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Composition Measurements of the LAW Phase 5 Glasses

M. C. Hsieh

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REVIEWS AND APPROVALS

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EXECUTIVE SUMMARY

This report provides the results from the chemical analyses of glass compositions for the Low-Activity Waste Phase 5 study glasses, a series of simulated nuclear waste glasses fabricated at Pacific Northwest National Laboratory. These data will be used in the development of enhanced property/composition models for waste glass vitrification at Hanford.

Chemical analyses were performed on a representative sample of each of the quenched glasses to allow for comparisons with targeted compositions. The relative differences between the targeted and measured concentrations of CaO, Cl^-, K_2O, Li_2O, and SO_3 for some of the glasses were greater than 10%. Several of these glass samples were rerun to verify original measurements; however, there were no significant changes in the measurements to indicate errors in preparation or analysis of the samples. 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

BDL	below detection limit
DOE	Department of Energy
IC	ion chromatography
ICP-OES	inductively coupled plasma – optical emission spectroscopy
ID	identifier
KH	potassium hydroxide fusion
LAW	low-activity waste
LM	lithium metaborate fusion
LRM	low-activity test 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 Waste Treatment and Immobilization Plant

1.0 Introduction

The U.S. Department of Energy (DOE) is responsible for 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 Office of River Protection (ORP) has requested that the Savannah River National Laboratory (SRNL) contribute in areas of recognized capabilities and expertise for glass waste form development to support successful startup of the WTP.

Successful efforts have allowed for demonstration of greatly enhanced treatment efficiencies of those projected from the minimum requirements set forth in the WTP Contract [a]. Additional flexibility and expansion of the qualified glass forming region are the current focus.[1] SRNL support of this work is defined in the Task Technical and Quality Assurance Plan (TTQAP).[2]

This report provides results from the chemical analyses of the baseline (quenched) versions of a series of simulated nuclear waste glasses fabricated at Pacific Northwest National Laboratory (PNNL). The glasses were selected as part of a broader study of the influence of glass composition on chemical durability, sulfur retention, and other properties.[3] The glasses were designated the Low-Activity Waste (LAW) Phase 5 study glasses. The resulting data will be used in the development, validation, and implementation of enhanced property/composition models for nuclear waste glasses.[1]

2.0 Experimental Procedure

2.1 Quality Assurance

Requirements for performing reviews of technical reports and the extent of review are established in manual E7 2.60. SRNL documents the extent and type of review using the SRNL Technical Report Design Checklist contained in WSRC-IM-2002-00011, Rev. 2.[4] Laboratory data for this study were recorded in the SRNL Electronic Laboratory Notebook system, experiment L6390-00441-02. The glasses provided by PNNL were fabricated following a Task Plan.[2]

2.2 Glasses Selected for Study

The baseline (quenched) glass compositions in this study were selected and fabricated by PNNL. Samples of the quenched baseline glasses were received at SRNL for chemical composition analysis. PNNL identifiers (IDs) for the glass samples and the associated SRNL sample identifiers are listed in Table 2-1.

[a]Contract DE-AC27-01RV14136, as amended, U.S. Department of Energy, Richland, WA (2000).

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

PNNL ID	Lab ID
LP5-01	S-12182
LP5-02	S-12183
LP5-03	S-12184
LP5-04	S-12185
LP5-05	S-12186
LP5-06-MOD1	S-12187
LP5-07	S-12188
LP5-08	S-12189
LP5-09	S-12190
LP5-10	S-12191
LP5-11	S-12192
LP5-12-1	S-12193
LP5-13	S-12194
LP5-14	S-12195
LP5-15	S-12196
LP5-16-MOD1	S-12197
LP5-17	S-12198
LP5-18	S-12199
LP5-19	S-12200
LP5-20	S-12201
LP5-21	S-12202
LP5-22	S-12203
LP5-23	S-12204
LP5-24	S-12205
LP5-25	S-12206

2.3 Glass Composition Analysis

Chemical analyses were performed under the auspices of an analytical plan[5] on a representative sample of each of the glasses listed in Table 2-1 to allow for comparisons with the targeted compositions. Three dissolution techniques were used for preparing each of the glass samples, in duplicate, for analysis (potassium hydroxide fusion (KH), lithium metaborate fusion (LM), and sodium peroxide fusion (PF)).[6-8] Note that for some analytes, the analytical plan specified more than one preparation method for analysis. 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)[9] or ion chromatography (IC),[10] 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 low-activity test reference material (LRM) were included as part of the analytical plans. The LRM composition reported as the "Consensus Average" is used as the reference composition of this glass.[11] 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 Analyte Concentrations of the Study Glasses

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

3.0 Results and Discussion

JMP® Version 14.3.0 (SAS Institute, Inc.)[12] was used to support these analyses.

3.1 Review and Evaluation of the Quenched Glass Composition Measurements

Table A-1, Table A-2, and Table A-3 in Appendix A provide the elemental concentration measurements in weight percent (wt.%) from glasses prepared using KH, LM, and PF methods, respectively. Elemental measurements for samples of the LRM glass are also included in the tables of Appendix A. These unprocessed data are provided so that the values are readily available should they be of interest for future reviews.

3.1.1 Treatment of Detection Limits

The elemental concentrations in Table A-1, Table A-2, and Table A-3 in Appendix A were converted to oxide concentrations by multiplying the values of each element by the gravimetric factor for the corresponding oxide. A concentration measurement that was reported to be below the detection limit was set to the detection limit for the purposes of data review and calculating a sum of oxides for each glass. Concentration measurements that were below the detection limit (BDL) are denoted with a less than symbol (<).

3.1.2 Composition Measurements by Glass Identifier

Exhibit A-1 in Appendix A provides plots of the oxide concentration measurements by the PNNL Glass ID (including the LRM 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. There were no indications of errors in preparation or measurement that had to be addressed in treatment of the data.

3.1.3 Results for the LRM Standard Glass

Exhibit A-2 in Appendix A provides a comparison of the LRM results to their acceptability limits utilized by SRNL.[9] 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 each element of interest. The results show that all measurements of the LRM elements of interest were within the acceptability limits during the execution of these analyses.

3.1.4 Measured versus Target Compositions

All measurements for each oxide for each glass (Table A-1, Table A-2, and Table A-3 in Appendix A) were used in calculating oxide values, which were then averaged to determine a representative chemical composition for each glass. A sum of oxides was also computed for each glass based upon the averaged oxide values. Exhibit A-3 in Appendix A provides plots showing the result for each glass for each oxide to allow PNNL to draw comparisons between the measured and targeted values.

Table A-7 in Appendix A provides a summary of the average compositions, targeted compositions and some associated differences and relative differences. The measured sums of oxides for all glasses fall within the interval of 99.4 wt.% to 102 wt. %, indicating acceptable recovery of the glass components.[13] Entries in Table A-7 show the relative differences between the measured and targeted values for the analytes with measured and targeted values above 1 wt.%. The relative differences were shaded if they are 10% or more and are summarized below.

- CaO relative differences were +10% or more for LP5-10 and LP5-12-1.
- K_2O relative differences were -10% or more for LP5-12-1 and LP5-17.
- Li_2O relative difference was -18% for LP5-25.
- SO_3 relative difference was -40% for LP5-12-1.
- ZrO_2 relative difference was -10% for LP5-10.
- Cl^- relative differences were significantly higher than +10% for the following:
    - LP5-15 relative difference was +482%.
    - LP5-17 relative difference was +230%.
    - LP5-24 relative difference was +406%.

Several of the above-mentioned glass samples were rerun to confirm initial measurements. These measurements are provided in Table A-4, Table A-5, and Table A-6 in Appendix A. LP5-12-1 was prepared one additional time using KH, LM, and PF and reanalyzed four times by IC or ICP-OES. LP5-15, LP5-17, and LP5-24 were each prepared two additional times using the KH method and reanalyzed twice by IC. There were no significant changes in the measurements to indicate errors in preparation or analysis of the samples. The source of the Cl^- differences was not determined. Rerun measurements were not used in the averaging of oxides.

4.0 Summary

Chemical analyses were performed on a representative sample of each of the LAW Phase 5 quenched glasses to allow for comparisons with the targeted compositions. The relative differences between the targeted and measured concentrations of CaO, Cl^-, K_2O, Li_2O, and SO_3 for some of the glasses were greater than 10%. Several of these glass samples were rerun to verify original measurements; however, there were no significant changes in the measurements to indicate errors in preparation or analysis of the samples. These results can be used in further characterization of this series of glasses, including the normalization of Product Consistency Test results.

5.0 References

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9. "Calibration, Verification, and Operation of the Agilent 5110 ICP-OES Inductively Coupled Plasma-Optical Emission Spectrometer," Savannah River National Laboratory, Aiken, SC, Manual L33, Procedure 0242, Rev. 1, 2021.

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Appendix A. Tables and Exhibits Supporting the LAW Phase 5 Glass Composition Measurements

Table A-1. KH Measurements (wt.%) of the Study Glasses

PNNL ID	Block	Sub – Block	Sequence	Lab ID	Cl^-	F^-
LRM	1	1	1	LRMKH111	<0.0250	0.933
LP5-03	1	1	2	S-12184KH11	0.514	0.218
LP5-17	1	1	3	S-12198KH21	0.815	0.0820
LP5-01	1	1	4	S-12182KH21	0.542	0.217
LP5-13	1	1	5	S-12194KH11	0.330	0.137
LP5-20	1	1	6	S-12201KH11	0.573	0.220
LP5-21	1	1	7	S-12202KH21	0.483	0.198
LP5-21	1	1	8	S-12202KH11	0.482	0.191
LP5-07	1	1	9	S-12188KH21	0.143	0.0548
LRM	1	1	10	LRMKH112	<0.0250	0.908
LP5-13	1	1	11	S-12194KH21	0.346	0.145
LP5-03	1	1	12	S-12184KH21	0.518	0.225
LP5-01	1	1	13	S-12182KH11	0.553	0.222
LP5-07	1	1	14	S-12188KH11	0.158	0.0553
LP5-15	1	1	15	S-12196KH21	1.10	0.0638
LP5-20	1	1	16	S-12201KH21	0.611	0.227
LP5-15	1	1	17	S-12196KH11	1.10	0.0642
LP5-17	1	1	18	S-12198KH11	0.824	0.0838
LRM	1	1	19	LRMKH113	<0.0250	0.906
LRM	1	2	1	LRMKH121	<0.0250	0.924
LP5-17	1	2	2	S-12198KH22	0.833	0.0870
LP5-13	1	2	3	S-12194KH12	0.347	0.146
LP5-07	1	2	4	S-12188KH22	0.153	0.0594
LP5-15	1	2	5	S-12196KH12	1.11	0.0654
LP5-21	1	2	6	S-12202KH22	0.499	0.207
LP5-20	1	2	7	S-12201KH12	0.596	0.231
LP5-07	1	2	8	S-12188KH12	0.159	0.0566
LP5-17	1	2	9	S-12198KH12	0.827	0.0851
LRM	1	2	10	LRMKH122	<0.0250	0.922
LP5-21	1	2	11	S-12202KH12	0.501	0.202
LP5-03	1	2	12	S-12184KH12	0.524	0.226
LP5-01	1	2	13	S-12182KH22	0.565	0.228
LP5-03	1	2	14	S-12184KH22	0.520	0.228
LP5-01	1	2	15	S-12182KH12	0.560	0.226
LP5-15	1	2	16	S-12196KH22	1.11	0.0660
LP5-13	1	2	17	S-12194KH22	0.348	0.148
LP5-20	1	2	18	S-12201KH22	0.618	0.231
LRM	1	2	19	LRMKH123	<0.0250	0.915
LRM	2	1	1	LRMKH211	<0.0250	0.870
LP5-19	2	1	2	S-12200KH21	0.246	0.109
LP5-23	2	1	3	S-12204KH11	0.183	0.0689
LP5-08	2	1	4	S-12189KH21	0.278	0.114
LP5-18	2	1	5	S-12199KH11	0.391	0.171
LP5-22	2	1	6	S-12203KH21	0.173	0.0646
LP5-05	2	1	7	S-12186KH21	0.251	0.101
LP5-24	2	1	8	S-12205KH11	1.06	0.270
LP5-08	2	1	9	S-12189KH11	0.284	0.115
LRM	2	1	10	LRMKH212	<0.0250	0.893

Table A-1. KH Measurements (wt.%) of the Study Glasses (continued)

PNNL ID	Block	Sub – Block	Sequence	Lab ID	Cl^-	F^-
LP5-09	2	1	11	S-12190KH21	0.467	0.203
LP5-19	2	1	12	S-12200KH11	0.245	0.110
LP5-10	2	1	13	S-12191KH21	0.172	0.0845
LP5-18	2	1	14	S-12199KH21	0.404	0.178
LP5-24	2	1	15	S-12205KH21	1.05	0.268
LP5-09	2	1	16	S-12190KH11	0.482	0.208
LP5-10	2	1	17	S-12191KH11	0.175	0.0833
LP5-22	2	1	18	S-12203KH11	0.167	0.0646
LP5-05	2	1	19	S-12186KH11	0.250	0.101
LP5-23	2	1	20	S-12204KH21	0.191	0.0695
LRM	2	1	21	LRMKH213	<0.0250	0.895
LRM	2	2	1	LRMKH221	<0.0250	0.905
LP5-22	2	2	2	S-12203KH12	0.166	0.0646
LP5-22	2	2	3	S-12203KH22	0.171	0.0644
LP5-09	2	2	4	S-12190KH12	0.482	0.208
LP5-24	2	2	5	S-12205KH12	1.07	0.272
LP5-08	2	2	6	S-12189KH12	0.279	0.116
LP5-18	2	2	7	S-12199KH22	0.391	0.175
LP5-19	2	2	8	S-12200KH22	0.245	0.109
LP5-05	2	2	9	S-12186KH12	0.245	0.0985
LRM	2	2	10	LRMKH222	<0.0250	0.894
LP5-23	2	2	11	S-12204KH12	0.192	0.0718
LP5-10	2	2	12	S-12191KH22	0.175	0.0864
LP5-08	2	2	13	S-12189KH22	0.288	0.119
LP5-19	2	2	14	S-12200KH12	0.247	0.112
LP5-09	2	2	15	S-12190KH22	0.471	0.205
LP5-18	2	2	16	S-12199KH12	0.395	0.173
LP5-24	2	2	17	S-12205KH22	1.07	0.271
LP5-10	2	2	18	S-12191KH12	0.180	0.0848
LP5-23	2	2	19	S-12204KH22	0.194	0.0710
LP5-05	2	2	20	S-12186KH22	0.255	0.102
LRM	2	2	21	LRMKH223	<0.0250	0.906
LRM	3	1	1	LRMKH311	<0.0250	0.890
LP5-11	3	1	2	S-12192KH21	0.517	0.227
LP5-14	3	1	3	S-12195KH11	0.474	0.219
LP5-16-MOD1	3	1	4	S-12197KH21	0.371	0.130
LP5-16-MOD1	3	1	5	S-12197KH11	0.370	0.129
LP5-12-1	3	1	6	S-12193KH21	0.123	0.208
LP5-06-MOD1	3	1	7	S-12187KH11	0.283	0.175
LP5-04	3	1	8	S-12185KH11	0.321	0.131
LP5-14	3	1	9	S-12195KH21	0.484	0.224
LRM	3	1	10	LRMKH312	<0.0250	0.886
LP5-11	3	1	11	S-12192KH11	0.483	0.215
LP5-04	3	1	12	S-12185KH21	0.314	0.130
LP5-12-1	3	1	13	S-12193KH11	0.124	0.208
LP5-02	3	1	14	S-12183KH11	0.357	0.151
LP5-02	3	1	15	S-12183KH21	0.356	0.145
LP5-06-MOD1	3	1	16	S-12187KH21	0.282	0.173
LP5-25	3	1	17	S-12206KH11	0.0321	0.244

Table A-1. KH Measurements (wt.%) of the Study Glasses (continued)

PNNL ID	Block	Sub – Block	Sequence	Lab ID	Cl^-	F^-
LP5-25	3	1	18	S-12206KH21	0.0306	0.238
LRM	3	1	19	LRMKH313	<0.0250	0.881
LRM	3	2	1	LRMKH321	<0.0250	0.887
LP5-16-MOD1	3	2	2	S-12197KH22	0.367	0.128
LP5-16-MOD1	3	2	3	S-12197KH12	0.367	0.129
LP5-25	3	2	4	S-12206KH22	0.0298	0.238
LP5-25	3	2	5	S-12206KH12	0.0302	0.243
LP5-02	3	2	6	S-12183KH22	0.356	0.145
LP5-04	3	2	7	S-12185KH22	0.314	0.131
LP5-02	3	2	8	S-12183KH12	0.356	0.151
LP5-14	3	2	9	S-12195KH12	0.484	0.223
LRM	3	2	10	LRMKH322	<0.0250	0.905
LP5-06-MOD1	3	2	11	S-12187KH12	0.289	0.180
LP5-11	3	2	12	S-12192KH22	0.530	0.233
LP5-12-1	3	2	13	S-12193KH12	0.128	0.215
LP5-14	3	2	14	S-12195KH22	0.489	0.227
LP5-06-MOD1	3	2	15	S-12187KH22	0.286	0.176
LP5-12-1	3	2	16	S-12193KH22	0.126	0.211
LP5-04	3	2	17	S-12185KH12	0.328	0.135
LP5-11	3	2	18	S-12192KH12	0.501	0.223
LRM	3	2	19	LRMKH323	<0.0250	0.901

Table A-2. LM Measurements (wt.%) of the Study Glasses

PNNL ID	Block	Sub – Block	Sequence	Lab ID	Ca	Cr	Fe	K	Mg	Na	Ni	P	Pb	Re	S	Sn	Ti	V
LRM	1	1	1	LRMLM111	0.341	0.129	0.974	1.14	<0.100	15.6	0.132	0.213	0.101	<0.0250	0.0883	<0.100	<0.100	<0.100
LP5-13	1	1	2	S-12194LM11	0.179	0.170	0.572	3.13	1.60	19.5	<0.100	0.168	<0.100	<0.0250	0.291	0.591	0.610	2.56
LP5-18	1	1	3	S-12199LM11	0.334	0.221	0.454	1.43	3.08	18.3	<0.100	0.215	<0.100	<0.0250	0.356	0.171	0.742	2.03
LP5-20	1	1	4	S-12201LM11	0.974	0.267	0.461	1.99	1.81	18.7	<0.100	0.256	<0.100	<0.0250	0.453	2.97	0.941	0.125
LP5-16-MOD1	1	1	5	S-12197LM21	5.76	0.189	0.448	0.454	2.81	18.3	0.141	0.168	<0.100	<0.0250	0.247	3.34	0.629	0.454
LP5-14	1	1	6	S-12195LM21	0.404	0.269	<0.100	2.96	0.887	17.4	<0.100	0.260	<0.100	<0.0250	0.450	2.68	0.949	2.35
LP5-13	1	1	7	S-12194LM21	0.182	0.174	0.586	3.10	1.62	20.0	<0.100	0.172	<0.100	<0.0250	0.304	0.607	0.629	2.57
LP5-12-1	1	1	8	S-12193LM11	0.918	0.259	0.408	1.56	3.24	17.3	<0.100	0.257	<0.100	<0.0250	0.267	1.21	1.02	1.87
LP5-18	1	1	9	S-12199LM21	0.341	0.210	0.369	1.40	3.14	17.8	<0.100	0.212	<0.100	<0.0250	0.365	0.228	0.745	2.06
LRM	1	1	10	LRMLM112	0.353	0.131	0.992	1.09	<0.100	15.9	0.134	0.216	0.102	<0.0250	0.0914	<0.100	<0.100	<0.100
LP5-07	1	1	11	S-12188LM11	0.921	0.0756	<0.100	1.68	2.54	19.4	<0.100	<0.100	<0.100	<0.0250	0.135	0.161	0.269	0.423
LP5-10	1	1	12	S-12191LM11	1.29	0.0925	0.318	2.47	2.75	19.8	<0.100	<0.100	<0.100	<0.0250	0.186	2.98	0.351	0.775
LP5-12-1	1	1	13	S-12193LM21	0.913	0.255	0.403	1.56	3.16	18.1	<0.100	0.254	<0.100	<0.0250	0.268	1.17	0.968	1.83
LP5-20	1	1	14	S-12201LM21	0.978	0.264	0.455	2.00	1.83	19.6	<0.100	0.249	<0.100	<0.0250	0.452	2.99	0.932	0.124
LP5-10	1	1	15	S-12191LM21	1.24	0.0917	0.315	2.39	2.69	19.9	<0.100	<0.100	<0.100	<0.0250	0.174	2.90	0.345	0.764
LP5-07	1	1	16	S-12188LM21	0.883	0.141	<0.100	1.62	2.52	19.3	0.313	<0.100	<0.100	<0.0250	0.135	0.160	0.262	0.412
LP5-14	1	1	17	S-12195LM11	0.417	0.261	<0.100	3.06	1.01	17.6	<0.100	0.253	<0.100	<0.0250	0.451	2.76	0.928	2.44
LP5-16-MOD1	1	1	18	S-12197LM11	5.73	0.186	0.441	0.445	2.87	18.1	0.139	0.162	<0.100	<0.0250	0.255	3.39	0.621	0.450
LRM	1	1	19	LRMLM113	0.350	0.130	0.985	1.11	<0.100	15.4	0.133	0.215	0.102	<0.0250	0.0945	<0.100	<0.100	<0.100
LRM	1	2	1	LRMLM121	0.374	0.132	1.01	1.26	<0.100	15.0	0.136	0.213	0.104	<0.0250	0.0872	<0.100	<0.100	<0.100
LP5-20	1	2	2	S-12201LM22	1.09	0.265	0.458	2.22	1.81	17.6	<0.100	0.245	<0.100	<0.0250	0.440	2.94	0.931	0.122
LP5-13	1	2	3	S-12194LM12	0.190	0.173	0.583	3.55	1.61	18.8	<0.100	0.165	<0.100	<0.0250	0.293	0.607	0.624	2.59
LP5-12-1	1	2	4	S-12193LM22	1.00	0.256	0.404	1.76	3.13	16.3	<0.100	0.247	<0.100	<0.0250	0.258	1.14	1.01	1.83
LP5-16-MOD1	1	2	5	S-12197LM22	6.54	0.189	0.448	0.469	2.84	17.5	0.142	0.161	<0.100	<0.0250	0.240	3.37	0.628	0.452
LP5-18	1	2	6	S-12199LM12	0.354	0.224	0.460	1.63	3.12	17.4	<0.100	0.210	<0.100	<0.0250	0.361	0.174	0.752	2.08
LP5-10	1	2	7	S-12191LM22	1.44	0.0926	0.319	2.78	2.69	19.4	<0.100	<0.100	<0.100	<0.0250	0.174	2.91	0.350	0.769
LP5-12-1	1	2	8	S-12193LM12	1.00	0.262	0.414	1.75	3.12	16.8	<0.100	0.253	<0.100	<0.0250	0.271	1.17	1.01	1.82
LP5-07	1	2	9	S-12188LM12	1.03	0.0756	<0.100	1.84	2.44	17.9	<0.100	<0.100	<0.100	<0.0250	0.131	0.164	0.268	0.419
LRM	1	2	10	LRMLM122	0.362	0.130	0.987	1.24	<0.100	14.8	0.133	0.211	0.102	<0.0250	0.0921	<0.100	<0.100	<0.100
LP5-16-MOD1	1	2	11	S-12197LM12	6.43	0.188	0.446	0.465	2.83	17.5	0.141	0.161	<0.100	<0.0250	0.245	3.36	0.626	0.451
LP5-14	1	2	12	S-12195LM12	0.441	0.266	<0.100	3.11	1.01	17.2	<0.100	0.249	<0.100	<0.0250	0.442	2.82	0.944	2.43
LP5-20	1	2	13	S-12201LM12	1.04	0.268	0.463	2.08	1.87	18.0	<0.100	0.248	<0.100	<0.0250	0.453	3.13	0.948	0.125
LP5-18	1	2	14	S-12199LM22	0.363	0.211	0.373	1.53	3.21	17.4	<0.100	0.207	<0.100	<0.0250	0.364	0.235	0.754	2.10
LP5-14	1	2	15	S-12195LM22	0.427	0.268	<0.100	3.32	1.02	17.1	<0.100	0.252	<0.100	<0.0250	0.455	2.88	0.953	2.48
LP5-10	1	2	16	S-12191LM12	1.39	0.0919	0.315	2.64	2.78	19.1	<0.100	<0.100	<0.100	<0.0250	0.175	3.10	0.347	0.763
LP5-13	1	2	17	S-12194LM22	0.190	0.173	0.582	3.31	1.66	18.9	<0.100	0.167	<0.100	<0.0250	0.304	0.613	0.627	2.63
LP5-07	1	2	18	S-12188LM22	0.939	0.144	<0.100	1.75	2.53	18.0	0.319	<0.100	<0.100	<0.0250	0.133	0.164	0.267	0.414
LRM	1	2	19	LRMLM123	0.367	0.131	0.994	1.22	<0.100	14.8	0.134	0.210	0.102	<0.0250	0.0911	<0.100	<0.100	<0.100
LRM	2	1	1	LRMLM211	0.360	0.129	1.00	1.20	<0.100	15.8	0.134	0.208	0.102	<0.0250	0.0888	<0.100	<0.100	<0.100
LP5-21	2	1	2	S-12202LM21	3.54	0.245	<0.100	3.80	1.83	16.6	<0.100	0.234	<0.100	<0.0250	0.405	0.929	0.872	1.92
LP5-23	2	1	3	S-12204LM11	4.58	0.0840	0.121	1.44	1.42	18.0	<0.100	<0.100	<0.100	<0.0250	0.150	1.06	0.309	1.50
LP5-25	2	1	4	S-12206LM21	3.78	<0.0250	3.67	0.104	0.886	10.8	<0.100	<0.100	<0.100	<0.0250	0.0705	<0.100	0.680	<0.100
LP5-17	2	1	5	S-12198LM21	3.62	0.0998	0.503	2.82	0.907	15.6	<0.100	0.100	<0.100	<0.0250	0.167	3.39	0.366	2.97
LP5-03	2	1	6	S-12184LM11	4.67	0.251	0.233	0.116	2.34	18.5	<0.100	0.248	<0.100	<0.0250	0.427	0.451	0.903	2.70
LP5-03	2	1	7	S-12184LM21	4.77	0.253	0.249	0.120	2.36	19.2	<0.100	0.228	<0.100	<0.0250	0.426	0.532	0.910	2.72
LP5-21	2	1	8	S-12202LM11	3.50	0.244	<0.100	3.80	1.82	16.4	<0.100	0.239	<0.100	<0.0250	0.404	0.932	0.872	1.91
LP5-25	2	1	9	S-12206LM11	3.76	<0.0250	3.60	0.100	0.888	10.8	<0.100	<0.100	<0.100	<0.0250	0.0722	<0.100	0.660	<0.100
LRM	2	1	10	LRMLM212	0.358	0.129	1.09	1.18	<0.100	15.7	0.134	0.210	0.103	<0.0250	0.0906	<0.100	<0.100	<0.100

Table A-2. LM Measurements (wt.%) of the Study Glasses (continued)

