U.S. Department of Energy
Office of River Protection
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DEC 18 2006

06-TF-019

Ms. Jane A. Hedges, Program Manager
Nuclear Waste Program
Washington State
Department of Ecology
3100 Port of Benton Blvd.
Richland, Washington 99354

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EDMC

Dear Ms. Hedges:

TRANSMITTAL OF THE INTEGRATED DISPOSAL FACILITY (IDF) IMMOBILIZED LOW-ACTIVITY WASTE (ILAW) WASTE FORM TECHNICAL REQUIREMENTS DOCUMENT (IWTRD), GLASS FORMULATIONS, TO SATISFY IDF PERMIT CONDITION III.11.I.2.a.i

References:

1. ORP letter from R. J. Schepens to J. A. Hedges, Ecology, "Modification of the Hanford Facility Resource Conservation and Recovery Act Permit for the Treatment, Storage, and Disposal of Dangerous Waste (WA7890008967), Revision 8 to Incorporate a Custodial Care Phase for the Integrated Disposal Facility," 06-TPD-064, dated November 6, 2006.

2. Ecology letter from J. A. Hedges to R. J. Schepens, ORP et al, "Modification of Hanford Facility Resource Conservation and Recovery Act Permit for the Treatment, Storage, and Disposal of Dangerous Waste (WA7890008967), Revision 8 to Incorporate Final Permit Conditions for the Integrated Disposal Facility," dated March 10, 2006.

Enclosed is the ILAW IWTRD, RPP-32071, Rev. 0, dated December 2006, which fulfills IDF Permit Condition III.11.I.2.a.i and describes the glass formulations that are anticipated to be disposed of in the IDF. The final IDF Permit (Reference 2) requires this report to be submitted to the Washington State Department of Ecology (Ecology) by January 31, 2007.

The IDF Permit, as issued, also requires the submittal of a performance assessment (Condition III.11.I.2.a.ii) and a quality assurance/quality control requirements process (Condition III.11.I.2.a.iii) by January 31, 2007. In Reference 1, the U.S. Department of Energy, Office of River Protection (ORP) and CH2M HILL Hanford Group, Inc. (CH2M HILL) requested that Ecology modify the IDF Permit to defer the submittal dates for these two items. The IDF has been placed in a custodial care phase, and will be maintained and monitored to ensure that it retains the integrity of a permitted waste disposal facility. Operation and placement of waste into IDF is not planned in the immediate future. It is our understanding that Ecology is in the process of issuing an agency initiated modification that will defer these submittals.

If you have any questions, please contact me, or your staff may contact Zack Smith, Assistant Manager for Tank Farms Project, (509) 373-9112.

Sincerely,

T. Zack Smith

for Roy J. Schepens, Manager
Office of River Protection

ORP:SAW

Enclosure

cc w/encl:
M. S. Spears, CH2M HILL
CH2M HILL Correspondence

Enclosure

06-TF-019

ILAW WASTE FORM TECHNICAL REQUIREMENTS DOCUMENT (IWTRD), RPP-32071, REV. 0, DATED DECEMBER 2006

Consisting of 32 pages, including coversheet

RPP-32071
Revision 0

ILAW Waste Form Technical Requirements Document (IWTRD)

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Date Published
December 2006

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Contractor for the U.S. Department of Energy
Office of River Protection under Contract DE-AC27-99RL14047

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Release Approval 12/07/2006
Date

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EXECUTIVE SUMMARY

The Resource Conservation and Recovery Act (RCRA) Part B Permit for the Integrated Disposal Facility[1] requires that an Immobilized Low-Activity Waste Form Technical Requirements Document (IWTRD) be created and maintained. This initial version of the IWTRD covers the immobilized low-activity waste to be produced from the Waste Treatment Plant and from the Demonstration Bulk Vitrification System. For each of the two waste forms, it contains

- Glass Compositions and the Basis for Their Selection
- Descriptions of Waste Streams
- Characteristics of the Glasses that Are Key to Satisfactory Performance
- Range of Key Characteristics
- Factors that Must be Controlled to Allow Satisfactory Performance.

[1] *Hanford Facility Resource Conservation and Recovery Act Permit for the Treatment, Storage, and Disposal of Dangerous Waste*, WA7890008967 (Permit) Part III, Operating Unit 11, Unit-Specific Conditions for the Integrated Disposal Facility, Washington State Department of Ecology, Richland, Washington, April 9, 2006.

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Acronyms

AEA	Atomic Energy Act
ASTM	American Society for Testing and Materials
BDAT	Best demonstrated available technology
BV	bulk vitrification
DBVS	Demonstration Bulk Vitrification System
DOE	U.S. Department of Energy
GFC	glass forming chemicals
IDF	Integrated Disposal Facility
ILAW	immobilized low-activity waste
IWTRD	Immobilized Low Activity Waste Form Technical Requirements Document
LDR	Land Disposal Restriction
MLLW	mixed low-level waste
PCT	product consistency test
RCRA	Resource Conservation and Recovery Act
TCLP	toxic characteristic leaching procedure
UHC	underlying hazardous constituents
VHT	vapor hydration test
WTP	Waste Treatment Plant

I. INTRODUCTION

A. Scope

One of the requirements in the RCRA Part B Permit for the Integrated Disposal Facility (IDF) (Ecology 2006) at the U.S. Department's of Energy (DOE) Hanford Site is the creation of the ILAW Waste Form Technical Requirements Document (IWTRD). The requirements are described in Section III.11.I.2.a of the permit and apply to all immobilized low-activity waste (ILAW) glass form(s) that DOE intends to dispose of in the IDF.

B. Background

The IDF consists of a single landfill with two separate, expandable cells. Both cells meet the requirements of the Resource, Conservation, and Recovery Act (RCRA) and the Atomic Energy Act (AEA). Cell 1 will be utilized for the disposal of mixed low-level waste (MLLW), including ILAW, and is permitted under RCRA. Cell 2 will be the disposal site for solid low-level radioactive waste. Both cells will be regulated under the DOE Order on Radioactive Waste Management (DOE O 435.1, DOE 1999). The first phase of IDF construction was completed on April 28, 2006 and included the installation of the cell liners and leachate collection tanks.

ILAW waste forms presently approved for disposal in IDF by the RCRA Permit will come from the Hanford Site Waste Treatment Plant (WTP) and from the Demonstration Bulk Vitrification System (DBVS). WTP is now being designed and constructed in the Hanford 200 East Area. The WTP will receive waste from Hanford's underground storage tanks, separate the streams into high-level and low-activity components, and vitrify both. The immobilized low-activity waste (or glass) is destined for the IDF. DBVS is being designed and will be constructed just west of the S Tank Farm in the Hanford 200 West Area. The DBVS facility will receive only the low-activity waste fraction from Hanford's tanks for vitrification.

The low-activity waste (LAW) to be treated is a result of defense nuclear fuel reprocessing and related chemical separations processes. Five major separation processes were employed: bismuth phosphate ($BiPO_4$); plutonium-uranium extraction (PUREX); reduction-oxidation (REDOX); uranium recovery; and Cs/Sr recovery). The resultant wastes were blended and concentrated by evaporation to reduce volume for storage in large underground storage tanks. Acidic wastes were made basic with sodium hydroxide or sodium carbonate to allow storage in the carbon steel tanks. As a result, the waste consists primarily of precipitated metal hydroxides (sludge), alkaline salt solutions (supernatant), and crystallized salts (saltcake). The total radioactivity in the waste is currently estimated to be about 128.3 MCi in the tank solids and 70.1 MCi in the tank liquids. The principal activity of the waste comes from cesium-137 (^{137}Cs) and strontium-90 (^{90}Sr). The ^{137}Cs wastes are soluble and are primarily contained in the supernatant, and the ^{90}Sr is largely contained in the solids. The wastes are stored in 28 double-shell tanks (DSTs) and 149 older single-shell tanks (SSTs).

C. Regulatory Requirements

The IDF RCRA Part B Permit was issued in March 2006, with an effective date of April 9, 2006. Operation and placement of waste in IDF has been delayed, and in the interim, the IDF will be placed in a custodial care phase and will be maintained and monitored to ensure that it retains its integrity as a permitted waste disposal facility. The Permit will be modified to defer and or reduce Permit conditions that are intended for monitoring of waste activities during the operational phase of the IDF. The current requirements for the contents of the IWTRD as specified by Permit condition III.11.I.2.a.i are:

- A description of each specific glass formulation that DOE intends to use,
- The basis for why each specific formulation is proposed for use,
- Waste streams each glass formulation is proposed for use with
- Characteristics of the glasses that are key to satisfactory performance
- Range in key characteristics anticipated if the specific glass formulation is produced in a production basis with tank waste, and
- Factors that DOE must protect against in producing the glass to ensure the intended glass characteristics will exist in the actual ILAW,

The requirements for a performance assessment and for a description of production processes that were contained in the original permit are being deferred by agreement between DOE and State of Washington, Department of Ecology.

Where information regarding treatment, management, and disposal of the radioactive source, byproduct material and/or special nuclear components of mixed waste (as defined by the Atomic Energy Act of 1954, as amended) has been incorporated into this document, it is not incorporated for the purpose of regulating the radiation hazards of such components under the authority of chapter 70.105 RCW and its implementing regulations but is provided for information purposes only.

