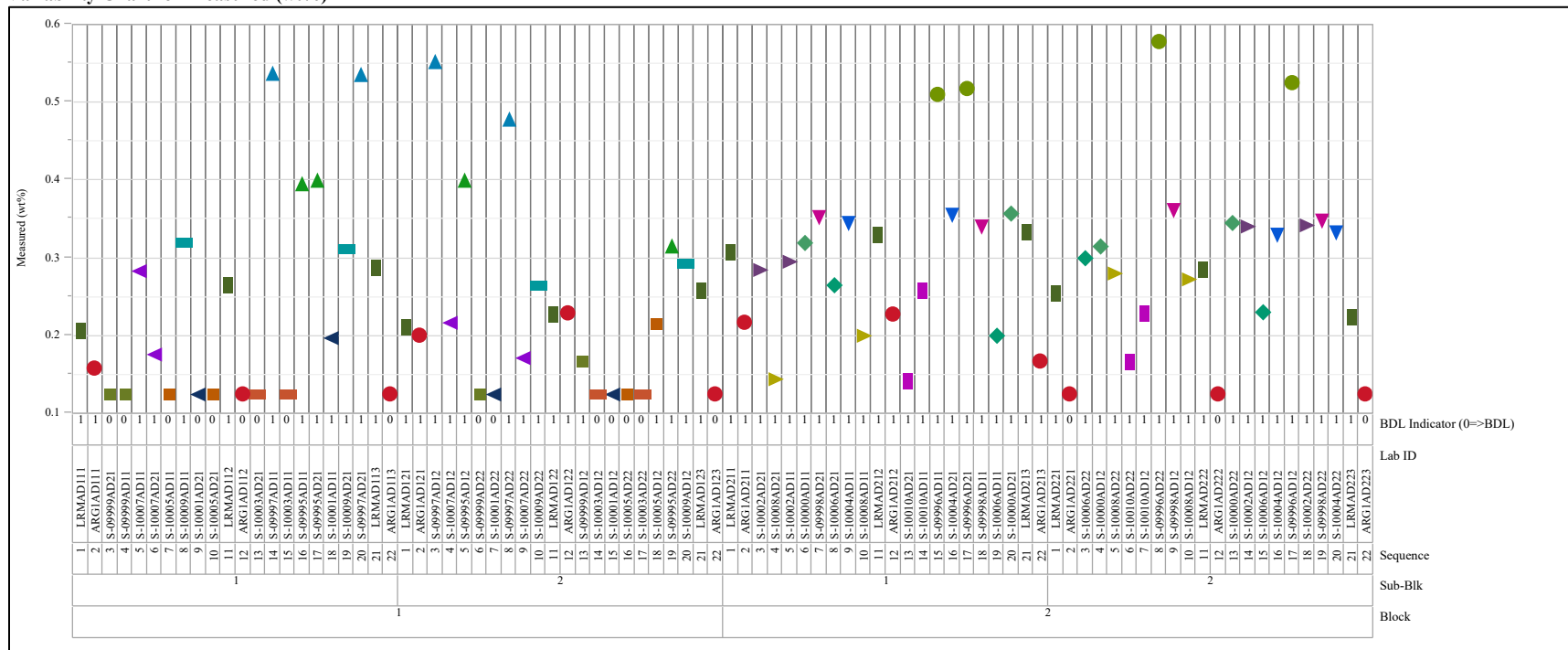
Variability Chart for Measured (wt%)





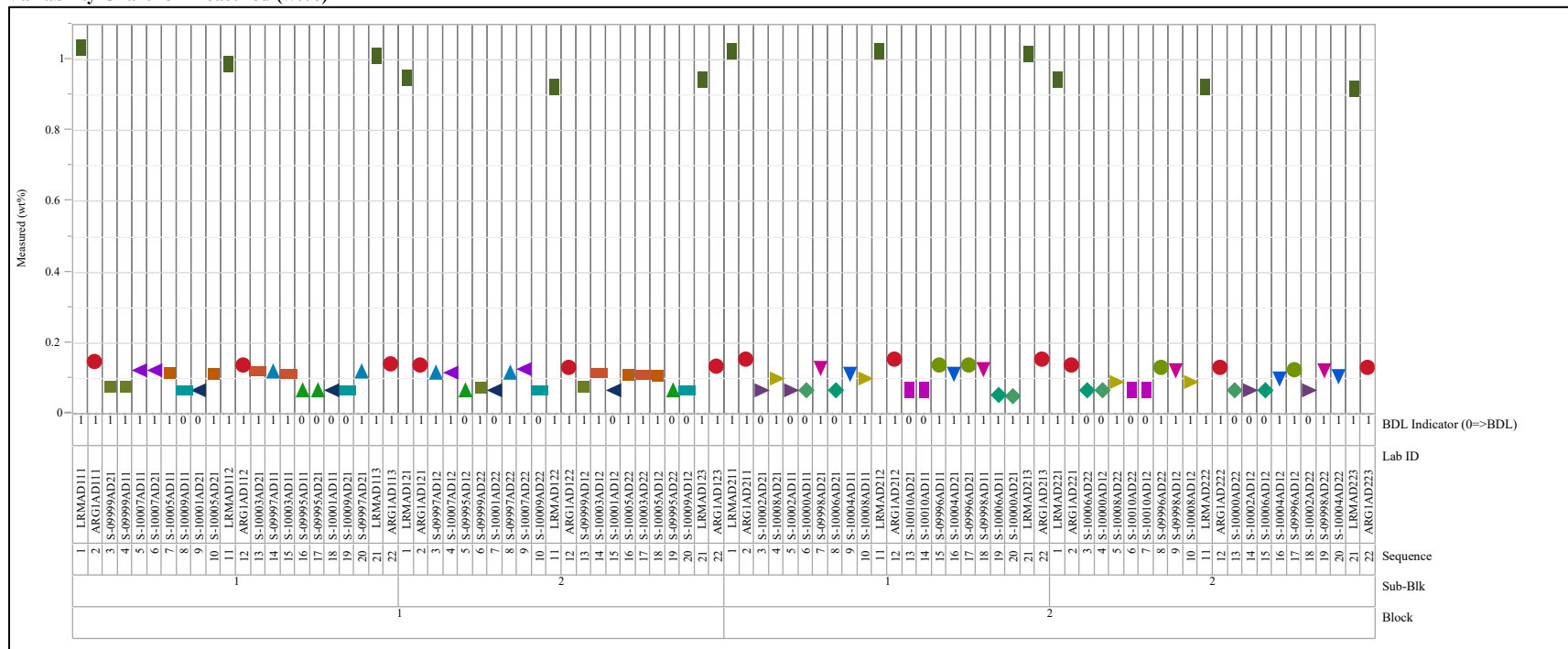
**Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence for the Group 1 Glasses (continued)**Analyte=SO<sub>3</sub>, Prep Method=AD

Variability Chart for Measured (wt%)

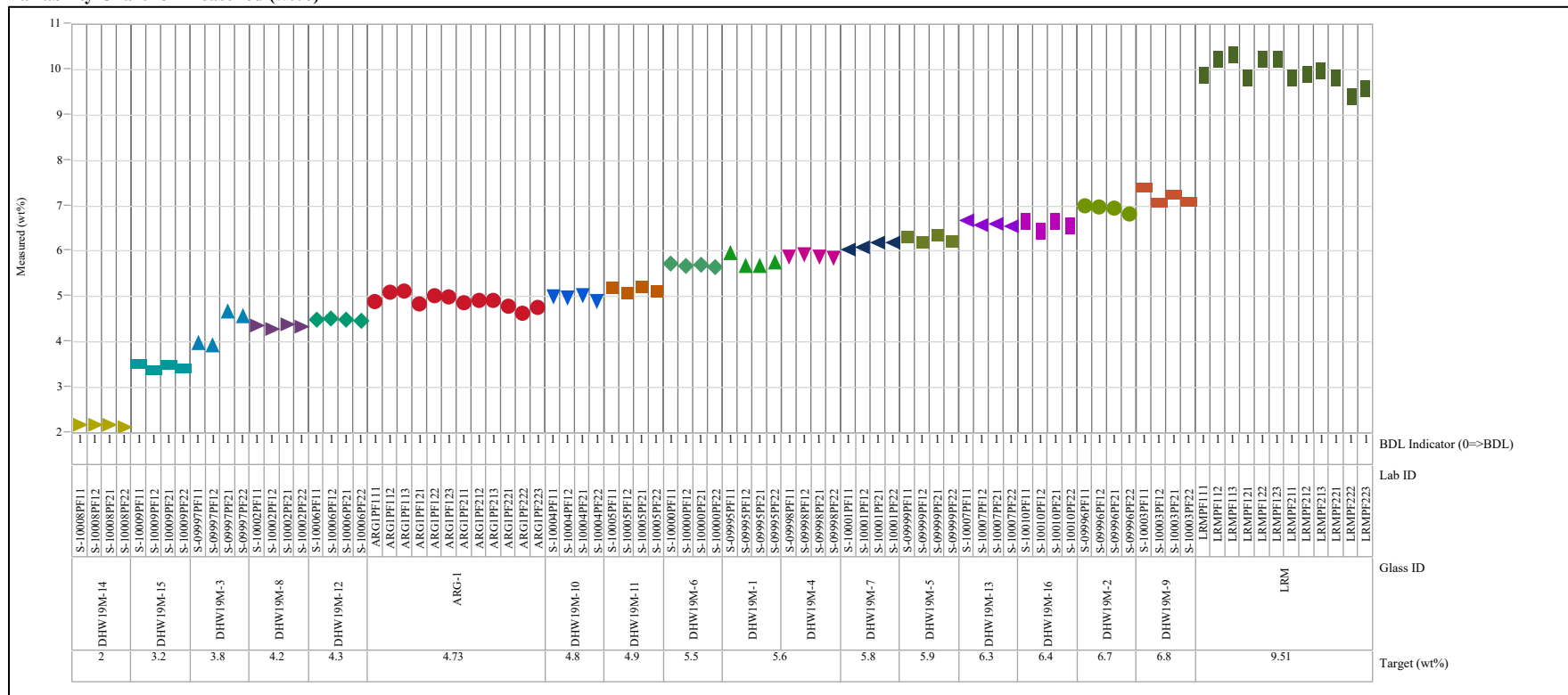


**Exhibit A-1. Plots of Oxide Measurements in Analytical Sequence for the Group 1 Glasses (continued)**Analyte=ZrO<sub>2</sub>, Prep Method=AD

Variability Chart for Measured (wt%)



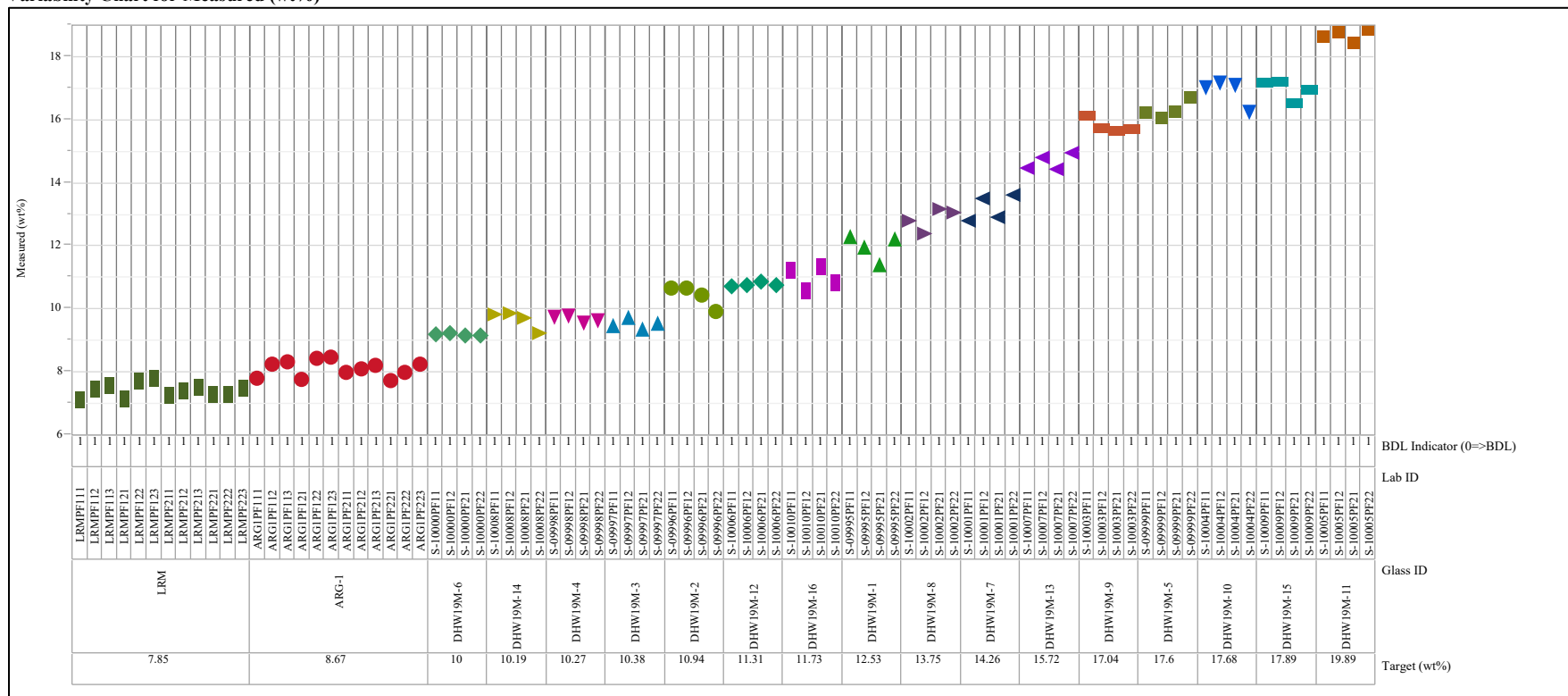
**Analyte=Al<sub>2</sub>O<sub>3</sub>, Prep Method=PF**  
**Variability Chart for Measured (wt%)**



**Exhibit A-2. Plots of Oxide Measurements by Group 1 Glass Identifier Grouped by Targeted Concentrations (continued)**

Analyte=B2O3, Prep Method=PF

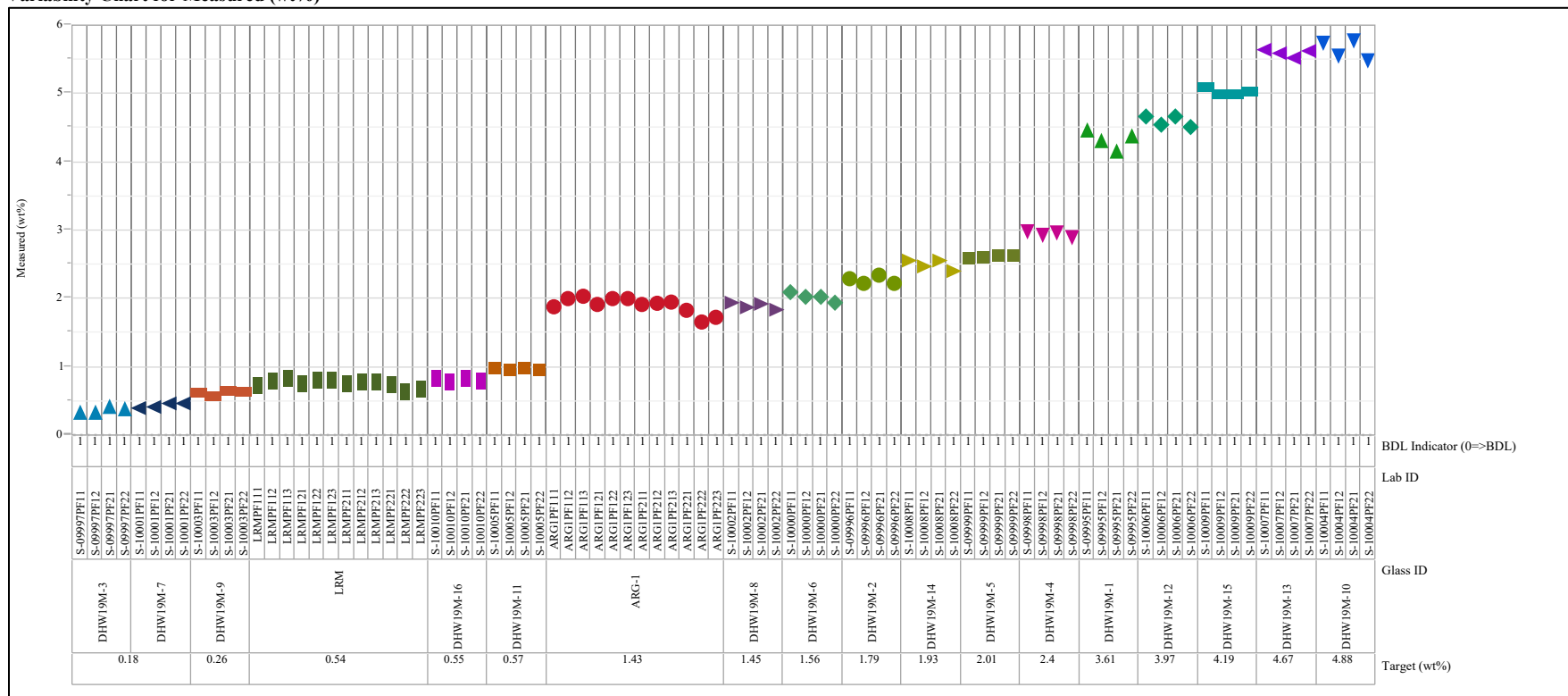
### Variability Chart for Measured (wt%)



**Exhibit A-2. Plots of Oxide Measurements by Group 1 Glass Identifier Grouped by Targeted Concentrations (continued)**

Analyte=CaO, Prep Method=PF

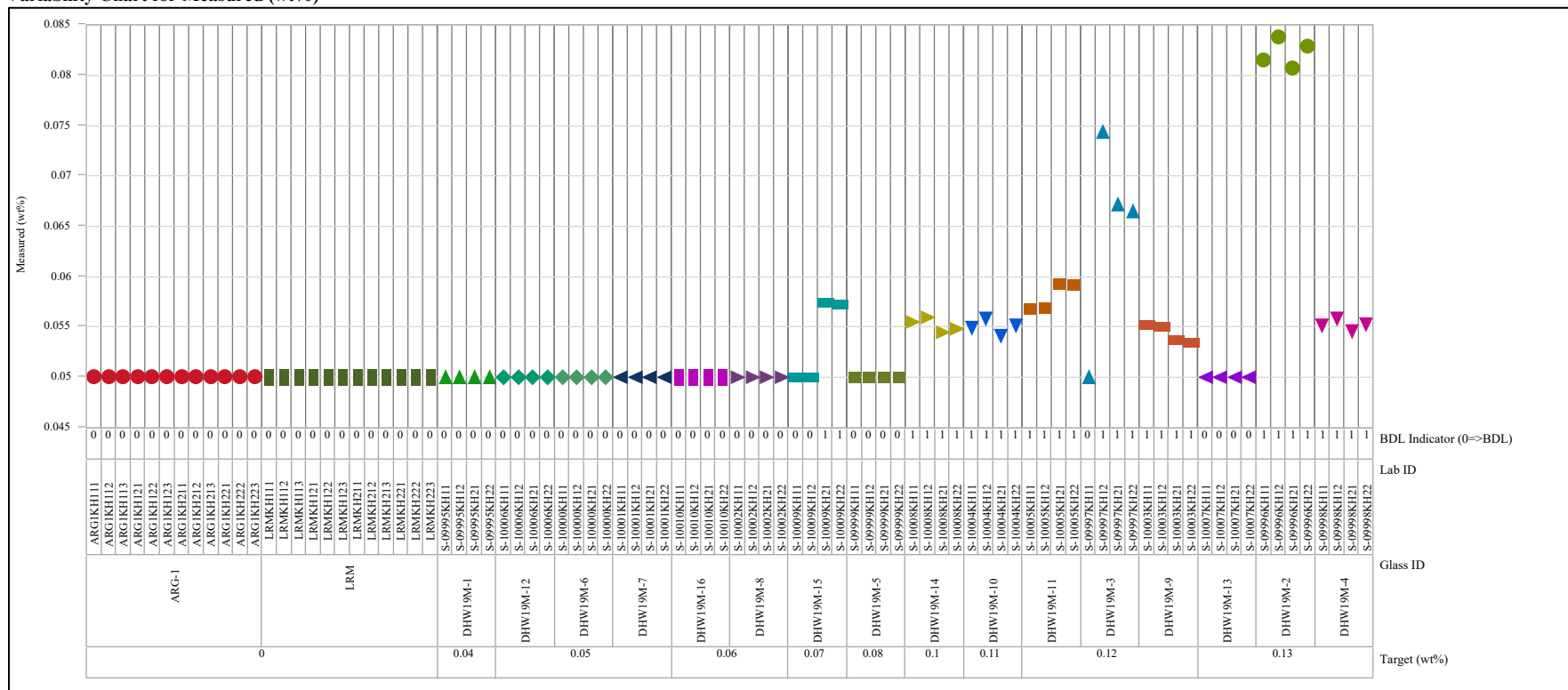
### Variability Chart for Measured (wt%)



**Exhibit A-2. Plots of Oxide Measurements by Group 1 Glass Identifier Grouped by Targeted Concentrations (continued)**

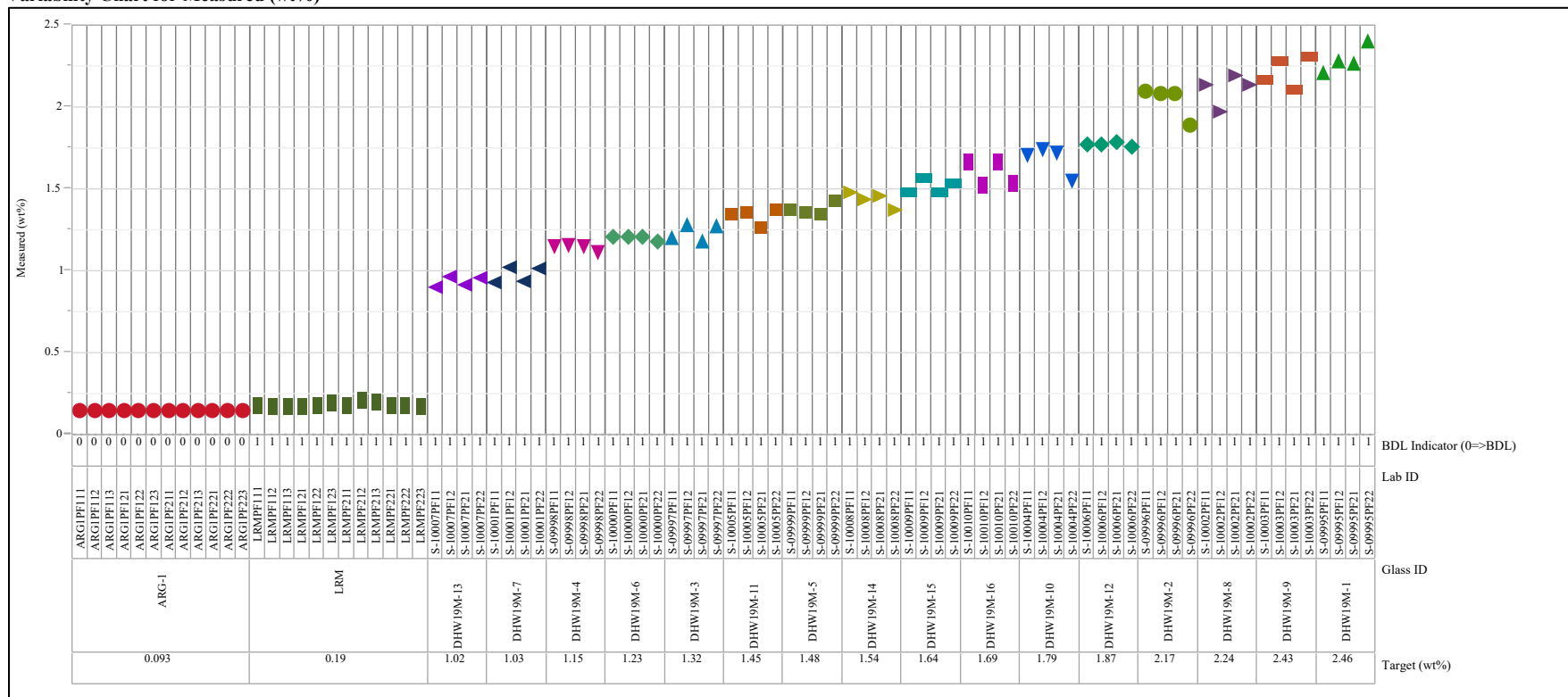
**Analyte=Cl, Prep Method=KH**

### Variability Chart for Measured (wt%)



## Exhibit A-2. Plots of Oxide Measurements by Group 1 Glass Identifier Grouped by Targeted Concentrations (continued)

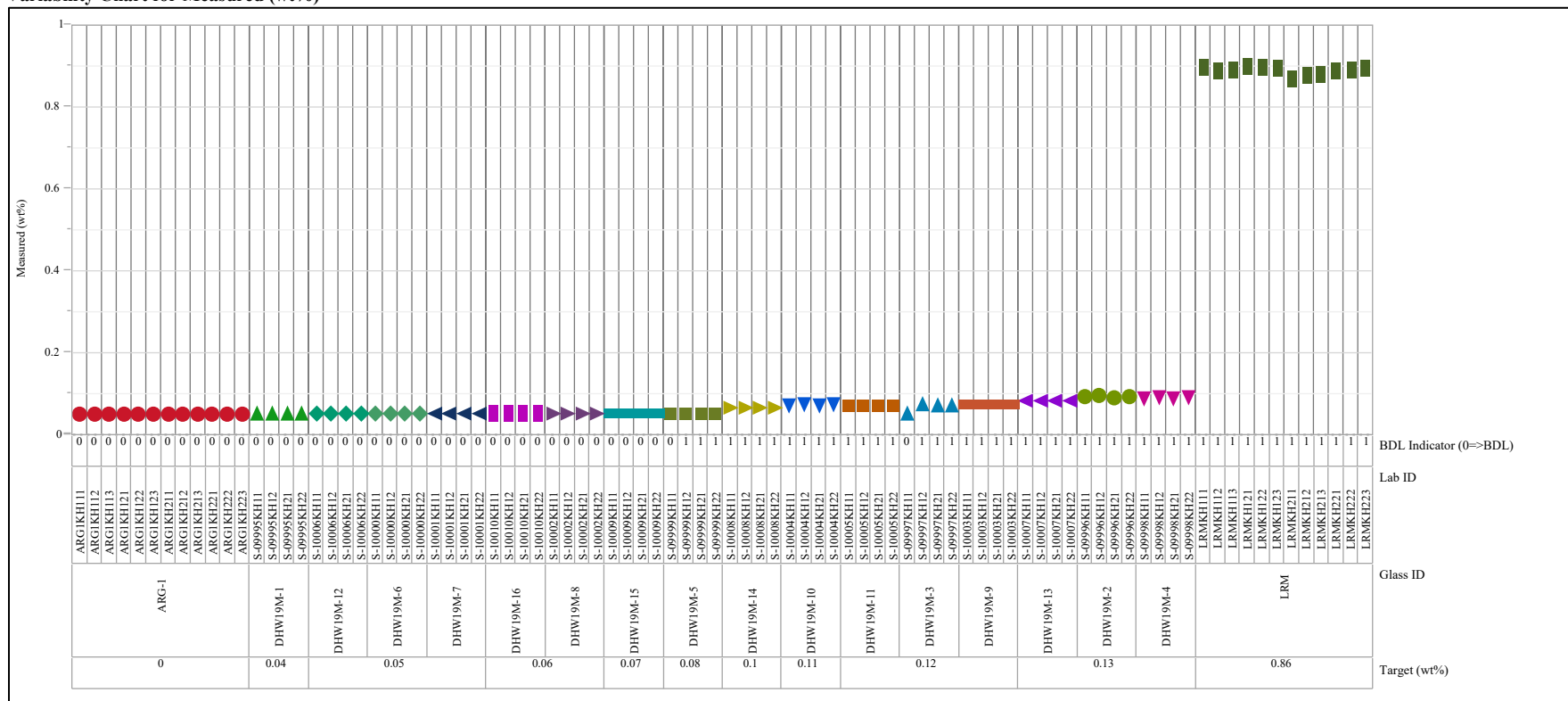
Analyte=Cr<sub>2</sub>O<sub>3</sub>, Prep Method=PF  
 Variability Chart for Measured (wt%)



**Exhibit A-2. Plots of Oxide Measurements by Group 1 Glass Identifier Grouped by Targeted Concentrations (continued)**

**Analyte=F, Prep Method=KH**

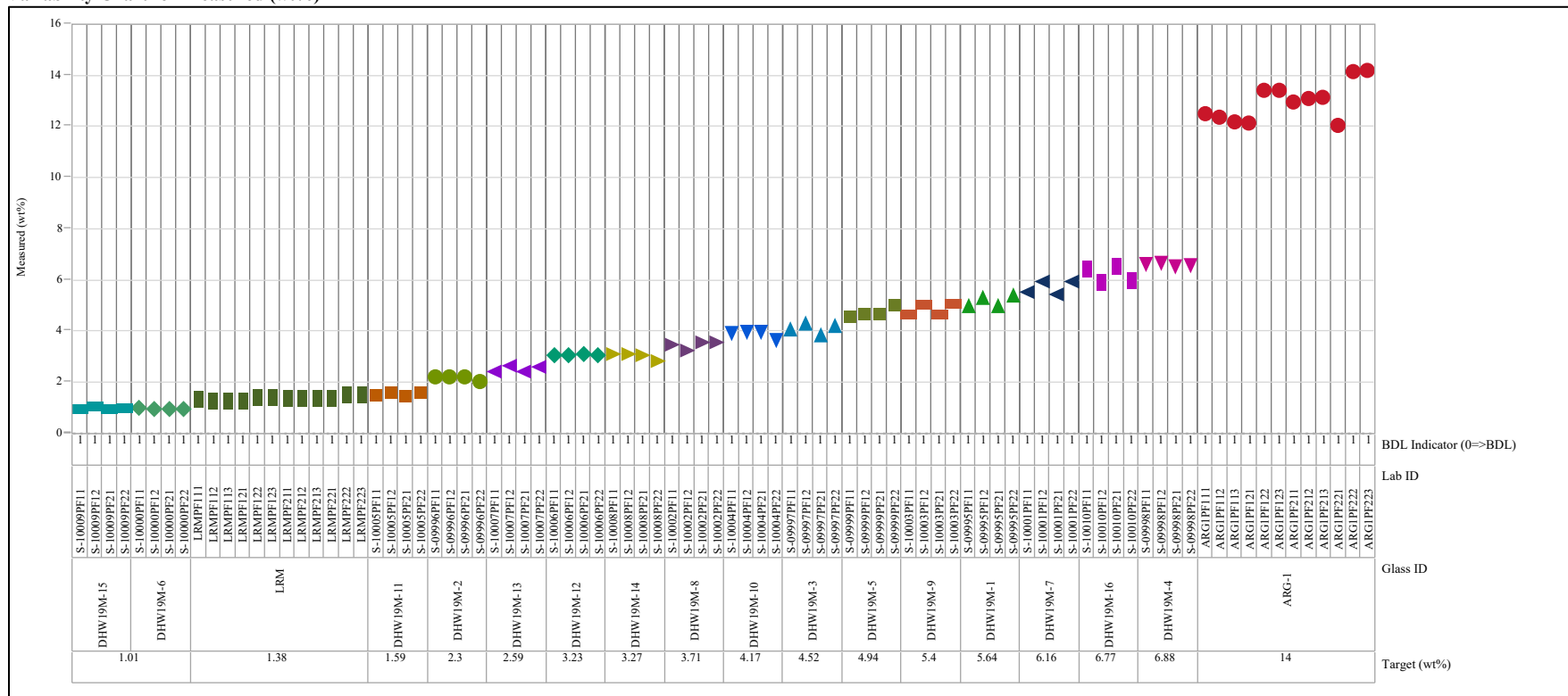
### Variability Chart for Measured (wt%)





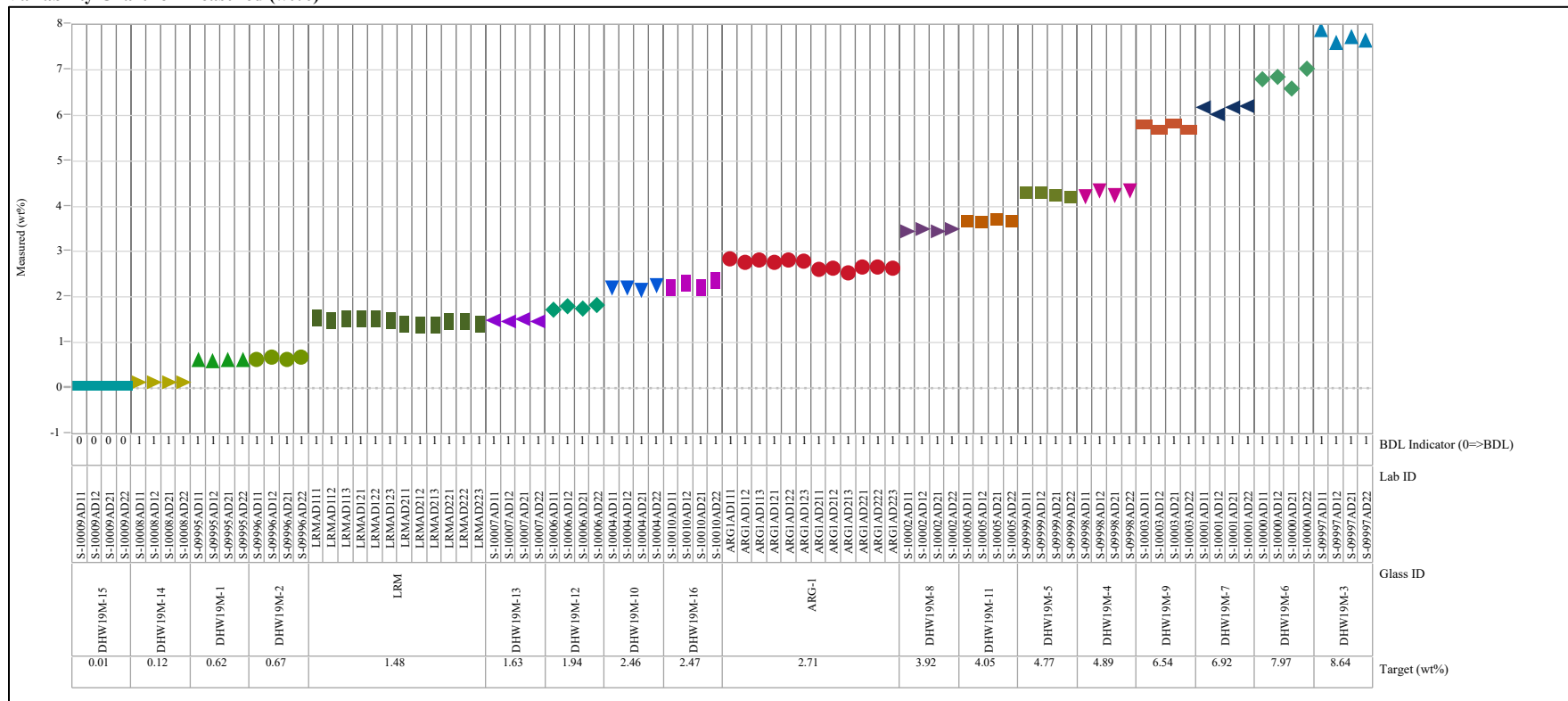
### Exhibit A-2. Plots of Oxide Measurements by Group 1 Glass Identifier Grouped by Targeted Concentrations (continued)

Analyte=Fe<sub>2</sub>O<sub>3</sub>, Prep Method=PF  
 Variability Chart for Measured (wt%)



**Exhibit A-2. Plots of Oxide Measurements by Group 1 Glass Identifier Grouped by Targeted Concentrations (continued)**Analyte=K<sub>2</sub>O, Prep Method=AD

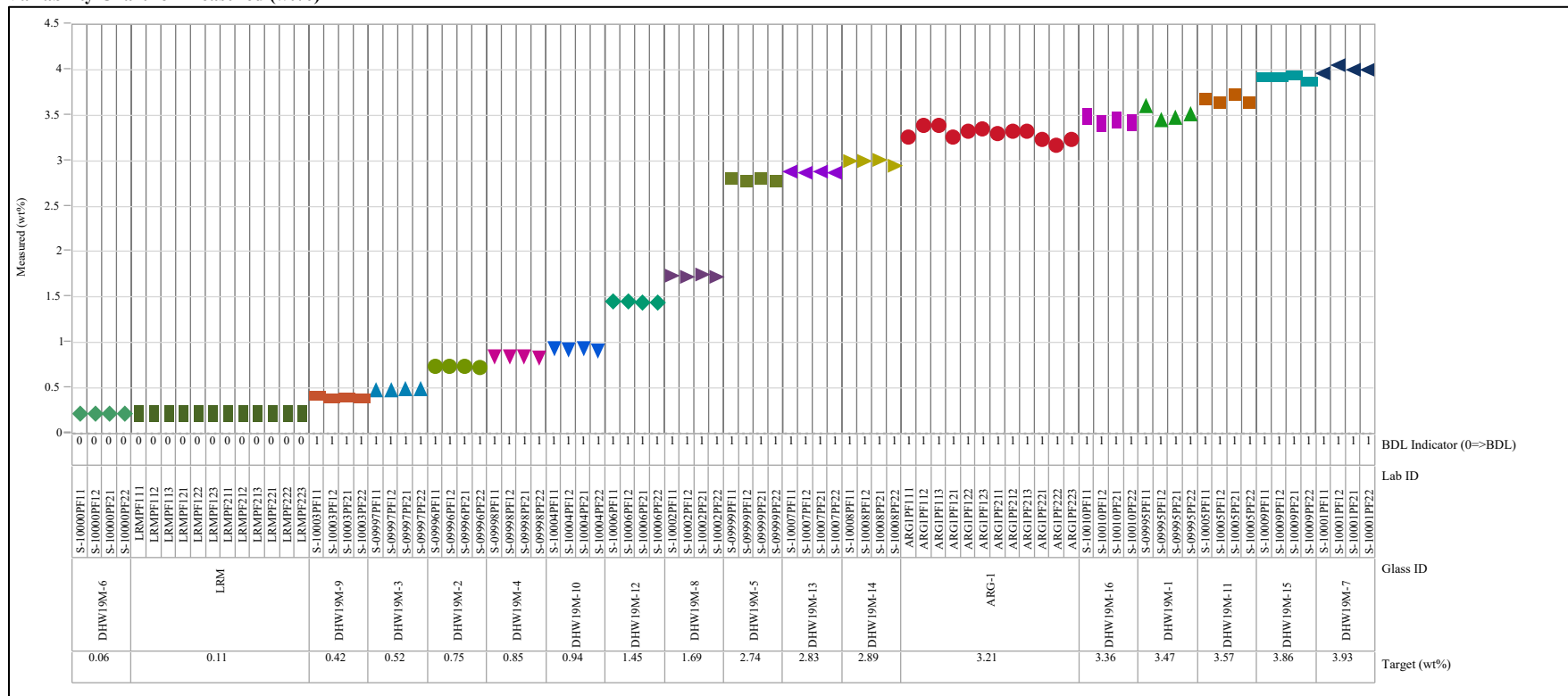
Variability Chart for Measured (wt%)



### Exhibit A-2. Plots of Oxide Measurements by Group 1 Glass Identifier Grouped by Targeted Concentrations (continued)

Analyte=Li<sub>2</sub>O, Prep Method=PF

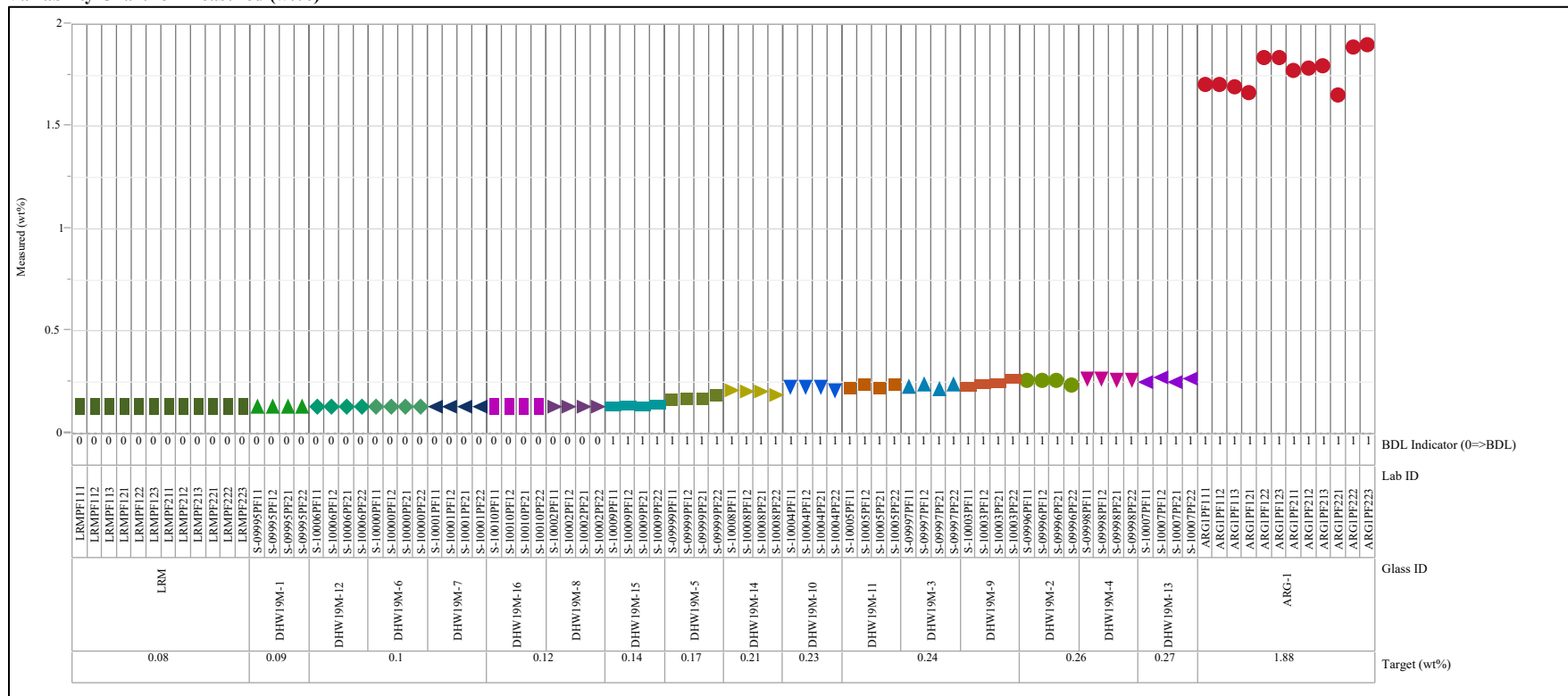
Variability Chart for Measured (wt%)



## Exhibit A-2. Plots of Oxide Measurements by Group 1 Glass Identifier Grouped by Targeted Concentrations (continued)

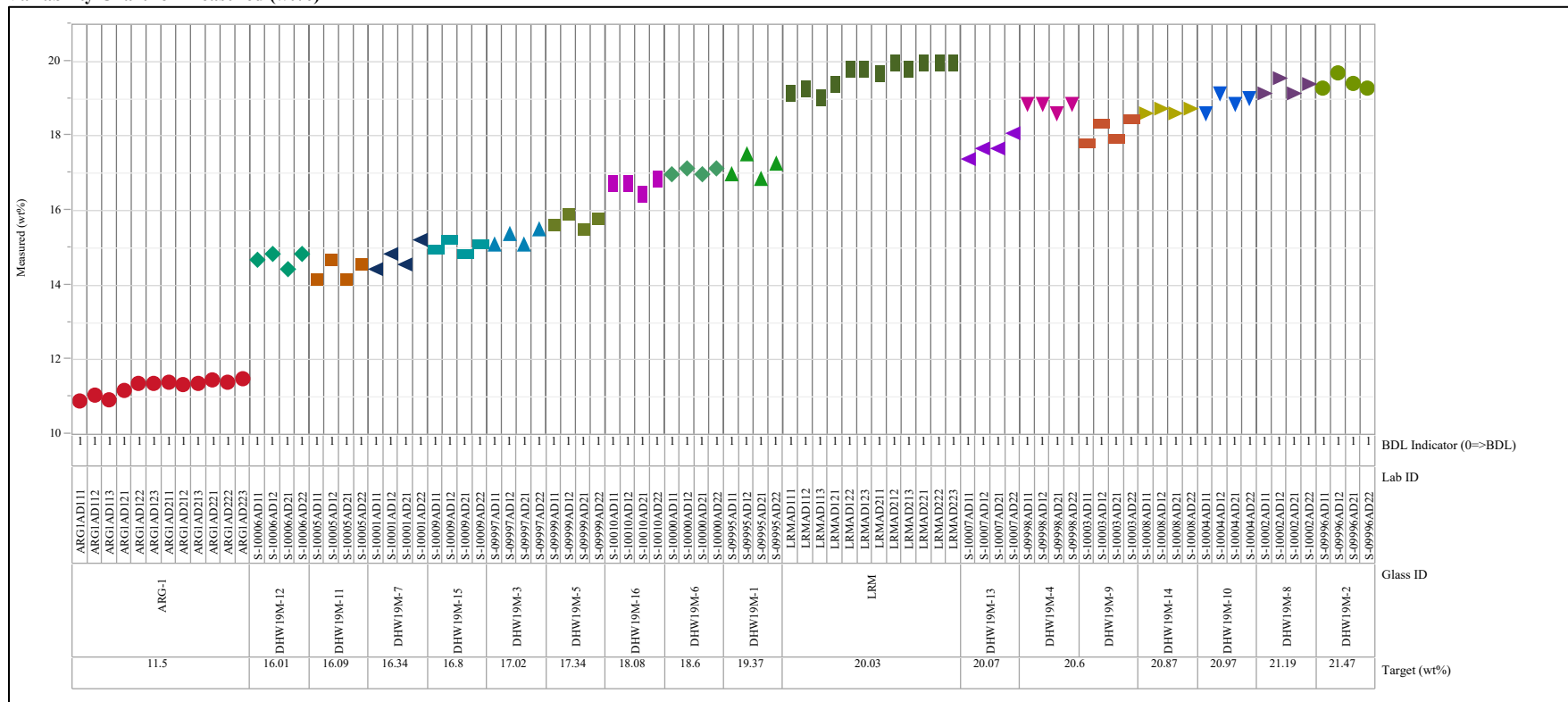
Analyte=MnO, Prep Method=PF

Variability Chart for Measured (wt%)



### Exhibit A-2. Plots of Oxide Measurements by Group 1 Glass Identifier Grouped by Targeted Concentrations (continued)

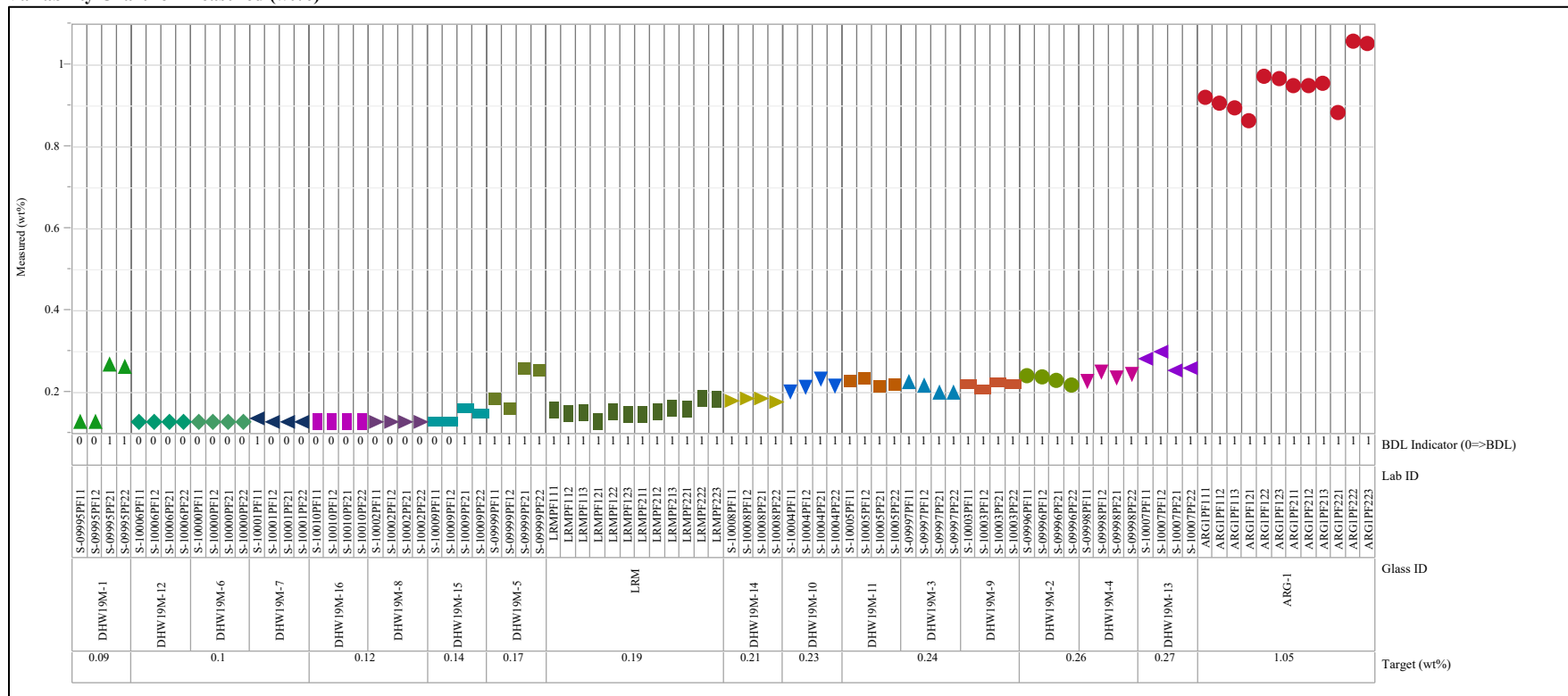
Analyte=Na<sub>2</sub>O, Prep Method=AD  
 Variability Chart for Measured (wt%)