PNNL ID	Block	Sub – Block	Sequence	Lab ID	Ca	Cr	Fe	K	Mg	Na	Ni	P	Pb	Re	S	Sn	Ti	V
LP5-05	2	1	11	S-12186LM21	5.12	0.119	0.639	2.02	2.97	17.0	<0.100	0.119	<0.100	<0.0250	0.219	2.77	0.428	3.05
LP5-11	2	1	12	S-12192LM11	1.78	0.274	0.472	0.379	2.22	19.2	<0.100	0.226	<0.100	<0.0250	0.442	1.23	0.919	3.21
LP5-04	2	1	13	S-12185LM11	8.10	0.161	<0.100	2.86	0.123	18.5	<0.100	0.157	<0.100	<0.0250	0.269	0.822	0.581	<0.100
LP5-08	2	1	14	S-12189LM11	0.565	0.124	0.352	4.66	<0.100	21.5	<0.100	0.118	<0.100	<0.0250	0.208	3.19	0.461	0.175
LP5-23	2	1	15	S-12204LM21	4.42	0.0827	0.120	1.77	1.51	18.0	<0.100	<0.100	<0.100	<0.0250	0.148	1.15	0.303	1.55
LP5-11	2	1	16	S-12192LM21	1.67	0.261	0.468	0.360	2.32	19.4	<0.100	0.237	<0.100	<0.0250	0.434	1.34	0.918	3.26
LP5-17	2	1	17	S-12198LM11	3.44	0.0979	0.480	3.28	1.02	15.6	<0.100	0.103	<0.100	<0.0250	0.164	3.60	0.359	3.01
LP5-04	2	1	18	S-12185LM21	7.83	0.162	0.107	3.36	0.128	18.3	<0.100	0.158	<0.100	<0.0250	0.271	0.836	0.593	<0.100
LP5-05	2	1	19	S-12186LM11	4.86	0.117	0.637	2.29	3.11	17.5	<0.100	0.117	<0.100	<0.0250	0.213	2.97	0.426	3.11
LP5-08	2	1	20	S-12189LM21	0.548	0.125	0.362	4.17	<0.100	20.3	<0.100	0.120	<0.100	<0.0250	0.207	3.19	0.468	0.180
LRM	2	1	21	LRMLM213	0.329	0.128	1.02	1.30	<0.100	15.9	0.132	0.208	0.101	<0.0250	0.0925	<0.100	<0.100	<0.100
LRM	2	2	1	LRMLM221	0.357	0.126	1.01	1.17	<0.100	15.6	0.131	0.208	0.101	<0.0250	0.0845	<0.100	<0.100	<0.100
LP5-11	2	2	2	S-12192LM22	1.70	0.255	0.465	0.357	2.15	19.1	<0.100	0.232	<0.100	<0.0250	0.422	1.22	0.906	3.15
LP5-08	2	2	3	S-12189LM12	0.499	0.122	0.354	3.66	<0.100	19.0	<0.100	0.115	<0.100	<0.0250	0.203	2.86	0.462	0.181
LP5-21	2	2	4	S-12202LM12	3.39	0.237	<0.100	3.56	1.74	15.6	<0.100	0.227	<0.100	<0.0250	0.393	0.919	0.845	1.86
LP5-11	2	2	5	S-12192LM12	1.68	0.269	0.467	0.381	2.14	18.9	<0.100	0.222	<0.100	<0.0250	0.420	1.19	0.908	3.13
LP5-05	2	2	6	S-12186LM22	5.12	0.116	0.634	1.96	2.90	17.0	<0.100	0.117	<0.100	<0.0250	0.213	2.70	0.423	3.01
LP5-03	2	2	7	S-12184LM12	4.66	0.245	0.232	0.117	2.27	17.9	<0.100	0.243	<0.100	<0.0250	0.413	0.452	0.889	2.65
LP5-04	2	2	8	S-12185LM12	8.18	0.159	<0.100	2.79	0.126	18.2	<0.100	0.156	<0.100	<0.0250	0.265	0.815	0.580	<0.100
LP5-23	2	2	9	S-12204LM12	4.59	0.0798	0.118	1.38	1.38	17.7	<0.100	<0.100	<0.100	<0.0250	0.149	1.03	0.298	1.50
LRM	2	2	10	LRMLM222	0.358	0.125	0.957	1.13	<0.100	15.3	0.130	0.204	0.100	<0.0250	0.0906	<0.100	<0.100	<0.100
LP5-25	2	2	11	S-12206LM12	3.71	<0.0250	3.53	<0.100	0.860	10.5	<0.100	<0.100	<0.100	<0.0250	0.0749	<0.100	0.633	<0.100
LP5-03	2	2	12	S-12184LM22	4.75	0.245	0.251	0.116	2.27	17.6	<0.100	0.218	<0.100	<0.0250	0.413	0.517	0.881	2.65
LP5-21	2	2	13	S-12202LM22	3.50	0.237	<0.100	3.59	1.77	16.2	<0.100	0.225	<0.100	<0.0250	0.397	0.908	0.844	1.90
LP5-17	2	2	14	S-12198LM22	3.58	0.0970	0.485	2.66	0.893	15.5	<0.100	<0.100	<0.100	<0.0250	0.162	3.22	0.357	2.89
LP5-08	2	2	15	S-12189LM22	0.519	0.120	0.353	3.57	<0.100	19.5	<0.100	0.114	<0.100	<0.0250	0.202	2.90	0.453	0.179
LP5-17	2	2	16	S-12198LM12	3.58	0.0931	0.467	2.66	0.870	15.4	<0.100	<0.100	<0.100	<0.0250	0.154	3.24	0.345	2.89
LP5-25	2	2	17	S-12206LM22	3.77	<0.0250	3.56	0.101	0.858	10.7	<0.100	<0.100	<0.100	<0.0250	0.0735	<0.100	0.648	<0.100
LP5-23	2	2	18	S-12204LM22	4.62	0.0798	0.129	1.37	1.39	17.7	<0.100	<0.100	<0.100	<0.0250	0.148	1.04	0.300	1.50
LP5-05	2	2	19	S-12186LM12	5.21	0.112	0.617	1.94	2.91	17.1	<0.100	0.110	<0.100	<0.0250	0.210	2.70	0.408	3.02
LP5-04	2	2	20	S-12185LM22	8.35	0.157	0.105	2.76	0.129	18.1	<0.100	0.153	<0.100	<0.0250	0.267	0.823	0.578	<0.100
LRM	2	2	21	LRMLM223	0.357	0.125	0.953	1.15	<0.100	15.4	0.130	0.203	0.100	<0.0250	0.0911	<0.100	<0.100	<0.100
LRM	3	1	1	LRMLM311	0.339	0.123	0.941	1.23	<0.100	14.7	0.124	0.204	<0.100	<0.0250	0.0863	<0.100	<0.100	<0.100
LP5-01	3	1	2	S-12182LM21	4.23	0.246	0.578	4.10	0.297	18.2	<0.100	0.253	<0.100	<0.0250	0.414	3.35	0.887	1.88
LP5-02	3	1	3	S-12183LM21	8.33	0.173	0.569	1.06	2.87	17.6	<0.100	0.175	<0.100	<0.0250	0.309	0.374	0.634	1.64
LP5-06-MOD1	3	1	4	S-12187LM11	2.74	0.202	0.125	2.73	1.60	16.3	<0.100	0.190	<0.100	<0.0250	0.315	2.30	0.737	3.09
LP5-09	3	1	5	S-12190LM11	3.20	0.220	0.480	2.62	0.452	18.2	<0.100	0.214	<0.100	<0.0250	0.370	1.90	0.804	0.552
LP5-24	3	1	6	S-12205LM11	3.63	0.256	0.399	0.855	0.398	15.4	<0.100	0.248	<0.100	<0.0250	0.154	1.15	<0.100	0.539
LP5-22	3	1	7	S-12203LM21	0.295	0.0747	0.482	0.329	2.74	17.6	<0.100	<0.100	<0.100	<0.0250	0.147	0.773	0.279	0.338
LP5-09	3	1	8	S-12190LM21	3.18	0.220	0.481	2.58	0.453	18.4	<0.100	0.211	<0.100	<0.0250	0.371	1.88	0.803	0.553
LP5-06-MOD1	3	1	9	S-12187LM21	2.72	0.208	0.128	2.74	1.60	15.9	<0.100	0.175	<0.100	<0.0250	0.330	2.26	0.750	3.08
LRM	3	1	10	LRMLM312	0.341	0.126	0.959	1.23	<0.100	14.7	0.126	0.211	<0.100	<0.0250	0.0947	<0.100	<0.100	<0.100
LP5-15	3	1	11	S-12196LM21	0.259	0.0510	0.620	3.63	1.19	17.5	<0.100	<0.100	<0.100	<0.0250	0.0962	0.299	0.280	1.42
LP5-22	3	1	12	S-12203LM11	0.301	0.0744	0.475	0.333	2.74	17.7	<0.100	<0.100	<0.100	<0.0250	0.147	0.754	0.279	0.337
LP5-02	3	1	13	S-12183LM11	8.53	0.173	0.570	1.10	2.93	17.9	<0.100	0.177	<0.100	<0.0250	0.314	0.377	0.638	1.67
LP5-19	3	1	14	S-12200LM11	4.89	0.124	<0.100	4.81	2.81	16.0	<0.100	0.121	<0.100	<0.0250	0.235	1.20	0.458	0.708
LP5-15	3	1	15	S-12196LM11	0.266	0.0513	0.620	3.80	1.23	18.5	<0.100	<0.100	<0.100	<0.0250	0.0993	0.301	0.281	1.47
LP5-19	3	1	16	S-12200LM21	4.82	0.122	<0.100	4.75	2.78	16.1	<0.100	0.120	<0.100	<0.0250	0.234	1.18	0.453	0.701
LP5-24	3	1	17	S-12205LM21	3.76	0.261	0.405	0.874	0.407	16.6	<0.100	0.252	<0.100	<0.0250	0.163	1.19	<0.100	0.551

Table A-2. LM Measurements (wt.%) of the Study Glasses (continued)

PNNL ID	Block	Sub – Block	Sequence	Lab ID	Ca	Cr	Fe	K	Mg	Na	Ni	P	Pb	Re	S	Sn	Ti	V
LP5-01	3	1	18	S-12182LM11	4.31	0.249	0.585	4.19	0.301	18.7	<0.100	0.256	<0.100	<0.0250	0.421	3.39	0.900	1.91
LRM	3	1	19	LRMLM313	0.353	0.125	0.953	1.25	<0.100	15.4	0.125	0.208	<0.100	<0.0250	0.0931	<0.100	<0.100	<0.100
LRM	3	2	1	LRMLM321	0.346	0.124	0.952	1.20	<0.100	15.3	0.124	0.206	<0.100	<0.0250	0.0892	<0.100	<0.100	<0.100
LP5-02	3	2	2	S-12183LM12	8.38	0.176	0.580	1.06	2.90	18.9	<0.100	0.176	<0.100	<0.0250	0.310	0.377	0.639	1.65
LP5-06-MOD1	3	2	3	S-12187LM22	2.69	0.209	0.129	2.64	1.60	16.5	<0.100	0.169	<0.100	<0.0250	0.330	2.23	0.748	3.06
LP5-09	3	2	4	S-12190LM12	3.14	0.224	0.490	2.54	0.455	19.7	<0.100	0.215	<0.100	<0.0250	0.378	1.88	0.816	0.567
LP5-01	3	2	5	S-12182LM22	4.16	0.248	0.582	3.97	0.296	19.1	<0.100	0.253	<0.100	<0.0250	0.411	3.30	0.889	1.86
LP5-22	3	2	6	S-12203LM22	0.292	0.0760	0.490	0.332	2.71	18.5	<0.100	<0.100	<0.100	<0.0250	0.146	0.777	0.282	0.346
LP5-24	3	2	7	S-12205LM22	3.69	0.263	0.409	0.872	0.404	17.0	<0.100	0.251	<0.100	<0.0250	0.163	1.18	<0.100	0.557
LP5-22	3	2	8	S-12203LM12	0.295	0.0741	0.475	0.338	2.73	19.0	<0.100	<0.100	<0.100	<0.0250	0.144	0.762	0.277	0.341
LP5-15	3	2	9	S-12196LM12	0.255	0.0509	0.617	3.66	1.22	19.6	<0.100	<0.100	<0.100	<0.0250	0.0967	0.298	0.277	1.45
LRM	3	2	10	LRMLM322	0.337	0.124	0.943	1.22	<0.100	16.1	0.123	0.207	<0.100	<0.0250	0.0909	<0.100	<0.100	<0.100
LP5-09	3	2	11	S-12190LM22	3.16	0.219	0.478	2.54	0.446	20.4	<0.100	0.207	<0.100	<0.0250	0.371	1.88	0.794	0.554
LP5-01	3	2	12	S-12182LM12	4.23	0.248	0.582	4.00	0.295	19.8	<0.100	0.251	<0.100	<0.0250	0.413	3.35	0.882	1.88
LP5-19	3	2	13	S-12200LM12	4.69	0.123	<0.100	4.52	2.74	16.7	<0.100	0.114	<0.100	<0.0250	0.227	1.16	0.448	0.702
LP5-19	3	2	14	S-12200LM22	4.79	0.121	<0.100	4.68	2.76	17.1	<0.100	0.119	<0.100	<0.0250	0.230	1.16	0.446	0.701
LP5-02	3	2	15	S-12183LM22	8.33	0.171	0.560	1.06	2.87	19.8	<0.100	0.170	<0.100	<0.0250	0.307	0.370	0.617	1.63
LP5-15	3	2	16	S-12196LM22	0.242	0.0494	0.603	3.51	1.17	19.1	<0.100	<0.100	<0.100	<0.0250	0.0918	0.291	0.268	1.39
LP5-24	3	2	17	S-12205LM12	3.60	0.255	0.396	0.835	0.393	17.4	<0.100	0.242	<0.100	<0.0250	0.154	1.15	<0.100	0.541
LP5-06-MOD1	3	2	18	S-12187LM12	2.78	0.201	0.124	2.81	1.61	17.2	<0.100	0.190	<0.100	<0.0250	0.325	2.30	0.734	3.10
LRM	3	2	19	LRMLM323	0.339	0.124	0.952	1.23	<0.100	16.3	0.124	0.208	<0.100	<0.0250	0.0890	<0.100	<0.100	<0.100

Table A-3. PF Measurements (wt.%) of the Study Glasses

PNNL ID	Block	Sub – Block	Sequence	Lab ID	Al	B	Li	Si	Zn	Zr
LRM	1	1	1	LRMPF111	5.17	2.42	<0.100	25.3	<0.100	0.694
LP5-24	1	1	2	S-12205PF11	5.09	2.98	<0.100	18.4	2.27	2.73
LP5-15	1	1	3	S-12196PF11	6.86	2.84	<0.100	16.1	<0.100	3.81
LP5-24	1	1	4	S-12205PF21	5.17	2.94	<0.100	18.3	2.23	2.72
LP5-04	1	1	5	S-12185PF21	2.46	3.16	<0.100	16.2	4.64	0.370
LP5-22	1	1	6	S-12203PF11	1.94	3.90	<0.100	22.2	<0.100	1.20
LP5-03	1	1	7	S-12184PF21	2.55	3.21	<0.100	15.8	0.155	3.75
LP5-04	1	1	8	S-12185PF11	2.48	3.16	<0.100	16.4	4.64	0.376
LP5-22	1	1	9	S-12203PF21	1.94	3.92	<0.100	22.5	<0.100	1.22
LRM	1	1	10	LRMPF112	5.20	2.43	<0.100	25.4	<0.100	0.718
LP5-18	1	1	11	S-12199PF21	3.07	2.98	<0.100	18.5	4.61	0.118
LP5-15	1	1	12	S-12196PF21	6.82	2.98	<0.100	16.8	<0.100	3.79
LP5-06-MOD1	1	1	13	S-12187PF11	6.20	2.50	<0.100	16.0	0.295	1.34
LP5-23	1	1	14	S-12204PF11	1.97	1.99	<0.100	22.7	0.361	0.274
LP5-23	1	1	15	S-12204PF21	1.97	1.99	<0.100	22.9	0.361	0.273
LP5-03	1	1	16	S-12184PF11	2.51	3.24	<0.100	15.8	0.157	3.81
LP5-18	1	1	17	S-12199PF11	3.05	2.97	<0.100	18.3	4.58	0.127
LP5-06-MOD1	1	1	18	S-12187PF21	6.28	2.69	0.136	16.9	0.287	1.30
LRM	1	1	19	LRMPF113	5.21	2.44	<0.100	25.5	<0.100	0.724
LRM	1	2	1	LRMPF121	5.22	2.43	<0.100	25.5	<0.100	0.703
LP5-03	1	2	2	S-12184PF12	2.51	3.23	<0.100	15.9	0.156	3.80
LP5-24	1	2	3	S-12205PF12	5.09	2.97	<0.100	18.3	2.30	2.76
LP5-24	1	2	4	S-12205PF22	5.21	2.95	<0.100	18.5	2.27	2.74
LP5-23	1	2	5	S-12204PF22	1.97	1.98	<0.100	23.0	0.361	0.279
LP5-18	1	2	6	S-12199PF22	3.05	2.94	<0.100	18.4	4.63	0.121
LP5-06-MOD1	1	2	7	S-12187PF22	6.23	2.64	0.131	16.8	0.288	1.28
LP5-22	1	2	8	S-12203PF22	1.94	4.02	<0.100	23.4	<0.100	1.24
LP5-06-MOD1	1	2	9	S-12187PF12	6.17	2.55	<0.100	16.5	0.308	1.35
LRM	1	2	10	LRMPF122	5.13	2.46	<0.100	26.1	<0.100	0.726
LP5-15	1	2	11	S-12196PF22	6.78	3.04	<0.100	17.4	<0.100	3.84
LP5-18	1	2	12	S-12199PF12	2.98	3.00	<0.100	18.6	4.79	0.129
LP5-23	1	2	13	S-12204PF12	1.94	2.00	<0.100	23.2	0.373	0.271
LP5-04	1	2	14	S-12185PF22	2.45	3.21	<0.100	16.8	4.88	0.367
LP5-04	1	2	15	S-12185PF12	2.45	3.21	<0.100	17.0	4.86	0.368
LP5-22	1	2	16	S-12203PF12	1.92	3.98	<0.100	23.0	<0.100	1.22
LP5-15	1	2	17	S-12196PF12	6.82	2.93	<0.100	16.6	<0.100	3.89
LP5-03	1	2	18	S-12184PF22	2.55	3.27	<0.100	16.3	0.161	3.81
LRM	1	2	19	LRMPF123	5.10	2.46	<0.100	26.0	<0.100	0.733
LRM	2	1	1	LRMPF211	5.05	2.34	<0.100	24.9	<0.100	0.686
LP5-07	2	1	2	S-12188PF21	7.29	3.18	<0.100	18.0	0.172	0.419
LP5-17	2	1	3	S-12198PF21	1.83	2.34	<0.100	16.2	4.46	3.43
LP5-11	2	1	4	S-12192PF11	2.86	2.18	<0.100	17.2	3.28	0.868
LP5-19	2	1	5	S-12200PF21	1.96	3.23	<0.100	16.3	4.19	1.06
LP5-09	2	1	6	S-12190PF11	4.76	2.08	<0.100	16.3	4.35	0.540
LP5-02	2	1	7	S-12183PF11	1.80	2.06	<0.100	16.4	2.75	0.217
LP5-05	2	1	8	S-12186PF21	2.10	2.74	<0.100	16.1	0.986	0.365
LP5-05	2	1	9	S-12186PF11	2.07	2.75	<0.100	16.2	0.993	0.375

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

PNNL ID	Block	Sub – Block	Sequence	Lab ID	Al	B	Li	Si	Zn	Zr
LRM	2	1	10	LRMPF212	5.05	2.35	<0.100	25.1	<0.100	0.698
LP5-14	2	1	11	S-12195PF11	2.35	2.04	<0.100	18.3	3.39	2.35
LP5-02	2	1	12	S-12183PF21	1.81	2.07	<0.100	16.4	2.75	0.224
LP5-11	2	1	13	S-12192PF21	2.82	2.19	<0.100	17.3	3.31	0.868
LP5-09	2	1	14	S-12190PF21	4.80	2.08	<0.100	16.4	4.34	0.541
LP5-12-1	2	1	15	S-12193PF11	7.06	1.80	<0.100	16.5	1.79	1.93
LP5-07	2	1	16	S-12188PF11	7.23	3.19	<0.100	18.0	0.173	0.425
LP5-17	2	1	17	S-12198PF11	1.90	2.41	<0.100	16.7	4.56	3.55
LP5-12-1	2	1	18	S-12193PF21	7.06	1.82	<0.100	16.5	1.82	1.97
LP5-19	2	1	19	S-12200PF11	1.98	3.22	<0.100	16.7	4.16	1.08
LP5-14	2	1	20	S-12195PF21	2.33	2.03	<0.100	18.3	3.40	2.36
LRM	2	1	21	LRMPF213	5.12	2.36	<0.100	25.3	<0.100	0.721
LRM	2	2	1	LRMPF221	5.17	2.43	<0.100	25.1	<0.100	0.700
LP5-17	2	2	2	S-12198PF12	1.92	2.47	<0.100	16.5	4.75	3.56
LP5-09	2	2	3	S-12190PF12	4.81	2.12	<0.100	16.2	4.52	0.544
LP5-14	2	2	4	S-12195PF22	2.35	2.06	<0.100	18.0	3.51	2.35
LP5-19	2	2	5	S-12200PF22	1.99	3.27	<0.100	16.2	4.34	1.08
LP5-07	2	2	6	S-12188PF12	7.32	3.24	<0.100	17.9	0.184	0.424
LP5-11	2	2	7	S-12192PF22	2.84	2.23	<0.100	17.1	3.43	0.868
LP5-12-1	2	2	8	S-12193PF22	7.01	1.85	<0.100	16.4	1.88	1.94
LP5-17	2	2	9	S-12198PF22	1.86	2.40	<0.100	16.1	4.62	3.48
LRM	2	2	10	LRMPF222	5.18	2.43	<0.100	25.1	<0.100	0.724
LP5-12-1	2	2	11	S-12193PF12	7.16	1.84	<0.100	16.3	1.87	1.95
LP5-14	2	2	12	S-12195PF12	2.40	2.10	<0.100	18.2	3.54	2.39
LP5-05	2	2	13	S-12186PF12	2.13	2.84	<0.100	16.2	1.05	0.383
LP5-07	2	2	14	S-12188PF22	7.56	3.31	<0.100	18.2	0.185	0.433
LP5-09	2	2	15	S-12190PF22	4.91	2.15	<0.100	16.5	4.55	0.553
LP5-05	2	2	16	S-12186PF22	2.19	2.84	<0.100	16.2	1.04	0.378
LP5-11	2	2	17	S-12192PF12	2.95	2.26	<0.100	17.2	3.45	0.883
LP5-19	2	2	18	S-12200PF12	2.01	3.31	<0.100	16.7	4.34	1.10
LP5-02	2	2	19	S-12183PF12	1.86	2.14	<0.100	16.5	2.90	0.221
LP5-02	2	2	20	S-12183PF22	1.83	2.13	<0.100	16.3	2.86	0.215
LRM	2	2	21	LRMPF223	5.28	2.46	<0.100	25.4	<0.100	0.720
LRM	3	1	1	LRMPF311	5.23	2.44	<0.100	25.3	<0.100	0.707
LP5-25	3	1	2	S-12206PF11	3.18	3.18	0.977	22.2	2.44	2.09
LP5-21	3	1	3	S-12202PF21	3.09	4.22	<0.100	16.7	1.22	0.546
LP5-21	3	1	4	S-12202PF11	3.10	4.26	<0.100	16.7	1.23	0.543
LP5-13	3	1	5	S-12194PF11	2.35	4.00	<0.100	15.8	1.28	2.80
LP5-16-MOD1	3	1	6	S-12197PF11	4.22	2.30	<0.100	16.3	0.28	2.22
LP5-08	3	1	7	S-12189PF21	7.07	3.07	<0.100	16.8	1.47	1.09
LP5-10	3	1	8	S-12191PF21	2.41	1.94	<0.100	17.0	4.40	2.74
LP5-20	3	1	9	S-12201PF21	2.16	4.46	<0.100	18.8	0.386	1.12
LRM	3	1	10	LRMPF312	5.30	2.50	<0.100	25.7	<0.100	0.732
LP5-16-MOD1	3	1	11	S-12197PF21	4.31	2.37	<0.100	16.5	0.282	2.26
LP5-10	3	1	12	S-12191PF11	2.49	2.02	<0.100	17.5	4.48	2.81
LP5-08	3	1	13	S-12189PF11	7.17	3.13	<0.100	16.9	1.48	1.11
LP5-01	3	1	14	S-12182PF11	2.02	3.57	<0.100	16.3	0.940	<0.100
LP5-25	3	1	16	S-12206PF21	3.23	3.31	0.98	22.8	2.48	2.14

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

PNNL ID	Block	Sub – Block	Sequence	Lab ID	Al	B	Li	Si	Zn	Zr
LP5-20	3	1	17	S-12201PF11	2.14	4.52	<0.100	18.9	0.385	1.13
LP5-13	3	1	18	S-12194PF21	2.44	4.25	<0.100	16.6	1.35	2.95
LRM	3	1	19	LRMPF313	5.42	2.56	<0.100	26.1	<0.100	0.747
LRM	3	2	1	LRMPF321	5.34	2.44	<0.100	25.1	<0.100	0.701
LP5-08	3	2	2	S-12189PF12	7.11	2.99	<0.100	16.4	1.46	1.07
LP5-21	3	2	3	S-12202PF12	3.16	4.18	<0.100	16.5	1.22	0.539
LP5-10	3	2	4	S-12191PF22	2.43	1.91	<0.100	16.6	4.36	2.70
LP5-13	3	2	5	S-12194PF12	2.36	3.88	<0.100	15.4	1.26	2.78
LP5-16-MOD1	3	2	6	S-12197PF22	4.32	2.29	<0.100	16.1	0.282	2.23
LP5-25	3	2	7	S-12206PF12	3.26	3.17	0.931	22.0	2.43	2.11
LP5-20	3	2	8	S-12201PF12	2.13	4.32	<0.100	18.4	0.382	1.11
LP5-08	3	2	9	S-12189PF22	7.19	3.04	<0.100	16.5	1.47	1.09
LRM	3	2	10	LRMPF322	5.41	2.46	<0.100	25.3	<0.100	0.727
LP5-10	3	2	11	S-12191PF12	2.49	1.95	<0.100	17.0	4.43	2.75
LP5-20	3	2	12	S-12201PF22	2.16	4.30	<0.100	18.4	0.384	1.10
LP5-13	3	2	13	S-12194PF22	2.46	4.10	<0.100	16.2	1.34	2.91
LP5-01	3	2	14	S-12182PF22	2.01	3.43	<0.100	16.0	0.934	<0.100
LP5-25	3	2	15	S-12206PF22	3.26	3.20	0.935	22.3	2.48	2.13
LP5-01	3	2	16	S-12182PF12	2.04	3.47	<0.100	16.0	0.939	<0.100
LP5-16-MOD1	3	2	17	S-12197PF12	4.27	2.27	<0.100	16.0	0.280	2.21
LP5-21	3	2	18	S-12202PF22	3.19	4.21	<0.100	16.7	1.23	0.550
LRM	3	2	19	LRMPF323	5.40	2.46	<0.100	25.3	<0.100	0.720

Table A-4. KH Measurements (wt.%) Rerun Samples

PNNL ID	Sequence	Lab ID	Cl^-	F^-
LRM	1	LRMKH	<0.0250	0.888
LP5-12-1	2	S-12193a	0.117	0.212
LP5-12-1	3	S-12193b	0.118	0.212
LP5-12-1	4	S-12193c	0.118	0.211
LP5-12-1	5	S-12193d	0.119	0.212
PNNL ID	**Sequence**	**Lab ID**	**Cl^-**	**F^-**
LRM	1	LRMKHa	<0.0250	0.858
LP5-15	2	S-12196a	1.05	0.0595
LP5-15	3	S-12196b	1.05	0.0586
LP5-17	4	S-12198a	0.772	0.0791
LP5-17	5	S-12198b	0.754	0.0759
LP5-24	6	S-12205a	1.01	0.256
LP5-24	7	S-12205b	1.03	0.259
LRM	8	LRMKHb	<0.0250	0.874
LRM	1	LRMKHc	<0.0250	0.873
LP5-15	2	S-12196c	1.05	0.0598
LP5-15	3	S-12196d	1.05	0.0581
LP5-17	4	S-12198c	0.772	0.0795
LP5-17	5	S-12198d	0.753	0.0764
LP5-24	6	S-12205c	1.01	0.260
LP5-24	7	S-12205d	1.02	0.261
LRM	8	LRMKHd	<0.0250	0.879

Table A-5. LM Measurements (wt.%) Rerun Results

PNNL ID	Sequence	Lab ID	Ca	Cr	Fe	K	Mg	Na	Ni	P	Pb	Re	S	Sn	Ti	V
LRM	1	LRMLM	0.345	0.128	0.962	1.17	<0.100	15.2	0.134	0.204	<0.100	<0.0250	0.0997	<0.100	<0.100	<0.100
LP5-12-1	2	S-12193a	0.921	0.256	0.404	1.63	2.95	17.1	<0.100	0.221	<0.100	<0.0250	0.304	0.782	0.943	1.76
LP5-12-1	3	S-12193b	0.921	0.257	0.402	1.63	2.96	17.0	<0.100	0.223	<0.100	<0.0250	0.300	0.785	0.940	1.77
LP5-12-1	4	S-12193c	0.922	0.256	0.403	1.64	3.00	17.1	<0.100	0.222	<0.100	<0.0250	0.304	0.781	0.942	1.79
LP5-12-1	5	S-12193d	0.922	0.255	0.403	1.66	3.01	17.2	<0.100	0.222	<0.100	<0.0250	0.314	0.791	0.942	1.80

Table A-6. PF Measurements (wt.%) Rerun Results

PNNL ID	Sequence	Lab ID	Al	B	Li	Si	Zn	Zr
LRM	1	LRMPF	5.20	2.29	<0.100	24.7	<0.100	0.715
LP5-12-1	2	S-12193a	7.27	1.71	<0.100	16.3	1.90	1.99
LP5-12-1	3	S-12193b	7.33	1.74	<0.100	16.2	1.92	2.01
LP5-12-1	4	S-12193c	7.35	1.73	<0.100	16.1	1.92	2.02
LP5-12-1	5	S-12193d	7.36	1.75	<0.100	16.3	1.92	2.02

Table A-7. Comparison of Measured versus Target Compositions

PNNL ID	Oxide	Mean Measured (wt.%)	Target (wt.%)	Difference of Measured versus Target	% Difference Measured versus Target
LRM	Al_2O_3	9.87	9.51	0.355	4%
LRM	B_2O_3	7.85	7.85	-0.002	0%
LRM	CaO	0.491	0.540	-0.049	
LRM	Cl	<0.025	0	0.025	
LRM	Cr_2O_3	0.186	0.190	-0.004	
LRM	F	0.901	0.860	0.041	
LRM	Fe_2O_3	1.40	1.38	0.024	2%
LRM	K_2O	1.44	1.48	-0.038	-3%
LRM	Li_2O	<0.215	0.110	0.105	
LRM	MgO	<0.166	0.100	0.066	
LRM	Na_2O	20.8	20.0	0.767	4%
LRM	NiO	0.165	0.190	-0.025	
LRM	P_2O_5	0.479	0.540	-0.061	
LRM	PbO	<0.109	0.100	0.009	
LRM	Re_2O_7	<0.0325	0	0.033	
LRM	SiO_2	54.4	54.2	0.174	0%
LRM	SnO_2	<0.127	0	0.127	
LRM	SO_3	0.226	0.300	-0.074	
LRM	TiO_2	<0.167	0.100	0.067	
LRM	V_2O_5	<0.179	0	0.179	
LRM	ZnO	<0.124	0	0.124	
LRM	ZrO_2	0.967	0.930	0.037	
LRM	**Sum of Oxides**	**100**	**98.4**	**1.879**	**2%**
LP5-01	Al_2O_3	3.81	3.74	0.067	2%
LP5-01	B_2O_3	11.3	10.8	0.458	4%
LP5-01	CaO	5.92	5.67	0.252	4%
LP5-01	Cl	0.555	0.650	-0.095	
LP5-01	Cr_2O_3	0.362	0.400	-0.038	
LP5-01	F	0.223	0.260	-0.037	
LP5-01	Fe_2O_3	0.832	0.900	-0.068	
LP5-01	K_2O	4.90	4.84	0.057	1%
LP5-01	Li_2O	<0.215	0	0.215	
LP5-01	MgO	0.493	0.480	0.013	
LP5-01	Na_2O	25.5	26.3	-0.755	-3%
LP5-01	NiO	<0.127	0.0500	0.077	
LP5-01	P_2O_5	0.580	0.630	-0.05	
LP5-01	PbO	<0.108	0.0500	0.058	
LP5-01	Re_2O_7	<0.0325	0.0500	-0.017	
LP5-01	SiO_2	34.5	33.6	0.95	3%
LP5-01	SnO_2	4.25	4.35	-0.1	-2%
LP5-01	SO_3	1.04	1.07	-0.034	-3%
LP5-01	TiO_2	1.48	1.56	-0.076	-5%
LP5-01	V_2O_5	3.36	3.34	0.021	1%
LP5-01	ZnO	1.17	1.16	0.005	0%
LP5-01	ZrO_2	<0.135	0.0600	0.075	
LP5-01	**Sum of Oxides**	**101**	**100**	**0.976**	**1%**

Table A-7. Comparison of Measured versus Target Compositions (continued)

PNNL ID	Oxide	Mean Measured (wt.%)	Target (wt.%)	Difference of Measured versus Target	% Difference Measured versus Target
LP5-02	Al_2O_3	3.45	3.55	-0.102	-3%
LP5-02	B_2O_3	6.76	6.71	0.052	1%
LP5-02	CaO	11.7	11.6	0.133	1%
LP5-02	Cl	0.356	0.460	-0.104	
LP5-02	Cr_2O_3	0.253	0.280	-0.027	
LP5-02	F	0.148	0.190	-0.042	
LP5-02	Fe_2O_3	0.815	0.890	-0.075	
LP5-02	K_2O	1.29	1.27	0.019	1%
LP5-02	Li_2O	<0.215	0	0.215	
LP5-02	MgO	4.80	4.77	0.027	1%
LP5-02	Na_2O	25.0	25.9	-0.895	-3%
LP5-02	NiO	<0.127	0.0400	0.087	
LP5-02	P_2O_5	0.400	0.450	-0.05	
LP5-02	PbO	<0.108	0.0400	0.068	
LP5-02	Re_2O_7	<0.0325	0.0400	-0.007	
LP5-02	SiO_2	35.1	34.6	0.485	1%
LP5-02	SnO_2	0.475	0.530	-0.055	
LP5-02	SO_3	0.774	0.760	0.014	
LP5-02	TiO_2	1.05	1.11	-0.056	-5%
LP5-02	V_2O_5	2.94	2.92	0.021	1%
LP5-02	ZnO	3.50	3.55	-0.046	-1%
LP5-02	ZrO_2	0.296	0.310	-0.014	
LP5-02	**Sum of Oxides**	**99.6**	**100**	**-0.352**	**0%**
LP5-03	Al_2O_3	4.78	4.87	-0.09	-2%
LP5-03	B_2O_3	10.4	10.4	0.074	1%
LP5-03	CaO	6.59	6.49	0.104	2%
LP5-03	Cl	0.519	0.640	-0.121	
LP5-03	Cr_2O_3	0.363	0.390	-0.027	
LP5-03	F	0.224	0.260	-0.036	
LP5-03	Fe_2O_3	0.345	0.320	0.025	
LP5-03	K_2O	0.141	0.120	0.021	
LP5-03	Li_2O	<0.215	0	0.215	
LP5-03	MgO	3.83	3.87	-0.039	-1%
LP5-03	Na_2O	24.7	24.4	0.268	1%
LP5-03	NiO	<0.127	0.0500	0.077	
LP5-03	P_2O_5	0.537	0.620	-0.083	
LP5-03	PbO	<0.108	0.0500	0.058	
LP5-03	Re_2O_7	<0.0325	0.0500	-0.017	
LP5-03	SiO_2	34.1	34.0	0.122	0%
LP5-03	SnO_2	0.620	0.590	0.03	
LP5-03	SO_3	1.05	1.05	-0.002	0%
LP5-03	TiO_2	1.49	1.53	-0.036	-2%
LP5-03	V_2O_5	4.78	4.84	-0.056	-1%
LP5-03	ZnO	0.196	0.180	0.016	
LP5-03	ZrO_2	5.12	5.33	-0.207	-4%
LP5-03	**Sum of Oxides**	**100**	**100**	**0.296**	**0%**