D. Future Efforts

This is the initial version of this document. It will be revised (as required by Section III.11.I.2.a.iv of the permit):

- Every five (5) years,
- Whenever a permit modification is submitted requesting additional waste forms be disposed of at the IDF,
- Whenever glass formulations other than already in the IWTRD are intended to be used for ILAW glasses to be disposed of at IDF, or
- Whenever the permit is modified changing the requirements for the ITWRD.

E. Structure of the Document

This chapter provides introduction and background material. The next chapter (II) addresses the information required for the WTP ILAW, while chapter III provides the information on the DBVS ILAW. Tables with supporting data are provided in the appendices:

A WTP Glass Compositions and Properties

B. Waste Streams for WTP

C. DBVS Glass Composition

D. DBVS Waste Stream

II. WTP GLASS COMPOSITIONS

A. Overview

The Waste Treatment Plant (WTP) has 3 major areas:

- waste feed and pretreatment,
- high-level waste (HLW) vitrification, and
- LAW vitrification.

The LAW vitrification processes will combine pretreated waste feeds with glass forming chemicals (GFCs) and melt the mixtures into borosilicate glass that will be poured into stainless steel containers. After the glass melt cools and hardens, lids will be sealed onto each container in preparation for disposal.

B. Glass Compositions and the Bases for Their Selection

Glass formulation development for LAW is primarily divided according to three waste envelopes A, B, and C (Envelope D is a high-level waste stream). Extensive glass testing has occurred to choose reference glasses for each of these envelopes. Table A-1 in Appendix A provides a summary tabulation of the Envelope A, B, and C reference glass compositions.

Envelope A constitutes the majority of LAW that is to be processed. Ultra-filtration during pretreatment will remove entrained solids from the waste while ion-exchange will remove cesium. The resulting Envelope A wastes have relatively little sulfate and high alkalis (primarily Na and K) contents. Two reference glasses for this envelope are LAWA44 and LAWA88, which incorporate 20.0 wt% of Na_2O. These formulations were developed to meet all of the processing and product quality related constraints for WTP ILAW (Muller et al. 2001). Samples of these glass have been well characterized through vitrification demonstrations of various scales (up to pilot scale), which included testing of process variations of ±15% from the targeted blending of waste and glass formers. Numerous samples of the ILAW glass product from these tests have also been characterized and verified to meet all of the WTP contractual constraints and processing requirements.

Envelope B waste is the liquid fraction of the combined envelopes B/D slurry. It has a high level of cesium, most of which will be removed prior to vitrification. Compositionally, this Envelope is characterized by a high sulfate to alkali ratio. The sulfur to alkali ratio largely determines the glass composition. Two reference glasses for this Envelope are LAWB83 and LAWB45 (Muller et al. 2001). They contain 5.47 wt% of Na_2O, towards the lower end of sodium concentrations among all ILAW glasses, and a small amount of K_2O. Lithium is added (~4.3 wt% Li_2O) as a glass forming additive to enhance sulfate incorporation and make up for the otherwise low alkali content. These glass formulations have also been tested with respect to processing and product performance properties, and on both intermediate and pilot melter systems.

Envelope C waste contains relatively high concentrations of cesium, technetium and organically complexed strontium and transuranics. The maximum sulfate to alkali ratio in Envelope C waste is more than twice that of Envelope A waste but roughly half that of Envelope B. Sulfate is also the waste loading limiting component in this case. Pretreatment of Envelope C waste includes cesium removal by ion-exchange and Sr/TRU removal by precipitation. Two

reference glasses for Envelope C are LAWC22 and LAWC31, which contain 14.4 wt% and 11.9 wt% of Na_2O, respectively (intermediate between LAW Envelope A and B glasses) (Muller et al. 2001). Lithium is added in these formulations (roughly 2.6 wt% Li_2O) as an additive to increase the loading of sulfate. Similar to the other LAW reference glasses, LAWC22 and LAWC31 have been subjected to extensive melter testing based on the associated glass formulation development work.

These six glass compositions (LAWA44, LAWA88, LAWB83, LAWB45, LAWC22, and LAWC31) are the current bases and examples of ILAW glass compositions. However, as waste composition data and glass formulation techniques improve through continued study and testing, the glass compositions for any given LAW can be expected to change. For example, Vienna (2005) describes a method of formulation that interpolates between the six glasses described above.

C. Descriptions of Waste Streams

Waste feeds are defined by the WTP Contract (DOE-ORP 2000) as Envelopes: Envelopes A, B, C, and D (where D is a high-level waste feed). Tables in Appendix B provide detailed information. Envelopes A, B, and C contain primarily sodium salts (such as nitrate, nitrite, aluminate, sulfate, phosphate, hydroxide) and soluble radionuclides such as cesium-137 (^{137}Cs) and technetium-99 (^{99}Tc). Most of the early LAW to be treated in the WTP will be from Envelope A. Envelope B has higher ^{137}Cs levels and higher concentrations of glass limiting constituents such as sulfate (SO_4^{-2}). Envelope C contains organically complexed strontium-90 (^{90}Sr) and transuranic (TRU) elements that will have to be removed to ensure that ILAW product specifications will be met. The chemical and radioactive composition limits of the soluble fraction of each waste Envelope is provided in Tables TS-7.1 and TS-7.2 of the WTP Contract.

D. Characteristics of the Glasses that Are Key to Satisfactory Performance

DOE intends to use two short-term tests as well as performance assessment analyses to determine whether glasses have satisfactory performance:

- Product Consistency Test (PCT)
- Vapor Hydration Test (VHT)

The PCT was chosen (Cunnane 1996) because it has been standardized (ASTM-1994) for testing nuclear glass waste forms. The PCT was developed for high-level borisilicate glass waste form testing. The value of the glass corrosion rate is specified as the value based on normalized silicon release as determined by the 7 day PCT test with the surface area of the tested glass as specified in ASTM Method C1285-94 (ASTM).

Use of the PCT, however, raises questions concerning how the results measured in such a short-term test relate to the longer term corrosion performance. The results of the VHT show a strong correlation ($R^2 = 0.91$) with the results of the lengthier and more complex test which mimic disposal facility conditions, the pressurized unsaturated test (see Section 7.5 of the *Hanford Immobilized Low-Activity Waste Performance Assessment: 2001 Version* (Mann et al. 2001). The VHT draft standard test method is currently being developed by technical consensus within ASTM Int. subcommittee C26.13 (ASTM 2003).

The Toxicity Characteristic Leaching Procedure (TCLP) (SW-486, Method 1311) is the standard test used (40 CFR 268.40) by the Environmental Protection Agency for determining how RCRA waste forms dissolve. This test is not currently a constraint as the Land Disposal Restriction (LDR) approach is to extend the best demonstrated available technology (BDAT) to include the four underlying hazardous constituents (UHC) from Hanford tank waste. In addition, for radioactive-mixed waste, HLVIT is the required technology based treatment standard for land disposal. There is currently no plan to delist the ILAW.

E. Range of Key Characteristics

The WTP Contract (DOE-ORP 2000) lists a number of constraints:

- Normalized released of sodium, boron, and silicon as determined by the Product Consistency Test being less than 2 (g/m^2)
- Alteration rate as determined by the vapor hydration test at 200 °C being less than 50 ($g/m^2/d$)
- Waste concentrations being less then Nuclear Regulatory Commission Class C limits (10 CFR 61.55)
- Strontium-90 waste concentration being less than 20 (Ci/m^3)
- Cesium-137 waste concentration limits being less than 3 (Ci/m^3)
- Sodium oxide waste loading being greater than 14 weight per cent for packages made from envelope A, 3% from envelope B, and 10% from envelope C.

The responses of the six example glass compositions to the VHT and PCT are listed in Table A-2 (in Appendix A). The radionuclide concentration related constraints are met by each glass tested. The Toxicity Characteristic Leaching Procedure (TCLP) (EPA 1997) responses for three of the glasses (LAWA88, LAWB83, and LAWC31) glass compositions spiked with excessive concentrations of hazardous components are documented separately (Kot et al. 2004). Longer-term testing including single pass flow-through test, pressurized unsaturated flow-through test, and long-term PCT have been performed on three of the glasses (LAWA44, LAWB45, and LAWC22) along with glass release modeling (Pierce et al. 2004).

F. Factors that Must be Controlled to Allow Satisfactory Performance

Satisfactory performance is defined as compliance to the Contract specifications defined in Section II.D, above. The property constraints can be described as functions of glass composition. These functions are used to control the composition of the feed to the WTP LAW melter so that each property is predicted to be met with sufficient confidence (as described in Vienna 2005). Specifically, the concentrations of major oxide components in glass (Al_2O_3, B_2O_3, CaO, Fe_2O_3, K_2O, Li_2O, MgO, SiO_2, TiO_2, ZnO, and ZrO_2) are controlled by mixing the appropriate amounts of glass forming chemicals and waste together so that the resulting glasses will meet all appropriate product quality and processability constraints.

III. DBVS GLASS COMPOSITIONS

A. Overview

Bulk vitrification is being considered as a supplemental treatment option for the vitrification of low-activity waste. Prior to a decision on such supplemental treatment, a demonstration bulk vitrification system (DBVS) is planned to produce up to fifty packages. The demonstration project will be conducted under a Research Development and Demonstration (RD&D) Permit issued by Ecology. The primary objective for the RD&D project is provide data for waste form qualification, risk assessments and performance assessments for treatment and near-surface land disposal.