**Exhibit A-2. Plots of Oxide Measurements by Group 1 Glass Identifier Grouped by Targeted Concentrations (continued)**

Analyte=NiO, Prep Method=PF

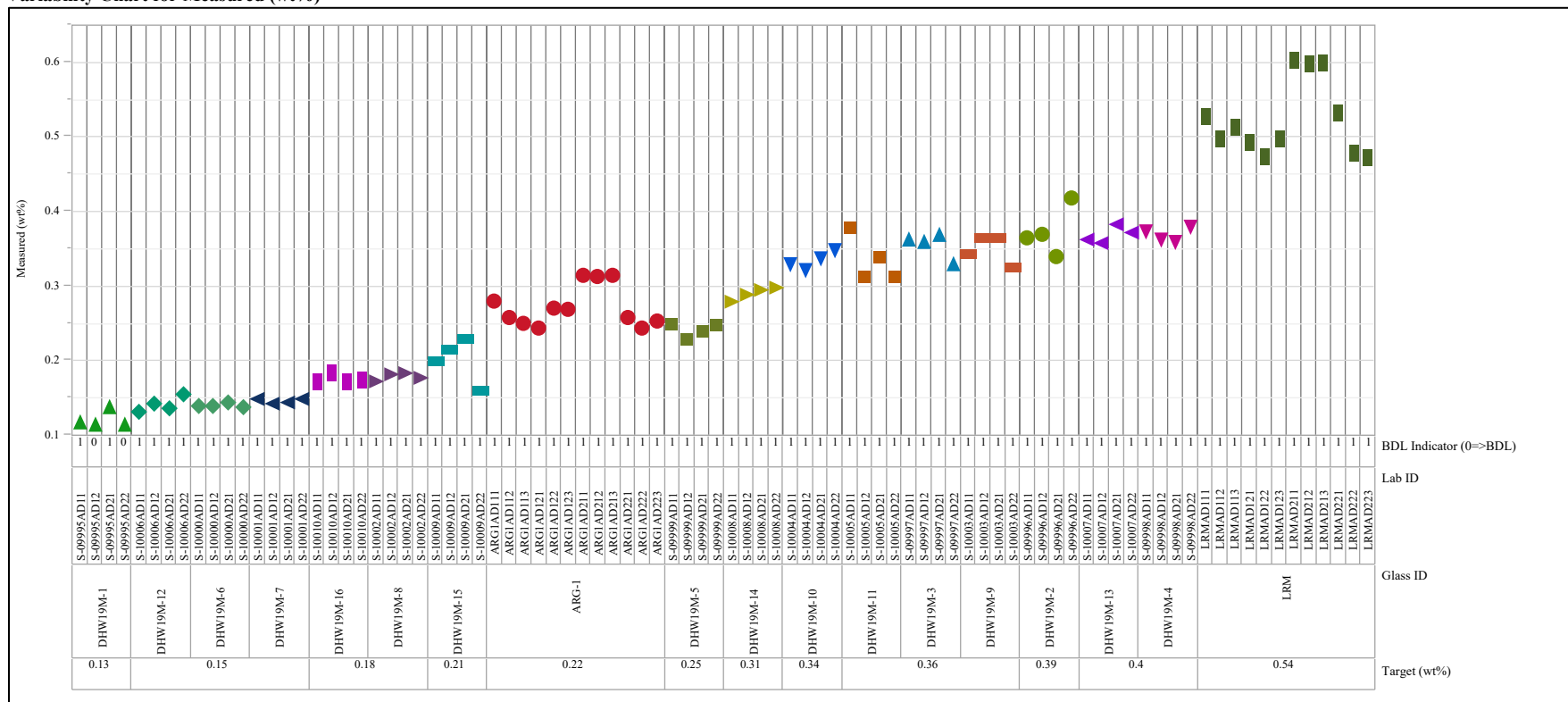
Variability Chart for Measured (wt%)



**Exhibit A-2. Plots of Oxide Measurements by Group 1 Glass Identifier Grouped by Targeted Concentrations (continued)**

Analyte=P2O5, Prep Method=AD

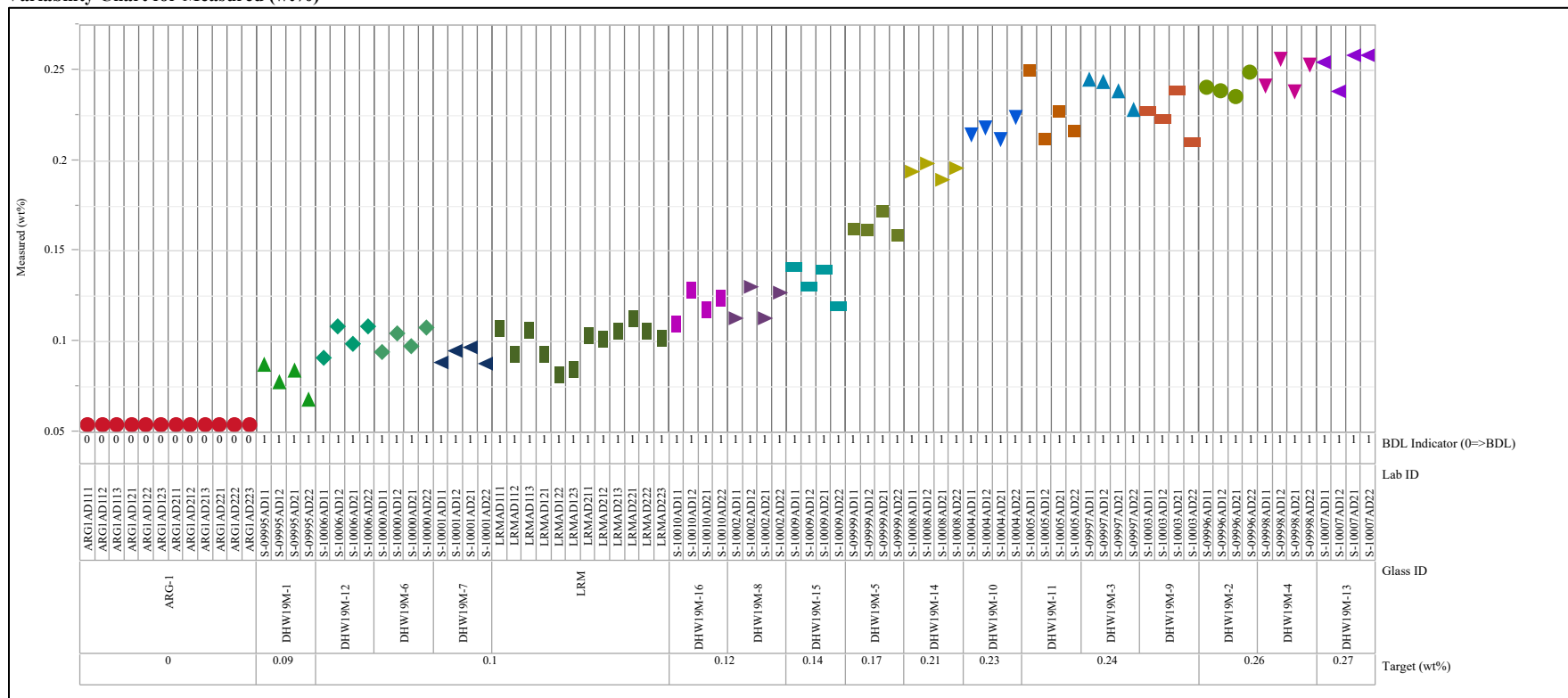
### Variability Chart for Measured (wt%)



**Exhibit A-2. Plots of Oxide Measurements by Group 1 Glass Identifier Grouped by Targeted Concentrations (continued)**

**Analyte=PbO, Prep Method=AD**

### Variability Chart for Measured (wt%)

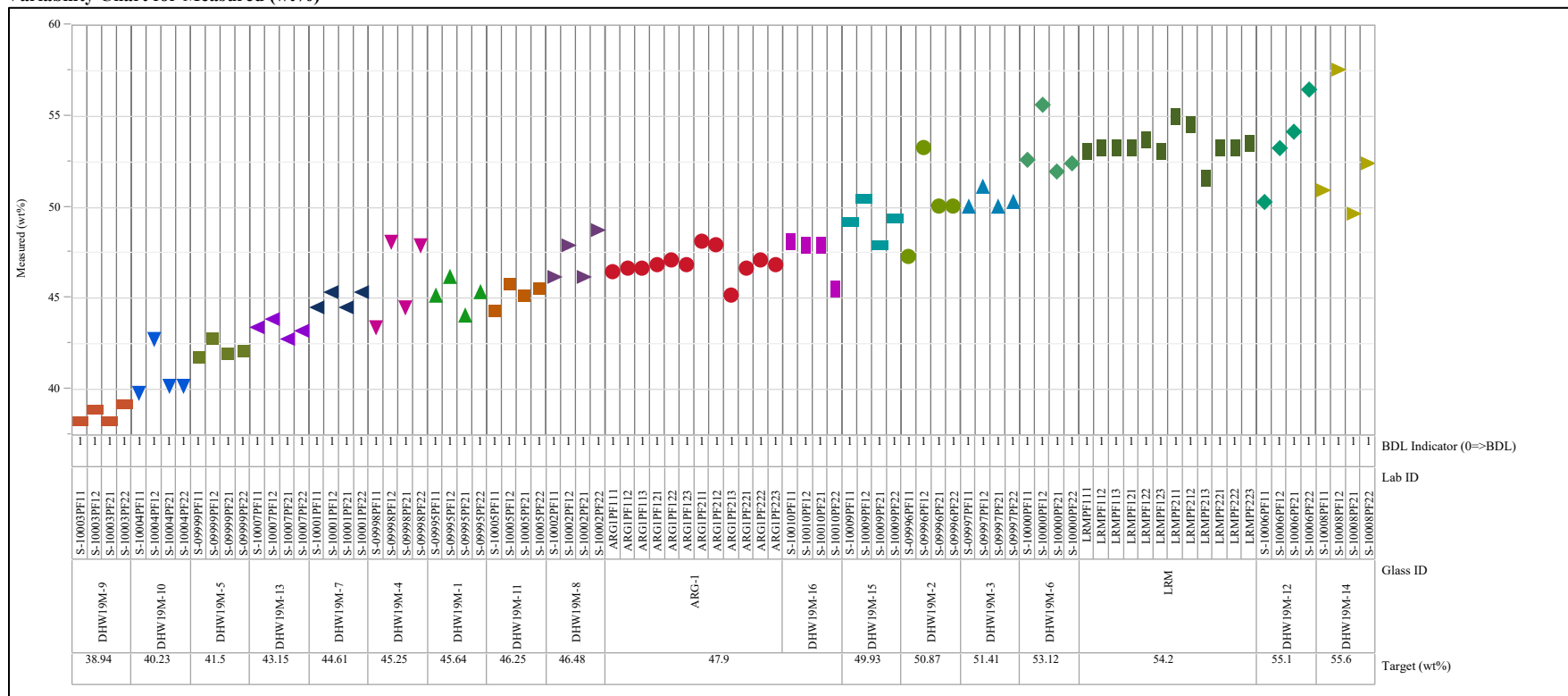




**Exhibit A-2. Plots of Oxide Measurements by Group 1 Glass Identifier Grouped by Targeted Concentrations (continued)**

Analyte=SiO2, Prep Method=PF

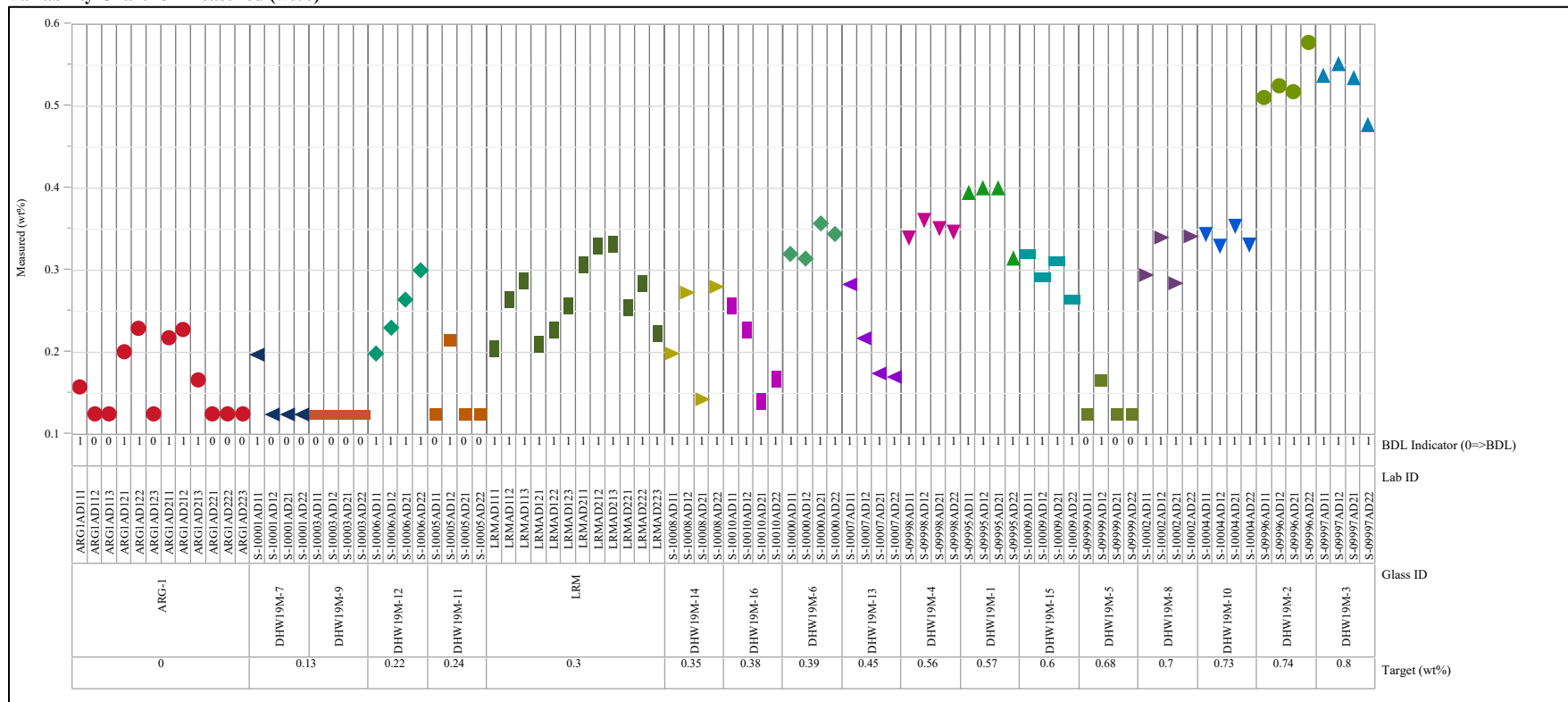
### Variability Chart for Measured (wt%)



### Exhibit A-2. Plots of Oxide Measurements by Group 1 Glass Identifier Grouped by Targeted Concentrations (continued)

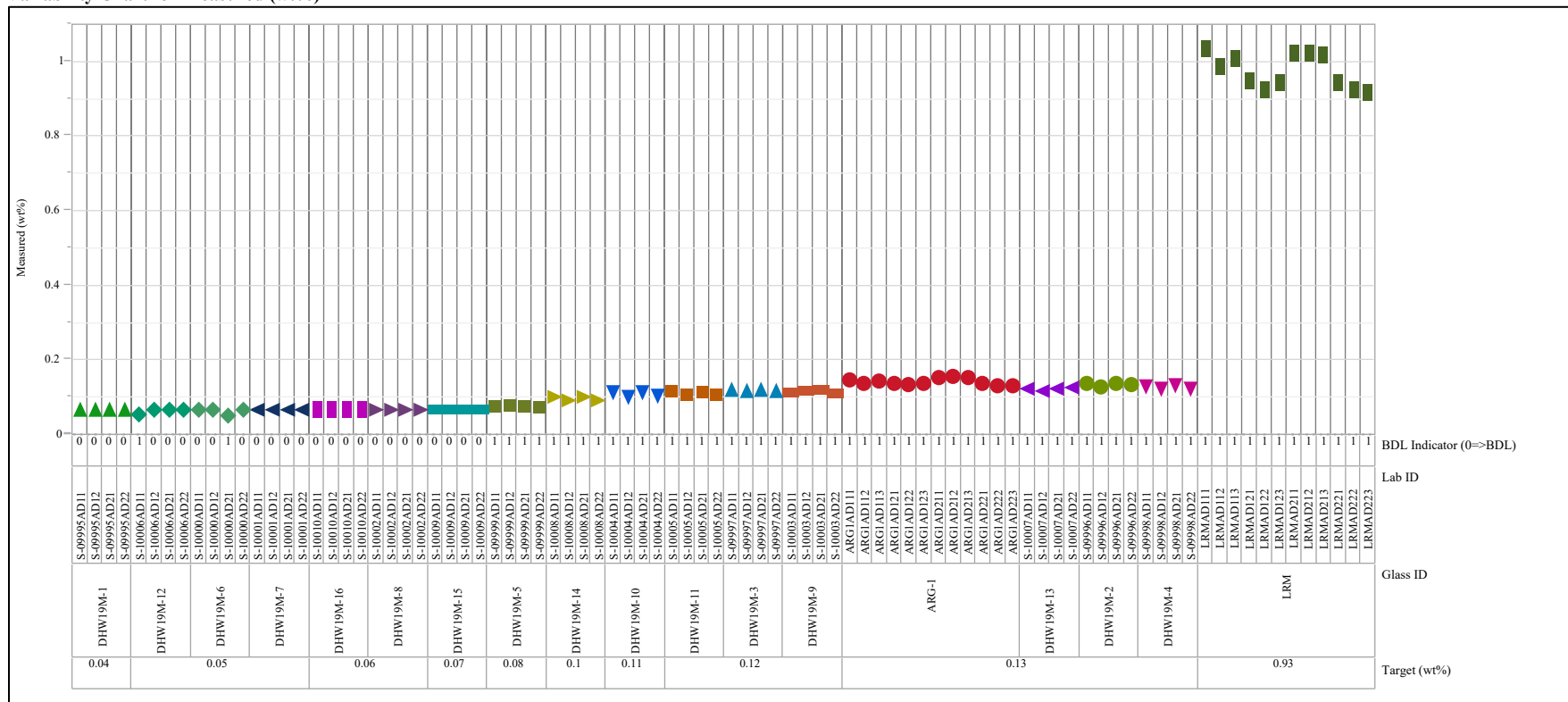
Analyte=SO<sub>3</sub>, Prep Method=AD

Variability Chart for Measured (wt%)



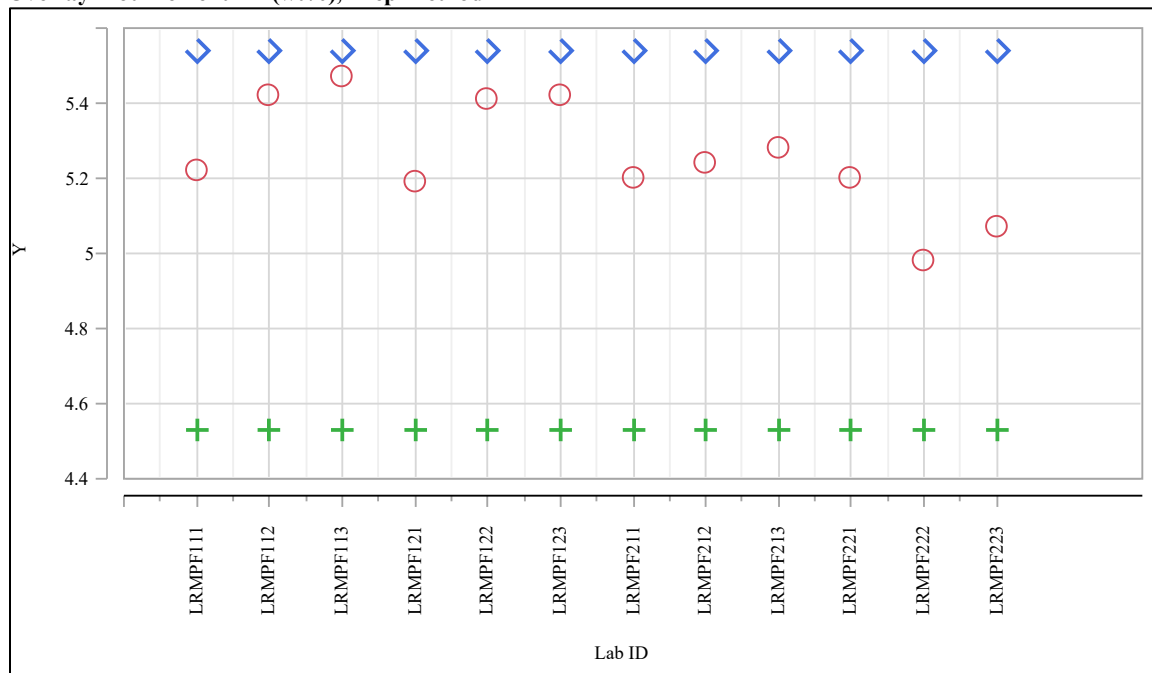
**Exhibit A-2. Plots of Oxide Measurements by Group 1 Glass Identifier Grouped by Targeted Concentrations (continued)**Analyte=ZrO<sub>2</sub>, Prep Method=AD

Variability Chart for Measured (wt%)

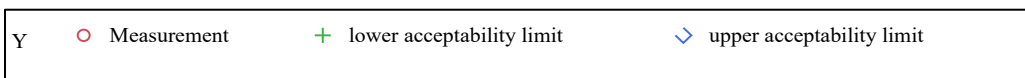
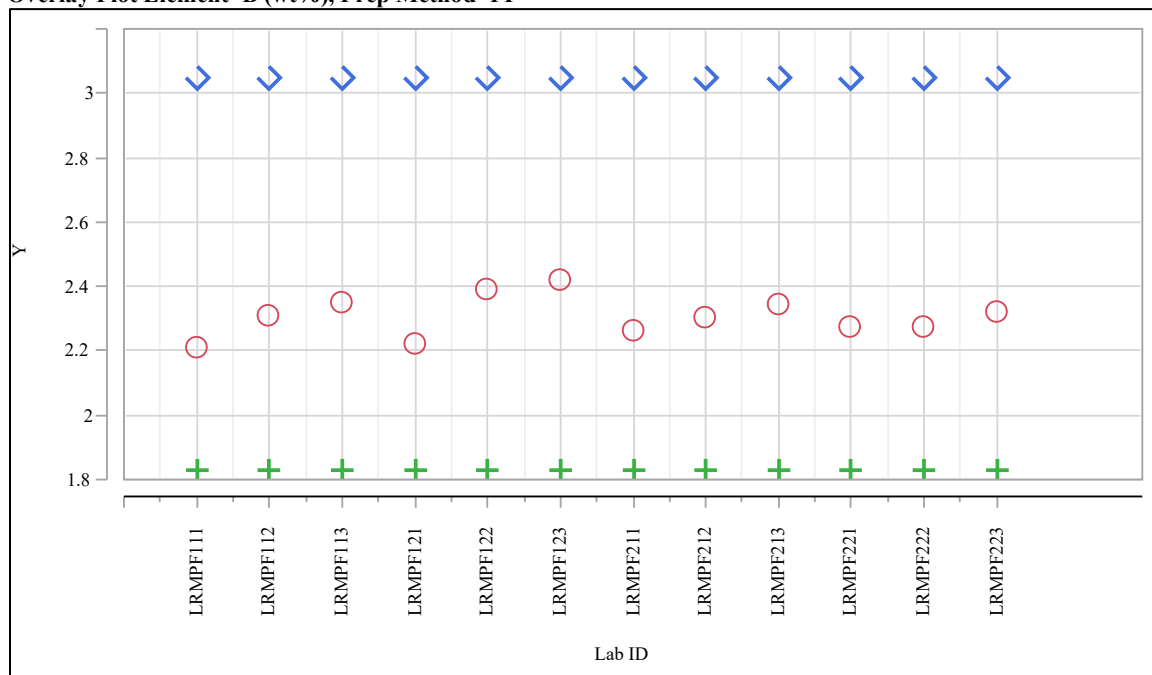


### Exhibit A-3. Acceptability Evaluation for Measurements of the LRM Standard Glass

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

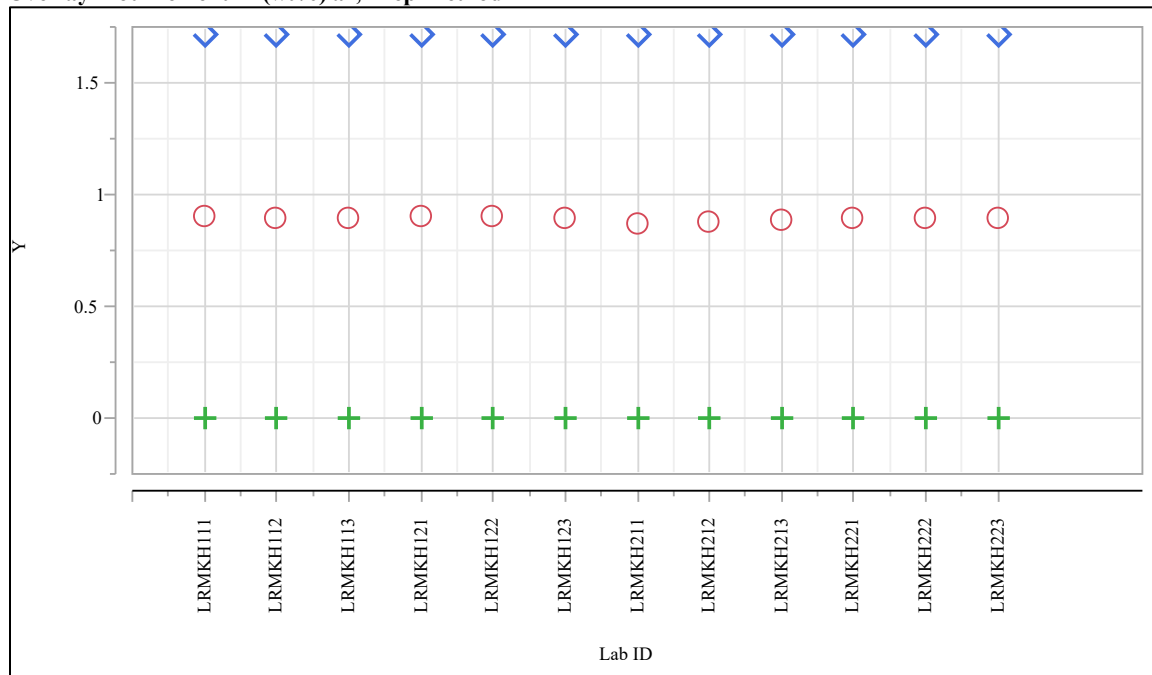


Overlay Plot Element=B (wt%), Prep Method=PF

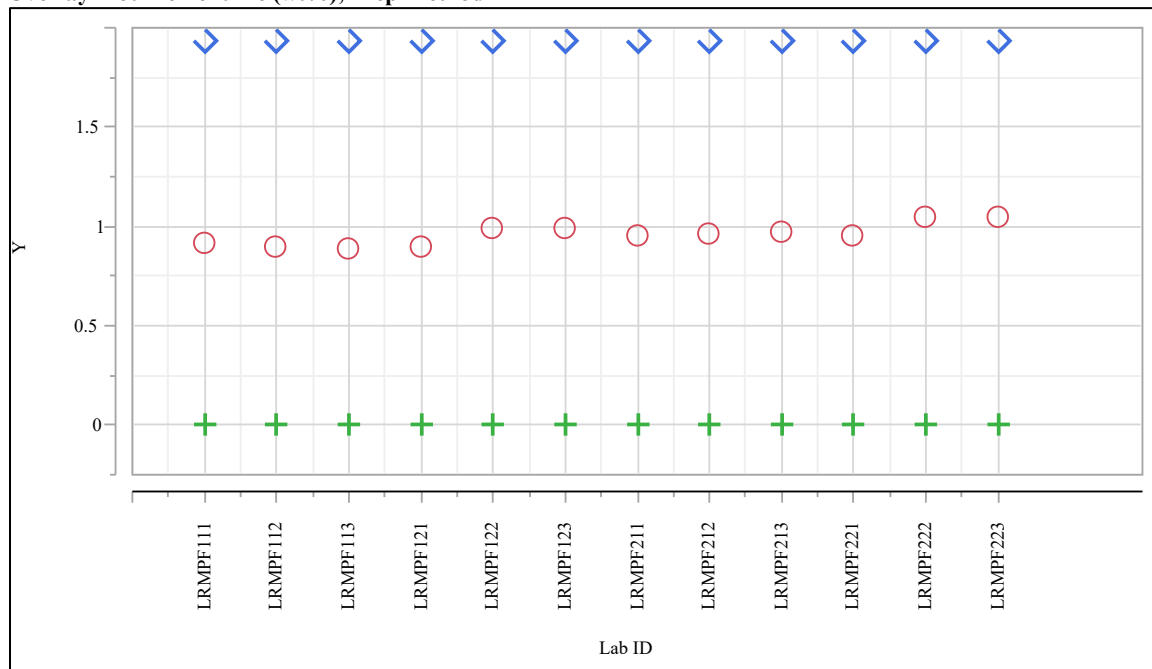


**Exhibit A-3. Acceptability Evaluation for Measurements of the LRM Standard Glass (continued)**

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



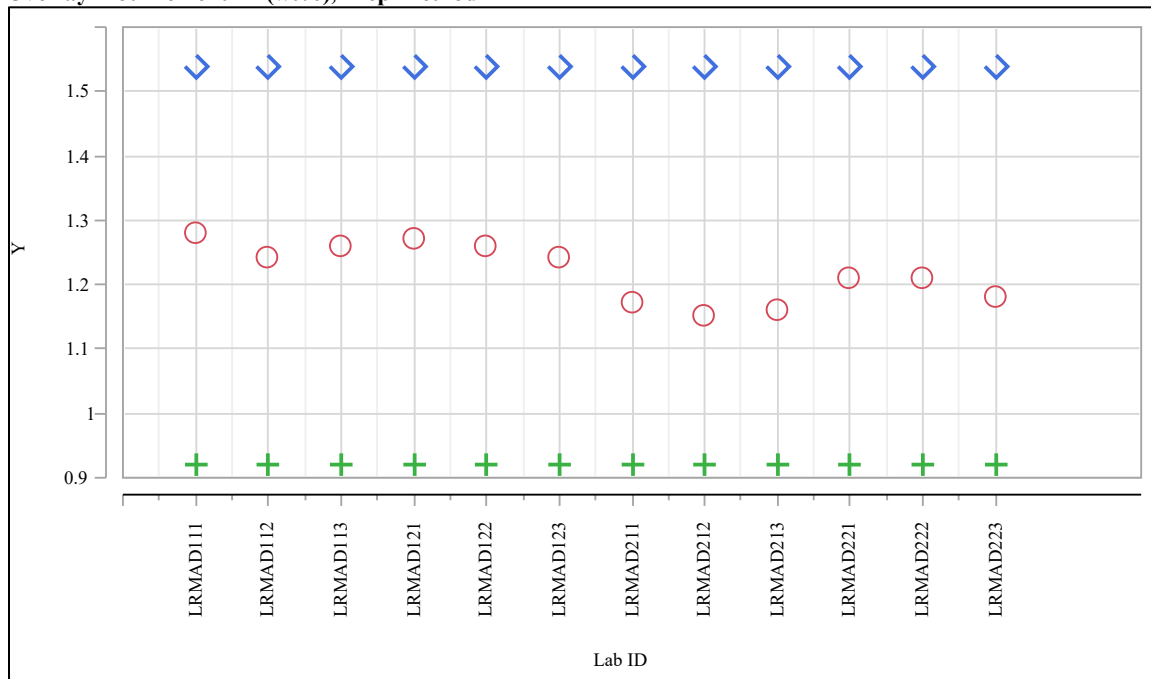
Overlay Plot Element=Fe (wt%), Prep Method=PF



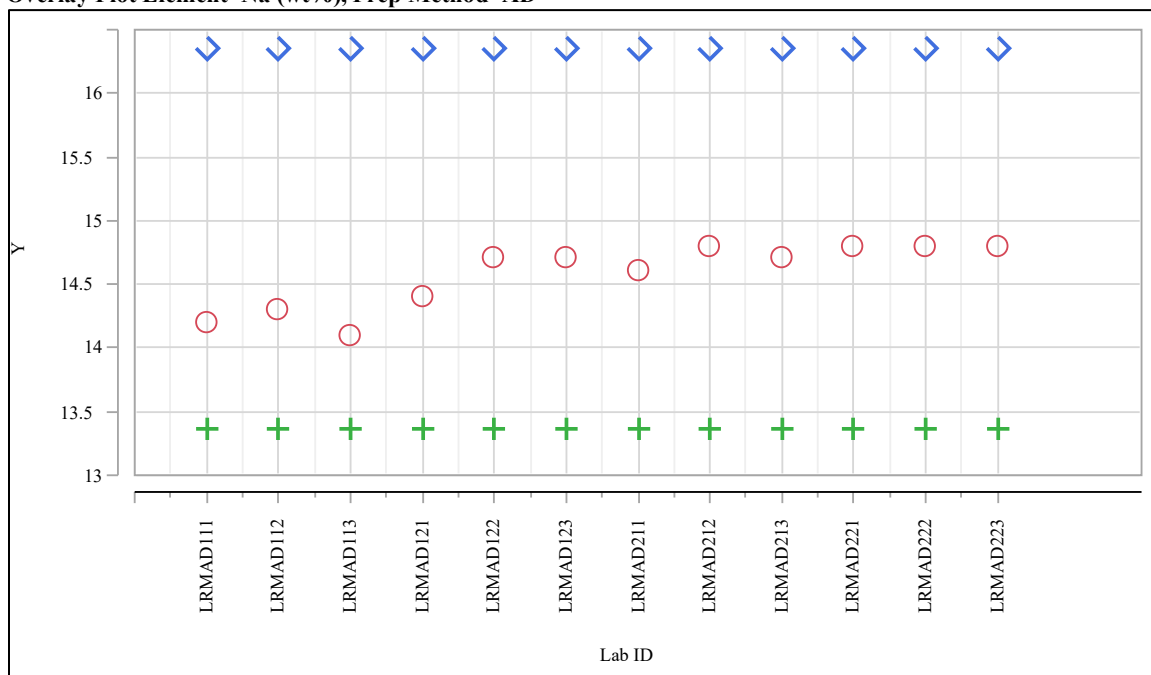
Y    ○ Measurement    + lower acceptability limit    ◇ upper acceptability limit

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

Overlay Plot Element=K (wt%), Prep Method=AD



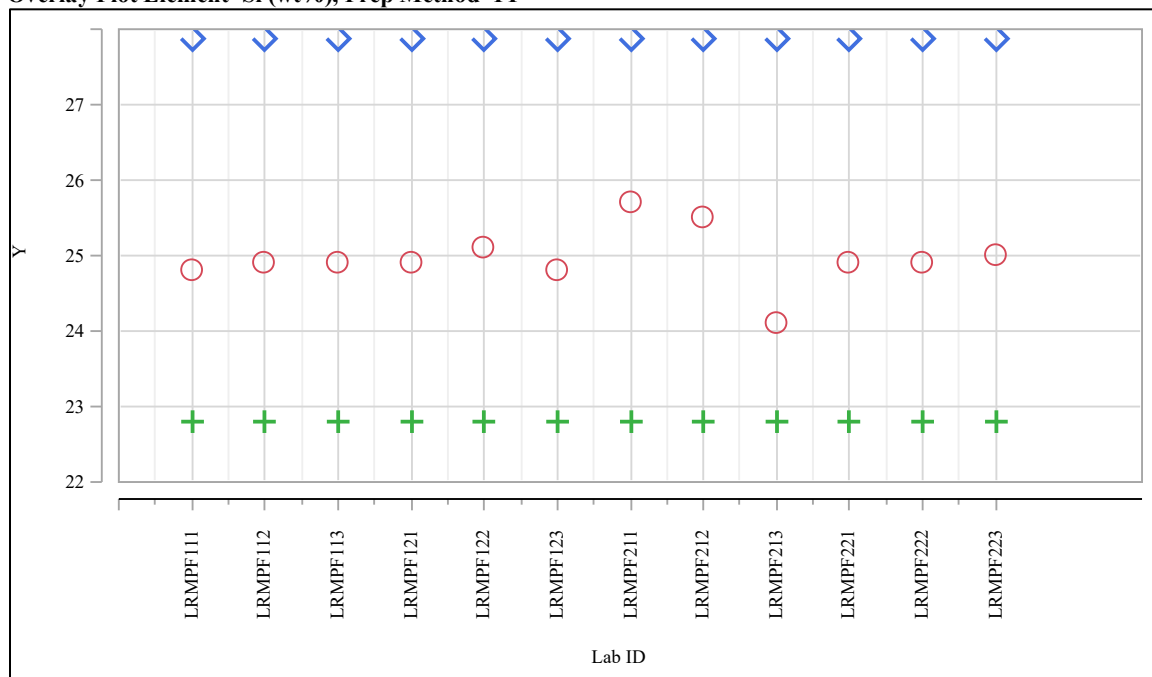
Overlay Plot Element=Na (wt%), Prep Method=AD



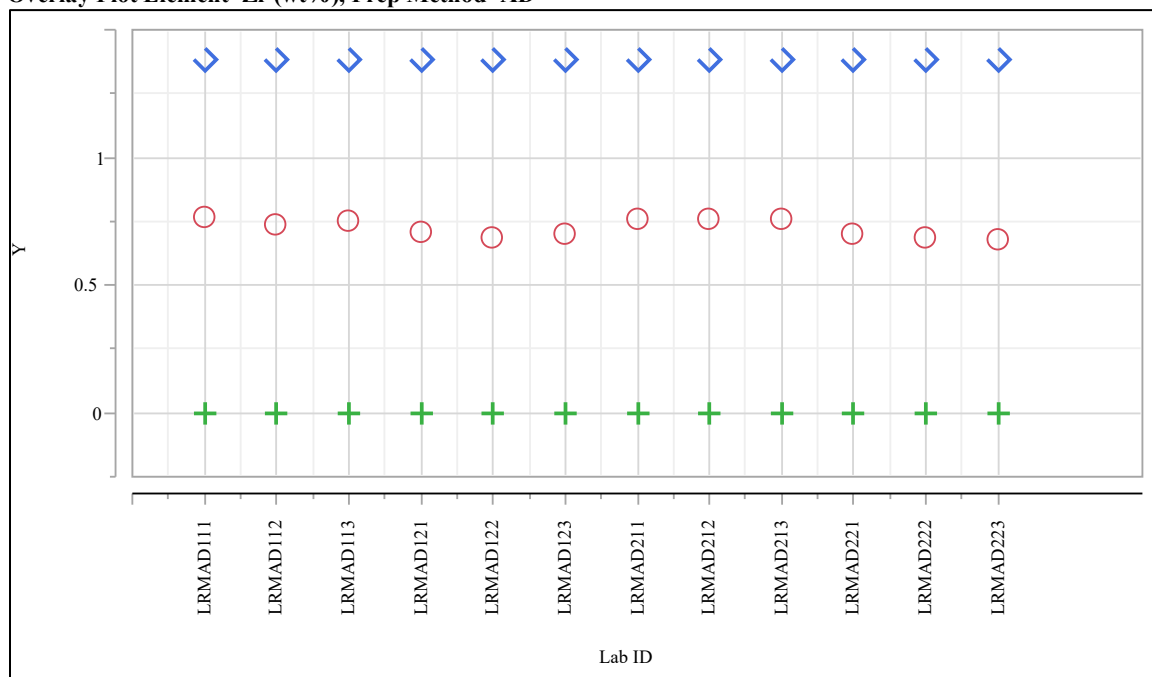
Y    ○ Measurement    + lower acceptability limit    ◇ upper acceptability limit

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

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



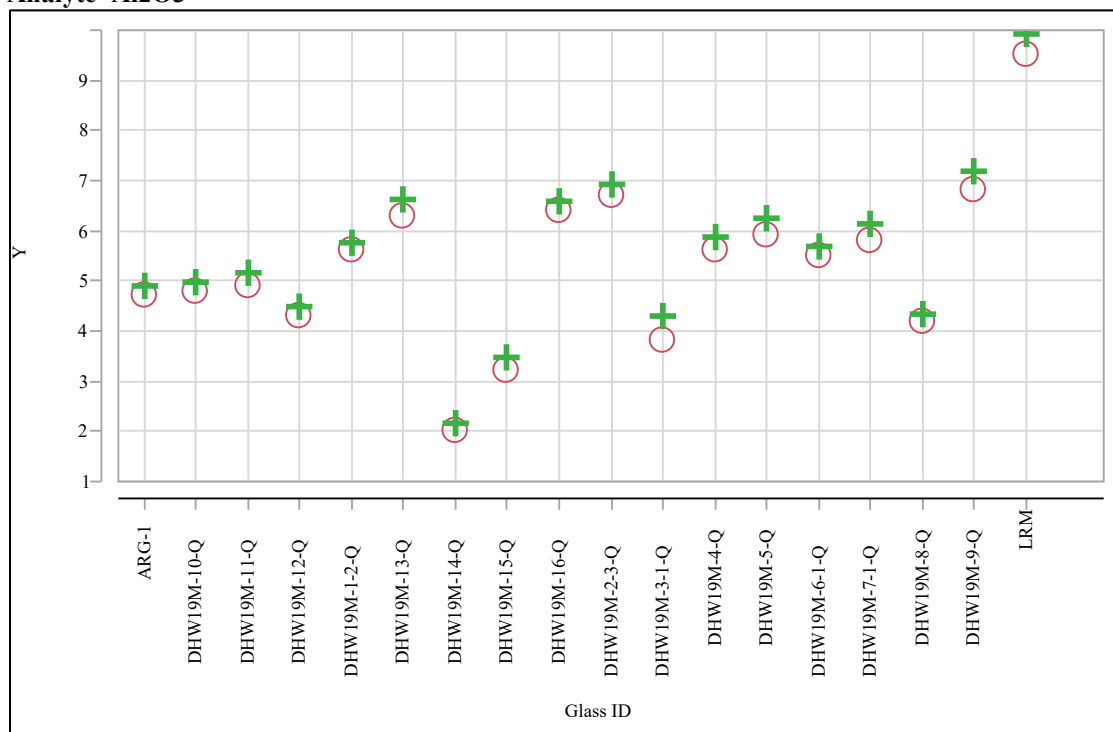
Overlay Plot Element=Zr (wt%), Prep Method=AD



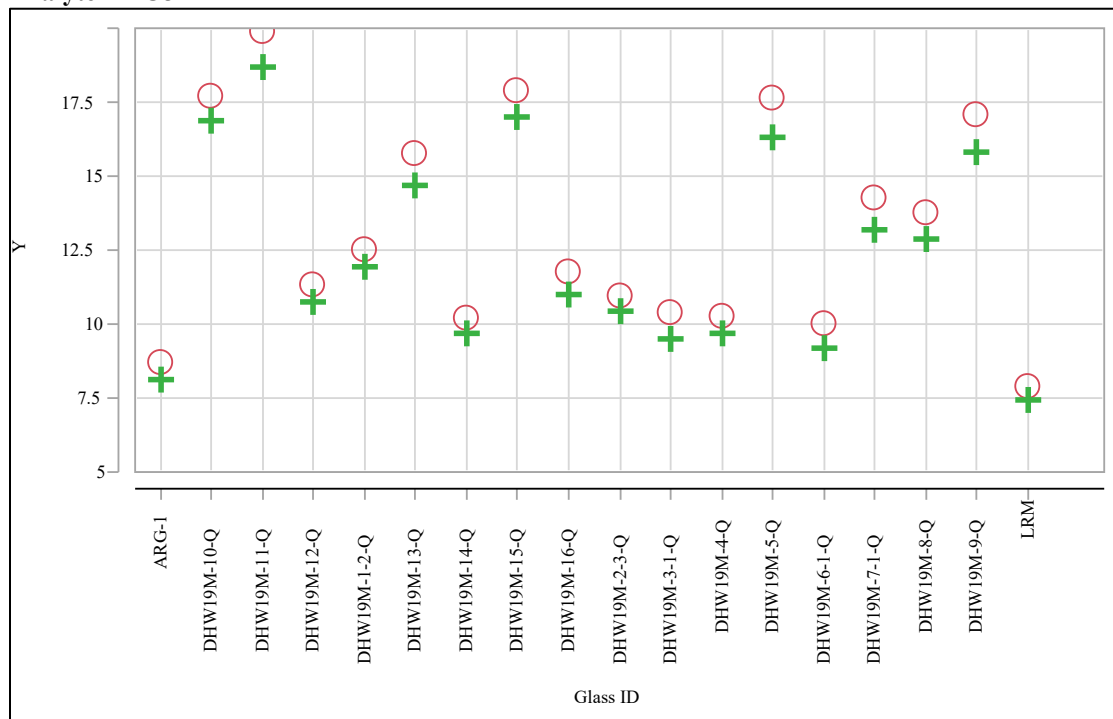
Y    ○ Measurement    + lower acceptability limit    ◇ upper acceptability limit

**Exhibit A-4. Measured versus Targeted Concentrations by Group 1 Glass ID by Oxide**

Analyte=Al<sub>2</sub>O<sub>3</sub>



Analyte=B<sub>2</sub>O<sub>3</sub>

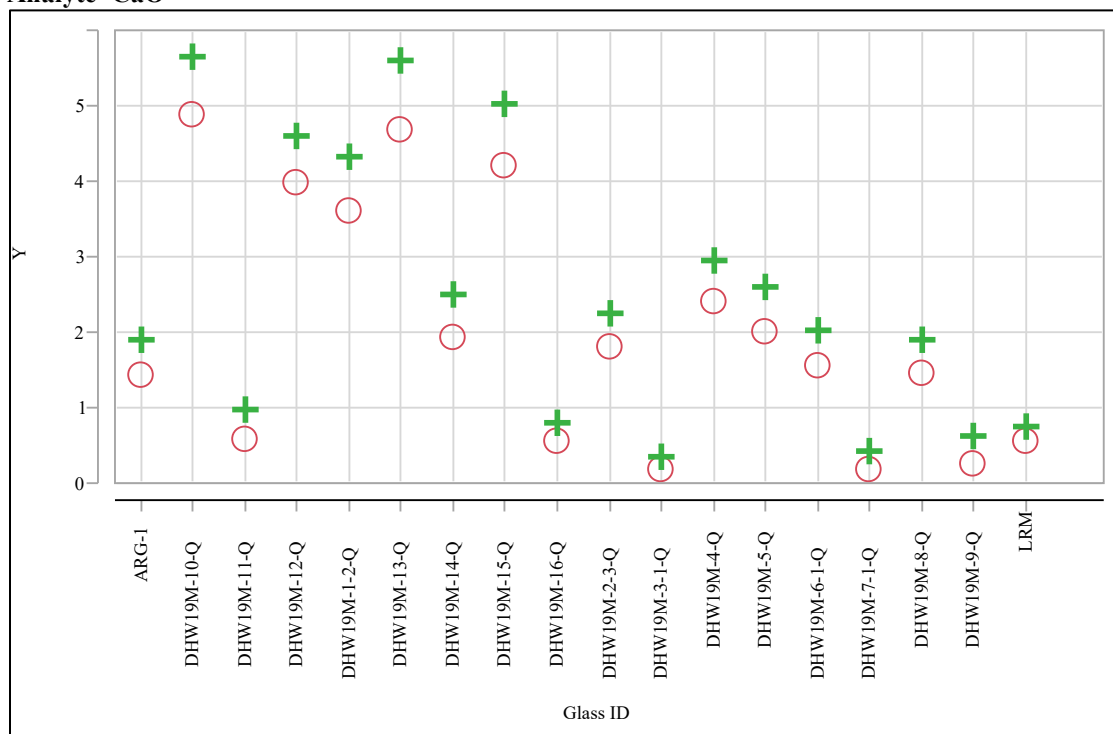


Y    ○ Target (wt%)    + Measured (wt%)    ◇ BDL (wt%)