Table A-7. Comparison of Measured versus Target Compositions (continued)

PNNL ID	Oxide	Mean Measured (wt.%)	Target (wt.%)	Difference of Measured versus Target	% Difference Measured versus Target
LP5-04	Al_2O_3	4.65	4.80	-0.152	-3%
LP5-04	B_2O_3	10.3	10.0	0.215	2%
LP5-04	CaO	11.4	11.5	-0.095	-1%
LP5-04	Cl	0.319	0.420	-0.101	
LP5-04	Cr_2O_3	0.233	0.250	-0.017	
LP5-04	F	0.132	0.170	-0.038	
LP5-04	Fe_2O_3	<0.147	0.130	0.017	
LP5-04	K_2O	3.54	3.64	-0.095	-3%
LP5-04	Li_2O	<0.215	0	0.215	
LP5-04	MgO	0.210	0.110	0.1	
LP5-04	Na_2O	24.6	25.0	-0.365	-1%
LP5-04	NiO	<0.127	0.0300	0.097	
LP5-04	P_2O_5	0.357	0.400	-0.043	
LP5-04	PbO	<0.108	0.0300	0.078	
LP5-04	Re_2O_7	<0.0325	0.0300	0.003	
LP5-04	SiO_2	35.5	34.3	1.212	4%
LP5-04	SnO_2	1.05	1.10	-0.054	-5%
LP5-04	SO_3	0.669	0.680	-0.011	
LP5-04	TiO_2	0.972	0.990	-0.018	
LP5-04	V_2O_5	<0.179	0.130	0.049	
LP5-04	ZnO	5.92	5.71	0.209	4%
LP5-04	ZrO_2	0.500	0.530	-0.03	
LP5-04	**Sum of Oxides**	**101**	**99.9**	**1.177**	**1%**
LP5-05	Al_2O_3	4.01	4.10	-0.09	-2%
LP5-05	B_2O_3	8.99	8.96	0.032	0%
LP5-05	CaO	7.10	7.12	-0.016	0%
LP5-05	Cl	0.250	0.300	-0.05	
LP5-05	Cr_2O_3	0.170	0.180	-0.01	
LP5-05	F	0.101	0.120	-0.019	
LP5-05	Fe_2O_3	0.903	0.960	-0.057	
LP5-05	K_2O	2.47	2.54	-0.068	-3%
LP5-05	Li_2O	<0.215	0	0.215	
LP5-05	MgO	4.93	4.95	-0.021	0%
LP5-05	Na_2O	23.1	23.8	-0.682	-3%
LP5-05	NiO	<0.127	0.0200	0.107	
LP5-05	P_2O_5	0.265	0.290	-0.025	
LP5-05	PbO	<0.108	0.0200	0.088	
LP5-05	Re_2O_7	<0.0325	0.0200	0.013	
LP5-05	SiO_2	34.6	34.4	0.203	1%
LP5-05	SnO_2	3.54	3.61	-0.074	-2%
LP5-05	SO_3	0.534	0.490	0.044	
LP5-05	TiO_2	0.703	0.720	-0.017	
LP5-05	V_2O_5	5.44	5.49	-0.05	-1%
LP5-05	ZnO	1.27	1.29	-0.024	-2%
LP5-05	ZrO_2	0.507	0.560	-0.053	
LP5-05	**Sum of Oxides**	**99.4**	**99.9**	**-0.553**	**-1%**

Table A-7. Comparison of Measured versus Target Compositions (continued)

PNNL ID	Oxide	Mean Measured (wt.%)	Target (wt.%)	Difference of Measured versus Target	% Difference Measured versus Target
LP5-06-MOD1	Al_2O_3	11.8	11.9	-0.127	-1%
LP5-06-MOD1	B_2O_3	8.36	7.98	0.376	5%
LP5-06-MOD1	CaO	3.82	3.71	0.113	3%
LP5-06-MOD1	Cl	0.285	0.538	-0.253	
LP5-06-MOD1	Cr_2O_3	0.300	0.325	-0.025	
LP5-06-MOD1	F	0.176	0.215	-0.039	
LP5-06-MOD1	Fe_2O_3	0.181	0.170	0.011	
LP5-06-MOD1	K_2O	3.29	3.32	-0.031	-1%
LP5-06-MOD1	Li_2O	<0.251	0	0.251	
LP5-06-MOD1	MgO	2.66	2.64	0.017	1%
LP5-06-MOD1	Na_2O	22.2	22.0	0.208	1%
LP5-06-MOD1	NiO	<0.127	0.0416	0.086	
LP5-06-MOD1	P_2O_5	0.415	0.516	-0.101	
LP5-06-MOD1	PbO	<0.108	0.0416	0.066	
LP5-06-MOD1	Re_2O_7	<0.0325	0.0416	-0.009	
LP5-06-MOD1	SiO_2	35.4	33.6	1.805	5%
LP5-06-MOD1	SnO_2	2.89	2.98	-0.095	-3%
LP5-06-MOD1	SO_3	0.811	0.883	-0.072	
LP5-06-MOD1	TiO_2	1.24	1.28	-0.042	-3%
LP5-06-MOD1	V_2O_5	5.50	5.49	0.013	0%
LP5-06-MOD1	ZnO	0.367	0.360	0.007	
LP5-06-MOD1	ZrO_2	1.78	1.90	-0.12	-6%
LP5-06-MOD1	**Sum of Oxides**	**102**	**99.9**	**2.038**	**2%**
LP5-07	Al_2O_3	13.9	14.5	-0.652	-4%
LP5-07	B_2O_3	10.4	10.4	-0.02	0%
LP5-07	CaO	1.32	1.35	-0.03	-2%
LP5-07	Cl	0.153	0.170	-0.017	
LP5-07	Cr_2O_3	0.159	0.100	0.059	
LP5-07	F	0.0565	0.0700	-0.013	
LP5-07	Fe_2O_3	<0.143	0.0500	0.093	
LP5-07	K_2O	2.07	2.12	-0.045	-2%
LP5-07	Li_2O	<0.215	0	0.215	
LP5-07	MgO	4.16	3.93	0.228	6%
LP5-07	Na_2O	25.1	26.5	-1.36	-5%
LP5-07	NiO	<0.265	0.0100	0.255	
LP5-07	P_2O_5	<0.229	0.160	0.069	
LP5-07	PbO	<0.108	0.0100	0.098	
LP5-07	Re_2O_7	<0.0325	0.0100	0.023	
LP5-07	SiO_2	38.6	38.1	0.461	1%
LP5-07	SnO_2	0.206	0.210	-0.004	
LP5-07	SO_3	0.333	0.280	0.053	
LP5-07	TiO_2	0.445	0.410	0.035	
LP5-07	V_2O_5	0.744	0.730	0.014	
LP5-07	ZnO	0.222	0.230	-0.008	
LP5-07	ZrO_2	0.574	0.620	-0.046	
LP5-07	**Sum of Oxides**	**99.4**	**100**	**-0.592**	**-1%**

Table A-7. Comparison of Measured versus Target Compositions (continued)

PNNL ID	Oxide	Mean Measured (wt.%)	Target (wt.%)	Difference of Measured versus Target	% Difference Measured versus Target
LP5-08	Al_2O_3	13.5	13.4	0.072	1%
LP5-08	B_2O_3	9.84	9.48	0.365	4%
LP5-08	CaO	0.745	0.710	0.035	
LP5-08	Cl	0.282	0.320	-0.038	
LP5-08	Cr_2O_3	0.179	0.190	-0.011	
LP5-08	F	0.116	0.130	-0.014	
LP5-08	Fe_2O_3	0.508	0.510	-0.002	
LP5-08	K_2O	4.84	4.62	0.216	5%
LP5-08	Li_2O	<0.215	0	0.215	
LP5-08	MgO	<0.166	0.0600	0.106	
LP5-08	Na_2O	27.1	26.9	0.161	1%
LP5-08	NiO	<0.127	0.0200	0.107	
LP5-08	P_2O_5	0.268	0.310	-0.042	
LP5-08	PbO	<0.108	0.0200	0.088	
LP5-08	Re_2O_7	<0.0325	0.0200	0.013	
LP5-08	SiO_2	35.6	34.5	1.119	3%
LP5-08	SnO_2	3.85	3.80	0.053	1%
LP5-08	SO_3	0.512	0.520	-0.008	
LP5-08	TiO_2	0.769	0.760	0.009	
LP5-08	V_2O_5	0.319	0.310	0.009	
LP5-08	ZnO	1.83	1.82	0.01	1%
LP5-08	ZrO_2	1.47	1.53	-0.058	-4%
LP5-08	**Sum of Oxides**	**102**	**99.9**	**2.406**	**2%**
LP5-09	Al_2O_3	9.11	9.39	-0.283	-3%
LP5-09	B_2O_3	6.79	6.76	0.026	0%
LP5-09	CaO	4.44	4.33	0.105	2%
LP5-09	Cl	0.476	0.580	-0.104	
LP5-09	Cr_2O_3	0.323	0.350	-0.027	
LP5-09	F	0.206	0.230	-0.024	
LP5-09	Fe_2O_3	0.689	0.740	-0.051	
LP5-09	K_2O	3.10	3.07	0.026	1%
LP5-09	Li_2O	<0.215	0	0.215	
LP5-09	MgO	0.749	0.760	-0.011	
LP5-09	Na_2O	25.8	26.5	-0.652	-2%
LP5-09	NiO	<0.127	0.0500	0.077	
LP5-09	P_2O_5	0.485	0.560	-0.075	
LP5-09	PbO	<0.108	0.0500	0.058	
LP5-09	Re_2O_7	<0.0325	0.0500	-0.017	
LP5-09	SiO_2	35.0	34.3	0.678	2%
LP5-09	SnO_2	2.39	2.45	-0.057	-2%
LP5-09	SO_3	0.930	0.960	-0.03	
LP5-09	TiO_2	1.34	1.39	-0.049	-3%
LP5-09	V_2O_5	0.993	1.03	-0.037	-4%
LP5-09	ZnO	5.53	5.59	-0.063	-1%
LP5-09	ZrO_2	0.736	0.770	-0.034	
LP5-09	**Sum of Oxides**	**99.6**	**99.9**	**-0.329**	**0%**

Table A-7. Comparison of Measured versus Target Compositions (continued)

PNNL ID	Oxide	Mean Measured (wt.%)	Target (wt.%)	Difference of Measured versus Target	% Difference Measured versus Target
LP5-10	Al_2O_3	4.64	4.63	0.009	0%
LP5-10	B_2O_3	6.29	6.15	0.145	2%
LP5-10	CaO	1.87	1.71	0.165	10%
LP5-10	Cl	0.176	0.240	-0.065	
LP5-10	Cr_2O_3	0.135	0.140	-0.005	
LP5-10	F	0.0848	0.0900	-0.005	
LP5-10	Fe_2O_3	0.453	0.450	0.003	
LP5-10	K_2O	3.10	3.25	-0.154	-5%
LP5-10	Li_2O	<0.215	0	0.215	
LP5-10	MgO	4.52	4.36	0.163	4%
LP5-10	Na_2O	26.4	26.9	-0.547	-2%
LP5-10	NiO	<0.127	0.0200	0.107	
LP5-10	P_2O_5	<0.229	0.230	-0.001	
LP5-10	PbO	<0.108	0.0200	0.088	
LP5-10	Re_2O_7	<0.0325	0.0200	0.013	
LP5-10	SiO_2	36.4	36.1	0.322	1%
LP5-10	SnO_2	3.77	3.68	0.094	3%
LP5-10	SO_3	0.443	0.390	0.053	
LP5-10	TiO_2	0.581	0.560	0.021	
LP5-10	V_2O_5	1.37	1.36	0.011	1%
LP5-10	ZnO	5.50	5.55	-0.051	-1%
LP5-10	ZrO_2	3.71	4.12	-0.405	-10%
LP5-10	**Sum of Oxides**	**100**	**100**	**0.174**	**0%**
LP5-11	Al_2O_3	5.42	5.50	-0.082	-1%
LP5-11	B_2O_3	7.13	7.14	-0.008	0%
LP5-11	CaO	2.39	2.29	0.099	4%
LP5-11	Cl	0.508	0.660	-0.152	
LP5-11	Cr_2O_3	0.387	0.400	-0.013	
LP5-11	F	0.225	0.260	-0.036	
LP5-11	Fe_2O_3	0.669	0.690	-0.021	
LP5-11	K_2O	0.445	0.410	0.035	
LP5-11	Li_2O	<0.215	0	0.215	
LP5-11	MgO	3.66	3.63	0.031	1%
LP5-11	Na_2O	25.8	26.5	-0.686	-3%
LP5-11	NiO	<0.127	0.0500	0.077	
LP5-11	P_2O_5	0.525	0.630	-0.105	
LP5-11	PbO	<0.108	0.0500	0.058	
LP5-11	Re_2O_7	<0.0325	0.0500	-0.017	
LP5-11	SiO_2	36.8	36.3	0.496	1%
LP5-11	SnO_2	1.58	1.59	-0.009	-1%
LP5-11	SO_3	1.07	1.08	-0.008	-1%
LP5-11	TiO_2	1.52	1.57	-0.048	-3%
LP5-11	V_2O_5	5.69	5.67	0.02	0%
LP5-11	ZnO	4.19	4.26	-0.068	-2%
LP5-11	ZrO_2	1.18	1.26	-0.082	-7%
LP5-11	**Sum of Oxides**	**99.7**	**100**	**-0.303**	**0%**

Table A-7. Comparison of Measured versus Target Compositions (continued)

PNNL ID	Oxide	Mean Measured (wt.%)	Target (wt.%)	Difference of Measured versus Target	% Difference Measured versus Target
LP5-12-1	Al_2O_3	13.4	13.6	-0.227	-2%
LP5-12-1	B_2O_3	5.88	6.04	-0.156	-3%
LP5-12-1	CaO	1.34	1.17	0.17	15%
LP5-12-1	Cl	0.125	0.670	-0.545	
LP5-12-1	Cr_2O_3	0.377	0.400	-0.023	
LP5-12-1	F	0.211	0.270	-0.06	
LP5-12-1	Fe_2O_3	0.582	0.570	0.012	
LP5-12-1	K_2O	2.00	2.25	-0.253	-11%
LP5-12-1	Li_2O	<0.215	0	0.215	
LP5-12-1	MgO	5.24	4.96	0.284	6%
LP5-12-1	Na_2O	23.1	22.9	0.185	1%
LP5-12-1	NiO	<0.127	0.0500	0.077	
LP5-12-1	P_2O_5	0.579	0.640	-0.061	
LP5-12-1	PbO	<0.108	0.0500	0.058	
LP5-12-1	Re_2O_7	<0.0325	0.0500	-0.017	
LP5-12-1	SiO_2	35.1	34.0	1.138	3%
LP5-12-1	SnO_2	1.49	1.39	0.099	7%
LP5-12-1	SO_3	0.664	1.10	-0.436	-40%
LP5-12-1	TiO_2	1.67	1.59	0.08	5%
LP5-12-1	V_2O_5	3.28	3.15	0.13	4%
LP5-12-1	ZnO	2.29	2.31	-0.02	-1%
LP5-12-1	ZrO_2	2.63	2.77	-0.139	-5%
LP5-12-1	**Sum of Oxides**	**100**	**99.9**	**0.513**	**1%**
LP5-13	Al_2O_3	4.54	4.49	0.05	1%
LP5-13	B_2O_3	13.1	12.9	0.175	1%
LP5-13	CaO	0.259	0.0600	0.199	
LP5-13	Cl	0.343	0.430	-0.087	
LP5-13	Cr_2O_3	0.252	0.260	-0.008	
LP5-13	F	0.144	0.170	-0.026	
LP5-13	Fe_2O_3	0.830	0.850	-0.02	
LP5-13	K_2O	3.94	4.19	-0.248	-6%
LP5-13	Li_2O	<0.215	0	0.215	
LP5-13	MgO	2.69	2.60	0.091	3%
LP5-13	Na_2O	26.0	26.5	-0.484	-2%
LP5-13	NiO	<0.127	0.0300	0.097	
LP5-13	P_2O_5	0.385	0.410	-0.025	
LP5-13	PbO	<0.108	0.0300	0.078	
LP5-13	Re_2O_7	<0.0325	0.0300	0.003	
LP5-13	SiO_2	34.2	34.1	0.129	0%
LP5-13	SnO_2	0.767	0.780	-0.013	
LP5-13	SO_3	0.744	0.710	0.034	
LP5-13	TiO_2	1.04	1.03	0.008	1%
LP5-13	V_2O_5	4.62	4.56	0.059	1%
LP5-13	ZnO	1.63	1.65	-0.022	-1%
LP5-13	ZrO_2	3.86	4.18	-0.317	-8%
LP5-13	**Sum of Oxides**	**99.8**	**100**	**-0.112**	**0%**

Table A-7. Comparison of Measured versus Target Compositions (continued)

PNNL ID	Oxide	Mean Measured (wt.%)	Target (wt.%)	Difference of Measured versus Target	% Difference Measured versus Target
LP5-14	Al_2O_3	4.45	4.51	-0.056	-1%
LP5-14	B_2O_3	6.62	6.68	-0.055	-1%
LP5-14	CaO	0.591	0.440	0.151	
LP5-14	Cl	0.483	0.670	-0.187	
LP5-14	Cr_2O_3	0.389	0.400	-0.011	
LP5-14	F	0.223	0.270	-0.047	
LP5-14	Fe_2O_3	<0.143	0.120	0.023	
LP5-14	K_2O	3.75	4.09	-0.341	-8%
LP5-14	Li_2O	<0.215	0	0.215	
LP5-14	MgO	1.63	1.55	0.078	5%
LP5-14	Na_2O	23.4	23.7	-0.346	-1%
LP5-14	NiO	<0.127	0.0500	0.077	
LP5-14	P_2O_5	0.581	0.640	-0.059	
LP5-14	PbO	<0.108	0.0500	0.058	
LP5-14	Re_2O_7	<0.0325	0.0500	-0.017	
LP5-14	SiO_2	38.9	38.6	0.335	1%
LP5-14	SnO_2	3.54	3.43	0.106	3%
LP5-14	SO_3	1.12	1.10	0.022	2%
LP5-14	TiO_2	1.57	1.59	-0.016	-1%
LP5-14	V_2O_5	4.33	4.25	0.079	2%
LP5-14	ZnO	4.31	4.40	-0.093	-2%
LP5-14	ZrO_2	3.19	3.42	-0.229	-7%
LP5-14	**Sum of Oxides**	**99.7**	**100**	**-0.312**	**0%**
LP5-15	Al_2O_3	12.9	13.3	-0.414	-3%
LP5-15	B_2O_3	9.49	9.06	0.431	5%
LP5-15	CaO	0.357	0.340	0.017	
LP5-15	Cl	1.11	0.190	0.915	482%
LP5-15	Cr_2O_3	0.0740	0.120	-0.046	
LP5-15	F	0.0649	0.0800	-0.015	
LP5-15	Fe_2O_3	0.879	0.950	-0.071	
LP5-15	K_2O	4.40	4.82	-0.423	-9%
LP5-15	Li_2O	<0.215	0	0.215	
LP5-15	MgO	1.99	1.96	0.034	2%
LP5-15	Na_2O	25.2	26.0	-0.826	-3%
LP5-15	NiO	<0.127	0.0100	0.117	
LP5-15	P_2O_5	<0.229	0.180	0.049	
LP5-15	PbO	<0.108	0.0100	0.098	
LP5-15	Re_2O_7	<0.0325	0.0100	0.023	
LP5-15	SiO_2	35.8	33.7	2.08	6%
LP5-15	SnO_2	0.377	0.400	-0.023	
LP5-15	SO_3	0.240	0.310	-0.07	
LP5-15	TiO_2	0.461	0.460	0.001	
LP5-15	V_2O_5	2.56	2.57	-0.013	0%
LP5-15	ZnO	<0.124	0.0200	0.104	
LP5-15	ZrO_2	5.18	5.51	-0.333	-6%
LP5-15	**Sum of Oxides**	**102**	**100**	**1.851**	**2%**

Table A-7. Comparison of Measured versus Target Compositions (continued)

PNNL ID	Oxide	Mean Measured (wt.%)	Target (wt.%)	Difference of Measured versus Target	% Difference Measured versus Target
LP5-16-MOD1	Al_2O_3	8.09	7.93	0.157	2%
LP5-16-MOD1	B_2O_3	7.43	7.22	0.207	3%
LP5-16-MOD1	CaO	8.56	8.76	-0.204	-2%
LP5-16-MOD1	Cl	0.369	0.431	-0.062	
LP5-16-MOD1	Cr_2O_3	0.275	0.261	0.014	
LP5-16-MOD1	F	0.129	0.172	-0.043	
LP5-16-MOD1	Fe_2O_3	0.637	0.630	0.007	
LP5-16-MOD1	K_2O	0.552	0.640	-0.088	
LP5-16-MOD1	Li_2O	<0.215	0	0.215	
LP5-16-MOD1	MgO	4.71	4.46	0.245	6%
LP5-16-MOD1	Na_2O	24.1	25.2	-1.138	-5%
LP5-16-MOD1	NiO	0.179	0.0333	0.146	
LP5-16-MOD1	P_2O_5	0.373	0.413	-0.04	
LP5-16-MOD1	PbO	<0.108	0.0333	0.074	
LP5-16-MOD1	Re_2O_7	<0.0325	0.0333	-0.001	
LP5-16-MOD1	SiO_2	34.7	33.5	1.21	4%
LP5-16-MOD1	SnO_2	4.27	4.19	0.082	2%
LP5-16-MOD1	SO_3	0.616	0.708	-0.092	
LP5-16-MOD1	TiO_2	1.04	1.03	0.014	1%
LP5-16-MOD1	V_2O_5	0.806	0.800	0.006	
LP5-16-MOD1	ZnO	0.350	0.350	0	
LP5-16-MOD1	ZrO_2	3.01	3.18	-0.168	-5%
LP5-16-MOD1	**Sum of Oxides**	**101**	**100**	**0.543**	**1%**
LP5-17	Al_2O_3	3.55	3.56	-0.012	0%
LP5-17	B_2O_3	7.74	7.74	0.004	0%
LP5-17	CaO	4.97	4.81	0.164	3%
LP5-17	Cl	0.825	0.250	0.575	230%
LP5-17	Cr_2O_3	0.142	0.150	-0.008	
LP5-17	F	0.0845	0.100	-0.016	
LP5-17	Fe_2O_3	0.692	0.710	-0.018	
LP5-17	K_2O	3.44	3.98	-0.541	-14%
LP5-17	Li_2O	<0.215	0	0.215	
LP5-17	MgO	1.53	1.52	0.01	1%
LP5-17	Na_2O	20.9	22.0	-1.072	-5%
LP5-17	NiO	<0.127	0.0200	0.107	
LP5-17	P_2O_5	<0.231	0.240	-0.009	
LP5-17	PbO	<0.108	0.0200	0.088	
LP5-17	Re_2O_7	<0.0325	0.0200	0.013	
LP5-17	SiO_2	35.0	33.8	1.231	4%
LP5-17	SnO_2	4.27	4.21	0.059	1%
LP5-17	SO_3	0.404	0.410	-0.006	
LP5-17	TiO_2	0.595	0.600	-0.005	
LP5-17	V_2O_5	5.25	5.15	0.098	2%
LP5-17	ZnO	5.72	5.68	0.043	1%
LP5-17	ZrO_2	4.73	5.02	-0.285	-6%
LP5-17	**Sum of Oxides**	**101**	**100**	**0.633**	**1%**

Table A-7. Comparison of Measured versus Target Compositions (continued)

PNNL ID	Oxide	Mean Measured (wt.%)	Target (wt.%)	Difference of Measured versus Target	% Difference Measured versus Target
LP5-18	Al_2O_3	5.74	5.76	-0.021	0%
LP5-18	B_2O_3	9.57	9.41	0.161	2%
LP5-18	CaO	0.487	0.420	0.067	
LP5-18	Cl	0.395	0.520	-0.125	
LP5-18	Cr_2O_3	0.316	0.310	0.006	
LP5-18	F	0.174	0.210	-0.036	
LP5-18	Fe_2O_3	0.592	0.520	0.072	
LP5-18	K_2O	1.80	1.89	-0.086	-5%
LP5-18	Li_2O	<0.215	0	0.215	
LP5-18	MgO	5.20	5.01	0.193	4%
LP5-18	Na_2O	23.9	24.5	-0.607	-2%
LP5-18	NiO	<0.127	0.0400	0.087	
LP5-18	P_2O_5	0.483	0.500	-0.017	
LP5-18	PbO	<0.108	0.0400	0.068	
LP5-18	Re_2O_7	<0.0325	0.0400	-0.007	
LP5-18	SiO_2	39.5	39.1	0.37	1%
LP5-18	SnO_2	0.256	0.190	0.066	
LP5-18	SO_3	0.903	0.850	0.053	
LP5-18	TiO_2	1.25	1.23	0.018	1%
LP5-18	V_2O_5	3.69	3.62	0.071	2%
LP5-18	ZnO	5.79	5.68	0.111	2%
LP5-18	ZrO_2	0.167	0.160	0.007	
LP5-18	**Sum of Oxides**	**101**	**100**	**0.668**	**1%**
LP5-19	Al_2O_3	3.75	3.81	-0.059	-2%
LP5-19	B_2O_3	10.5	10.4	0.049	0%
LP5-19	CaO	6.71	6.44	0.273	4%
LP5-19	Cl	0.246	0.330	-0.084	
LP5-19	Cr_2O_3	0.179	0.200	-0.021	
LP5-19	F	0.110	0.130	-0.02	
LP5-19	Fe_2O_3	<0.143	0.0400	0.103	
LP5-19	K_2O	5.65	5.58	0.07	1%
LP5-19	Li_2O	<0.215	0	0.215	
LP5-19	MgO	4.60	4.62	-0.022	0%
LP5-19	Na_2O	22.2	22.3	-0.092	0%
LP5-19	NiO	<0.127	0.0300	0.097	
LP5-19	P_2O_5	0.272	0.320	-0.048	
LP5-19	PbO	<0.108	0.0300	0.078	
LP5-19	Re_2O_7	<0.0325	0.0300	0.003	
LP5-19	SiO_2	35.2	34.6	0.645	2%
LP5-19	SnO_2	1.49	1.53	-0.038	-2%
LP5-19	SO_3	0.578	0.540	0.038	
LP5-19	TiO_2	0.753	0.790	-0.037	
LP5-19	V_2O_5	1.25	1.31	-0.055	-4%
LP5-19	ZnO	5.30	5.38	-0.08	-1%
LP5-19	ZrO_2	1.46	1.55	-0.091	-6%
LP5-19	**Sum of Oxides**	**101**	**100**	**0.921**	**1%**

Table A-7. Comparison of Measured versus Target Compositions (continued)

PNNL ID	Oxide	Mean Measured (wt.%)	Target (wt.%)	Difference of Measured versus Target	% Difference Measured versus Target
LP5-20	Al_2O_3	4.06	3.88	0.178	5%
LP5-20	B_2O_3	14.2	13.5	0.658	5%
LP5-20	CaO	1.43	1.37	0.058	4%
LP5-20	Cl	0.600	0.660	-0.061	
LP5-20	Cr_2O_3	0.389	0.400	-0.011	
LP5-20	F	0.227	0.260	-0.033	
LP5-20	Fe_2O_3	0.657	0.660	-0.003	
LP5-20	K_2O	2.50	2.64	-0.143	-5%
LP5-20	Li_2O	<0.215	0	0.215	
LP5-20	MgO	3.03	2.90	0.135	5%
LP5-20	Na_2O	24.9	25.5	-0.596	-2%
LP5-20	NiO	<0.127	0.0500	0.077	
LP5-20	P_2O_5	0.572	0.630	-0.058	
LP5-20	PbO	<0.108	0.0500	0.058	
LP5-20	Re_2O_7	<0.0325	0.0500	-0.017	
LP5-20	SiO_2	39.8	38.8	1.044	3%
LP5-20	SnO_2	3.82	3.73	0.088	2%
LP5-20	SO_3	1.12	1.08	0.042	4%
LP5-20	TiO_2	1.56	1.56	0.005	0%
LP5-20	V_2O_5	0.221	0.210	0.011	
LP5-20	ZnO	0.478	0.470	0.008	
LP5-20	ZrO_2	1.51	1.56	-0.054	-3%
LP5-20	**Sum of Oxides**	**102**	**100**	**1.601**	**2%**
LP5-21	Al_2O_3	5.92	5.86	0.064	1%
LP5-21	B_2O_3	13.6	13.2	0.41	3%
LP5-21	CaO	4.87	4.73	0.143	3%
LP5-21	Cl	0.491	0.610	-0.119	
LP5-21	Cr_2O_3	0.352	0.370	-0.018	
LP5-21	F	0.200	0.250	-0.051	
LP5-21	Fe_2O_3	<0.143	0.110	0.033	
LP5-21	K_2O	4.44	4.62	-0.178	-4%
LP5-21	Li_2O	<0.215	0	0.215	
LP5-21	MgO	2.97	2.97	-0.002	0%
LP5-21	Na_2O	21.8	22.1	-0.262	-1%
LP5-21	NiO	<0.127	0.0500	0.077	
LP5-21	P_2O_5	0.530	0.590	-0.06	
LP5-21	PbO	<0.108	0.0500	0.058	
LP5-21	Re_2O_7	<0.0325	0.0500	-0.017	
LP5-21	SiO_2	35.6	35.0	0.619	2%
LP5-21	SnO_2	1.17	1.23	-0.059	-5%
LP5-21	SO_3	0.998	1.01	-0.012	-1%
LP5-21	TiO_2	1.43	1.46	-0.028	-2%
LP5-21	V_2O_5	3.39	3.40	-0.013	0%
LP5-21	ZnO	1.52	1.51	0.015	1%
LP5-21	ZrO_2	0.736	0.770	-0.034	
LP5-21	**Sum of Oxides**	**101**	**99.9**	**0.78**	**1%**

Table A-7. Comparison of Measured versus Target Compositions (continued)

