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ALTERNATIVES GENERATION AND ANALYSIS FOR PHASE 1 HIGH-LEVEL WASTE FEED TANKS SELECTION

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Abstract: A recent revision of the U.S. Department of Energy privatization contract for the immobilization of high-level waste (HLW) at Hanford necessitates the investigation of alternative waste feed sources to meet contractual feed requirements. This analysis identifies wastes to be considered as HLW feeds and develops and conducts alternative analyses to comply with established criteria. A total of 12,426 cases involving 72 waste streams are evaluated and ranked in three cost-based alternative models. Additional programmatic criteria are assessed against leading alternative options to yield an optimum blended waste feed stream.

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May 1999

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EXECUTIVE SUMMARY

The Phase 1 privatization contract between British Nuclear Fuels Limited (BNFL) and the U.S. Department of Energy (DOE) establishes specific requirements for the high-level waste (HLW) feeds to be vitrified. These requirements provide criteria for retrieval, staging, and delivery of HLW slurry to BNFL. Under terms of the 1998 contract, BNFL is required to produce at least 600 canisters of HLW glass during Phase 1 and the DOE is responsible for providing the requisite waste feed. This document was prepared to generate and evaluate a series of alternative combinations of tanks to meet criteria established for feed delivery.

The analysis presented here provides a basis for selecting an optimum set of HLW feed tanks for Phase 1. The general approach is to reduce HLW glass volume (life-cycle cost), shorten the length of Hanford's waste disposal mission, and improve the reliability of feed delivery. The HLW glass volume is expected to be reduced by blending compatible HLW source tanks, which increases waste oxide loading in glass and reduces the number of HLW canisters produced. As a result, at a fixed HLW vitrification rate, the retrieval rate of HLW tanks can be increased enabling an earlier completion of the mission.

A total of 31 HLW feed tanks, primarily located in Hanford's 200 East Area, were identified as possible candidates for Phase 1 HLW vitrification. Altogether, 41 different blending options were evaluated in an effort to minimize HLW glass volume for this

project. Among the 72 potential waste streams, a total of 12,426 different tank and cost model combinations (cases) were evaluated for this optimization study.

The set of tanks recommended as the optimum for Phase 1 feed is as follows:

- *241-AZ-101*
- *241-AZ-102*
- *241-AY-102/241-C-106 blended with 20 percent of 241-AW-103*
- *241-AY-101 blended with 30 percent of 241-AW-103*
- *241-SY-102 blended with 40 percent of 241-AW-103.*

These wastes are expected to produce 1,215 canisters based on the BNFL contract specifications or as few as 1,023 canisters based on the Pacific Northwest National Laboratory glass property models. The primary reasons for recommending this set of tanks include the following:

- *The waste blending recommended optimizes the use of compatible waste types resulting in the production of a minimum amount of glass.*

- *If wastes from the recommended tanks were treated unblended, an additional 540 to 610 canisters would be produced.*

- *The cost avoidance achievable by blending the recommended tanks would be about $1 billion based on $1 million per canister for treatment and $1 million per canister for interim storage and disposal.*

- *The number and location of waste feed tanks recommended improves the reliability of HLW feed delivery by providing continual backup staged feed capability from independent tank farms.*

- *Blending of wastes to produce high waste oxide loaded glasses tends to reduce the number of non-compliance cases and improves the probability that the waste feed is within contract Specification.*

- *Current data indicate the recommended tanks are unlikely to have a visible separate organic layer. Historical records indicate that waste retrieved from tanks 241-C-102 and 241-C-104 are likely to have a visible separate organic layer.*

- *The recommended tanks, which are double-shell tanks (DST), provide an increased probability of meeting project schedules since they are much newer than single-shell tanks (SST).*

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LIST OF TERMS

AGA	Alternative Generation and Analysis
BNFL	British Nuclear Fuels, Limited
BPR	Blend product ratio
DOE	U.S. Department of Energy
DST	Double-shell tank
EAC	Estimate at Completion
GPM	Glass property models
HLW	High-level waste
IHLW	Immobilized high-level waste
LAW	Low-activity waste
PCT	Product Consistency Test
PHMC	Project Hanford Management Contract
PNNL	Pacific Northwest National Laboratory
SST	Single-shell tank
TWRS	Tank Waste Remediation System
TWRSO&UP	Tank Waste Remediation System Operation and Utilization Plan
WFD	Waste Feed Delivery
WOL	Waste oxide loading
WRF	Waste retrieval facility

DEFINITIONS

The following underlined terms have been frequently used throughout the text; their meaning in this document has been defined here for clarity.

A <u>case</u> is a combination of HLW tanks or blended feeds that is evaluated against the selected criteria to determine the best options for HLW feed to the vitrification plant.

The <u>base case</u> is a set of tanks consisting of 241-AZ-101, 241-AZ-102, and 241-AY-102/241-C-106.

A <u>category</u> is any one of four classifications of cases. Three categories are the base case tanks plus either one, two, or three tanks; the fourth is an optimum blend allowing more than three tanks.

