Compositions of Simulated LAW Glasses Saturated with Sulfur at Various Temperatures

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EXECUTIVE SUMMARY

In this report, the Savannah River National Laboratory (SRNL) provides chemical analysis for several simulated low-activity waste (LAW) glass compositions, as well as chemical analysis of the wash solutions resulting from the preparation of these glasses. The Pacific Northwest National Laboratory (PNNL) selected and fabricated these glasses as part of a study on sulfur retention in glasses as a function of melting temperature.

Chemical analyses were performed on a representative sample of each of the study glasses to allow for comparisons with the targeted compositions. Three dissolution techniques, sodium peroxide fusion, lithium metaborate fusion, and potassium hydroxide fusion, were used for preparing each of the glass samples for analysis. Each of the samples was analyzed twice for each element of interest by Inductively Coupled Plasma – Atomic Emission Spectroscopy (ICP-AES) or Ion Chromatography (IC). Cesium concentrations were measured a single time by Inductively Coupled Plasma – Mass Spectroscopy (ICP-MS). A glass standard was also measured as a check of the performance of the analytical instruments. Average concentrations of each of the glass components were determined and reported.

Chemical analyses were also performed on a representative sample of each of the wash solutions resulting from the preparation of the sulfur saturated melt (SSM) versions of the study glasses. The samples were analyzed in duplicate for each element of interest by ICP-AES or IC. Cesium concentrations were measured once by ICP-MS. Average concentrations of each analyte were determined and reported.

These results will be used by PNNL in the development of improved property/composition models for LAW glass production at Hanford.

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LIST OF ABBREVIATIONS

DOE	U.S. Department of Energy
IC	Ion Chromatography
ICP-AES	Inductively Coupled Plasma – Atomic Emission Spectroscopy
ICP-MS	Inductively Coupled Plasma – Mass Spectroscopy
HLW	High-Level Waste
KH	Potassium hydroxide digestion
LAW	Low-Activity Waste
LM	Lithium Metaborate fusion
LRM	Low-level Reference Material
ORP	Office of River Protection
PF	Peroxide Fusion
PNNL	Pacific Northwest National Laboratory
ppm	parts per million
SRNL	Savannah River National Laboratory
SSM	Sulfur Saturated Melt
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 program. DOE is building the Hanford Tank Waste Treatment and Immobilization Plant (WTP) at the Hanford Site in Washington to remediate 55 million gallons of radioactive waste that is temporarily stored in 177 underground tanks. The low-activity waste (LAW) fraction will be partitioned from the high-level waste (HLW). Both the LAW and HLW will then be vitrified into borosilicate glass using Joule-heated ceramic melters.

Efforts are being made to increase the loading of Hanford tank wastes in the glass while conforming to processing requirements and product quality regulations. DOE-ORP has requested that SRNL support the advancement of glass formulations and process control strategies in key technical areas, as defined in the Task Technical and Quality Assurance Plan (TTQAP).[1] 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 for several simulated LAW glass compositions, as well as chemical analysis of the wash solutions resulting from the preparation of these glasses. The Pacific Northwest National Laboratory (PNNL) selected and fabricated these glasses as part of a study on sulfur retention. The resulting data will be used in the development of improved property/composition models for LAW glass production at Hanford.

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 C3489-00079-20.

2.2 Glasses Selected for Study

The glass compositions in this study were selected and fabricated at PNNL. Identifiers for each of the 16 glasses are listed in Table 2-1. The suffixes 950 through 1200 indicate the melting temperature (°C) used in producing the glass samples. The SSM suffix indicates that these glasses were fabricated from sulfur saturated melts. In the sections that follow, the methods used for measuring chemical compositions of the glasses and wash solutions are described, and brief reviews of the resulting data are provided. Detailed data from these analyses are included in the appendices.

Table 2-1. Glass Identifiers Included in This Study

Glass ID
LAWA161-950-SSM
LAWA161-1000-SSM
LAWA161-1100-SSM
LAWA161-1200-SSM
ORPLG27-950-SSM
ORPLG27-1000-SSM
ORPLG27-1100-SSM
ORPLG27-1200-SSM
LAWB99-950-SSM
LAWB99-1000-SSM
LAWB99-1100-SSM
LAWB99-1200-SSM
161SAS-950-SSM
161SAS-1000-SSM
161SAS-1100-SSM
161SAS-1200-SSM

2.3 Glass Composition Analysis

Chemical analyses were performed on a representative sample of each of the glasses listed in Table 2-1 to allow for comparisons with the targeted compositions. Three dissolution techniques, sodium peroxide fusion (PF),[2] lithium metaborate fusion (LM),[3] and potassium hydroxide fusion (KH),[4] were used for preparing each of the glass samples for analysis.

Each of the prepared samples was analyzed twice for each element of interest by Inductively Coupled Plasma – Atomic Emission Spectroscopy (ICP-AES)[5] or ion chromatography (IC).[6] A sample of the low-level reference material (LRM)[7] glass was included as a check of the performance of the ICP-AES and IC instruments. The LRM composition reported as the "Consensus Average" is used as the reference composition of this glass for the purposes of this study.[7] The prepared samples from the LAWA161-series glasses were each measured a single time by Inductively Coupled Plasma – Mass Spectroscopy (ICP-MS)[8] to determine cesium concentrations. 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	LM	ICP-AES
B	PF	ICP-AES
Ca	LM	ICP-AES
Cl	KH	IC
Cr	LM	ICP-AES
Cs	LM	ICP-MS
F	KH	IC
Fe	LM	ICP-AES
K	LM	ICP-AES
Li	PF	ICP-AES
Mg	LM	ICP-AES
Mn	LM	ICP-AES
Na	LM	ICP-AES
Ni	LM	ICP-AES
P	LM	ICP-AES
Pb	LM	ICP-AES
S	LM	ICP-AES
Si	PF	ICP-AES
Sn	LM	ICP-AES
V	LM	ICP-AES
Zn	LM	ICP-AES
Zr	LM	ICP-AES

2.4 Wash Solution Analysis

Chemical analyses were performed on a representative sample of each of the wash solutions from the SSM glasses listed in Table 2-1. These wash solutions were prepared at PNNL and provided to SRNL for analysis. Each of the samples was analyzed in duplicate for each element of interest by ICP-AES[5] and IC.[6] The samples from the LAWA161-series glasses were each measured a single time by ICP-MS to determine cesium concentrations. The measurement methods used for each of the reported wash solution components are listed in Table 2-3.

Note that PNNL provided a second sample of the wash solution resulting from the fabrication of glass LAWA161-950-SSM for analysis. The suffix -W2 was added to identify this sample. Cesium concentration was not determined for this second sample.