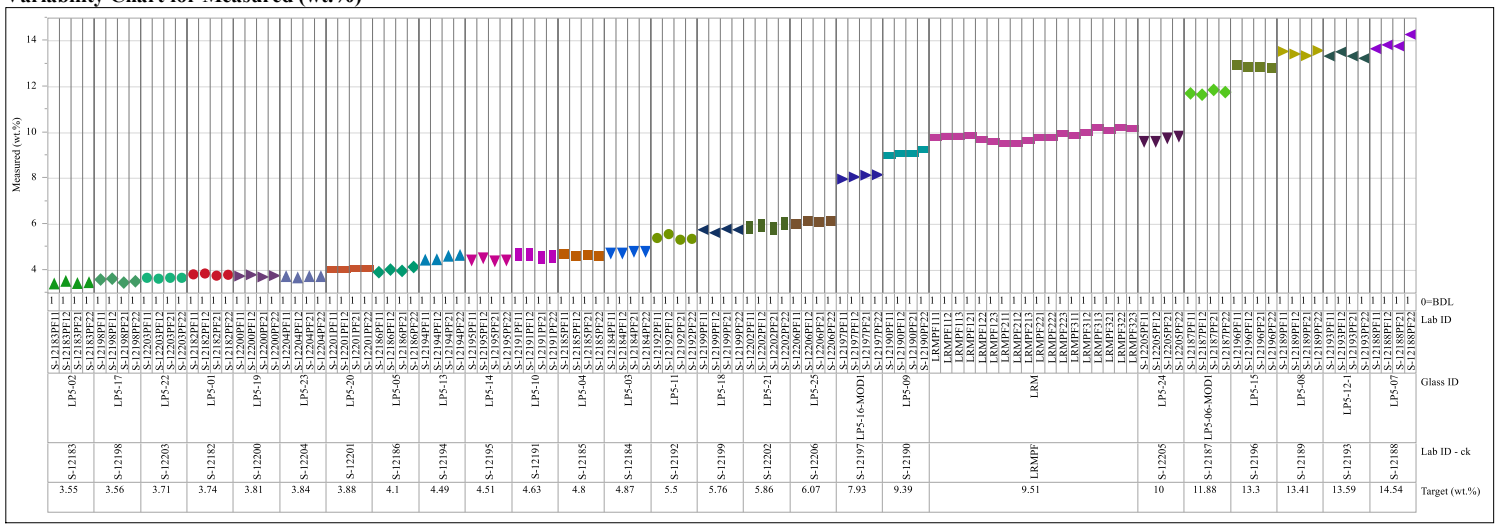
PNNL ID	Oxide	Mean Measured (wt.%)	Target (wt.%)	Difference of Measured versus Target	% Difference Measured versus Target
LP5-22	Al_2O_3	3.66	3.71	-0.054	-1%
LP5-22	B_2O_3	12.7	12.6	0.135	1%
LP5-22	CaO	0.414	0.310	0.104	
LP5-22	Cl	0.169	0.200	-0.031	
LP5-22	Cr_2O_3	0.109	0.120	-0.011	
LP5-22	F	0.0646	0.0800	-0.015	
LP5-22	Fe_2O_3	0.687	0.740	-0.053	
LP5-22	K_2O	0.401	0.320	0.081	
LP5-22	Li_2O	<0.215	0	0.215	
LP5-22	MgO	4.53	4.66	-0.133	-3%
LP5-22	Na_2O	24.5	24.7	-0.166	-1%
LP5-22	NiO	<0.127	0.0200	0.107	
LP5-22	P_2O_5	<0.229	0.190	0.039	
LP5-22	PbO	<0.108	0.0200	0.088	
LP5-22	Re_2O_7	<0.0325	0.0200	0.013	
LP5-22	SiO_2	48.7	48.0	0.723	2%
LP5-22	SnO_2	0.973	1.06	-0.087	-8%
LP5-22	SO_3	0.365	0.330	0.035	
LP5-22	TiO_2	0.466	0.480	-0.014	
LP5-22	V_2O_5	0.608	0.630	-0.022	
LP5-22	ZnO	<0.124	0.0600	0.064	
LP5-22	ZrO_2	1.65	1.78	-0.132	-7%
LP5-22	**Sum of Oxides**	**101**	**100**	**0.885**	**1%**
LP5-23	Al_2O_3	3.71	3.84	-0.132	-3%
LP5-23	B_2O_3	6.41	6.37	0.038	1%
LP5-23	CaO	6.37	6.30	0.07	1%
LP5-23	Cl	0.190	0.220	-0.03	
LP5-23	Cr_2O_3	0.119	0.130	-0.011	
LP5-23	F	0.0703	0.0900	-0.02	
LP5-23	Fe_2O_3	0.174	0.160	0.014	
LP5-23	K_2O	1.79	1.74	0.055	3%
LP5-23	Li_2O	<0.215	0	0.215	
LP5-23	MgO	2.36	2.35	0.013	1%
LP5-23	Na_2O	24.1	23.8	0.262	1%
LP5-23	NiO	<0.127	0.0200	0.107	
LP5-23	P_2O_5	<0.229	0.210	0.019	
LP5-23	PbO	<0.108	0.0200	0.088	
LP5-23	Re_2O_7	<0.0325	0.0200	0.013	
LP5-23	SiO_2	49.1	49.0	0.097	0%
LP5-23	SnO_2	1.36	1.38	-0.022	-2%
LP5-23	SO_3	0.371	0.350	0.021	
LP5-23	TiO_2	0.505	0.510	-0.005	
LP5-23	V_2O_5	2.70	2.72	-0.02	-1%
LP5-23	ZnO	0.453	0.440	0.013	
LP5-23	ZrO_2	0.370	0.390	-0.02	
LP5-23	**Sum of Oxides**	**101**	**100**	**0.766**	**1%**

Table A-7. Comparison of Measured versus Target Compositions (continued)

PNNL ID	Oxide	Mean Measured (wt.%)	Target (wt.%)	Difference of Measured versus Target	% Difference Measured versus Target
LP5-24	Al_2O_3	9.71	10.0	-0.288	-3%
LP5-24	B_2O_3	9.53	9.50	0.031	0%
LP5-24	CaO	5.14	5.00	0.135	3%
LP5-24	Cl	1.06	0.210	0.853	406%
LP5-24	Cr_2O_3	0.378	0.450	-0.072	
LP5-24	F	0.270	0.320	-0.05	
LP5-24	Fe_2O_3	0.575	0.600	-0.025	
LP5-24	K_2O	1.03	1.00	0.035	3%
LP5-24	Li_2O	<0.215	0	0.215	
LP5-24	MgO	0.664	0.650	0.014	
LP5-24	Na_2O	22.4	23.0	-0.623	-3%
LP5-24	NiO	<0.127	0	0.127	
LP5-24	P_2O_5	0.569	0.680	-0.111	
LP5-24	PbO	<0.108	0	0.108	
LP5-24	Re_2O_7	<0.0325	0	0.033	
LP5-24	SiO_2	39.3	38.8	0.51	1%
LP5-24	SnO_2	1.48	1.50	-0.018	-1%
LP5-24	SO_3	0.396	0.500	-0.104	
LP5-24	TiO_2	<0.167	0	0.167	
LP5-24	V_2O_5	0.977	1.00	-0.023	-2%
LP5-24	ZnO	2.82	2.80	0.023	1%
LP5-24	ZrO_2	3.70	4.00	-0.302	-8%
LP5-24	**Sum of Oxides**	**101**	**100**	**0.633**	**1%**
LP5-25	Al_2O_3	6.11	6.07	0.038	1%
LP5-25	B_2O_3	10.4	10.1	0.302	3%
LP5-25	CaO	5.25	5.11	0.144	3%
LP5-25	Cl	0.0307	0.0500	-0.019	
LP5-25	Cr_2O_3	<0.0365	0.0100	0.027	
LP5-25	F	0.241	0.340	-0.099	
LP5-25	Fe_2O_3	5.13	5.42	-0.287	-5%
LP5-25	K_2O	<0.122	0.0800	0.042	
LP5-25	Li_2O	2.06	2.51	-0.447	-18%
LP5-25	MgO	1.45	1.51	-0.062	-4%
LP5-25	Na_2O	14.4	14.4	0.024	0%
LP5-25	NiO	<0.127	0.0260	0.101	
LP5-25	P_2O_5	<0.229	0.0700	0.159	
LP5-25	PbO	<0.108	0.0100	0.098	
LP5-25	Re_2O_7	<0.0325	0.100	-0.067	
LP5-25	SiO_2	47.8	46.6	1.16	2%
LP5-25	SnO_2	<0.127	0	0.127	
LP5-25	SO_3	0.182	0.320	-0.138	
LP5-25	TiO_2	1.09	1.14	-0.047	-4%
LP5-25	V_2O_5	<0.179	0	0.179	
LP5-25	ZnO	3.06	3.07	-0.011	0%
LP5-25	ZrO_2	2.86	3.03	-0.17	-6%
LP5-25	**Sum of Oxides**	**101**	**99.9**	**1.05**	**1%**

Exhibit A-1. Plots of Oxide Measurements by Glass Identifier by Target Concentrations

Analyte=Al_2O_3, Prep Method=PF
Variability Chart for Measured (wt.%)



Analyte=B_2O_3, Prep Method=PF
Variability Chart for Measured (wt.%)

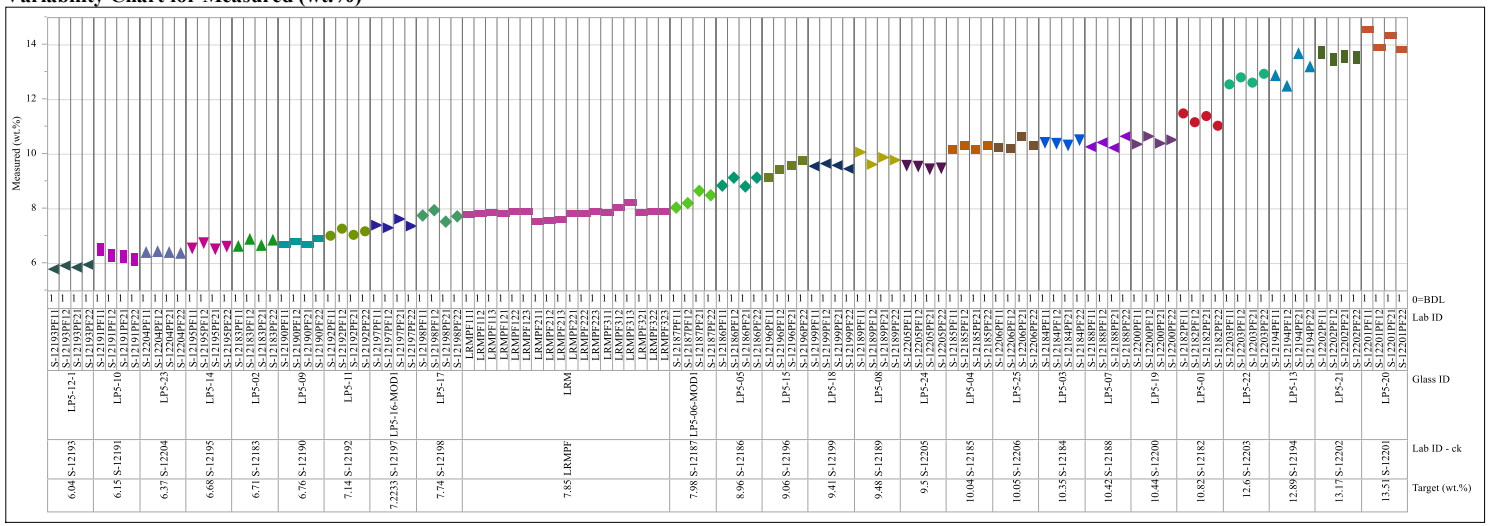
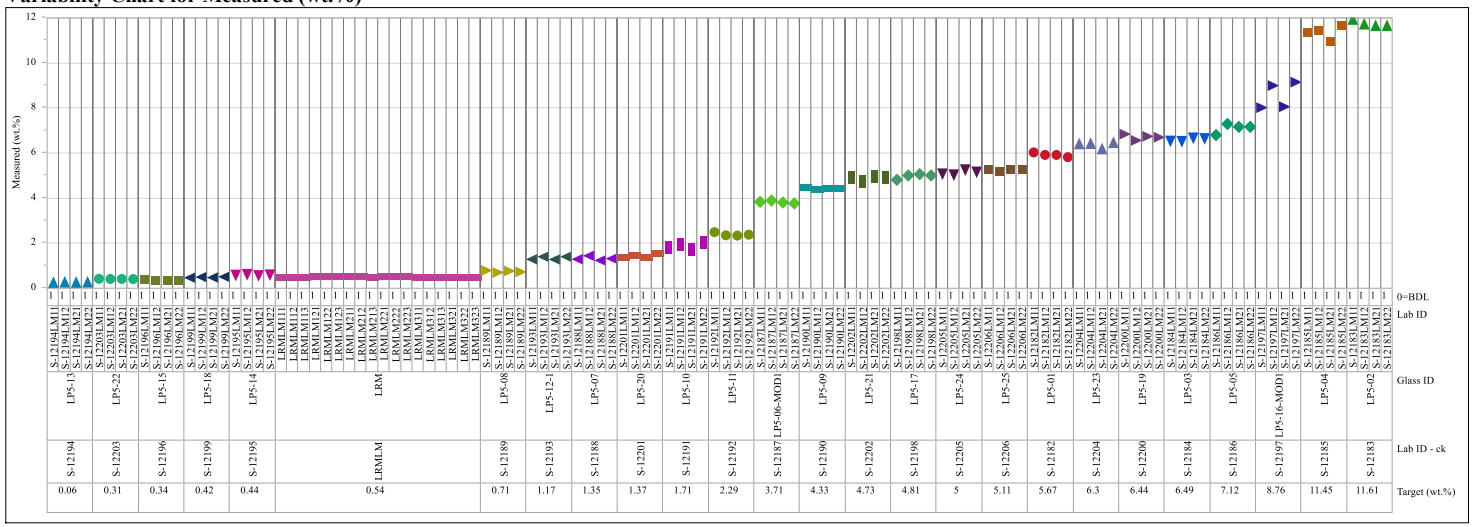


Exhibit A-1. Plots of Oxide Measurements by Glass Identifier by Target Concentrations (continued)

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



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

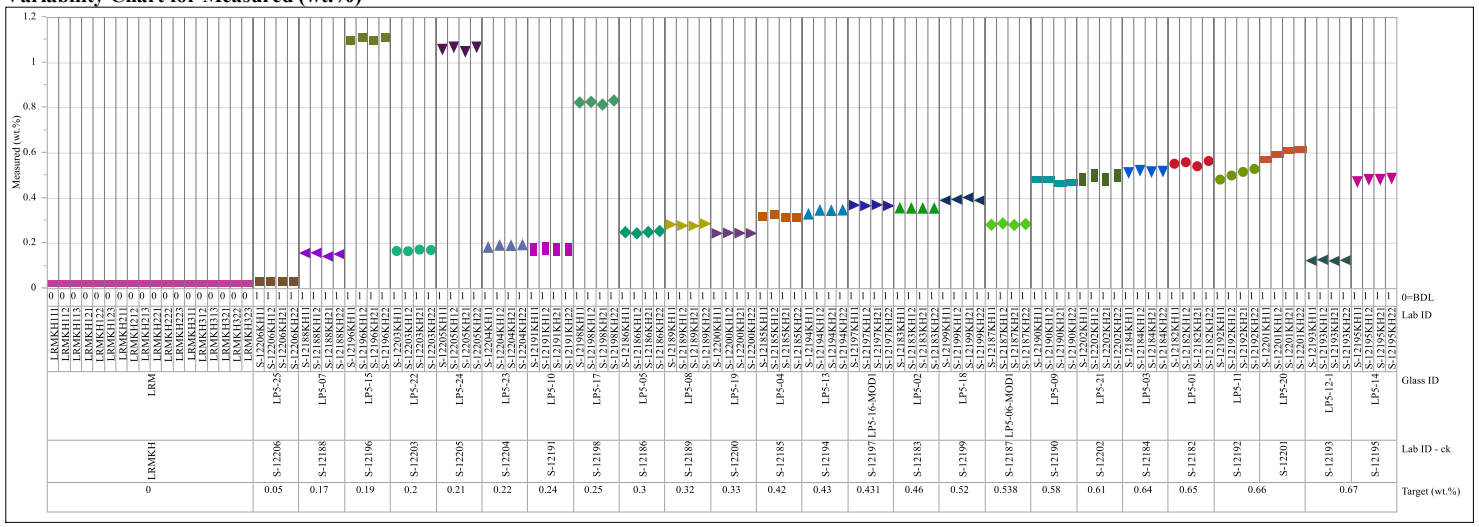
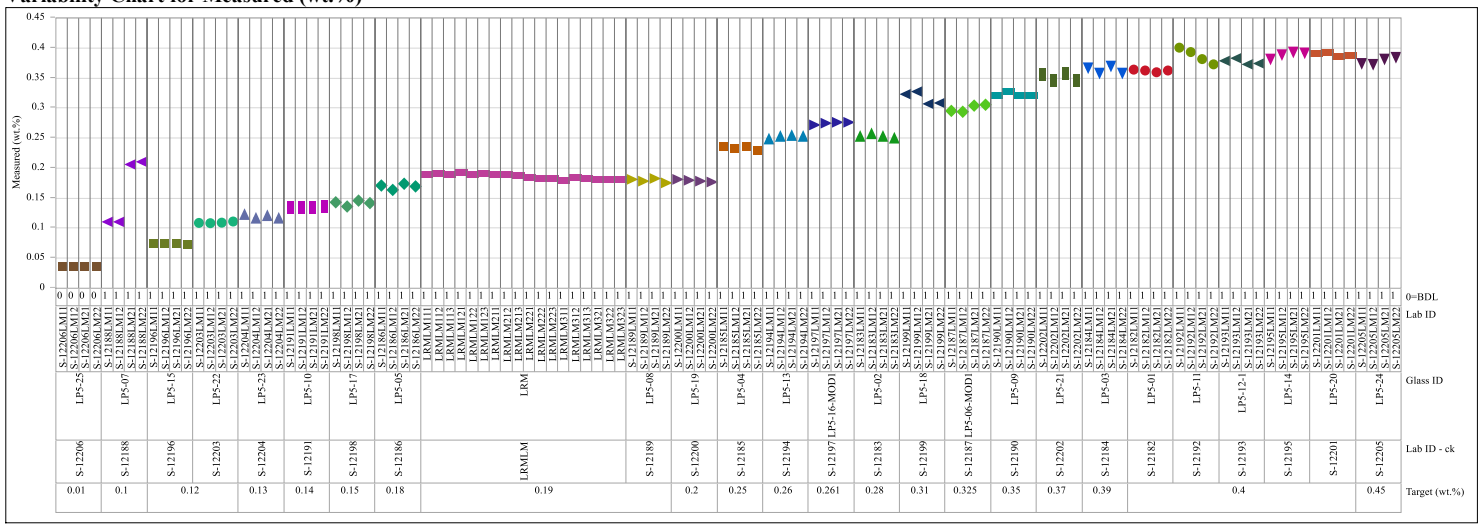


Exhibit A-1. Plots of Oxide Measurements by Glass Identifier by Target Concentrations (continued)

Analyte=Cr_2O_3, Prep Method=LM
Variability Chart for Measured (wt.%)



Analyte=F^-, Prep Method=KH
Variability Chart for Measured (wt.%)

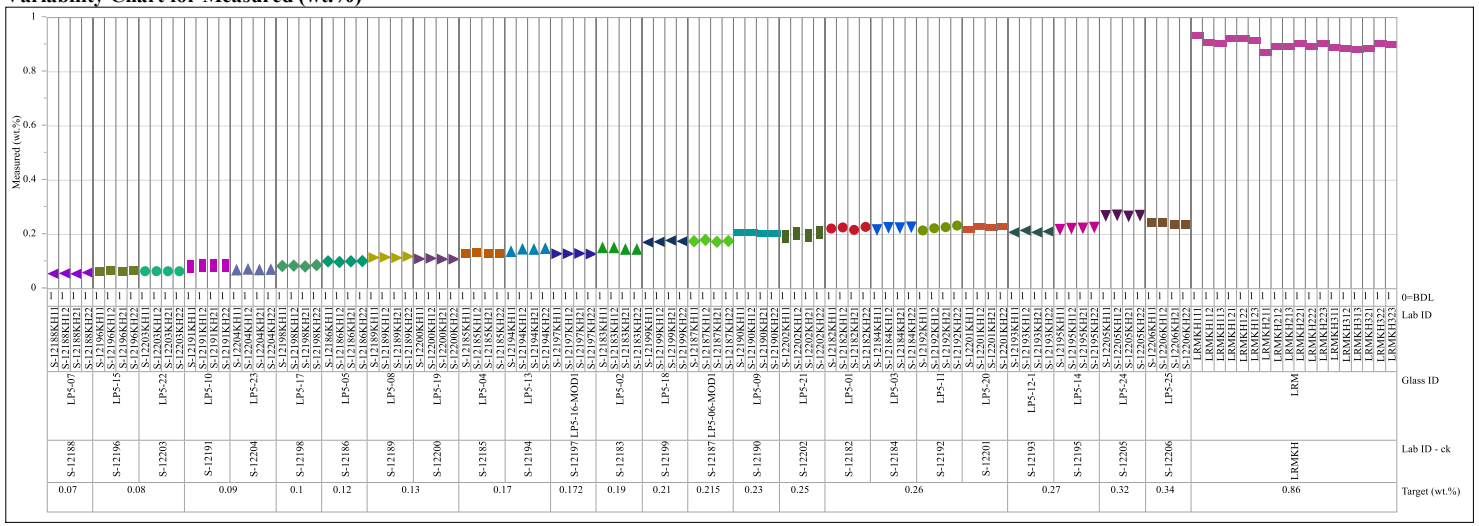
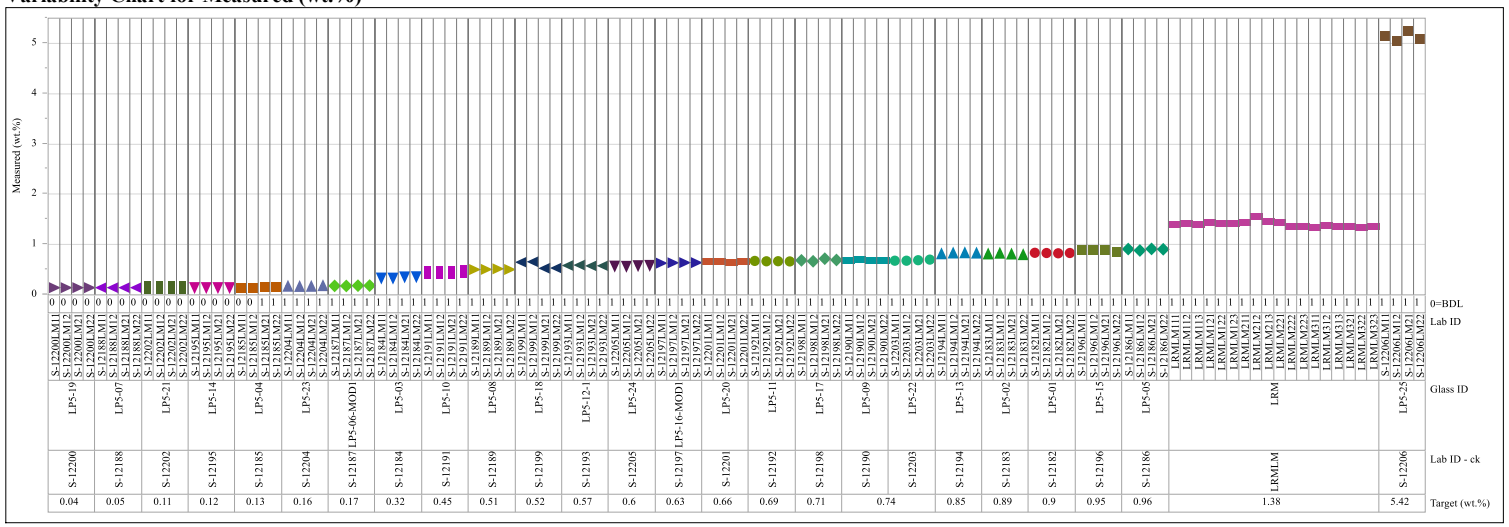


Exhibit A-1. Plots of Oxide Measurements by Glass Identifier by Target Concentrations (continued)

Analyte=Fe_2O_3, Prep Method=LM
Variability Chart for Measured (wt.%)



Analyte=K_2O, Prep Method=LM
Variability Chart for Measured (wt.%)

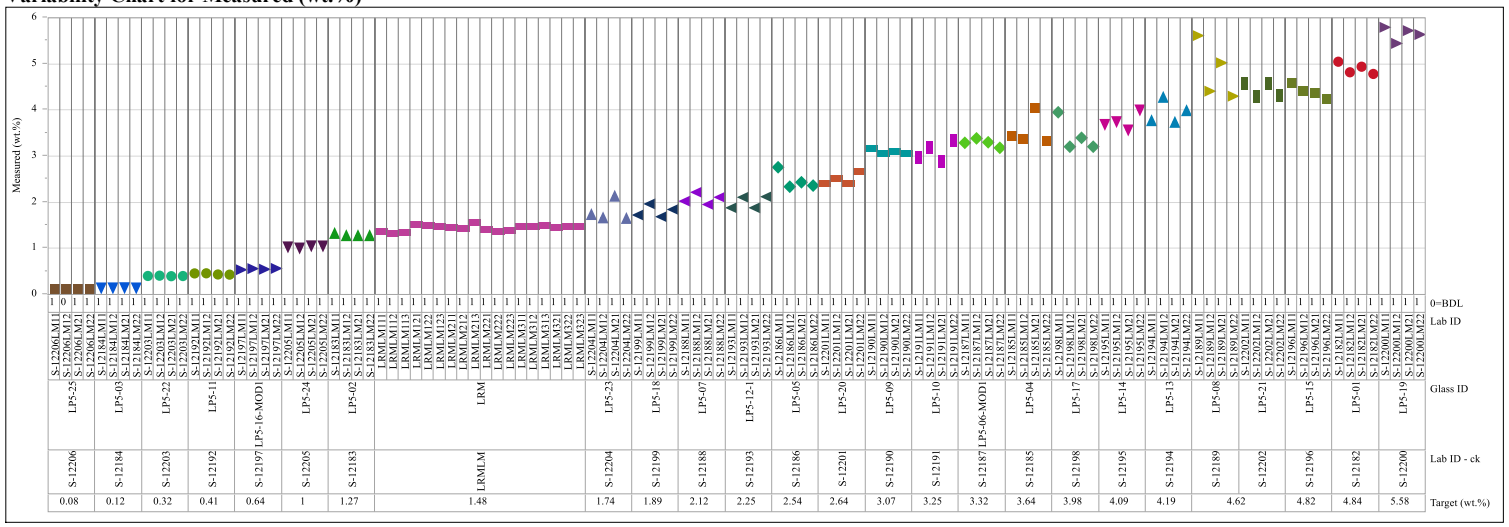
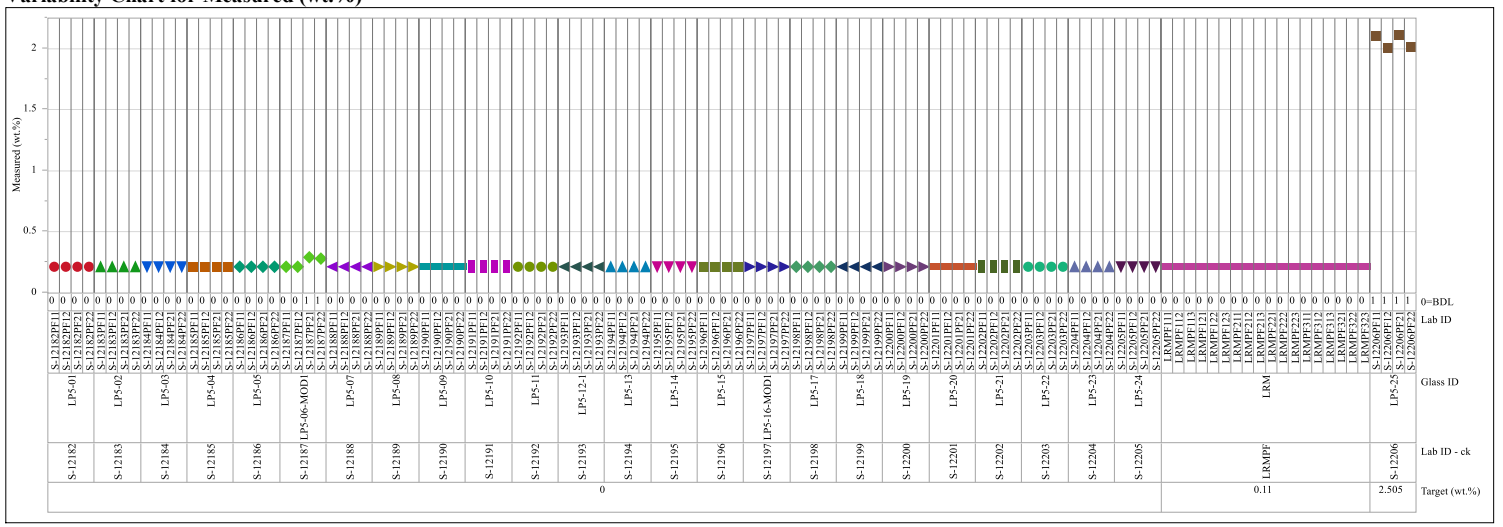


Exhibit A-1. Plots of Oxide Measurements by Glass Identifier by Target Concentrations (continued)

Analyte=Li_2O, Prep Method=PF
Variability Chart for Measured (wt.%)