An <u>alternative</u> is any one of three cost models described in the text.

ALTERNATIVES GENERATION AND ANALYSIS FOR PHASE I HIGH-LEVEL WASTE FEED TANKS SELECTION

1.0 DECISION ANALYSIS SUMMARY

The 1998 contract between the U. S. Department of Energy (DOE) and British Nuclear Fuels, Limited (BNFL) establishes specific requirements for the quantity of feed material, feed composition, and product specifications. The purpose of this study is to identify high-level waste (HLW) feeds and the optimum set of tanks for meeting the waste feed delivery (WFD) commitments for Phase 1 vitrification.

A total of 31 HLW feed tanks, primarily located in the Hanford 200 East Area, were identified as possible candidates for Phase 1 HLW vitrification. Various blends were also evaluated for the purpose of minimizing the amount of HLW glass produced from these wastes. Altogether, 41 different blending scenarios were considered in an effort to minimize HLW glass volume (life-cycle costs) for this project.

Cost algorithms were developed in this report in an attempt to quantify the impacts of glass volume deltas on costs of processing by BNFL and disposal (interim storage and repository disposal). Although retrieval costs are included in the analysis, they are less sensitive to glass volumes and are relatively much smaller than processing and disposal costs. These costs are "order of magnitude" estimates at this time and are useful only to compare alternatives. The cost assumptions used herein are: BNFL processing ($978,000 per canister) and disposal ($538,000 per canister for interim storage and $422,000 per canister for repository disposal).

Among the 72 potential waste streams, a total of 12,426 different tank and cost model combinations (cases) were evaluated for this optimization study. Each case was analyzed in terms of the retrieval costs, product yield, and total cost to DOE. Total cost includes the cost of retrieval, BNFL processing cost, cost of interim storage at the Hanford Site, and disposal of the product glass canisters.

This analysis uses three different cost models to define the optimum blended waste feed stream for minimizing overall project cost. The cost models include the following:

- Least cost per unit product
- Least total cost
- Least retrieval cost.

The highest ranked cases are identified for each cost model and are discussed in terms of the selection criteria that have been developed to optimize the WFD mission at Hanford. An optimum set of tanks, shown below, was also identified for each cost model and the results are compared to provide a better understanding of the cost sensitivity of this selection process:

- *Least Cost Per Unit Product* – The highest ranked case, with blending and DST retrieval, includes tanks 241-AZ-101, 241-AZ-102, 241-AW-105, and 241-AY-102/241-C-106, and all of the waste from 241-AW-103. This case provides for blending all the zirconium-limited 241-AW-103 waste with the spinel-limited 241-AY-102/241-C-106 waste, and includes high waste oxide loaded 241-AW-105 waste. This case results in a unit cost of $2.0 million per canister for 1,652 canisters of HLW glass. Total project costs for this case are $3.3 billion, including $130 million in retrieval costs.

- *Least Total Cost* – The highest ranked case for this model is the baseline set of tanks 241-AZ-101, 241-AZ-102, and 241-AY-102/241-C-106, and 30 percent of the waste from 241-AW-103 and all of the waste in tank 241-AY-101. This scenario can be achieved by blending 30 percent of the zirconium-limited 241-AW-103 waste with the spinel-limited waste of 241-AY-102/241-C-106 waste, together with a separate feed stream from tank 241-AY-101. This case provides for a unit cost of $2.1 million per canister for 835 canisters. Total project costs for this case are $1.7 billion, including $96 million in retrieval costs.

- *Least Retrieval Cost* - The highest ranked case for this model includes tanks 241-AZ-101, 241-AZ-102, and 241-AY-102/241-C-106, as well as all of the waste from tank 241-AW-103. This case calls for blending all the zirconium-limited 241-AW-103 waste with the spinel-limited 241-AY-102/241-C-106 waste. This scenario is expected to generate a unit cost of $2.0 million per canister for 1,276 canisters. Total project costs for this case are $2.6 billion, including $100 million in retrieval costs.

1.1 RECOMMENDATIONS

Based on the results of this study, the following optimum set of tanks is recommended for satisfying the WFD requirements for Phase 1:

- 241-AZ-101
- 241-AZ-102
- 241-AY-102/241-C-106 blended with 20 percent of 241-AW-103
- 241-AY-101 blended with 30 percent of 241-AW-103
- 241-SY-102 blended with 40 percent of 241-AW-103.

These wastes are expected to produce 1,215 canisters based on the BNFL contract specifications or as few as 1,023 canisters based on the Pacific Northwest National Laboratory (PNNL) glass properties model (GPM). The total cost is estimated to be $2.5 billion, including $150 million for retrieval.