Table 2-3. Measurement Methods Used in Reporting the Concentrations of Each of the Analytes of the Wash Solutions

Analyte	Measurement Method
Al	ICP-AES
B	ICP-AES
Ca	ICP-AES
Cl^-	IC
Cr	ICP-AES
Cs	ICP-MS
F^-	IC
Fe	ICP-AES
K	ICP-AES
Li	ICP-AES
Mg	ICP-AES
Na	ICP-AES
Ni	ICP-AES
P	ICP-AES
Pb	ICP-AES
S	ICP-AES
Si	ICP-AES
Sn	ICP-AES
Ti	ICP-AES
V	ICP-AES
Zn	ICP-AES
Zr	ICP-AES

3.0 Results and Discussion

3.1 Review of the Glass Composition Measurements

Table A-1 and Table A-2 in Appendix A provide the elemental concentration measurements in wt % for the study glasses. The duplicate measurements for each prepared glass sample are shown. Elemental measurements for the LRM glass are also included in these tables. The LRM measurements are within the acceptability limits utilized by SRNL.[5] Table A-3 in Appendix A provides the elemental cesium concentrations measured in the prepared glass samples and the dilution factors used to convert the values to wt % oxide. The data in these tables are provided so that the values are readily available should they be of interest for future reviews.

The duplicate (except for cesium) measurements for each analyte were converted to oxides using the appropriate gravimetric factors and averaged to determine a representative chemical composition for each glass. A sum of oxides was also computed for each glass using the averaged, measured values. All the measured sums of oxides for the study glasses fall within the interval of 96.2 to 100.4 wt %, indicating acceptable recovery of the glass components. Table A-4 in Appendix A provides a summary of the average compositions as well as the targeted compositions and some relative differences. Entries in Table A-4 show the relative differences between the measured values and the targeted values for those oxides with measured values that were above the limits of detection.

3.2 Review and Evaluation of Wash Solution Measurements

Table B-1 and Table B-2 in Appendix B provide the elemental concentration measurements in mg/L for the wash solutions as measured by ICP-AES. Table B-3 in Appendix B provides the anion concentration measurements in mg/L for the wash solutions as measured by IC. Table B-4 in Appendix B provides the cesium concentration measurements in mg/L for the wash solutions as measured by ICP-MS. The data in these tables are provided so that the values are readily available should they be of interest for future reviews.

The duplicate measurements for each analyte (except for cesium) for each wash solution were averaged to determine a representative chemical composition for each solution. Table B-5 in Appendix B provides a summary of the average measured compositions of the wash solutions.

Note that no significant differences were observed among the measured concentration values for samples LAWA161-950-SSM-W and LAWA161-950-SSM-W2.

4.0 Summary

In this report, SRNL provides chemical analysis for several simulated LAW glass compositions, as well as chemical analysis of the wash solutions resulting from the preparation of these glasses. PNNL selected and fabricated these glasses as part of a study on sulfur retention in glasses as a function of melting temperature.

Chemical analyses were performed on a representative sample of each of the study glasses to allow for comparisons with the targeted compositions. Three dissolution techniques, sodium peroxide fusion, lithium metaborate fusion, and potassium hydroxide fusion, were used for preparing each of the glass samples for analysis. Each of the samples was analyzed twice for each element of interest by ICP-AES or IC. Cesium concentrations were measured a single time by ICP-MS. A glass standard was also measured as a check of the performance of the analytical instruments. Average concentrations of each of the glass components were determined and reported.

Chemical analyses were also performed on a representative sample of each of the wash solutions resulting from the preparation of the SSM versions of the study glasses. The samples were analyzed in duplicate for each element of interest by ICP-AES or IC. Cesium concentrations were measured by ICP-MS. Average concentrations of each analyte were determined and reported.

These results will be used by PNNL in the development of improved property/composition models for LAW glass production at Hanford.

5.0 References

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Appendix A Tables Supporting the Chemical Analysis of the Study Glasses

Table A-1. ICP-AES and IC Measurement Data (elemental wt %) for the Study Glasses (Part 1 of 2)