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

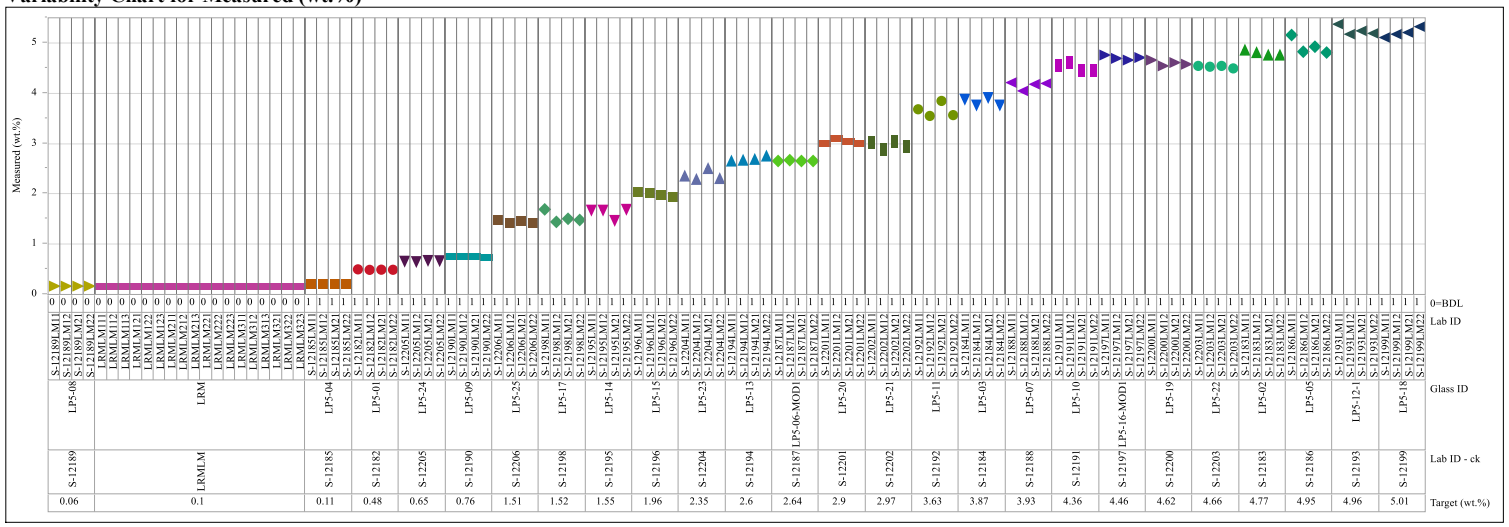
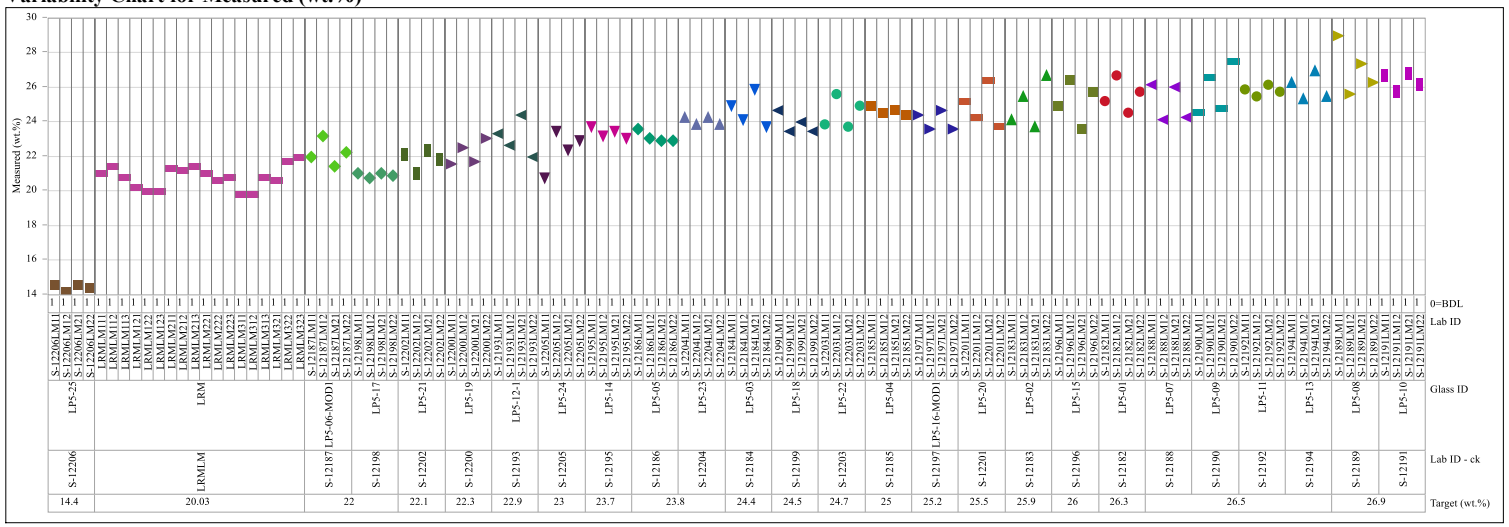


Exhibit A-1. Plots of Oxide Measurements by Glass Identifier by Target Concentrations (continued)

Analyte=Na_2O, Prep Method=LM
Variability Chart for Measured (wt.%)



Analyte=NiO, Prep Method=LM
Variability Chart for Measured (wt.%)

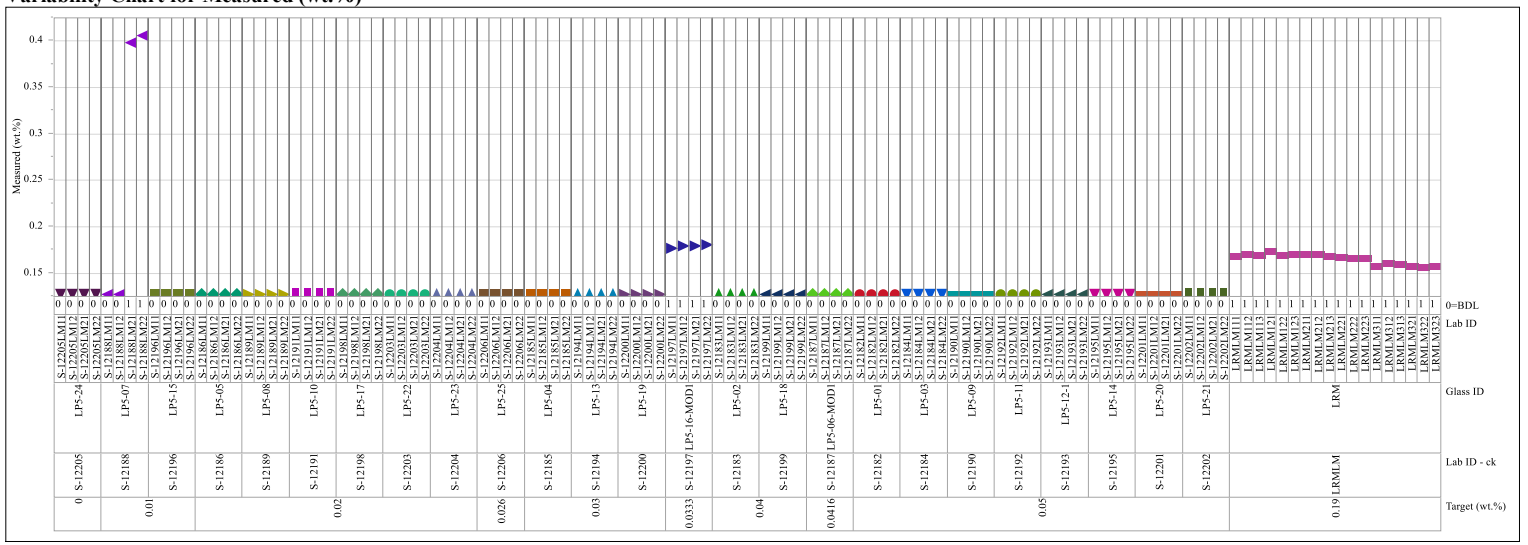
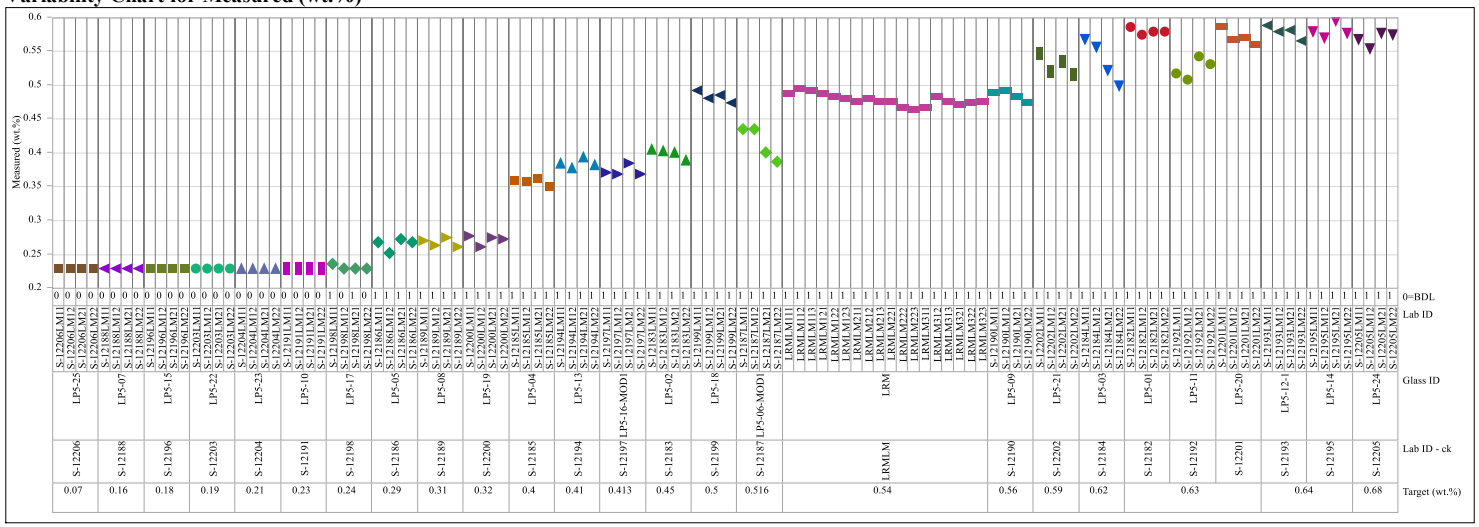


Exhibit A-1. Plots of Oxide Measurements by Glass Identifier by Target Concentrations (continued)

Analyte=P_2O_5, Prep Method=LM
Variability Chart for Measured (wt.%)



Analyte=PbO, Prep Method=LM
Variability Chart for Measured (wt.%)

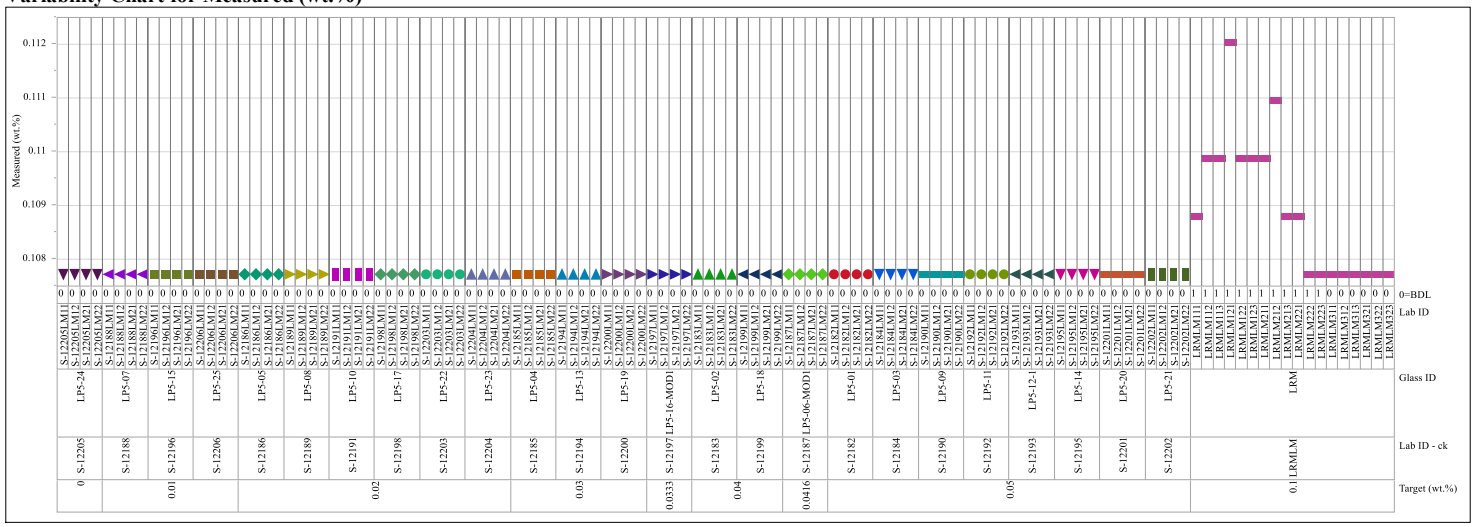
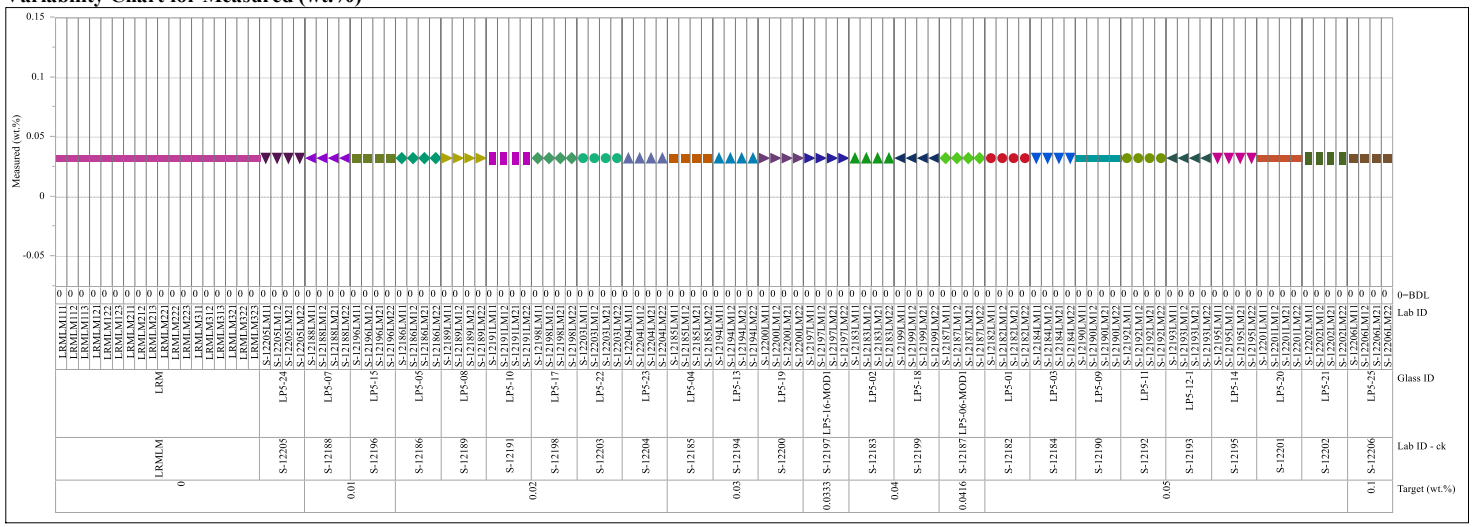


Exhibit A-1. Plots of Oxide Measurements by Glass Identifier by Target Concentrations (continued)

Analyte=Re_2O_7, Prep Method=LM
Variability Chart for Measured (wt.%)



Analyte=SO_3, Prep Method=LM
Variability Chart for Measured (wt.%)

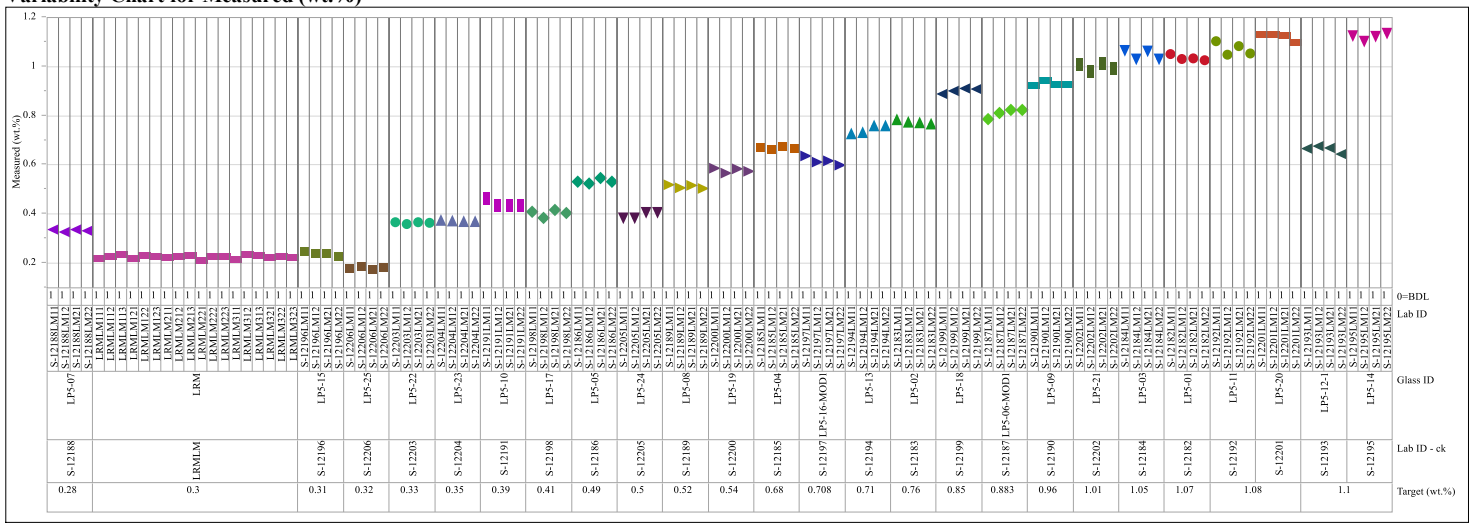
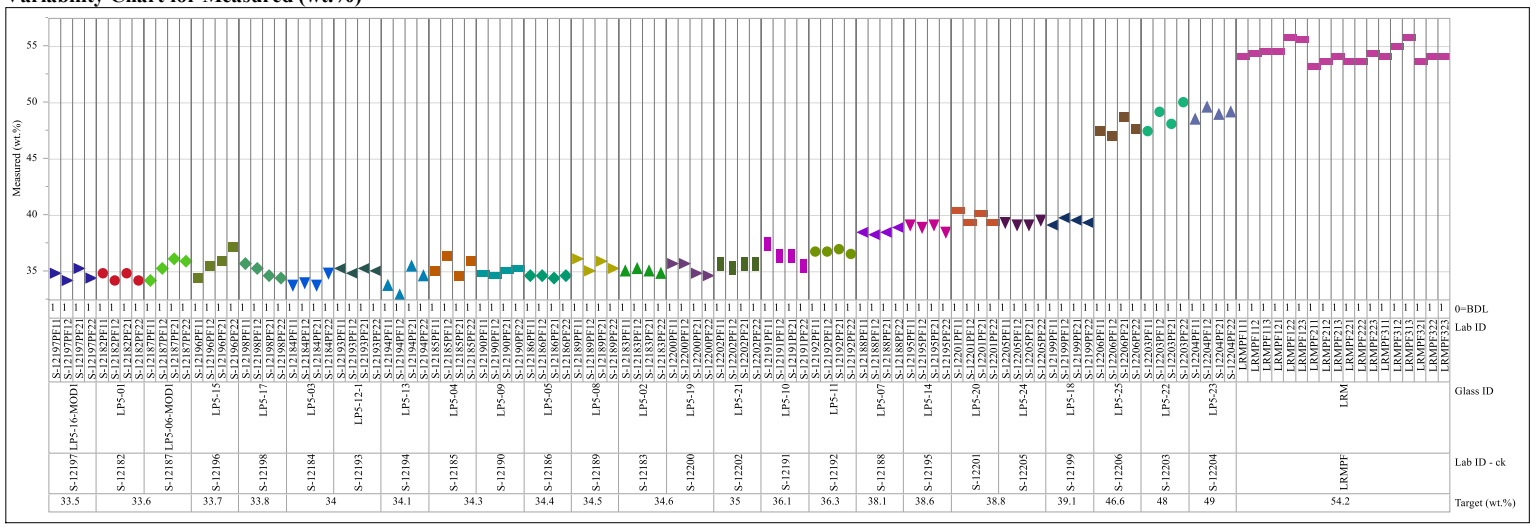


Exhibit A-1. Plots of Oxide Measurements by Glass Identifier by Target Concentrations (continued)

Analyte=SiO_2, Prep Method=PF
Variability Chart for Measured (wt.%)



Analyte=SnO_2, Prep Method=LM
Variability Chart for Measured (wt.%)

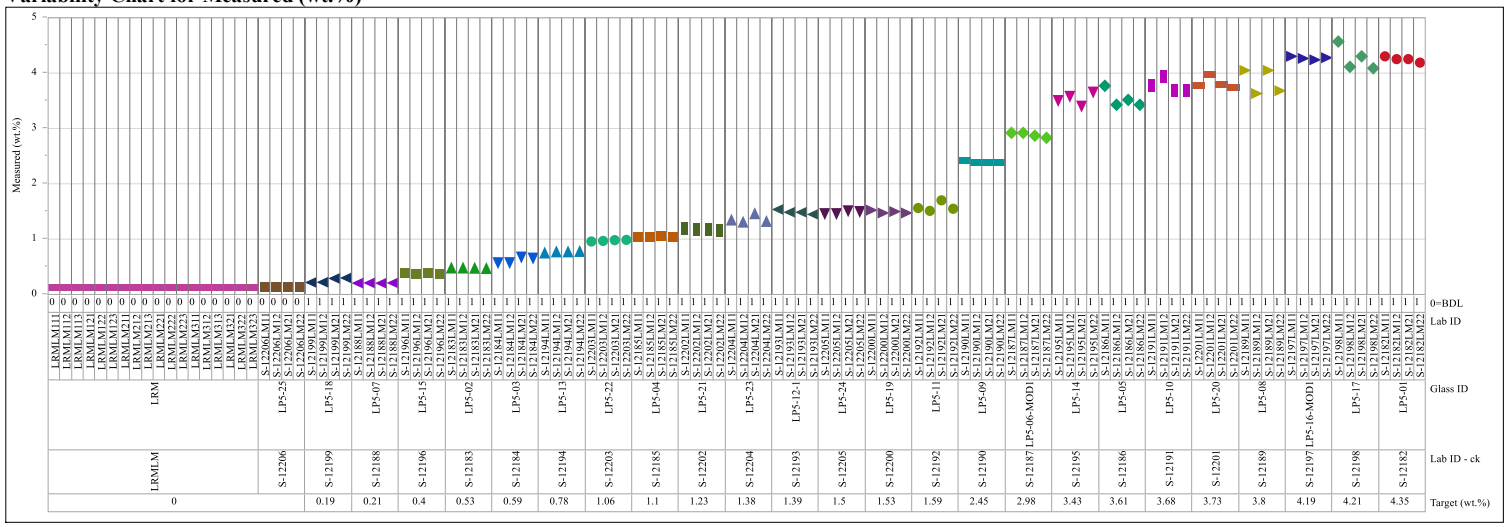
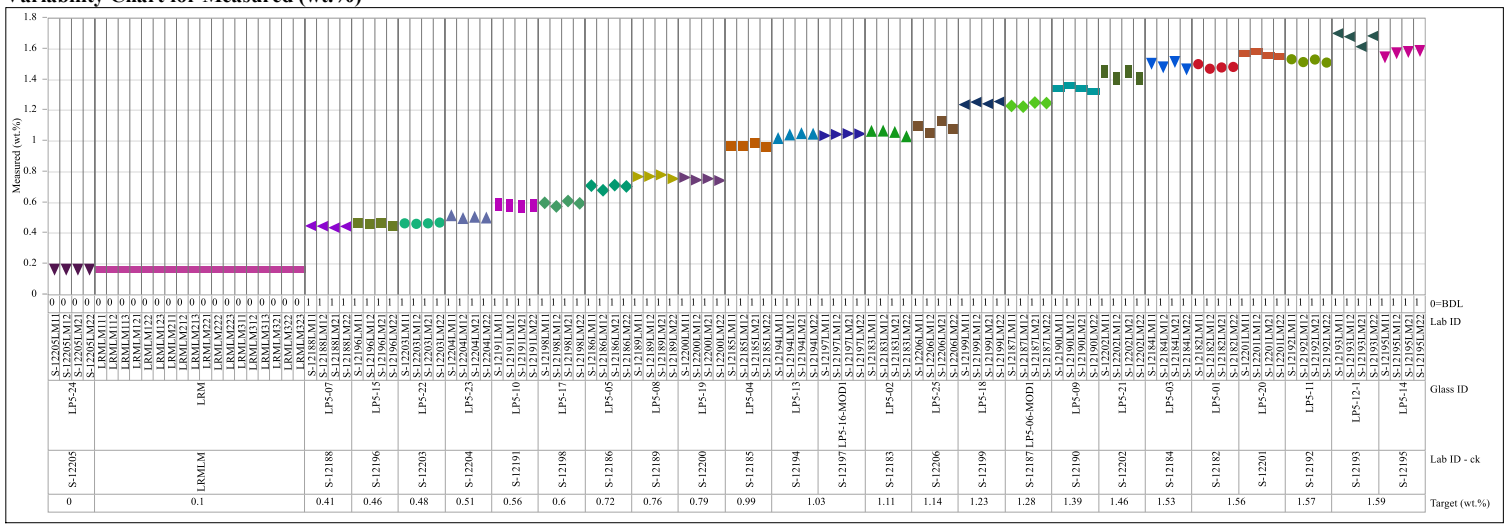


Exhibit A-1. Plots of Oxide Measurements by Glass Identifier by Target Concentrations (continued)

Analyte=TiO_2, Prep Method=LM
Variability Chart for Measured (wt.%)



Analyte=V_2O_5, Prep Method=LM
Variability Chart for Measured (wt.%)

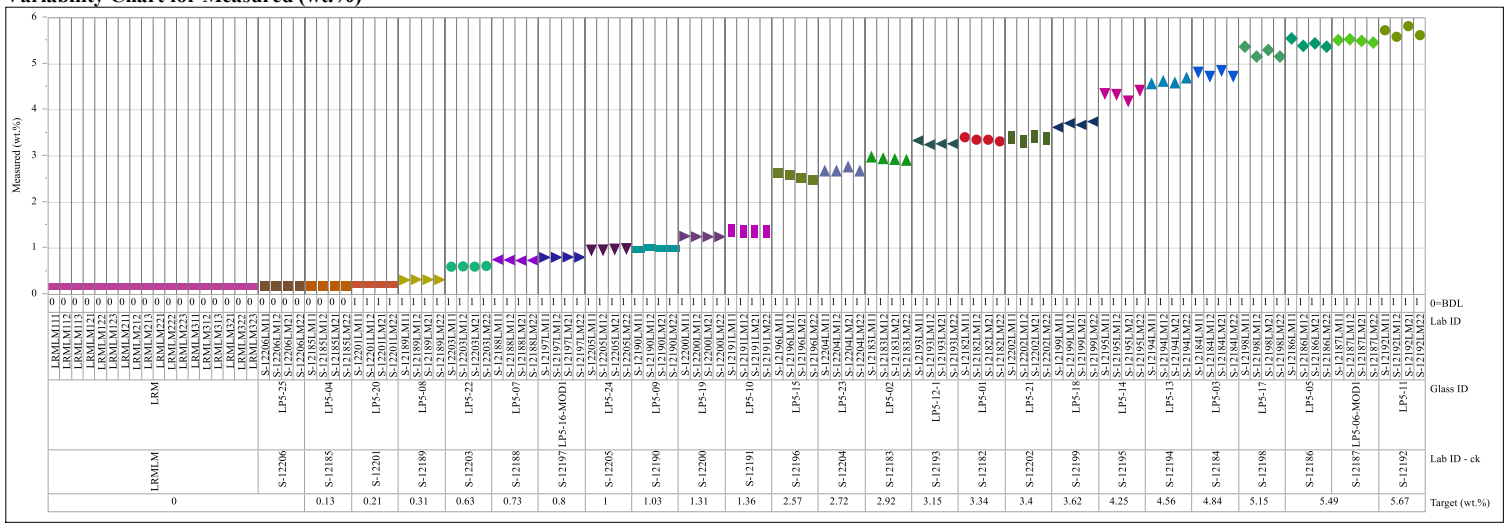
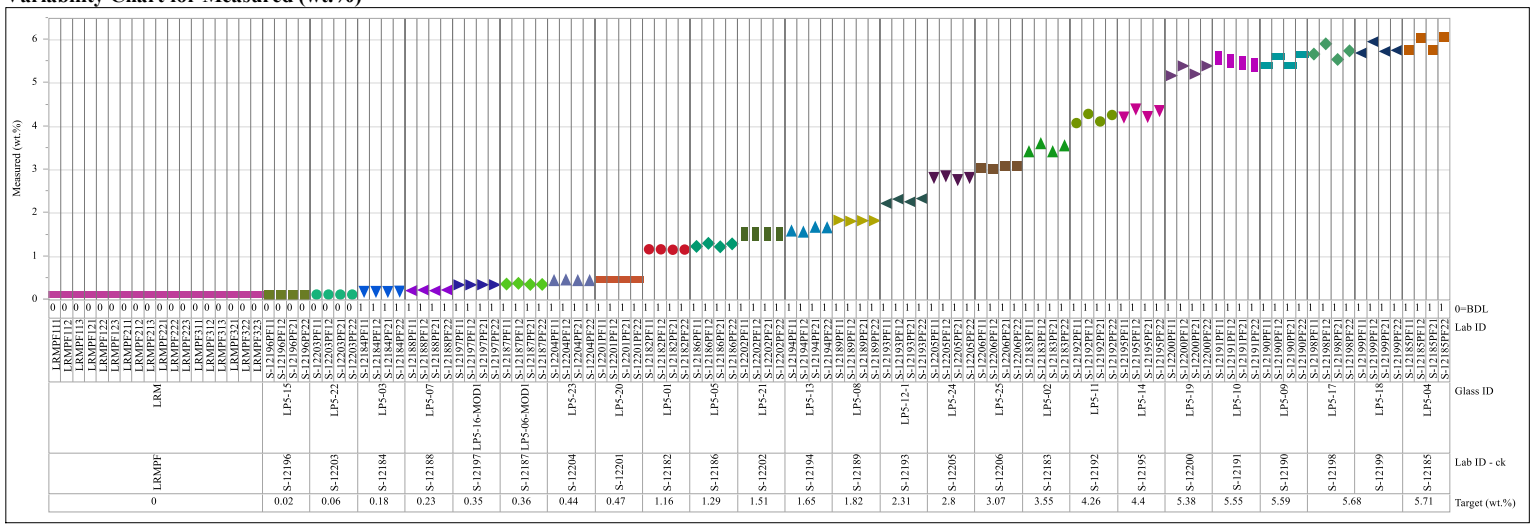


Exhibit A-1. Plots of Oxide Measurements by Glass Identifier by Target Concentrations (continued)

Analyte=ZnO, Prep Method=PF
Variability Chart for Measured (wt.%)



Analyte=ZrO_2, Prep Method=PF
Variability Chart for Measured (wt.%)