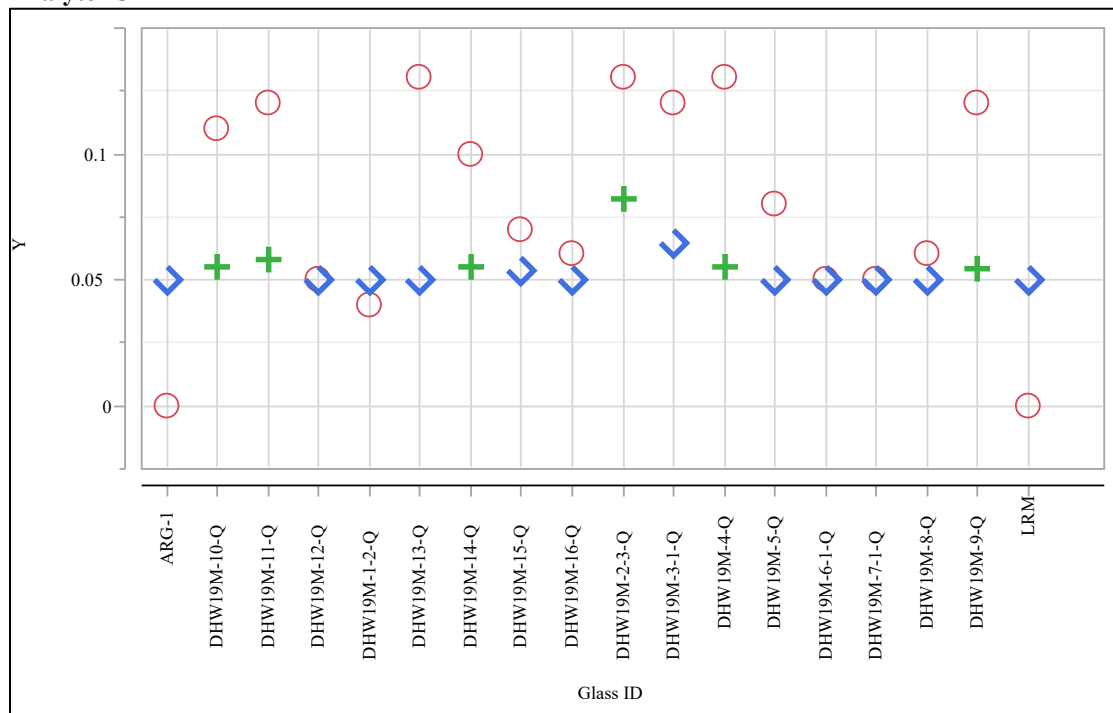


**Exhibit A-4. Measured versus Targeted Concentrations by Group 1 Glass ID by Oxide (continued)**

Analyte=CaO



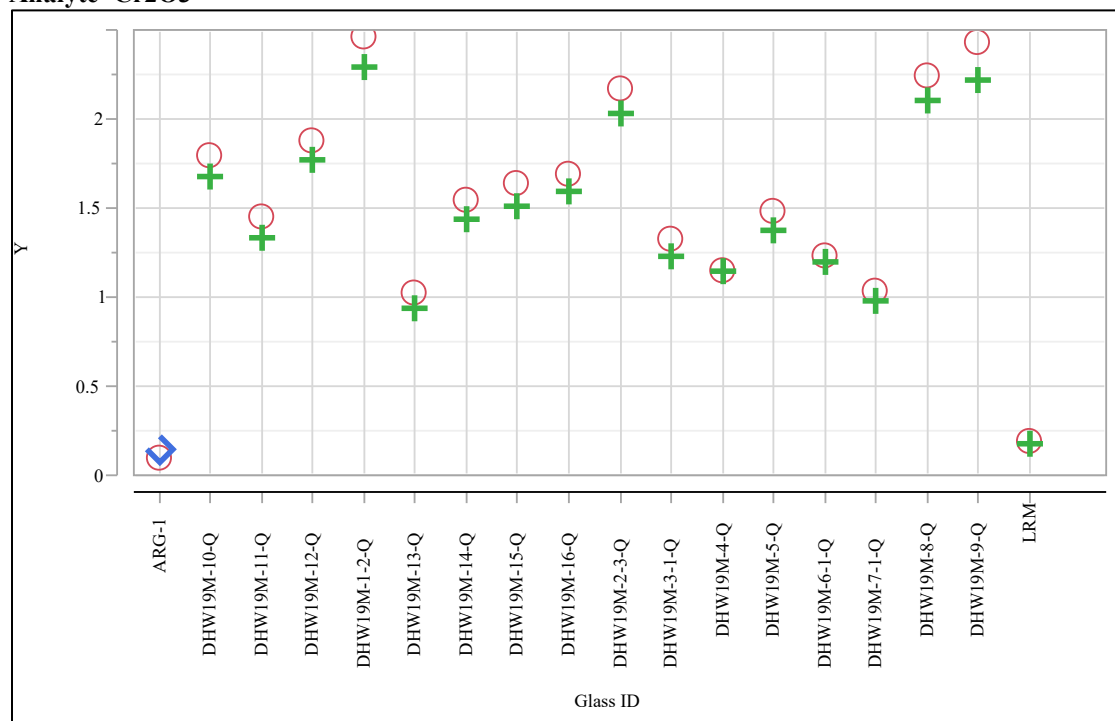
Analyte=Cl



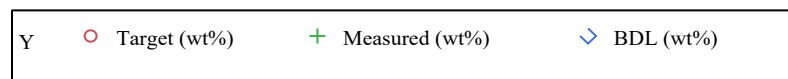
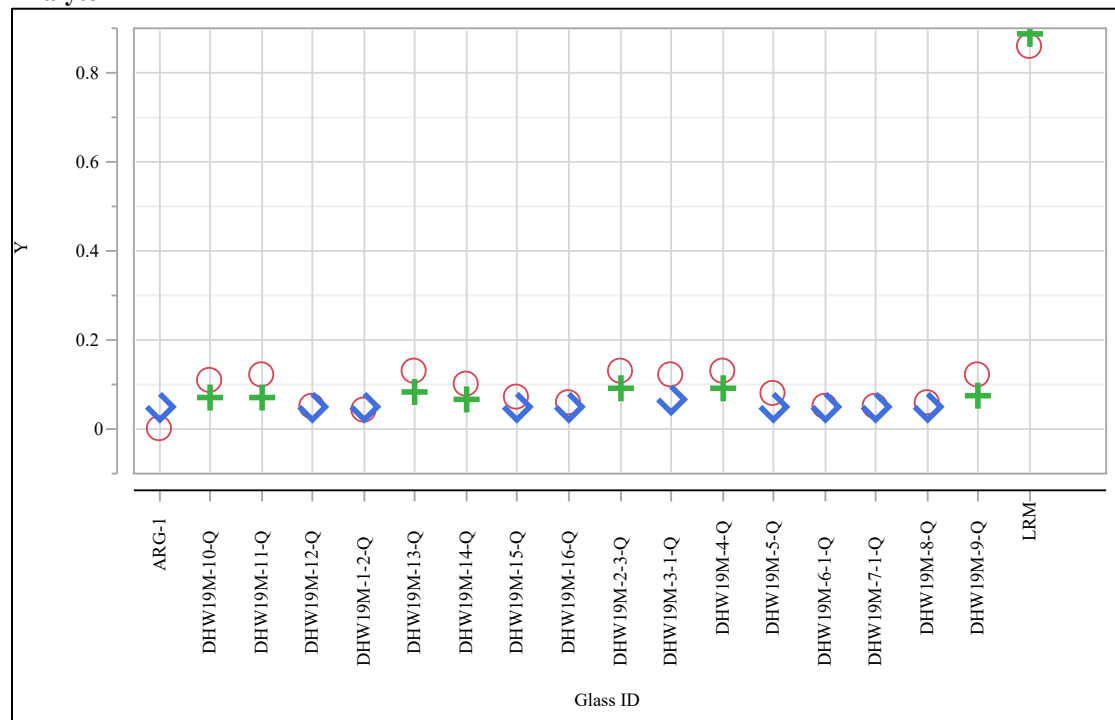
Y    ○ Target (wt%)    + Measured (wt%)    ◇ BDL (wt%)

**Exhibit A-4. Measured versus Targeted Concentrations by Group 1 Glass ID by Oxide (continued)**

Analyte=Cr2O3

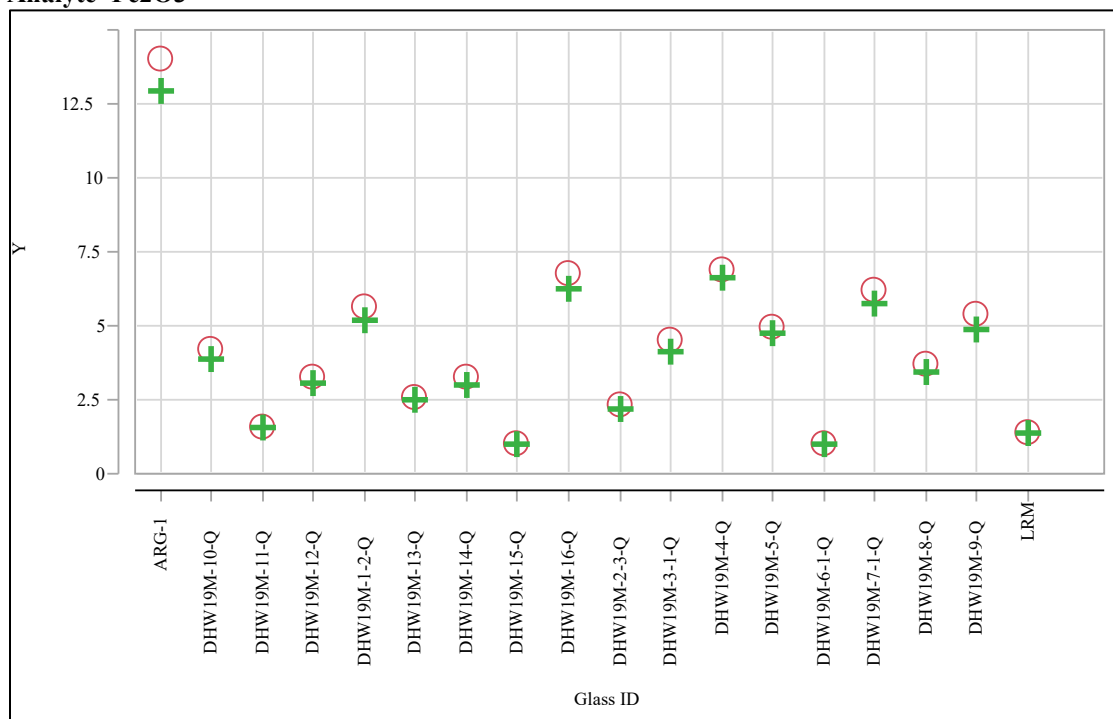


Analyte=F

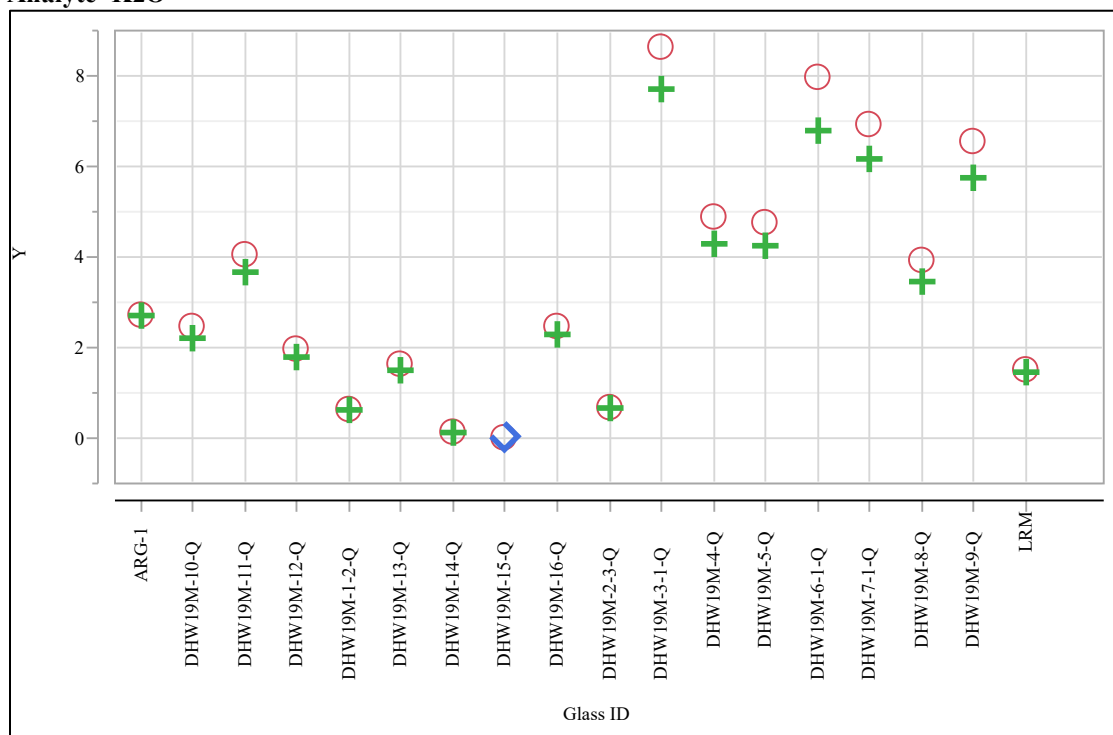


**Exhibit A-4. Measured versus Targeted Concentrations by Group 1 Glass ID by Oxide (continued)**

Analyte=Fe2O3



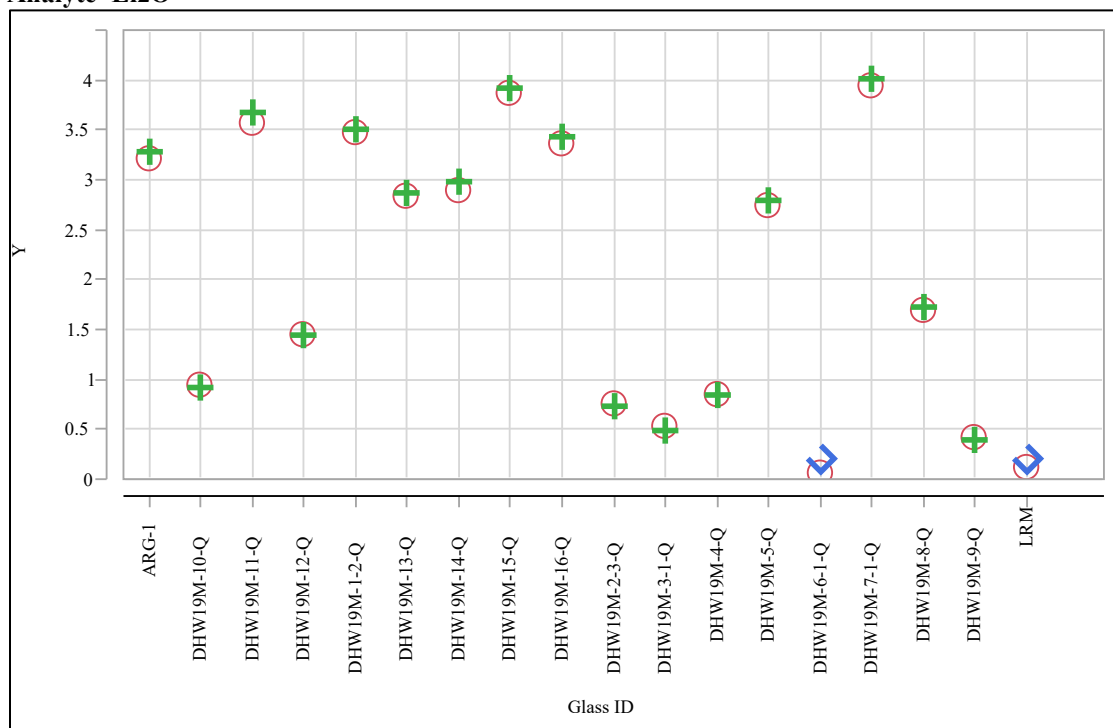
Analyte=K2O



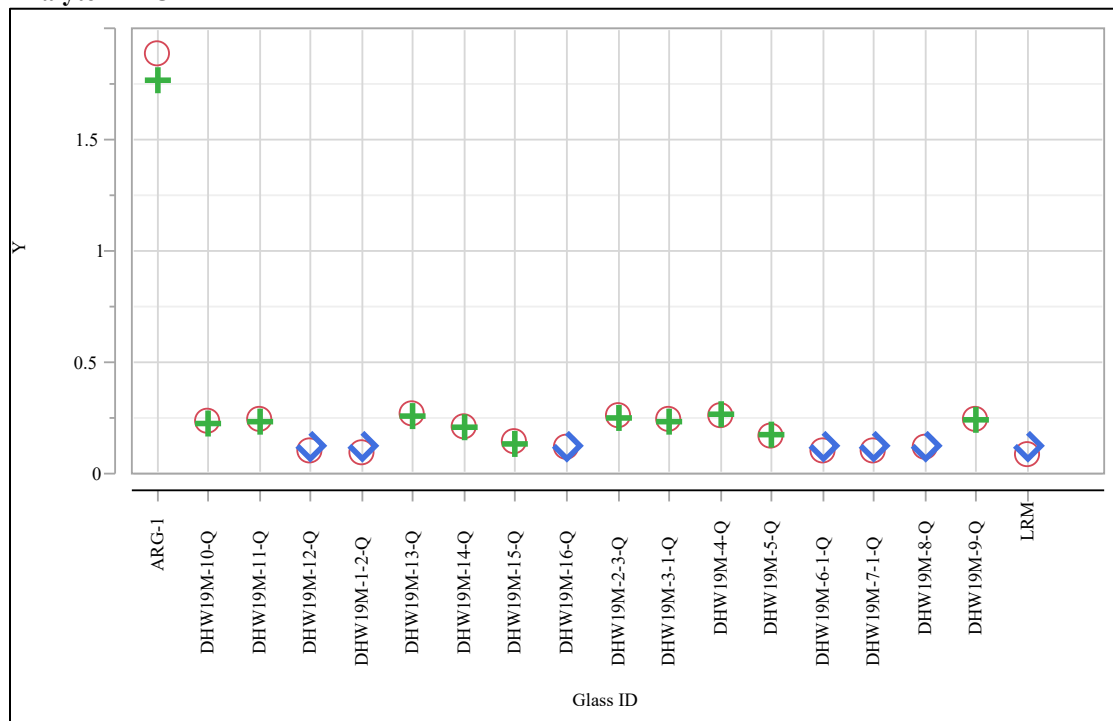
Y    ○ Target (wt%)    + Measured (wt%)    ◇ BDL (wt%)

**Exhibit A-4. Measured versus Targeted Concentrations by Group 1 Glass ID by Oxide (continued)**

Analyte=Li<sub>2</sub>O



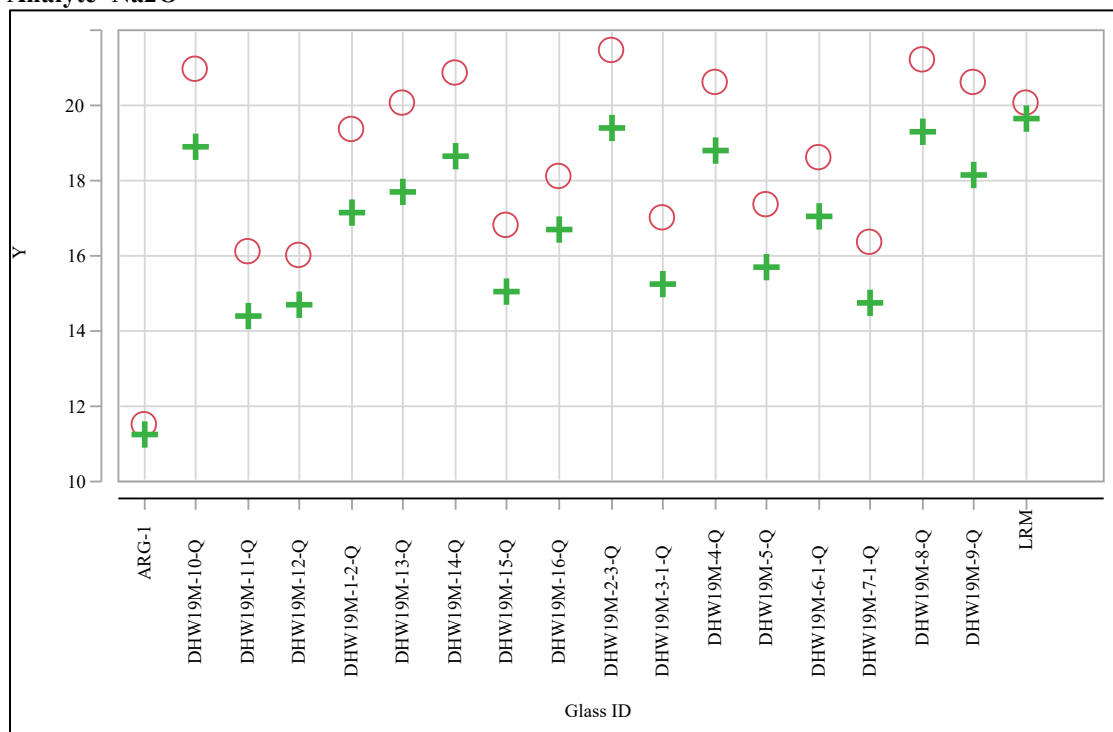
Analyte=MnO



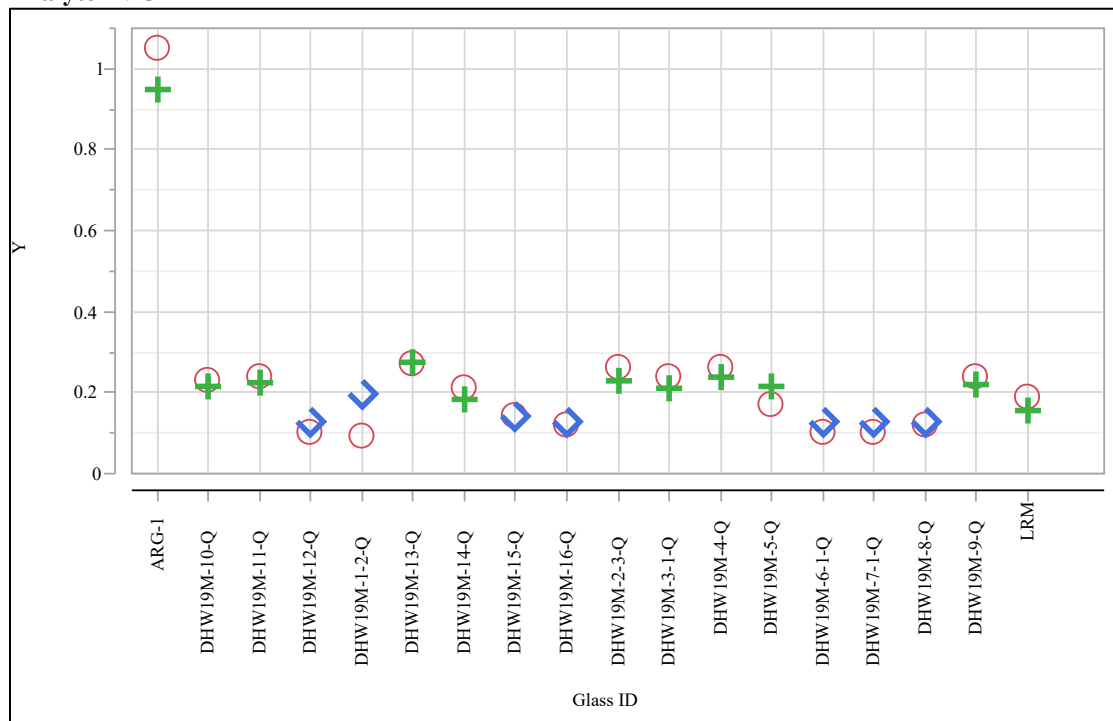
Y    ○ Target (wt%)    + Measured (wt%)    ◇ BDL (wt%)

**Exhibit A-4. Measured versus Targeted Concentrations by Group 1 Glass ID by Oxide (continued)**

Analyte=Na<sub>2</sub>O



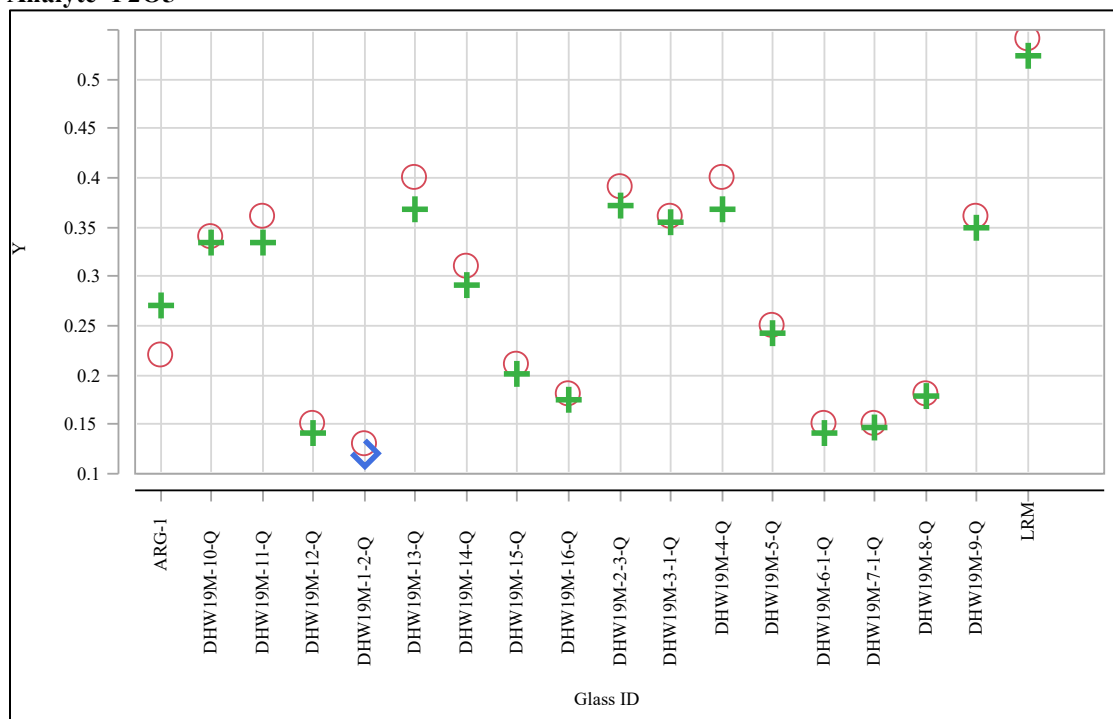
Analyte=NiO



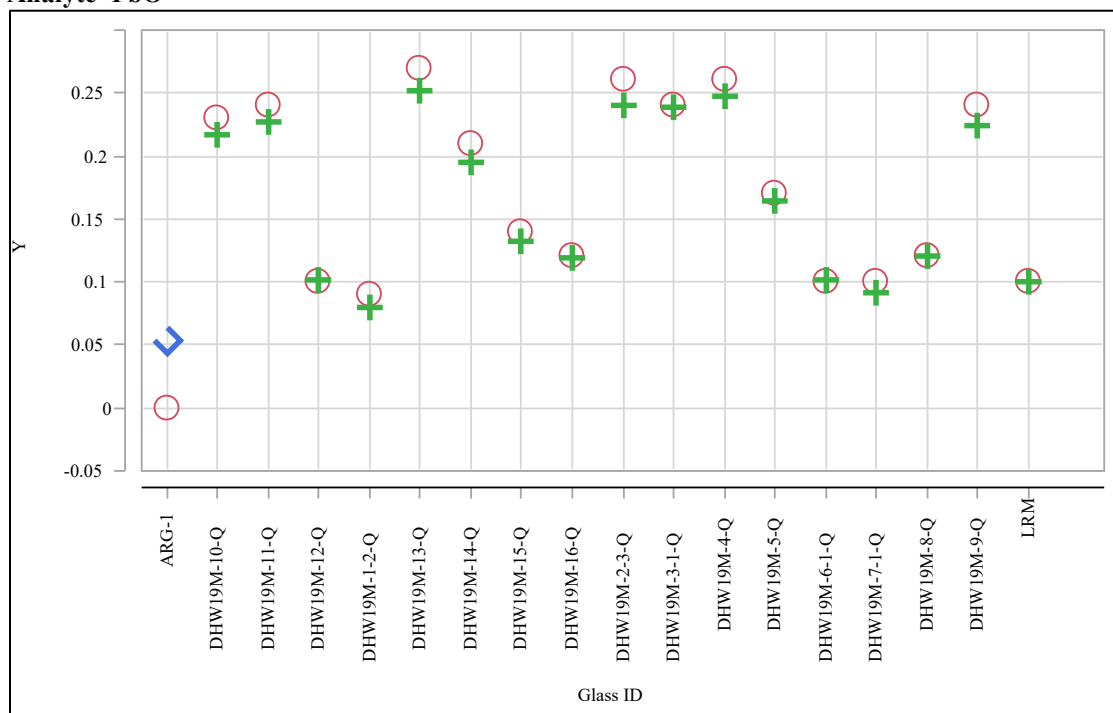
Y    ○ Target (wt%)    + Measured (wt%)    ◇ BDL (wt%)

**Exhibit A-4. Measured versus Targeted Concentrations by Group 1 Glass ID by Oxide (continued)**

**Analyte=P2O5**



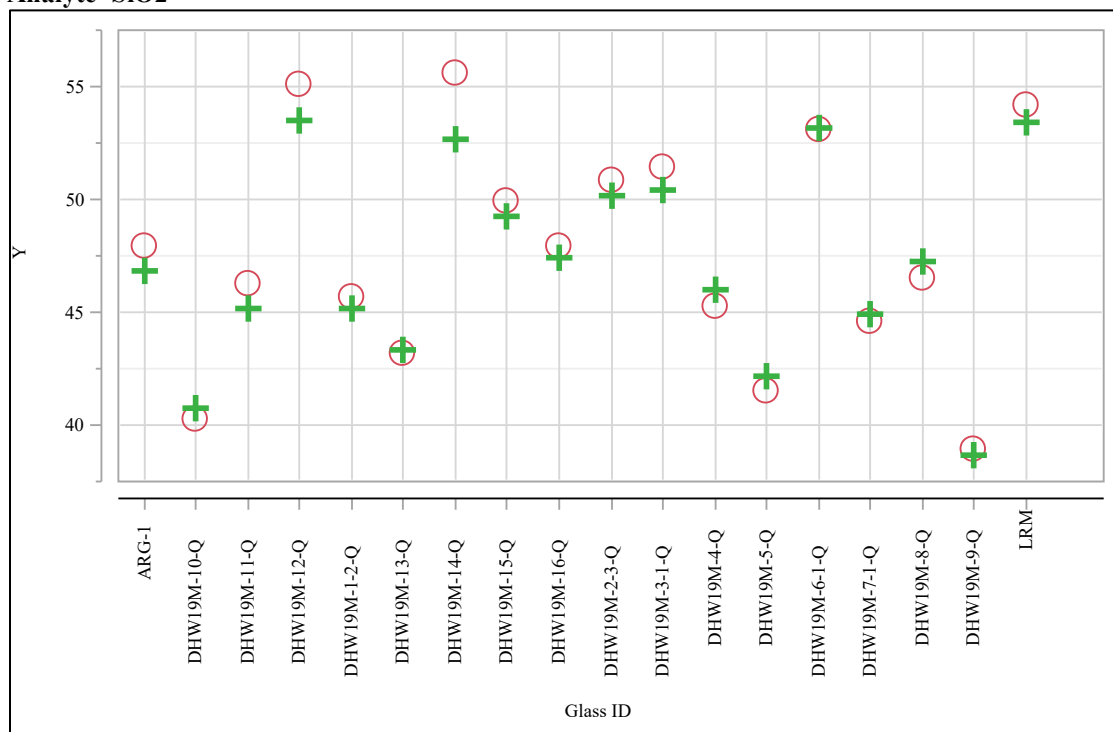
**Analyte=PbO**



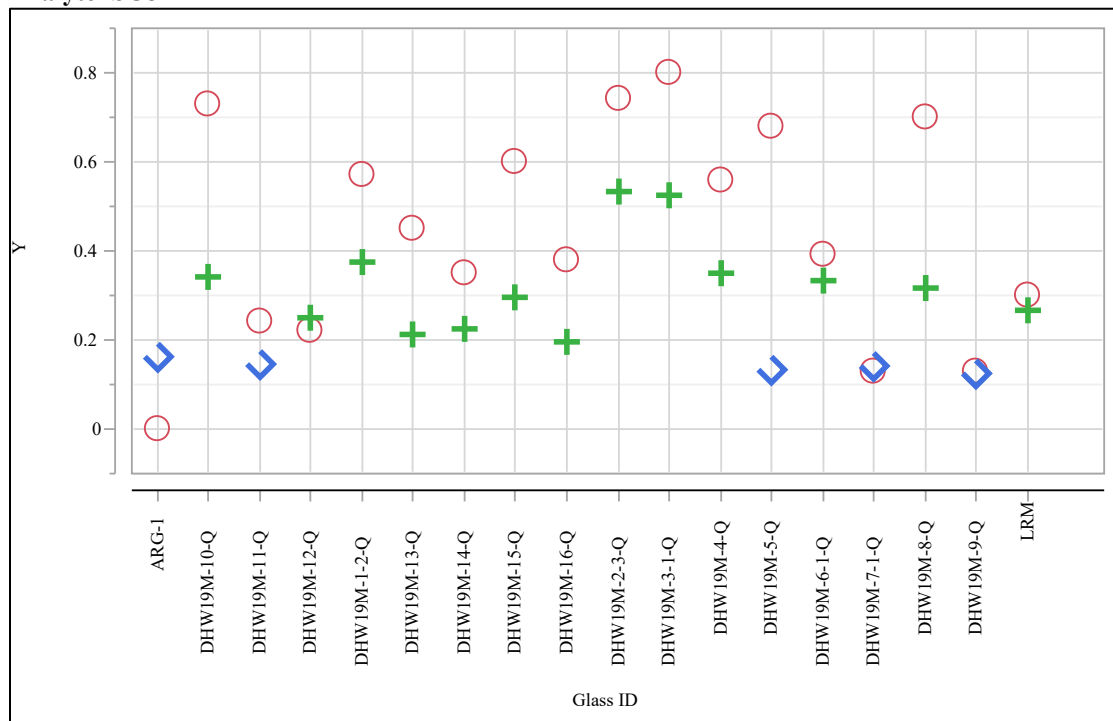
Y    ○ Target (wt%)    + Measured (wt%)    ◇ BDL (wt%)

**Exhibit A-4. Measured versus Targeted Concentrations by Group 1 Glass ID by Oxide (continued)**

Analyte=SiO<sub>2</sub>



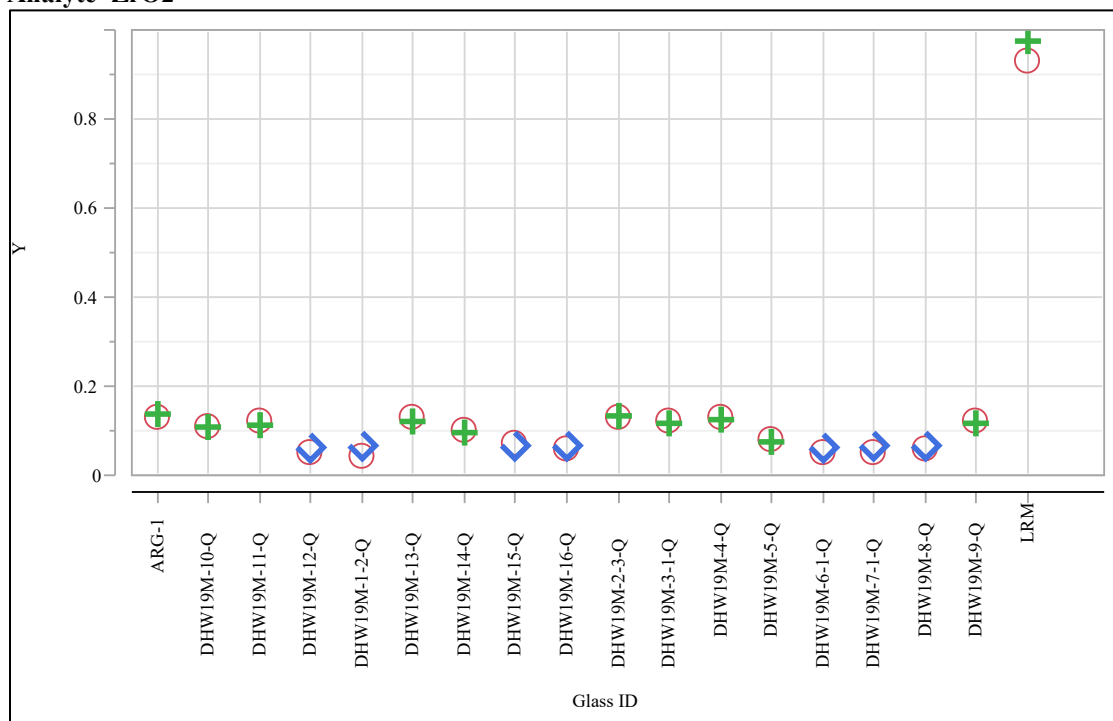
Analyte=SO<sub>3</sub>



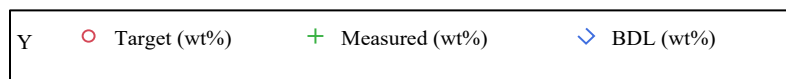
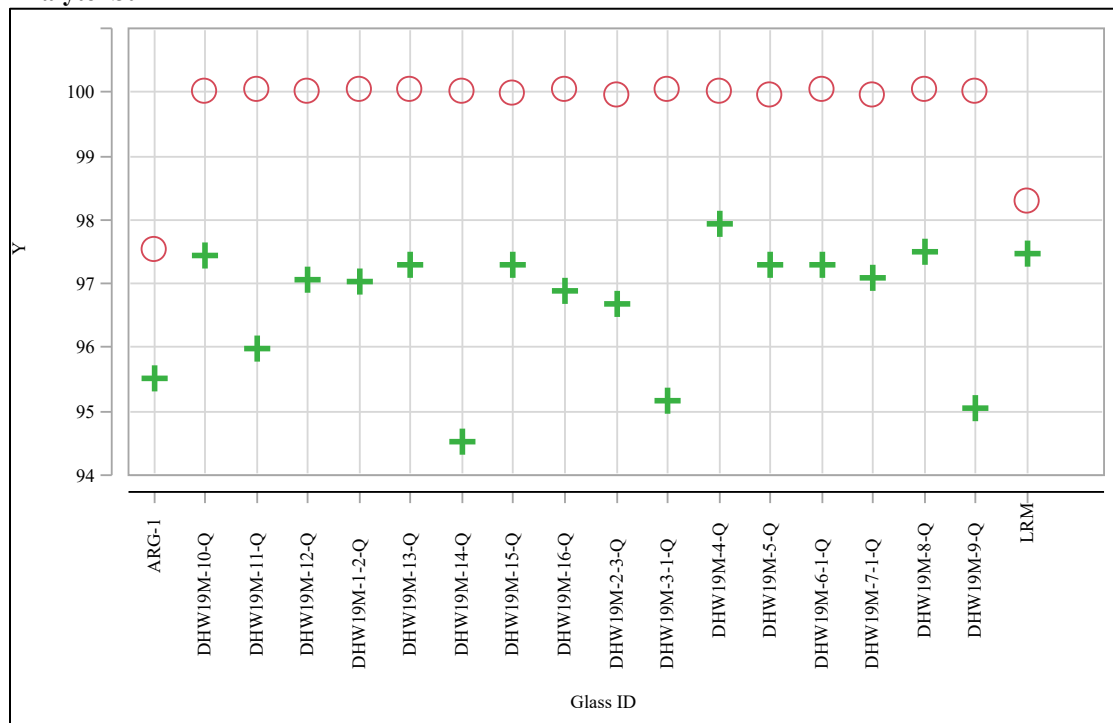
Y    ○ Target (wt%)    + Measured (wt%)    ◇ BDL (wt%)

**Exhibit A-4. Measured versus Targeted Concentrations by Group 1 Glass ID by Oxide (continued)**

Analyte=ZrO2



Analyte=Sum





## **Appendix B   Tables and Exhibits Supporting the Group 2 Glass Composition Measurements**

**Table B-1. PF Measurements of the Group 2 Glasses**

ID	Block	Sub-Blk	Sequence	Lab ID	Al (wt%)	B (wt%)	Ca (wt%)	Cr (wt%)	Fe (wt%)	Li (wt%)	Mn (wt%)	Ni (wt%)	Si (wt%)
LRM	1	1	1	LRMPF111	5.34	2.62	0.463	0.138	1.16	<0.100	<0.100	0.165	26.5
ARG-1	1	1	2	ARG1PF111	2.60	2.54	1.33	<0.100	9.33	1.55	1.39	0.767	21.7
DHW19M-29-Q	1	1	3	S-10075PF11	1.11	2.98	1.58	1.01	2.27	1.29	0.161	0.173	24.0
DHW19M-27-Q	1	1	4	S-10073PF21	3.48	2.94	2.81	0.634	0.150	1.29	<0.100	<0.100	21.9
DHW19M-21-Q	1	1	5	S-10067PF21	3.60	2.78	2.89	0.654	0.188	1.32	<0.100	<0.100	22.2
DHW19M-33-Q	1	1	6	S-10079PF21	2.75	3.54	1.07	1.34	4.64	0.134	0.157	0.181	20.2
DHW19M-17-1-Q	1	1	7	S-10063PF21	1.37	4.53	3.64	1.53	0.412	0.118	0.202	0.209	22.2
DHW19M-33-Q	1	1	8	S-10079PF11	2.73	3.52	1.03	1.35	4.58	0.130	0.157	0.152	20.0
DHW19M-23-Q	1	1	9	S-10069PF21	3.14	5.30	0.218	1.28	1.86	<0.100	<0.100	0.102	21.8
DHW19M-31-Q	1	1	10	S-10077PF11	3.50	5.67	2.23	0.741	4.04	0.932	0.102	0.120	18.9
DHW19M-19-Q	1	1	11	S-10065PF11	1.79	5.45	3.55	1.51	3.51	0.526	<0.100	<0.100	18.6
LRM	1	1	12	LRMPF112	5.39	2.67	0.469	0.142	1.16	<0.100	<0.100	0.170	25.7
ARG-1	1	1	13	ARG1PF112	2.55	2.46	1.31	<0.100	9.11	1.52	1.35	0.758	21.3
DHW19M-25-Q	1	1	14	S-10071PF11	1.89	3.17	0.562	1.62	1.50	0.155	0.140	0.136	21.8
DHW19M-31-Q	1	1	15	S-10077PF21	3.52	5.76	2.25	0.753	4.09	0.946	0.105	<0.100	18.8
DHW19M-25-Q	1	1	16	S-10071PF21	1.92	3.21	0.609	1.60	1.59	0.159	0.144	0.185	22.1
DHW19M-19-Q	1	1	17	S-10065PF21	1.81	5.47	3.59	1.51	3.53	0.534	<0.100	<0.100	19.1
DHW19M-21-Q	1	1	18	S-10067PF11	3.48	2.74	2.81	0.676	0.184	1.28	<0.100	0.194	21.2
DHW19M-29-Q	1	1	19	S-10075PF21	1.11	2.94	1.58	1.01	2.25	1.28	0.159	0.172	23.8
DHW19M-17-1-Q	1	1	20	S-10063PF11	1.37	4.47	3.69	1.50	0.322	0.121	0.200	0.211	21.8
DHW19M-27-Q	1	1	21	S-10073PF11	3.47	2.90	2.81	0.640	0.166	1.28	<0.100	<0.100	21.2
DHW19M-23-Q	1	1	22	S-10069PF11	3.23	5.43	0.226	1.32	1.91	<0.100	<0.100	<0.100	20.9
LRM	1	1	23	LRMPF113	5.43	2.70	0.477	0.144	1.16	<0.100	<0.100	0.164	26.0
ARG-1	1	1	24	ARG1PF113	2.56	2.46	1.31	<0.100	9.14	1.53	1.35	0.758	21.2
LRM	1	2	1	LRMPF121	5.25	2.45	0.459	0.134	1.04	<0.100	<0.100	0.124	27.3
ARG-1	1	2	2	ARG1PF121	2.49	2.27	1.28	<0.100	8.34	1.48	1.27	0.670	22.2
DHW19M-27-Q	1	2	3	S-10073PF22	3.31	2.62	2.69	0.591	0.122	1.24	<0.100	<0.100	22.3
DHW19M-27-Q	1	2	4	S-10073PF12	3.36	2.67	2.73	0.599	0.141	1.25	<0.100	<0.100	22.1
DHW19M-19-Q	1	2	5	S-10065PF22	1.74	4.99	3.46	1.41	3.19	0.513	<0.100	<0.100	19.4
DHW19M-25-Q	1	2	6	S-10071PF22	1.82	2.90	0.583	1.48	1.42	0.153	0.131	0.143	23.0
DHW19M-31-Q	1	2	7	S-10077PF12	3.39	5.18	2.16	0.689	3.63	0.903	<0.100	<0.100	19.7
DHW19M-21-Q	1	2	8	S-10067PF12	3.34	2.49	2.71	0.630	0.156	1.22	<0.100	0.152	21.8
DHW19M-19-Q	1	2	9	S-10065PF12	1.71	4.95	3.41	1.40	3.15	0.502	<0.100	<0.100	19.1
DHW19M-23-Q	1	2	10	S-10069PF22	3.00	4.83	0.202	1.18	1.68	<0.100	<0.100	<0.100	22.1
DHW19M-33-Q	1	2	11	S-10079PF22	2.65	3.23	1.03	1.24	4.19	0.129	0.146	0.152	20.5
LRM	1	2	12	LRMPF122	5.23	2.41	0.457	0.132	1.03	<0.100	<0.100	0.129	27.1

**Table B-1. PF Measurements of the Group 2 Glasses (continued)**

ID	Block	Sub-Blk	Sequence	Lab ID	Al (wt%)	B (wt%)	Ca (wt%)	Cr (wt%)	Fe (wt%)	Li (wt%)	Mn (wt%)	Ni (wt%)	Si (wt%)
ARG-1	1	2	13	ARG1PF122	2.51	2.36	1.29	<0.100	8.52	1.49	1.30	0.680	21.8
DHW19M-17-1-Q	1	2	14	S-10063PF12	1.33	4.14	3.61	1.40	0.284	0.116	0.187	0.174	22.4
DHW19M-29-Q	1	2	15	S-10075PF22	1.06	2.71	1.51	0.928	2.04	1.22	0.148	0.135	24.2
DHW19M-25-Q	1	2	16	S-10071PF12	1.83	2.98	0.543	1.52	1.38	0.149	0.131	0.110	22.1
DHW19M-23-Q	1	2	17	S-10069PF12	3.14	5.21	0.215	1.25	1.78	<0.100	<0.100	<0.100	21.3
DHW19M-33-Q	1	2	18	S-10079PF12	2.64	3.32	1.00	1.26	4.25	0.125	0.149	0.127	20.1
DHW19M-29-Q	1	2	19	S-10075PF12	1.07	2.77	1.53	0.944	2.08	1.24	0.151	0.143	24.1
DHW19M-17-1-Q	1	2	20	S-10063PF22	1.31	4.24	3.52	1.43	0.366	0.111	0.189	0.175	22.3
DHW19M-31-Q	1	2	21	S-10077PF22	3.37	5.36	2.18	0.699	3.75	0.901	<0.100	<0.100	18.9
DHW19M-21-Q	1	2	22	S-10067PF22	3.43	2.57	2.78	0.615	0.163	1.25	<0.100	<0.100	22.0
LRM	1	2	23	LRMPF123	5.22	2.43	0.458	0.133	1.01	<0.100	<0.100	0.126	27.2
ARG-1	1	2	24	ARG1PF123	2.51	2.35	1.30	<0.100	8.61	1.49	1.31	0.677	21.4
LRM	2	1	1	LRMPF211	5.40	2.42	0.507	0.129	1.00	<0.100	<0.100	0.120	25.5
ARG-1	2	1	2	ARG1PF211	2.67	2.64	1.32	<0.100	9.61	1.58	1.44	0.772	22.3
DHW19M-28-Q	2	1	3	S-10074PF21	1.59	4.37	0.241	0.763	0.186	1.44	<0.100	<0.100	24.7
DHW19M-18-Q	2	1	4	S-10064PF11	1.46	3.74	1.01	0.914	4.40	0.520	0.182	0.155	22.7
DHW19M-30-Q	2	1	5	S-10076PF21	3.43	4.36	2.01	1.12	1.10	0.210	0.108	<0.100	20.9
DHW19M-1-3-Q	2	1	6	S-10080PF11	2.84	3.73	2.78	1.63	3.79	1.52	<0.100	<0.100	20.8
DHW19M-18-Q	2	1	7	S-10064PF21	1.47	3.82	1.01	0.928	4.48	0.516	0.186	0.164	22.8
DHW19M-28-Q	2	1	8	S-10074PF11	1.61	4.35	0.391	0.744	0.188	1.50	<0.100	<0.100	24.6
DHW19M-26-Q	2	1	9	S-10072PF21	2.08	3.37	2.84	0.946	4.00	0.811	0.197	0.165	20.5
DHW19M-32-Q	2	1	10	S-10078PF11	1.30	4.91	1.79	1.33	1.92	1.15	0.153	0.135	22.3
DHW19M-22-1-Q	2	1	11	S-10068PF11	1.19	4.60	2.79	1.14	0.131	0.475	0.131	0.112	24.4
LRM	2	1	12	LRMPF212	5.42	2.40	0.508	0.130	1.00	<0.100	<0.100	0.129	25.3
ARG-1	2	1	13	ARG1PF212	2.66	2.65	1.33	<0.100	9.68	1.58	1.45	0.788	22.4
DHW19M-26-Q	2	1	14	S-10072PF11	2.05	3.40	2.76	0.948	3.98	0.791	0.198	0.173	20.7
DHW19M-20-Q	2	1	15	S-10066PF21	2.16	3.86	1.13	1.49	2.53	0.718	<0.100	<0.100	21.4
DHW19M-32-Q	2	1	16	S-10078PF21	1.30	4.81	1.85	1.32	1.90	1.18	0.153	0.133	22.7
DHW19M-24-Q	2	1	17	S-10070PF21	2.69	3.83	2.46	0.710	1.38	0.690	0.148	0.130	22.7
DHW19M-1-3-Q	2	1	18	S-10080PF21	2.85	3.69	2.76	1.65	3.83	1.52	<0.100	<0.100	21.3
DHW19M-22-1-Q	2	1	19	S-10068PF21	1.18	4.51	2.76	1.13	0.125	0.470	0.130	0.113	24.1
DHW19M-20-Q	2	1	20	S-10066PF11	2.20	3.90	1.16	1.48	2.52	0.737	<0.100	<0.100	21.5
DHW19M-24-Q	2	1	21	S-10070PF11	2.69	3.78	2.44	0.691	1.35	0.692	0.146	0.122	23.2
DHW19M-30-Q	2	1	22	S-10076PF11	3.43	4.27	1.99	1.10	1.07	0.236	0.102	<0.100	21.1
LRM	2	1	23	LRMPF213	5.40	2.38	0.503	0.124	0.987	<0.100	<0.100	0.127	25.6
ARG-1	2	1	24	ARG1PF213	2.67	2.63	1.33	<0.100	9.70	1.59	1.45	0.787	22.3
LRM	2	2	1	LRMPF221	5.26	2.40	0.464	0.127	0.990	<0.100	<0.100	0.135	25.9

**Table B-1. PF Measurements of the Group 2 Glasses (continued)**

ID	Block	Sub-Blk	Sequence	Lab ID	Al (wt%)	B (wt%)	Ca (wt%)	Cr (wt%)	Fe (wt%)	Li (wt%)	Mn (wt%)	Ni (wt%)	Si (wt%)
ARG-1	2	2	2	ARG1PF221	2.59	2.62	1.22	<0.100	9.63	1.54	1.45	0.790	22.6
DHW19M-28-Q	2	2	3	S-10074PF12	1.57	4.31	0.353	0.733	0.182	1.46	<0.100	<0.100	25.1
DHW19M-18-Q	2	2	4	S-10064PF22	1.40	3.75	0.918	0.912	4.35	0.501	0.182	0.161	23.4
DHW19M-28-Q	2	2	5	S-10074PF22	1.52	4.31	0.209	0.752	0.186	1.39	<0.100	<0.100	25.6
DHW19M-20-Q	2	2	6	S-10066PF22	2.10	3.91	1.04	1.47	2.51	0.702	<0.100	<0.100	22.2
DHW19M-22-1-Q	2	2	7	S-10068PF22	1.15	4.58	2.59	1.12	0.124	0.464	0.130	0.108	24.6
DHW19M-26-Q	2	2	8	S-10072PF22	2.02	3.44	2.66	0.939	3.97	0.801	0.194	0.175	21.0
DHW19M-18-Q	2	2	9	S-10064PF12	1.42	3.75	0.941	0.906	4.35	0.509	0.182	0.159	23.2
DHW19M-24-Q	2	2	10	S-10070PF12	2.63	3.79	2.27	0.697	1.35	0.680	0.145	0.130	23.4
DHW19M-32-Q	2	2	11	S-10078PF22	1.27	4.90	1.72	1.31	1.89	1.17	0.153	0.139	23.4
LRM	2	2	12	LRMPF222	5.28	2.40	0.469	0.130	0.994	<0.100	<0.100	0.130	25.9
ARG-1	2	2	13	ARG1PF222	2.58	2.62	1.23	<0.100	9.66	1.55	1.46	0.788	22.7
DHW19M-22-1-Q	2	2	14	S-10068PF12	1.15	4.57	2.59	1.13	0.129	0.463	0.130	0.117	25.1
DHW19M-30-Q	2	2	15	S-10076PF22	3.31	4.28	1.86	1.12	1.08	0.227	0.108	<0.100	21.7
DHW19M-20-Q	2	2	16	S-10066PF12	2.13	3.94	1.07	1.48	2.51	0.717	<0.100	<0.100	21.9
DHW19M-26-Q	2	2	17	S-10072PF12	1.98	3.36	2.55	0.941	3.93	0.768	0.194	0.169	21.6
DHW19M-30-Q	2	2	18	S-10076PF12	3.34	4.32	1.88	1.09	1.06	0.218	0.102	<0.100	21.5
DHW19M-32-Q	2	2	19	S-10078PF12	1.25	4.85	1.66	1.31	1.89	1.13	0.152	0.140	23.0
DHW19M-1-3-Q	2	2	20	S-10080PF12	2.73	3.61	2.56	1.60	3.69	1.48	<0.100	<0.100	21.6
DHW19M-24-Q	2	2	21	S-10070PF22	2.56	3.73	2.24	0.691	1.34	0.666	0.142	0.134	23.3
DHW19M-1-3-Q	2	2	22	S-10080PF22	2.73	3.59	2.54	1.61	3.70	1.48	<0.100	<0.100	21.6
LRM	2	2	23	LRMPF223	5.25	2.37	0.462	0.127	0.984	<0.100	<0.100	0.133	25.7
ARG-1	2	2	24	ARG1PF223	2.59	2.66	1.23	<0.100	9.67	1.55	1.46	0.792	22.8