Sample ID	Lab ID	Al	B	Ca	Cl	Cr	F	Fe	K	Li	Mg
LRM	-	5.03	2.45	0.386	<0.0500	0.124	0.886	1.10	1.19	<0.100	<0.100
LAWA161-950-SSM-S	S-7491	4.93	4.07	5.53	0.330	<0.100	<0.0500	0.751	0.291	<0.100	0.582
LAWA161-950-SSM-S	S-7491	4.91	3.80	5.45	0.339	<0.100	<0.0500	0.752	0.293	<0.100	0.580
LAWA161-1000-SSM-S	S-7492	5.48	3.87	6.04	0.355	<0.100	<0.0500	0.755	0.324	<0.100	0.649
LAWA161-1000-SSM-S	S-7492	5.45	4.34	5.92	0.342	<0.100	<0.0500	0.756	0.320	<0.100	0.646
LAWA161-1100-SSM-S	S-7493	5.44	4.24	5.98	0.328	<0.100	<0.0500	0.726	0.321	<0.100	0.643
LAWA161-1100-SSM-S	S-7493	5.40	4.11	5.97	0.377	<0.100	<0.0500	0.712	0.311	<0.100	0.628
LAWA161-1200-SSM-S	S-7494	5.46	4.18	5.96	0.391	<0.100	<0.0500	0.698	0.326	<0.100	0.618
LAWA161-1200-SSM-S	S-7494	5.29	4.00	5.82	0.332	<0.100	<0.0500	0.687	0.327	<0.100	0.616
ORPLG27-950-SSM-S	S-7495	3.12	2.23	1.97	<0.0500	0.214	<0.0500	0.225	3.77	<0.100	0.265
ORPLG27-950-SSM-S	S-7495	2.99	2.17	1.95	<0.0500	0.211	<0.0500	0.225	3.63	<0.100	0.262
ORPLG27-1000-SSM-S	S-7496	2.99	2.39	1.94	<0.0500	0.221	0.0554	0.217	3.68	<0.100	0.253
ORPLG27-1000-SSM-S	S-7496	3.27	2.41	2.12	<0.0500	0.243	0.0550	0.215	4.02	<0.100	0.283
ORPLG27-1100-SSM-S	S-7497	3.25	2.33	2.13	<0.0500	0.272	<0.0500	0.221	4.02	<0.100	0.278
ORPLG27-1100-SSM-S	S-7497	3.34	2.29	2.12	<0.0500	0.270	<0.0500	0.219	4.18	<0.100	0.277
ORPLG27-1200-SSM-S	S-7498	3.28	2.16	2.10	<0.0500	0.282	0.0590	0.219	3.96	<0.100	0.278
ORPLG27-1200-SSM-S	S-7498	3.32	2.40	2.10	<0.0500	0.277	0.0633	0.214	4.08	<0.100	0.274
LAWB99-950-SSM-S	S-7499	4.96	3.37	6.83	<0.0500	<0.100	<0.0500	0.873	0.314	1.32	0.654
LAWB99-950-SSM-S	S-7499	4.92	3.16	6.75	<0.0500	<0.100	<0.0500	0.874	0.303	1.28	0.646
LAWB99-1000-SSM-S	S-7500	4.89	3.05	6.74	<0.0500	<0.100	<0.0500	0.851	0.296	1.27	0.639
LAWB99-1000-SSM-S	S-7500	5.39	2.97	7.20	<0.0500	<0.100	<0.0500	0.853	0.338	1.25	0.698
LAWB99-1100-SSM-S	S-7501	5.27	3.33	7.15	<0.0500	<0.100	<0.0500	0.836	0.328	1.35	0.693
LAWB99-1100-SSM-S	S-7501	5.21	3.36	7.16	<0.0500	<0.100	<0.0500	0.832	0.331	1.35	0.695
LAWB99-1200-SSM-S	S-7502	5.25	3.28	7.20	<0.0500	<0.100	<0.0500	0.818	0.324	1.33	0.683
LAWB99-1200-SSM-S	S-7502	5.19	3.22	7.09	<0.0500	<0.100	<0.0500	0.803	0.324	1.31	0.674
161SAS-950-SSM-S	S-7503	5.15	4.30	5.72	<0.0500	<0.100	<0.0500	0.727	<0.100	<0.100	0.603
161SAS-950-SSM-S	S-7503	5.02	4.23	5.58	<0.0500	<0.100	<0.0500	0.797	<0.100	<0.100	0.593
161SAS-1000-SSM-S	S-7504	4.94	4.23	5.48	<0.0500	<0.100	<0.0500	0.782	<0.100	<0.100	0.583
161SAS-1000-SSM-S	S-7504	4.85	3.92	5.49	<0.0500	<0.100	<0.0500	0.776	<0.100	<0.100	0.578
161SAS-1100-SSM-S	S-7505	5.34	3.84	5.92	<0.0500	<0.100	<0.0500	0.749	<0.100	<0.100	0.630
161SAS-1100-SSM-S	S-7505	5.29	4.39	5.93	<0.0500	<0.100	<0.0500	0.746	<0.100	<0.100	0.621
161SAS-1200-SSM-S	S-7506	5.40	4.31	5.98	<0.0500	<0.100	<0.0500	0.740	<0.100	<0.100	0.630
161SAS-1200-SSM-S	S-7506	5.37	4.11	5.88	<0.0500	<0.100	<0.0500	0.747	<0.100	<0.100	0.616

Table A-2. ICP-AES and IC Measurement Data (elemental wt %) for the Study Glasses (Part 2 of 2)

Sample ID	Lab ID	Na	Ni	P	Pb	S	Si	Sn	Ti	V	Zn	Zr
LRM	-	15.4	0.114	0.201	<0.100	0.0856	24.0	<0.100	<0.100	<0.100	<0.100	0.678
LAWA161-950-SSM-S	S-7491	14.4	<0.100	<0.100	<0.100	0.444	17.8	<0.100	<0.100	0.508	2.26	1.99
LAWA161-950-SSM-S	S-7491	14.3	<0.100	<0.100	<0.100	0.455	16.9	<0.100	<0.100	0.505	2.22	1.97
LAWA161-1000-SSM-S	S-7492	16.0	<0.100	<0.100	<0.100	0.501	16.0	<0.100	<0.100	0.576	2.50	2.21
LAWA161-1000-SSM-S	S-7492	15.8	<0.100	<0.100	<0.100	0.500	15.8	<0.100	<0.100	0.568	2.49	2.19
LAWA161-1100-SSM-S	S-7493	16.0	<0.100	<0.100	<0.100	0.526	15.4	<0.100	<0.100	0.565	2.49	2.16
LAWA161-1100-SSM-S	S-7493	16.0	<0.100	<0.100	<0.100	0.522	14.9	<0.100	<0.100	0.549	2.49	2.16
LAWA161-1200-SSM-S	S-7494	16.0	<0.100	<0.100	<0.100	0.528	16.5	<0.100	<0.100	0.545	2.50	2.21
LAWA161-1200-SSM-S	S-7494	15.5	<0.100	<0.100	<0.100	0.526	15.9	<0.100	<0.100	0.545	2.41	2.14
ORPLG27-950-SSM-S	S-7495	15.3	<0.100	<0.100	<0.100	0.398	19.0	2.34	<0.100	<0.100	2.06	4.41
ORPLG27-950-SSM-S	S-7495	15.3	<0.100	<0.100	<0.100	0.383	19.2	2.36	<0.100	<0.100	2.05	4.37
ORPLG27-1000-SSM-S	S-7496	15.1	<0.100	<0.100	<0.100	0.388	18.6	2.33	<0.100	<0.100	2.04	4.34
ORPLG27-1000-SSM-S	S-7496	16.3	<0.100	<0.100	<0.100	0.436	19.3	2.59	<0.100	<0.100	2.23	4.74
ORPLG27-1100-SSM-S	S-7497	16.4	<0.100	<0.100	<0.100	0.429	18.0	2.61	<0.100	<0.100	2.25	4.78
ORPLG27-1100-SSM-S	S-7497	16.4	<0.100	<0.100	<0.100	0.427	18.1	2.62	<0.100	<0.100	2.26	4.82
ORPLG27-1200-SSM-S	S-7498	16.3	<0.100	<0.100	<0.100	0.479	18.9	2.57	<0.100	<0.100	2.21	4.74
ORPLG27-1200-SSM-S	S-7498	16.3	<0.100	<0.100	<0.100	0.481	19.5	2.60	<0.100	<0.100	2.22	4.75
LAWB99-950-SSM-S	S-7499	7.77	<0.100	<0.100	<0.100	0.594	19.8	<0.100	<0.100	0.632	2.71	2.37
LAWB99-950-SSM-S	S-7499	7.62	<0.100	<0.100	<0.100	0.590	19.6	<0.100	<0.100	0.616	2.66	2.34
LAWB99-1000-SSM-S	S-7500	7.66	<0.100	<0.100	<0.100	0.605	18.9	<0.100	<0.100	0.609	2.65	2.32
LAWB99-1000-SSM-S	S-7500	8.31	<0.100	<0.100	<0.100	0.668	18.8	<0.100	<0.100	0.672	2.91	2.55
LAWB99-1100-SSM-S	S-7501	8.26	<0.100	<0.100	<0.100	0.700	18.6	<0.100	<0.100	0.666	2.87	2.51
LAWB99-1100-SSM-S	S-7501	8.20	<0.100	<0.100	<0.100	0.724	17.8	<0.100	<0.100	0.666	2.87	2.51
LAWB99-1200-SSM-S	S-7502	8.54	<0.100	<0.100	<0.100	0.726	19.6	<0.100	<0.100	0.660	2.88	2.50
LAWB99-1200-SSM-S	S-7502	8.31	<0.100	<0.100	<0.100	0.697	19.4	<0.100	<0.100	0.650	2.80	2.46
161SAS-950-SSM-S	S-7503	15.9	<0.100	<0.100	<0.100	0.682	16.4	<0.100	<0.100	<0.100	2.34	2.09
161SAS-950-SSM-S	S-7503	15.5	<0.100	<0.100	<0.100	0.669	16.4	<0.100	<0.100	<0.100	2.29	2.03
161SAS-1000-SSM-S	S-7504	15.0	<0.100	<0.100	<0.100	0.522	18.1	<0.100	<0.100	<0.100	2.26	2.00
161SAS-1000-SSM-S	S-7504	14.9	<0.100	<0.100	<0.100	0.529	17.6	<0.100	<0.100	<0.100	2.23	1.98
161SAS-1100-SSM-S	S-7505	16.2	<0.100	<0.100	<0.100	0.622	16.9	<0.100	<0.100	<0.100	2.47	2.18
161SAS-1100-SSM-S	S-7505	16.2	<0.100	<0.100	<0.100	0.609	16.4	<0.100	<0.100	<0.100	2.46	2.17
161SAS-1200-SSM-S	S-7506	16.4	<0.100	<0.100	<0.100	0.652	16.2	<0.100	<0.100	<0.100	2.48	2.20
161SAS-1200-SSM-S	S-7506	16.3	<0.100	<0.100	<0.100	0.624	16.7	<0.100	<0.100	<0.100	2.46	2.19