B. Glass Compositions and the Bases for Their Selection

The glass formulation for the Demonstration Bulk Vitrification System (DBVS) (Kim et al. 2003 and Kim et al. 2006) is based on a single formulation that uses soil as the main glass former with additions of about 7 wt% ZrO_2 and about 5 wt% B_2O_3. The nominal Na_2O loading is 20wt% (of which, up to about 1.5% of the sodium coming from sodium in the soil, depending on the source of the soil). The base formulation may be modified slightly to reduce the Fe content of the glass by replacing a small amount of the soil with other constituents: silica in the form of silica sand and in the form of $ZrSiO_4$ that was used in place of the ZrO_2. The table in Appendix C presents the composition of the Horn Rapids Test Site soil as well as the range of the glass compositions tested to date.

The DBVS glass formulation was developed for the original waste simulant and actual tank waste sample that was supplied as part of the supplemental treatment selection process. The tank waste sample was a composite of available samples from six different tanks. The baseline formulation showed good performance for the composite stimulant and the tank waste sample. The baseline formulation was then tested to verify that it had similar good performance for the range of potential compositions that might be retrieved from S-109. Further testing during DBVS on spiked feed will be used to further improve the basis for the use of this glass formulation on a range of potential LAW feed compositions.

C. Descriptions of Waste Streams

DBVS will treat dissolved saltcake (with less than 3% insoluble sludge) from Tank 241-S-109. Mahoney 2003 reviewed existing S-109 tank waste sample compositional and historical information and provided cold simulant recipes that were used to represent a nominal and a potential range of S-109 waste feeds. See the table in Appendix D for expected waste composition.

D. Characteristics of the Glasses that Are Key to Satisfactory Performance

As the expected long-term performance of the glass matrix of the bulk-vitrified products will be governed by the same scientific principles as the WTP glass products, the tests given in Section III.D will be used.

E. Range of Key Characteristics

In BV testing (Kim et al. 2006), the VHT response was found to be the most restrictive property on waste loading and glass composition. The BV project has examined the VHT response for different:

- Sodium levels
- Soil compositions
- ZrO_2 and B_2O_3 additions
- S-109 Tank Waste variations
- Cooling profiles
- Oxidation states of the glass

The results show that BV glasses will pass VHT requirements if the composition is controlled within the following ranges:

- $Na_2O \leq 22$ mass%
- $3 \leq B_2O_3 \leq 5$ mass%
- $8 \leq Al_2O_3 \leq 12.5$ mass%
- $5.5 \leq ZrO_2 \leq 8$ mass%; $6.4 \leq ZrO_2 \leq 8$ mass% if $Al_2O_3 \geq 9.5$ mass%
- $40 \leq SiO_2 \leq 48.5$ mass%

The BV glass produced in multiple engineering scale and full scale tests have never exceeded the acceptable range and both PCT and VHT results are generally ten times better than the acceptance limit. DBVS operations will supply more information based on the planned testing of samples from actual full-scale, tank waste vitrification with the full range of (spiked) S-109 waste to improve the basis for the performance on a wide range of potential feed material.

F. Factors that Must Be Controlled to Allow Satisfactory Performance

The following factors must be controlled to have satisfactory performance:

- Soil used in BV process must fall within acceptable compositional envelope,
- B_2O_3 and ZrO_2 must fall within acceptable compositional envelope in the glass.
- The quantity of sodium needs to be maintained below 22% and the main components in the waste fall within the tested and accepted compositional envelope (see Section E above).
- The process of the glass melt needs to prevent significant Fe metal segregation or reduced iron feed and glass formulations must be implemented.
- The melt duration needs to be long enough to process all of the waste constituents.

IV. REFERENCES

10CFR61.55, "Waste Classification", Subpart D (Technical Requirements for Land Disposal Facilities) of Part 61 (Licensing Requirements for Land Disposal of Radioactive Waste) of Title 10 (Energy) of the *Code of Federal Regulations*, U.S. Government Printing Office. Last updated November 2, 2001.

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APPENDIX A: WTP GLASS COMPOSITIONS AND PROPERTIES

Table A-1 LAW Reference Glass Compositions

	Envelope A		Envelope B		Envelope C	
Oxide	LAW A88	LAWA44	LAWB83	LAWB45	LAW C31	LAWC22
Al_2O_3	6.08%	6.20%	6.18%	6.13%	6.11%	6.08%
B_2O_3	9.70%	8.90%	10.03%	12.34%	10.03%	10.06%
CaO	1.99%	1.99%	6.78%	6.63%	7.40%	5.12%
Cl	0.15%	0.65%	0.05%	0.01%	0.21%	0.09%
Cr_2O_3	0.02%	0.02%	0.05%	0.07%	0.01%	0.02%
F	0.25%	0.01%	0.15%	0.08%	0.11%	0.16%
Fe_2O_3	5.53%	6.98%	5.29%	5.26%	4.42%	5.43%
K_2O	2.58%	0.50%	0.19%	0.26%	0.14%	0.10%
Li_2O	0.00%	0.00%	4.31%	4.62%	2.73%	2.51%
MgO	1.47%	1.99%	2.97%	2.97%	1.50%	1.51%
Na_2O	20.00%	20.00%	5.47%	6.50%	11.90%	14.40%
P_2O_5	0.10%	0.03%	0.05%	0.03%	0.16%	0.17%
SiO_2	43.99%	44.55%	48.60%	47.86%	46.67%	46.67%
SO_3	0.21%	0.10%	0.49%	0.84%	0.47%	0.34%
TiO_2	1.99%	1.99%	1.39%	0.00%	1.12%	1.14%
ZnO	2.95%	2.96%	4.84%	3.15%	4.01%	3.07%
ZrO_2	2.99%	2.99%	3.16%	3.15%	3.01%	3.03%

Table A-2. Properties of Selected WTP LAW Glasses

Glass	LAWA88	LAWB83	LAW31	Limit
Normalized PCT Boron Release (g/m^2)	0.59	0.28	0.26	2
Normalized PCT Sodium Release (g/m^2)	0.51	0.24	0.28	2
Normalized PCT Silicon Release (g/m^2)	0.19	0.11	0.11	2
Glass Density (kg/m^3)	2.67	2.75	2.71	N/A
200°C VHT Alteration Rate ($g/m^2/d$)	1.4	1.5	8.2	50
Glass	**LAWA44**	**LAWB45**	**LAWC22**	**Limit**
Normalized PCT Boron Release (g/m^2)	0.41	0.53	0.49	2
Normalized PCT Sodium Release (g/m^2)	0.40	0.44	0.47	2
Normalized PCT Silicon Release (g/m^2)	0.18	0.14	0.19	2
Glass Density (kg/m^3)	2.69	2.65	2.67	N/A
200°C VHT Alteration Rate ($g/m^2/d$)	1.2	1.9	5.9	50

After Muller et al. 2005. LAWB45 values come from Muller 2001

APPENDIX B: COMPOSITION OF WTP WASTE ENVELOPES

Table B-1 identifies which LAW feed Envelope is expected from various source tanks. Table B-2 provided the expected chemical and radionuclide composition from these source tanks.

Table B-1 Feed Envelopes

	Envelope A		Envelope B		Envelope C	
Tank Waste Sources [c]	AY-102 [a]	AP-104	AZ-101 [a]	AZ-102 [a]	AN-102	AN-107
	AP-101	AN-103				
	AP-102	AN-105				
	AP-103	AW-101				
	AP-105	SY-101 [a]				

a Supernatant fraction of tank waste.

b Solids fraction of tank waste.

c From Tank Farm Contractor Operations and Utilization Plan (Kirkbride et al. 2003).