**Table B-2. AD Measurements of the Group 2 Glasses**

ID	Block	Sub-Blk	Sequence	Lab ID	K (wt%)	Na (wt%)	P (wt%)	Pb (wt%)	S (wt%)	Zr (wt%)
LRM	1	1	1	LRMAD111	1.18	15.7	0.207	0.0881	0.0739	0.694
ARG1	1	1	2	ARG1AD111	2.19	8.96	0.103	<0.0500	<0.0500	0.103
DHW19M-17-1-Q	1	1	3	S-10063AD21	5.10	12.1	0.160	0.228	<0.0500	0.0939
DHW19M-33-Q	1	1	4	S-10079AD11	6.65	13.3	0.119	0.175	0.1352	0.0733
DHW19M-31-Q	1	1	5	S-10077AD11	0.325	13.8	0.0802	0.109	0.0535	<0.0500
DHW19M-19-Q	1	1	6	S-10065AD21	2.15	12.3	0.0500	0.0850	0.0652	<0.0500
DHW19M-19-Q	1	1	7	S-10065AD11	2.15	12.4	<0.0500	0.0773	0.0564	<0.0500
DHW19M-17-1-Q	1	1	8	S-10063AD11	5.09	12.0	0.158	0.221	<0.0500	0.0931
DHW19M-33-Q	1	1	9	S-10079AD21	6.70	13.1	0.112	0.171	0.126	0.0718
DHW19M-21-Q	1	1	10	S-10067AD11	3.71	15.9	<0.0500	0.0862	<0.0500	<0.0500
DHW19M-23-Q	1	1	11	S-10069AD11	1.01	15.0	0.0571	0.0799	0.123	<0.0500
LRM	1	1	12	LRMAD112	1.11	15.7	0.211	0.0823	0.0737	0.689
ARG1	1	1	13	ARG1AD112	2.10	8.88	0.105	<0.0500	<0.0500	0.101
DHW19M-31-Q	1	1	14	S-10077AD21	0.324	14.0	0.0824	0.115	0.0670	<0.0500
DHW19M-25-Q	1	1	15	S-10071AD21	3.11	14.2	0.105	0.153	0.103	0.0651
DHW19M-25-Q	1	1	16	S-10071AD11	3.09	14.1	0.109	0.156	0.0942	0.0649
DHW19M-21-Q	1	1	17	S-10067AD21	3.67	15.9	0.0529	0.0899	0.0561	<0.0500
DHW19M-27-Q	1	1	18	S-10073AD21	3.87	15.8	0.0531	0.0892	0.0844	<0.0500
DHW19M-27-Q	1	1	19	S-10073AD11	3.92	16.0	0.0545	0.0879	0.0835	<0.0500
DHW19M-29-Q	1	1	20	S-10075AD11	0.0708	15.1	0.122	0.173	0.0709	0.0695
DHW19M-29-Q	1	1	21	S-10075AD21	0.0727	14.9	0.120	0.181	0.0747	0.0703
DHW19M-23-Q	1	1	22	S-10069AD21	0.993	15.1	0.0545	0.0795	0.123	<0.0500
LRM	1	1	23	LRMAD113	1.09	15.6	0.203	0.0816	0.0704	0.681
ARG1	1	1	24	ARG1AD113	2.08	8.96	0.101	<0.0500	<0.0500	0.100
LRM	1	2	1	LRMAD121	1.21	14.8	0.207	0.0865	0.0906	0.699
ARG1	1	2	2	ARG1AD121	2.28	8.45	0.110	<0.0500	<0.0500	0.104
DHW19M-25-Q	1	2	3	S-10071AD22	3.37	13.4	0.111	0.153	0.121	0.0666
DHW19M-27-Q	1	2	4	S-10073AD12	4.29	15.5	0.0556	0.0837	0.114	<0.0500
DHW19M-23-Q	1	2	5	S-10069AD12	1.08	15.0	0.0632	0.0758	0.154	<0.0500
DHW19M-21-Q	1	2	6	S-10067AD12	3.99	15.4	0.0631	0.0871	0.0625	<0.0500
DHW19M-21-Q	1	2	7	S-10067AD22	3.99	15.6	0.0613	0.0871	0.0749	<0.0500
DHW19M-29-Q	1	2	8	S-10075AD12	0.0869	14.8	0.125	0.181	0.0852	0.0729
DHW19M-25-Q	1	2	9	S-10071AD12	3.37	13.6	0.110	0.154	0.115	0.0673
DHW19M-17-1-Q	1	2	10	S-10063AD22	5.47	11.4	0.166	0.224	0.0624	0.0951
DHW19M-17-1-Q	1	2	11	S-10063AD12	5.51	11.5	0.161	0.226	0.0531	0.0957
LRM	1	2	12	LRMAD122	1.20	14.8	0.199	0.0784	0.0978	0.703
ARG1	1	2	13	ARG1AD122	2.29	8.51	0.113	<0.0500	<0.0500	0.104
DHW19M-29-Q	1	2	14	S-10075AD22	0.0892	13.1	0.126	0.174	0.0982	0.0736
DHW19M-27-Q	1	2	15	S-10073AD22	4.23	15.8	0.0542	0.0811	0.110	<0.0500
DHW19M-31-Q	1	2	16	S-10077AD22	0.348	13.0	0.0763	0.112	0.0771	0.0509
DHW19M-19-Q	1	2	17	S-10065AD22	2.27	11.7	<0.0500	0.0771	0.0823	<0.0500
DHW19M-31-Q	1	2	18	S-10077AD12	0.36	13.0	0.0774	0.112	0.0740	0.0516
DHW19M-19-Q	1	2	19	S-10065AD12	2.32	11.7	<0.0500	0.0765	0.0796	<0.0500
DHW19M-33-Q	1	2	20	S-10079AD22	6.97	12.4	0.117	0.171	0.152	0.0740
DHW19M-33-Q	1	2	21	S-10079AD12	7.03	12.7	0.118	0.168	0.152	0.0749
DHW19M-23-Q	1	2	22	S-10069AD22	1.10	15.2	0.0589	0.0791	0.154	<0.0500
LRM	1	2	23	LRMAD123	1.20	14.7	0.204	0.0832	0.0856	0.694
ARG1	1	2	24	ARG1AD123	2.30	8.41	0.109	<0.0500	<0.0500	0.104
LRM	2	1	1	LRMAD211	1.19	13.8	0.197	0.0856	0.0823	0.6633
ARG1	2	1	2	ARG1AD211	2.23	8.08	0.104	<0.0500	<0.0500	0.0979
DHW19M-24-Q	2	1	3	S-10070AD21	4.27	11.7	0.108	0.159	0.0606	0.0629
DHW19M-20-Q	2	1	4	S-10066AD21	3.06	14.2	0.0737	0.0981	0.0923	0.0555
DHW19M-28-Q	2	1	5	S-10074AD21	3.04	12.3	0.0518	0.0721	0.0682	<0.0500
DHW19M-20-Q	2	1	6	S-10066AD11	2.96	14.2	0.0788	0.0958	0.0970	<0.0500
DHW19M-32-Q	2	1	7	S-10078AD11	1.83	12.4	0.120	0.167	0.0520	0.0698
DHW19M-1-3-Q	2	1	8	S-10080AD21	0.488	12.8	0.0521	0.0700	0.0997	<0.0500
DHW19M-1-3-Q	2	1	9	S-10080AD11	0.482	13.0	0.0555	0.0742	0.110	<0.0500
DHW19M-26-Q	2	1	10	S-10072AD11	4.31	12.8	0.157	0.212	0.144	0.0907
DHW19M-30-Q	2	1	11	S-10076AD21	6.27	11.4	0.0738	0.110	<0.0500	<0.0500

**Table B-2. AD Measurements of the Group 2 Glasses (continued)**

ID	Block	Sub-Blk	Sequence	Lab ID	K (wt%)	Na (wt%)	P (wt%)	Pb (wt%)	S (wt%)	Zr (wt%)
LRM	2	1	12	LRMAD212	1.17	14.0	0.201	0.0756	0.0755	0.6542
ARG1	2	1	13	ARG1AD212	2.23	8.18	0.113	<0.0500	<0.0500	0.0976
DHW19M-22-1-Q	2	1	14	S-10068AD21	1.01	13.5	0.0970	0.141	<0.0500	0.0552
DHW19M-32-Q	2	1	15	S-10078AD21	1.83	12.3	0.126	0.169	0.0506	0.0698
DHW19M-30-Q	2	1	16	S-10076AD11	6.29	11.3	0.0741	0.104	<0.0500	<0.0500
DHW19M-26-Q	2	1	17	S-10072AD21	4.32	12.5	0.162	0.205	0.132	0.0890
DHW19M-28-Q	2	1	18	S-10074AD11	2.97	12.2	<0.0500	0.0750	0.0761	<0.0500
DHW19M-18-Q	2	1	19	S-10064AD11	2.27	13.1	0.137	0.188	0.0639	0.0767
DHW19M-22-1-Q	2	1	20	S-10068AD11	1.02	13.6	0.103	0.146	<0.0500	0.0549
DHW19M-24-Q	2	1	21	S-10070AD11	4.21	11.9	0.109	0.156	0.0593	0.0629
DHW19M-18-Q	2	1	22	S-10064AD21	2.20	13.0	0.143	0.190	0.0713	0.0766
LRM	2	1	23	LRMAD213	1.16	14.1	0.203	0.0746	0.0908	0.656
ARG1	2	1	24	ARG1AD213	2.20	8.24	0.106	<0.0500	<0.0500	0.0973
LRM	2	2	1	LRMAD221	1.16	14.0	0.201	0.0797	0.0861	0.693
ARG1	2	2	2	ARG1AD221	2.25	7.96	0.105	<0.0500	<0.0500	0.105
DHW19M-30-Q	2	2	3	S-10076AD22	6.30	11.4	0.0774	0.111	<0.0500	<0.0500
DHW19M-1-3-Q	2	2	4	S-10080AD12	0.481	12.7	0.0513	0.0648	0.132	<0.0500
DHW19M-28-Q	2	2	5	S-10074AD12	2.97	12.0	<0.0500	0.0694	0.0888	<0.0500
DHW19M-18-Q	2	2	6	S-10064AD12	2.25	12.8	0.134	0.185	0.0827	0.0828
DHW19M-24-Q	2	2	7	S-10070AD12	4.22	11.6	0.117	0.163	0.0739	0.0688
DHW19M-24-Q	2	2	8	S-10070AD22	4.19	11.5	0.105	0.160	0.0636	0.0678
DHW19M-18-Q	2	2	9	S-10064AD22	2.23	12.8	0.137	0.191	0.0847	0.0821
DHW19M-28-Q	2	2	10	S-10074AD22	2.98	12.0	0.0521	0.0772	0.0990	<0.0500
DHW19M-32-Q	2	2	11	S-10078AD22	1.85	12.2	0.120	0.169	0.0829	0.0758
LRM	2	2	12	LRMAD222	1.18	14.4	0.204	0.0770	0.0925	0.693
ARG1	2	2	13	ARG1AD222	2.21	7.92	0.105	<0.0500	<0.0500	0.105
DHW19M-26-Q	2	2	14	S-10072AD22	4.29	12.5	0.164	0.210	0.159	0.0960
DHW19M-1-3-Q	2	2	15	S-10080AD22	0.485	12.8	0.0558	0.0741	0.122	<0.0500
DHW19M-26-Q	2	2	16	S-10072AD12	4.47	12.6	0.157	0.207	0.145	0.0970
DHW19M-22-1-Q	2	2	17	S-10068AD22	1.00	13.4	0.0981	0.141	<0.0500	0.0589
DHW19M-32-Q	2	2	18	S-10078AD12	1.84	12.3	0.128	0.161	0.0778	0.0753
DHW19M-30-Q	2	2	19	S-10076AD12	6.25	11.3	0.0789	0.108	<0.0500	<0.0500
DHW19M-20-Q	2	2	20	S-10066AD22	2.89	14.0	0.0807	0.102	0.110	0.0600
DHW19M-20-Q	2	2	21	S-10066AD12	2.95	14.1	0.0754	0.102	0.118	<0.0500
DHW19M-22-1-Q	2	2	22	S-10068AD12	1.01	13.5	0.0988	0.139	<0.0500	0.0595
LRM	2	2	23	LRMAD223	1.19	14.0	0.205	0.0824	0.0934	0.692
ARG1	2	2	24	ARG1AD223	1.18	8.01	0.108	<0.0500	<0.0500	0.104

**Table B-3. KH Measurements of the Group 2 Glasses**

ID	Block	Sub-Blk	Sequence	Lab ID	Cl (wt%)	F (wt%)
LRM	1	1	1	LRMKH111	<0.0500	0.874
ARG1	1	1	2	ARG1KH111	<0.0500	1.23
DHW19M-17-1-Q	1	1	3	S-10063KH21	<0.0500	0.0722
DHW19M-29-Q	1	1	4	S-10075KH21	0.0629	0.0650
DHW19M-27-Q	1	1	5	S-10073KH11	<0.0500	<0.0500
DHW19M-21-Q	1	1	6	S-10067KH21	<0.0500	<0.0500
DHW19M-33-Q	1	1	7	S-10079KH11	0.0508	0.0627
DHW19M-25-Q	1	1	8	S-10071KH11	0.0590	0.0503
DHW19M-25-Q	1	1	9	S-10071KH21	0.0546	0.0542
DHW19M-27-Q	1	1	10	S-10073KH21	<0.0500	<0.0500
DHW19M-21-Q	1	1	11	S-10067KH11	<0.0500	<0.0500
LRM	1	1	12	LRMKH112	<0.0500	0.885
ARG1	1	1	13	ARG1KH112	<0.0500	1.23
DHW19M-29-Q	1	1	14	S-10075KH11	0.0657	0.0650
DHW19M-31-Q	1	1	15	S-10077KH21	<0.0500	<0.0500
DHW19M-17-1-Q	1	1	16	S-10063KH11	<0.0500	0.0734
DHW19M-33-Q	1	1	17	S-10079KH21	<0.0500	0.0646
DHW19M-19-Q	1	1	18	S-10065KH11	<0.0500	<0.0500
DHW19M-23-Q	1	1	19	S-10069KH21	<0.0500	<0.0500
DHW19M-19-Q	1	1	20	S-10065KH21	<0.0500	<0.0500
DHW19M-23-Q	1	1	21	S-10069KH11	<0.0500	<0.0500
DHW19M-31-Q	1	1	22	S-10077KH11	<0.0500	<0.0500
LRM	1	1	23	LRMKH113	<0.0500	0.884
ARG1	1	1	24	ARG1KH113	<0.0500	1.23
LRM	1	2	1	LRMKH121	<0.0500	0.883
ARG1	1	2	2	ARG1KH121	<0.0500	1.24
DHW19M-25-Q	1	2	3	S-10071KH22	0.0551	0.0536
DHW19M-17-1-Q	1	2	4	S-10063KH12	<0.0500	0.0734
DHW19M-29-Q	1	2	5	S-10075KH22	0.0634	0.0655
DHW19M-21-Q	1	2	6	S-10067KH12	<0.0500	<0.0500
DHW19M-31-Q	1	2	7	S-10077KH22	<0.0500	<0.0500
DHW19M-31-Q	1	2	8	S-10077KH12	<0.0500	<0.0500
DHW19M-27-Q	1	2	9	S-10073KH12	<0.0500	<0.0500
DHW19M-19-Q	1	2	10	S-10065KH22	<0.0500	<0.0500
DHW19M-33-Q	1	2	11	S-10079KH22	<0.0500	0.0650
LRM	1	2	12	LRMKH122	<0.0500	0.884
ARG1	1	2	13	ARG1KH122	<0.0500	1.24
DHW19M-27-Q	1	2	14	S-10073KH22	<0.0500	<0.0500
DHW19M-19-Q	1	2	15	S-10065KH12	<0.0500	<0.0500
DHW19M-33-Q	1	2	16	S-10079KH12	0.0512	0.0632
DHW19M-17-1-Q	1	2	17	S-10063KH22	<0.0500	0.0732
DHW19M-23-Q	1	2	18	S-10069KH22	<0.0500	<0.0500
DHW19M-25-Q	1	2	19	S-10071KH12	0.0591	0.0502
DHW19M-23-Q	1	2	20	S-10069KH12	<0.0500	<0.0500
DHW19M-21-Q	1	2	21	S-10067KH22	<0.0500	<0.0500
DHW19M-29-Q	1	2	22	S-10075KH12	0.0644	0.0650
LRM	1	2	23	LRMKH123	<0.0500	0.890
ARG1	1	2	24	ARG1KH123	<0.0500	1.24
LRM	2	1	1	LRMKH211	<0.0500	0.839
ARG1	2	1	2	ARG1KH211	<0.0500	1.18
DHW19M-24-Q	2	1	3	S-10070KH21	<0.0500	0.0557
DHW19M-1-3-Q	2	1	4	S-10080KH21	<0.0500	<0.0500
DHW19M-20-Q	2	1	5	S-10066KH11	<0.0500	<0.0500

**Table B-3. KH Measurements of the Group 2 Glasses (continued)**

ID	Block	Sub-Blk	Sequence	Lab ID	Cl (wt%)	F (wt%)
DHW19M-28-Q	2	1	6	S-10074KH11	<0.0500	<0.0500
DHW19M-26-Q	2	1	7	S-10072KH21	<0.0500	0.0863
DHW19M-32-Q	2	1	8	S-10078KH11	<0.0500	0.0588
DHW19M-18-Q	2	1	9	S-10064KH11	<0.0500	0.0551
DHW19M-24-Q	2	1	10	S-10070KH11	<0.0500	0.0552
DHW19M-22-1-Q	2	1	11	S-10068KH21	0.0526	<0.0500
LRM	2	1	12	LRMKH212	<0.0500	0.832
ARG1	2	1	13	ARG1KH212	<0.0500	1.17
DHW19M-30-Q	2	1	14	S-10076KH11	<0.0500	<0.0500
DHW19M-20-Q	2	1	15	S-10066KH21	<0.0500	<0.0500
DHW19M-32-Q	2	1	16	S-10078KH21	<0.0500	0.0578
DHW19M-26-Q	2	1	17	S-10072KH11	<0.0500	0.0852
DHW19M-18-Q	2	1	18	S-10064KH21	<0.0500	0.0562
DHW19M-1-3-Q	2	1	19	S-10080KH11	<0.0500	<0.0500
DHW19M-30-Q	2	1	20	S-10076KH21	<0.0500	<0.0500
DHW19M-28-Q	2	1	21	S-10074KH21	<0.0500	<0.0500
DHW19M-22-1-Q	2	1	22	S-10068KH11	0.0514	<0.0500
LRM	2	1	23	LRMKH213	<0.0500	0.836
ARG1	2	1	24	ARG1KH213	<0.0500	1.19
LRM	2	2	1	LRMKH221	<0.0500	0.839
ARG1	2	2	2	ARG1KH221	<0.0500	1.18
DHW19M-20-Q	2	2	3	S-10066KH22	<0.0500	<0.0500
DHW19M-22-1-Q	2	2	4	S-10068KH22	0.0528	<0.0500
DHW19M-18-Q	2	2	5	S-10064KH22	<0.0500	0.0557
DHW19M-28-Q	2	2	6	S-10074KH22	<0.0500	<0.0500
DHW19M-26-Q	2	2	7	S-10072KH22	<0.0500	0.0849
DHW19M-18-Q	2	2	8	S-10064KH12	<0.0500	0.0541
DHW19M-20-Q	2	2	9	S-10066KH12	<0.0500	<0.0500
DHW19M-32-Q	2	2	10	S-10078KH22	<0.0500	0.0572
DHW19M-30-Q	2	2	11	S-10076KH12	<0.0500	<0.0500
LRM	2	2	12	LRMKH222	<0.0500	0.835
ARG1	2	2	13	ARG1KH222	<0.0500	1.17
DHW19M-24-Q	2	2	14	S-10070KH12	<0.0500	0.0537
DHW19M-26-Q	2	2	15	S-10072KH12	<0.0500	0.0848
DHW19M-28-Q	2	2	16	S-10074KH12	<0.0500	<0.0500
DHW19M-22-1-Q	2	2	17	S-10068KH12	0.0504	<0.0500
DHW19M-24-Q	2	2	18	S-10070KH22	<0.0500	0.0539
DHW19M-1-3-Q	2	2	19	S-10080KH22	<0.0500	<0.0500
DHW19M-30-Q	2	2	20	S-10076KH22	<0.0500	<0.0500
DHW19M-32-Q	2	2	21	S-10078KH12	<0.0500	0.0567
DHW19M-1-3-Q	2	2	22	S-10080KH12	<0.0500	<0.0500
LRM	2	2	23	LRMKH223	<0.0500	0.833
ARG1	2	2	24	ARG1KH223	<0.0500	1.19



**Table B-4. Revised PF Measurements for Three of the Group 2 Glasses**

ID	Block	Sub-Blk	Sequence	Lab ID	Al (wt%)	B (wt%)	Ca (wt%)	Cr (wt%)	Fe (wt%)	Li (wt%)	Mn (wt%)	Ni (wt%)	Si (wt%)
LRM	3	1	1	LRMPF	5.45	2.40	0.526	0.123	0.991	<0.100	<0.100	0.1076	25.7
DHW19M-19-Q	3	1	2	S-10065a	1.84	4.94	3.80	1.37	3.14	0.507	<0.100	<0.100	19.8
DHW19M-19-Q	3	1	3	S-10065b	1.81	4.86	3.74	1.35	3.08	0.495	<0.100	<0.100	19.6
DHW19M-25-Q	3	1	4	S-10071a	2.06	3.27	0.537	1.59	1.71	0.103	0.168	<0.100	27.0
DHW19M-25-Q	3	1	5	S-10071b	2.07	3.25	0.554	1.60	1.69	0.110	0.166	<0.100	27.0
DHW19M-29-Q	3	1	6	S-10075a	1.13	2.96	1.55	0.964	2.13	1.21	0.173	<0.100	27.1
DHW19M-29-Q	3	1	7	S-10075b	1.14	2.98	1.61	0.966	2.15	1.23	0.172	<0.100	27.4
LRM	3	2	1	LRMPF	5.20	2.37	0.417	0.129	0.997	<0.100	<0.100	<0.100	24.3
DHW19M-19-Q	3	2	2	S-10065a	1.83	5.27	3.38	1.59	3.44	0.516	<0.100	<0.100	19.1
DHW19M-19-Q	3	2	3	S-10065b	1.84	5.27	3.41	1.61	3.45	0.523	<0.100	<0.100	19.3
DHW19M-25-Q	3	2	4	S-10071a	2.06	3.45	0.428	1.79	1.82	<0.100	0.174	<0.100	25.8
DHW19M-25-Q	3	2	5	S-10071b	2.04	3.38	0.414	1.79	1.81	0.109	0.170	<0.100	25.6
DHW19M-29-Q	3	2	6	S-10075a	1.12	3.13	1.37	1.09	2.30	1.25	0.176	<0.100	26.0
DHW19M-29-Q	3	2	7	S-10075b	1.10	3.12	1.35	1.08	2.29	1.23	0.175	<0.100	25.8

**Table B-5. Evaluation of LRM Data Resulting from the Revised PF Measurements for Three of the Group 2 Glasses**

ID	Lab ID	Element	Measurement (wt %)	Lower Acceptability Limit (wt%)	Upper Acceptability Limit (wt%)	Acceptable/ Unacceptable
LRM	LRMPF1	Al	5.451	4.53	5.54	Accept
LRM	LRMPF1	Fe	0.9914	0	1.93	Accept
LRM	LRMPF1	Si	25.73	22.8	27.87	Accept
LRM	LRMPF2	Al	5.196	4.53	5.54	Accept
LRM	LRMPF2	Fe	0.9968	0	1.93	Accept
LRM	LRMPF2	Si	24.28	22.8	27.87	Accept

**Table B-6. Comparison of Measured and Targeted Compositions of the Group 2 Glasses**

Glass ID	Oxide	BDL ( $<$ )	Measured (wt %)	Targeted (wt %)	Difference of Measured versus Targeted	% Difference of Measured versus Targeted
DHW19M-1-3-Q	Al <sub>2</sub> O <sub>3</sub>		5.267	5.600	-0.333	-5.9%
DHW19M-1-3-Q	B <sub>2</sub> O <sub>3</sub>		11.769	12.530	-0.761	-6.1%
DHW19M-1-3-Q	CaO		3.722	3.610	0.112	
DHW19M-1-3-Q	Cl	$<$	0.050	0.040	0.010	
DHW19M-1-3-Q	Cr <sub>2</sub> O <sub>3</sub>		2.371	2.460	-0.089	
DHW19M-1-3-Q	F	$<$	0.050	0.040	0.010	
DHW19M-1-3-Q	Fe <sub>2</sub> O <sub>3</sub>		5.365	5.640	-0.275	-4.9%
DHW19M-1-3-Q	K <sub>2</sub> O		0.583	0.620	-0.037	
DHW19M-1-3-Q	Li <sub>2</sub> O		3.229	3.470	-0.241	
DHW19M-1-3-Q	MnO	$<$	0.129	0.090	0.039	
DHW19M-1-3-Q	Na <sub>2</sub> O		17.288	19.370	-2.082	-10.7%
DHW19M-1-3-Q	NiO	$<$	0.127	0.090	0.037	
DHW19M-1-3-Q	P <sub>2</sub> O <sub>5</sub>		0.123	0.130	-0.007	
DHW19M-1-3-Q	PbO		0.076	0.090	-0.014	
DHW19M-1-3-Q	SiO <sub>2</sub>		45.621	45.640	-0.019	0.0%
DHW19M-1-3-Q	SO <sub>3</sub>		0.289	0.570	-0.281	
DHW19M-1-3-Q	ZrO <sub>2</sub>	$<$	0.068	0.040	0.028	
DHW19M-1-3-Q	sum		96.128	100.030	-3.902	-3.9%
DHW19M-17-1-Q	Al <sub>2</sub> O <sub>3</sub>		2.541	2.500	0.041	
DHW19M-17-1-Q	B <sub>2</sub> O <sub>3</sub>		13.990	16.170	-2.180	-13.5%
DHW19M-17-1-Q	CaO		5.058	4.610	0.448	
DHW19M-17-1-Q	Cl	$<$	0.050	0.130	-0.080	
DHW19M-17-1-Q	Cr <sub>2</sub> O <sub>3</sub>		2.141	2.290	-0.149	
DHW19M-17-1-Q	F		0.073	0.130	-0.057	
DHW19M-17-1-Q	Fe <sub>2</sub> O <sub>3</sub>		0.495	0.410	0.085	
DHW19M-17-1-Q	K <sub>2</sub> O		6.375	7.750	-1.375	-17.7%
DHW19M-17-1-Q	Li <sub>2</sub> O		0.251	0.330	-0.079	
DHW19M-17-1-Q	MnO		0.251	0.260	-0.009	
DHW19M-17-1-Q	Na <sub>2</sub> O		15.839	16.070	-0.231	-1.4%
DHW19M-17-1-Q	NiO		0.245	0.260	-0.015	
DHW19M-17-1-Q	P <sub>2</sub> O <sub>5</sub>		0.369	0.390	-0.021	
DHW19M-17-1-Q	PbO		0.242	0.260	-0.018	
DHW19M-17-1-Q	SiO <sub>2</sub>		47.439	47.970	-0.531	-1.1%
DHW19M-17-1-Q	SO <sub>3</sub>	$<$	0.135	0.300	-0.165	
DHW19M-17-1-Q	ZrO <sub>2</sub>		0.128	0.130	-0.002	
DHW19M-17-1-Q	sum		95.623	99.960	-4.337	-4.3%
DHW19M-18-Q	Al <sub>2</sub> O <sub>3</sub>		2.716	2.700	0.016	
DHW19M-18-Q	B <sub>2</sub> O <sub>3</sub>		12.123	12.970	-0.847	-6.5%
DHW19M-18-Q	CaO		1.357	1.260	0.097	
DHW19M-18-Q	Cl	$<$	0.050	0.110	-0.060	
DHW19M-18-Q	Cr <sub>2</sub> O <sub>3</sub>		1.337	1.380	-0.043	
DHW19M-18-Q	F		0.055	0.110	-0.055	
DHW19M-18-Q	Fe <sub>2</sub> O <sub>3</sub>		6.284	6.510	-0.226	-3.5%
DHW19M-18-Q	K <sub>2</sub> O		2.695	2.910	-0.215	
DHW19M-18-Q	Li <sub>2</sub> O		1.101	1.230	-0.129	
DHW19M-18-Q	MnO		0.236	0.230	0.006	
DHW19M-18-Q	Na <sub>2</sub> O		17.423	19.410	-1.987	-10.2%
DHW19M-18-Q	NiO		0.203	0.230	-0.027	
DHW19M-18-Q	P <sub>2</sub> O <sub>5</sub>		0.316	0.340	-0.024	
DHW19M-18-Q	PbO		0.203	0.230	-0.027	
DHW19M-18-Q	SiO <sub>2</sub>		49.257	49.880	-0.623	-1.2%
DHW19M-18-Q	SO <sub>3</sub>		0.189	0.390	-0.201	
DHW19M-18-Q	ZrO <sub>2</sub>		0.107	0.110	-0.003	
DHW19M-18-Q	sum		95.654	100.000	-4.346	-4.3%
DHW19M-19-Q	Al <sub>2</sub> O <sub>3</sub>		3.458	3.400	0.058	
DHW19M-19-Q	B <sub>2</sub> O <sub>3</sub>		16.373	19.140	-2.767	-14.5%
DHW19M-19-Q	CaO		5.013	4.690	0.323	
DHW19M-19-Q	Cl	$<$	0.050	0.040	0.010	

**Table B-6. Comparison of Measured and Targeted Compositions of the Group 2 Glasses  
(continued)**

Glass ID	Oxide	BDL ( $<$ )	Measured (wt %)	Targeted (wt %)	Difference of Measured versus Targeted	% Difference of Measured versus Targeted
DHW19M-19-Q	Cr <sub>2</sub> O <sub>3</sub>		2.163	2.290	-0.127	
DHW19M-19-Q	F	$<$	0.050	0.040	0.010	
DHW19M-19-Q	Fe <sub>2</sub> O <sub>3</sub>		4.686	5.230	-0.544	-10.4%
DHW19M-19-Q	K <sub>2</sub> O		2.677	3.010	-0.333	
DHW19M-19-Q	Li <sub>2</sub> O		1.099	1.290	-0.191	
DHW19M-19-Q	MnO	$<$	0.129	0.090	0.039	
DHW19M-19-Q	Na <sub>2</sub> O		16.210	16.650	-0.440	-2.6%
DHW19M-19-Q	NiO	$<$	0.127	0.090	0.037	
DHW19M-19-Q	P <sub>2</sub> O <sub>5</sub>	$<$	0.115	0.130	-0.015	
DHW19M-19-Q	PbO		0.085	0.090	-0.005	
DHW19M-19-Q	SiO <sub>2</sub>		41.609	42.950	-1.341	-3.1%
DHW19M-19-Q	SO <sub>3</sub>		0.177	0.790	-0.613	
DHW19M-19-Q	ZrO <sub>2</sub>	$<$	0.068	0.040	0.028	
DHW19M-19-Q	sum		94.088	99.960	-5.872	-5.9%
DHW19M-20-Q	Al <sub>2</sub> O <sub>3</sub>		4.058	4.200	-0.142	
DHW19M-20-Q	B <sub>2</sub> O <sub>3</sub>		12.566	13.750	-1.184	-8.6%
DHW19M-20-Q	CaO		1.539	1.450	0.089	
DHW19M-20-Q	Cl	$<$	0.050	0.060	-0.010	
DHW19M-20-Q	Cr <sub>2</sub> O <sub>3</sub>		2.163	2.240	-0.077	
DHW19M-20-Q	F	$<$	0.050	0.060	-0.010	
DHW19M-20-Q	Fe <sub>2</sub> O <sub>3</sub>		3.599	3.710	-0.111	
DHW19M-20-Q	K <sub>2</sub> O		3.572	3.920	-0.348	
DHW19M-20-Q	Li <sub>2</sub> O		1.547	1.690	-0.143	
DHW19M-20-Q	MnO	$<$	0.129	0.120	0.009	
DHW19M-20-Q	Na <sub>2</sub> O		19.041	21.190	-2.149	-10.1%
DHW19M-20-Q	NiO	$<$	0.127	0.120	0.007	
DHW19M-20-Q	P <sub>2</sub> O <sub>5</sub>		0.177	0.180	-0.003	
DHW19M-20-Q	PbO		0.107	0.120	-0.013	
DHW19M-20-Q	SiO <sub>2</sub>		46.530	46.480	0.050	0.1%
DHW19M-20-Q	SO <sub>3</sub>		0.260	0.700	-0.440	
DHW19M-20-Q	ZrO <sub>2</sub>	$<$	0.073	0.060	0.013	
DHW19M-20-Q	sum		95.587	100.050	-4.463	-4.5%
DHW19M-21-Q	Al <sub>2</sub> O <sub>3</sub>		6.542	6.700	-0.158	-2.4%
DHW19M-21-Q	B <sub>2</sub> O <sub>3</sub>		8.517	10.410	-1.893	-18.2%
DHW19M-21-Q	CaO		3.914	3.570	0.344	
DHW19M-21-Q	Cl	$<$	0.050	0.050	0.000	
DHW19M-21-Q	Cr <sub>2</sub> O <sub>3</sub>		0.941	1.000	-0.059	
DHW19M-21-Q	F	$<$	0.050	0.050	0.000	
DHW19M-21-Q	Fe <sub>2</sub> O <sub>3</sub>		0.247	0.170	0.077	
DHW19M-21-Q	K <sub>2</sub> O		4.626	5.610	-0.984	-17.5%
DHW19M-21-Q	Li <sub>2</sub> O		2.729	2.900	-0.171	
DHW19M-21-Q	MnO	$<$	0.129	0.100	0.029	
DHW19M-21-Q	Na <sub>2</sub> O		21.164	21.790	-0.626	-2.9%
DHW19M-21-Q	NiO	$<$	0.174	0.100	0.074	
DHW19M-21-Q	P <sub>2</sub> O <sub>5</sub>	$<$	0.130	0.140	-0.010	
DHW19M-21-Q	PbO		0.094	0.100	-0.006	
DHW19M-21-Q	SiO <sub>2</sub>		46.637	46.900	-0.263	-0.6%
DHW19M-21-Q	SO <sub>3</sub>	$<$	0.152	0.340	-0.188	
DHW19M-21-Q	ZrO <sub>2</sub>	$<$	0.068	0.050	0.018	
DHW19M-21-Q	sum		96.163	99.980	-3.817	-3.8%
DHW19M-22-1-Q	Al <sub>2</sub> O <sub>3</sub>		2.206	2.200	0.006	
DHW19M-22-1-Q	B <sub>2</sub> O <sub>3</sub>		14.699	15.560	-0.861	-5.5%
DHW19M-22-1-Q	CaO		3.753	3.640	0.113	
DHW19M-22-1-Q	Cl		0.052	0.080	-0.028	
DHW19M-22-1-Q	Cr <sub>2</sub> O <sub>3</sub>		1.652	1.690	-0.038	
DHW19M-22-1-Q	F	$<$	0.050	0.080	-0.030	

**Table B-6. Comparison of Measured and Targeted Compositions of the Group 2 Glasses  
(continued)**

Glass ID	Oxide	BDL ( $<$ )	Measured (wt %)	Targeted (wt %)	Difference of Measured versus Targeted	% Difference of Measured versus Targeted
DHW19M-22-1-Q	Fe <sub>2</sub> O <sub>3</sub>		0.182	0.150	0.032	
DHW19M-22-1-Q	K <sub>2</sub> O		1.217	1.270	-0.053	
DHW19M-22-1-Q	Li <sub>2</sub> O		1.008	1.150	-0.142	
DHW19M-22-1-Q	MnO		0.168	0.170	-0.002	
DHW19M-22-1-Q	Na <sub>2</sub> O		18.198	20.250	-2.052	-10.1%
DHW19M-22-1-Q	NiO		0.143	0.170	-0.027	
DHW19M-22-1-Q	P <sub>2</sub> O <sub>5</sub>		0.227	0.250	-0.023	
DHW19M-22-1-Q	PbO		0.153	0.170	-0.017	
DHW19M-22-1-Q	SiO <sub>2</sub>		52.520	52.950	-0.430	-0.8%
DHW19M-22-1-Q	SO <sub>3</sub>	$<$	0.125	0.100	0.025	
DHW19M-22-1-Q	ZrO <sub>2</sub>		0.077	0.080	-0.003	
DHW19M-22-1-Q	sum		96.429	99.960	-3.531	-3.5%
DHW19M-23-Q	Al <sub>2</sub> O <sub>3</sub>		5.909	6.000	-0.091	-1.5%
DHW19M-23-Q	B <sub>2</sub> O <sub>3</sub>		16.719	18.230	-1.511	-8.3%
DHW19M-23-Q	CaO		0.301	0.230	0.071	
DHW19M-23-Q	Cl	$<$	0.050	0.050	0.000	
DHW19M-23-Q	Cr <sub>2</sub> O <sub>3</sub>		1.838	1.940	-0.102	
DHW19M-23-Q	F	$<$	0.050	0.050	0.000	
DHW19M-23-Q	Fe <sub>2</sub> O <sub>3</sub>		2.584	2.660	-0.076	
DHW19M-23-Q	K <sub>2</sub> O		1.260	1.380	-0.120	
DHW19M-23-Q	Li <sub>2</sub> O	$<$	0.215	0.050	0.165	
DHW19M-23-Q	MnO	$<$	0.129	0.090	0.039	
DHW19M-23-Q	Na <sub>2</sub> O		20.321	20.990	-0.669	-3.2%
DHW19M-23-Q	NiO	$<$	0.128	0.090	0.038	
DHW19M-23-Q	P <sub>2</sub> O <sub>5</sub>		0.134	0.140	-0.006	
DHW19M-23-Q	PbO		0.085	0.090	-0.005	
DHW19M-23-Q	SiO <sub>2</sub>		46.048	47.220	-1.172	-2.5%
DHW19M-23-Q	SO <sub>3</sub>		0.346	0.780	-0.434	
DHW19M-23-Q	ZrO <sub>2</sub>	$<$	0.068	0.050	0.018	
DHW19M-23-Q	sum		96.185	100.040	-3.855	-3.9%
DHW19M-24-Q	Al <sub>2</sub> O <sub>3</sub>		4.993	5.200	-0.207	-4.0%
DHW19M-24-Q	B <sub>2</sub> O <sub>3</sub>		12.179	13.270	-1.091	-8.2%
DHW19M-24-Q	CaO		3.292	3.160	0.132	
DHW19M-24-Q	Cl	$<$	0.050	0.090	-0.040	
DHW19M-24-Q	Cr <sub>2</sub> O <sub>3</sub>		1.019	1.070	-0.051	
DHW19M-24-Q	F		0.055	0.090	-0.035	
DHW19M-24-Q	Fe <sub>2</sub> O <sub>3</sub>		1.937	2.020	-0.083	
DHW19M-24-Q	K <sub>2</sub> O		5.086	5.520	-0.434	-7.9%
DHW19M-24-Q	Li <sub>2</sub> O		1.468	1.580	-0.112	
DHW19M-24-Q	MnO		0.188	0.190	-0.002	
DHW19M-24-Q	Na <sub>2</sub> O		15.738	17.450	-1.712	-9.8%
DHW19M-24-Q	NiO		0.164	0.190	-0.026	
DHW19M-24-Q	P <sub>2</sub> O <sub>5</sub>		0.251	0.280	-0.029	
DHW19M-24-Q	PbO		0.172	0.190	-0.018	
DHW19M-24-Q	SiO <sub>2</sub>		49.525	49.420	0.105	0.2%
DHW19M-24-Q	SO <sub>3</sub>		0.161	0.240	-0.079	
DHW19M-24-Q	ZrO <sub>2</sub>		0.089	0.090	-0.001	
DHW19M-24-Q	sum		96.367	100.050	-3.683	-3.7%
DHW19M-25-Q	Al <sub>2</sub> O <sub>3</sub>		3.888	3.500	0.388	
DHW19M-25-Q	B <sub>2</sub> O <sub>3</sub>		10.746	11.340	-0.594	-5.2%
DHW19M-25-Q	CaO		0.676	0.600	0.076	
DHW19M-25-Q	Cl		0.057	0.090	-0.033	
DHW19M-25-Q	Cr <sub>2</sub> O <sub>3</sub>		2.474	2.490	-0.016	
DHW19M-25-Q	F		0.052	0.090	-0.038	
DHW19M-25-Q	Fe <sub>2</sub> O <sub>3</sub>		2.513	2.220	0.293	
DHW19M-25-Q	K <sub>2</sub> O		3.897	4.360	-0.463	

**Table B-6. Comparison of Measured and Targeted Compositions of the Group 2 Glasses  
(continued)**

Glass ID	Oxide	BDL ( $<$ )	Measured (wt %)	Targeted (wt %)	Difference of Measured versus Targeted	% Difference of Measured versus Targeted
DHW19M-25-Q	Li <sub>2</sub> O	$<$	0.227	0.410	-0.183	
DHW19M-25-Q	MnO		0.219	0.180	0.039	
DHW19M-25-Q	Na <sub>2</sub> O		18.636	19.080	-0.444	-2.3%
DHW19M-25-Q	NiO	$<$	0.127	0.180	-0.053	
DHW19M-25-Q	P <sub>2</sub> O <sub>5</sub>		0.249	0.270	-0.021	
DHW19M-25-Q	PbO		0.166	0.180	-0.014	
DHW19M-25-Q	SiO <sub>2</sub>		56.371	54.420	1.951	3.6%
DHW19M-25-Q	SO <sub>3</sub>		0.270	0.470	-0.200	
DHW19M-25-Q	ZrO <sub>2</sub>		0.089	0.090	-0.001	
DHW19M-25-Q	sum		100.657	99.970	0.687	0.7%
DHW19M-26-Q	Al <sub>2</sub> O <sub>3</sub>		3.840	3.900	-0.060	
DHW19M-26-Q	B <sub>2</sub> O <sub>3</sub>		10.924	11.910	-0.986	-8.3%
DHW19M-26-Q	CaO		3.781	3.660	0.121	
DHW19M-26-Q	Cl	$<$	0.050	0.130	-0.080	
DHW19M-26-Q	Cr <sub>2</sub> O <sub>3</sub>		1.379	1.440	-0.061	
DHW19M-26-Q	F		0.085	0.130	-0.045	
DHW19M-26-Q	Fe <sub>2</sub> O <sub>3</sub>		5.676	5.950	-0.274	-4.6%
DHW19M-26-Q	K <sub>2</sub> O		5.237	5.840	-0.603	-10.3%
DHW19M-26-Q	Li <sub>2</sub> O		1.707	1.870	-0.163	
DHW19M-26-Q	MnO		0.253	0.250	0.003	
DHW19M-26-Q	Na <sub>2</sub> O		16.985	18.740	-1.755	-9.4%
DHW19M-26-Q	NiO		0.217	0.250	-0.033	
DHW19M-26-Q	P <sub>2</sub> O <sub>5</sub>		0.367	0.380	-0.013	
DHW19M-26-Q	PbO		0.225	0.250	-0.025	
DHW19M-26-Q	SiO <sub>2</sub>		44.818	44.390	0.428	1.0%
DHW19M-26-Q	SO <sub>3</sub>		0.362	0.750	-0.388	
DHW19M-26-Q	ZrO <sub>2</sub>		0.126	0.130	-0.004	
DHW19M-26-Q	sum		96.031	99.970	-3.939	-3.9%
DHW19M-27-Q	Al <sub>2</sub> O <sub>3</sub>		6.434	6.700	-0.266	-4.0%
DHW19M-27-Q	B <sub>2</sub> O <sub>3</sub>		8.959	10.410	-1.451	-13.9%
DHW19M-27-Q	CaO		3.862	3.570	0.292	
DHW19M-27-Q	Cl	$<$	0.050	0.050	0.000	
DHW19M-27-Q	Cr <sub>2</sub> O <sub>3</sub>		0.900	1.000	-0.100	
DHW19M-27-Q	F	$<$	0.050	0.050	0.000	
DHW19M-27-Q	Fe <sub>2</sub> O <sub>3</sub>		0.207	0.170	0.037	
DHW19M-27-Q	K <sub>2</sub> O		4.912	5.610	-0.698	-12.4%
DHW19M-27-Q	Li <sub>2</sub> O		2.723	2.900	-0.177	
DHW19M-27-Q	MnO	$<$	0.129	0.100	0.029	
DHW19M-27-Q	Na <sub>2</sub> O		21.265	21.790	-0.525	-2.4%
DHW19M-27-Q	NiO	$<$	0.127	0.100	0.027	
DHW19M-27-Q	P <sub>2</sub> O <sub>5</sub>		0.125	0.140	-0.015	
DHW19M-27-Q	PbO		0.092	0.100	-0.008	
DHW19M-27-Q	SiO <sub>2</sub>		46.797	46.900	-0.103	-0.2%
DHW19M-27-Q	SO <sub>3</sub>		0.245	0.340	-0.095	
DHW19M-27-Q	ZrO <sub>2</sub>	$<$	0.068	0.050	0.018	
DHW19M-27-Q	sum		96.944	99.980	-3.036	-3.0%
DHW19M-28-Q	Al <sub>2</sub> O <sub>3</sub>		2.971	3.000	-0.029	
DHW19M-28-Q	B <sub>2</sub> O <sub>3</sub>		13.958	14.880	-0.922	-6.2%
DHW19M-28-Q	CaO		0.418	0.320	0.098	
DHW19M-28-Q	Cl	$<$	0.050	0.040	0.010	
DHW19M-28-Q	Cr <sub>2</sub> O <sub>3</sub>		1.093	1.140	-0.047	
DHW19M-28-Q	F	$<$	0.050	0.040	0.010	
DHW19M-28-Q	Fe <sub>2</sub> O <sub>3</sub>		0.265	0.250	0.015	
DHW19M-28-Q	K <sub>2</sub> O		3.602	3.830	-0.228	
DHW19M-28-Q	Li <sub>2</sub> O		3.116	3.260	-0.144	
DHW19M-28-Q	MnO	$<$	0.129	0.090	0.039	

**Table B-6. Comparison of Measured and Targeted Compositions of the Group 2 Glasses  
(continued)**

Glass ID	Oxide	BDL (<)	Measured (wt %)	Targeted (wt %)	Difference of Measured versus Targeted	% Difference of Measured versus Targeted
DHW19M-28-Q	Na <sub>2</sub> O		16.345	17.930	-1.585	-8.8%
DHW19M-28-Q	NiO	<	0.127	0.090	0.037	
DHW19M-28-Q	P <sub>2</sub> O <sub>5</sub>	<	0.117	0.130	-0.013	
DHW19M-28-Q	PbO		0.079	0.090	-0.011	
DHW19M-28-Q	SiO <sub>2</sub>		53.483	54.540	-1.057	-1.9%
DHW19M-28-Q	SO <sub>3</sub>		0.207	0.350	-0.143	
DHW19M-28-Q	ZrO <sub>2</sub>	<	0.068	0.040	0.028	
DHW19M-28-Q	sum		96.078	100.020	-3.942	-3.9%
DHW19M-29-Q	Al <sub>2</sub> O <sub>3</sub>		2.121	2.000	0.121	
DHW19M-29-Q	B <sub>2</sub> O <sub>3</sub>		9.813	10.190	-0.377	-3.7%
DHW19M-29-Q	CaO		2.057	1.930	0.127	
DHW19M-29-Q	Cl		0.064	0.100	-0.036	
DHW19M-29-Q	Cr <sub>2</sub> O <sub>3</sub>		1.498	1.540	-0.042	
DHW19M-29-Q	F		0.065	0.100	-0.035	
DHW19M-29-Q	Fe <sub>2</sub> O <sub>3</sub>		3.170	3.270	-0.100	
DHW19M-29-Q	K <sub>2</sub> O		0.096	0.120	-0.024	
DHW19M-29-Q	Li <sub>2</sub> O		2.648	2.890	-0.242	
DHW19M-29-Q	MnO		0.225	0.210	0.015	
DHW19M-29-Q	Na <sub>2</sub> O		19.512	20.870	-1.358	-6.5%
DHW19M-29-Q	NiO	<	0.127	0.210	-0.083	
DHW19M-29-Q	P <sub>2</sub> O <sub>5</sub>		0.282	0.310	-0.028	
DHW19M-29-Q	PbO		0.191	0.210	-0.019	
DHW19M-29-Q	SiO <sub>2</sub>		56.852	55.600	1.252	2.3%
DHW19M-29-Q	SO <sub>3</sub>		0.205	0.350	-0.145	
DHW19M-29-Q	ZrO <sub>2</sub>		0.097	0.100	-0.003	
DHW19M-29-Q	sum		99.024	100.000	-0.976	-1.0%
DHW19M-30-Q	Al <sub>2</sub> O <sub>3</sub>		6.382	6.600	-0.218	-3.3%
DHW19M-30-Q	B <sub>2</sub> O <sub>3</sub>		13.870	15.230	-1.360	-8.9%
DHW19M-30-Q	CaO		2.707	2.580	0.127	
DHW19M-30-Q	Cl	<	0.050	0.060	-0.010	
DHW19M-30-Q	Cr <sub>2</sub> O <sub>3</sub>		1.619	1.680	-0.061	
DHW19M-30-Q	F	<	0.050	0.060	-0.010	
DHW19M-30-Q	Fe <sub>2</sub> O <sub>3</sub>		1.541	1.550	-0.009	
DHW19M-30-Q	K <sub>2</sub> O		7.562	8.840	-1.278	-14.5%
DHW19M-30-Q	Li <sub>2</sub> O		0.480	0.600	-0.120	
DHW19M-30-Q	MnO		0.136	0.130	0.006	
DHW19M-30-Q	Na <sub>2</sub> O		15.300	16.750	-1.450	-8.7%
DHW19M-30-Q	NiO	<	0.127	0.130	-0.003	
DHW19M-30-Q	P <sub>2</sub> O <sub>5</sub>		0.174	0.190	-0.016	
DHW19M-30-Q	PbO		0.117	0.130	-0.013	
DHW19M-30-Q	SiO <sub>2</sub>		45.567	45.280	0.287	0.6%
DHW19M-30-Q	SO <sub>3</sub>	<	0.125	0.120	0.005	
DHW19M-30-Q	ZrO <sub>2</sub>	<	0.068	0.060	0.008	
DHW19M-30-Q	sum		95.873	99.990	-4.117	-4.1%
DHW19M-31-Q	Al <sub>2</sub> O <sub>3</sub>		6.509	6.800	-0.291	-4.3%
DHW19M-31-Q	B <sub>2</sub> O <sub>3</sub>		17.685	19.670	-1.985	-10.1%
DHW19M-31-Q	CaO		3.085	2.910	0.175	
DHW19M-31-Q	Cl	<	0.050	0.070	-0.020	
DHW19M-31-Q	Cr <sub>2</sub> O <sub>3</sub>		1.053	1.130	-0.077	
DHW19M-31-Q	F	<	0.050	0.070	-0.020	
DHW19M-31-Q	Fe <sub>2</sub> O <sub>3</sub>		5.544	6.020	-0.476	-7.9%
DHW19M-31-Q	K <sub>2</sub> O		0.409	0.460	-0.051	
DHW19M-31-Q	Li <sub>2</sub> O		1.982	2.190	-0.208	
DHW19M-31-Q	MnO	<	0.131	0.130	0.001	
DHW19M-31-Q	Na <sub>2</sub> O		18.131	18.420	-0.289	-1.6%
DHW19M-31-Q	NiO	<	0.134	0.130	0.004	