Table A-3. ICP-MS Measurement Data for Cesium Concentrations in the Study Glasses

Sample ID	LAWA161-950-SSM-S	LAWA161-1000-SSM-S	LAWA161-1100-SSM-S	LAWA161-1200-SSM-S
Lab ID	LW9927 S-7491	LW9928 S-7492	LW9929 S-7493	LW9930 S-7494
Measured Cs (ug/L)	4.24E+02	4.20E+02	4.26E+02	4.33E+02
Solution Volume(L)	0.250	0.250	0.250	0.250
Sample Mass (g)	0.1504	0.1511	0.1512	0.1504
g Cs / g sample	7.05E-04	6.95E-04	7.04E-04	7.19E-04
Cs_2O (wt %)	0.07	0.07	0.07	0.08

Table A-4. Summary of Measured Composition Data (wt % oxide) for the Study Glasses

Glass ID	View	Al_2O_3	B_2O_3	CaO	Cl^-	Cr_2O_3	Cs2O	F^-	Fe_2O_3	K_2O	Li_2O	MgO	Na_2O	NiO	P_2O_5	PbO	SO_3	SiO_2	SnO_2	TiO_2	V_2O_5	ZnO	ZrO_2	Sum
LRM	Measured	9.50	7.87	0.540	<0.0500	0.181		0.886	1.57	1.43	<0.215	<0.166	20.7	0.146	0.462	<0.108	0.214	51.3	<0.127	<0.167	<0.179	<0.124	0.916	96.9
	Targeted	9.51	7.85	0.54	0	0.19		0.86	1.38	1.48	0.11	0.1	20.03	0.19	0.54	0.1	0.3	54.2	0	0.1	0	0	0.93	98.4
	Percent Error	0%	0%	0%		-5%		3%	14%	-3%			3%	-23%	-14%		-29%	-5%					-2%	
LAWA161-950-SSM-S	Measured	9.30	12.7	7.68	0.334	<0.146	0.07	<0.0500	1.07	0.352	<0.215	0.963	19.4	<0.127	<0.229	<0.108	1.12	37.1	<0.127	<0.167	0.904	2.79	2.68	97.6
	Targeted	10.16	13.67	7.99	1.17	0.02	0.15	0	1	0.44	0	1	20.66	0	0	0	0.19	36.58	0	0	1	2.99	2.99	100.0
	Percent Error	-8%	-7%	-4%	-71%		-53%		7%	-20%		-4%	-6%				n/a	1%			-10%	-7%	-10%	
LAWA161-1000-SSM-S	Measured	10.3	13.2	8.37	0.348	<0.146	0.07	<0.0500	1.08	0.388	<0.215	1.07	21.4	<0.127	<0.229	<0.108	1.25	34.0	<0.127	<0.167	1.02	3.10	2.97	99.7
	Targeted	10.16	13.67	7.99	1.17	0.02	0.15	0	1	0.44	0	1	20.66	0	0	0	0.19	36.58	0	0	1	2.99	2.99	100.0
	Percent Error	1%	-3%	5%	-70%		-53%		8%	-12%		7%	4%				n/a	-7%			2%	4%	-1%	
LAWA161-1100-SSM-S	Measured	10.2	13.4	8.36	0.353	<0.146	0.07	<0.0500	1.03	0.381	<0.215	1.05	21.5	<0.127	<0.229	<0.108	1.31	32.4	<0.127	<0.167	0.995	3.10	2.92	98.2
	Targeted	10.16	13.67	7.99	1.17	0.02	0.15	0	1	0.44	0	1	20.66	0	0	0	0.19	36.58	0	0	1	2.99	2.99	100.0
	Percent Error	0%	-2%	5%	-70%		-53%		3%	-13%		5%	4%				n/a	-11%			-1%	4%	-2%	
LAWA161-1200-SSM-S	Measured	10.2	13.2	8.24	0.361	<0.146	0.08	<0.0500	0.990	0.393	<0.215	1.02	21.3	<0.127	<0.229	<0.108	1.32	34.7	<0.127	<0.167	0.973	3.05	2.93	99.9
	Targeted	10.16	13.67	7.99	1.17	0.02	0.15	0	1	0.44	0	1	20.66	0	0	0	0.19	36.58	0	0	1	2.99	2.99	100.0
	Percent Error	0%	-3%	3%	-69%		-47%		-1%	-11%		2%	3%				n/a	-5%			-3%	2%	-2%	
ORPLG27-950-SSM-S	Measured	5.78	7.07	2.74	<0.0500	0.310		<0.0500	0.321	4.46	<0.215	0.437	20.6	<0.127	<0.229	<0.108	0.976	40.9	2.98	<0.167	<0.179	2.55	5.93	96.2
	Targeted	6.03	7.92	2.69	0.23	0.59		0.09	0.28	5.75	0	0.44	21	0.01	0.14	0.01	0.41	42.1	3.19	0	0	2.69	6.44	100.0
	Percent Error	-4%	-11%	2%		-47%			15%	-22%		-1%	-2%				n/a	-3%	-7%			-5%	-8%	
ORPLG27-1000-SSM-S	Measured	5.91	7.72	2.84	<0.0500	0.339		0.0552	0.309	4.64	<0.215	0.444	21.2	<0.127	<0.229	<0.108	1.03	40.6	3.12	<0.167	<0.179	2.66	6.13	98.1
	Targeted	6.03	7.92	2.69	0.23	0.59		0.09	0.28	5.75	0	0.44	21	0.01	0.14	0.01	0.41	42.1	3.19	0	0	2.69	6.44	100.0
	Percent Error	-2%	-3%	6%		-43%		-39%	10%	-19%		1%	1%				n/a	-4%	-2%			-1%	-5%	
ORPLG27-1100-SSM-S	Measured	6.23	7.43	2.98	<0.0500	0.396		<0.0500	0.314	4.94	<0.215	0.461	22.1	<0.127	<0.229	<0.108	1.07	38.6	3.32	<0.167	<0.179	2.81	6.48	98.3