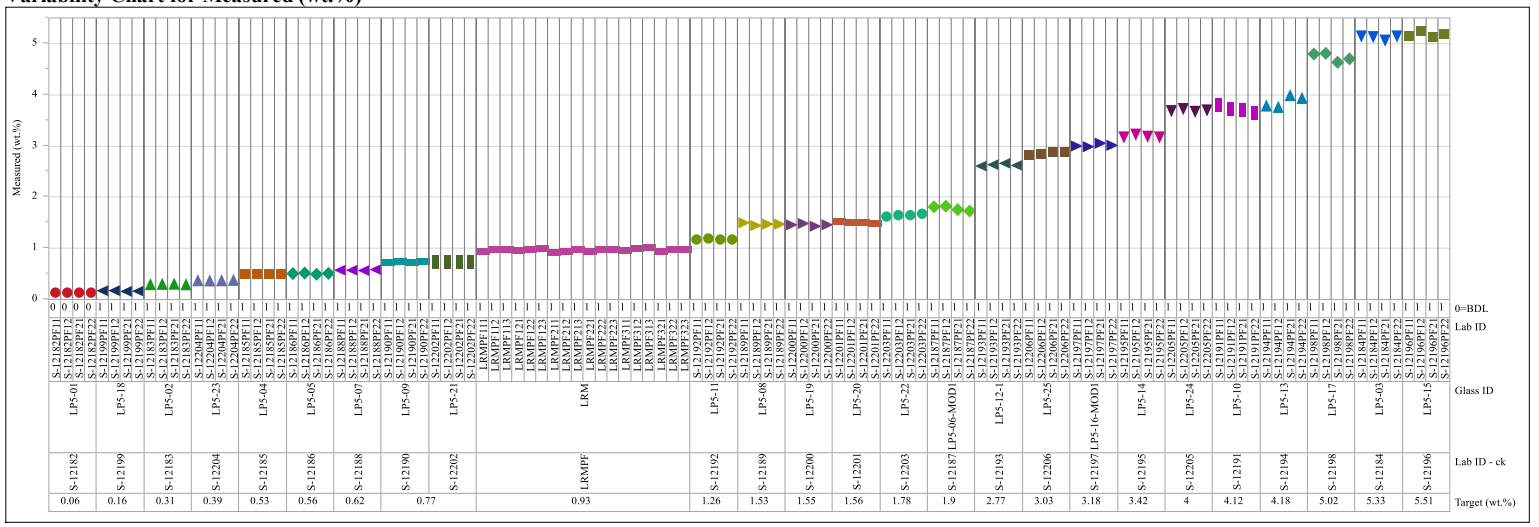
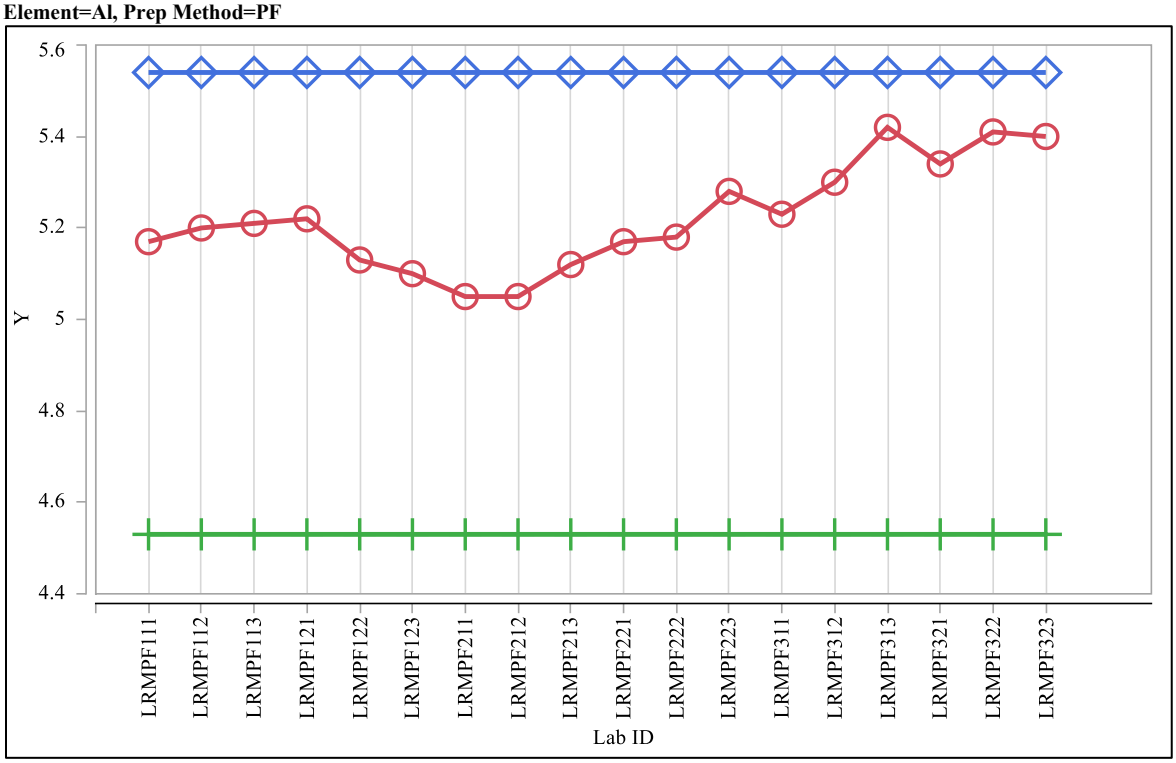
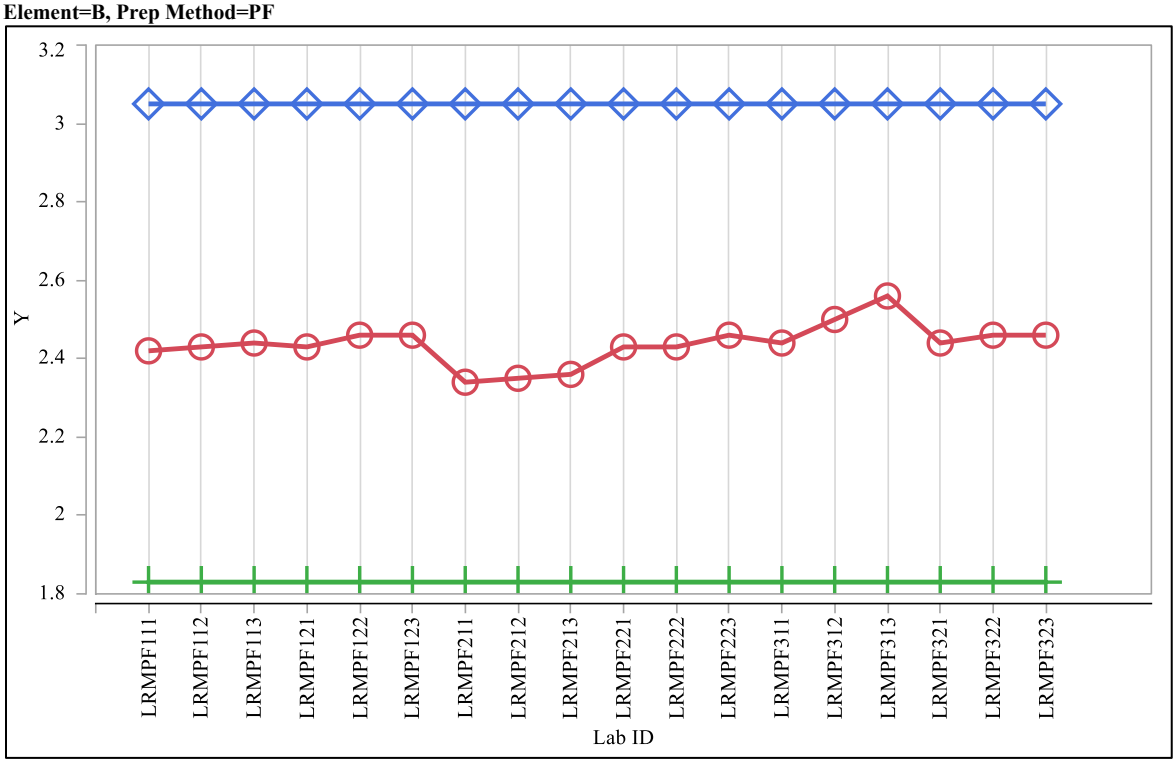


Exhibit A-2. Acceptability Evaluation for Measurements of the LRM Glass

Element=Al, Prep Method=PF



Element=B, Prep Method=PF



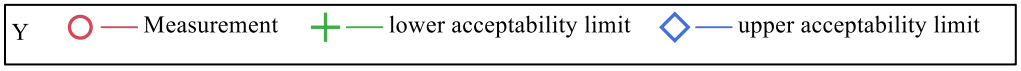
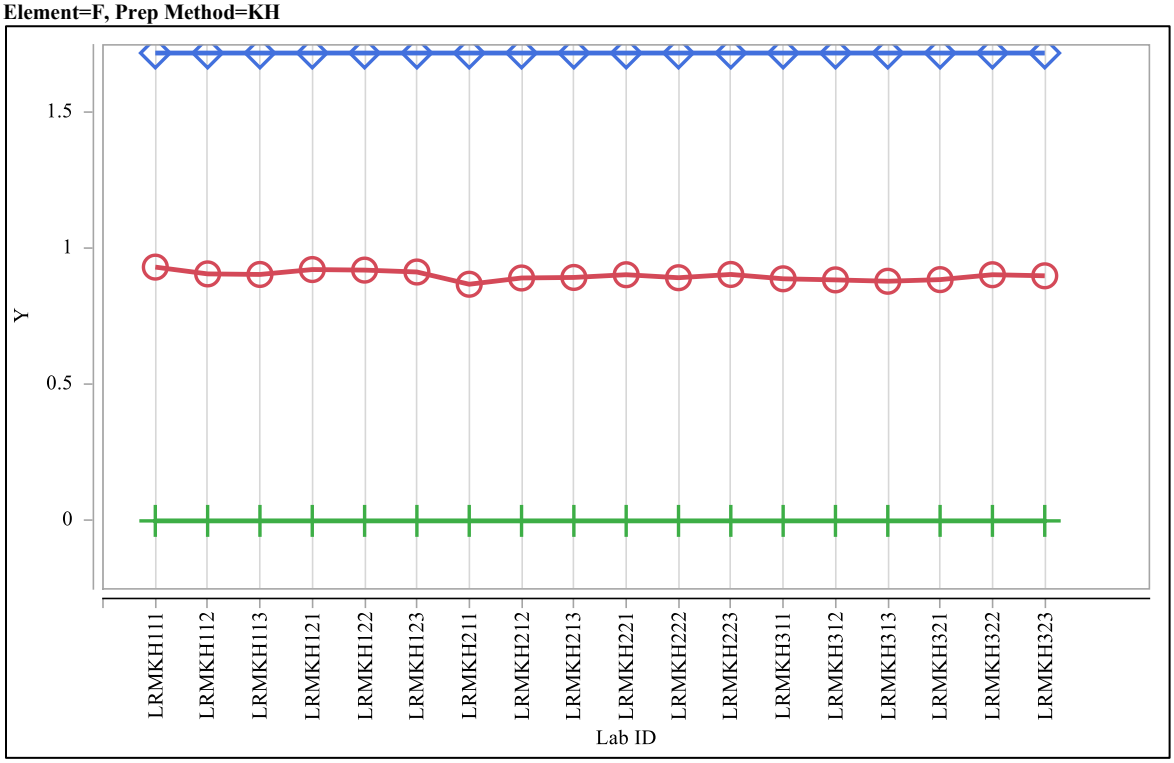
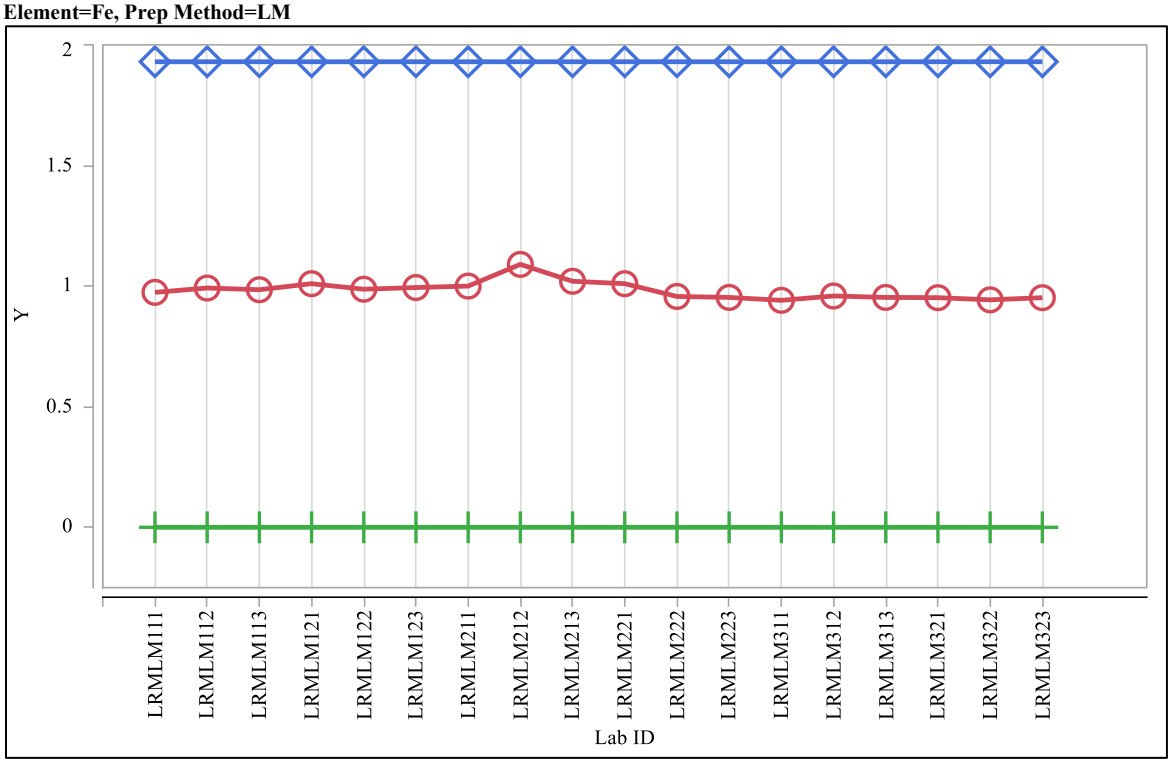


Exhibit A-2. Acceptability Evaluation for Measurements of the LRM Glass (continued)

Element=F, Prep Method=KH



Element=Fe, Prep Method=LM



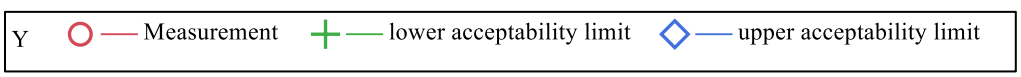
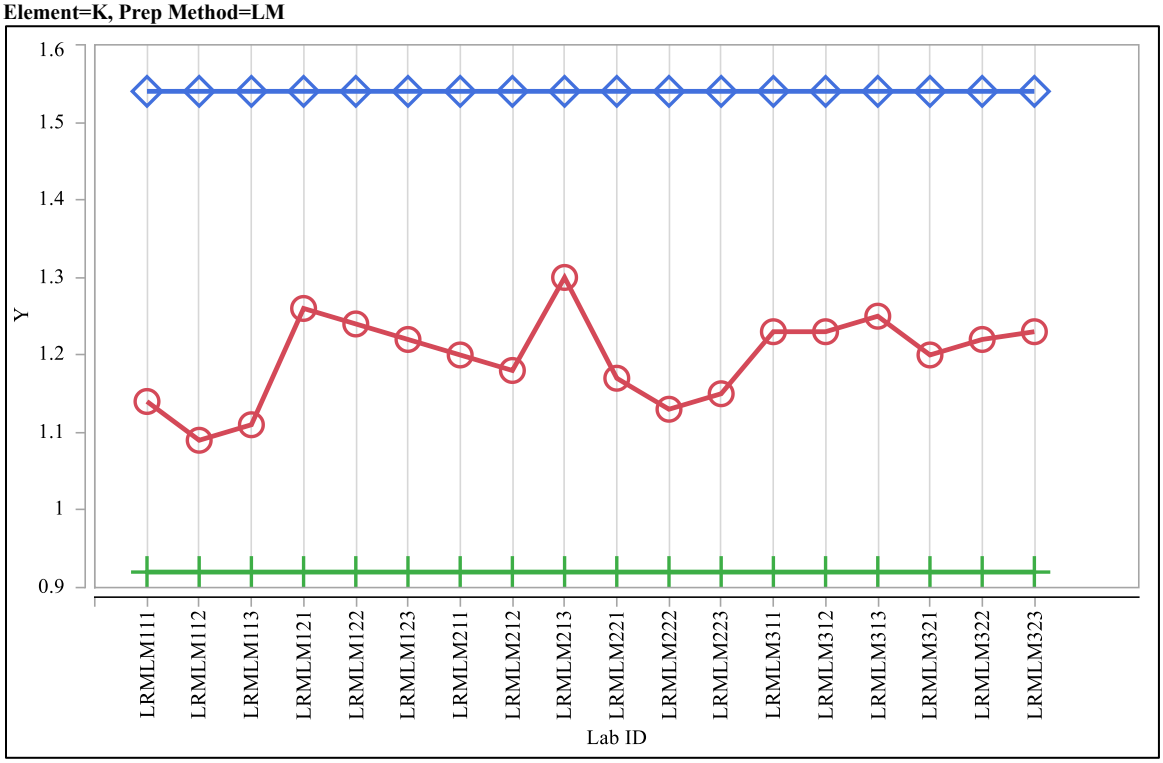
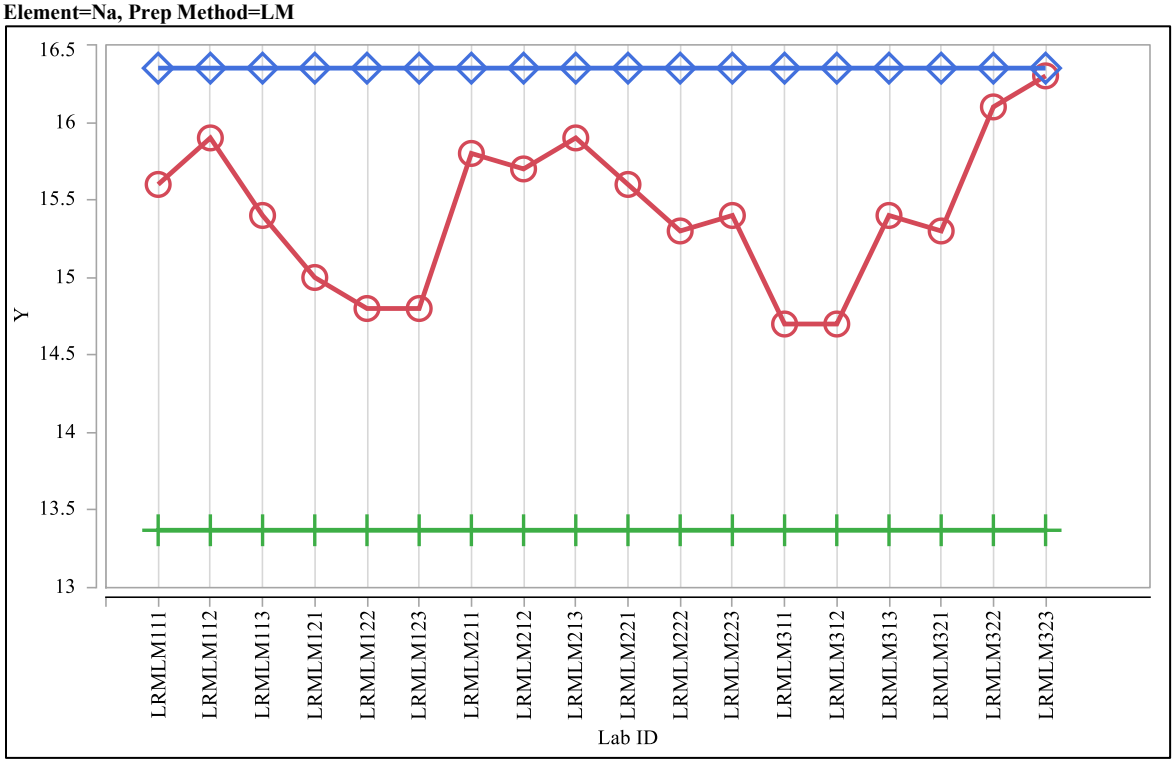


Exhibit A-2. Acceptability Evaluation for Measurements of the LRM Glass (continued)

Element=K, Prep Method=LM



Element=Na, Prep Method=LM



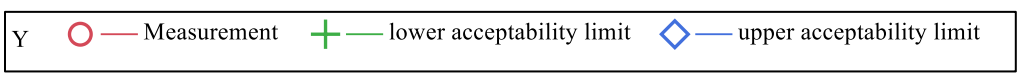
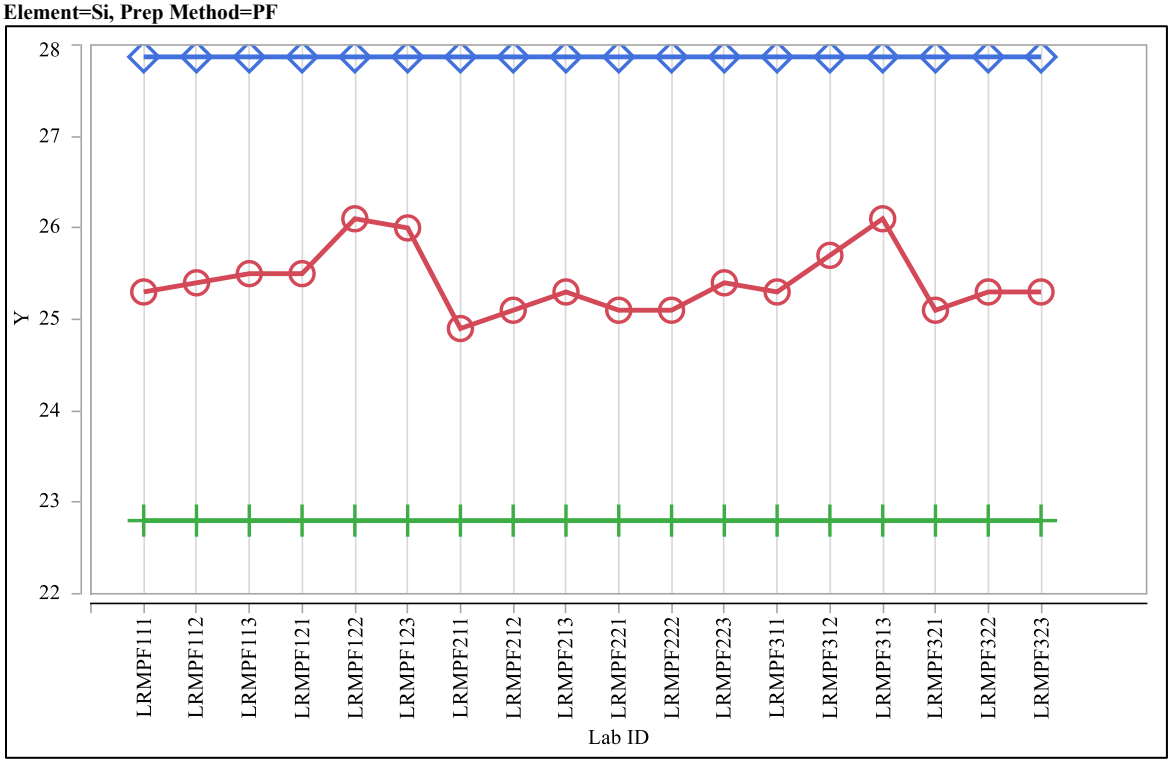
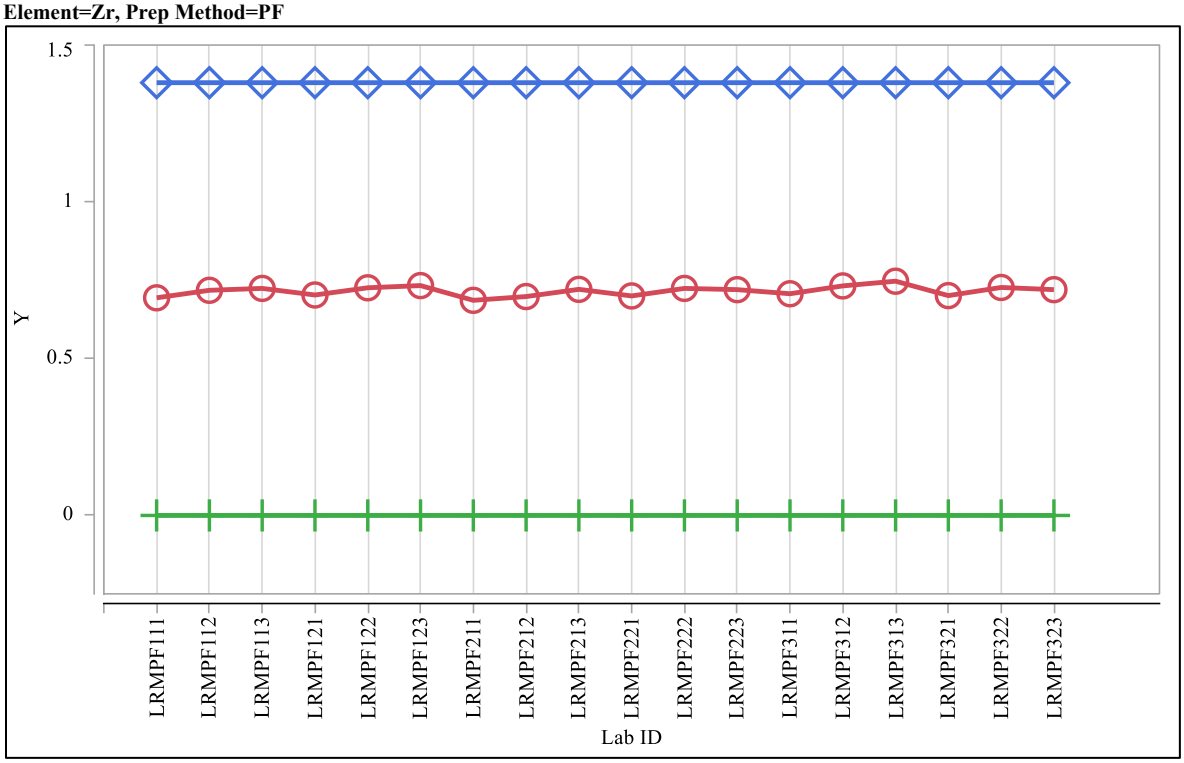


Exhibit A-2. Acceptability Evaluation for Measurements of the LRM Glass (continued)

Element=Si, Prep Method=PF



Element=Zr, Prep Method=PF



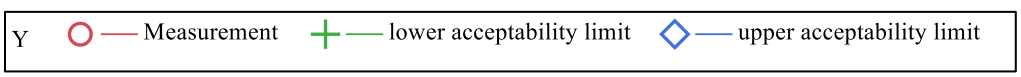
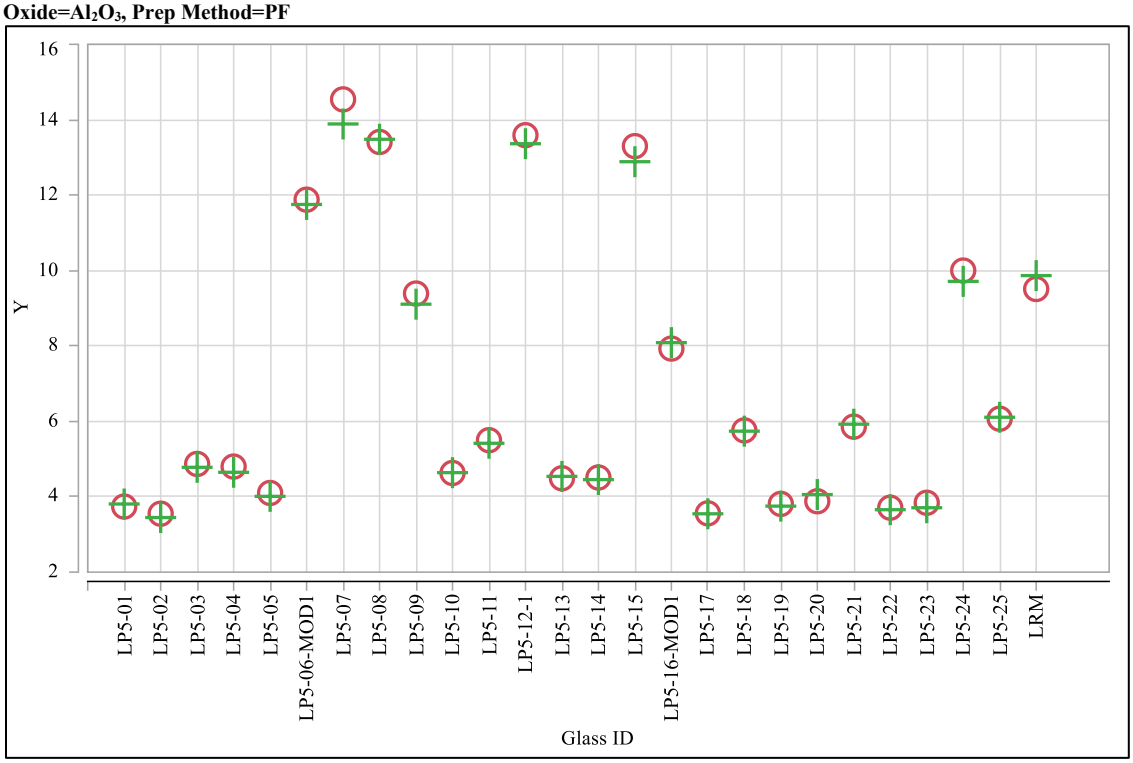
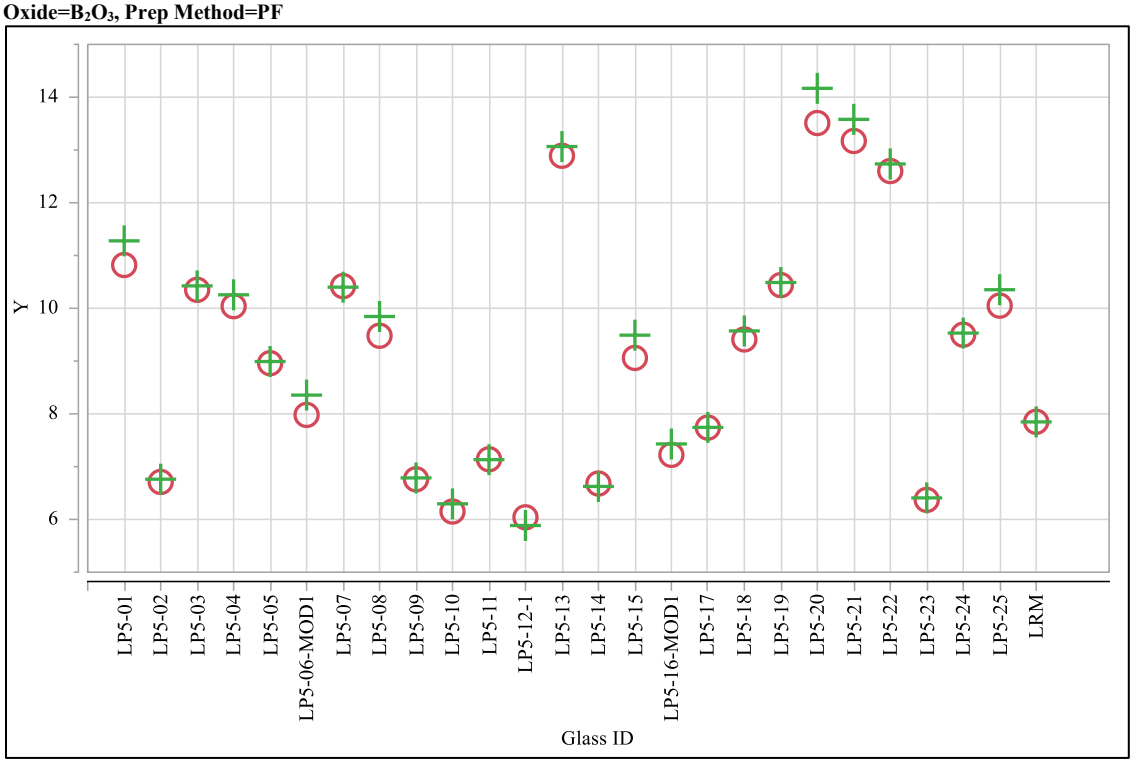