**Table B-6. Comparison of Measured and Targeted Compositions of the Group 2 Glasses  
(continued)**

Glass ID	Oxide	BDL ( $<$ )	Measured (wt %)	Targeted (wt %)	Difference of Measured versus Targeted	% Difference of Measured versus Targeted
DHW19M-31-Q	P <sub>2</sub> O <sub>5</sub>		0.181	0.200	-0.019	
DHW19M-31-Q	PbO		0.121	0.130	-0.009	
DHW19M-31-Q	SiO <sub>2</sub>		40.807	41.120	-0.313	-0.8%
DHW19M-31-Q	SO <sub>3</sub>		0.170	0.480	-0.310	
DHW19M-31-Q	ZrO <sub>2</sub>	$<$	0.068	0.070	-0.002	
DHW19M-31-Q	sum		96.110	100.000	-3.890	-3.9%
DHW19M-32-Q	Al <sub>2</sub> O <sub>3</sub>		2.419	2.400	0.019	
DHW19M-32-Q	B <sub>2</sub> O <sub>3</sub>		15.673	16.800	-1.127	-6.7%
DHW19M-32-Q	CaO		2.456	2.360	0.096	
DHW19M-32-Q	Cl	$<$	0.050	0.100	-0.050	
DHW19M-32-Q	Cr <sub>2</sub> O <sub>3</sub>		1.926	2.020	-0.094	
DHW19M-32-Q	F		0.058	0.100	-0.042	
DHW19M-32-Q	Fe <sub>2</sub> O <sub>3</sub>		2.716	2.840	-0.124	
DHW19M-32-Q	K <sub>2</sub> O		2.213	2.370	-0.157	
DHW19M-32-Q	Li <sub>2</sub> O		2.492	2.680	-0.188	
DHW19M-32-Q	MnO		0.197	0.200	-0.003	
DHW19M-32-Q	Na <sub>2</sub> O		16.580	18.290	-1.710	-9.3%
DHW19M-32-Q	NiO		0.174	0.200	-0.026	
DHW19M-32-Q	P <sub>2</sub> O <sub>5</sub>		0.283	0.300	-0.017	
DHW19M-32-Q	PbO		0.179	0.200	-0.021	
DHW19M-32-Q	SiO <sub>2</sub>		48.883	48.670	0.213	0.4%
DHW19M-32-Q	SO <sub>3</sub>		0.164	0.340	-0.176	
DHW19M-32-Q	ZrO <sub>2</sub>		0.098	0.100	-0.002	
DHW19M-32-Q	sum		96.562	99.970	-3.408	-3.4%
DHW19M-33-Q	Al <sub>2</sub> O <sub>3</sub>		5.087	5.100	-0.013	-0.3%
DHW19M-33-Q	B <sub>2</sub> O <sub>3</sub>		10.956	12.520	-1.564	-12.5%
DHW19M-33-Q	CaO		1.445	1.190	0.255	
DHW19M-33-Q	Cl	$<$	0.051	0.100	-0.049	
DHW19M-33-Q	Cr <sub>2</sub> O <sub>3</sub>		1.896	2.060	-0.164	
DHW19M-33-Q	F		0.064	0.100	-0.036	
DHW19M-33-Q	Fe <sub>2</sub> O <sub>3</sub>		6.312	6.830	-0.518	-7.6%
DHW19M-33-Q	K <sub>2</sub> O		8.236	9.690	-1.454	-15.0%
DHW19M-33-Q	Li <sub>2</sub> O		0.279	0.350	-0.071	
DHW19M-33-Q	MnO		0.197	0.200	-0.003	
DHW19M-33-Q	Na <sub>2</sub> O		17.356	17.250	0.106	0.6%
DHW19M-33-Q	NiO		0.195	0.200	-0.005	
DHW19M-33-Q	P <sub>2</sub> O <sub>5</sub>		0.267	0.300	-0.033	
DHW19M-33-Q	PbO		0.184	0.200	-0.016	
DHW19M-33-Q	SiO <sub>2</sub>		43.214	43.200	0.014	0.0%
DHW19M-33-Q	SO <sub>3</sub>		0.353	0.620	-0.267	
DHW19M-33-Q	ZrO <sub>2</sub>		0.099	0.100	-0.001	
DHW19M-33-Q	sum		96.190	100.010	-3.820	-3.8%
ARG-1	Al <sub>2</sub> O <sub>3</sub>		4.878	4.730	0.148	
ARG-1	B <sub>2</sub> O <sub>3</sub>		8.120	8.670	-0.550	-6.3%
ARG-1	CaO		1.805	1.430	0.375	
ARG-1	Cl	$<$	0.050	0.000	0.050	
ARG-1	Cr <sub>2</sub> O <sub>3</sub>	$<$	0.146	0.093	0.053	
ARG-1	F		1.208	0.000	1.208	
ARG-1	Fe <sub>2</sub> O <sub>3</sub>		13.225	14.000	-0.775	-5.5%
ARG-1	K <sub>2</sub> O		2.564	2.710	-0.146	
ARG-1	Li <sub>2</sub> O		3.310	3.210	0.100	
ARG-1	MnO		1.795	1.880	-0.085	
ARG-1	Na <sub>2</sub> O		11.296	11.500	-0.204	-1.8%
ARG-1	NiO		0.957	1.050	-0.093	
ARG-1	P <sub>2</sub> O <sub>5</sub>		0.245	0.220	0.025	
ARG-1	PbO	$<$	0.054	0.000	0.054	

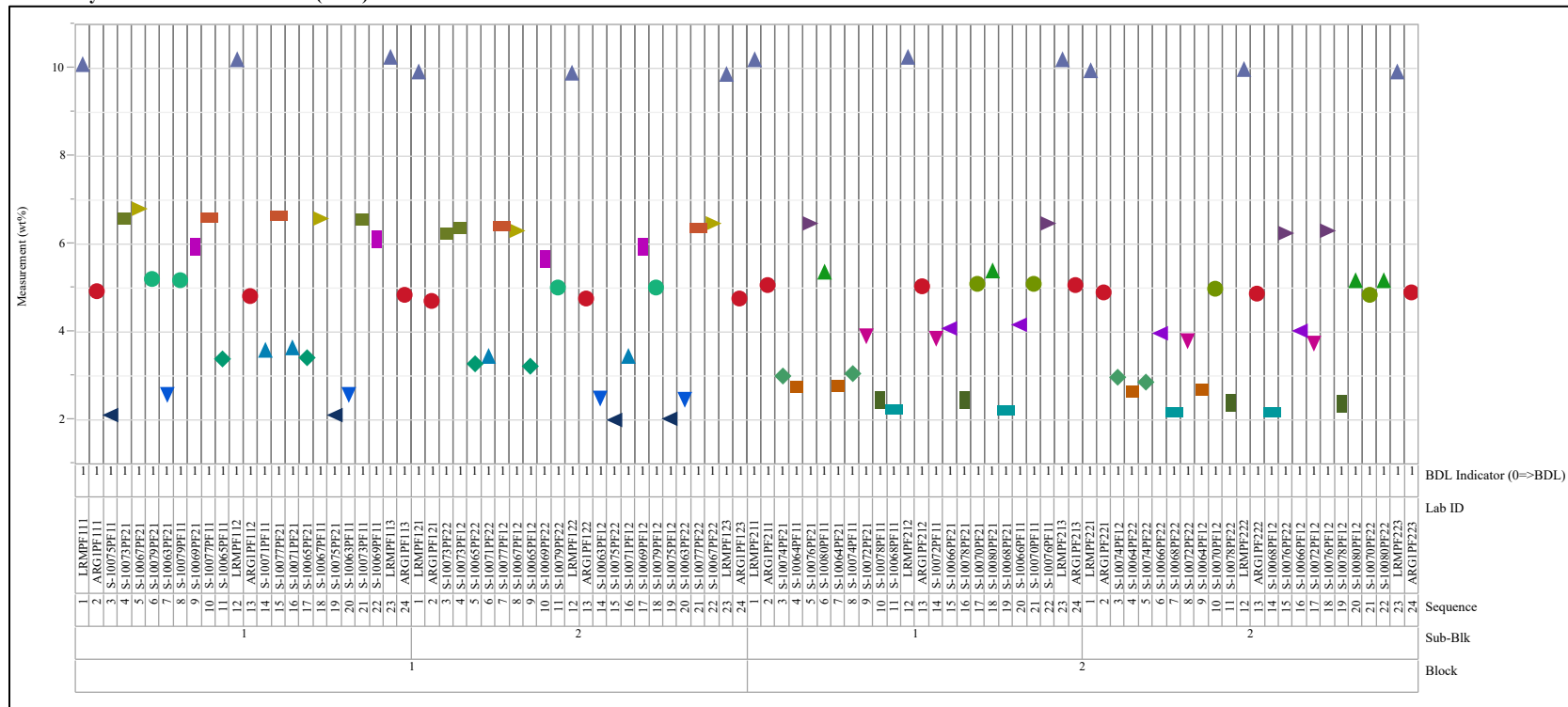
**Table B-6. Comparison of Measured and Targeted Compositions of the Group 2 Glasses  
(continued)**

Glass ID	Oxide	BDL (<)	Measured (wt %)	Targeted (wt %)	Difference of Measured versus Targeted	% Difference of Measured versus Targeted
ARG-1	SiO <sub>2</sub>		47.189	47.900	-0.711	-1.5%
ARG-1	SO <sub>3</sub>	<	0.125	0.000	0.125	
ARG-1	ZrO <sub>2</sub>		0.138	0.130	0.008	
ARG-1	sum		97.104	97.523	-0.419	-0.4%
LRM	Al <sub>2</sub> O <sub>3</sub>		10.057	9.510	0.547	5.8%
LRM	B <sub>2</sub> O <sub>3</sub>		7.956	7.850	0.106	1.4%
LRM	CaO		0.664	0.540	0.124	
LRM	Cl	<	0.050	0.000	0.050	
LRM	Cr <sub>2</sub> O <sub>3</sub>		0.194	0.190	0.004	
LRM	F		0.859	0.860	-0.001	
LRM	Fe <sub>2</sub> O <sub>3</sub>		1.491	1.380	0.111	
LRM	K <sub>2</sub> O		1.409	1.480	-0.071	
LRM	Li <sub>2</sub> O	<	0.215	0.110	0.105	
LRM	MnO	<	0.129	0.080	0.049	
LRM	Na <sub>2</sub> O		19.726	20.030	-0.304	-1.5%
LRM	NiO		0.175	0.190	-0.015	
LRM	P <sub>2</sub> O <sub>5</sub>		0.466	0.540	-0.074	
LRM	PbO		0.088	0.100	-0.012	
LRM	SiO <sub>2</sub>		55.925	54.200	1.725	3.2%
LRM	SO <sub>3</sub>		0.211	0.300	-0.089	
LRM	ZrO <sub>2</sub>		0.924	0.930	-0.006	
LRM	sum		100.540	98.290	2.250	2.3%



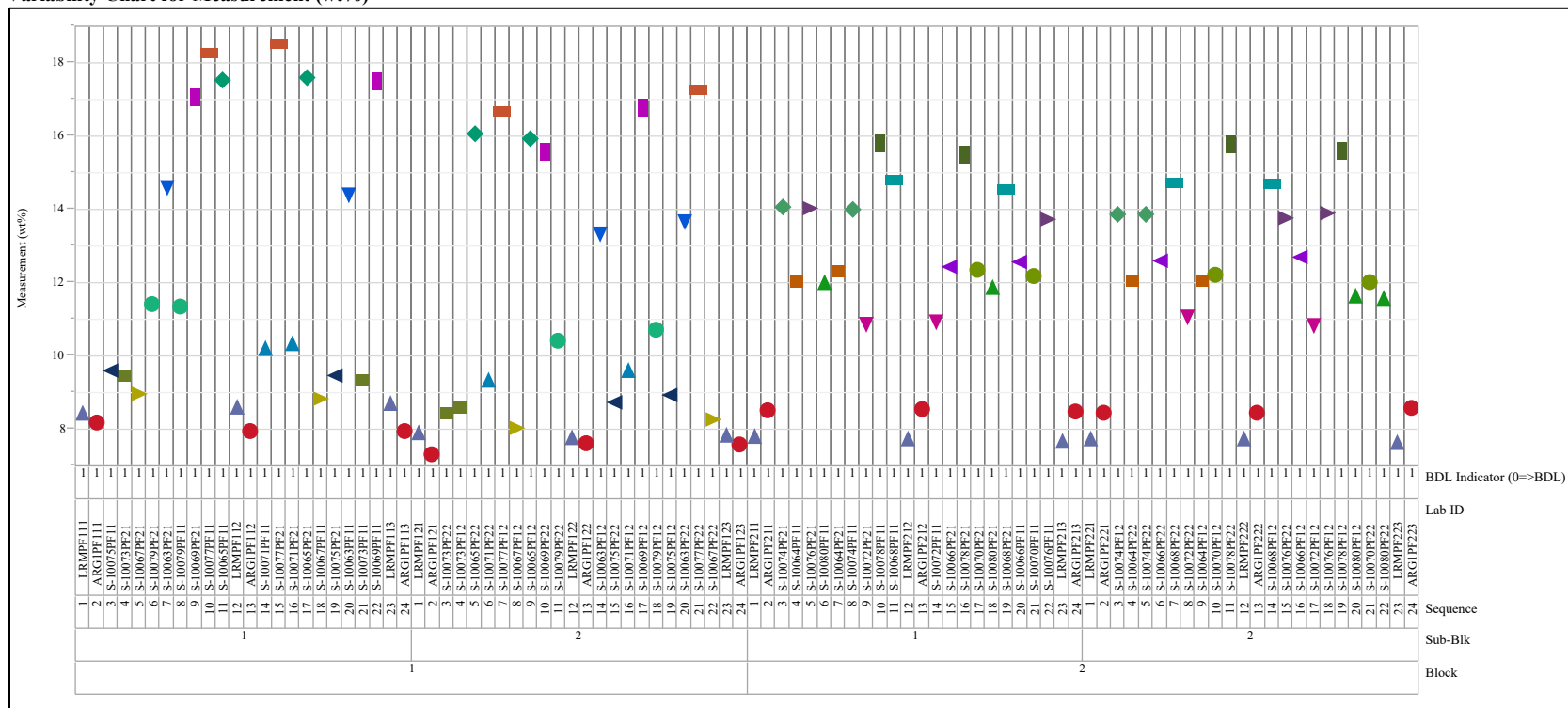
## Exhibit B-1. Plots of Oxide Measurements in Analytical Sequence for the Group 2 Glasses

Oxide=Al<sub>2</sub>O<sub>3</sub> (wt%), Prep Method=PF  
 Variability Chart for Measurement (wt%)



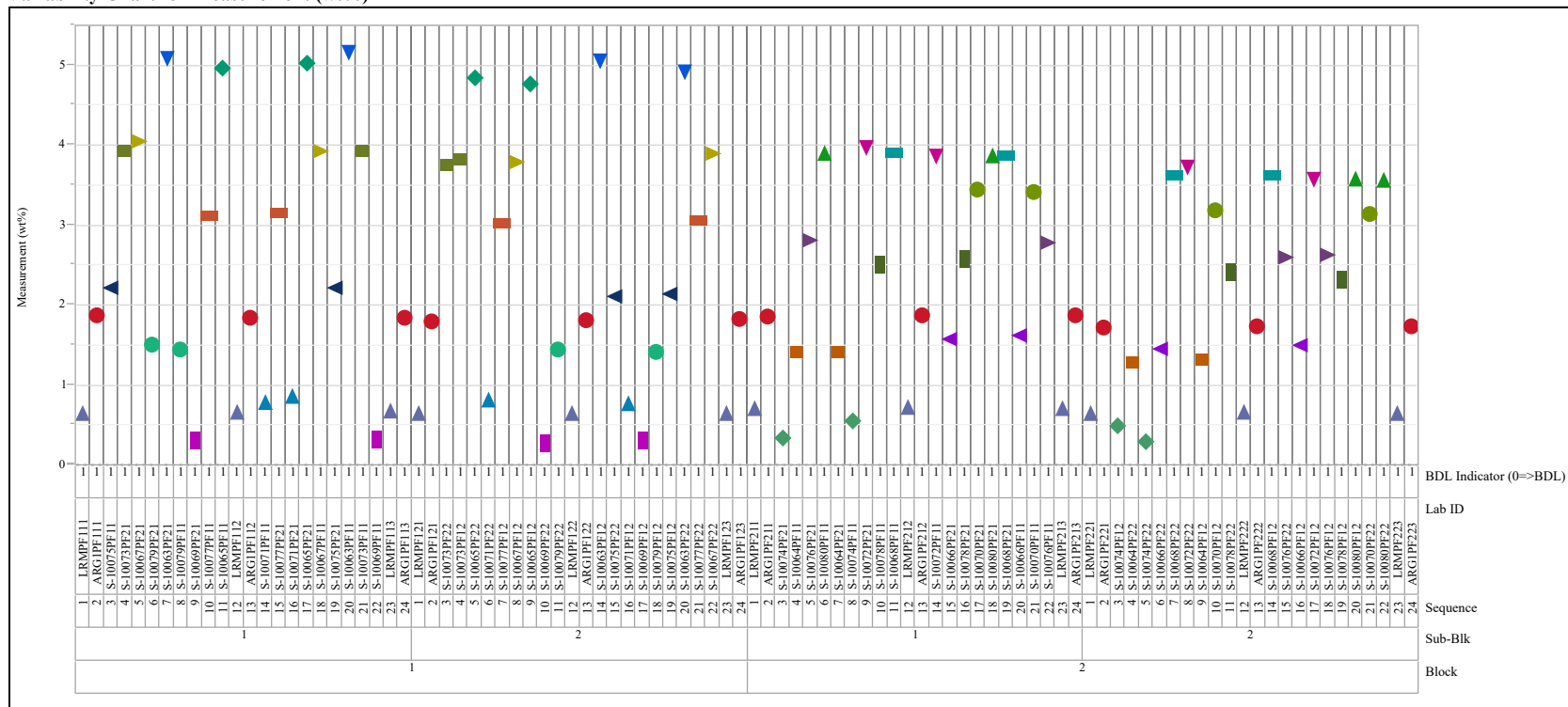
## Exhibit B-1. Plots of Oxide Measurements in Analytical Sequence for the Group 2 Glasses (continued)

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



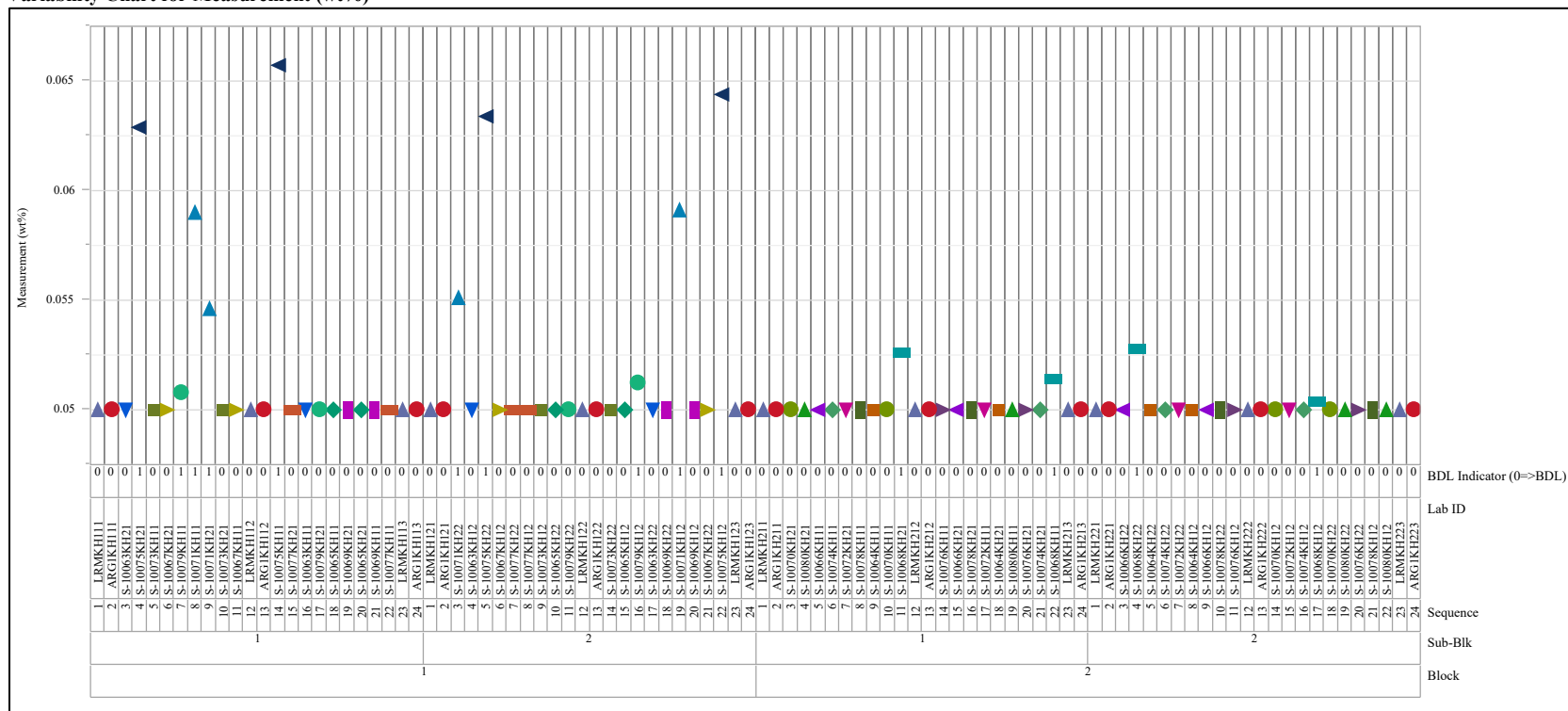
**Exhibit B-1. Plots of Oxide Measurements in Analytical Sequence for the Group 2 Glasses (continued)**

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



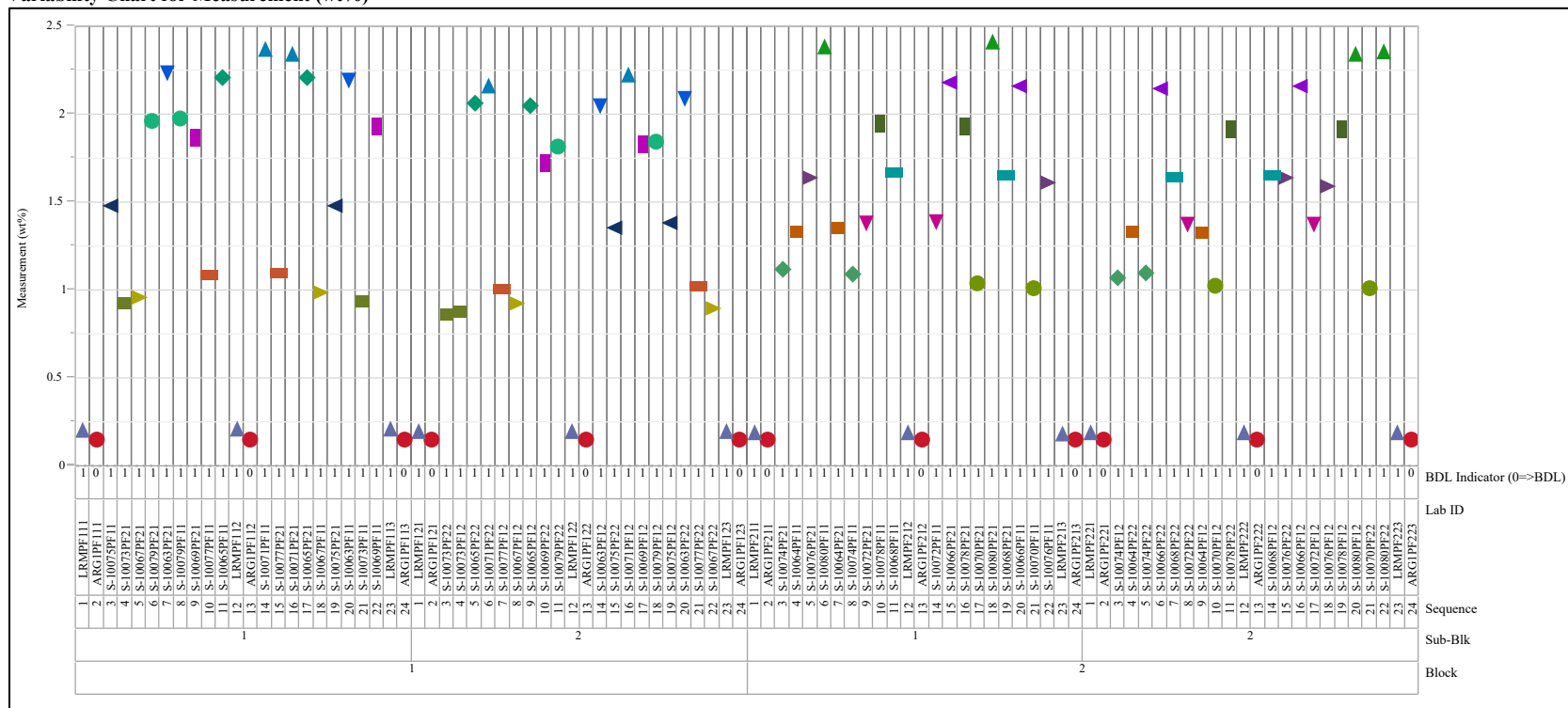
## Exhibit B-1. Plots of Oxide Measurements in Analytical Sequence for the Group 2 Glasses (continued)

Oxide=Cl (wt%), Prep Method=KH  
 Variability Chart for Measurement (wt%)



## Exhibit B-1. Plots of Oxide Measurements in Analytical Sequence for the Group 2 Glasses (continued)

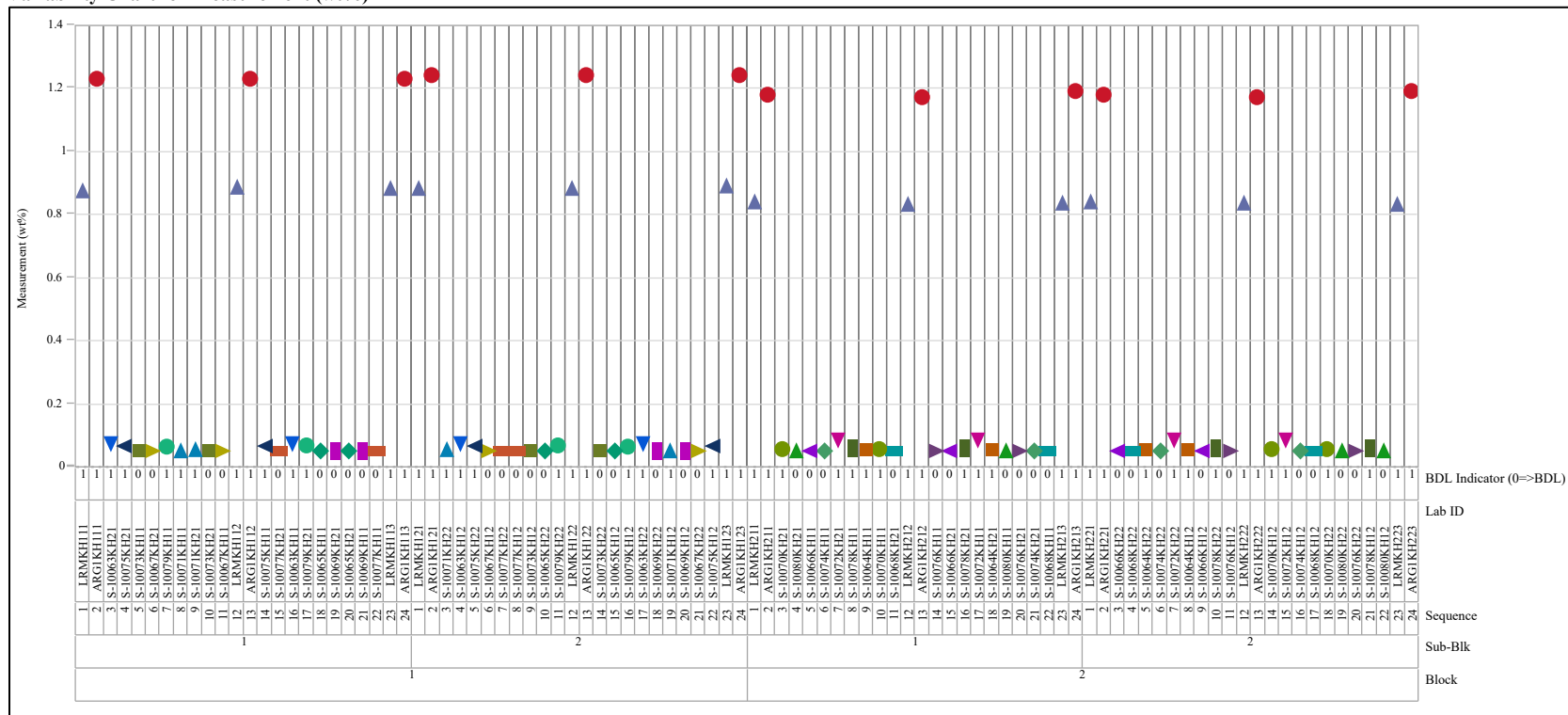
Oxide=Cr<sub>2</sub>O<sub>3</sub> (wt%), Prep Method=PF  
 Variability Chart for Measurement (wt%)



## Exhibit B-1. Plots of Oxide Measurements in Analytical Sequence for the Group 2 Glasses (continued)

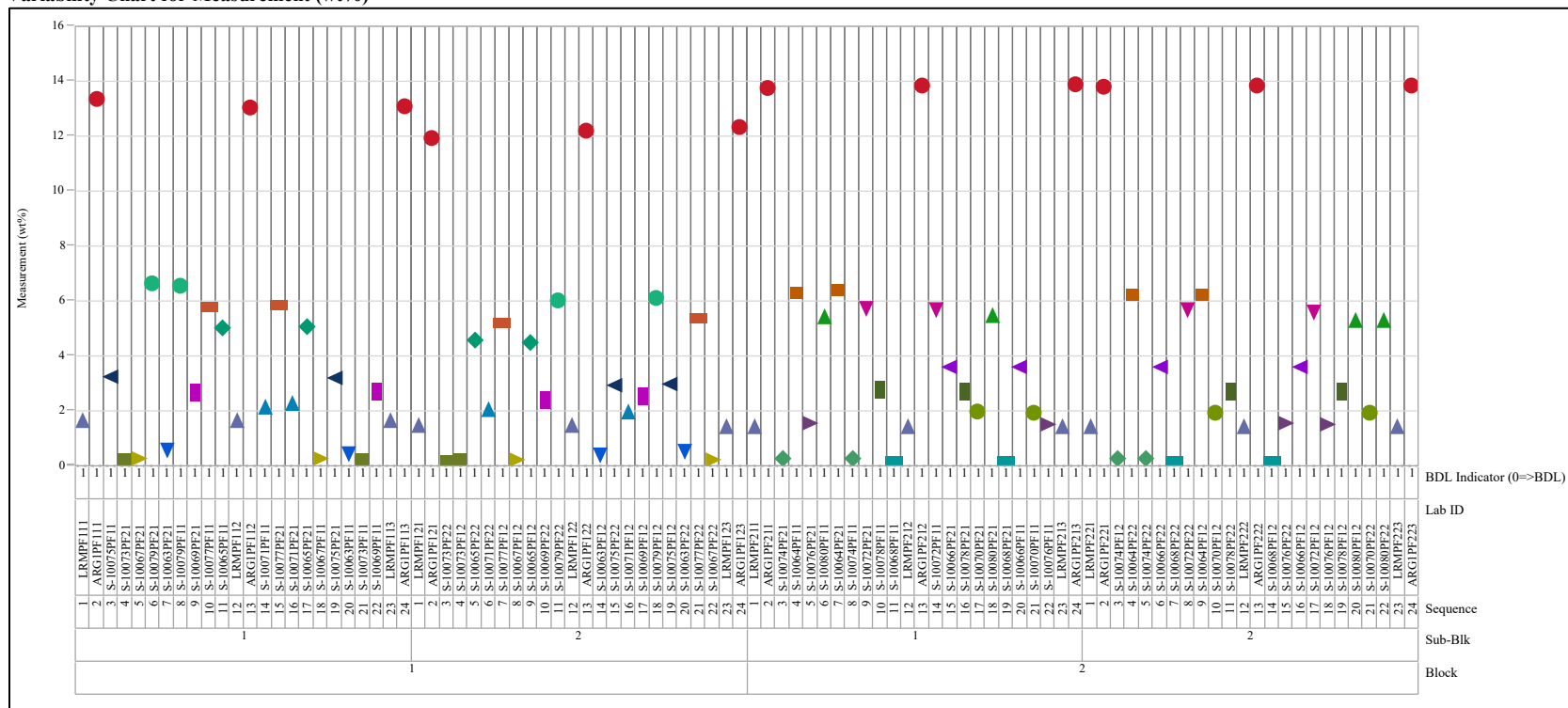
Oxide=F (wt%), Prep Method=KH

Variability Chart for Measurement (wt%)



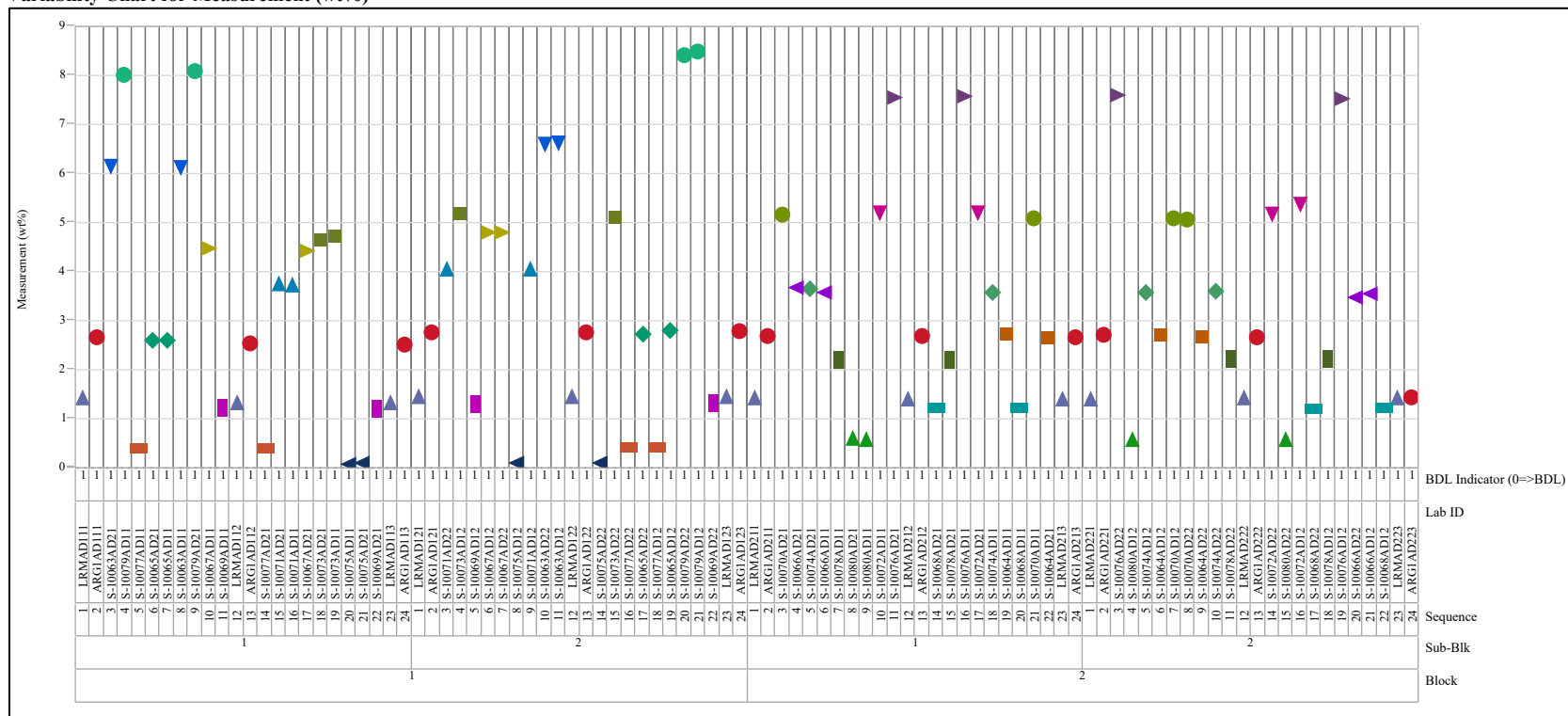
## Exhibit B-1. Plots of Oxide Measurements in Analytical Sequence for the Group 2 Glasses (continued)

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



## Exhibit B-1. Plots of Oxide Measurements in Analytical Sequence for the Group 2 Glasses (continued)

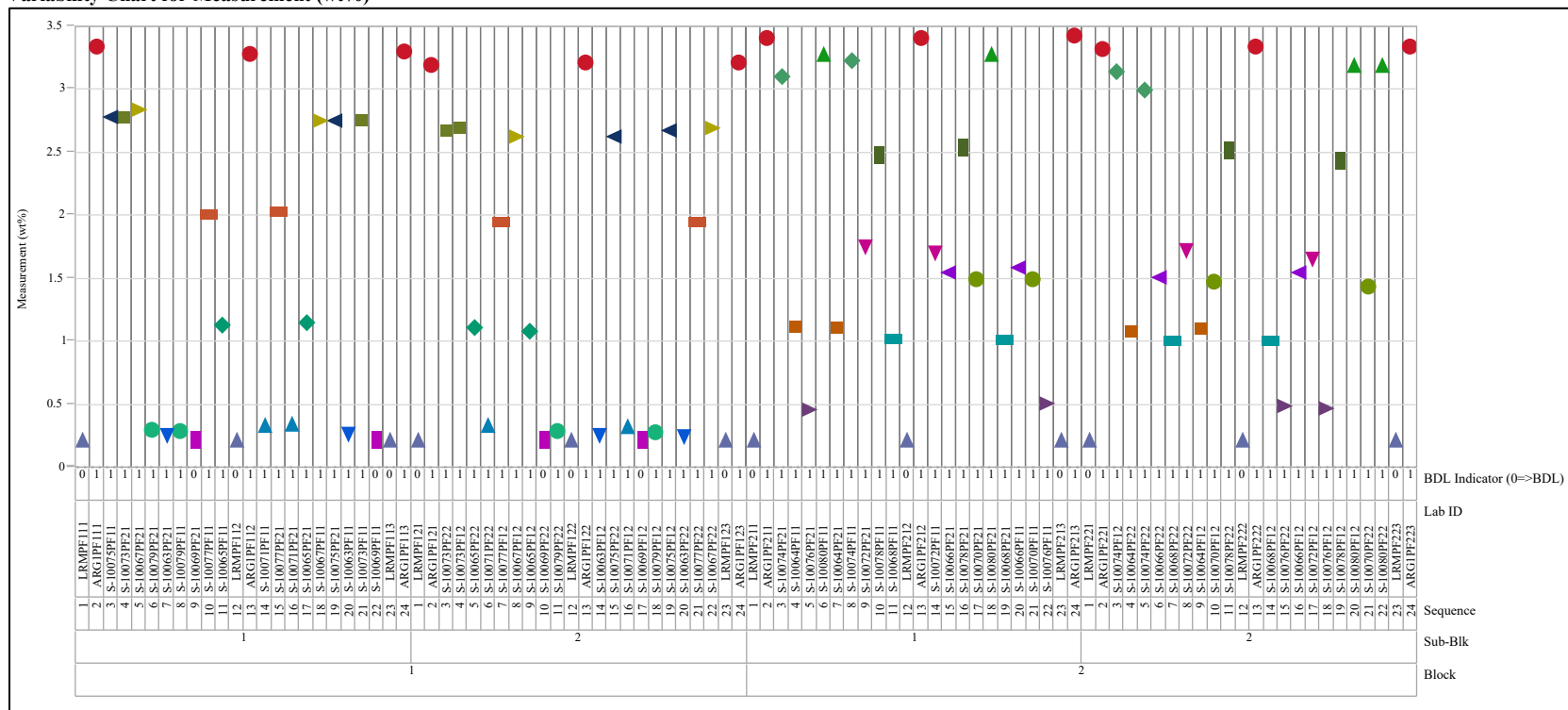
Oxide=K<sub>2</sub>O (wt%), Prep Method=AD  
 Variability Chart for Measurement (wt%)





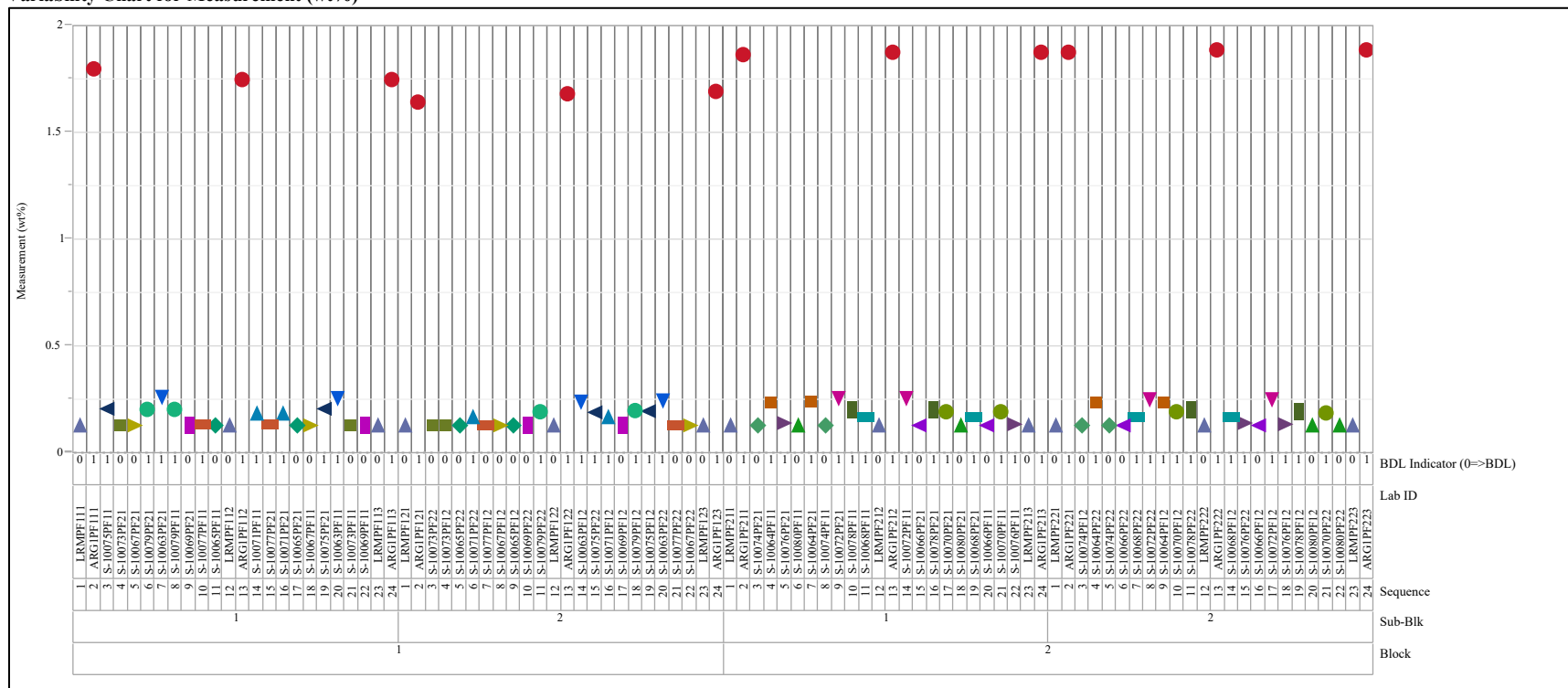
## Exhibit B-1. Plots of Oxide Measurements in Analytical Sequence for the Group 2 Glasses (continued)

Oxide=Li<sub>2</sub>O (wt%), Prep Method=PF  
 Variability Chart for Measurement (wt%)



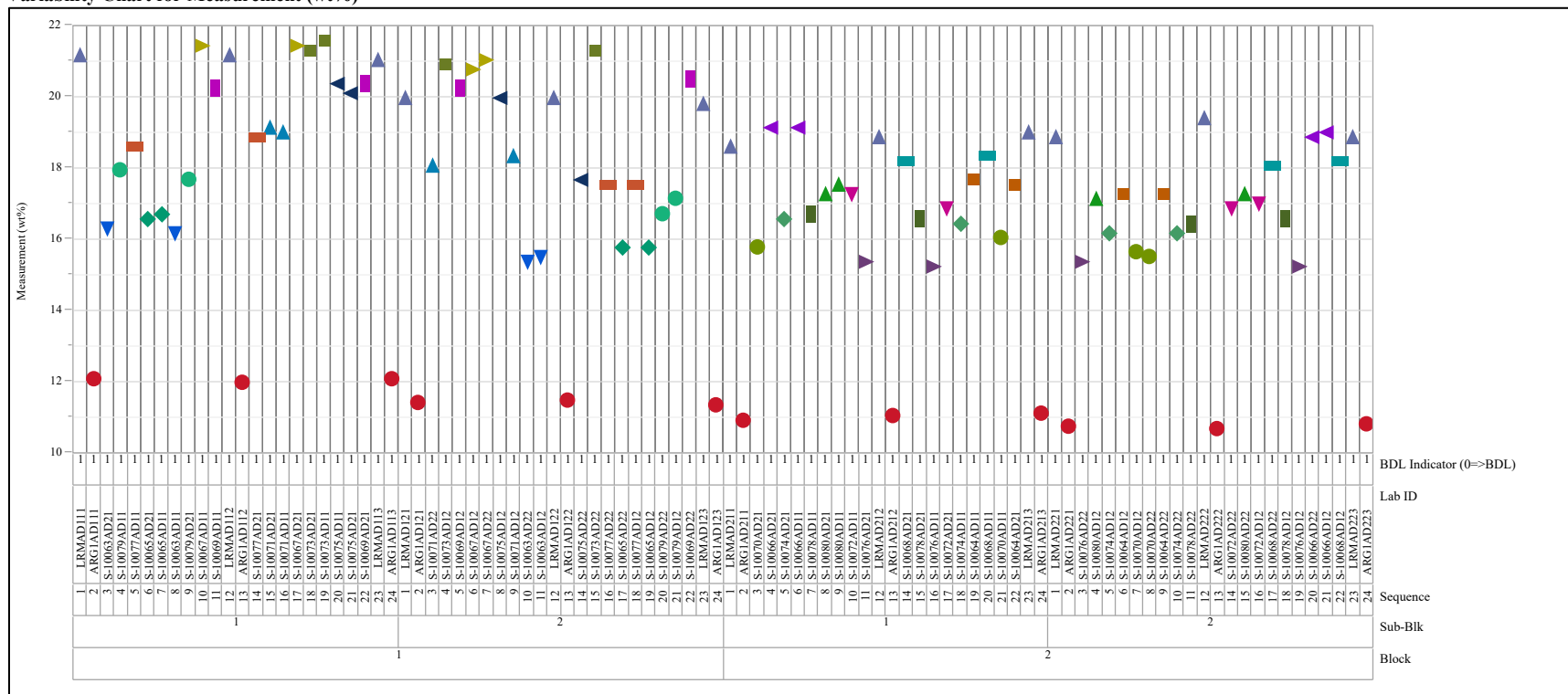
## Exhibit B-1. Plots of Oxide Measurements in Analytical Sequence for the Group 2 Glasses (continued)