The primary reasons for recommending this set of tanks include the following:

- The waste blending recommended optimizes the use of compatible waste types resulting in the production of a minimum amount of glass
- If wastes from the recommended tanks were treated unblended, an additional 540 to 610 canisters would be produced.
- The cost avoidance for treatment and disposal of blended waste instead of treating unblended waste would be about $1 billion.
- The number and location of waste feed tanks recommended improves the reliability of HLW feed delivery by providing continual backup staged feed capability from independent tank farms.
- Blending of wastes to produce high waste oxide loaded glasses tends to reduce the number of non-compliance cases and improves the probability that the waste feed is within contract Specification.
- Current data indicates the recommended tanks are unlikely to have a visible separate organic layer. Historical records indicate that waste retrieved from tanks 241-C-102 and 241-C-104 are likely to have a visible separate organic layer.
- The recommended tanks, which are double-shell tanks (DST), provide an increased probability of meeting project schedules since they are much newer than single-shell tanks (SST).

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2.0 PROBLEM STATEMENT

Remediation and disposal of HLW is mandated by milestones under a fixed schedule governed by the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1994). The Tank Waste Remediation System (TWRS) privatization contract between the DOE and BNFL specifies that in Phase 1, the DOE will make available to BNFL HLW feed quantities sufficient to produce 600 canisters of vitrified waste (DOE 1998). As specified in the contract, the DOE is liable for penalties for each day of delay in providing BNFL with waste that meets feed specifications.

A number of HLW tanks have been selected to provide feed to the proposed BNFL vitrification plant. The tanks selected are 241-AZ-101, 241-AZ-102, 241-C-106/241-AY-102, 241-C-104, and a contingency tank 241-C-102 as documented during the TWRS 1998 readiness-to-proceed (RTP) effort. During the request for proposal process, the waste in tanks 241-AZ-101, 241-AZ-102, and 241-C-106/241-AY-102 were deemed adequate to satisfy the minimum requirement of 245 metric tons of waste oxides (exclusive of Na_2O or SiO_2), but did not satisfy the maximum requirement of 465 MT of waste oxides. Tanks 241-C-104 and 241-C-102 were tentatively selected to meet the projected shortfall of the Phase 1 contract quantity but are expected to yield insufficient feed material to meet the current contract requirement of 600 canisters with any large contingency. As the HLW feed specifications changed in the privatization contract revision (July 1998), HLW tank selection will be reevaluated with emphasis beyond 241-C-106/241-AY-102.

There are many considerations, some with apparent conflicts, that play a part in deciding which tank wastes should be staged for treatment during Phase 1 and in what order. Ideal sequencing of the waste will allow generation of the minimum amount of glass at the lowest possible cost. Examples of constraints in the TWRS project include limitations in operations, e.g., waste retrieval and transfer capabilities; scheduling restrictions during construction activities in the tank farms; waste sampling/characterization anomalies and limitations of best-basis inventory data; non-homogeneity of tank waste; waste feed quantity and quality specifications; tank space availability for blending of waste for optimum glass production; and project schedule pressures. A systems engineering approach is used to evaluate these multiple factors and develop a list of the next set of tanks best suited for HLW feed beyond the first four.

2.1 OBJECTIVES

The objective of this task is to reassess the technical basis for the selection of Phase 1 HLW feed tanks. This reassessment is required due to the revision of the privatization contract in July 1998. The first three tanks were selected based on criteria established in the *TWRS Operation and Utilization Plan* (TWRSO&UP) (Kirkbride et al. 1997). This reassessment was performed through a systematic process of criteria development and ranking known as an alternatives generation and analysis (AGA). The primary objective was to determine the hierarchy of tanks to be treated to minimize life-cycle cost consistent with all of the other identified constraints. Life-cycle cost was not the only standard for determining the optimum set of tanks. Other criteria also have an important impact on meeting the requirements of the WFD mission.

The analysis presented here provides a basis for selecting an optimum set of HLW feed tanks for Phase 1. The general approach is to reduce life-cycle cost, shorten the length of Hanford's waste disposal mission, and improve the reliability of feed delivery. The cost is expected to be reduced by blending compatible HLW source tanks, which increases waste oxide loading in glass and reduces the number of HLW canisters produced. As a result, at a fixed HLW vitrification rate, the retrieval rate of HLW tanks can be increased enabling an earlier completion of the mission.

2.2 ISSUES OF CONCERN

Various cost models can have a useful role in defining the optimum set of tanks for Phase 1 vitrification. It is anticipated that these models will also aid in developing the minimum life-cycle cost profile for the Phase 2 vitrification contract. With improved understanding of the relationship between waste composition and waste loading in HLW glass, these models could also be used to establish incentives for the contractor to increase waste loading, thereby yielding fewer canisters of glass.

Retrieval activities may be affected by construction delays and/or problems associated with insufficient retrieval of waste from a tank. Some blending of wastes is beneficial as described previously. In cases where the retrieved waste may be highly variable in composition, the retrieval program needs to provide some flexibility to address this contingency. If a partial heel is left in the tank, it could affect other uses of the tank.

Sodium borosilicate glass is expected to be employed to immobilize the HLW constituents. The BNFL contract Specification 1 identifies the requirements for the immobilized high-level waste (IHLW) product. Specification 1.2.2.1.6 additionally defines the requirements for product waste loading. According to this specification, the loading of non-volatile components in waste Envelope D "shall be such that the concentration of at least one of the waste components or waste component combinations exceeds the minimum weight percent in HLW glass defined in Table TS-1.1." That table identifies the minimum component limits in HLW glass.