Exhibit A-3. Measured versus Targeted Concentrations by Glass ID by Oxide

Oxide=Al_2O_3, Prep Method=PF



Oxide=B_2O_3, Prep Method=PF



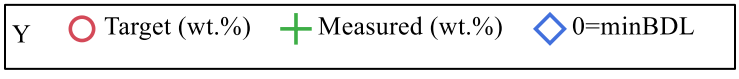
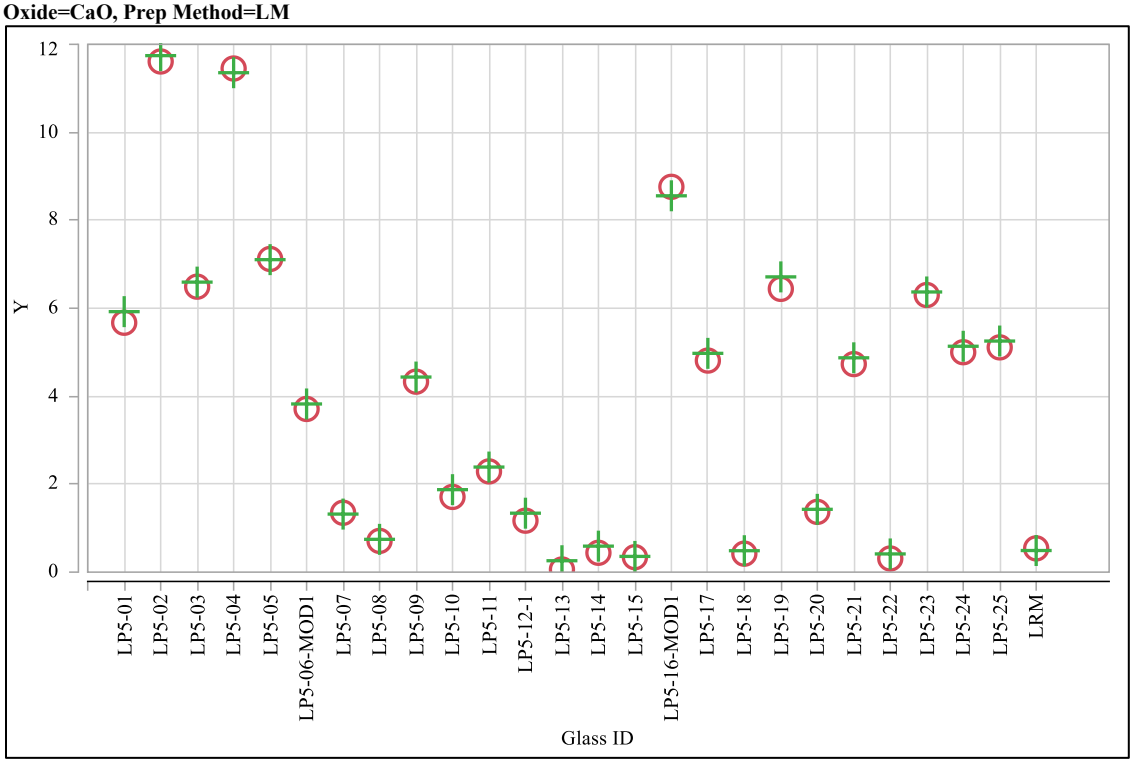
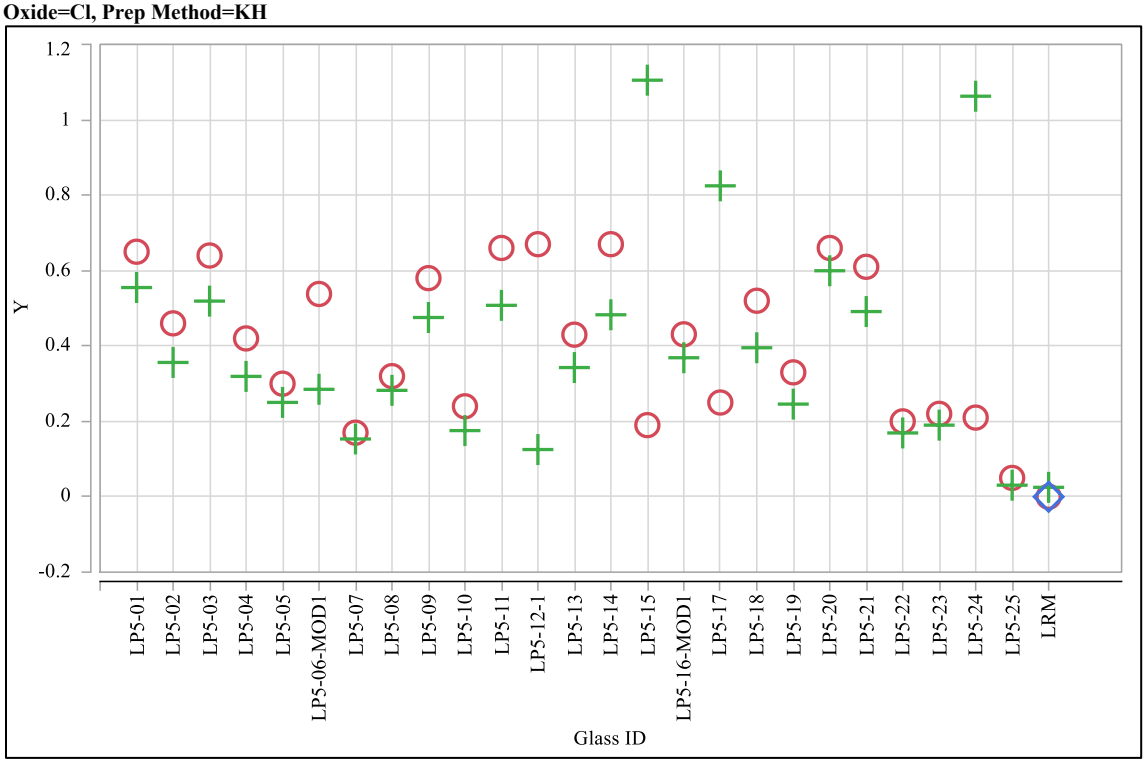


Exhibit A-3. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

Oxide=CaO, Prep Method=LM



Oxide=Cl, Prep Method=KH



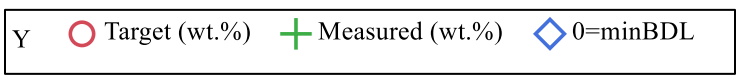
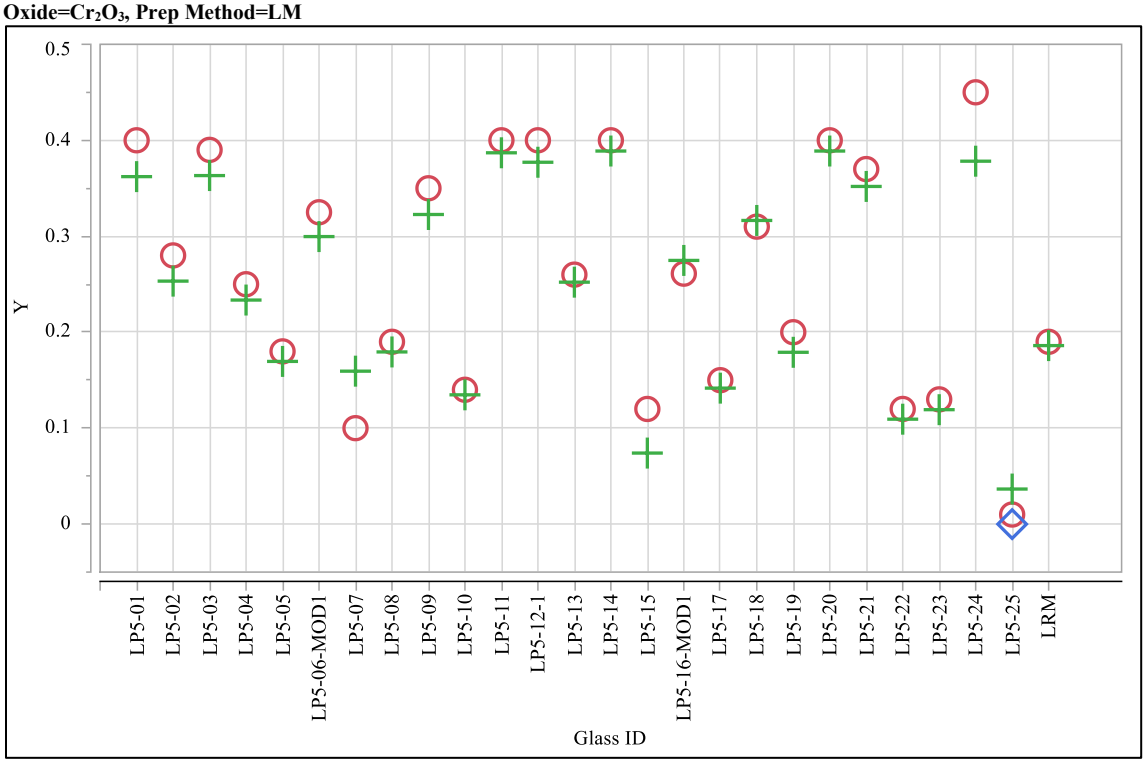
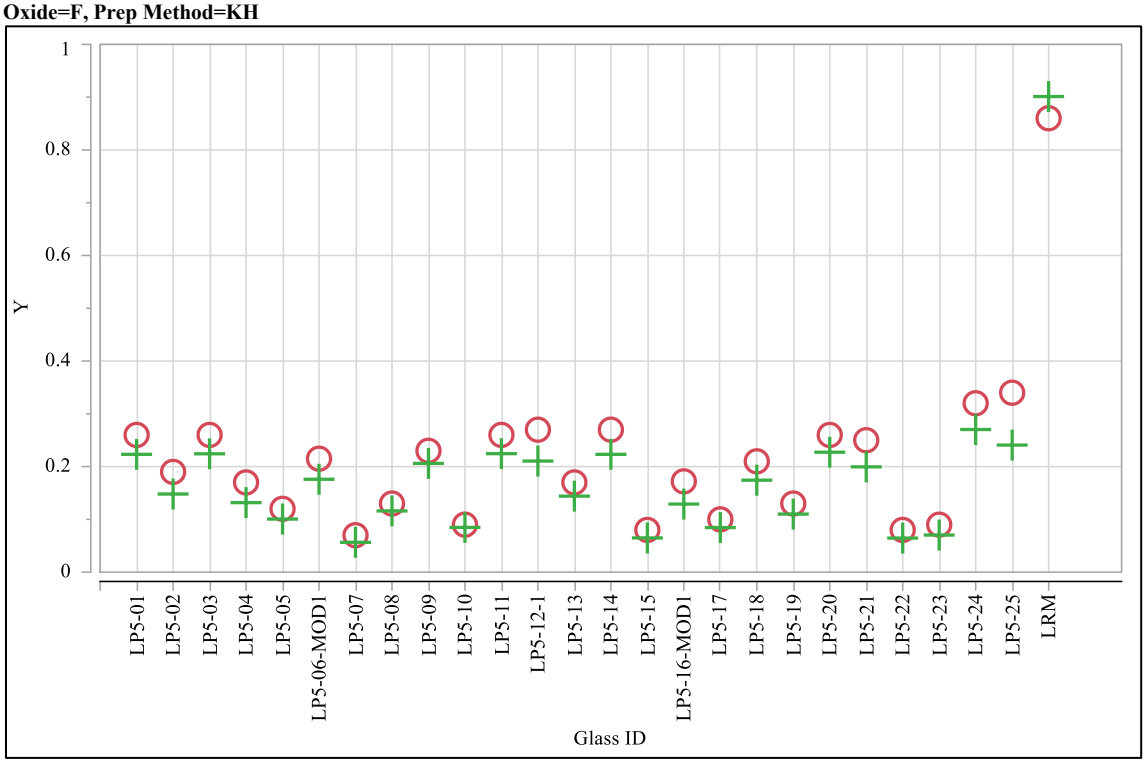


Exhibit A-3. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

Oxide=Cr_2O_3, Prep Method=LM



Oxide=F, Prep Method=KH



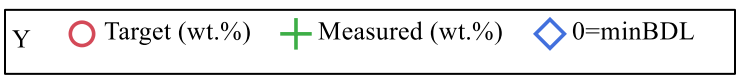
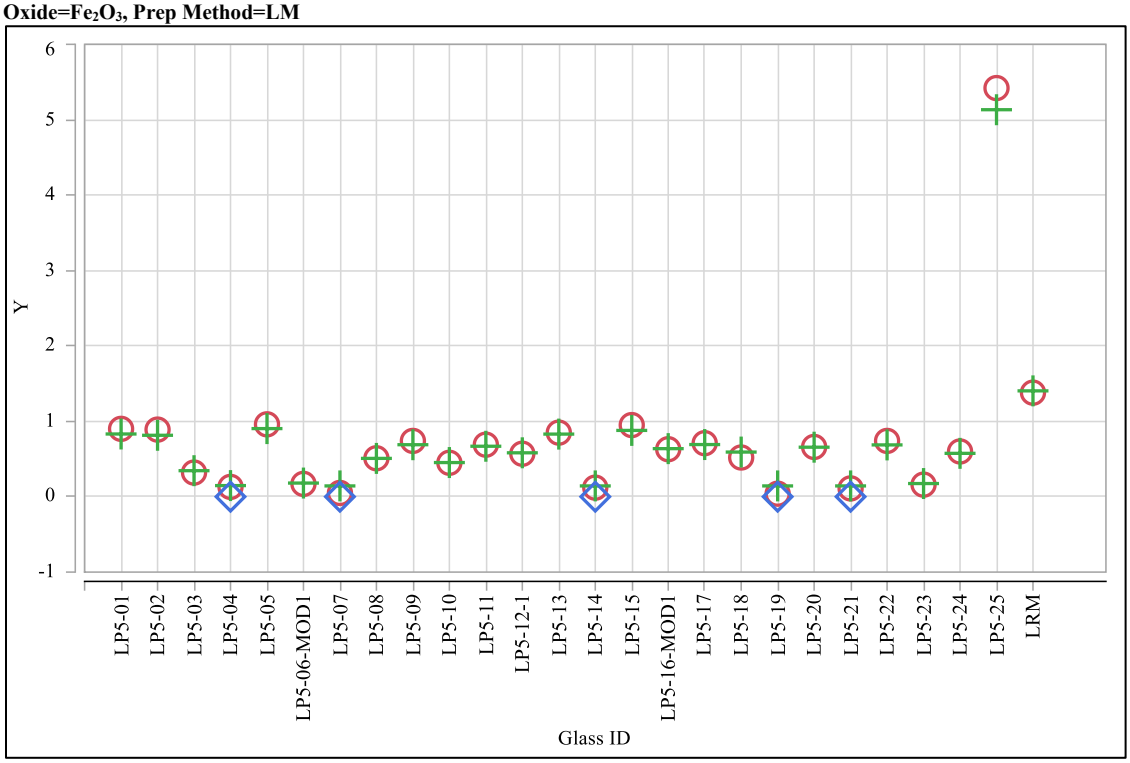
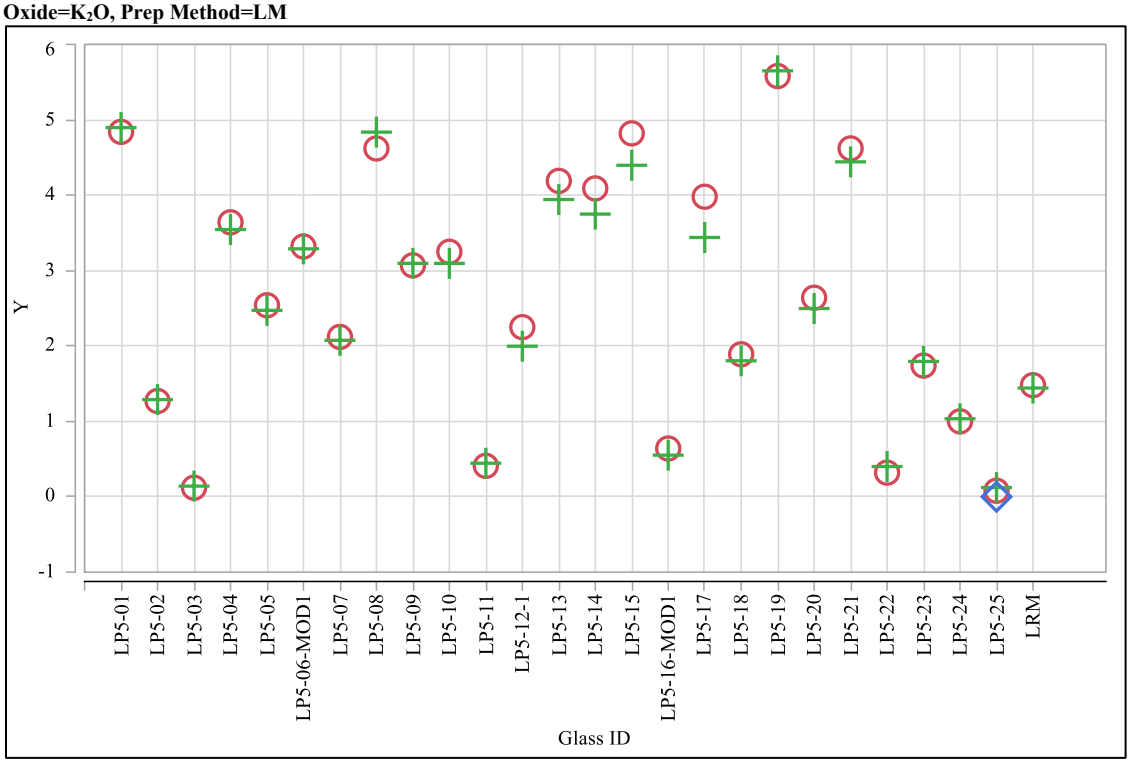


Exhibit A-3. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

Oxide=Fe_2O_3, Prep Method=LM



Oxide=K_2O, Prep Method=LM



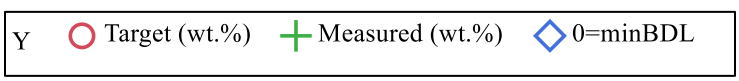
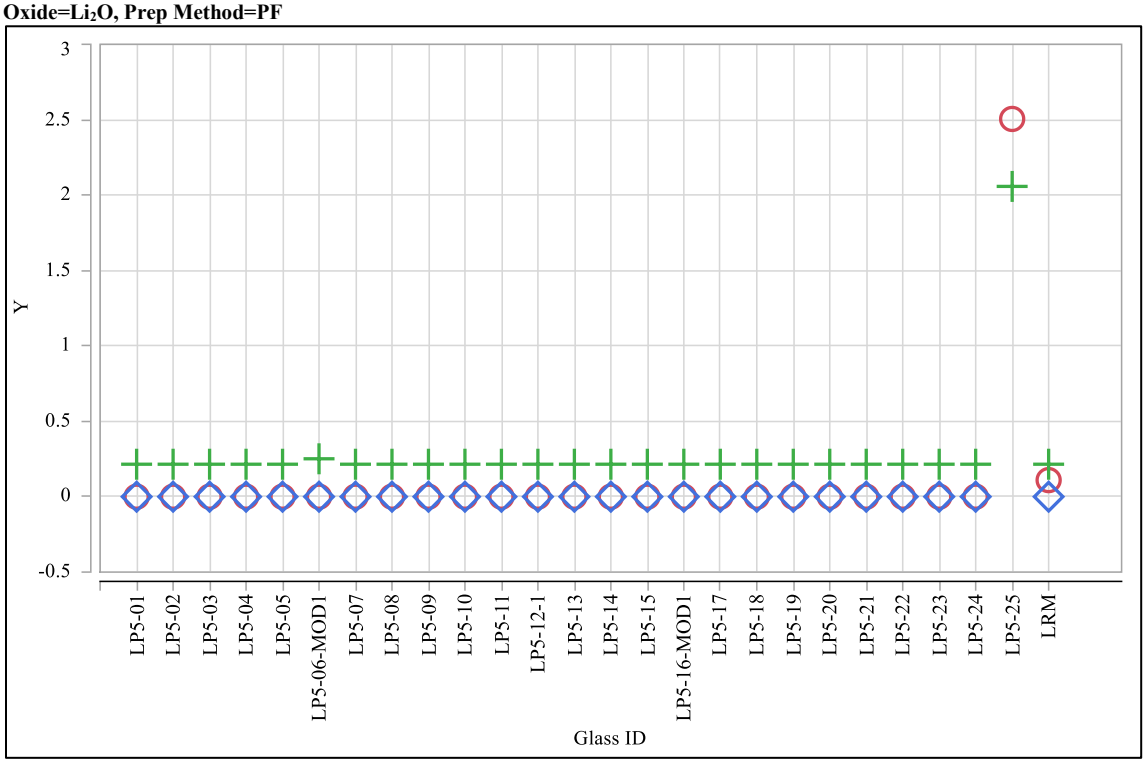
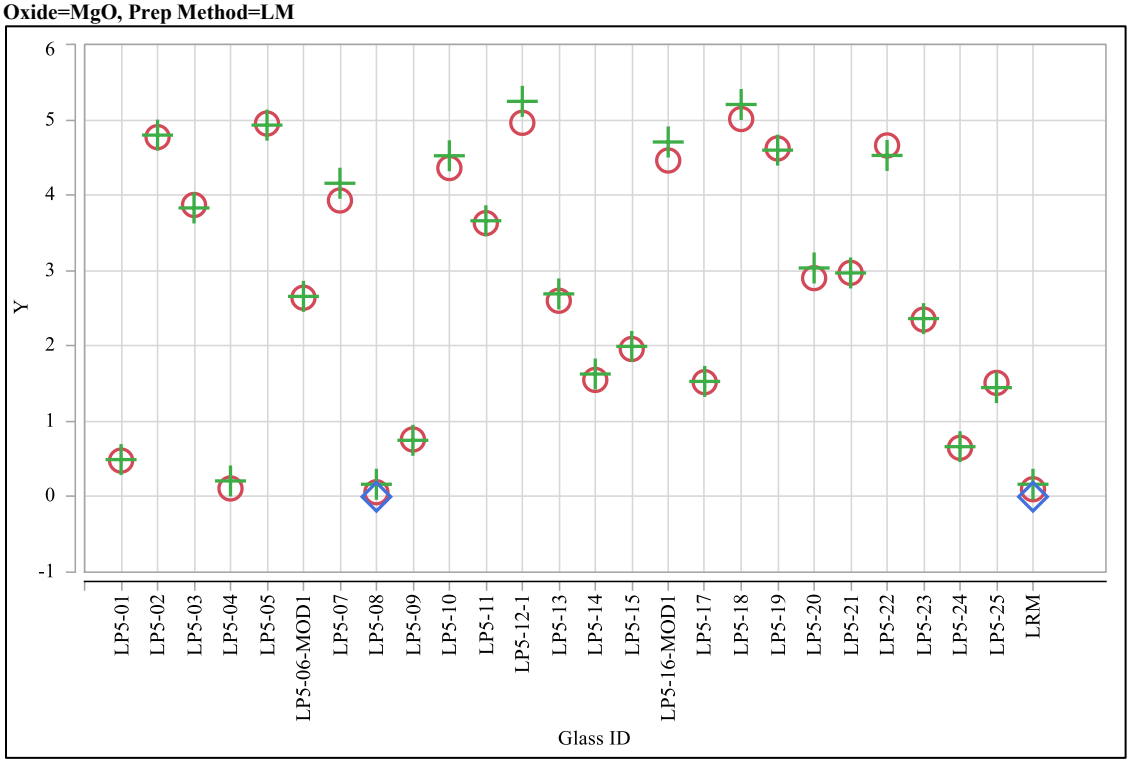


Exhibit A-3. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

Oxide=Li_2O, Prep Method=PF



Oxide=MgO, Prep Method=LM



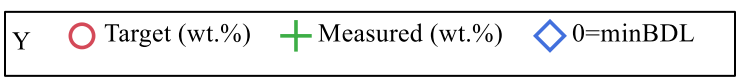
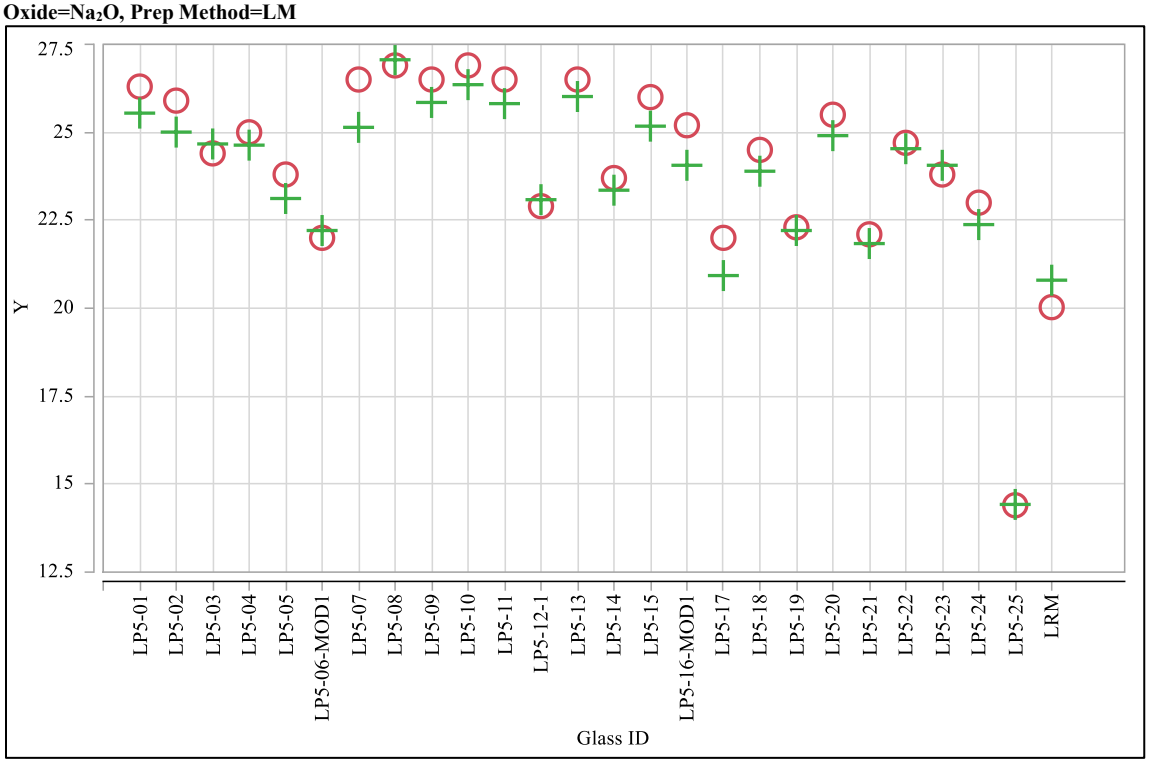
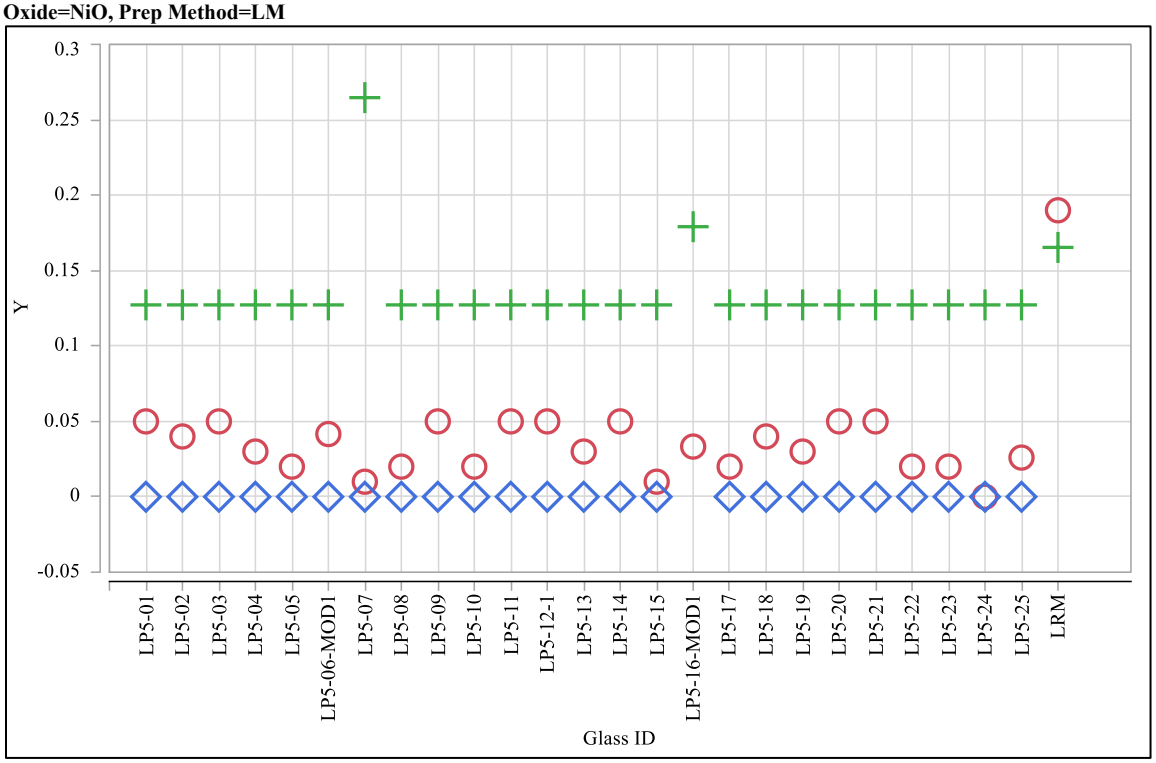