Table B-2 Chemical and Radionuclide Composition of WTP LAW Feeds

Source Tank		AY-102	AP-101	AP-103	AP-105	AN-104		AN-102	AN-102
Batch Name		**LAW-1**	**LAW-2**	**LAW-3**	**LAW-4**	**LAW-5**	**LAW-6**	**LAW-7**	**LAW-8**
Component	**Units**	**Concentration**							
Ag	mg/L	8.07E-01	1.86E+00	6.35E+00	3.45E+00	6.59E+00	7.26E+00	1.66E+00	1.66E+00
$Al(OH)_4^-$	mg/L	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Al	mg/L	8.14E+03	1.46E+04	2.11E+04	2.33E+04	2.10E+04	2.14E+04	8.64E+03	8.64E+03
As	mg/L	2.22E+00	9.12E+00	3.35E+01	1.84E+01	2.90E+00	3.22E+00	1.54E+01	1.54E+01
B	mg/L	1.89E+01	1.90E+01	3.80E+01	3.70E+01	2.41E+01	2.65E+01	2.22E+01	2.22E+01
Ba [a]	mg/L	4.89E-01	3.91E+00	1.99E+01	9.29E+00	1.46E+00	1.62E+00	6.34E+00	6.33E+00
Be	mg/L	1.48E+00	6.17E-01	2.05E+00	9.98E-01	2.12E-01	2.35E-01	4.00E-01	4.00E-01
Bi	mg/L	3.05E+00	1.88E+01	3.28E+01	2.38E+01	7.93E+00	7.49E+00	1.72E+01	1.72E+01
Ca	mg/L	9.54E+00	3.87E+01	6.82E+01	4.73E+01	3.90E+00	4.31E+00	2.47E+02	2.47E+02
Cd [a]	mg/L	2.28E+00	2.83E+00	7.50E+00	1.48E+00	4.27E-01	4.56E-01	3.46E+01	3.46E+01
Ce	mg/L	2.50E-01	7.85E+00	3.98E+01	1.87E+01	2.93E+00	3.22E+00	6.32E+00	6.31E+00
Cl	mg/L	2.27E+03	3.81E+03	4.39E+03	5.91E+03	4.94E+03	4.92E+03	2.42E+03	2.42E+03
CN	mg/L	8.91E+00	6.47E+00	5.69E-02	8.14E-01	6.88E-04	7.68E-04	0.00E+00	0.00E+00
Co [a]	mg/L	5.88E-01	2.06E+00	7.97E+00	3.77E+00	6.94E-01	7.77E-01	1.52E+00	1.52E+00
CO_3^{-2} [a]	mg/L	4.49E+04	5.97E+04	3.49E+04	4.72E+04	3.30E+04	2.89E+04	4.67E+04	4.67E+04
$Cr(OH)_4^-$	mg/L	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cr	mg/L	1.86E+02	1.32E+03	6.91E+02	1.33E+03	1.90E+02	1.95E+02	1.63E+02	1.63E+02
Cs [a]	mg/L	7.53E+00	6.98E+00	1.13E+01	1.00E+01	9.64E+00	1.05E+01	1.15E+01	1.15E+01
Cu	mg/L	1.92E+00	1.90E+00	4.44E+00	3.20E+00	1.79E+00	1.98E+00	1.50E+01	1.50E+01
F	mg/L	3.20E+03	2.81E+03	9.01E+02	2.60E+03	4.31E+02	3.82E+02	1.09E+02	1.09E+02
Fe	mg/L	3.14E+00	1.17E+01	2.14E+01	1.64E+01	6.68E+00	7.12E+00	2.48E+01	2.48E+01
H^+	mg/L	0.00E+00	7.16E+01	0.00E+00	8.82E-04	3.35E-04	3.41E-04	0.00E+00	0.00E+00
H_2O	mg/L	8.78E+05	8.00E+05	7.73E+05	7.65E+05	8.86E+05	8.77E+05	8.22E+05	8.22E+05
Hg	mg/L	4.91E-02	1.31E+01	1.23E-02	4.39E-02	2.70E-02	3.01E-02	0.00E+00	0.00E+00
K	mg/L	3.45E+04	5.63E+03	7.67E+03	6.02E+03	3.27E+03	3.40E+03	1.29E+03	1.29E+03
La	mg/L	1.48E+00	2.16E+00	4.80E+00	4.26E+00	1.12E+01	1.24E+01	7.82E+00	7.81E+00

Table B-2 Chemical and Radionuclide Composition of WTP LAW Feeds

Source Tank		AY-102	AP-101	AP-103	AP-105	AN-104		AN-102	AN-102
Batch Name		**LAW-1**	**LAW-2**	**LAW-3**	**LAW-4**	**LAW-5**	**LAW-6**	**LAW-7**	**LAW-8**
Component	**Units**	**Concentration**							
Li	mg/L	4.13E-01	1.48E+00	4.29E+00	3.14E+00	4.40E+00	4.85E+00	5.34E-01	5.33E-01
Mg	mg/L	3.71E+00	1.08E+01	3.99E+01	2.16E+01	2.25E+01	2.48E+01	1.57E+01	1.57E+01
Mn	mg/L	1.51E+00	4.46E+00	4.30E+00	3.41E+00	2.61E+00	2.79E+00	1.22E+01	1.21E+01
Mo	mg/L	1.72E+01	4.54E+01	5.56E+01	2.53E+01	3.00E+01	3.31E+01	2.84E+01	2.84E+01
Na	mg/L	1.57E+05	2.11E+05	1.93E+05	2.27E+05	1.59E+05	1.59E+05	1.61E+05	1.61E+05
Nd	mg/L	3.24E+00	8.87E+00	3.33E+01	1.87E+01	2.25E+01	2.48E+01	1.19E+01	1.19E+01
NH3	mg/L	2.52E+00	3.82E+01	1.08E+01	1.64E+02	8.41E-02	9.79E-02	7.85E+01	7.84E+01
Ni [a]	mg/L	9.08E+00	2.19E+01	6.03E+01	2.66E+01	5.86E+00	6.35E+00	2.35E+02	2.34E+02
NO_2	mg/L	5.31E+04	6.56E+04	7.87E+04	7.98E+04	7.32E+04	7.31E+04	6.22E+04	6.22E+04
NO_3	mg/L	1.49E+05	2.12E+05	1.63E+05	2.18E+05	1.26E+05	1.24E+05	1.49E+05	1.49E+05
OH (BOUND)	mg/L	6.58E+03	3.78E+04	6.02E+04	5.77E+04	3.45E+04	3.80E+04	2.27E+04	2.27E+04
OH^-	mg/L	4.72E+04	2.42E+04	2.25E+04	2.93E+04	5.41E+04	5.18E+04	5.28E+03	5.28E+03
Pb	mg/L	1.69E+01	3.53E+01	4.42E+01	3.66E+01	2.75E+01	2.93E+01	9.93E+01	9.92E+01
Pd	mg/L	1.14E-01	2.79E-01	0.00E+00	7.38E-04	2.71E-04	3.03E-04	0.00E+00	0.00E+00
PO_4	mg/L	1.72E+03	1.00E+04	2.86E+03	5.02E+03	2.98E+03	2.84E+03	3.92E+03	3.92E+03
Pr	mg/L	2.98E-02	2.45E-02	4.87E-05	3.00E-03	2.06E-06	2.30E-06	0.00E+00	0.00E+00
Pu [a]	mg/L	7.64E-03	5.63E-02	1.53E-02	9.05E-03	2.51E-03	2.52E-03	5.54E-02	5.54E-02
Rb	mg/L	4.35E+00	5.80E-01	8.05E-04	5.61E-02	3.47E-04	3.88E-04	0.00E+00	0.00E+00
Rh	mg/L	4.77E-01	1.06E+00	1.56E-03	9.01E-02	5.51E-04	6.16E-04	0.00E+00	0.00E+00
Ru [a]	mg/L	6.41E+00	1.29E+01	5.86E-03	3.54E-01	6.33E-04	7.07E-04	1.98E-15	1.98E-15
Sb [a]	mg/L	1.30E-01	3.92E+00	2.43E+01	6.26E+00	1.35E+01	1.48E+01	1.28E-01	1.28E-01
Se [a]	mg/L	3.78E+00	2.62E+01	6.07E+01	4.11E+01	2.26E+01	2.50E+01	1.55E+01	1.55E+01
Si	mg/L	1.72E+02	3.61E+02	1.26E+02	2.01E+02	1.62E+02	1.61E+02	3.05E+01	3.05E+01

Table B-2 Chemical and Radionuclide Composition of WTP LAW Feeds

Source Tank		AY-102	AP-101	AP-103	AP-105	AN-104		AN-102	AN-102
Batch Name		**LAW-1**	**LAW-2**	**LAW-3**	**LAW-4**	**LAW-5**	**LAW-6**	**LAW-7**	**LAW-8**
Component	**Units**	**Concentration**							
SO_4	mg/L	5.06E+03	1.29E+04	5.74E+03	1.34E+04	6.57E+03	5.89E+03	1.07E+04	1.07E+04
Sr [a]	mg/L	4.71E-01	4.14E+00	2.57E+00	3.20E+00	2.30E+00	2.55E+00	1.44E+00	1.44E+00
Ta	mg/L	1.29E-01	3.96E-02	9.83E-06	6.11E-04	2.10E-06	2.35E-06	0.00E+00	0.00E+00
Tc [a]	mg/L	3.25E+00	7.30E+00	1.24E+01	1.18E+01	6.70E+00	6.79E+00	5.70E+00	5.69E+00
Te	mg/L	1.82E-01	3.63E-01	4.87E-05	3.00E-03	2.94E-06	3.28E-06	0.00E+00	0.00E+00
Th [a]	mg/L	1.38E+02	4.00E+01	9.78E+01	4.53E+01	1.17E+01	1.05E+01	1.30E+00	1.30E+00
Ti	mg/L	7.33E-01	1.01E+00	4.10E+00	2.13E+00	2.25E+00	2.48E+00	3.85E-01	3.85E-01
Tl	mg/L	2.18E-01	9.35E+00	1.30E+00	2.20E+01	4.48E+01	4.93E+01	1.14E+00	1.14E+00
TOC	mg/L	2.38E+03	3.26E+03	6.24E+03	3.57E+03	2.02E+03	2.00E+03	1.74E+04	1.74E+04
U [a]	mg/L	7.83E+01	4.66E+02	2.03E+01	2.01E+01	1.46E+01	1.39E+01	1.35E+01	1.35E+01
V	mg/L	9.98E-01	4.17E+00	1.67E+01	9.69E+00	1.12E+01	1.24E+01	1.55E+00	1.55E+00
W	mg/L	3.16E+01	3.90E+00	2.56E-02	1.57E+00	5.08E-04	5.67E-04	0.00E+00	0.00E+00
Y [a]	mg/L	2.64E-02	2.72E-01	7.20E+00	3.50E-01	3.33E-04	3.72E-04	1.21E+00	1.21E+00
Zn	mg/L	6.24E+00	2.43E+00	4.21E+00	4.28E+00	5.41E+00	5.97E+00	1.58E+00	1.58E+00
Zr [a]	mg/L	3.06E+00	2.82E+01	4.89E+00	3.75E+00	3.71E+00	3.89E+00	8.77E+00	8.76E+00
106-Ru	Bq/L	6.80E-03	1.87E-02	4.20E-03	1.86E-03	3.59E-04	3.95E-04	2.55E-04	2.55E-04
113m-Cd	Bq/L	7.36E+05	4.25E+05	8.87E+05	6.37E+05	2.72E+05	3.00E+05	4.63E+05	4.64E+05
125-Sb	Bq/L	2.79E+05	9.96E+04	7.15E+04	4.49E+04	2.08E+04	2.18E+04	2.28E+04	2.28E+04
126-Sn	Bq/L	3.77E+04	2.32E+04	4.63E+04	3.47E+04	6.03E+04	7.16E+04	1.85E+04	1.85E+04
129-I	Bq/L	3.60E+03	9.95E+03	1.44E+04	1.47E+04	4.16E+03	4.27E+03	3.24E+03	3.24E+03
134-Cs	Bq/L	1.08E+05	2.73E+04	6.66E+03	2.25E+03	2.43E+02	2.63E+02	2.05E+02	2.05E+02
137-Cs	Bq/L	5.01E+09	4.72E+09	7.22E+09	6.64E+09	7.85E+09	8.18E+09	7.69E+09	7.68E+09
137m-Ba	Bq/L	4.72E+09	4.42E+09	6.87E+09	6.28E+09	7.50E+09	7.68E+09	7.27E+09	7.27E+09