The BNFL contract specification, however, does not necessarily define the minimum volume of HLW glass that must be produced in the vitrification process. This volume usually can be more accurately predicted by using the GPM developed by the PNNL. These models define the glass property limits, such as viscosity, electrical conductivity, liquidus temperature, and sodium Product Consistency Test (PCT) release, that are considered to be limiting constraints for the melter and IHLW product.

Three technical uncertainties that influence the probability of achieving a HLW delivery schedule are (1) retrieval efficiency, (2) concentration of glass limiting component(s) in delivered solids, and (3) solubility of limiting component(s) in glass. Very low solubilities of iron and zirconium present in HLW tanks in either water washing or caustic leaching solutions significantly decreases the pretreatment uncertainty from the WFD perspective. The GPM and component limits in Specification 1 of the BNFL contract bracket solubilities of iron and zirconium in glass. This fixed range of solubilities limits the uncertainty in waste oxide loading assuming a given melter technology. Waste feed delivery's largest uncertainty can be managed by adequately characterizing the sludge, meeting expected retrieval efficiencies, and planning contingency feed.

The major risk associated with the optimum selection of waste feed tanks is the seven additional transfers required to blend HLW feed. This risk is judged to be low since the number of transfers are a small increment over the minimum approximately 60 HLW feed delivery transfers that are required over a 15-year period. The potential benefits resulting from blending waste are large and outweigh risks due to additional transfers.

2.3 BOUNDARIES OF THE ANALYSIS

The boundaries of this analysis are as follows:

- Phase 1 HLW feed tanks will be identified for the WFD mission.
- Tanks 241-AZ-101, 241-AZ-102, and 241-AY-102/241-C-106 are to be used for the baseline HLW feed.
- Additional wastes will be required to supplement the baseline feed.
- Cost analysis will be based on tank-specific retrieval costs (construction and operation), glass production costs, and waste disposal costs.

Several different models were used for this cost analysis. The most important model was used to select tanks or combinations of tanks based on minimum life-cycle cost for Phase 1. Because the Phase 1 mission is expected to be relatively short-term, other cost models were used to generate alternative sets of tanks based on minimum retrieval cost and minimum product unit cost. Certain costs were not considered in this analysis, including costs associated with construction of waste feed lines to the contractor receiver tanks, and costs for the sampling and analysis of retrieved waste before transfer to the contractor facility. Current estimates also may not cover all of the acceptance and product verification tests that may be required by the DOE and the contractor. These cost elements are not expected to have a significant effect on this selection process because these costs will generally apply to all of the wastes.

2.4 ANALYSIS APPROACH

This analysis is based on the AGA procedure (HNF-IP-0842, Vol. IV, Section 3.3). The format for this study is shown below, together with those sections of the report that address each element:

- Development of a clear problem statement (Section 2.0)
- Development of the constraints, requirements, and assumptions (Section 3.0)
- Development of the decision criteria (Section 4.0)
- Development of the alternative cost models (Section 5.0)
- Conduct of the analysis (Section 6.0).

The alternatives generation approach is broad. Generally, all of the possible feed sources were considered, except those that may be restricted by programmatic constraints (e.g., limited number of new projects). Section 5.1 provides a more complete discussion of the alternatives that were considered in this study. These alternatives result in the development of cost profiles for 12,426 cases involving tanks or groups of tanks, in addition to those already identified in the baseline, and the analysis of 220 different blending cases.

The analyses were performed in four steps:

- Analysis of each waste feed stream (72 in all) to determine the glass yield (or number of canisters) based on the BNFL contract specification and on the GPM developed by PNNL.

- Development of cost estimates, on a tank-specific basis, to determine waste retrieval costs, glass production costs, and canister disposition costs

- Analysis of possible blending cases

- Ranking of each case based on the various cost estimates, together with identified selection criteria based on waste feed delivery constraints.

Section 6.1.1 provides a more detailed discussion of the BNFL contract specifications and the PNNL GPM used in this analysis. This analysis is largely mathematical in nature, with linear algebra and the use of binary inclusion flags to sort the results. A binary inclusion flag was used to identify the tanks that were included in each case. This flag was set to zero for those tanks that were not included in the sample population. Glass vectors were generated for those tanks with inclusion flags, which is mathematically equivalent to adding together the glass production volumes from all tanks in the sample population. A uniform algorithm was developed to collect the results from each case. The tanks in each case were identified by name in the output files, including the fraction of each waste for those cases where the wastes were blended.

Cases were ranked based on minimum cost and other criteria in a hierarchical structure. These criteria often served to reduce the level of distinction between various cases. The waste feed specifications in the BNFL contract, however, were often a more useful discriminator in this optimization study.

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3.0 CONSTRAINTS, REQUIREMENTS, AND ASSUMPTIONS

The main constraints in WFD are feed delivery specifications, physical and chemical properties of the feed, construction and scheduling requirements, and waste retrieval risk. Several assumptions were also found to be necessary for this study, including those relating to the composition and homogeneity of the wastes, validity of the glass models and cost factors used to identify the optimum set of tanks.