	Targeted	6.03	7.92	2.69	0.23	0.59		0.09	0.28	5.75	0	0.44	21	0.01	0.14	0.01	0.41	42.1	3.19	0	0	2.69	6.44	100.0
	Percent Error	3%	-6%	11%		-33%			12%	-14%		5%	5%				n/a	-8%	4%			4%	1%	
ORPLG27-1200-SSM-S	Measured	6.23	7.33	2.94	<0.0500	0.408		0.0612	0.309	4.85	<0.215	0.457	22.0	<0.127	<0.229	<0.108	1.20	41.0	3.28	<0.167	<0.179	2.76	6.41	100.3
	Targeted	6.03	7.92	2.69	0.23	0.59		0.09	0.28	5.75	0	0.44	21	0.01	0.14	0.01	0.41	42.1	3.19	0	0	2.69	6.44	100.0
	Percent Error	3%	-7%	9%		-31%		-32%	10%	-16%		4%	5%				n/a	-3%	3%			3%	0%	
LAWAB99-950-SSM-S	Measured	9.33	10.5	9.51	<0.0500	<0.146		<0.0500	1.25	0.372	2.80	1.08	10.4	<0.127	<0.229	<0.108	1.48	42.2	<0.127	<0.167	1.11	3.34	3.19	97.6
	Targeted	10.15	11.01	10.21	0.01	0.11		0.07	1.15	0.41	3.54	1.15	10	0	0.03	0	0.75	43.08	0	0	1.24	3.54	3.54	100.0
	Percent Error	-8%	-5%	-7%					9%	-9%	-21%	-6%	4%				n/a	-2%			-10%	-6%	-10%	
LAWAB99-1000-SSM-S	Measured	9.71	9.70	9.75	<0.0500	<0.146		<0.0500	1.22	0.382	2.72	1.11	10.8	<0.127	<0.229	<0.108	1.59	40.4	<0.127	<0.167	1.14	3.46	3.29	96.3
	Targeted	10.15	11.01	10.21	0.01	0.11		0.07	1.15	0.41	3.54	1.15	10	0	0.03	0	0.75	43.08	0	0	1.24	3.54	3.54	100.0
	Percent Error	-4%	-12%	-5%					6%	-7%	-23%	-3%	8%				n/a	-6%			-8%	-2%	-7%	
LAWAB99-1100-SSM-S	Measured	9.91	10.8	10.0	<0.0500	<0.146		<0.0500	1.19	0.397	2.90	1.15	11.1	<0.127	<0.229	<0.108	1.78	39.0	<0.127	<0.167	1.19	3.57	3.39	97.4
	Targeted	10.15	11.01	10.21	0.01	0.11		0.07	1.15	0.41	3.54	1.15	10	0	0.03	0	0.75	43.08	0	0	1.24	3.54	3.54	100.0
	Percent Error	-2%	-2%	-2%					3%	-3%	-18%	0%	11%				n/a	-9%			-4%	1%	-4%	
LAWAB99-1200-SSM-S	Measured	9.86	10.5	9.99	<0.0500	<0.146		<0.0500	1.16	0.390	2.83	1.12	11.4	<0.127	<0.229	<0.108	1.78	41.7	<0.127	<0.167	1.17	3.53	3.35	99.8
	Targeted	10.15	11.01	10.21	0.01	0.11		0.07	1.15	0.41	3.54	1.15	10	0	0.03	0	0.75	43.08	0	0	1.24	3.54	3.54	100.0
	Percent Error	-3%	-5%	-2%					1%	-5%	-20%	-3%	14%				n/a	-3%			-6%	0%	-5%	
161SAS-950-SSM-S	Measured	9.61	13.7	7.91	<0.0500	<0.146		<0.0500	1.09	<0.120	<0.215	0.992	21.2	<0.127	<0.229	<0.108	1.69	35.1	<0.127	<0.167	<0.179	2.88	2.78	98.5
	Targeted	10.47	14.09	8.23	0	0		0	1.03	0	0	1.03	21.29	0	0	0	0	37.7	0	0	0	3.08	3.08	100.0
	Percent Error	-8%	-3%	-4%					6%			-4%	0%				n/a	-7%				-6%	-10%	
161SAS-1000-SSM-S	Measured	9.25	13.1	7.68	<0.0500	<0.146		<0.0500	1.11	<0.120	<0.215	0.963	20.2	<0.127	<0.229	<0.108	1.31	38.2	<0.127	<0.167	<0.179	2.79	2.69	98.8
	Targeted	10.47	14.09	8.23	0	0		0	1.03	0	0	1.03	21.29	0	0	0	0	37.7	0	0	0	3.08	3.08	100.0
	Percent Error	-12%	-7%	-7%					8%			-7%	-5%				n/a	1%				-9%	-13%	
161SAS-1100-SSM-S	Measured	10.0	13.2	8.29	<0.0500	<0.146		<0.0500	1.07	<0.120	<0.215	1.04	21.9	<0.127	<0.229	<0.108	1.54	35.6	<0.127	<0.167	<0.179	3.07	2.93	100.2
	Targeted	10.47	14.09	8.23	0	0		0	1.03	0	0	1.03	21.29	0	0	0	0	37.7	0	0	0	3.08	3.08	100.0
	Percent Error	-4%	-6%	1%					4%			1%	3%				n/a	-6%				0%	-5%	
161SAS-1200-SSM-S	Measured	10.2	13.6	8.29	<0.0500	<0.146		<0.0500	1.06	<0.120	<0.215	1.03	22.0	<0.127	<0.229	<0.108	1.59	35.1	<0.127	<0.167	<0.179	3.07	2.96	100.4
	Targeted	10.47	14.09	8.23	0	0		0	1.03	0	0	1.03	21.29	0	0	0	0	37.7	0	0	0	3.08	3.08	100.0
	Percent Error	-3%	-3%	1%					3%			0%	3%				n/a	-7%				0%	-4%	