Table B-2 Chemical and Radionuclide Composition of WTP LAW Feeds

Source Tank		AY-102	AP-101	AP-103	AP-105	AN-104		AN-102	AN-102
Batch Name		**LAW-1**	**LAW-2**	**LAW-3**	**LAW-4**	**LAW-5**	**LAW-6**	**LAW-7**	**LAW-8**
Component	**Units**	**Concentration**							
14-C	Bq/L	1.94E+04	4.34E+05	3.72E+05	4.34E+05	2.90E+05	2.46E+05	2.17E+04	2.17E+04
151-Sm	Bq/L	2.09E+08	1.28E+08	2.24E+08	1.60E+08	5.56E+07	9.90E+07	1.02E+08	1.02E+08
152-Eu	Bq/L	5.58E+04	3.06E+04	4.23E+04	2.59E+04	1.66E+04	1.84E+04	2.24E+04	2.24E+04
154-Eu	Bq/L	1.03E+05	5.30E+05	3.93E+05	7.38E+05	3.57E+05	3.94E+05	1.88E+06	1.88E+06
155-Eu	Bq/L	2.86E+04	1.56E+05	1.95E+05	3.31E+05	1.60E+05	1.77E+05	4.40E+05	4.40E+05
226-Ra	Bq/L	3.63E+03	7.24E+03	3.32E+00	2.45E+00	1.02E+00	1.11E+00	1.72E+00	1.72E+00
227-Ac	Bq/L	2.61E+01	4.03E+01	4.96E+01	3.63E+01	1.81E+01	1.91E+01	2.70E+01	2.70E+01
228-Ra	Bq/L	2.10E+03	4.34E+02	1.11E+03	6.58E+02	3.25E+02	3.46E+02	4.39E+02	4.39E+02
229-Th	Bq/L	1.07E+02	3.57E+01	1.19E+02	5.96E+01	5.62E+01	6.00E+01	8.44E+01	8.44E+01
231-Pa	Bq/L	6.37E+01	1.21E+02	9.07E+01	7.19E+01	3.79E+01	3.90E+01	4.88E+01	4.88E+01
232-Th	Bq/L	5.61E+02	1.63E+02	3.99E+02	1.84E+02	4.77E+01	4.28E+01	5.28E+00	5.28E+00
232-U	Bq/L	5.60E+02	3.93E+02	1.19E+02	1.13E+02	1.14E+02	1.00E+02	1.98E+02	1.98E+02
233-U	Bq/L	2.49E+03	2.49E+03	5.37E+02	5.22E+02	5.27E+02	4.68E+02	9.14E+02	9.14E+02
234-U	Bq/L	1.10E+03	5.79E+03	2.96E+02	2.77E+02	1.83E+02	1.68E+02	1.89E+02	1.89E+02
235-U	Bq/L	4.75E+01	2.46E+02	1.25E+01	1.25E+01	7.22E+00	6.43E+00	6.65E+00	6.65E+00
236-U	Bq/L	4.65E+01	1.25E+02	1.41E+01	9.97E+00	9.41E+00	8.59E+00	6.71E+00	6.71E+00
237-Np	Bq/L	4.40E+03	1.49E+04	1.52E+05	2.03E+04	7.48E+02	7.43E+02	2.81E+04	2.81E+04
238-Pu	Bq/L	2.36E+03	7.02E+03	1.73E+03	7.70E+02	2.09E+02	2.09E+02	3.31E+03	3.30E+03
238-U	Bq/L	9.66E+02	5.75E+03	2.51E+02	2.48E+02	1.80E+02	1.72E+02	1.66E+02	1.66E+02
239-Pu	Bq/L	1.62E+04	1.20E+05	3.29E+04	1.95E+04	5.35E+03	5.37E+03	1.19E+05	1.19E+05
240-Pu	Bq/L	3.29E+03	2.33E+04	5.70E+03	3.21E+03	1.02E+03	1.02E+03	2.10E+04	2.09E+04
241-Am	Bq/L	9.16E+03	3.51E+06	3.12E+05	4.71E+04	1.06E+05	1.10E+05	3.53E+06	3.53E+06
241-Pu	Bq/L	2.90E+04	2.36E+05	4.18E+04	1.81E+04	8.42E+03	8.43E+03	1.10E+05	1.10E+05
242-Cm	Bq/L	4.45E+00	3.14E+02	9.47E+02	1.21E+02	4.96E+02	4.22E+02	1.01E+04	1.01E+04

Table B-2 Chemical and Radionuclide Composition of WTP LAW Feeds

Source Tank		AY-102	AP-101	AP-103	AP-105	AN-104		AN-102	AN-102
Batch Name		**LAW-1**	**LAW-2**	**LAW-3**	**LAW-4**	**LAW-5**	**LAW-6**	**LAW-7**	**LAW-8**
Component	**Units**	**Concentration**							
242-Pu	Bq/L	4.20E-01	5.70E+00	6.53E-01	2.35E-01	1.14E-01	1.16E-01	1.47E+00	1.47E+00
243-Am	Bq/L	4.64E-01	4.49E+00	1.23E+01	1.92E+00	5.66E+00	5.82E+00	1.42E+02	1.42E+02
243-Cm	Bq/L	1.65E+00	1.07E+02	1.86E+02	5.45E+01	3.43E+01	2.91E+01	6.67E+02	6.67E+02
244-Cm	Bq/L	3.00E+01	2.17E+03	2.83E+03	9.79E+02	2.73E+02	2.33E+02	4.42E+03	4.41E+03
3-H	Bq/L	1.88E+05	1.69E+06	1.30E+06	2.10E+06	8.84E+04	7.84E+04	1.03E+04	1.03E+04
59-Ni	Bq/L	1.32E+04	1.25E+04	2.29E+04	1.37E+04	5.59E+03	6.06E+03	9.91E+03	9.91E+03
60-Co	Bq/L	5.41E+04	7.94E+04	1.46E+05	8.38E+04	3.29E+04	3.60E+04	3.59E+05	3.58E+05
63-Ni	Bq/L	1.18E+06	1.09E+06	1.90E+06	1.15E+06	4.91E+05	5.32E+05	8.60E+05	8.59E+05
79-Se	Bq/L	2.90E+03	2.67E+04	2.23E+04	1.78E+04	1.54E+04	2.06E+04	1.42E+04	1.42E+04
90-Sr	Bq/L	1.21E+07	3.91E+08	8.69E+07	9.79E+07	8.64E+06	9.18E+06	1.56E+09	1.56E+09
90-Y	Bq/L	1.21E+07	3.71E+08	8.70E+07	1.29E+08	8.64E+06	9.18E+06	1.51E+09	1.51E+09
93-Zr	Bq/L	2.90E+05	2.23E+05	3.71E+05	2.50E+05	1.35E+05	1.43E+05	2.09E+05	2.08E+05
93m-Nb	Bq/L	2.39E+05	2.02E+05	3.24E+05	2.30E+05	1.25E+05	1.33E+05	1.88E+05	1.88E+05
99-Tc	Bq/L	2.08E+06	4.67E+06	7.91E+06	7.58E+06	4.29E+06	4.35E+06	3.65E+06	3.64E+06