3.1 CONSTRAINTS

The following constraints were considered in developing the optimized set of HLW feed tanks for Phase 1.

3.1.1 Identification of Waste Feeds

The candidate feed tanks included all DSTs in the 200 East Area (except tank 241-SY-102) and all non-leaking SSTs also in the 200 East Area with a significant amount of sludge (and minimal saltcake). These tanks are listed in Table 1.

Table 1. Waste Feed Sources for the Analysis.

Single-Shell Tanks	Double-Shell Tanks
241-B-104	241-AN-102
241-B-202	241-AN-103
241-BX-103	241-AN-104
241-BX-104	241-AN-106
241-BX-105	241-AN-107
241-BX-107	241-AW-102
241-BX-109	241-AW-103
241-BX-112	241-AW-104
241-C-102	241-AW-105
241-C-103	241-AW-106
241-C-104	241-AY-101
241-C-105	241-SY-102
241-C-107	
241-C-108	
241-C-109	
241-C-112	

In addition to these wastes, certain blends were also considered when the compositions were such that a net reduction in glass volume could be realized for the blend. For example, the GPM shows that spinel-limited high iron wastes can usually be mixed with zirconium-limited waste to reduce the number of canisters otherwise produced from the zirconium-limited waste. This approach, in some cases, can lead to an 80 percent reduction in glass volume for some zirconium-limited wastes. This study, consequently, focused on specific blends of waste, including blends of high iron waste from tanks 241-AY-101, 241-AY-102/241-C-106, 241-SY-102, 241-AW-104, and 241-C-102, with zirconium-limited waste from tank 241-AW-103. The waste blends were generated in 10 percent increments to optimize the blend ratios for these tanks.

3.1.2 Waste Feed Limitations

Limits on waste feeds are generally based on specifications in the BNFL contract, rather than on other criteria such as the properties of the waste or the retrieval risk associated with certain tanks.

3.1.2.1 Contract Limitations. Under conditions of the current contract, BNFL is obliged to produce a minimum of 600 canisters of HLW glass during Phase 1. In this analysis, a 25 percent contingency is used to address the risk of poor retrieval efficiency. Cases that did not provide a minimum of 750 canisters of glass were screened out.

3.1.2.2 Physical/Chemical Limitations. Physical and chemical property limits are defined in Specification 7 of the contract for low-activity waste (LAW) and Specification 8 for HLW. The LAW specification also applies to the supernate fraction separated from the HLW slurry delivered to the contractor. At present, very few wastes satisfy all of these specifications. These specifications need to be met to minimize penalties that may be assessed for off-specification feed. Selected cases were analyzed for compliance with solid and/or liquid LAW specifications. Blending of wastes to produce high waste oxide loaded glasses tends to reduce the number of non-compliance cases and improves the probability that the waste feed is within contract Specification 8. Based on current guidance from DOE, adjustment of the feed to satisfy feed non-compliance conditions is not to be considered.

Table 2 and 3 identify the LAW and HLW feed specifications, respectively, in the BNFL contract.

Table 2. Contract Specification 7 Low-Activity Waste Feed Requirements.

Table TS-7.1 LAW Chemical Composition, Soluble Fraction Only (maximum ratio, moles of analyte to moles of sodium)			
Chemical Analyte	Envelope A	Envelope B	Envelope C
Al	2.5E-01	2.5E-01	2.5E-01
Ba	1.0E-04	1.0E-04	1.0E-04
Ca	4.0E-02	4.0E-02	4.0E-02
Cd	4.0E-03	4.0E-03	4.0E-03
Cl	3.7E-02	8.9E-02	3.7E-02
Cr	6.9E-03	2.0E-02	6.9E-03
F	9.1E-02	2.0E-01	9.1E-02
Fe	1.0E-02	1.0E-02	1.0E-02
Hg	1.4E-05	1.4E-05	1.4E-05
K	1.8E-01	1.8E-01	1.8E-01
La	8.3E-05	8.3E-05	8.3E-05
Ni	3.0E-03	3.0E-03	3.0E-03
NO_2	3.8E-01	3.8E-01	3.8E-01
NO_3	8.0E-01	8.0E-01	8.0E-01
Pb	6.8E-04	6.8E-04	6.8E-04
PO_4	3.8E-02	1.3E-01	3.8E-02
SO_4	1.0E-02	7.0E-02	2.0E-02
TIC	3.0E-01	3.0E-01	3.0E-01
TOC	5.0E-01	5.0E-01	5.0E-01
U	1.2E-03	1.2E-03	1.2E-03
Table TS-7.2 LAW Radionuclide Content, Soluble Fraction Only (maximum ratio, Bq of radionuclide to moles of sodium)			
Radionuclide	Envelope A	Envelope B	Envelope C
TRU	4.8E+05	4.8E+05	3.0E+06
^{137}Cs	4.3E+09	2.0E+10	4.3E+09
^{90}Sr	4.4E+07	4.4E+07	8.0E+08
^{99}Tc	7.1E+06	7.1E+06	7.1E+06
^{60}Co	6.1E+04	6.1E+04	3.7E+05
$^{154}Eu + ^{155}Eu$	1.2E+06	1.2E+06	4.3E+06