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



**Exhibit B-1. Plots of Oxide Measurements in Analytical Sequence for the Group 2 Glasses (continued)**

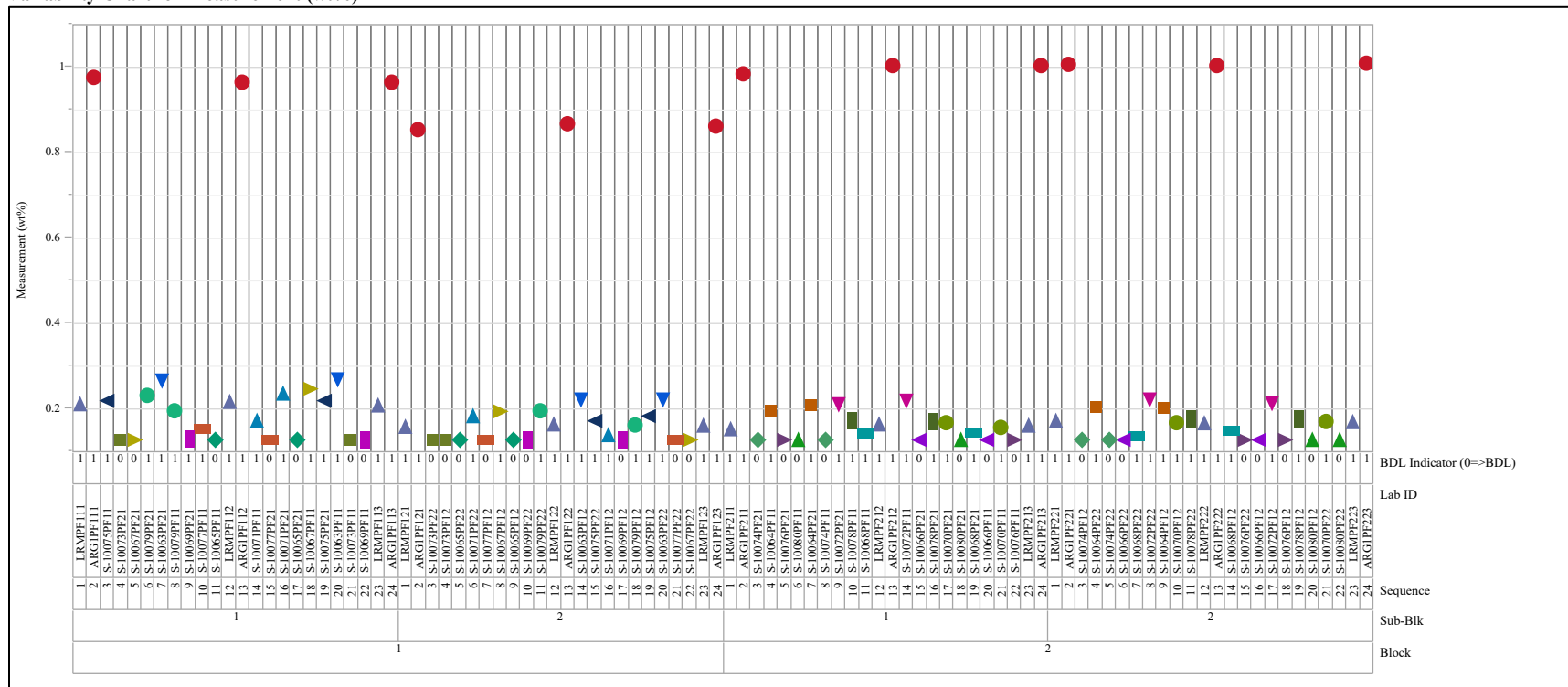
Oxide=Na<sub>2</sub>O (wt%), Prep Method=AD  
Variability Chart for Measurement (wt%)



## Exhibit B-1. Plots of Oxide Measurements in Analytical Sequence for the Group 2 Glasses (continued)

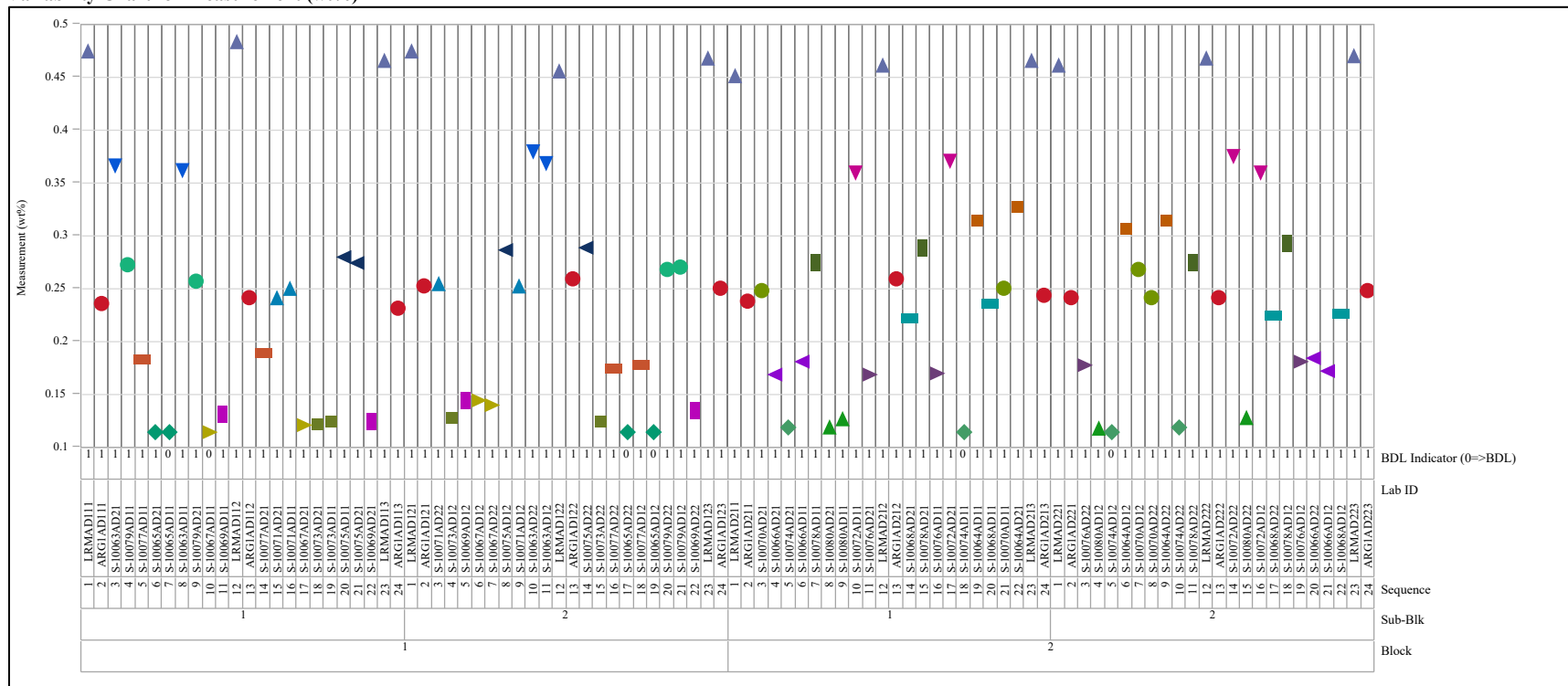
Oxide=NiO (wt%), Prep Method=PF

Variability Chart for Measurement (wt%)



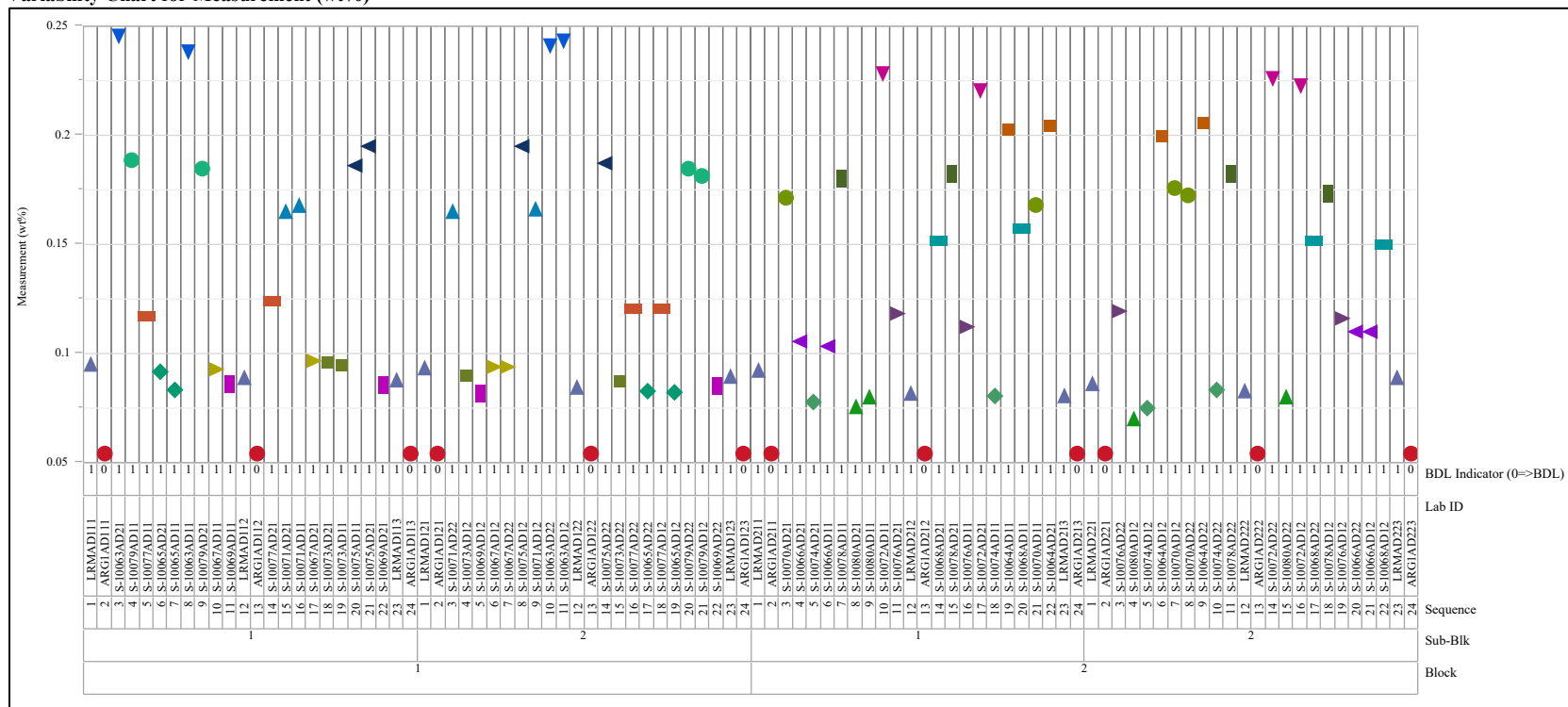
### Exhibit B-1. Plots of Oxide Measurements in Analytical Sequence for the Group 2 Glasses (continued)

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



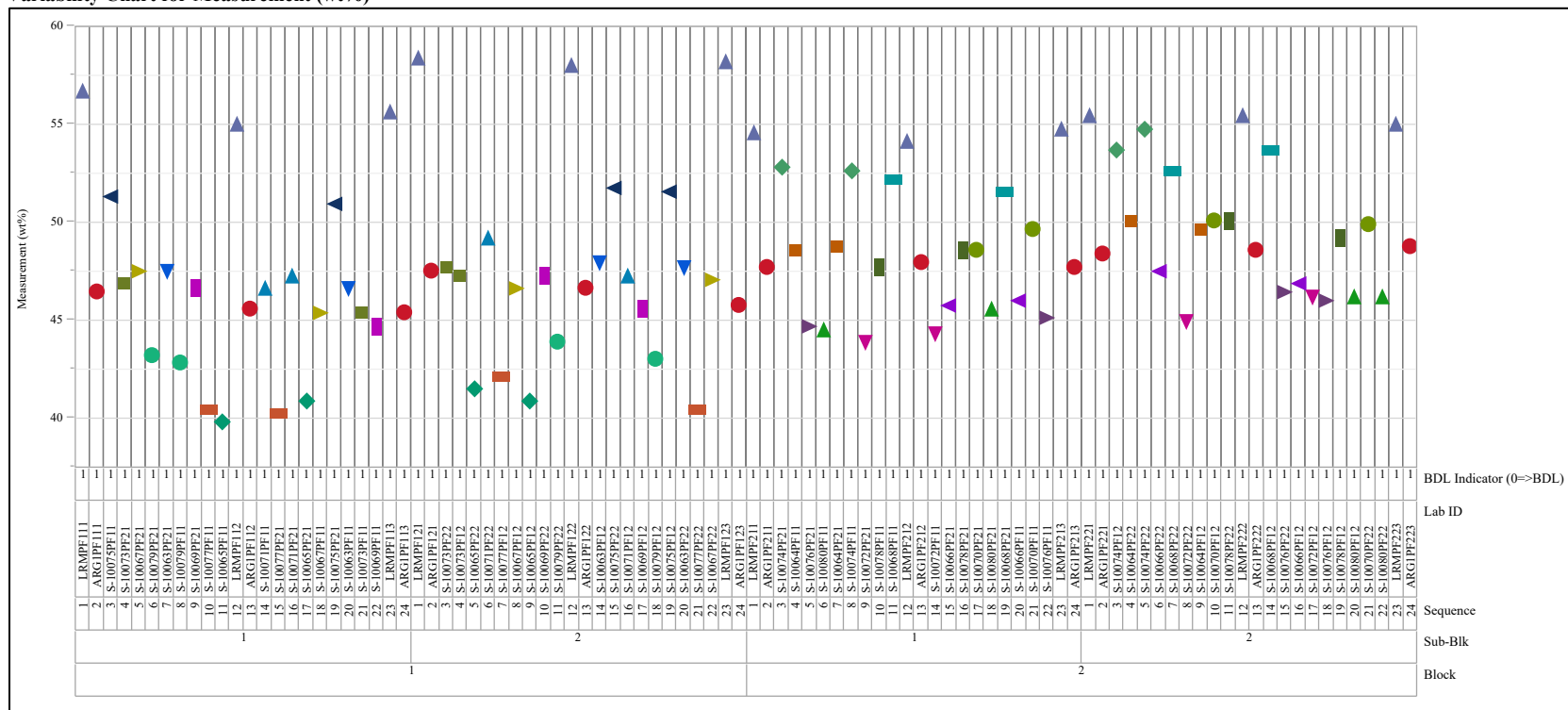
## Exhibit B-1. Plots of Oxide Measurements in Analytical Sequence for the Group 2 Glasses (continued)

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



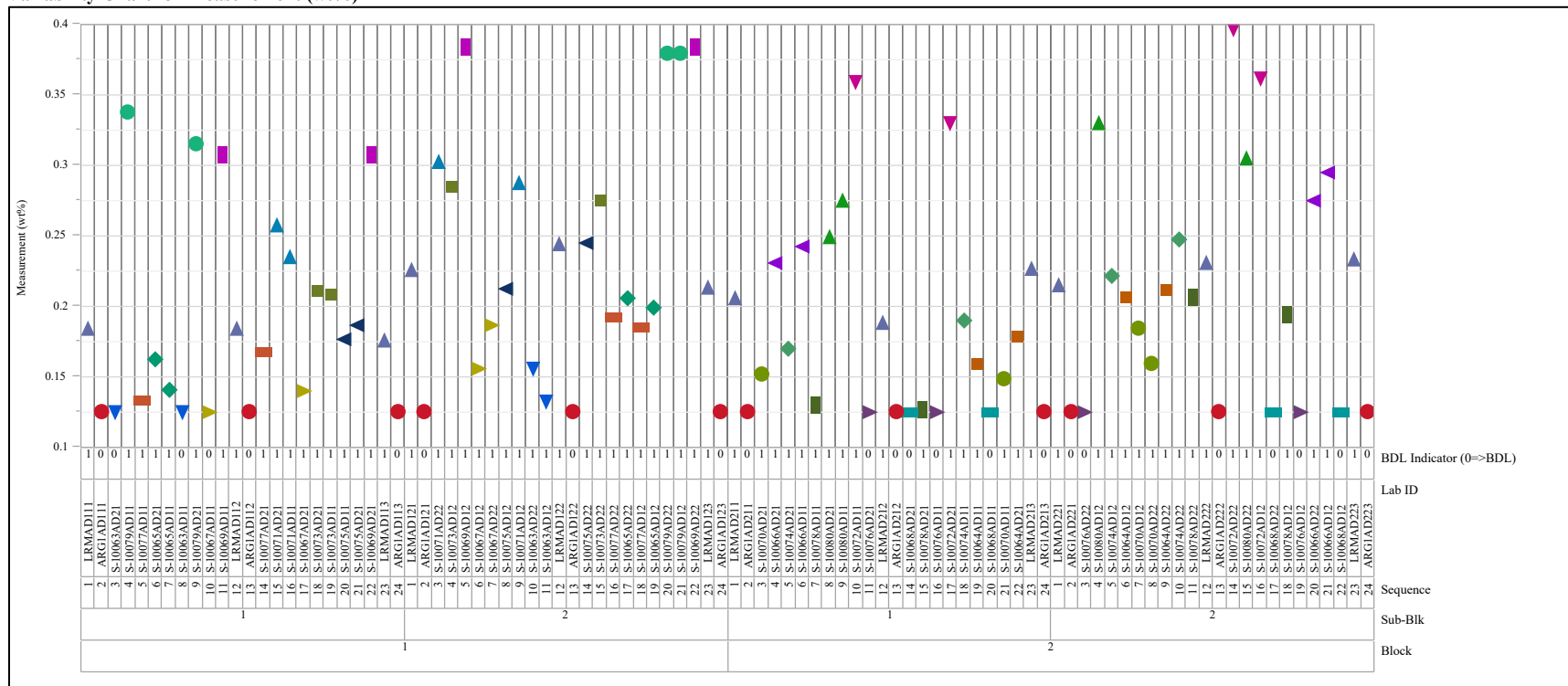
## Exhibit B-1. Plots of Oxide Measurements in Analytical Sequence for the Group 2 Glasses (continued)

Oxide=SiO<sub>2</sub> (wt%), Prep Method=PF  
 Variability Chart for Measurement (wt%)



**Exhibit B-1. Plots of Oxide Measurements in Analytical Sequence for the Group 2 Glasses (continued)**

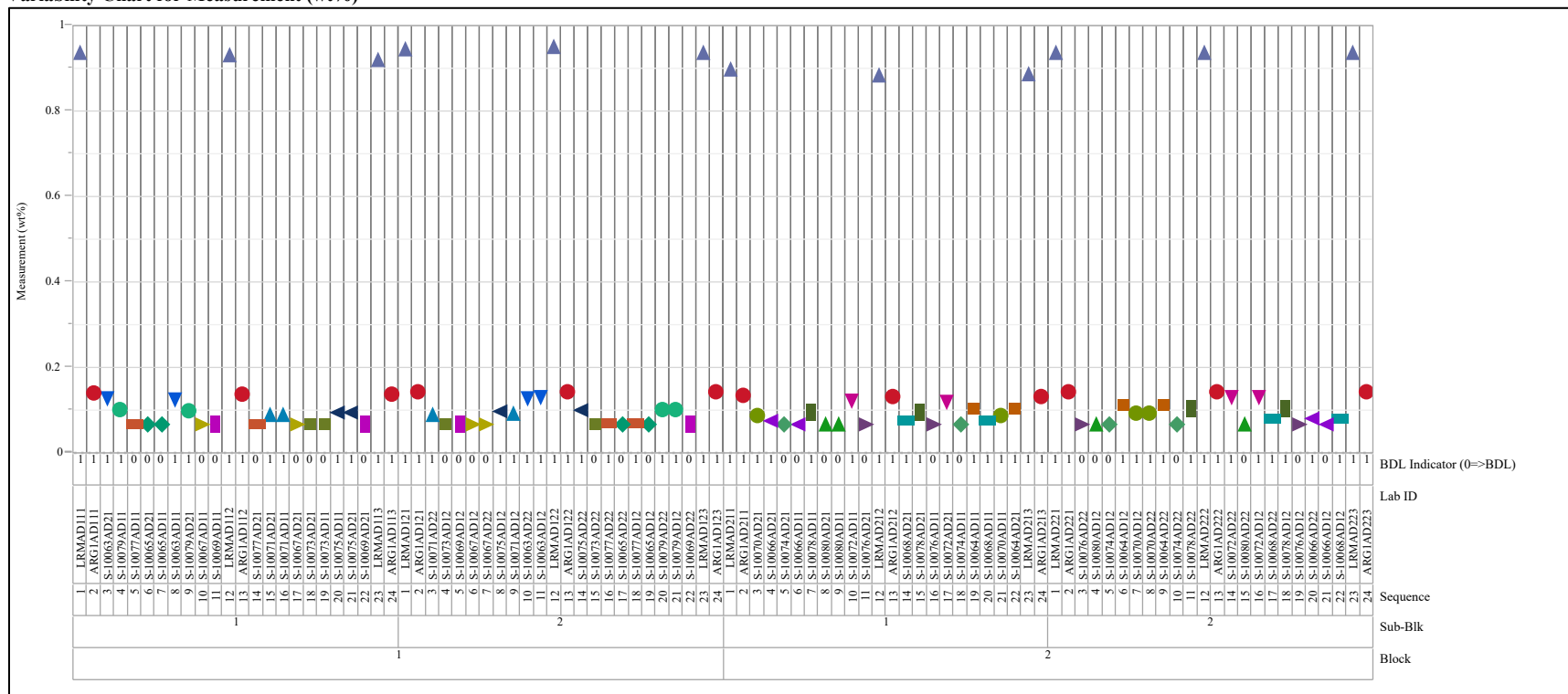
Oxide=SO<sub>3</sub> (wt%), Prep Method=AD  
Variability Chart for Measurement (wt%)





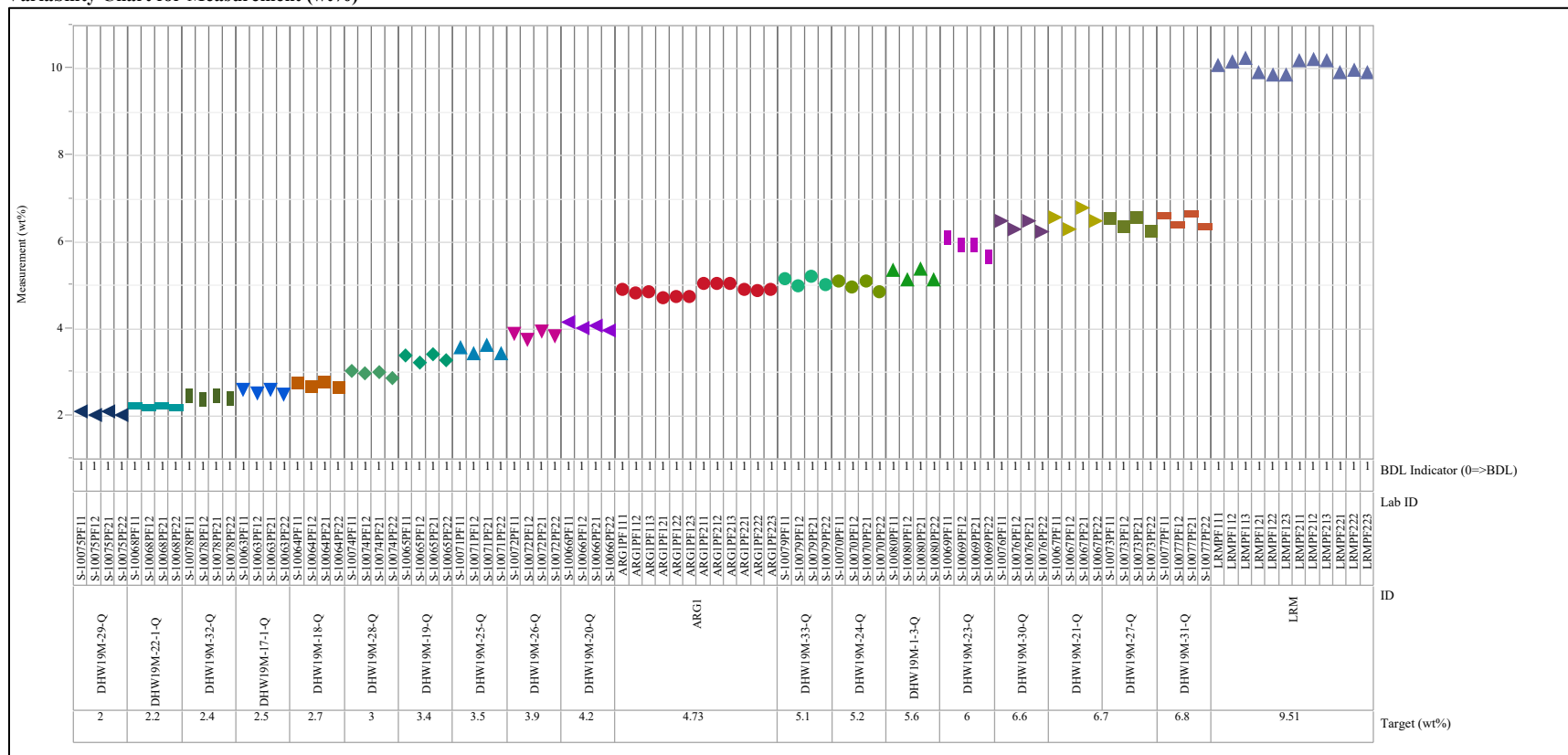
**Exhibit B-1. Plots of Oxide Measurements in Analytical Sequence for the Group 2 Glasses (continued)**

Oxide=ZrO<sub>2</sub> (wt%), Prep Method=AD  
Variability Chart for Measurement (wt%)



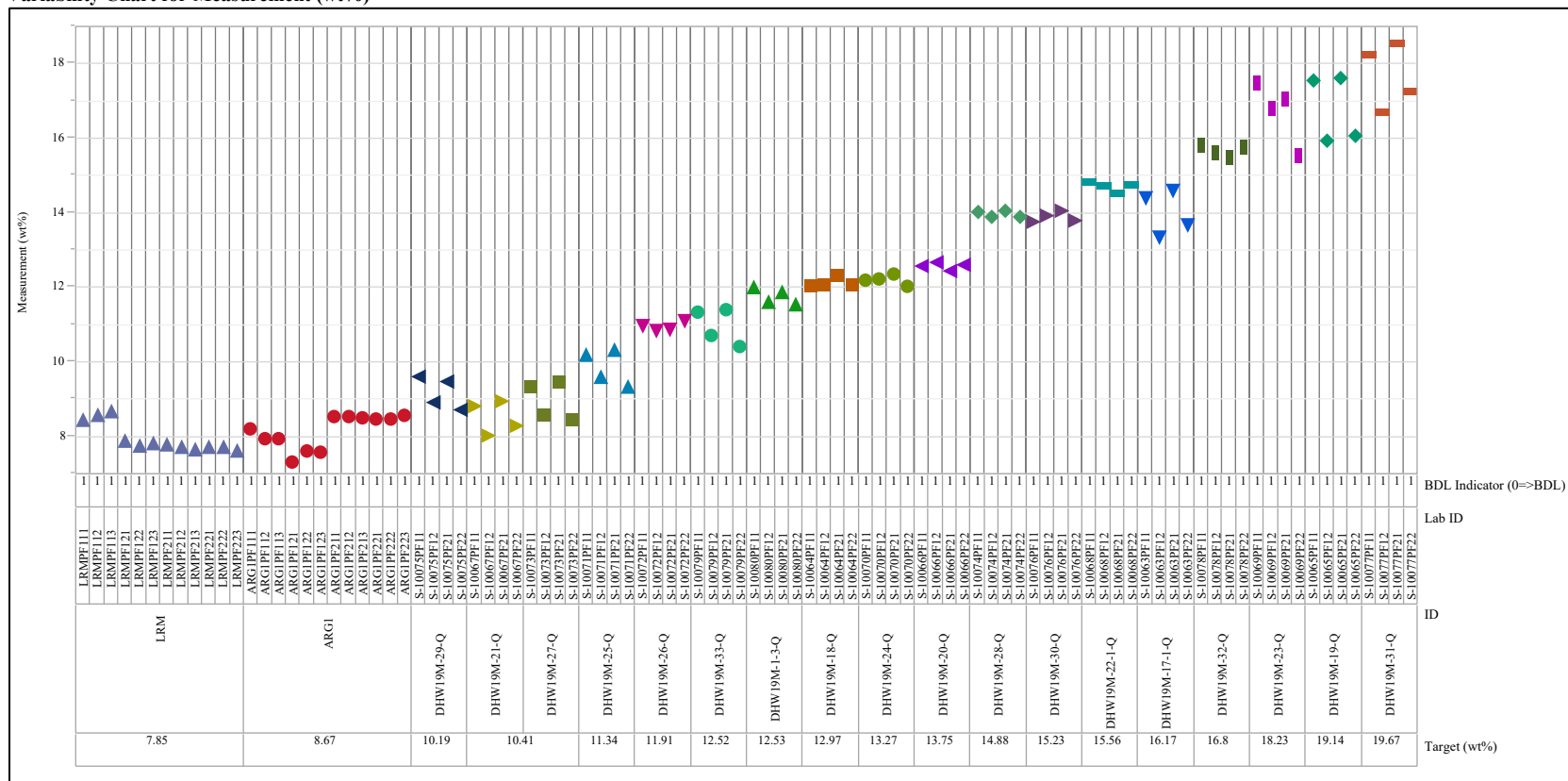
## Exhibit B-2. Plots of Oxide Measurements by Group 2 Glass Identifier Grouped by Targeted Concentrations

Oxide=Al<sub>2</sub>O<sub>3</sub> (wt%), Prep Method=PF  
 Variability Chart for Measurement (wt%)



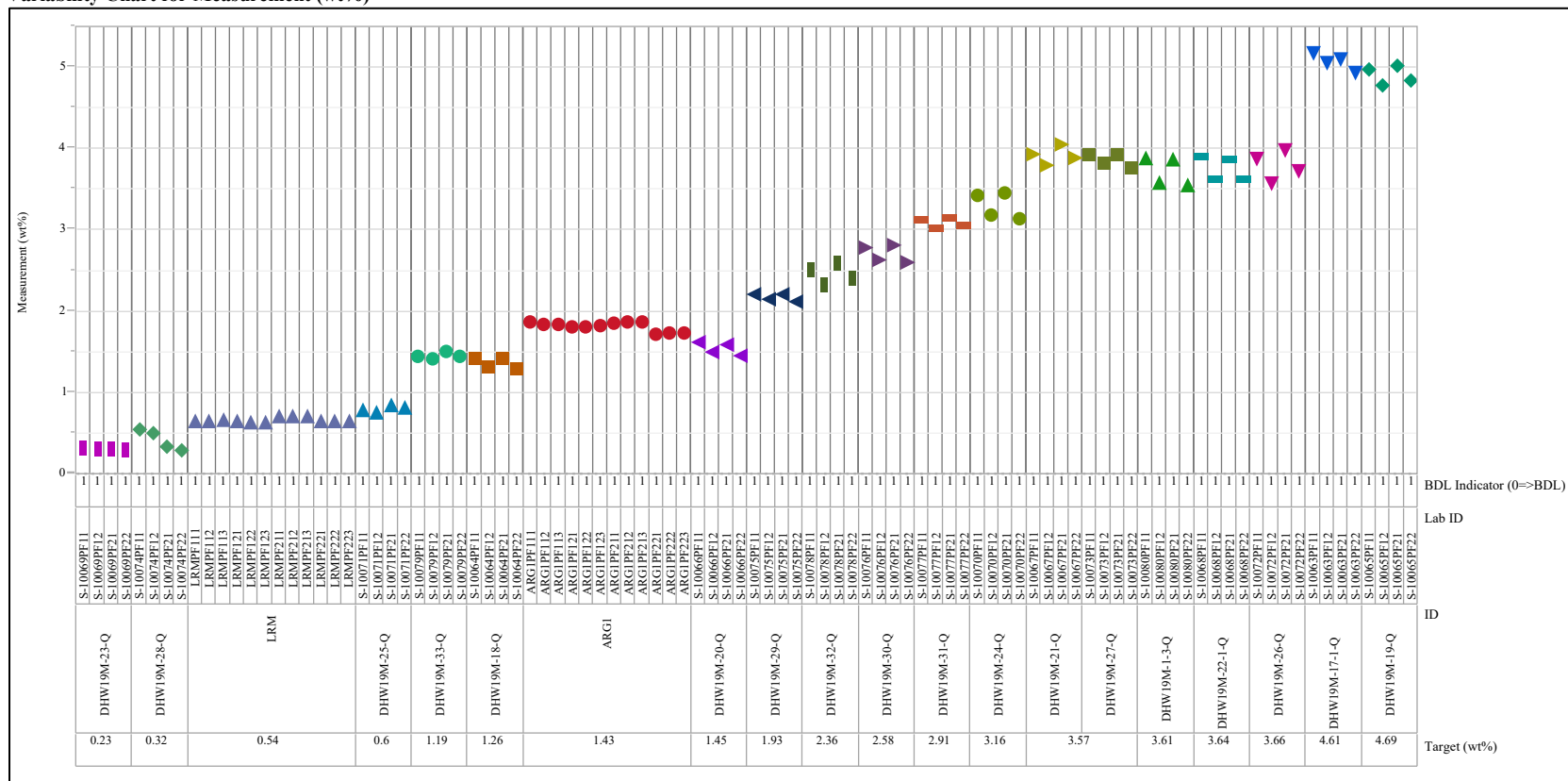
**Exhibit B-2. Plots of Oxide Measurements by Group 2 Glass Identifier Grouped by Targeted Concentrations (continued)**

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



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

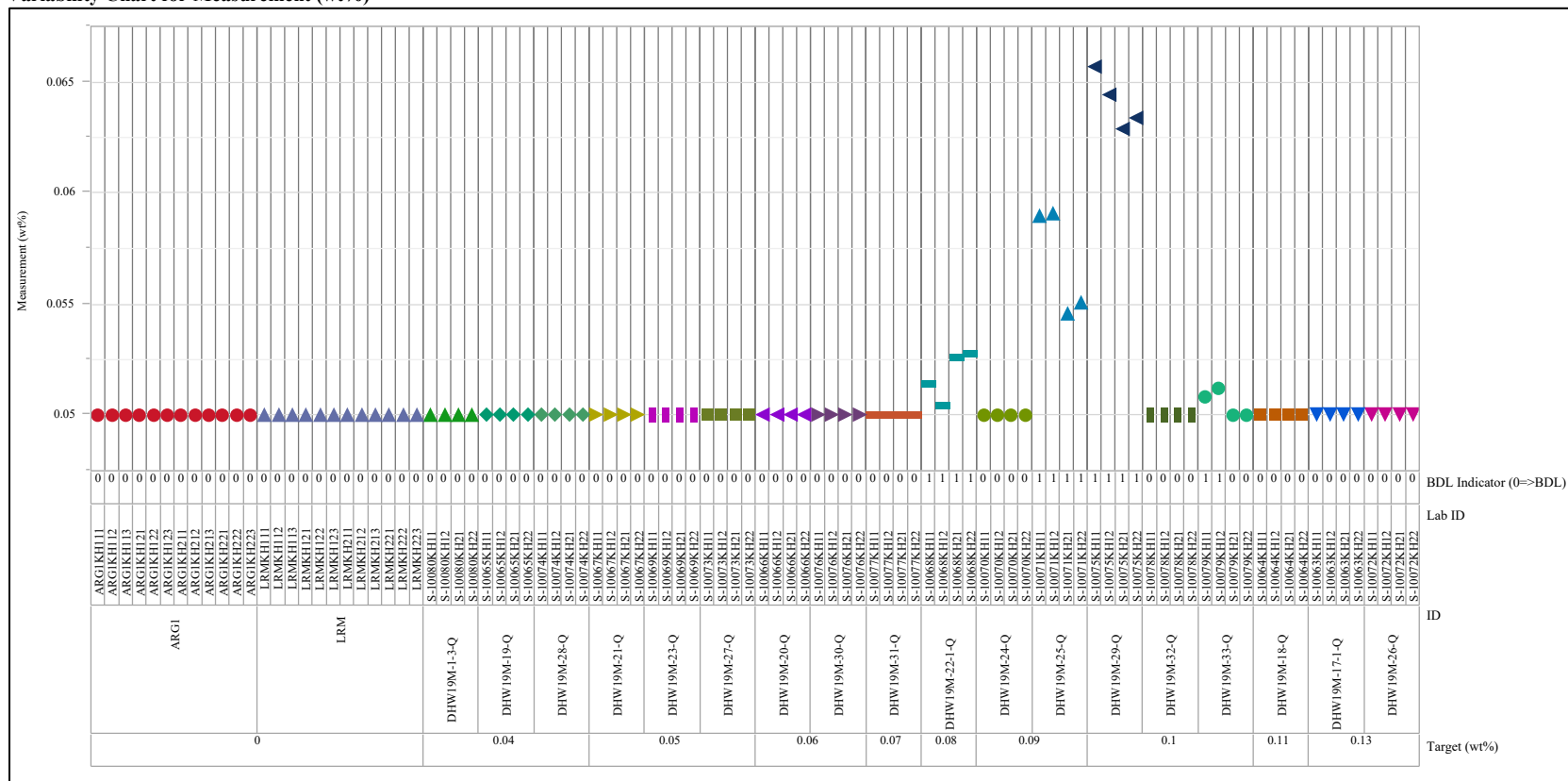
Oxide=CaO (wt%), Prep Method=PF  
 Variability Chart for Measurement (wt%)



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

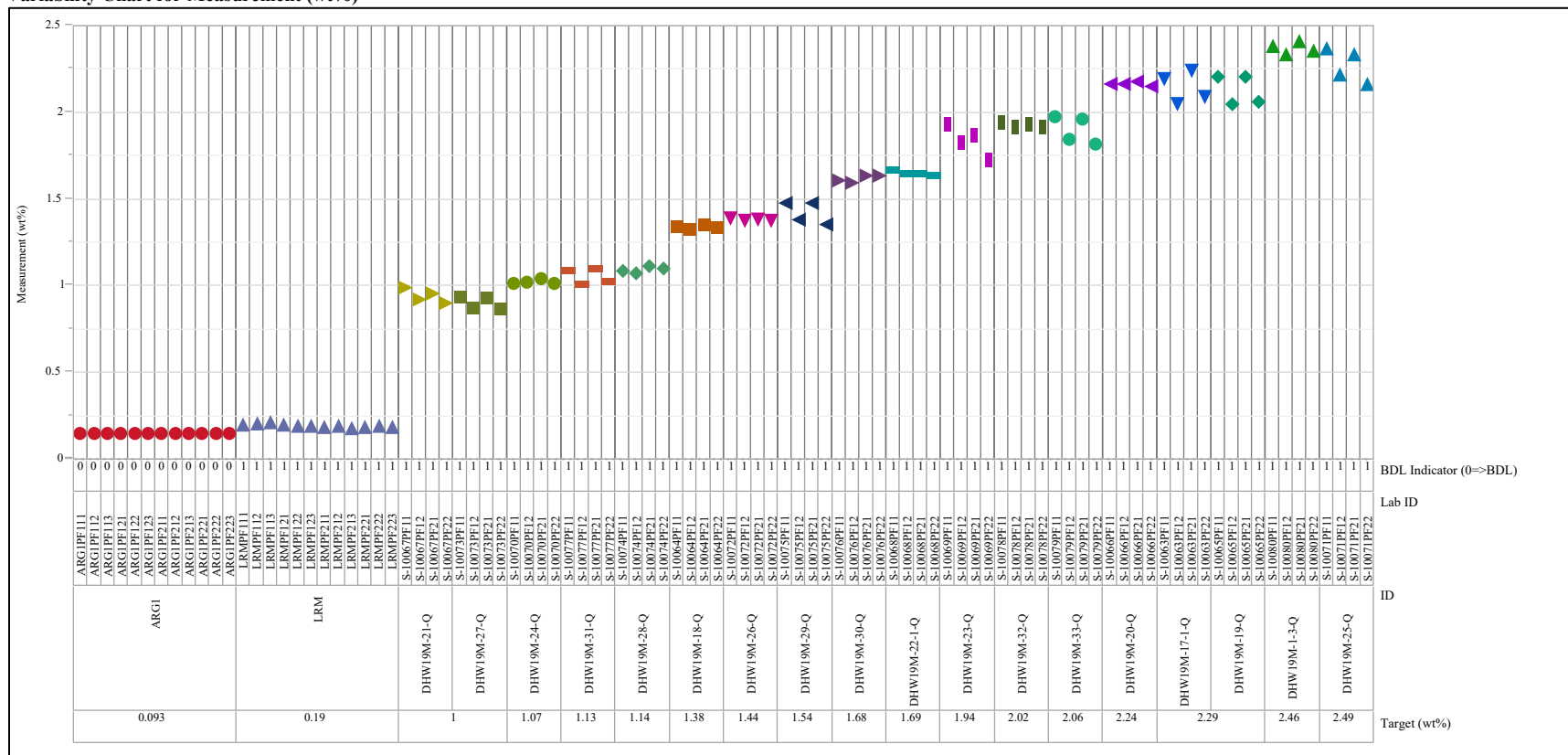
**Oxide=Cl (wt%), Prep Method=KH**

### Variability Chart for Measurement (wt%)



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

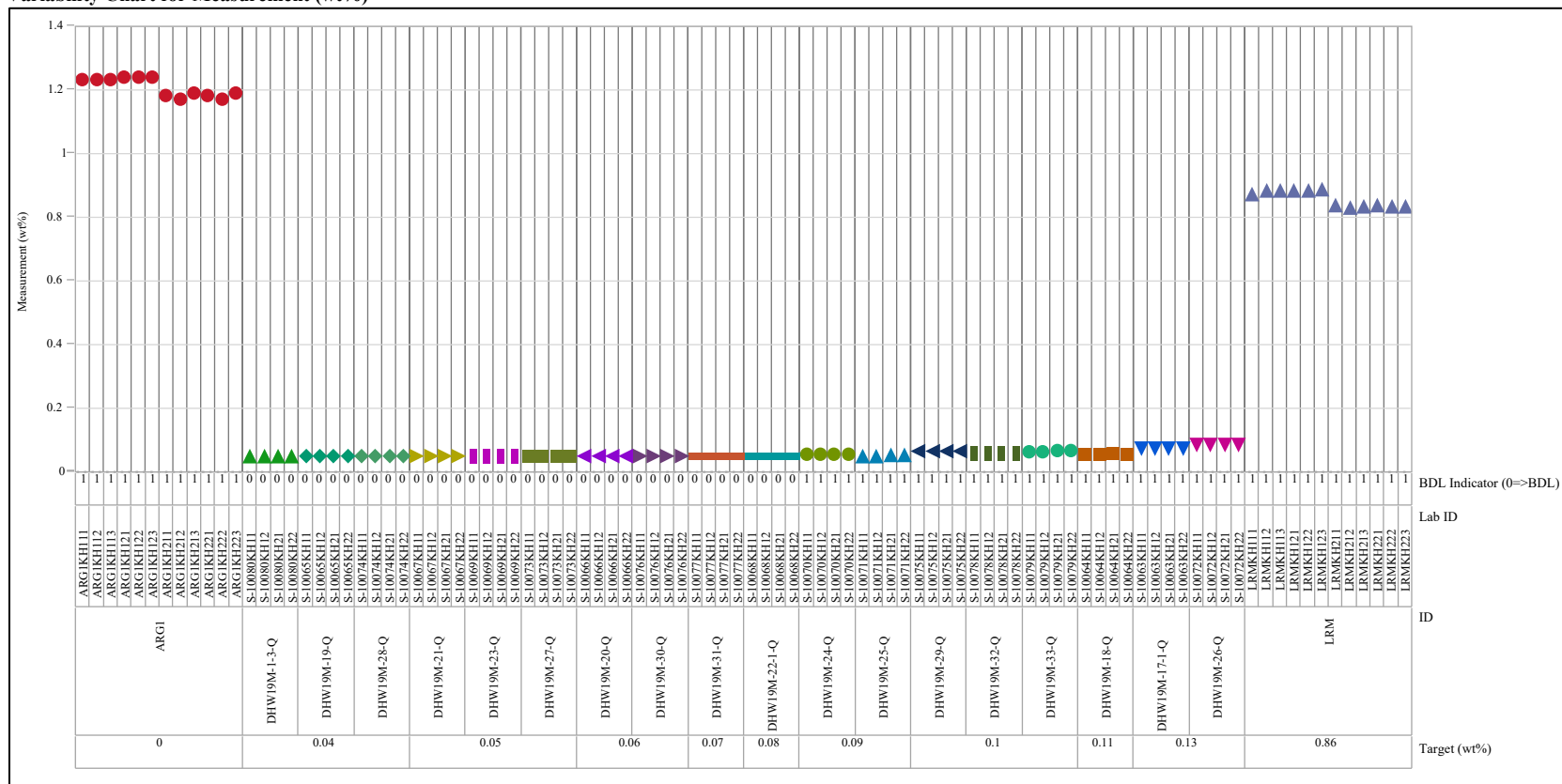
Oxide=Cr2O3 (wt%), Prep Method=PF  
 Variability Chart for Measurement (wt%)



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

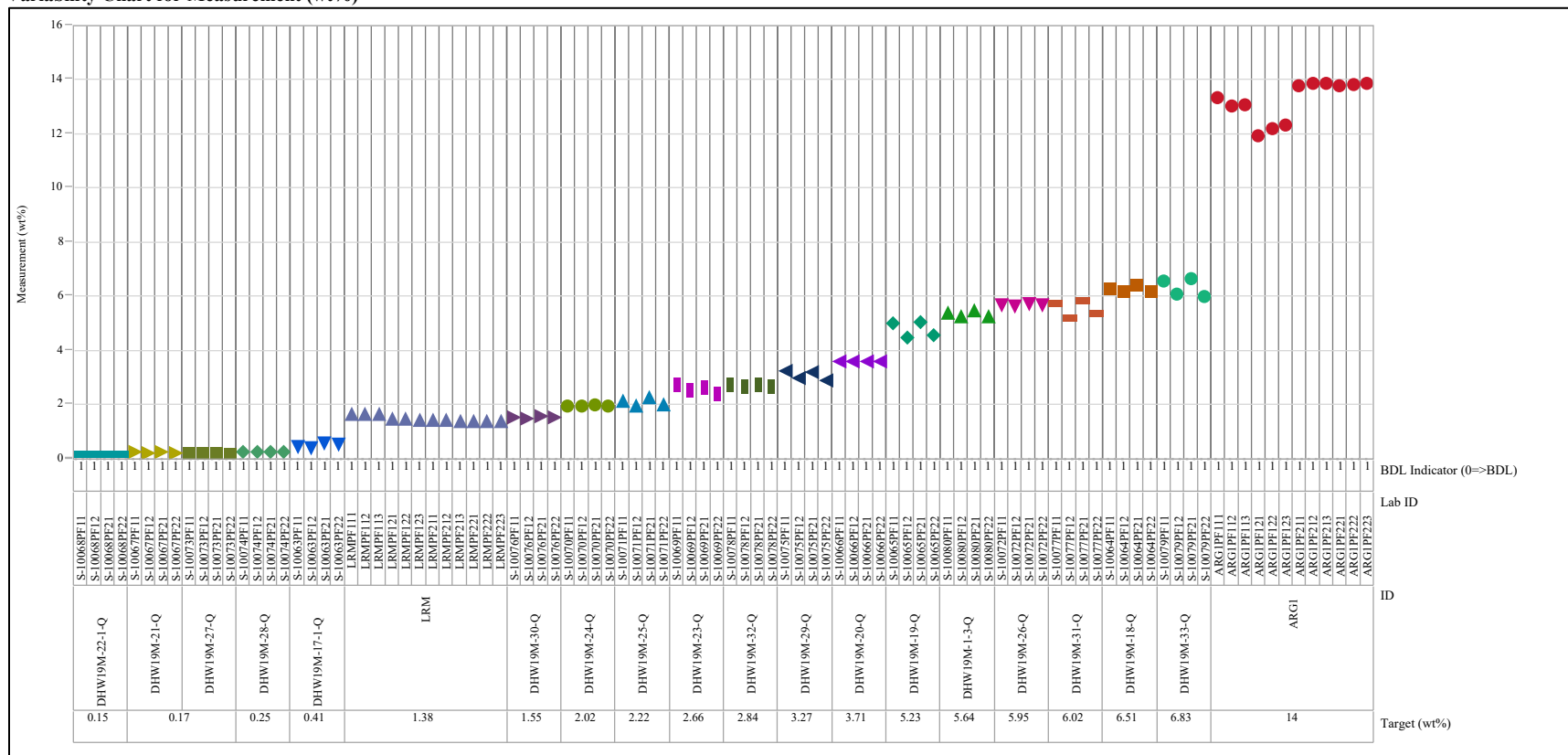
**Oxide=F (wt%), Prep Method=KH**

### Variability Chart for Measurement (wt%)



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

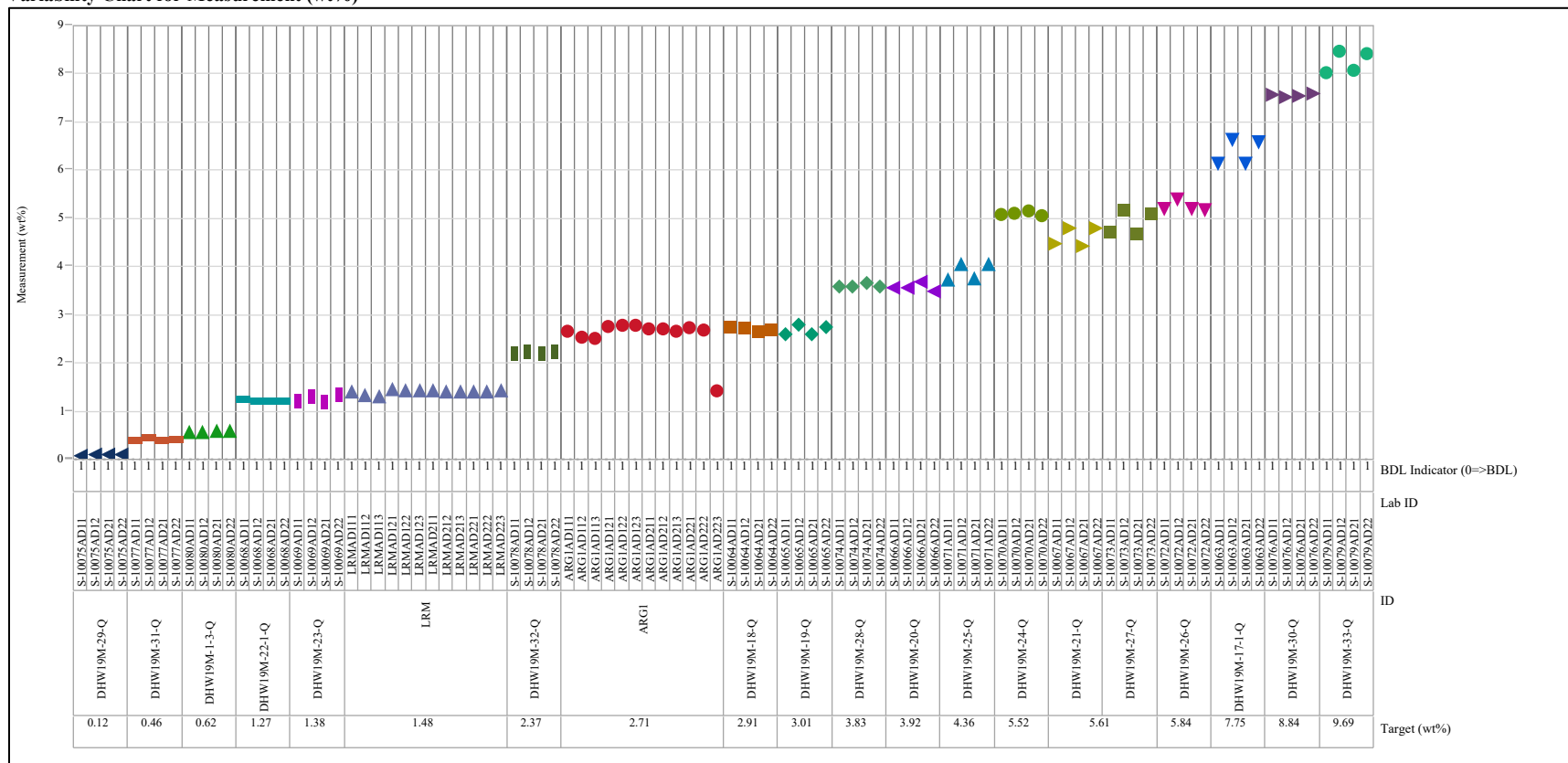
Oxide=Fe<sub>2</sub>O<sub>3</sub> (wt%), Prep Method=PF  
 Variability Chart for Measurement (wt%)