Table B-2 (Cont.) Chemical and Radionuclide Composition of WTP LAW Feeds										
Source Tank		AN-105		AN-107	SY-101		AN-103		AW-101	
Batch Name		**LAW-9**	**LAW-10**	**LAW-11**	**LAW-12**	**LAW-13**	**LAW-14**	**LAW-15**	**LAW-16**	**LAW-17**
Component	**Units**	**Concentration**								
Ag	mg/L	1.08E+01	2.57E+00	1.49E+00	3.78E+00	8.30E-01	8.77E+00	2.69E+00	1.21E+00	7.49E-01
$Al(OH)_4^-$	mg/L	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Al	mg/L	2.56E+04	1.37E+04	9.24E+02	2.65E+04	3.06E+04	2.34E+04	3.43E+04	1.78E+04	1.65E+04
As	mg/L	2.98E+01	7.03E+00	2.35E+01	1.65E+01	6.95E+00	4.45E+00	1.13E+00	2.63E+01	2.07E+01
B	mg/L	4.52E+01	1.07E+01	1.81E+01	4.89E+01	6.16E+00	3.55E+01	1.09E+01	2.23E+01	1.71E+01
Ba [a]	mg/L	1.50E+01	3.56E+00	4.69E+00	7.57E+00	3.50E+00	2.21E+00	5.50E-01	8.47E-01	3.81E-01
Be	mg/L	1.49E+00	3.50E-01	7.42E-01	8.62E-01	3.51E-01	5.40E-01	1.58E-01	1.29E+00	1.02E+00
Bi	mg/L	3.02E+01	1.66E+01	7.62E+00	2.85E+01	2.06E+01	5.88E+00	5.60E+00	5.80E+00	3.71E+00
Ca	mg/L	3.00E+01	7.03E+00	4.48E+02	7.84E+01	3.02E+01	4.45E+00	1.14E+00	1.03E+01	7.72E+00
Cd [a]	mg/L	1.51E+00	3.54E-01	5.07E+01	2.07E+00	4.20E-01	2.29E+00	7.27E-01	9.97E-01	7.80E-01
Ce	mg/L	2.98E+01	7.01E+00	3.90E+01	1.51E+01	6.96E+00	4.42E+00	1.12E+00	2.59E+00	1.52E+00
Cl	mg/L	6.08E+03	6.14E+03	1.75E+03	7.41E+03	5.62E+03	5.03E+03	3.64E+03	4.26E+03	3.85E+03
CN	mg/L	3.23E-04	0.00E+00	0.00E+00	2.28E+01	5.15E-02	9.68E-06	0.00E+00	0.00E+00	0.00E+00
Co [a]	mg/L	5.95E+00	1.40E+00	3.33E+00	3.68E+00	1.41E+00	9.47E-01	2.54E-01	2.02E+00	1.51E+00
CO_3^{-2} [a]	mg/L	1.36E+04	6.03E+04	5.95E+04	3.25E+04	1.93E+04	8.01E+03	1.67E+04	1.86E+04	2.09E+04
$Cr(OH)_4^-$	mg/L	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cr	mg/L	1.50E+02	2.60E+02	1.37E+02	7.65E+02	6.66E+02	2.92E+02	2.22E+02	1.12E+02	1.14E+02
Cs [a]	mg/L	8.77E+00	3.68E+00	1.22E+01	1.40E+01	1.12E+01	1.38E+01	5.20E+00	9.94E+00	8.23E+00
Cu	mg/L	3.21E+00	7.56E-01	2.32E+01	3.85E+00	7.68E-01	1.89E+00	5.68E-01	1.35E+00	1.02E+00
F	mg/L	2.67E+02	1.66E+03	1.41E+02	6.87E+02	3.42E+02	4.46E+02	5.67E+02	1.15E+03	1.61E+03
Fe	mg/L	1.50E+01	4.65E+00	1.42E+03	2.17E+01	8.92E+00	2.68E+00	7.40E-01	4.05E+00	2.96E+00
H^+	mg/L	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
H_2O	mg/L	8.28E+05	9.14E+05	8.04E+05	7.60E+05	7.68E+05	8.64E+05	9.84E+05	8.78E+05	8.85E+05
Hg	mg/L	7.12E-05	0.00E+00	0.00E+00	3.10E-02	1.17E-02	1.24E-01	3.09E-01	0.00E+00	0.00E+00
K	mg/L	4.10E+03	3.01E+03	1.57E+03	7.02E+03	5.40E+03	8.38E+03	5.69E+03	2.26E+04	2.54E+04
La	mg/L	8.34E-01	1.94E-01	2.57E+01	1.52E+00	2.59E+00	6.44E-01	2.14E-01	7.50E-01	5.79E-01

Table B-2 (Cont.) Chemical and Radionuclide Composition of WTP LAW Feeds										
Source Tank		AN-105		AN-107	SY-101		AN-103		AW-101	
Batch Name		**LAW-9**	**LAW-10**	**LAW-11**	**LAW-12**	**LAW-13**	**LAW-14**	**LAW-15**	**LAW-16**	**LAW-17**
Component	**Units**	**Concentration**								
Li	mg/L	3.63E+00	8.58E-01	2.35E+00	3.18E+00	1.46E+00	1.08E+01	3.42E+00	3.05E+00	2.39E+00
Mg	mg/L	2.98E+01	7.04E+00	6.69E+00	3.71E+01	7.11E+00	3.45E+01	1.08E+01	4.47E+00	3.02E+00
Mn	mg/L	3.03E+00	1.52E+00	4.37E+02	4.17E+00	2.73E+00	3.46E+00	1.08E+00	2.22E+00	1.94E+00
Mo	mg/L	5.86E+01	1.39E+01	2.70E+01	7.00E+01	1.05E+01	5.20E+01	1.61E+01	3.07E+01	2.37E+01
Na	mg/L	1.56E+05	1.61E+05	1.88E+05	2.23E+05	1.99E+05	1.61E+05	1.61E+05	1.61E+05	1.61E+05
Nd	mg/L	2.97E+01	7.02E+00	7.42E+01	3.70E+01	6.94E+00	3.46E+01	1.08E+01	4.45E+00	3.00E+00
NH3	mg/L	2.24E+03	5.34E+02	3.77E+01	2.80E+01	1.04E+01	6.50E+03	2.06E+03	6.10E+01	3.77E+00
Ni [a]	mg/L	6.55E+00	6.45E+00	4.83E+02	4.26E+01	9.67E+00	6.93E+00	2.21E+00	3.60E+00	2.46E+00
NO_2	mg/L	7.49E+04	7.55E+04	6.64E+04	1.00E+05	9.10E+04	7.16E+04	5.95E+04	6.93E+04	6.50E+04
NO_3	mg/L	1.00E+05	1.26E+05	2.04E+05	1.89E+05	1.72E+05	8.79E+04	1.10E+05	1.26E+05	1.32E+05
OH (BOUND)	mg/L	6.08E+04	1.44E+04	0.00E+00	6.11E+04	7.35E+04	4.62E+04	1.42E+04	2.37E+04	1.80E+04
OH^-	mg/L	3.80E+04	4.63E+04	1.13E+04	3.60E+04	3.26E+04	6.57E+04	1.20E+05	6.59E+04	6.78E+04
Pb	mg/L	3.32E+01	1.71E+01	3.39E+02	4.23E+01	4.84E+01	6.74E+01	2.13E+01	2.88E+01	2.21E+01
Pd	mg/L	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PO_4	mg/L	1.02E+03	5.94E+03	2.19E+03	6.93E+03	8.48E+03	1.14E+03	1.41E+03	1.31E+03	1.11E+03
Pr	mg/L	2.82E-07	0.00E+00	0.00E+00	1.54E-01	4.65E-05	8.45E-09	0.00E+00	0.00E+00	0.00E+00
Pu [a]	mg/L	4.60E-04	1.29E-03	8.29E-01	9.63E-03	8.27E-03	4.73E-03	1.71E-03	5.98E-03	7.89E-03
Rb	mg/L	4.67E-06	0.00E+00	0.00E+00	2.47E+00	7.70E-04	1.40E-07	0.00E+00	0.00E+00	0.00E+00
Rh	mg/L	9.03E-06	0.00E+00	2.01E+01	4.77E+00	1.49E-03	2.70E-07	0.00E+00	0.00E+00	0.00E+00
Ru [a]	mg/L	3.40E-05	4.60E-16	1.75E-15	1.80E+01	5.60E-03	1.02E-06	1.26E-16	4.58E-16	3.60E-16
Sb [a]	mg/L	1.79E+01	4.22E+00	2.51E-01	8.95E+00	3.96E+00	2.07E+01	6.45E+00	1.58E+01	1.24E+01
Se [a]	mg/L	2.99E+01	7.07E+00	1.67E+01	6.90E+01	2.73E+01	3.48E+01	1.09E+01	1.03E+01	7.72E+00
Si	mg/L	1.34E+02	6.11E+01	2.07E+01	1.21E+02	7.86E+01	2.32E+02	1.87E+02	1.16E+02	1.39E+02
SO_4	mg/L	1.98E+03	5.81E+03	8.10E+03	5.76E+03	3.92E+03	1.15E+03	1.85E+03	1.91E+03	2.01E+03
Sr [a]	mg/L	6.26E-02	8.40E-01	7.22E-01	3.24E+00	1.47E+00	3.60E+00	1.84E+00	2.49E-01	3.62E-01
Ta	mg/L	5.70E-08	0.00E+00	1.88E+01	3.01E-02	9.40E-06	1.71E-09	0.00E+00	0.00E+00	0.00E+00