Table 3. Specification 8 High-Level Waste Feed Requirements. (2 Sheets)

Table TS-8.1 HLW Feed Unwashed Solids Maximum Non-Volatile Component Composition (grams per 100 grams non-volatile waste oxides)			
Non-volatile element	Maximum (grams/100 grams waste oxides)	Non-volatile element	Maximum (grams/100 grams waste oxides)
As	0.16	Pu	0.054
B	1.3	Rb	0.19
Be	0.065	Sb	0.84
Ce	0.81	Se	0.52
Co	0.45	Sr	0.52
Cs	0.58	Ta	0.03
Cu	0.48	Tc	0.26
Hg	0.1	Te	0.13
La	2.6	Th	0.52
Li	0.14	Tl	0.45
Mn	6.5	V	0.032
Mo	0.65	W	0.24
Nd	1.7	Y	0.16
Pr	0.35	Zn	0.42
Table TS-8.2 HLW Feed Unwashed Solids Maximum Volatile Component Composition (grams per 100 grams non-volatile waste oxides)			
Volatile components	Maximum (grams/100 grams waste oxides)	Volatile components	Maximum (grams/100 grams waste oxides)
Cl	0.33	TOC	11
CO_3^{-2}	30	CN	1.6
$NO_2 + NO_3$	36	NH_3	1.6
Table TS-8.3 HLW Feed Unwashed Solids Maximum Radionuclide Composition (Curies per 100 grams non-volatile waste oxides)			
Isotope	Maximum	Isotope	Maximum
^{3}H	6.5E-05	^{154}Eu	5.2E-02
^{14}C	6.5E-06	^{155}Eu	2.9E-02
^{60}Co	1E-02	^{233}U	9.0E-07
^{90}Sr	1E+01	^{235}U	2.5E-07
^{99}Tc	1.5E-02	^{237}Np	7.4E-05
^{125}Sb	3.2E-02	^{238}Pu	3.5E-04
^{126}Sn	1.5E-04	^{239}Pu	3.1E-03
^{129}I	2.9E-07	^{241}Pu	2.2E-02
^{137}Cs	1.0E+01	^{241}Am	9.0E-02
^{152}Eu	4.8E-04	$^{243+244}Cm$	3.0E-03
Table TS-8.4 Additional HLW Feed Composition for Non-Volatile Components			

Table 3. Specification 8 High-Level Waste Feed Requirements. (2 Sheets)

(grams per 100 grams non-volatile waste oxides)			
Non-volatile element	Maximum	Non-volatile element	Maximum
Ag	0.55	Ni	2.4
Al	14	P	1.7
Ba	4.5	Pb	1.1
Bi	2.8	Pd	0.13
Ca	7.1	Rh	0.13
Cd	4.5	Ru	0.35
Cr	0.68	S	0.65
F	3.5	Si	19
Fe	29	Ti	1.3
K	1.3	U	14
Mg	2.1	Zr	15
Na	19		

3.2 REQUIREMENTS

It was assumed in this analysis that no more than two new retrieval projects will be started to support the Phase 1 contract. As a derived requirement, resulting from the complexity of ongoing projects, cases of three or more projects are not considered in this analysis.

A contingency of 25 percent of the contract feed requirement is assumed to address retrieval risks of the contract.

3.3 ASSUMPTIONS

As described above, certain assumptions were found to be necessary for this evaluation, including those relating to the composition and homogeneity of the wastes, validity of the glass models, and cost models that were used to identify the optimum set of tanks.
These assumptions are described in this section of the AGA.

3.3.1 Waste Composition and Homogeneity

It has been widely recognized that SST and DST wastes are often distributed in discrete layers in the tanks. These layers are often co-mingled with one another and vary widely in composition. Sometimes discrete pockets of waste exist in various sections of the tanks. The waste compositions in this study are based on the Best-Basis Inventory profiles for each tank (LHMC 1998). The Best-Basis Inventory is not yet capable of providing a full description of waste layers; therefore, all wastes were handled as if they were homogeneous. Since caustic washing is being considered as the baseline treatment process, all of the wastes were theoretically subjected to this form of waste treatment using the leach factors that were developed by Hendrickson (1999). These leach factors are based on a limited amount of experimental data, together with Environmental Simulation Process (ESP) thermodynamic modeling results and chemical analogue comparisons. Caustic washing results were used to produce the most conservative estimates of glass volume.

Non-homogeneity could be a significant issue for those wastes that may be only partially blended with other tanks. The use of tank 241-AW-103 waste for blending appears to be an acceptable approach because this waste is unusually homogeneous in the tank. Tank 241-C-104, which is considered to be an alternate source of high zirconium waste, is less acceptable because this waste is highly stratified and varies significantly in composition depending on depth.