Exhibit A-3. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

Oxide=Na_2O, Prep Method=LM



Oxide=NiO, Prep Method=LM



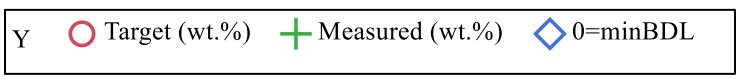
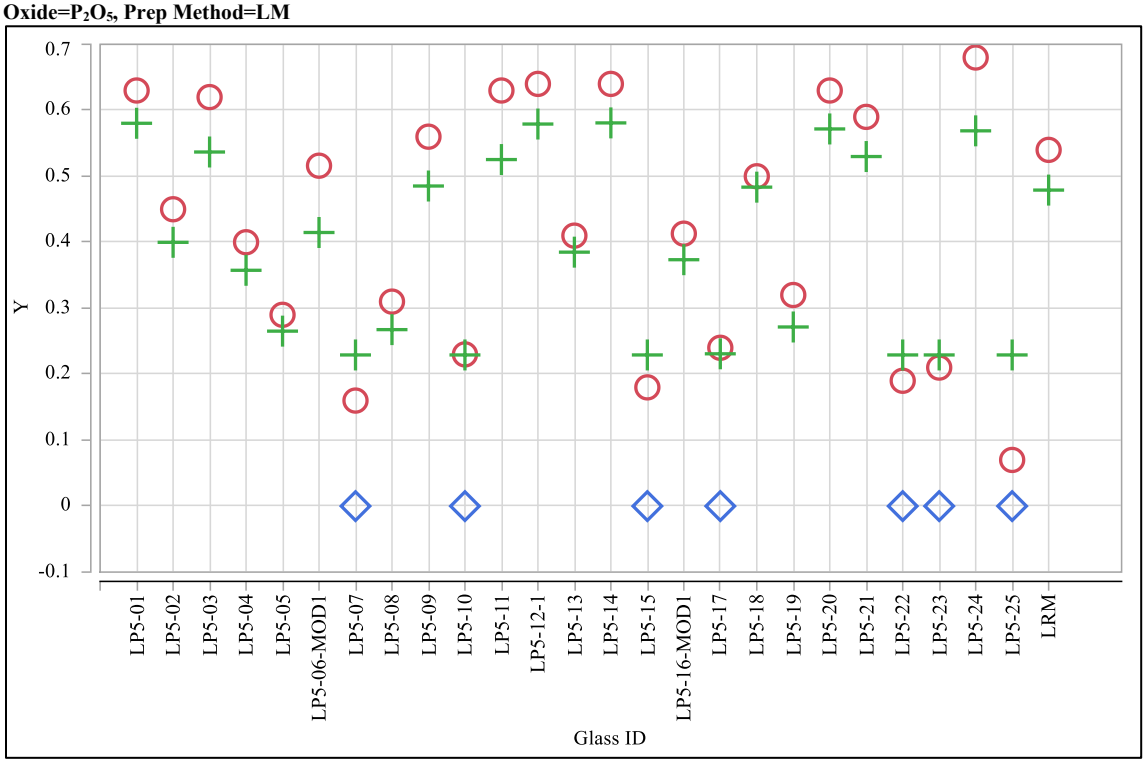
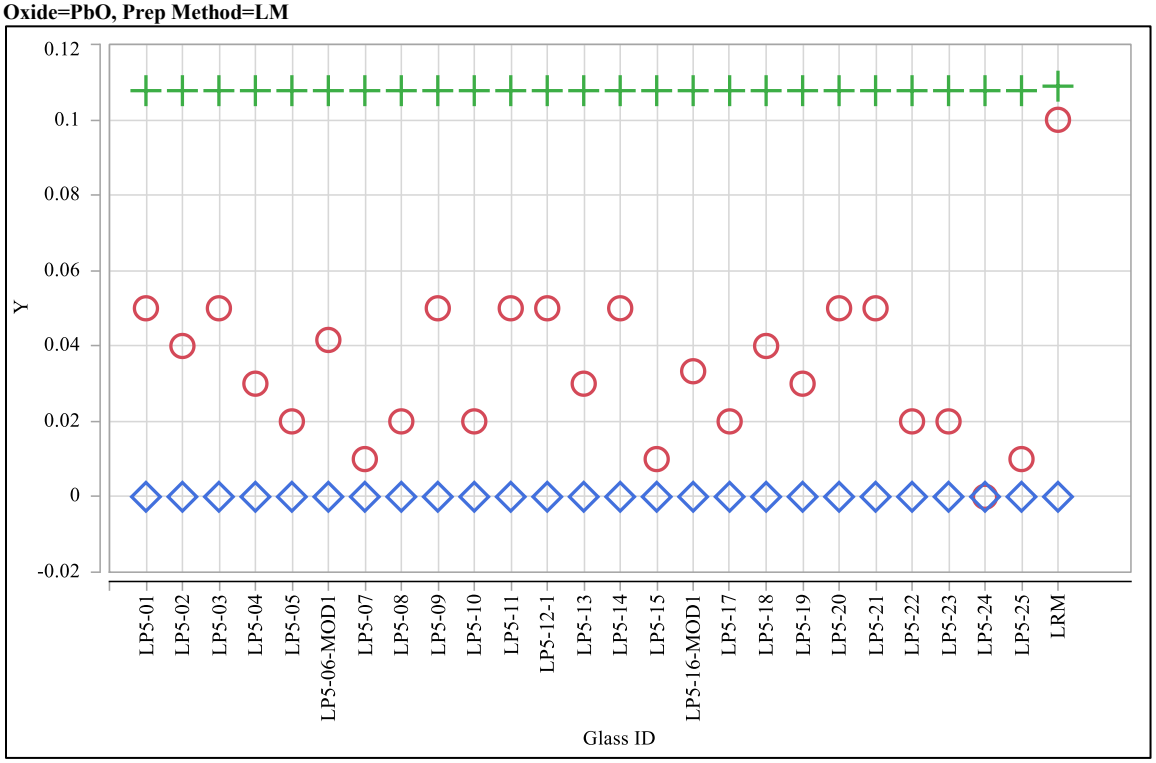


Exhibit A-3. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

Oxide=P_2O_5, Prep Method=LM



Oxide=PbO, Prep Method=LM



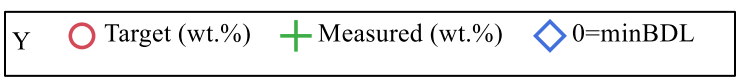
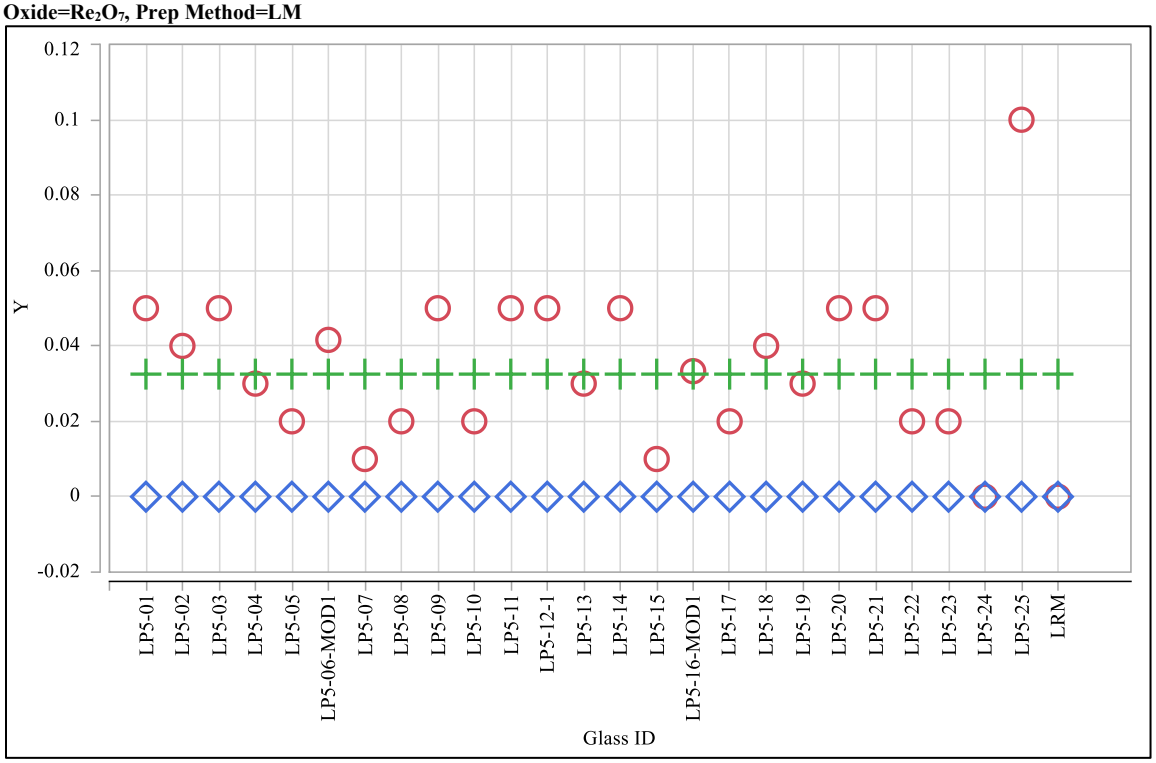
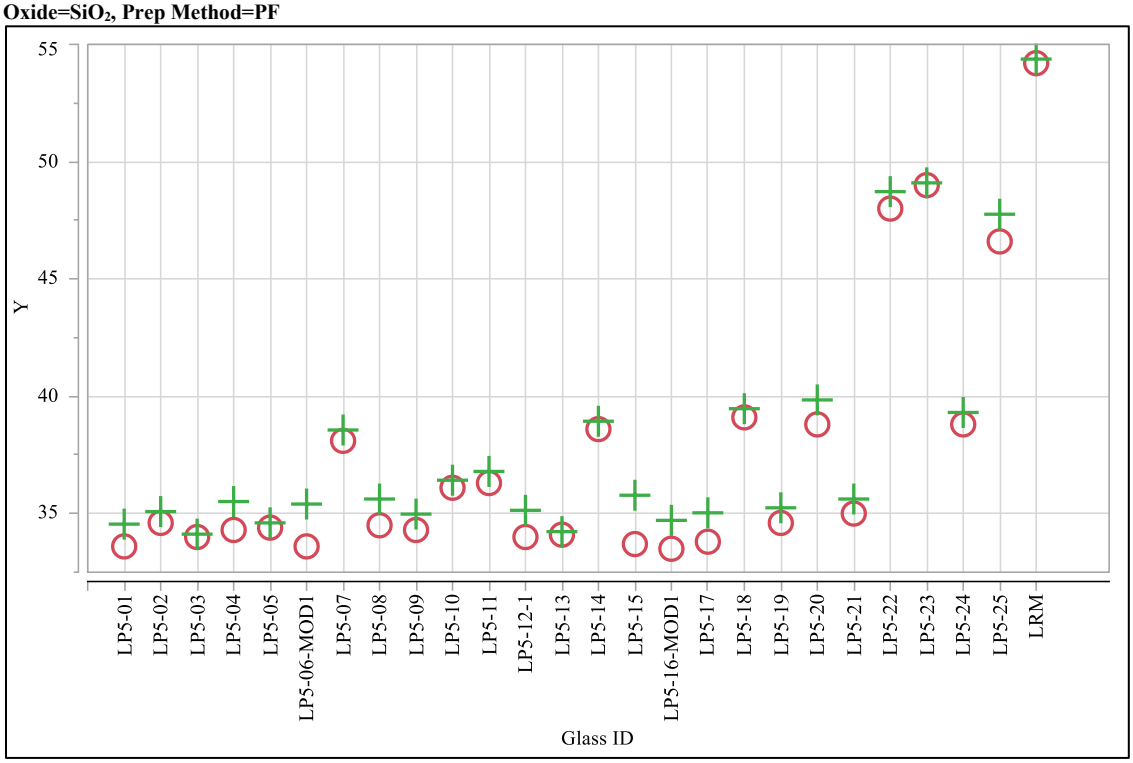


Exhibit A-3. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

Oxide=Re_2O_7, Prep Method=LM



Oxide=SiO_2, Prep Method=PF



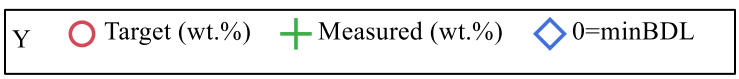
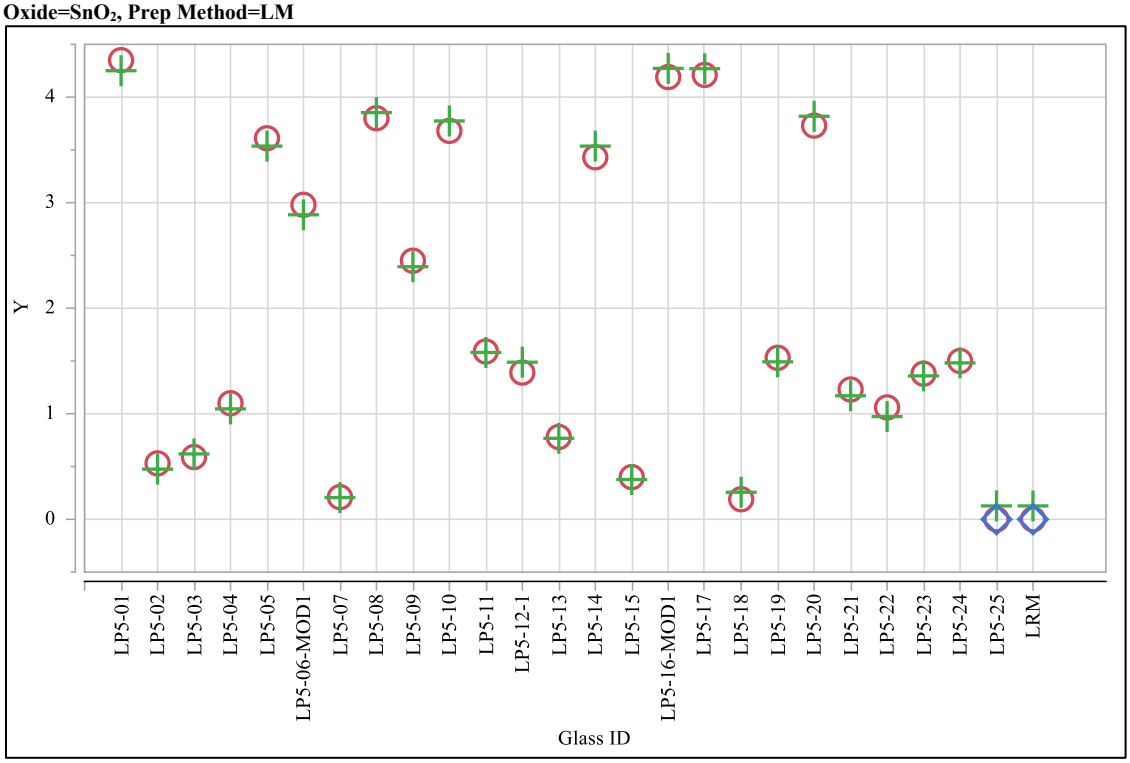
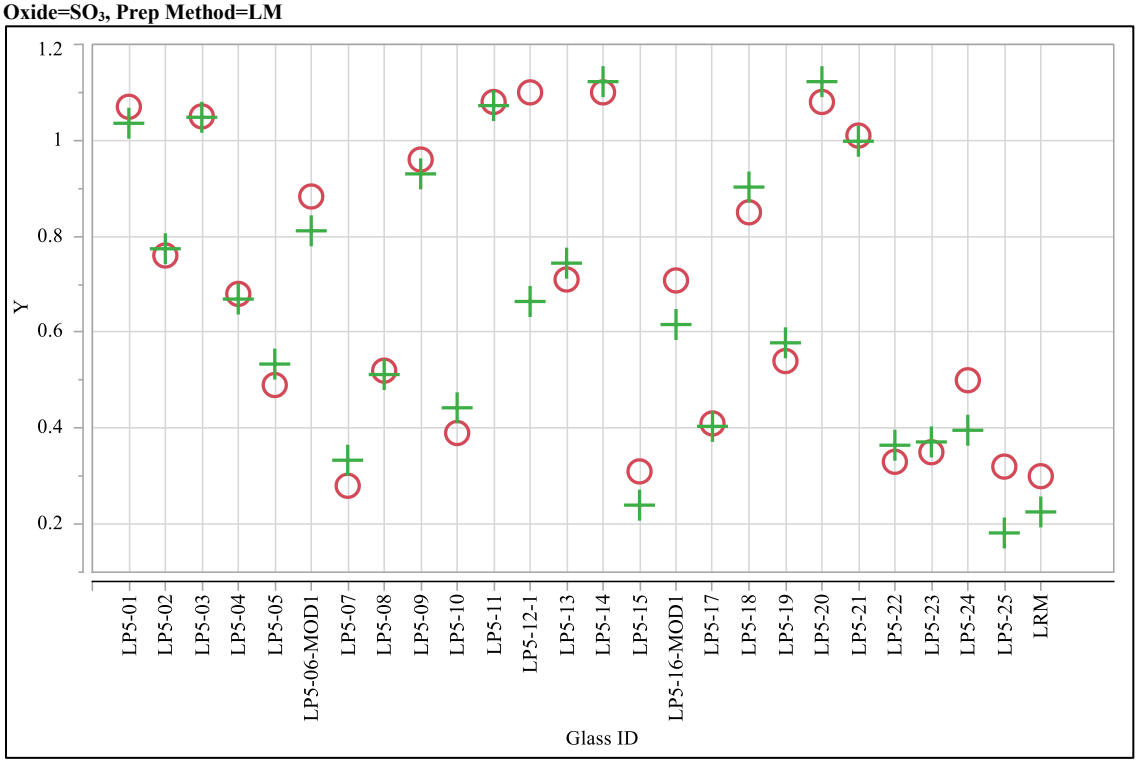


Exhibit A-3. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

Oxide=SnO_2, Prep Method=LM



Oxide=SO_3, Prep Method=LM



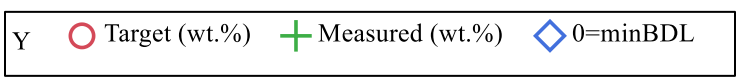
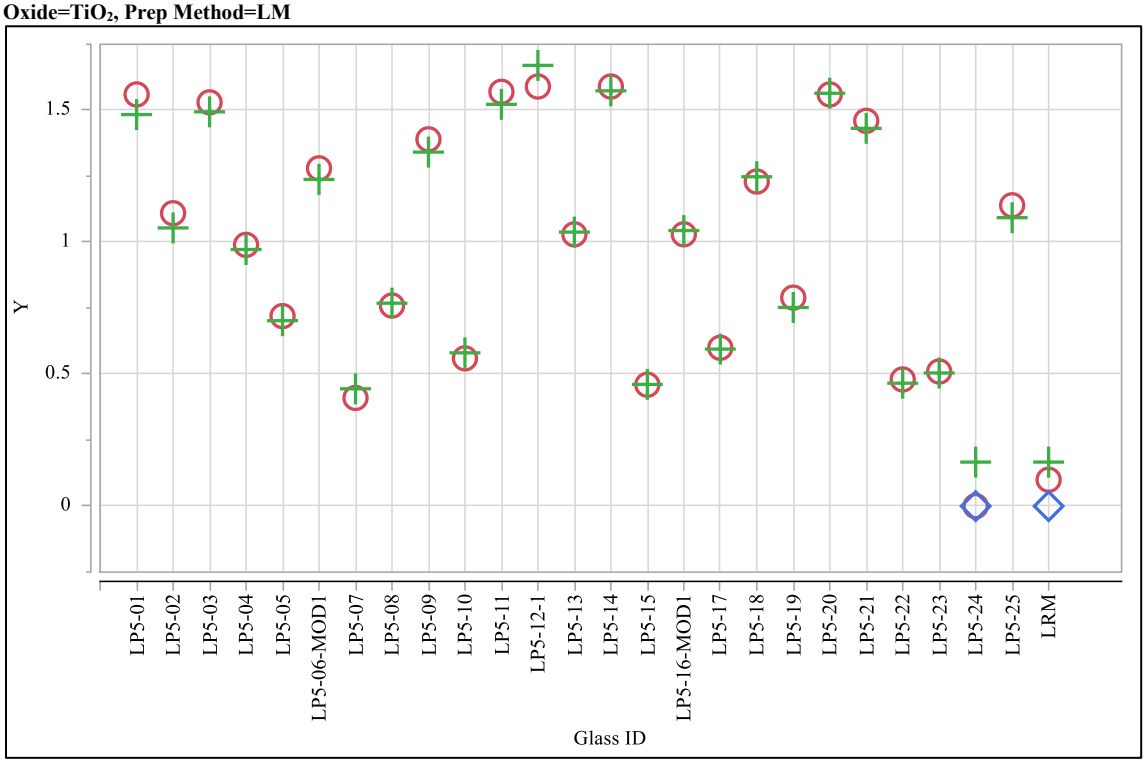
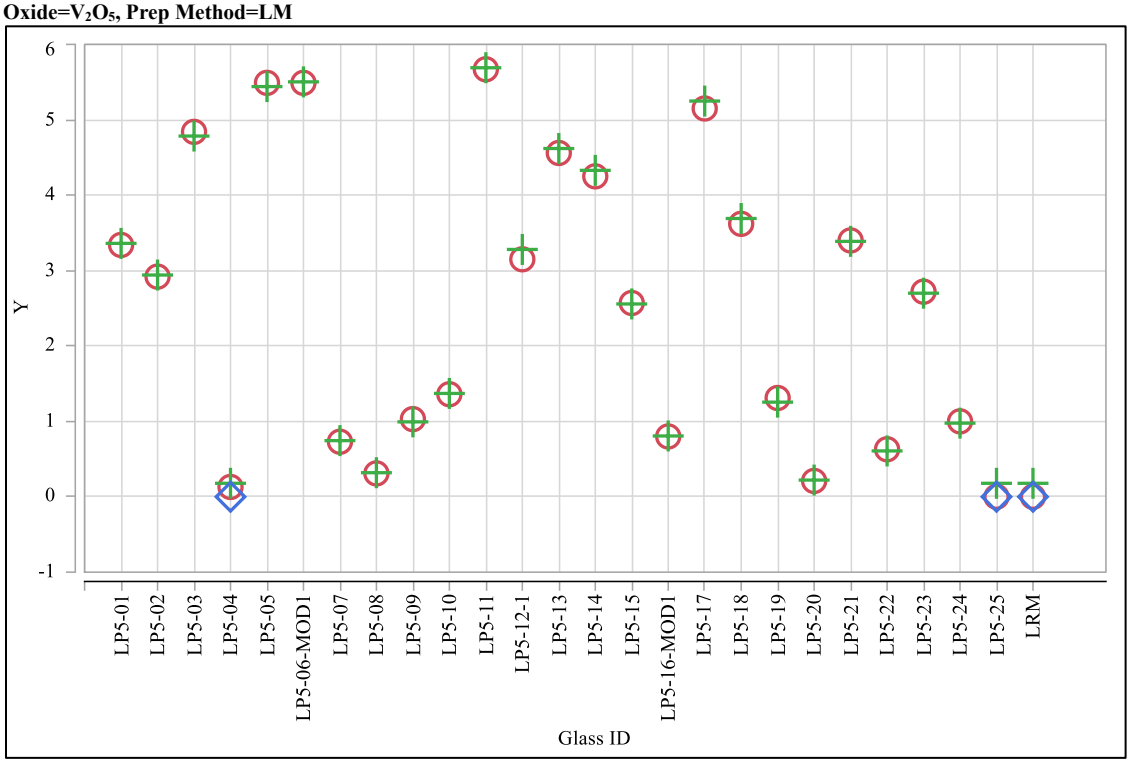


Exhibit A-3. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

Oxide=TiO_2, Prep Method=LM



Oxide=V_2O_5, Prep Method=LM



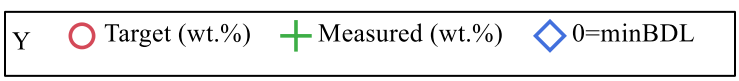
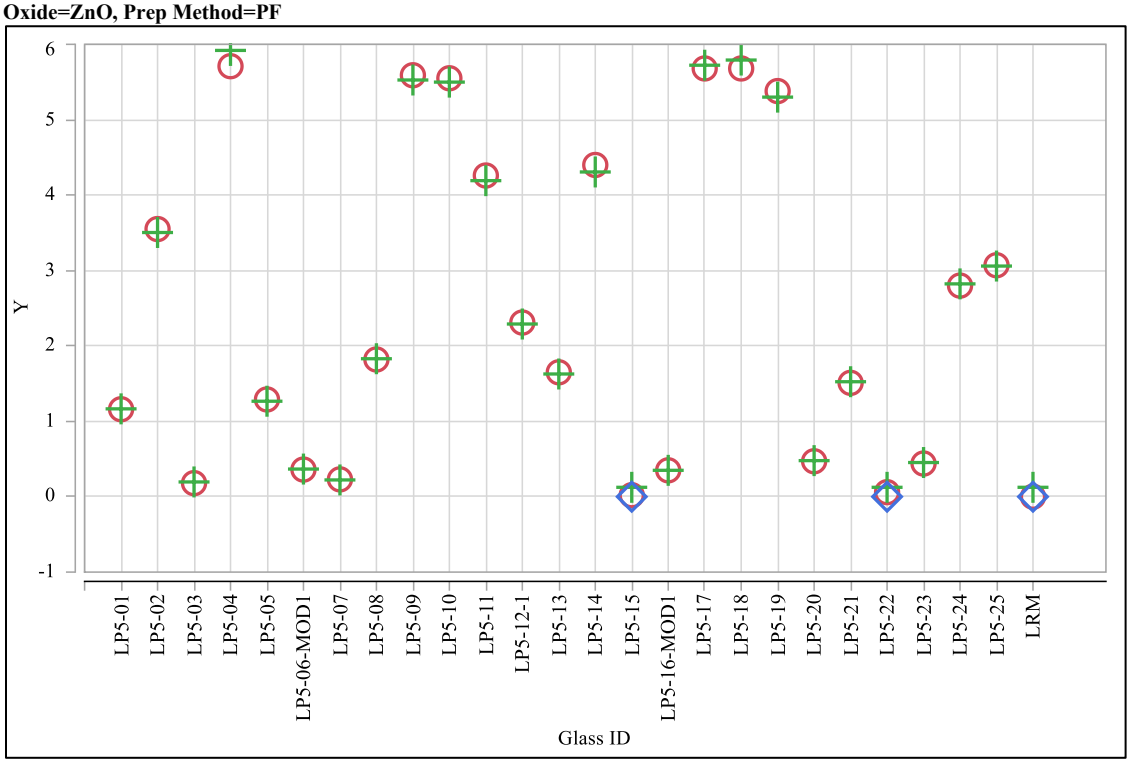
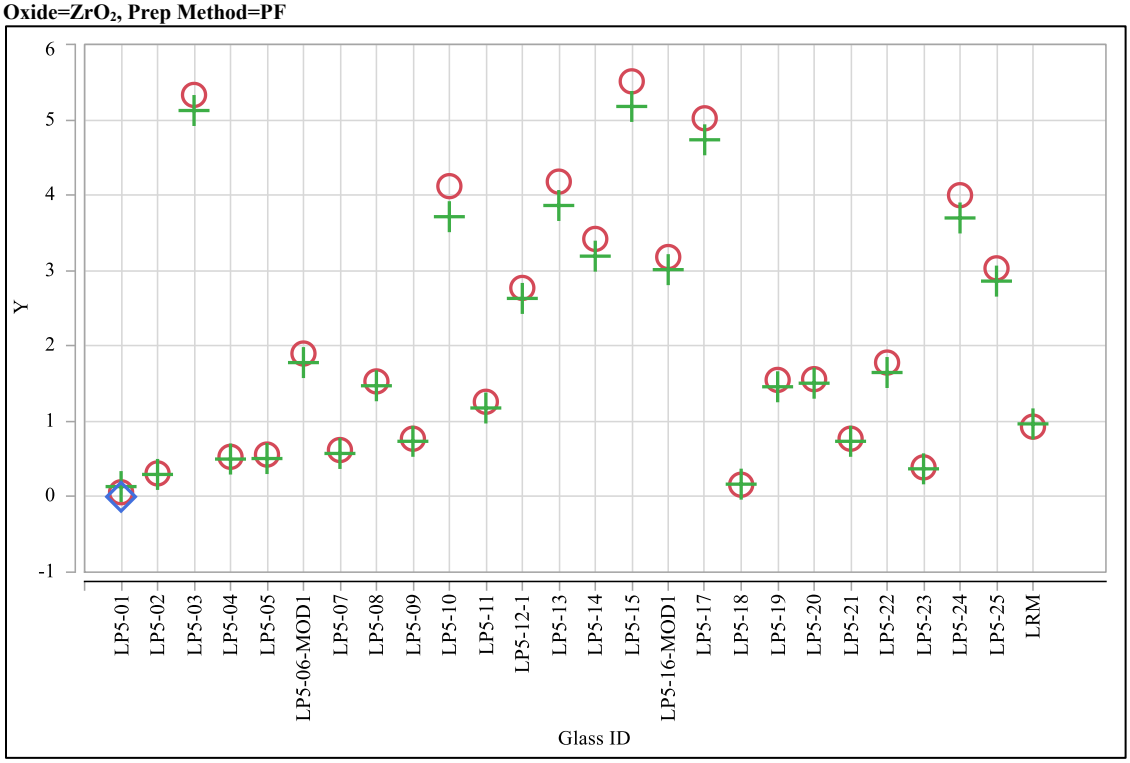


Exhibit A-3. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)

Oxide=ZnO, Prep Method=PF



Oxide=ZrO_2, Prep Method=PF



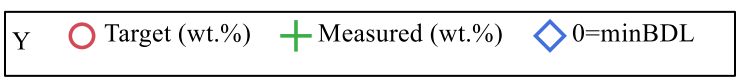
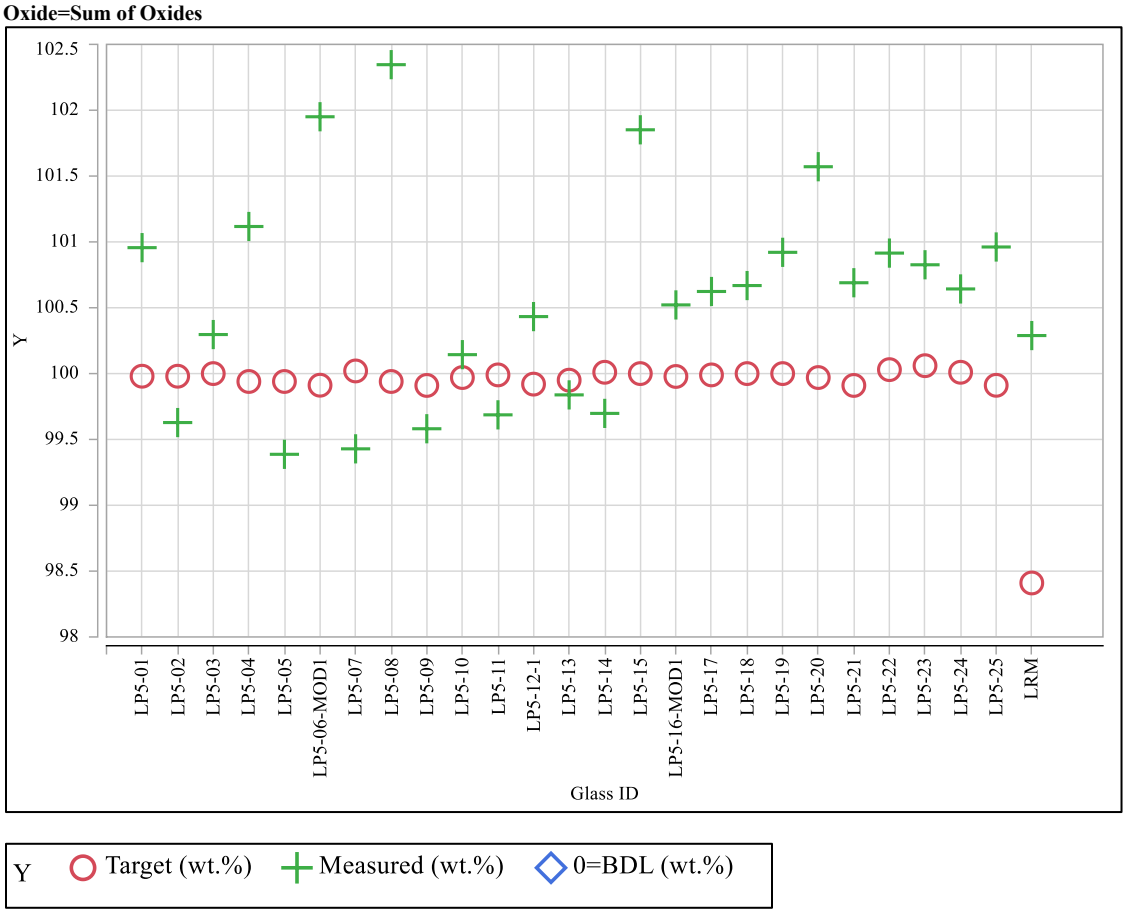


Exhibit A-3. Measured versus Targeted Concentrations by Glass ID by Oxide (continued)



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