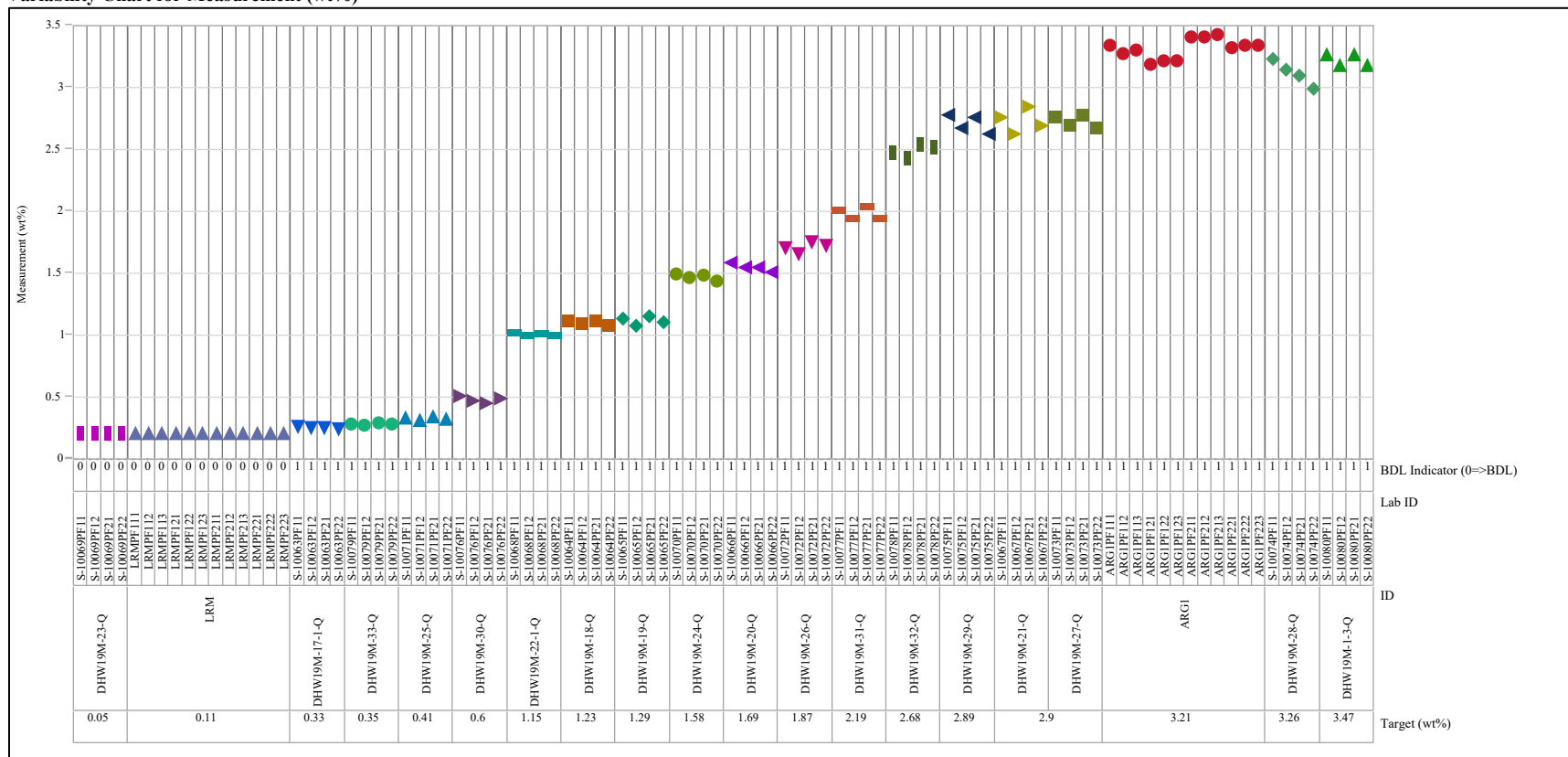
### Exhibit B-2. Plots of Oxide Measurements by Group 2 Glass Identifier Grouped by Targeted Concentrations (continued)

Oxide=K<sub>2</sub>O (wt%), Prep Method=AD  
 Variability Chart for Measurement (wt%)



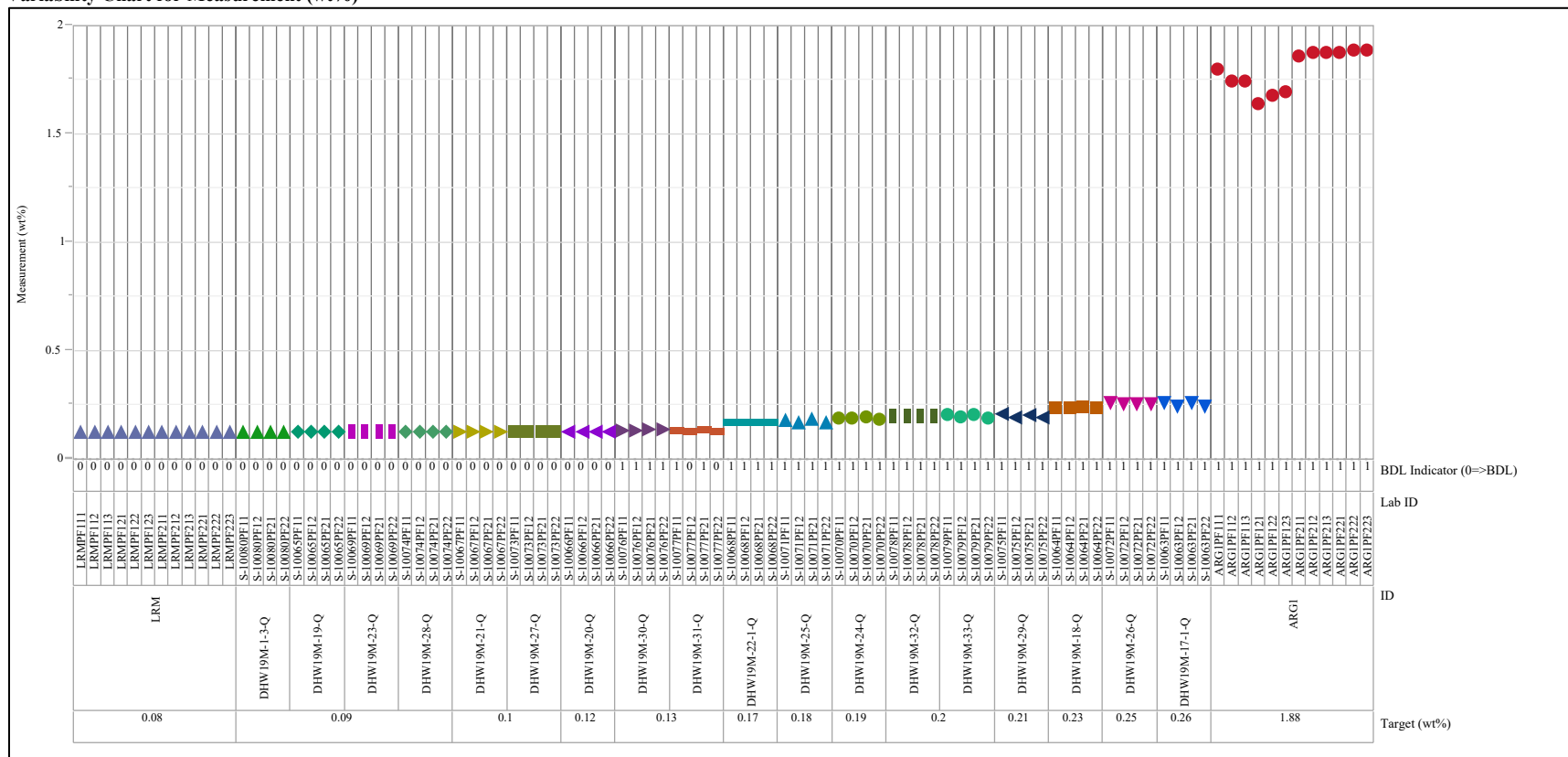
### Exhibit B-2. Plots of Oxide Measurements by Group 2 Glass Identifier Grouped by Targeted Concentrations (continued)

Oxide=Li<sub>2</sub>O (wt%), Prep Method=PF  
 Variability Chart for Measurement (wt%)



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

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



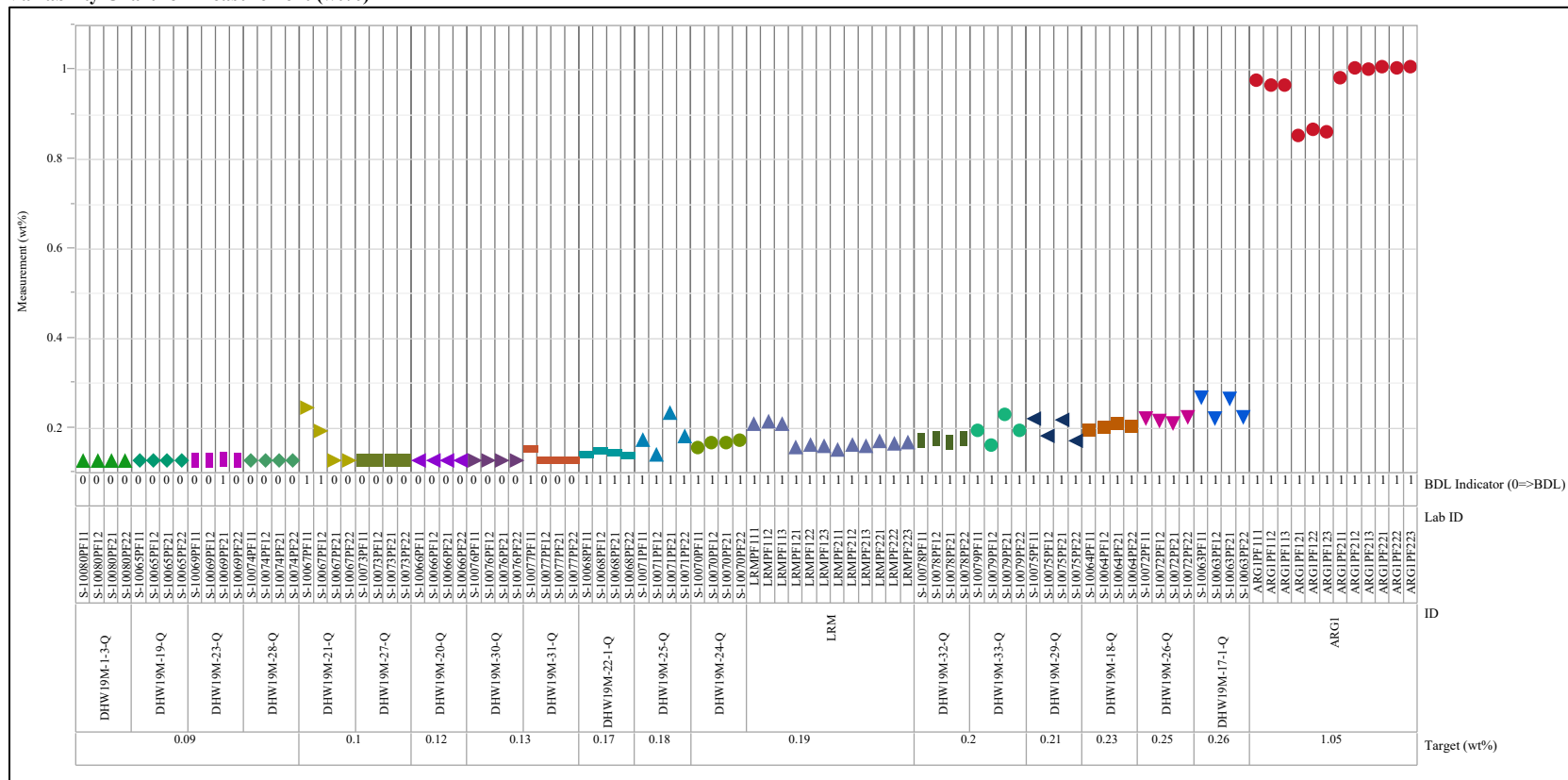
**Oxide=Na<sub>2</sub>O (wt%), Prep Method=AD**  
**Variability Chart for Measurement (wt%)**



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

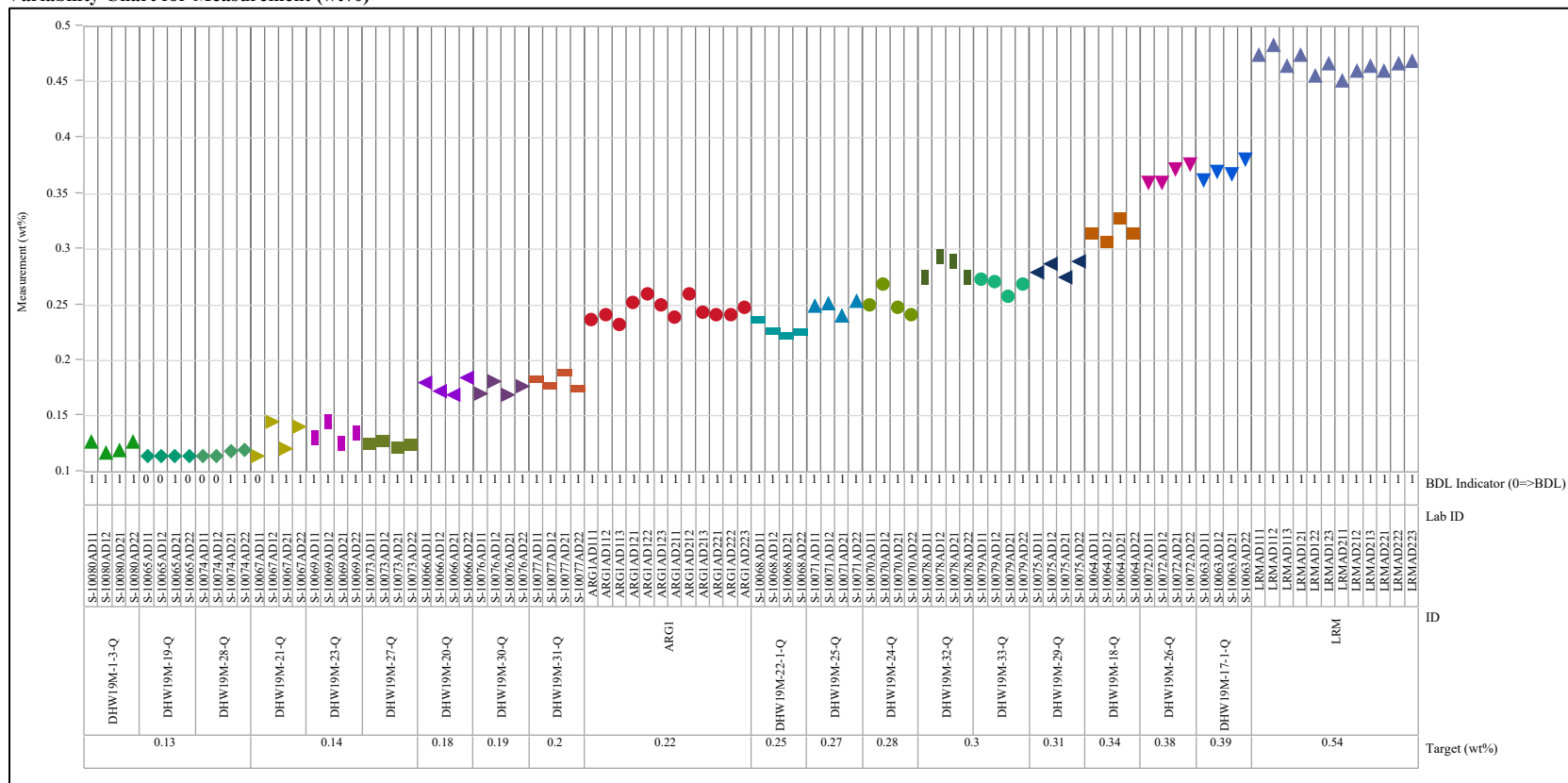
Oxide=NiO (wt%), Prep Method=PF

Variability Chart for Measurement (wt%)



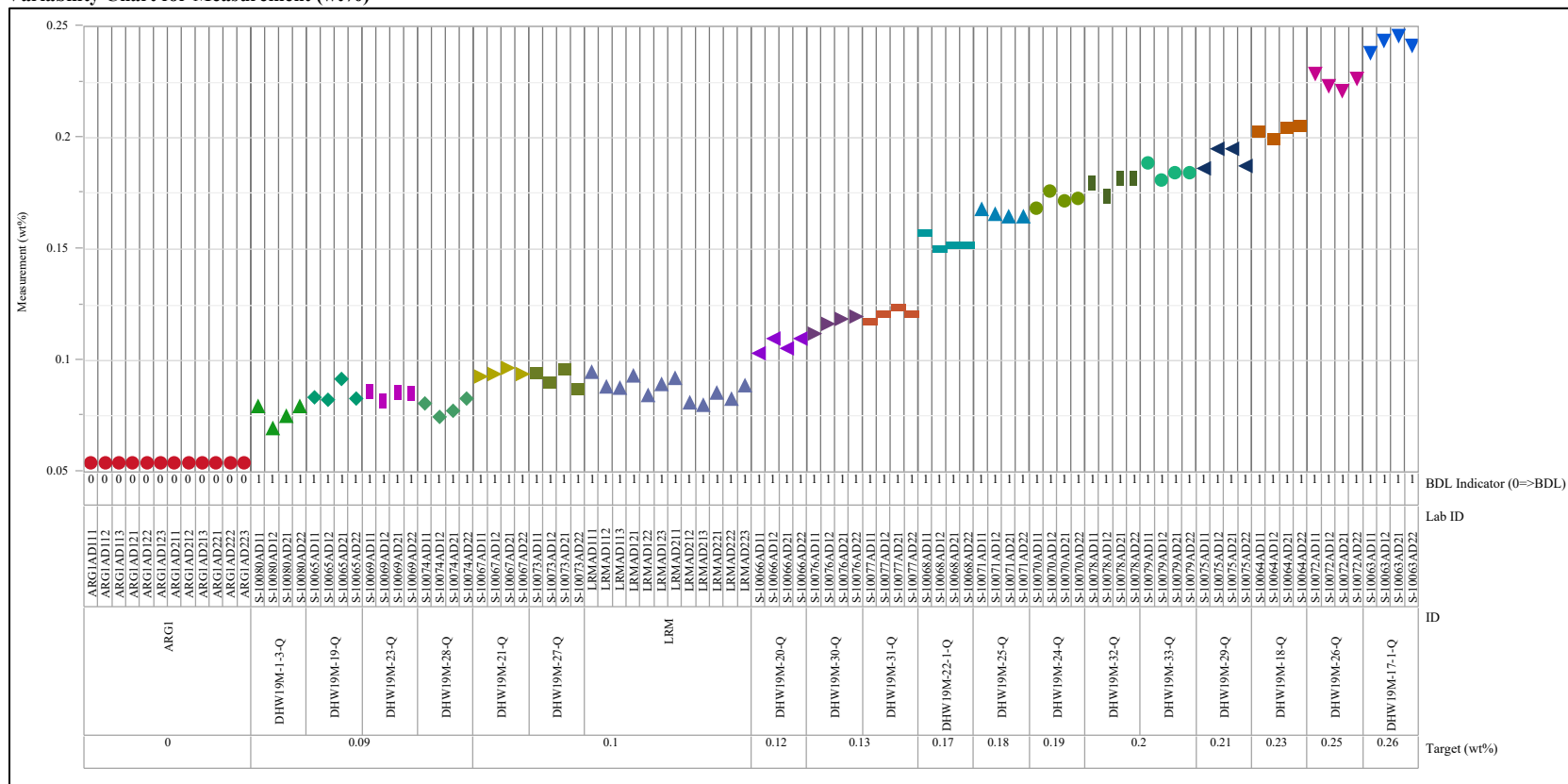
**Exhibit B-2. Plots of Oxide Measurements by Group 2 Glass Identifier Grouped by Targeted Concentrations (continued)**

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



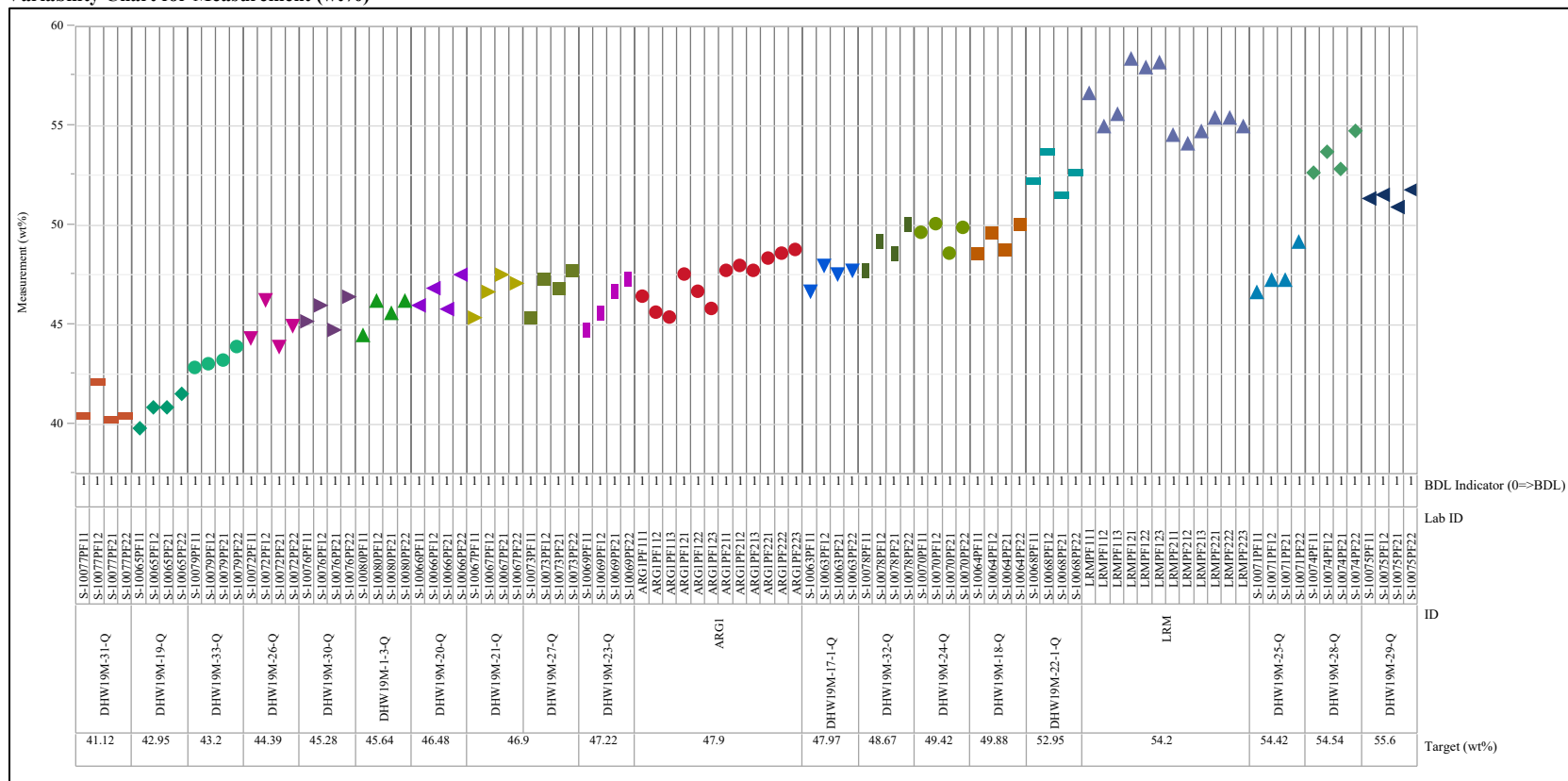
**Exhibit B-2. Plots of Oxide Measurements by Group 2 Glass Identifier Grouped by Targeted Concentrations (continued)**

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



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

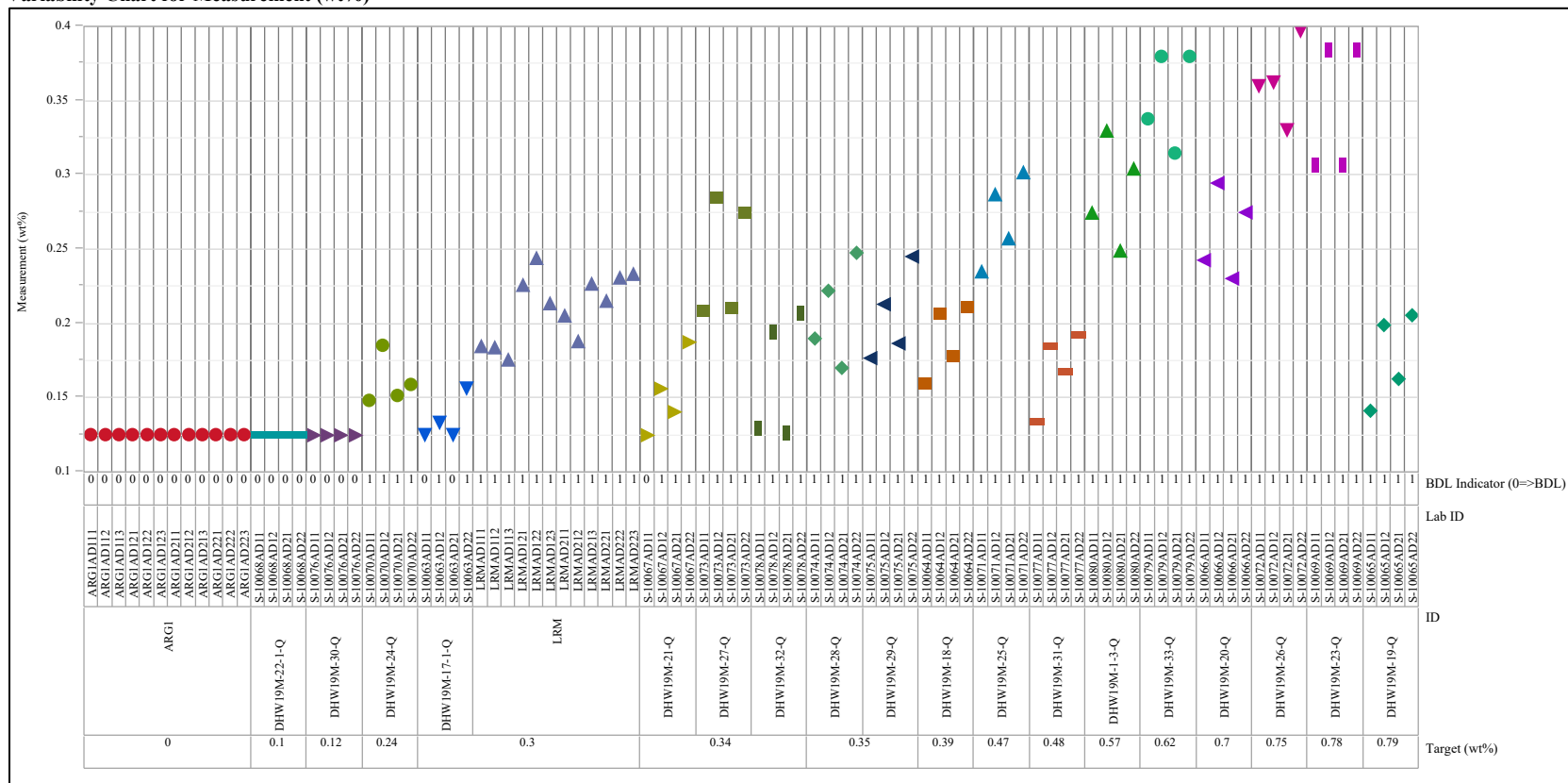
Oxide=SiO<sub>2</sub> (wt%), Prep Method=PF  
 Variability Chart for Measurement (wt%)





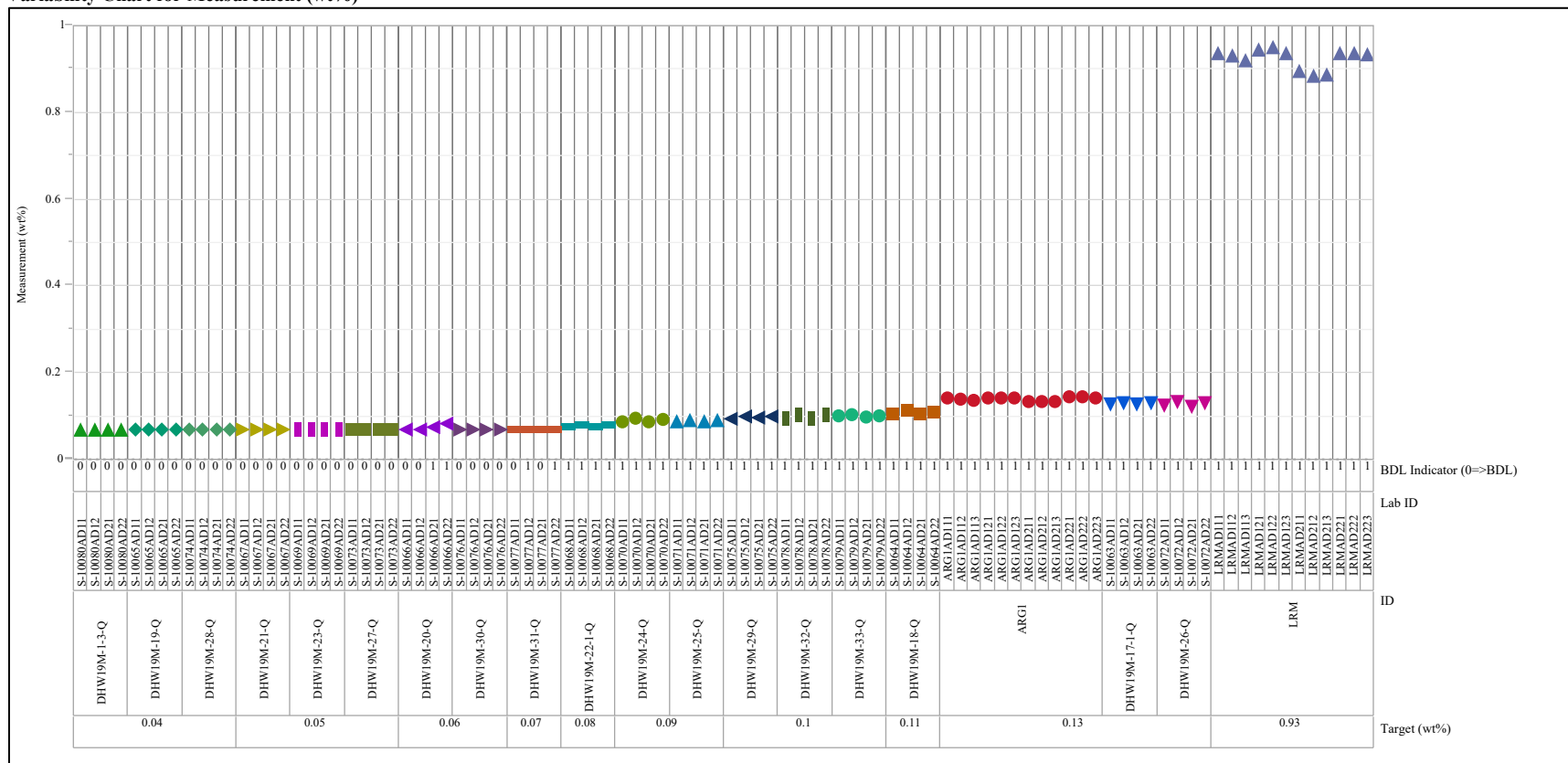
### Exhibit B-2. Plots of Oxide Measurements by Group 2 Glass Identifier Grouped by Targeted Concentrations (continued)

Oxide=SO<sub>3</sub> (wt%), Prep Method=AD  
 Variability Chart for Measurement (wt%)



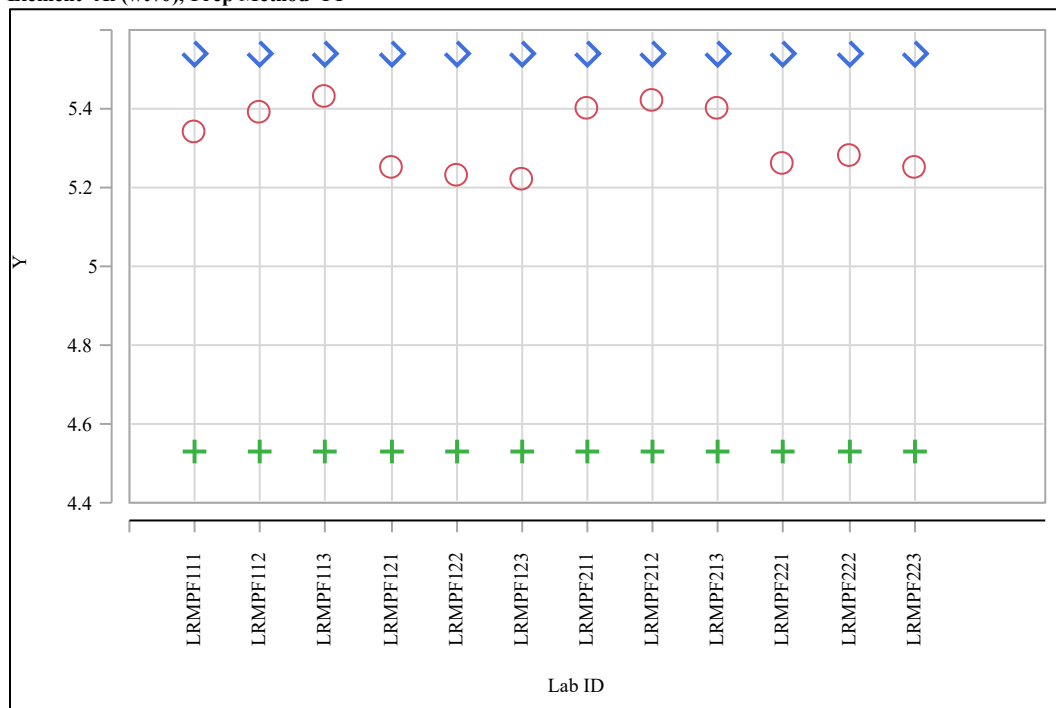
## Exhibit B-2. Plots of Oxide Measurements by Group 2 Glass Identifier Grouped by Targeted Concentrations (continued)

Oxide=ZrO<sub>2</sub> (wt%), Prep Method=AD  
 Variability Chart for Measurement (wt%)

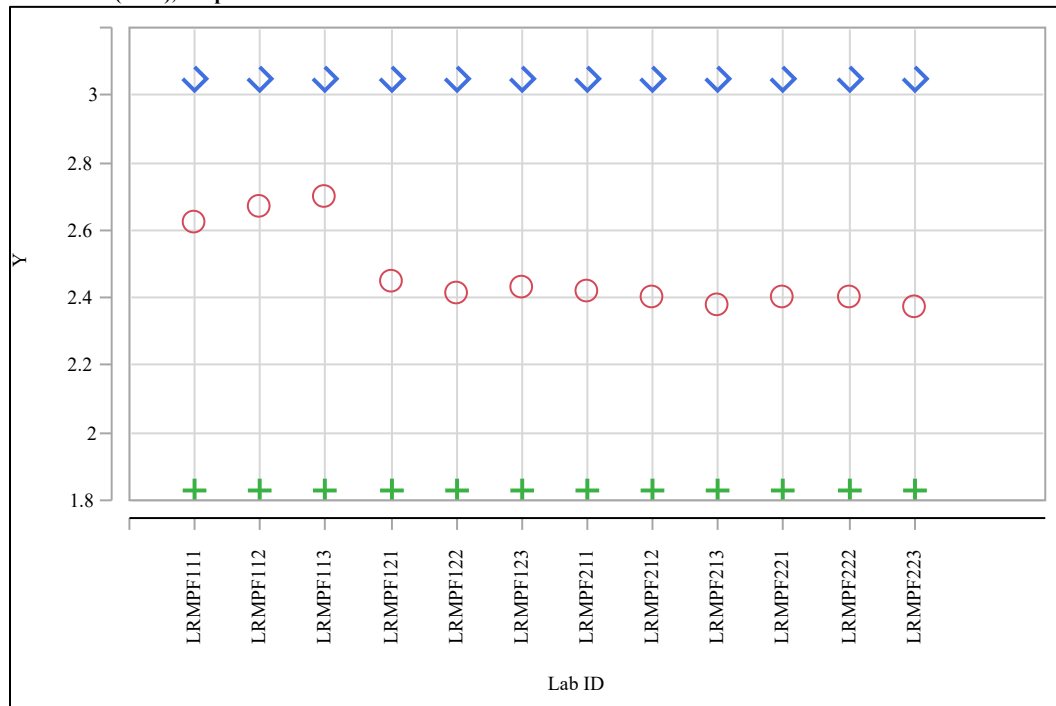


### Exhibit B-3. Acceptability Evaluation for Measurements of the LRM Standard Glass

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



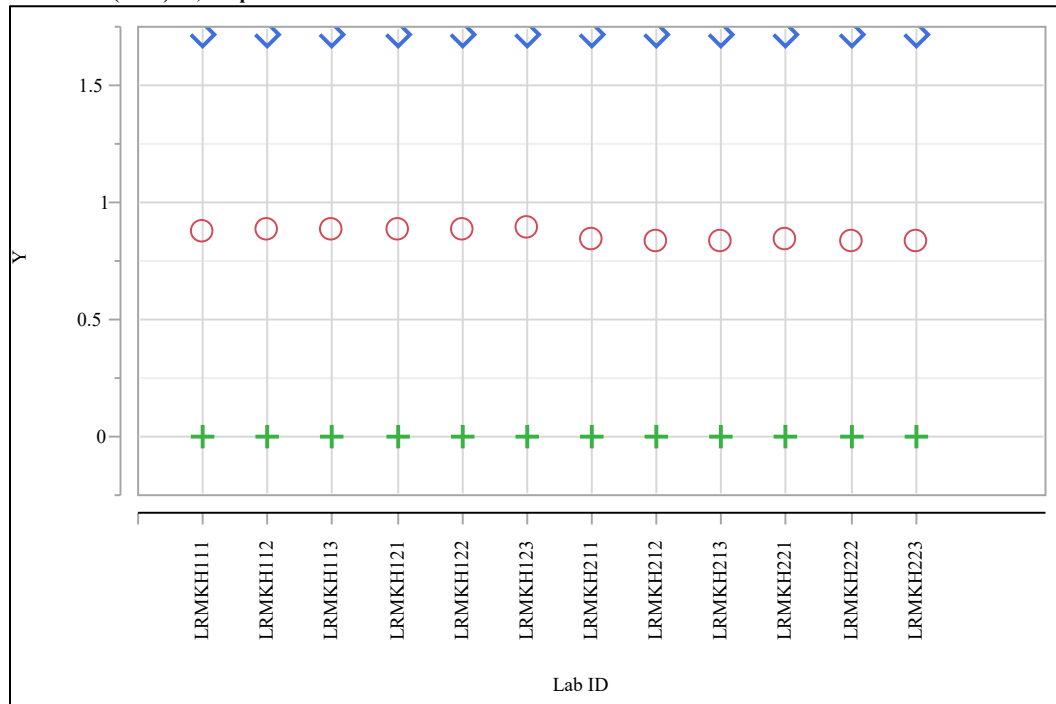
Element=B (wt%), Prep Method=PF



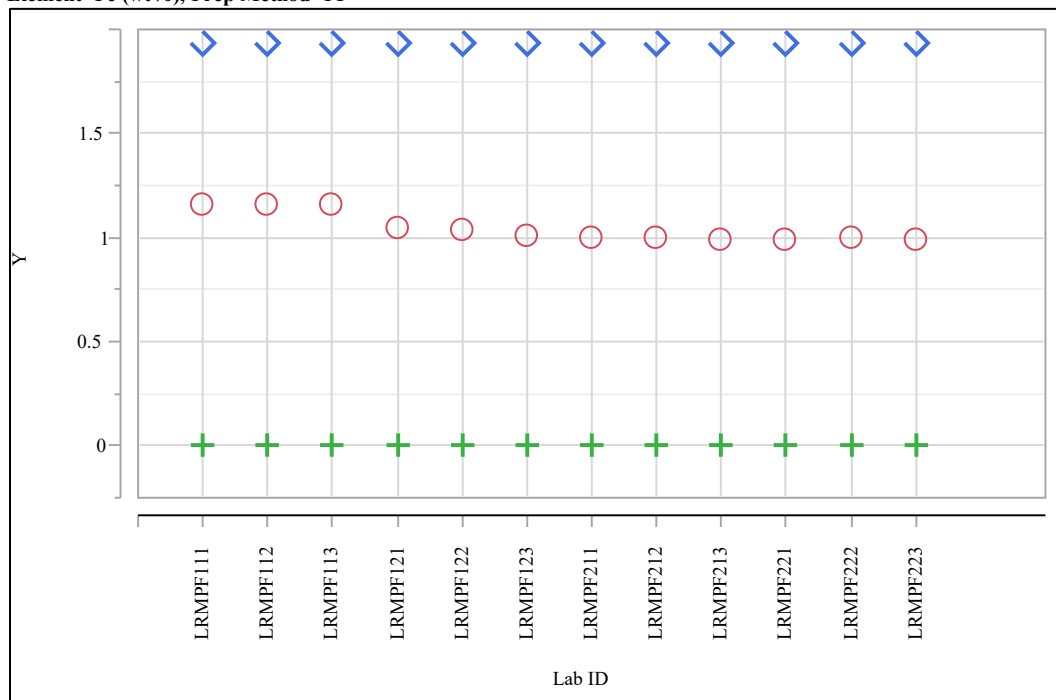
Y    ○ Measurement    + lower acceptability limit    ◇ upper acceptability limit

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

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



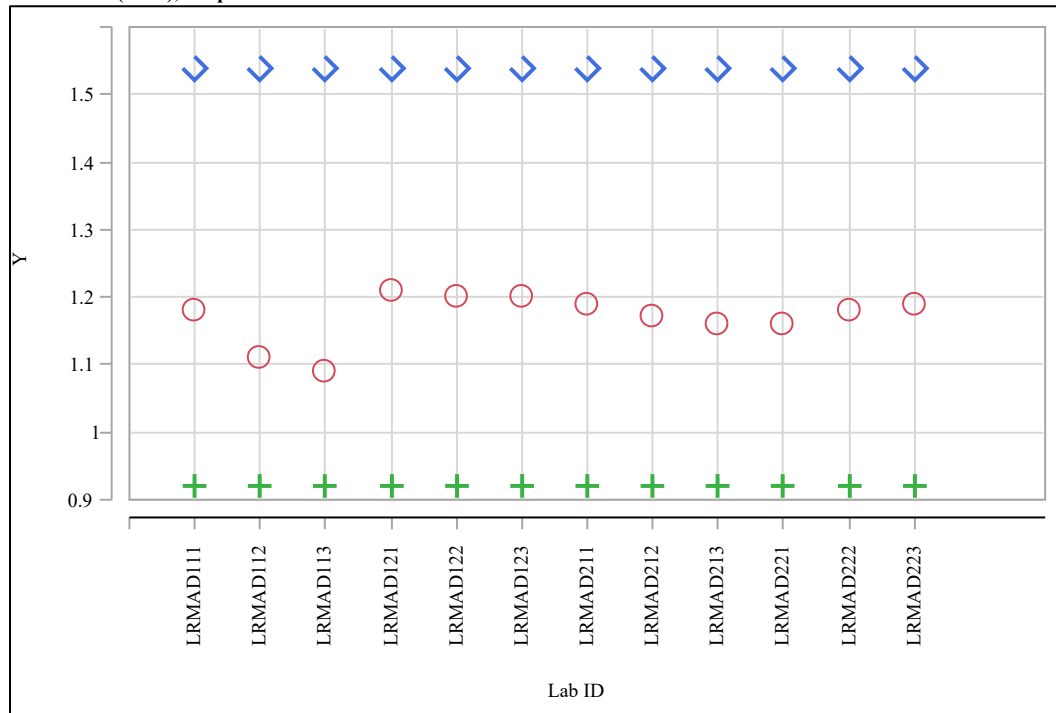
Element=Fe (wt%), Prep Method=PF



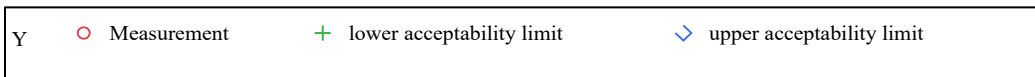
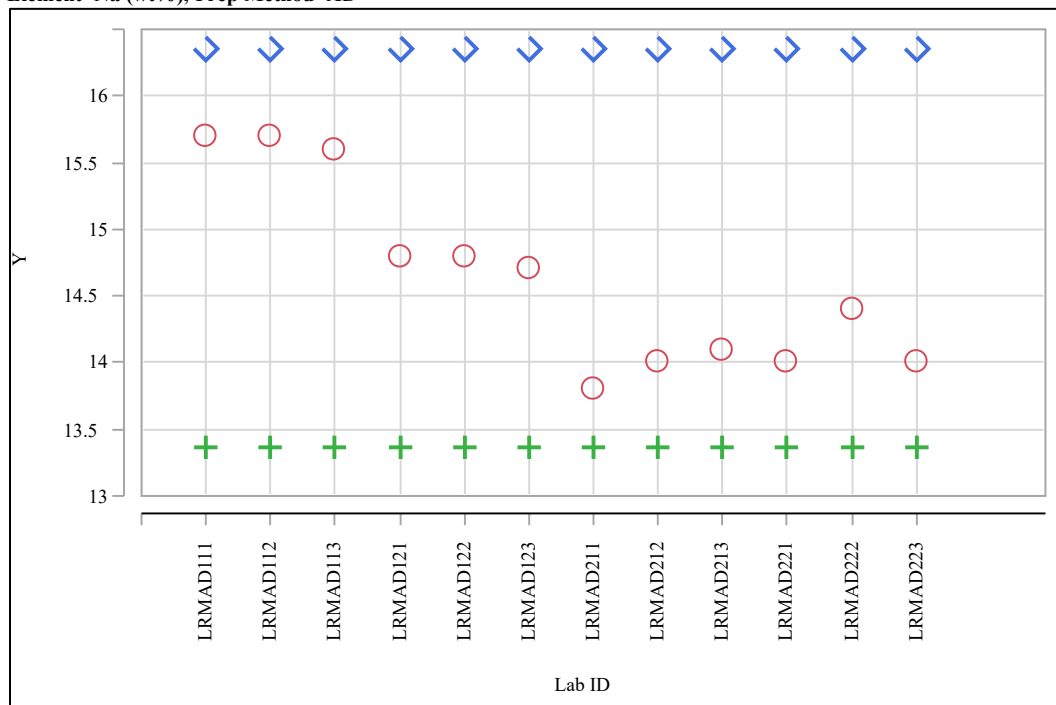
Y    ○ Measurement    + lower acceptability limit    ◇ upper acceptability limit