3.3.2 Glass Property Models

The GPM in this study was developed by PNNL from statistical analysis of laboratory data. These models appear to be generally reliable for estimating the properties of HLW glass (if the component concentrations are within the region defined by the experimental glasses used to develop the models). The glass property models are described in more detail in Section 6.1.1.

3.3.3 Cost Factors

In addition to program-related costs for production and disposal of glass canisters, cost factors were also developed to estimate capital and operating costs for retrieval. Cost algorithms were developed in this report in an attempt to quantify the impacts of glass volume deltas on costs of processing by BNFL and disposal (interim storage and repository disposal). Although retrieval costs are included in the analysis, they are less sensitive to glass volumes and are relatively much smaller than processing and disposal costs. These costs are "order of magnitude" estimates at this time and are useful only to compare alternatives.

3.3.3.1 Glass Canister Production and Disposal Cost. Canister production and disposal are expected to be in the range of $978,000 per canister for production and $960,000 per canister for interim storage, transport, and disposal (Holton 1998). The portion of the disposal cost directly attributable to repository disposal is $422,000 per canister (Kinzer 1997).

3.3.3.2 Capital Construction Costs. Capital costs include costs for the installation of sluicers or mixer pumps, installation of in-farm piping, installation of ex-farm piping, and the development of a waste retrieval facility if necessary.

3.3.3.2.1 Retrieval System Capital Costs. Sluicer installation costs were estimated based upon Project W-320 costs. Mixer pump installation costs were similarly estimated from Project W-211 costs, which are comparable to Project W-523 costs from the mid-year work plan. In each case, costs were slightly reduced to account for savings associated with the second and subsequent installations of similar retrieval systems. Each SST was assumed to require sluicers, while mixer pumps were assumed for each DST. Sluicer and mixer pump cost estimates are provided in **Table 4.**

Table 4. Retrieval Equipment Capital Costs

	1st	2nd	Benefit
Sluicer	$67,700,000	$49,800,000	$17,900,000
Mixer	$28,000,000	$25,000,000	$3,000,000

3.3.3.2.2 Piping Capital Costs. Piping is required to transport waste material to its holding point pending delivery to the contractor. It was assumed in this study that a new pump pit and 280 ft of additional piping would be required for retrieval of B, BX, or BY (B-complex) tank wastes. Other tanks in the B tank farm can be retrieved by installing additional piping in increments of 100 ft of in-farm piping. In-farm piping costs were based upon Project W-314 estimates.

In addition to in-farm piping, previous studies have shown that 10,000 feet of additional pipe would be required to retrieve the waste from B-complex. This portion of the estimate is based on the results that were referenced in TWRSO&UP (Kirkbride et al. 1997) (Table 4.3-3). Piping cost estimates are summarized in **Table 5.**

Table 5. Piping Cost Estimates.

Piping	Cost	Length	Jumper assembly	Total cost
Jumper manifold to 1 tank	$3,426,105	280 ft	$165,885	$3,591,990
Additional Line to another tank	$1,223,609	100 ft	$165,885	$1,389,494
Long length Ex-farm		10,000 ft		$35,384,000

3.3.3.2.3 Waste Retrieval Facility Capital Costs. TWRSO&UP (Kirkbride et al. 1997) analyses have also identified the need for U-farm upgrades to support the sluicing of B-complex tank wastes. These upgrades and usage are termed a Waste Retrieval Facility (WRF). WRF cost estimates are provided in **Table 6**. The two-tank cost was described in the TWRSO&UP. The cost for one tank was assumed to be 60 percent of the two-tank cost. Two tanks were employed in the cost estimates if more than one tank in the B-complex is retrieved.

Table 6. Waste Retrieval Facility Costs.

1 tank	$76,432,200
2 tanks	$127,387,000

3.3.3.3 Operating Costs. Operating costs were developed based upon assumed manloading rate and duration of the activity as a function of sluicing or mixer pump retrieval. Operating cost assumptions are provided in Table 7. The cost of partial retrieval for blending is assumed to be proportional to the total retrieval cost for the tank. This may be somewhat higher than the actual cost for this activity, but the difference is probably negligible compared to overall project costs (e.g., minimum overall project exceeds $1.5 billion).

Table 7. Operating Costs/Tank.

	Time (weeks)	FTE	Hours	Rate	Cost
Sluicer	6	4	4,032	$70	$282,240
Mixer	2.5	4	1,680	$70	$117,600

4.0 DECISION CRITERIA

A number of factors were considered in developing the selection criteria for this study. The ultimate goal is to safely treat and dispose all of the tank waste. There are a variety of activities underway in the tank farms to characterize waste and to ensure personnel safety and protection of the environment. These activities will gradually diminish as the tanks are emptied.

Several projects were recently undertaken for the waste retrieval program, e.g. installation of the cross-site waste transfer line. Other construction activities are expected to take place that will have some impact on tank accessibility. Also, there are certain Tri-Party Agreement milestones and other DOE schedule commitments, such as those in the BNFL contract, that must be met. These issues were considered in developing the selected criteria that are listed in Table 8.