Table B-2 (Cont.) Chemical and Radionuclide Composition of WTP LAW Feeds										
Source Tank		AN-105		AN-107	SY-101		AN-103		AW-101	
Batch Name		**LAW-9**	**LAW-10**	**LAW-11**	**LAW-12**	**LAW-13**	**LAW-14**	**LAW-15**	**LAW-16**	**LAW-17**
Component	**Units**	**Concentration**								
Tc [a]	mg/L	9.66E+00	1.04E+01	5.28E+00	1.29E+01	9.19E+00	5.70E+00	5.77E+00	7.59E+00	7.49E+00
Te	mg/L	2.82E-07	0.00E+00	0.00E+00	1.40E-01	4.66E-05	8.45E-09	0.00E+00	0.00E+00	0.00E+00
Th [a]	mg/L	1.07E+02	2.62E+01	9.22E+01	3.98E+01	1.00E+02	1.50E+01	2.99E+01	1.21E+01	1.87E+01
Ti	mg/L	2.97E+00	7.04E-01	2.35E+00	3.71E+00	7.05E-01	3.45E+00	1.08E+00	2.62E+00	2.06E+00
Tl	mg/L	5.92E+01	1.41E+01	1.20E-01	2.55E+00	1.21E+00	6.89E+01	2.14E+01	2.08E+01	1.57E+01
TOC	mg/L	1.79E+03	2.28E+03	3.06E+04	5.78E+03	3.05E+03	1.50E+03	8.34E+02	2.59E+03	2.50E+03
U [a]	mg/L	2.29E+00	1.18E+00	8.44E+01	2.76E+01	1.96E+01	1.41E+00	2.00E+00	1.84E+01	3.55E+01
V	mg/L	1.49E+01	3.53E+00	3.33E+00	1.85E+01	3.49E+00	1.73E+01	5.37E+00	2.24E+00	1.51E+00
W	mg/L	1.49E-04	0.00E+00	0.00E+00	7.84E+01	2.45E-02	4.44E-06	0.00E+00	0.00E+00	0.00E+00
Y [a]	mg/L	3.14E-02	2.98E-06	6.88E+00	3.46E+00	5.67E-01	1.25E-03	4.33E-07	3.05E-06	5.38E-06
Zn	mg/L	1.88E+01	4.46E+00	1.52E+01	3.88E+00	8.19E-01	5.84E+00	1.69E+00	3.25E+00	2.25E+00
Zr [a]	mg/L	3.12E+00	1.69E+00	5.00E+01	5.27E+00	4.19E+00	4.37E+00	1.88E+00	8.23E+00	9.85E+00
106-Ru	Bq/L	2.54E-04	5.90E-05	2.25E-04	6.31E-04	4.54E-04	5.24E-05	1.61E-05	5.87E-05	4.63E-05
113m-Cd	Bq/L	4.46E+05	2.16E+05	5.49E+05	9.13E+05	6.21E+05	3.23E+05	9.94E+04	3.74E+05	2.86E+05
125-Sb	Bq/L	2.17E+04	1.20E+04	2.10E+04	3.84E+04	2.70E+04	1.15E+04	6.45E+03	1.32E+04	1.13E+04
126-Sn	Bq/L	1.87E+04	1.05E+04	2.80E+05	5.79E+04	3.49E+04	1.47E+05	4.89E+04	2.04E+04	1.47E+04
129-I	Bq/L	6.24E+03	3.83E+03	4.21E+03	1.22E+04	1.22E+04	7.55E+03	6.23E+03	6.82E+03	6.32E+03
134-Cs	Bq/L	2.15E+02	9.26E+01	1.79E+02	2.65E+03	1.29E+03	8.84E+01	4.72E+01	7.69E+03	6.23E+03
137-Cs	Bq/L	5.59E+09	6.62E+09	8.41E+09	8.47E+09	6.77E+09	8.97E+09	5.83E+09	7.30E+09	6.96E+09
137m-Ba	Bq/L	5.30E+09	6.30E+09	8.00E+09	8.03E+09	6.44E+09	8.54E+09	5.55E+09	6.98E+09	6.60E+09
14-C	Bq/L	3.63E+04	5.80E+05	2.33E+05	9.53E+04	1.34E+05	1.49E+05	4.43E+05	2.01E+05	2.82E+05
151-Sm	Bq/L	1.03E+08	2.90E+07	8.62E+07	2.88E+08	1.93E+08	9.05E+07	3.03E+07	1.13E+08	8.13E+07
152-Eu	Bq/L	2.21E+04	5.21E+03	1.89E+04	4.12E+04	2.89E+04	1.62E+04	4.97E+03	1.82E+04	1.43E+04
154-Eu	Bq/L	2.24E+05	5.29E+04	8.39E+06	7.15E+05	5.02E+05	2.06E+05	6.41E+04	1.72E+05	1.35E+05
155-Eu	Bq/L	6.33E+04	1.49E+04	2.33E+06	1.26E+05	1.33E+05	4.99E+04	1.55E+04	1.48E+05	1.19E+05
226-Ra	Bq/L	1.65E+00	8.53E-01	1.78E+00	4.18E+00	2.59E+00	1.35E+00	5.10E-01	1.56E+00	1.23E+00
227-Ac	Bq/L	2.60E+01	1.29E+01	2.24E+01	5.90E+01	4.65E+01	2.34E+01	1.17E+01	2.67E+01	2.23E+01

Table B-2 (Cont.) Chemical and Radionuclide Composition of WTP LAW Feeds										
Source Tank		AN-105		AN-107	SY-101		AN-103		AW-101	
Batch Name		LAW-9	LAW-10	LAW-11	LAW-12	LAW-13	LAW-14	LAW-15	LAW-16	LAW-17
Component	Units	Concentration								
228-Ra	Bq/L	7.98E+02	3.24E+02	7.94E+02	7.69E+02	1.13E+03	3.21E+02	2.03E+02	3.53E+02	3.08E+02
229-Th	Bq/L	8.31E+01	2.03E+01	7.15E+01	1.31E+02	1.14E+02	7.46E+01	4.33E+01	8.26E+01	7.38E+01
231-Pa	Bq/L	4.59E+01	3.23E+01	3.99E+01	1.10E+02	7.18E+01	4.09E+01	2.51E+01	4.72E+01	4.08E+01
232-Th	Bq/L	4.34E+02	1.07E+02	3.76E+02	1.62E+02	4.08E+02	6.11E+01	1.22E+02	4.92E+01	7.61E+01
232-U	Bq/L	3.14E+01	1.68E+01	2.04E+03	1.64E+02	2.18E+02	1.36E+01	1.86E+01	1.12E+02	2.14E+02
233-U	Bq/L	1.45E+02	7.75E+01	9.43E+03	7.62E+02	1.02E+03	6.42E+01	8.80E+01	5.26E+02	1.01E+03
234-U	Bq/L	3.39E+01	1.76E+01	1.21E+03	4.10E+02	2.85E+02	2.22E+01	3.10E+01	3.04E+02	5.90E+02
235-U	Bq/L	1.33E+00	6.91E-01	4.48E+01	1.67E+01	1.25E+01	8.61E-01	1.20E+00	1.47E+01	2.11E+01
236-U	Bq/L	1.54E+00	7.98E-01	4.27E+01	2.04E+01	1.24E+01	1.28E+00	1.81E+00	3.38E+01	6.74E+01
237-Np	Bq/L	1.36E+03	1.63E+02	1.66E+03	2.16E+04	2.04E+04	6.62E+02	9.57E+02	9.11E+02	1.05E+03
238-Pu	Bq/L	3.68E+01	9.29E+01	4.99E+04	1.88E+03	1.05E+03	4.57E+02	1.66E+02	1.46E+03	2.06E+03
238-U	Bq/L	2.82E+01	1.45E+01	1.04E+03	3.40E+02	2.42E+02	1.74E+01	2.46E+01	2.26E+02	4.37E+02
239-Pu	Bq/L	9.84E+02	2.76E+03	1.78E+06	2.06E+04	1.77E+04	1.01E+04	3.64E+03	1.25E+04	1.65E+04
240-Pu	Bq/L	1.83E+02	5.19E+02	3.19E+05	3.78E+03	3.13E+03	2.10E+03	7.59E+02	3.40E+03	4.53E+03
241-Am	Bq/L	2.93E+03	6.42E+03	1.80E+07	1.19E+05	6.21E+04	8.94E+04	2.94E+04	1.77E+04	1.99E+04
241-Pu	Bq/L	1.19E+03	3.36E+03	1.66E+06	2.59E+04	2.12E+04	1.65E+04	5.99E+03	4.56E+04	6.12E+04
242-Cm	Bq/L	1.07E+01	7.57E+01	5.28E+04	3.25E+02	1.74E+02	1.87E+02	1.22E+02	2.77E+02	5.36E+02
242-Pu	Bq/L	1.58E-02	4.17E-02	2.22E+01	3.21E-01	4.11E-01	2.13E-01	7.72E-02	4.81E-01	6.44E-01
243-Am	Bq/L	1.20E-01	2.82E-01	9.16E+02	5.49E+00	2.78E+00	6.10E+00	2.00E+00	1.13E+00	1.27E+00
243-Cm	Bq/L	1.39E+00	5.21E+00	3.48E+03	2.14E+02	7.26E+01	1.27E+01	8.30E+00	1.01E+02	2.02E+02
244-Cm	Bq/L	1.78E+01	3.73E+01	2.05E+04	3.86E+03	1.22E+03	1.28E+02	8.38E+01	1.93E+03	3.86E+03
3-H	Bq/L	8.39E+03	2.81E+04	5.27E+04	2.56E+05	3.71E+05	1.67E+04	2.56E+04	5.88E+04	8.02E+04
59-Ni	Bq/L	9.15E+03	8.52E+03	1.80E+04	3.79E+04	1.89E+04	7.22E+03	2.52E+03	8.78E+03	6.51E+03
60-Co	Bq/L	2.12E+04	1.61E+04	8.53E+05	7.82E+04	4.57E+04	2.90E+04	9.13E+03	2.27E+04	1.74E+04
63-Ni	Bq/L	7.92E+05	7.43E+05	1.57E+06	3.08E+06	1.53E+06	6.22E+05	2.17E+05	7.52E+05	5.57E+05
79-Se	Bq/L	4.42E+03	6.69E+03	2.39E+04	3.56E+04	2.68E+04	1.26E+04	6.27E+03	1.57E+04	1.13E+04
90-Sr	Bq/L	3.90E+06	6.06E+07	2.24E+09	9.79E+07	3.49E+07	3.15E+06	8.82E+06	6.21E+07	1.10E+08
90-Y	Bq/L	3.90E+06	6.07E+07	2.30E+09	1.09E+08	3.49E+07	3.15E+06	8.82E+06	6.21E+07	1.10E+08