Appendix B Tables and Exhibits Supporting the Wash Solution Chemical Composition Analysis

Table B-1. ICP-AES Measurement Data (mg/L) for the Study Glass Wash Solutions (Part 1 of 2)

Sample ID	Lab ID	Al	B	Ca	Cr	Fe	K	Li	Mg	Na	Ni
LAWA161-950-SSM-W	S-7507	<1.00	5.41	<1.00	<1.00	<1.00	<0.500	<1.00	<1.00	44.1	<1.00
LAWA161-950-SSM-W	S-7507	<1.00	6.18	<1.00	<1.00	<1.00	<0.500	<1.00	<1.00	47.3	<1.00
LAWA161-950-SSM-W2	S-7570	<1.00	6.13	<1.00	<1.00	<1.00	<0.500	-	<1.00	48.1	-
LAWA161-950-SSM-W2	S-7570	<1.00	6.05	<1.00	<1.00	<1.00	<0.500	-	<1.00	49.1	-
LAWA161-1000-SSM-W	S-7508	<1.00	10.3	3.17	<1.00	<1.00	6.16	<1.00	<1.00	262	<1.00
LAWA161-1000-SSM-W	S-7508	<1.00	9.57	3.16	<1.00	<1.00	5.58	<1.00	<1.00	256	<1.00
LAWA161-1100-SSM-W	S-7509	<1.00	25.2	18.6	<1.00	<1.00	27.4	<1.00	<1.00	949	<1.00
LAWA161-1100-SSM-W	S-7509	<1.00	23.2	18.8	<1.00	<1.00	27.0	<1.00	<1.00	896	<1.00
LAWA161-1200-SSM-W	S-7510	<1.00	25.9	18.9	1.17	<1.00	24.6	<1.00	<1.00	836	<1.00
LAWA161-1200-SSM-W	S-7510	<1.00	27.9	19.1	1.21	<1.00	26.7	<1.00	<1.00	820	<1.00
ORPLG27-950-SSM-W	S-7511	<1.00	12.9	<1.00	35.9	<1.00	208	<1.00	<1.00	500	<1.00
ORPLG27-950-SSM-W	S-7511	<1.00	12.6	<1.00	36.6	<1.00	194	<1.00	<1.00	475	<1.00
ORPLG27-1000-SSM-W	S-7512	<1.00	17.1	<1.00	58.5	<1.00	282	<1.00	<1.00	676	<1.00
ORPLG27-1000-SSM-W	S-7512	<1.00	18.4	<1.00	58.7	<1.00	296	<1.00	<1.00	696	<1.00
ORPLG27-1100-SSM-W	S-7513	<1.00	22.2	<1.00	53.8	<1.00	348	<1.00	<1.00	799	<1.00
ORPLG27-1100-SSM-W	S-7513	<1.00	21.9	<1.00	53.7	<1.00	362	<1.00	<1.00	843	<1.00
ORPLG27-1200-SSM-W	S-7514	<1.00	29.6	<1.00	55.5	<1.00	375	<1.00	<1.00	911	<1.00
ORPLG27-1200-SSM-W	S-7514	<1.00	31.3	<1.00	55.8	<1.00	369	<1.00	<1.00	884	<1.00
LAWB99-950-SSM-W	S-7515	<1.00	6.59	72.6	5.29	<1.00	23.0	45.3	<1.00	637	<1.00
LAWB99-950-SSM-W	S-7515	<1.00	6.66	73.0	5.25	<1.00	23.1	44.9	<1.00	645	<1.00
LAWB99-1000-SSM-W	S-7516	<1.00	6.69	74.6	3.88	<1.00	25.1	46.9	<1.00	604	<1.00
LAWB99-1000-SSM-W	S-7516	<1.00	6.20	74.2	3.84	<1.00	23.5	46.9	<1.00	624	<1.00
LAWB99-1100-SSM-W	S-7517	<1.00	7.65	69.1	3.18	<1.00	23.5	41.8	<1.00	523	<1.00
LAWB99-1100-SSM-W	S-7517	<1.00	7.84	69.1	3.18	<1.00	24.8	41.6	<1.00	511	<1.00
LAWB99-1200-SSM-W	S-7518	<1.00	11.1	58.2	2.80	<1.00	25.2	38.3	<1.00	521	<1.00
LAWB99-1200-SSM-W	S-7518	<1.00	11.4	58.4	2.76	<1.00	25.6	38.5	<1.00	509	<1.00
161SAS-950-SSM-W	S-7519	<1.00	16.6	7.83	<1.00	<1.00	1.12	<1.00	<1.00	617	<1.00
161SAS-950-SSM-W	S-7519	<1.00	14.8	7.82	<1.00	<1.00	0.934	<1.00	<1.00	630	<1.00
161SAS-1000-SSM-W	S-7520	<1.00	17.8	10.3	<1.00	<1.00	1.38	<1.00	<1.00	824	<1.00
161SAS-1000-SSM-W	S-7520	<1.00	16.2	10.3	<1.00	<1.00	1.18	<1.00	<1.00	773	<1.00
161SAS-1100-SSM-W	S-7521	<1.00	21.2	13.2	<1.00	<1.00	1.16	<1.00	<1.00	743	<1.00
161SAS-1100-SSM-W	S-7521	<1.00	23.3	13.3	<1.00	<1.00	1.20	<1.00	<1.00	743	<1.00
161SAS-1200-SSM-W	S-7522	<1.00	22.9	13.4	<1.00	<1.00	1.16	<1.00	<1.00	664	<1.00
161SAS-1200-SSM-W	S-7522	<1.00	23.2	13.3	<1.00	<1.00	1.17	<1.00	<1.00	649	<1.00

Table B-2. ICP-AES Measurement Data (mg/L) for the Study Glass Wash Solutions (Part 2 of 2)