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

Element=K (wt%), Prep Method=AD

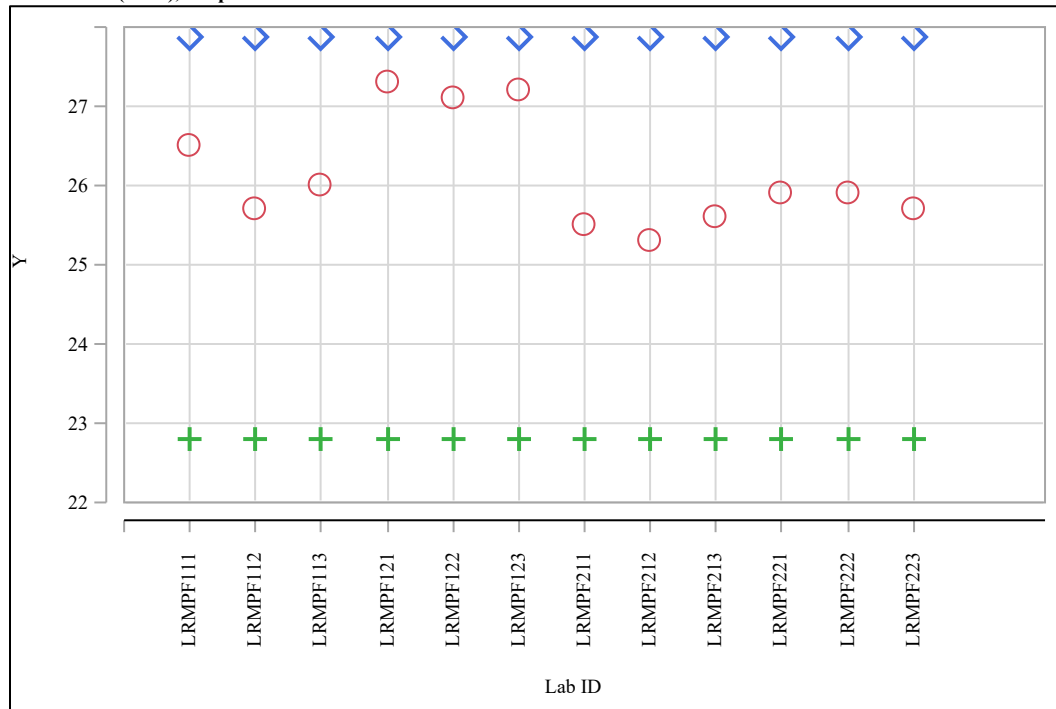


Element=Na (wt%), Prep Method=AD

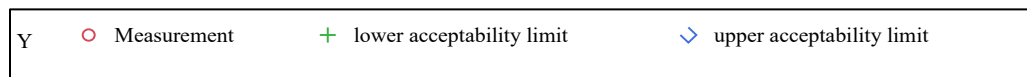
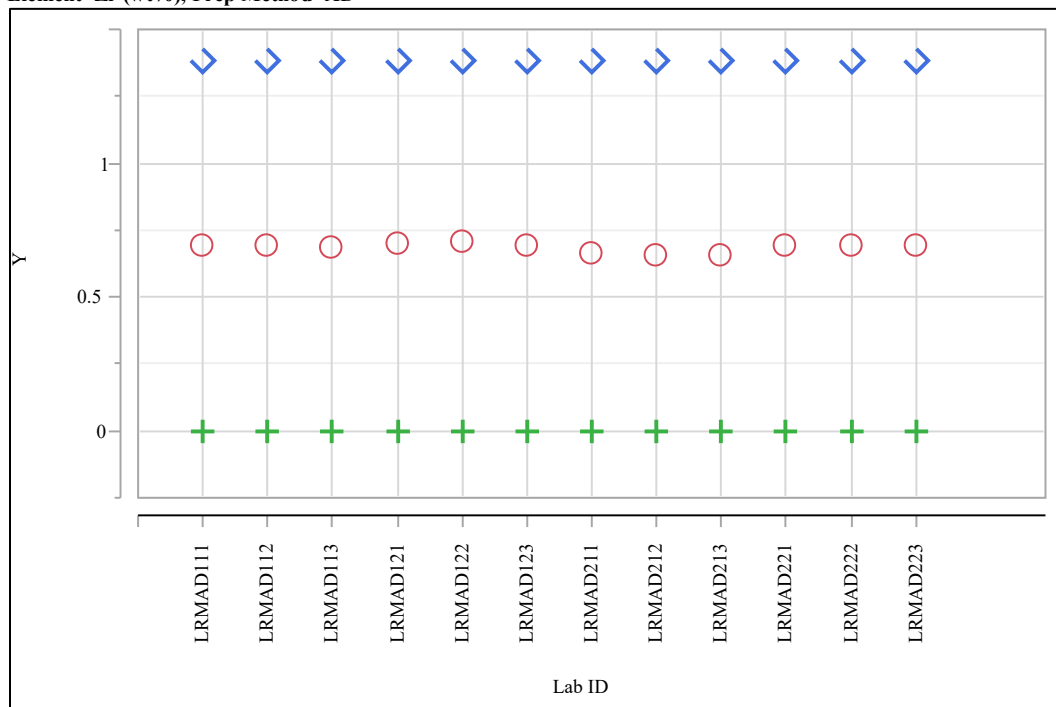


**Exhibit B-3. Acceptability Evaluation for Measurements of the LRM Standard Glass (continued)**

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

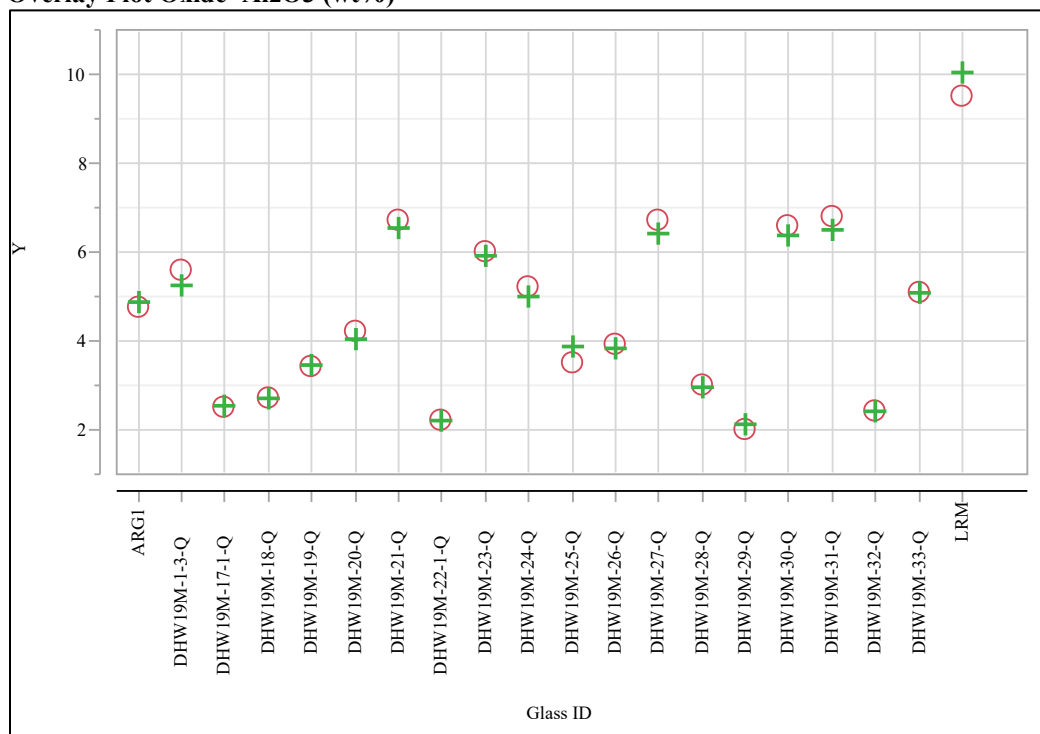


Element=Zr (wt%), Prep Method=AD

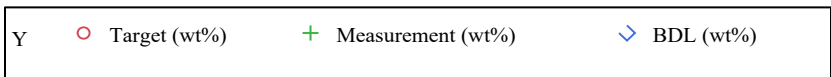
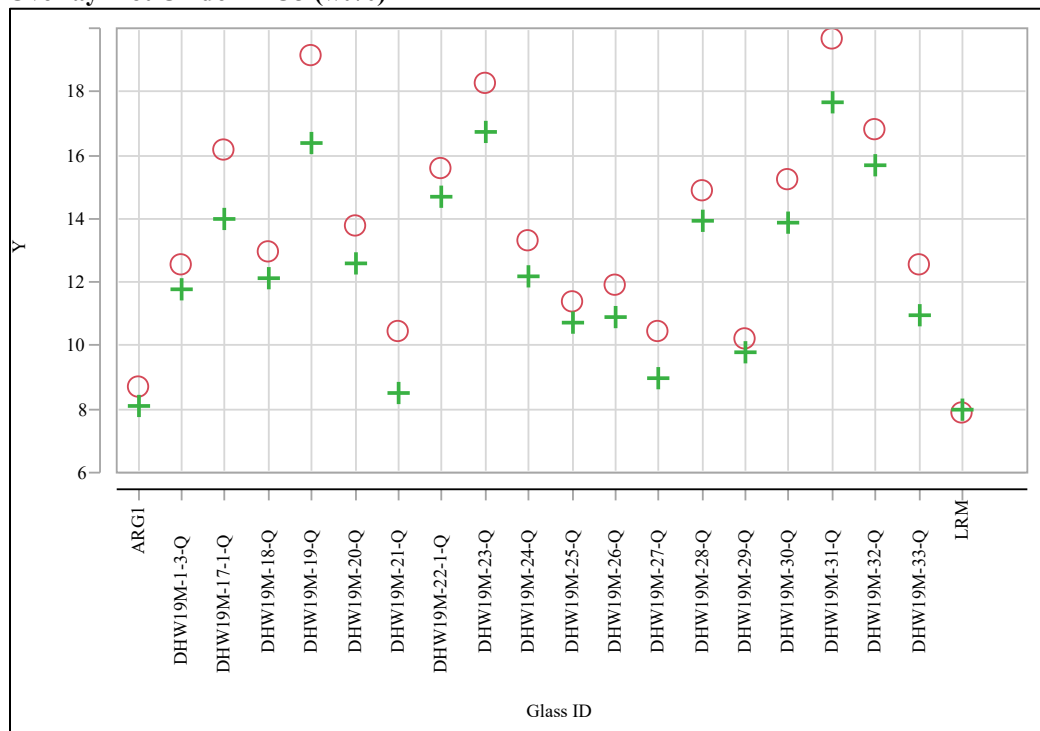


**Exhibit B-4. Measured versus Targeted Concentrations by Group 2 Glass ID by Oxide**

**Overlay Plot Oxide=Al<sub>2</sub>O<sub>3</sub> (wt%)**

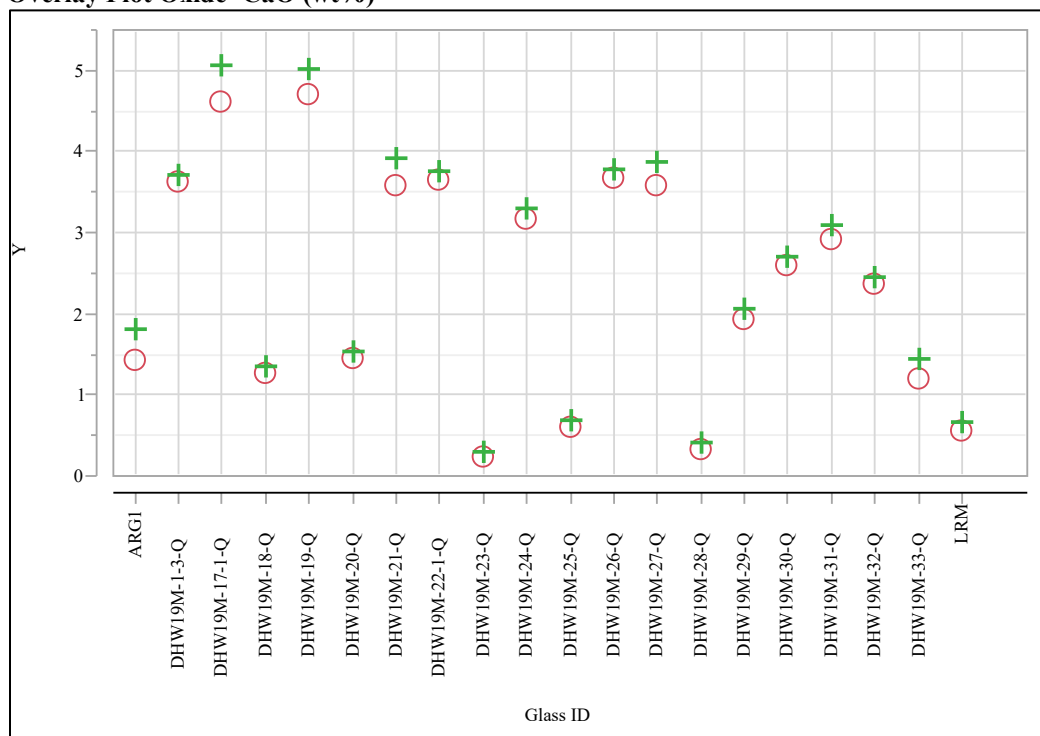


**Overlay Plot Oxide=B<sub>2</sub>O<sub>3</sub> (wt%)**

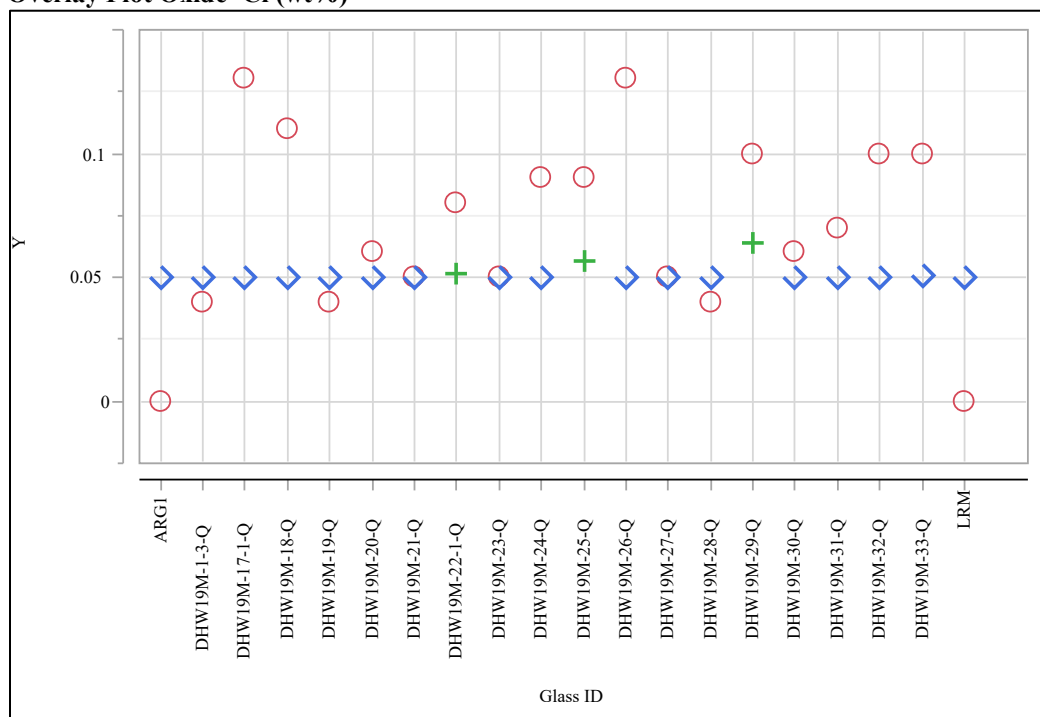


**Exhibit B-4. Measured versus Targeted Concentrations by Group 2 Glass ID by Oxide (continued)**

**Overlay Plot Oxide=CaO (wt%)**



**Overlay Plot Oxide=Cl (wt%)**

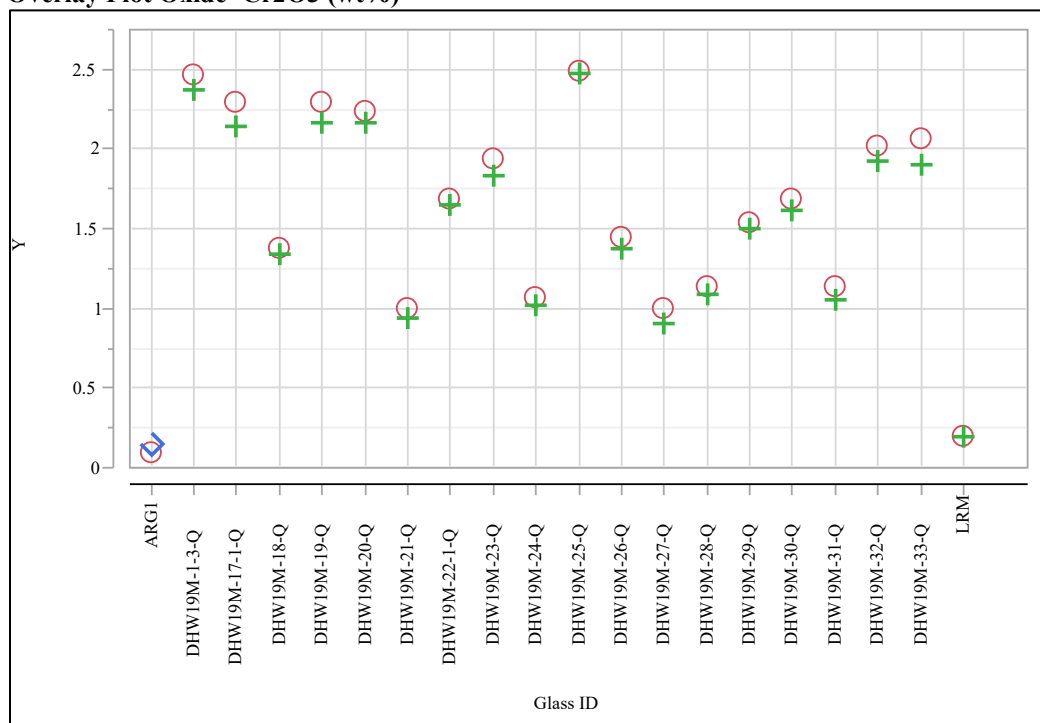


Y    ○ Target (wt%)    + Measurement (wt%)    ◇ BDL (wt%)

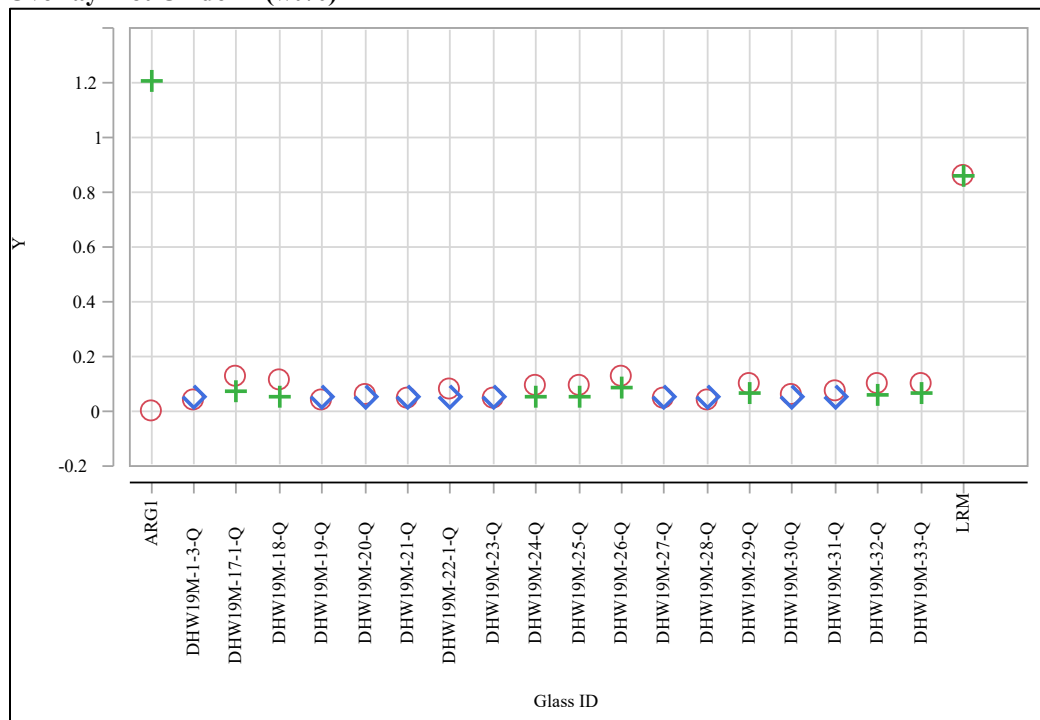


**Exhibit B-4. Measured versus Targeted Concentrations by Group 2 Glass ID by Oxide (continued)**

**Overlay Plot Oxide=Cr2O3 (wt%)**



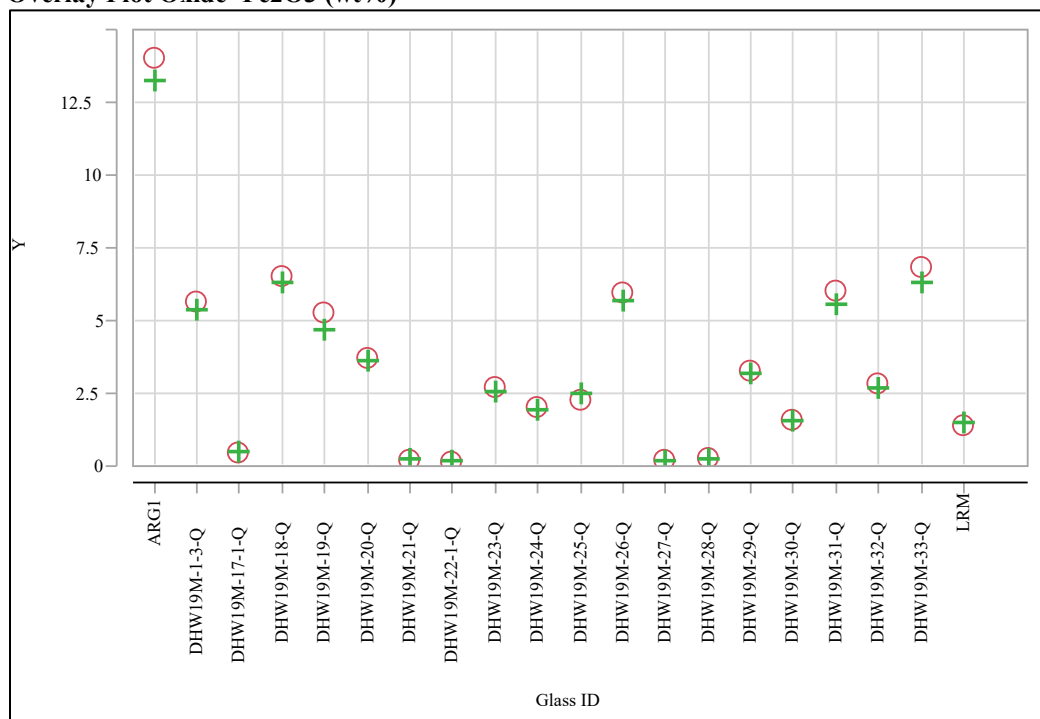
**Overlay Plot Oxide=F (wt%)**



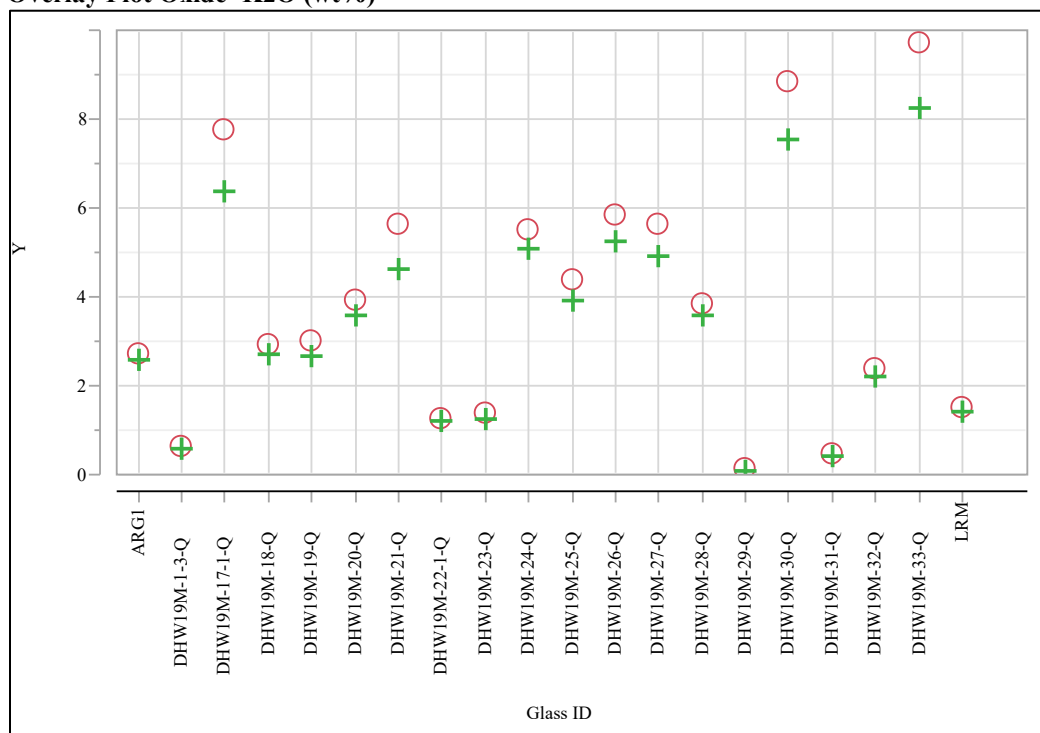
Y    ○ Target (wt%)    + Measurement (wt%)    ◇ BDL (wt%)

**Exhibit B-4. Measured versus Targeted Concentrations by Group 2 Glass ID by Oxide (continued)**

**Overlay Plot Oxide=Fe2O3 (wt%)**



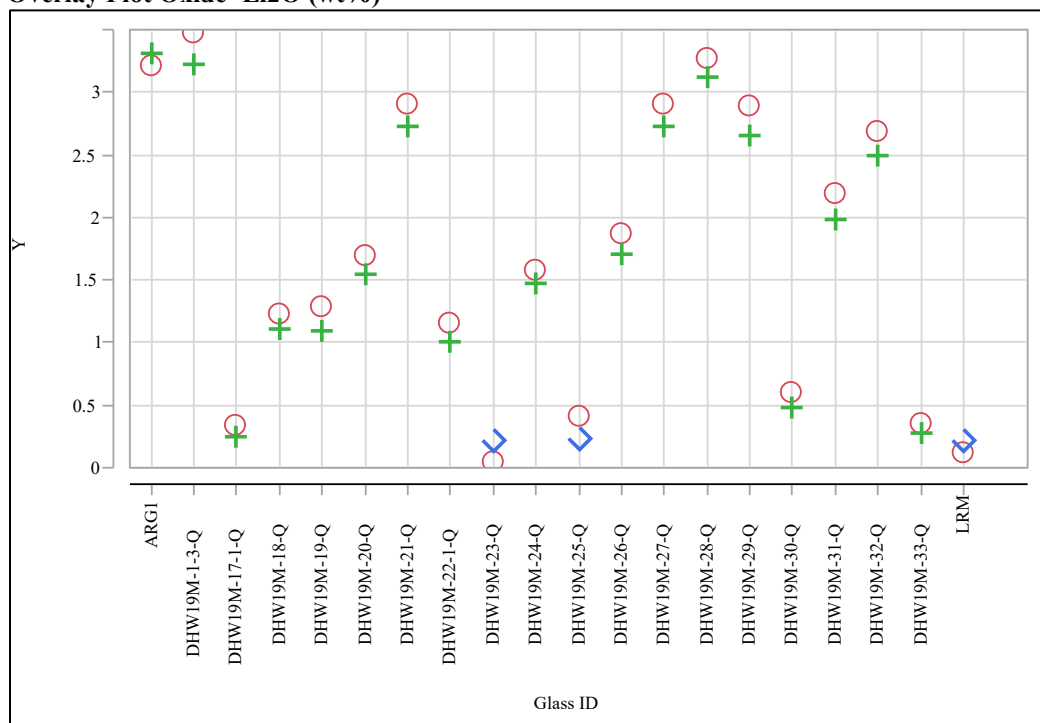
**Overlay Plot Oxide=K2O (wt%)**



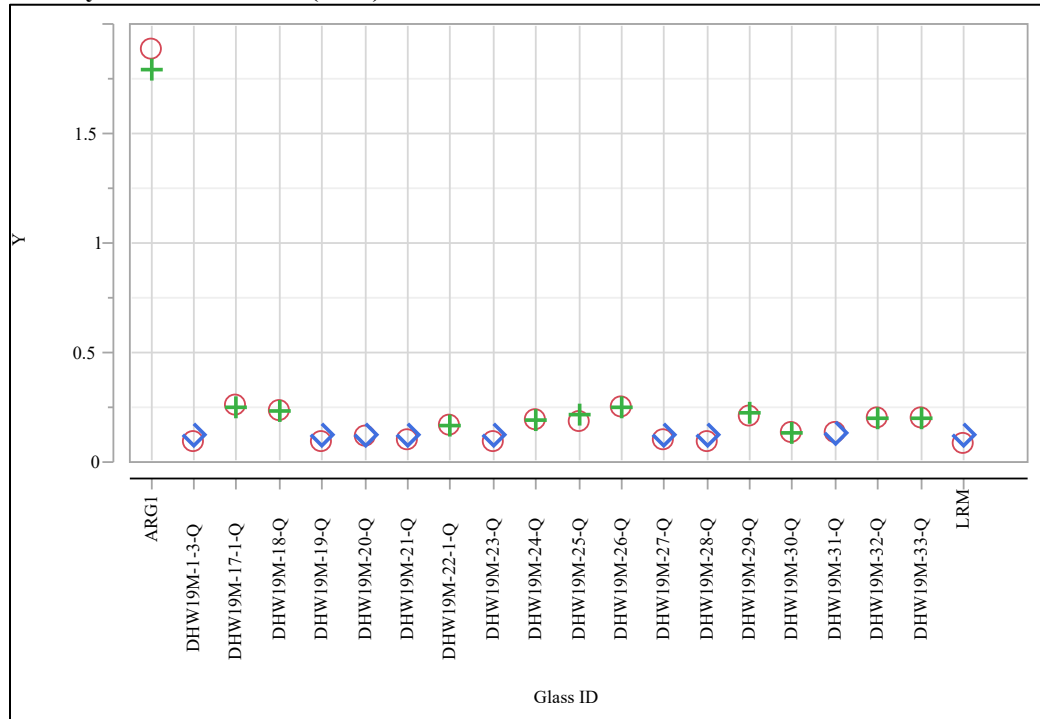
Y    ○ Target (wt%)    + Measurement (wt%)    ◇ BDL (wt%)

**Exhibit B-4. Measured versus Targeted Concentrations by Group 2 Glass ID by Oxide (continued)**

**Overlay Plot Oxide=Li<sub>2</sub>O (wt%)**



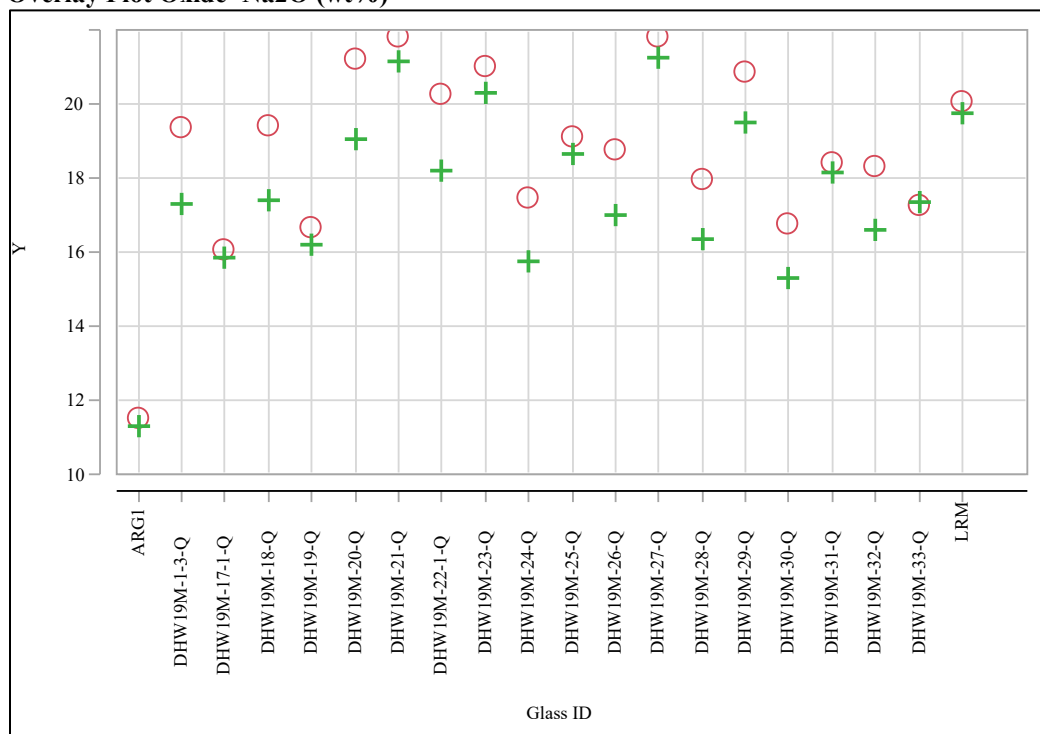
**Overlay Plot Oxide=MnO (wt%)**



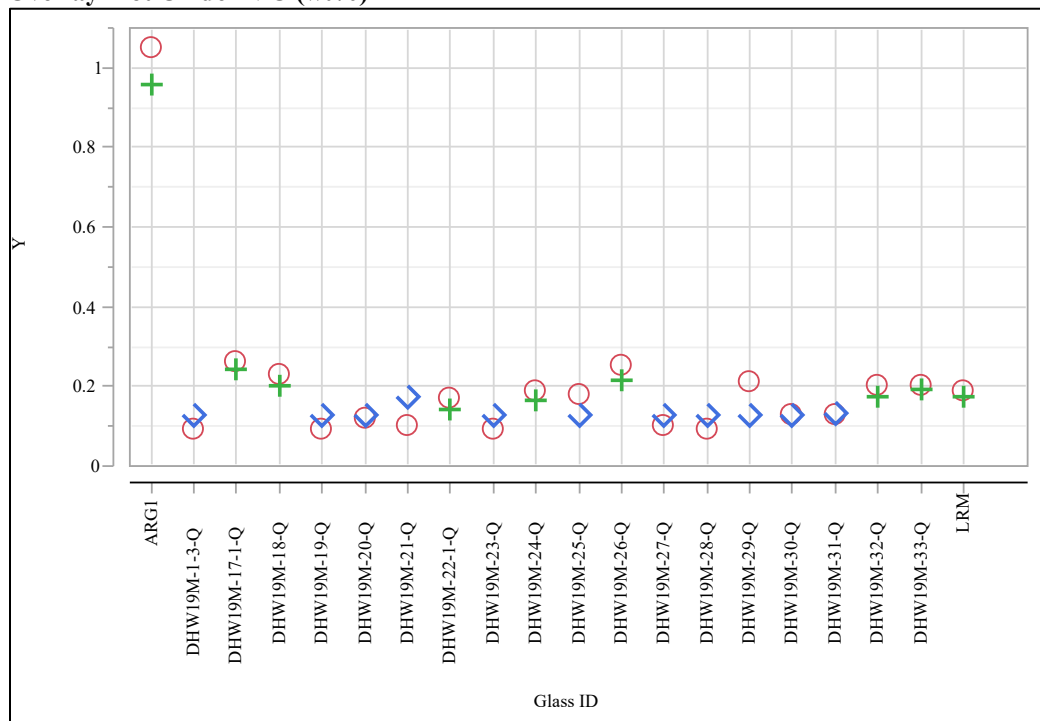
Y    ○ Target (wt%)    + Measurement (wt%)    ◇ BDL (wt%)

**Exhibit B-4. Measured versus Targeted Concentrations by Group 2 Glass ID by Oxide (continued)**

**Overlay Plot Oxide=Na<sub>2</sub>O (wt%)**



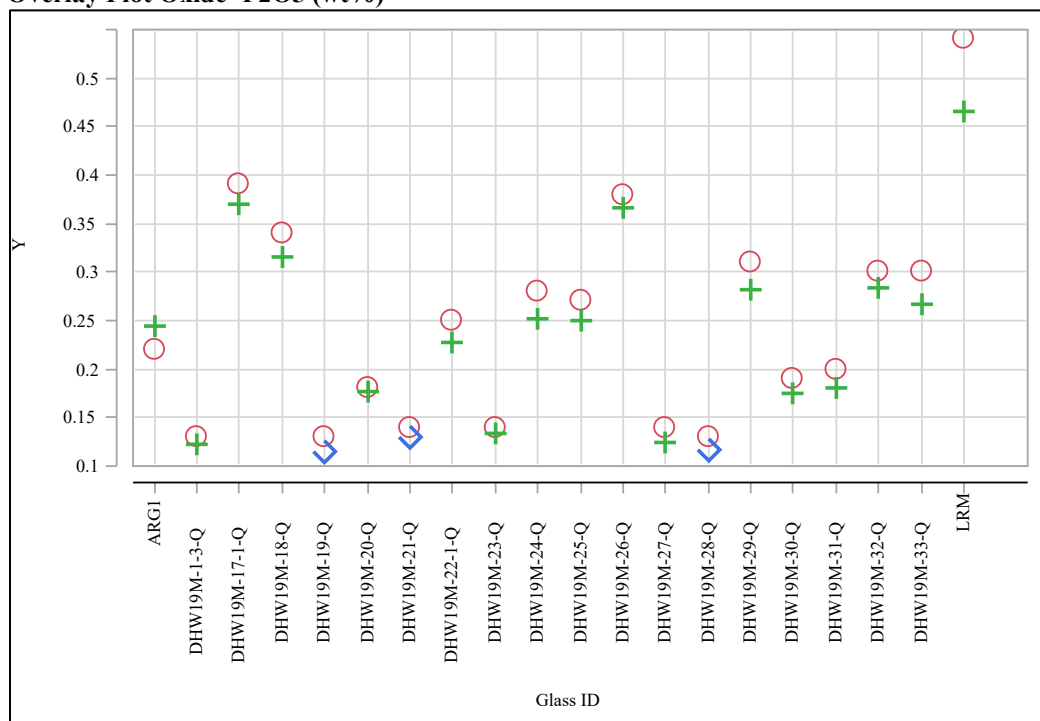
**Overlay Plot Oxide=NiO (wt%)**



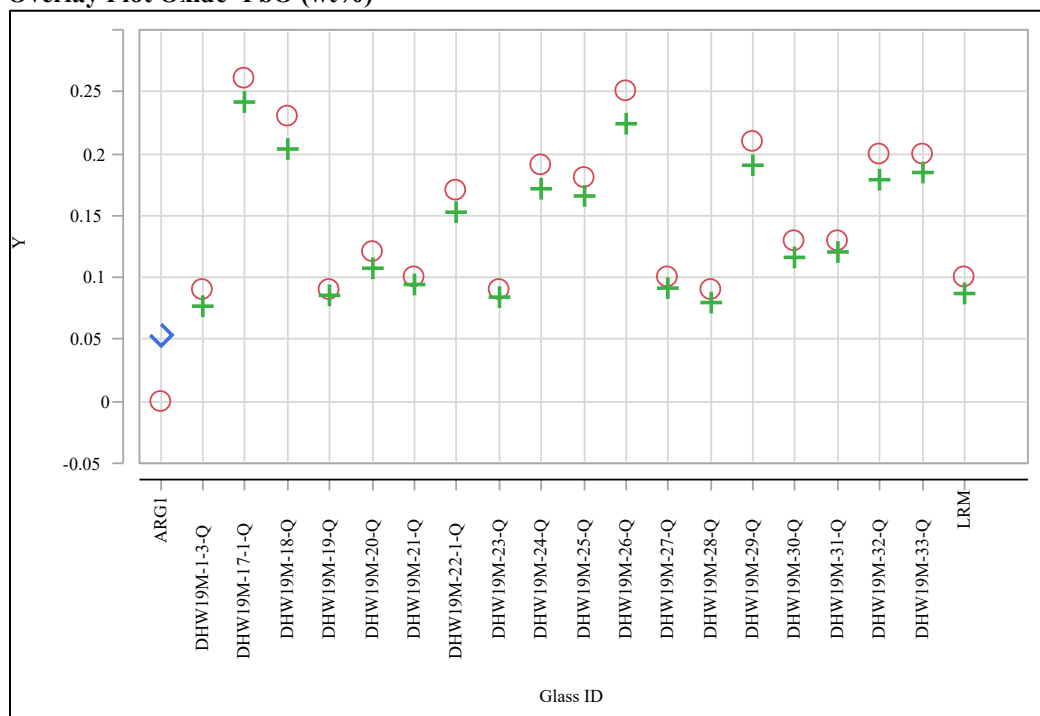
Y    ○ Target (wt%)    + Measurement (wt%)    ◇ BDL (wt%)

**Exhibit B-4. Measured versus Targeted Concentrations by Group 2 Glass ID by Oxide (continued)**

**Overlay Plot Oxide=P2O5 (wt%)**



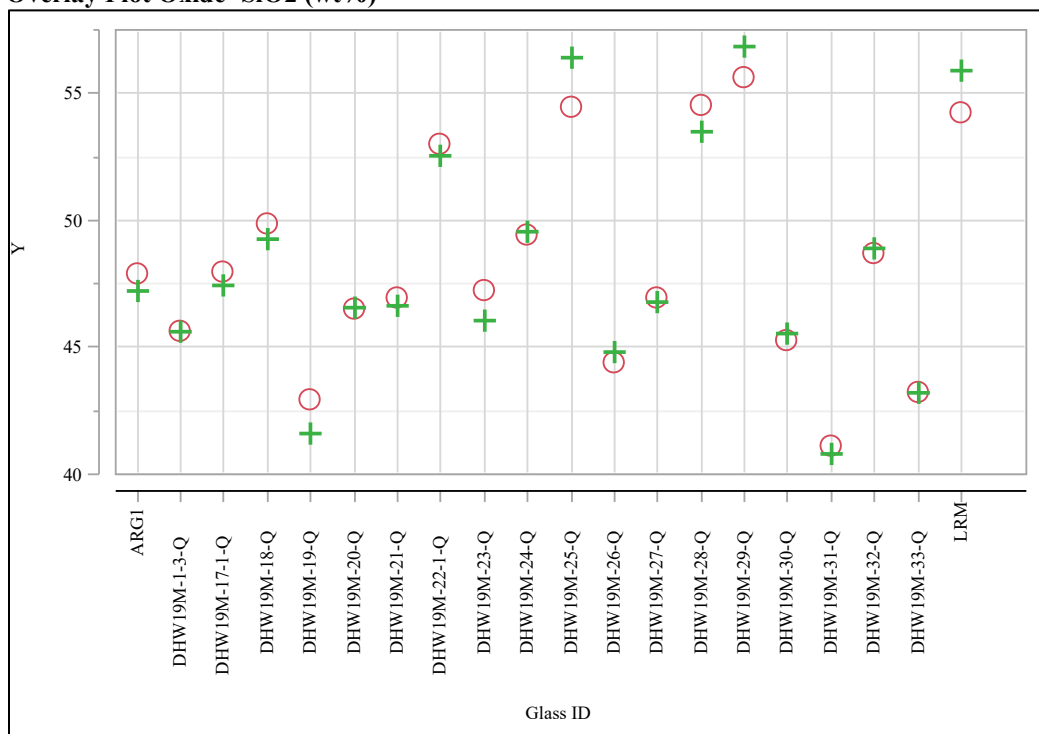
**Overlay Plot Oxide=PbO (wt%)**



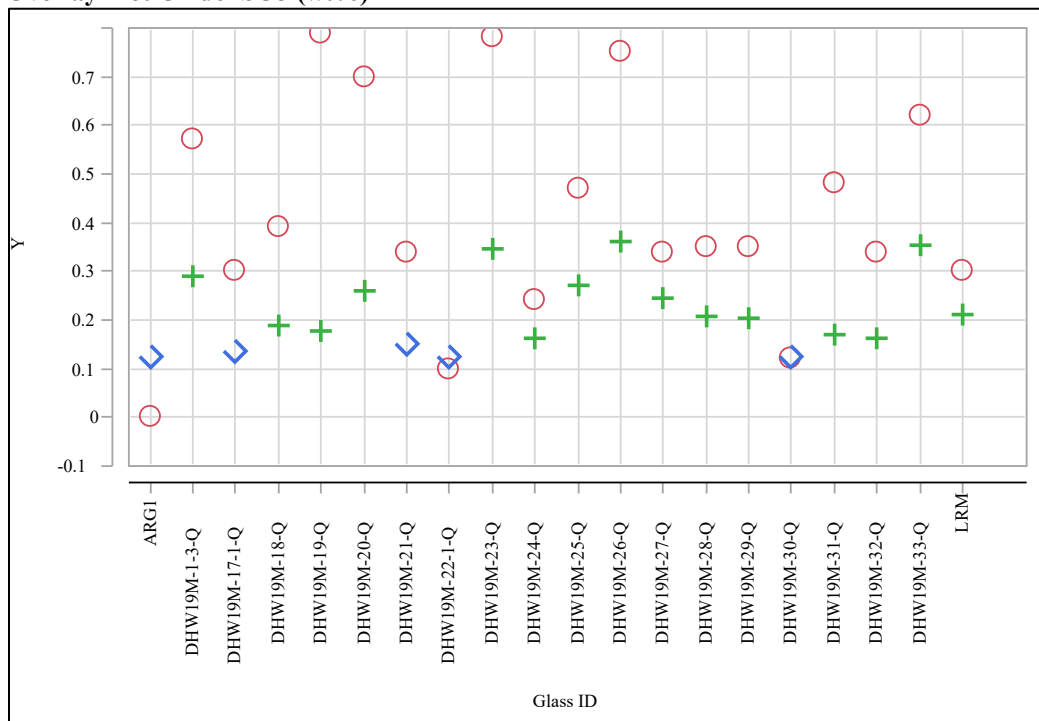
Y    ○ Target (wt%)    + Measurement (wt%)    ◇ BDL (wt%)

**Exhibit B-4. Measured versus Targeted Concentrations by Group 2 Glass ID by Oxide (continued)**

**Overlay Plot Oxide=SiO<sub>2</sub> (wt%)**



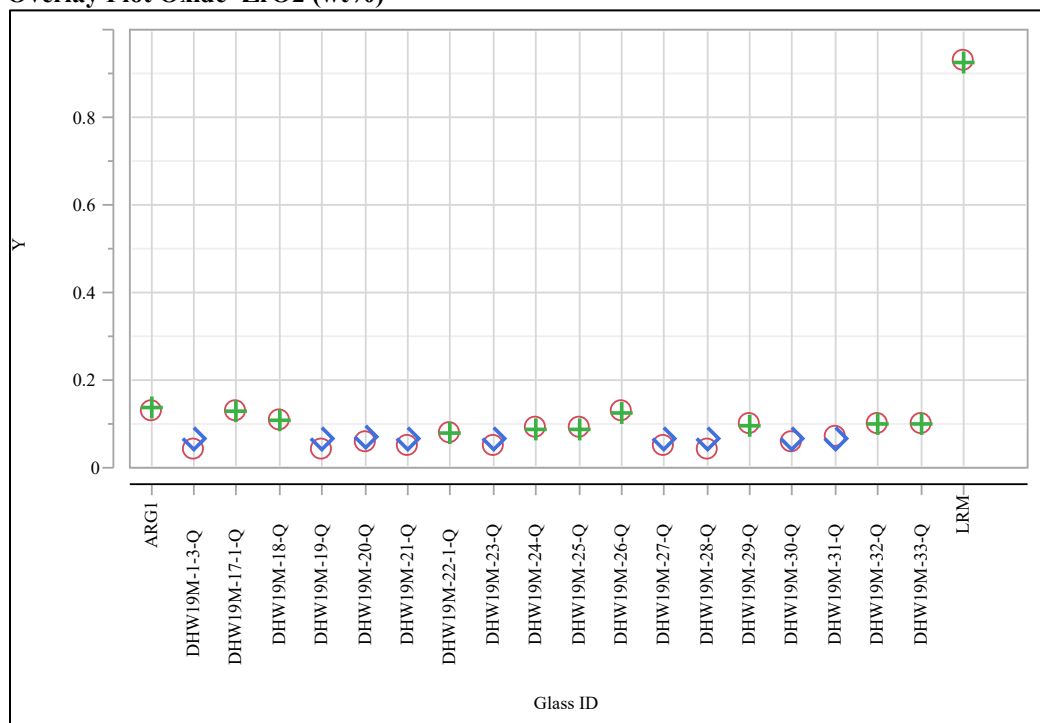
**Overlay Plot Oxide=SO<sub>3</sub> (wt%)**



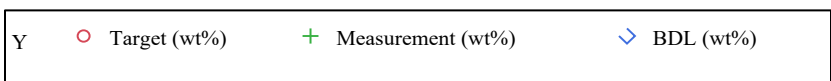
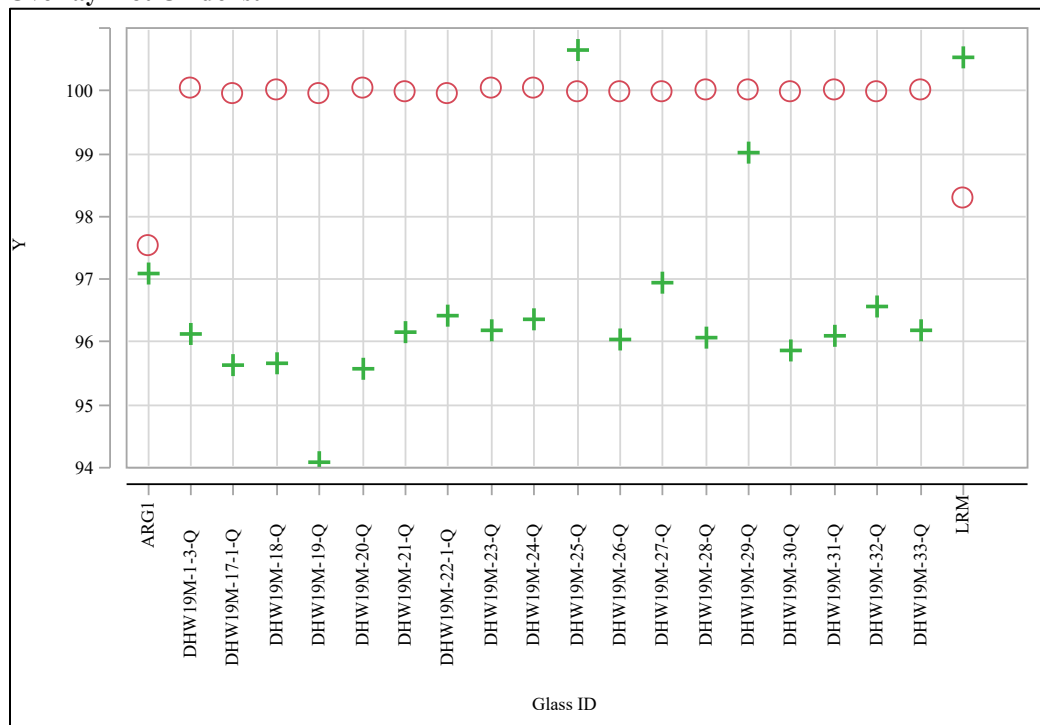
Y    ○ Target (wt%)    + Measurement (wt%)    ◇ BDL (wt%)

**Exhibit B-4. Measured versus Targeted Concentrations by Group 2 Glass ID by Oxide (continued)**

**Overlay Plot Oxide=ZrO2 (wt%)**



**Overlay Plot Oxide=sum**



**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. Fellingner, 773-42A  
S. D. Fink, 773-A  
K. M. Fox, 999-W  
B. L. Garcia-Diaz, 999-2W  
H. K. Hall, 999-1W  
C. C. Herman, 773-A  
A. M. Howe, 999-W  
M. C. Hsieh, 999-W  
T. Jin, PNNL  
F. C. Johnson, 999-W  
D. S. Kim, PNNL  
A. A. Kruger, DOE-ORP  
C. E. Lonergan, PNNL  
J. Manna, 999-W  
D. J. McCabe, 773-42A  
D. L. McClane, 999-W  
G. A. Morgan, 999-W  
F. M. Pennebaker, 773-42A  
W. T. Riley, 999-1W  
R. L. Russell, PNNL  
T. E. Skidmore, 730-A  
C. L. Trivelpiece, 999-W  
J. D. Vienna, PNNL  
B. J. Wiedenman, 773-42A  
Records Administration (EDWS)