Table B-2 (Cont.) Chemical and Radionuclide Composition of WTP LAW Feeds										
Source Tank		AN-105		AN-107	SY-101		AN-103		AW-101	
Batch Name		**LAW-9**	**LAW-10**	**LAW-11**	**LAW-12**	**LAW-13**	**LAW-14**	**LAW-15**	**LAW-16**	**LAW-17**
Component	**Units**	**Concentration**								
93-Zr	Bq/L	2.02E+05	8.18E+04	1.78E+05	4.09E+05	3.52E+05	1.76E+05	9.60E+04	2.00E+05	1.71E+05
93m-Nb	Bq/L	1.81E+05	8.38E+04	1.66E+05	3.68E+05	3.21E+05	1.60E+05	8.58E+04	1.81E+05	1.55E+05
99-Tc	Bq/L	6.18E+06	6.65E+06	3.38E+06	8.26E+06	5.88E+06	3.65E+06	3.69E+06	4.86E+06	4.79E+06

a Includes contribution of isotopes.

Source: TFCOUP, Rev 5, Appendix D, Tables D-1 and D-2 (Kirkbride et al. 2003). Chemical concentrations converted from mol/L to mg/L equivalents.

APPENDIX C: DBVS GLASS COMPOSITION

Glass Compositions Tested for Demonstration Bulk Vitrification System [a]

Component	Horn Rapids Soil	Glass Composition Range Tested	
		Minimum	Maximum
Al_2O_3	0.13	0.08	0.17
B_2O_3		0.017	0.060
BaO	0.0007	0.0004	0.0005
CaO	0.040	0.025	0.055
Cl		0.0001	0.0010
Cr_2O_3	0.0001	0.0012	0.0058
F		0.0001	0.0010
Fe_2O_3	0.063	0.040	0.110
K_2O	0.022	0.009	0.025
MgO	0.020	0.009	0.030
MnO	0.0010	0.0006	0.0010
Na_2O	0.027	0.18	0.24
P_2O_5	0.0021	0.002	0.016
SiO_2	0.683	0.39	0.55
SO_3		0.0010	0.0095
SrO	0.0004	0.0002	0.0003
TiO_2	0.0116	0.0070	0.0200
ZrO_2		0.020	0.08

a) Taken from Table VI of Kim 2006

APPENDIX D: DBVS WASTE STREAM COMPOSITION

Waste Chemical Composition [a]

Analyte	Average Analyte to Na Mole Ratio
Al^{+3}	9.32E-03
Ca^{+2}	2.43E-04
Cl^{-1}	1.50E-03
Cr (TOTAL)	2.96E-03
F^{-1}	1.13E-03
Fe^{+3}	9.57E-04
K^{+}	8.73E-04
Mn^{+4}	2.85E-05
Ni^{+2}	2.13E-05
NO_2^{-1}	1.31E-02
NO_3^{1-}	9.29E-01
Pb^{+2}	2.78E-05
PO_4^{-3}	1.16E-02
Si^{+4}	1.13E-03
SO_4^{-2}	7.79E-03
Sr^{+2}	6.53E-06
TIC as CO_3^{-2}	3.58E-02
Total Organic Carbon (TOC)	5.26E-03
U (Total)	2.34E-05

a) Taken from Table 3.2 of Mahoney 2003.

Distribution Sheet

To: Distribution	From: Fred Mann	Page 1 of 1
Project Title/Work Order: ILAW Waste Form Technical Requirements Document (IWTRD)		Date: December 2006

Name	MSIN	Text With All Attach	Text Only	Attach./ App. Only	
DOE-ORP					
C.A. Babel	H6-60	X			
C.S. Louie	H6-60	X			
S.A. Wiegnman	H6-60	X			
CH2M Hill Hanford Group, Inc.					
M.N. Jaraysi	H6-03	X			
F.M. Mann	H6-03	X			
F.R. Miera	H6-03	X			
G.L. Parsons	H6-19	X			
Lockheed Martin Information Technology, Inc.					
Central Files	B1-07	X			
Document Clearance		X			

Task# ORP-TF-2006-0013

E-STARS™ Report
Task Detail Report
12/18/2006 0918

TASK INFORMATION			
Task#	ORP-TF-2006-0013		
Subject	Concur - 06-TF-019 Transmittal of IDF ILAW Waste Form Technical Requirements Document, Glass Formulations, to Satisfy IDF Permit COndition III.11.2.a.i		
Parent Task#		**Status**	CLOSED
Reference		**Due**	
Originator	Mendoza, Stella	**Priority**	High
Originator Phone	(509) 373-9112	**Category**	None
Origination Date	12/12/2006 0827	**Generic1**	
Remote Task#		**Generic2**	
Deliverable	None	**Generic3**	
Class	None	**View Permissions**	Normal
Instructions	bcc: TF OFF FILE TF RDG FILE DEP RDG FILE S. Wiegman, TF C. Louie, TPD D. Noyes, TPD RECORD NOTE: This completes Cars Action 11268.		

ROUTING LISTS

1	Route List	Inactive
	• Louie, Catherine S - Review - Cancelled - 12/18/2006 0918 *Instructions:*	
	• Smith, Zack - Review - Concur with comments - 12/12/2006 1629 *Instructions:*	
	• Schepens, Roy J - Approve - Approved with comments - 12/18/2006 0916 *Instructions:*	

ATTACHMENTS

Attachments	1. 06-TF-019hedges.saw.doc

COLLABORATION

COMMENTS

Poster	Smith, Zack (Mendoza, Stella) - 12/12/2006 0412
	Concur
	Zack has concurred on the letter
Poster	Schepens, Roy J (Mendoza, Stella) - 12/18/2006 0912
	Approve
	Zack signed for Roy as acting

RECEIVED
DEC 1 8 2006
DOE-ORP/ORPCC

Task# ORP-TF-2006-0013

TASK DUE DATE HISTORY

No Due Date History

SUB TASK HISTORY

No Subtasks

-- end of report --

Task# ORP-TF-2006-0013

E-STARS™ Report
Task Detail Report
12/12/2006 0832

TASK INFORMATION			
Task#	ORP-TF-2006-0013		
Subject	Concur - 06-TF-019 Transmittal of IDF ILAW Waste Form Technical Requirements Document, Glass Formulations, to Satisfy IDF Permit COndition III.11.2.a.i		
Parent Task#		**Status**	Open
Reference		**Due**	
Originator	Mendoza, Stella	**Priority**	High
Originator Phone	(509) 373-9112	**Category**	None
Origination Date	12/12/2006 0827	**Generic1**	
Remote Task#		**Generic2**	
Deliverable	None	**Generic3**	
Class	None	**View Permissions**	Normal
Instructions	bcc: TF OFF FILE TF RDG FILE DEP RDG FILE S. Wiegman, TF C. Louie, TPD D. Noyes, TPD RECORD NOTE: This completes Cars Action 11268.		

ROUTING LISTS

1	Route List	Active
	• Louie, Catherine S - Review - Awaiting Response *Instructions:* 10/12/06	
	• Smith, Zack - Review - Awaiting Response *Instructions:* 12/12/06	
	• Schepens, Roy J - Approve - Awaiting Response *Instructions:* KB for	

ATTACHMENTS

Attachments	1. 06-TF-019hedges.saw.doc

COLLABORATION

COMMENTS

No Comments

TASK DUE DATE HISTORY

No Due Date History

SUB TASK HISTORY

No Subtasks

-- end of report --