Sample ID	Lab ID	P	Pb	S	Si	Sn	Ti	V	Zn	Zr
LAWA161-950-SSM-W	S-7507	<2.00	<1.00	9.55	2.13	<1.00	<1.00	1.02	<1.00	<1.00
LAWA161-950-SSM-W	S-7507	<2.00	<1.00	9.47	2.52	<1.00	<1.00	1.03	<1.00	<1.00
LAWA161-950-SSM-W2	S-7570	<2.00	-	8.88	3.50	-	-	<1.00	<1.00	<1.00
LAWA161-950-SSM-W2	S-7570	<2.00	-	9.35	3.63	-	-	<1.00	<1.00	<1.00
LAWA161-1000-SSM-W	S-7508	<2.00	<1.00	165	2.65	<1.00	<1.00	2.48	<1.00	<1.00
LAWA161-1000-SSM-W	S-7508	<2.00	<1.00	171	2.21	<1.00	<1.00	2.48	<1.00	<1.00
LAWA161-1100-SSM-W	S-7509	<2.00	<1.00	570	2.67	<1.00	<1.00	6.25	<1.00	<1.00
LAWA161-1100-SSM-W	S-7509	<2.00	<1.00	574	2.39	<1.00	<1.00	6.36	<1.00	<1.00
LAWA161-1200-SSM-W	S-7510	<2.00	<1.00	515	1.52	<1.00	<1.00	5.96	<1.00	<1.00
LAWA161-1200-SSM-W	S-7510	<2.00	<1.00	522	2.00	<1.00	<1.00	5.99	<1.00	<1.00
ORPLG27-950-SSM-W	S-7511	2.10	<1.00	362	5.57	<1.00	<1.00	<1.00	<1.00	<1.00
ORPLG27-950-SSM-W	S-7511	2.06	<1.00	361	5.50	<1.00	<1.00	<1.00	<1.00	<1.00
ORPLG27-1000-SSM-W	S-7512	3.52	<1.00	512	7.28	<1.00	<1.00	<1.00	<1.00	<1.00
ORPLG27-1000-SSM-W	S-7512	3.77	<1.00	509	8.00	<1.00	<1.00	<1.00	<1.00	<1.00
ORPLG27-1100-SSM-W	S-7513	3.85	<1.00	605	3.03	<1.00	<1.00	<1.00	<1.00	<1.00
ORPLG27-1100-SSM-W	S-7513	4.06	<1.00	602	2.92	<1.00	<1.00	<1.00	<1.00	<1.00
ORPLG27-1200-SSM-W	S-7514	3.90	<1.00	673	4.25	<1.00	<1.00	<1.00	<1.00	<1.00
ORPLG27-1200-SSM-W	S-7514	4.02	<1.00	671	4.74	<1.00	<1.00	<1.00	<1.00	<1.00
LAWB99-950-SSM-W	S-7515	<2.00	<1.00	615	<1.00	<1.00	<1.00	5.42	<1.00	<1.00
LAWB99-950-SSM-W	S-7515	<2.00	<1.00	611	<1.00	<1.00	<1.00	5.50	<1.00	<1.00
LAWB99-1000-SSM-W	S-7516	<2.00	<1.00	600	<1.00	<1.00	<1.00	5.26	<1.00	<1.00
LAWB99-1000-SSM-W	S-7516	<2.00	<1.00	586	<1.00	<1.00	<1.00	5.24	<1.00	<1.00
LAWB99-1100-SSM-W	S-7517	<2.00	<1.00	524	<1.00	<1.00	<1.00	5.08	<1.00	<1.00
LAWB99-1100-SSM-W	S-7517	<2.00	<1.00	530	<1.00	<1.00	<1.00	5.06	<1.00	<1.00
LAWB99-1200-SSM-W	S-7518	<2.00	<1.00	492	<1.00	<1.00	<1.00	5.03	<1.00	<1.00
LAWB99-1200-SSM-W	S-7518	<2.00	<1.00	477	<1.00	<1.00	<1.00	5.02	<1.00	<1.00
161SAS-950-SSM-W	S-7519	<2.00	<1.00	430	3.44	<1.00	<1.00	<1.00	<1.00	<1.00
161SAS-950-SSM-W	S-7519	<2.00	<1.00	431	2.77	<1.00	<1.00	<1.00	<1.00	<1.00
161SAS-1000-SSM-W	S-7520	<2.00	<1.00	503	5.45	<1.00	<1.00	<1.00	<1.00	<1.00
161SAS-1000-SSM-W	S-7520	<2.00	<1.00	501	5.02	<1.00	<1.00	<1.00	<1.00	<1.00
161SAS-1100-SSM-W	S-7521	<2.00	<1.00	484	2.65	<1.00	<1.00	<1.00	<1.00	<1.00
161SAS-1100-SSM-W	S-7521	<2.00	<1.00	480	2.71	<1.00	<1.00	<1.00	<1.00	<1.00
161SAS-1200-SSM-W	S-7522	<2.00	<1.00	458	1.33	<1.00	<1.00	<1.00	<1.00	<1.00
161SAS-1200-SSM-W	S-7522	<2.00	<1.00	454	1.47	<1.00	<1.00	<1.00	<1.00	<1.00

Table B-3. IC Measurement Data (mg/L) for the Study Glass Wash Solutions

Sample ID	Lab ID	Cl	F
1ppm standard	-	0.983	1.08
LAWA161-950-SSM-W	S-7507	<10.0	<10.0
LAWA161-950-SSM-W	S-7507	<10.0	<10.0
LAWA161-1000-SSM-W	S-7508	10.5	<10.0
LAWA161-1000-SSM-W	S-7508	11.7	<10.0
LAWA161-1100-SSM-W	S-7509	114	<10.0
LAWA161-1100-SSM-W	S-7509	112	<10.0
LAWA161-1200-SSM-W	S-7510	106	<10.0
LAWA161-1200-SSM-W	S-7510	110	<10.0
ORPLG27-950-SSM-W	S-7511	10.1	<10.0
ORPLG27-950-SSM-W	S-7511	10.6	<10.0
ORPLG27-1000-SSM-W	S-7512	12.2	<10.0
ORPLG27-1000-SSM-W	S-7512	11.9	<10.0
ORPLG27-1100-SSM-W	S-7513	17.5	<10.0
ORPLG27-1100-SSM-W	S-7513	16.3	<10.0
1ppm standard	-	1.00	1.08
ORPLG27-1200-SSM-W	S-7514	31.3	<10.0
ORPLG27-1200-SSM-W	S-7514	30.4	<10.0
LAWB99-950-SSM-W	S-7515	<10.0	<10.0
LAWB99-950-SSM-W	S-7515	<10.0	<10.0
LAWB99-1000-SSM-W	S-7516	<10.0	<10.0
LAWB99-1000-SSM-W	S-7516	<10.0	<10.0
LAWB99-1100-SSM-W	S-7517	<10.0	<10.0
LAWB99-1100-SSM-W	S-7517	<10.0	<10.0
LAWB99-1200-SSM-W	S-7518	<10.0	<10.0
LAWB99-1200-SSM-W	S-7518	<10.0	<10.0
161SAS-950-SSM-W	S-7519	<10.0	<10.0
161SAS-950-SSM-W	S-7519	<10.0	<10.0
161SAS-1000-SSM-W	S-7520	<10.0	<10.0
161SAS-1000-SSM-W	S-7520	<10.0	<10.0
161SAS-1100-SSM-W	S-7521	<10.0	<10.0
161SAS-1100-SSM-W	S-7521	<10.0	<10.0
161SAS-1200-SSM-W	S-7522	<10.0	<10.0
161SAS-1200-SSM-W	S-7522	<10.0	<10.0
1ppm standard	-	1.06	1.01
5ppm standard	-	5.34	5.22
LAWA161-950-SSM-W2	S-7570	<10.0	<10.0
LAWA161-950-SSM-W2	S-7570	<10.0	<10.0

Table B-4. ICP-MS Measurement Data for Cesium Concentrations in the Study Glass Wash Solutions

Sample ID	LAWA161-950-SSM-S	LAWA161-1000-SSM-S	LAWA161-1100-SSM-S	LAWA161-1200-SSM-S
Lab ID	LW9931 S-7507	LW9932 S-7508	LW9933 S-7509	LW9934 S-7510
Cs (mg/L)	0.110	1.38	7.64	7.53

Table B-5. Summary of Measured Composition Data (mg/L) for the Study Glass Wash Solutions

Identifier	Al	B	Ca	Cl^-	Cr	Cs	F^-	Fe	K	Li	Mg	Na	Ni	P	Pb	S	Si	Sn	Ti	V	Zn	Zr
LAWA161-950-SSM-W	<1.00	5.80	<1.00	<10.0	<1.00	0.110	<10.0	<1.00	<0.500	<1.00	<1.00	45.7	<1.00	<2.00	<1.00	9.51	2.33	<1.00	<1.00	1.02	<1.00	<1.00
LAWA161-950-SSM-W2	<1.00	6.09	<1.00	<10.0	<1.00	-	<10.0	<1.00	<0.500	-	<1.00	48.6	-	<2.00	-	9.12	3.57	-	-	<1.00	<1.00	<1.00
LAWA161-1000-SSM-W	<1.00	9.94	3.17	11.1	<1.00	1.38	<10.0	<1.00	5.87	<1.00	<1.00	259	<1.00	<2.00	<1.00	168	2.43	<1.00	<1.00	2.48	<1.00	<1.00
LAWA161-1100-SSM-W	<1.00	24.2	18.7	113	<1.00	7.64	<10.0	<1.00	27.2	<1.00	<1.00	923	<1.00	<2.00	<1.00	572	2.53	<1.00	<1.00	6.31	<1.00	<1.00
LAWA161-1200-SSM-W	<1.00	26.9	19.0	108	1.19	7.53	<10.0	<1.00	25.6	<1.00	<1.00	828	<1.00	<2.00	<1.00	519	1.76	<1.00	<1.00	5.98	<1.00	<1.00
ORPLG27-950-SSM-W	<1.00	12.7	<1.00	10.3	36.2	-	<10.0	<1.00	201	<1.00	<1.00	487	<1.00	2.08	<1.00	361	5.53	<1.00	<1.00	<1.00	<1.00	<1.00
ORPLG27-1000-SSM-W	<1.00	17.8	<1.00	12.1	58.6	-	<10.0	<1.00	289	<1.00	<1.00	686	<1.00	3.65	<1.00	510	7.64	<1.00	<1.00	<1.00	<1.00	<1.00
ORPLG27-1100-SSM-W	<1.00	22.0	<1.00	16.9	53.8	-	<10.0	<1.00	355	<1.00	<1.00	821	<1.00	3.95	<1.00	603	2.98	<1.00	<1.00	<1.00	<1.00	<1.00
ORPLG27-1200-SSM-W	<1.00	30.5	<1.00	30.9	55.6	-	<10.0	<1.00	372	<1.00	<1.00	898	<1.00	3.96	<1.00	672	4.49	<1.00	<1.00	<1.00	<1.00	<1.00
LAWB99-950-SSM-W	<1.00	6.62	72.8	<10.0	5.27	-	<10.0	<1.00	23.1	45.1	<1.00	641	<1.00	<2.00	<1.00	613	<1.00	<1.00	<1.00	5.46	<1.00	<1.00
LAWB99-1000-SSM-W	<1.00	6.45	74.4	<10.0	3.86	-	<10.0	<1.00	24.3	46.9	<1.00	614	<1.00	<2.00	<1.00	593	<1.00	<1.00	<1.00	5.25	<1.00	<1.00
LAWB99-1100-SSM-W	<1.00	7.75	69.1	<10.0	3.18	-	<10.0	<1.00	24.1	41.7	<1.00	517	<1.00	<2.00	<1.00	527	<1.00	<1.00	<1.00	5.07	<1.00	<1.00
LAWB99-1200-SSM-W	<1.00	11.3	58.3	<10.0	2.78	-	<10.0	<1.00	25.4	38.4	<1.00	515	<1.00	<2.00	<1.00	485	<1.00	<1.00	<1.00	5.02	<1.00	<1.00
161SAS-950-SSM-W	<1.00	15.7	7.83	<10.0	<1.00	-	<10.0	<1.00	1.03	<1.00	<1.00	623	<1.00	<2.00	<1.00	430	3.10	<1.00	<1.00	<1.00	<1.00	<1.00
161SAS-1000-SSM-W	<1.00	17.0	10.3	<10.0	<1.00	-	<10.0	<1.00	1.28	<1.00	<1.00	799	<1.00	<2.00	<1.00	502	5.24	<1.00	<1.00	<1.00	<1.00	<1.00
161SAS-1100-SSM-W	<1.00	22.3	13.3	<10.0	<1.00	-	<10.0	<1.00	1.18	<1.00	<1.00	743	<1.00	<2.00	<1.00	482	2.68	<1.00	<1.00	<1.00	<1.00	<1.00
161SAS-1200-SSM-W	<1.00	23.1	13.3	<10.0	<1.00	-	<10.0	<1.00	1.16	<1.00	<1.00	656	<1.00	<2.00	<1.00	456	1.40	<1.00	<1.00	<1.00	<1.00	<1.00

Distribution:

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