A graded approach was used to define the relative importance of each criterion. Scaling factors were developed to quantify the relative significance of these criteria. For example, a scaling rank of 1 was assigned to those issues that are expected to have a major impact on feed quantity and delivery schedule, while a rank of 4 was assigned to those issues likely to have little impact on the waste feed delivery mission. Only two of the listed criteria, glass quantity and costs, were quantitatively evaluated; the other criteria were assessed qualitatively.

The sludge and supernate composition compliance criteria are not discriminating factors because all tanks and blends are slightly out of specification. Resolving safety-related issues such as organic solvents in tank 241-C-103 were judged to be of less importance than those factors that directly affect the timely delivery of an acceptable amount of feed to BNFL. In general, the composition of blended tanks come closer to meeting specifications than unblended tanks. The most important issues appear to be glass production quantity, feed quantity, delivery schedule, and penalties incurred for late feed delivery in the BNFL contract.

Table 8. Tank Selection Criteria Ranking.

Ranking	Tank selection criteria	Driver
Prerequisite (non-tradable)		
1	Glass quantity produced	Meet contract minimum value (600 canisters)
Retrieval		
1	Meeting schedule AB Change impact on schedule Regulatory changes – impacts on schedule	Penalties per contract with BNFL
1	Retrieval risk organic vapor generation floating organic layer	Contract quantity and schedule
2	Waste retrieval cost; maximize use of existing infrastructure	Minimize cost
2	Availability of early DST space	DST volume projection limitation
3	Early SST retrieval	Improved safety; technology demonstration on full tank
4	Safety (organics, C-103)	Resolve tank safety issues
Cost of Product (including disposal)		
2	Blending of compatible waste (e.g. high Fe/Cr and high Zr)	Maximize waste oxide loading (WOL) [DOE-RL guidance on optimization]
Contract Specification		
2	Impact on existing plans	Eliminate bottlenecks; expedite overall TWRS progress
3	Sludge composition compliance	Meet contract Envelope D Specification 8
3	Supernatant composition compliance	Meet contract Envelope A, B, or C Specification 7

5.0 IDENTIFICATION OF CASES

The tank materials previously selected for Phase 1 delivery were insufficient to meet the original contract maximum feed requirements of 465 MT of waste oxides. Recent contract revisions to the BNFL contract have increased the minimum delivery requirement from 245 MT of waste oxides to enough HLW feed for BNFL to produce 600 canisters of glass product. The purpose of this section is to develop alternative cost models to be used to optimize the feed selection to meet the new minimum feed requirements.

Table 1 provided a list of tank wastes to be considered. For the purposes of this analysis, preliminary identification of blending opportunities indicated that the blending of zirconium-limited and spinel-limited wastes might provide the greatest value. Spinel-limited wastes in 241-AY-101, 241-C-102, 241-AW-104, 241-SY-102, and 241-AY-102/241-C-106 were deemed of greatest availability. Zirconium-limited wastes include 241-C-104, 241-AW-103, and 241-AW-105. Due to the low volume of waste solids available in 241-AW-105, this blend agent was dropped from consideration. Blending of wastes is further described and analyzed in Section 6.1.1.3.

There are some concerns in the use of various spinel-limited materials. Tank 241-C-107 was not considered since availability of this SST waste is not likely during early Phase 1 treatment. Tank 241-AW-106 composition is subject to some question as the waste may be more saltcake than sludge.

5.1 DESCRIPTION OF CASE DEVELOPMENT

The selection of tanks 241-AZ-101, 241-AZ-102, and 241-C-106/241-AY-102 as the first three to provide feed to the proposed BNFL vitrification plant has been previously established in the TWRSO&UP (Kirkbride et al. 1997). Each alternative evaluated in this document considers possible combinations of the base case with the other 28 potential HLW feed tanks and 41 blends that use either 241-C-104 or 241-AW-103. Wastes from a total of 31 HLW tanks were investigated.

All three of the base case tanks are included in currently identified retrieval projects. Table 9 provides a listing of tanks currently under projects. Any of the identified potential feed tanks not in this project list are considered to require a new project. Programmatic, cost, and schedule constraints were imposed in selecting cases such that no combination of the additional tanks and blends would require more than two new projects to accommodate retrieval.

Table 9. Current Tanks Under Retrieval Projects.
(excluding base case tanks)

Tank	Project
241-C-102	W-523
241-C-104	W-523
241-AN-102	W-521
241-AN-104	W-211
241-AN-107	W-521
241-SY-102	W-211

Implementation of the new projects constraint resulted in identification of three categories, each consisting of combinations of the three base case tanks plus additional tanks or blends. In addition, the blending driver resulted in a fourth category. Each combination is termed a case that is evaluated against the selected criteria to determine the best options for HLW feed to the vitrification plant. Constraints in the analysis exclude redundant combinations of tanks/blends. The alternatives identified are as follows:

- The three base case tanks plus one additional tank or blend
- The three base case tanks plus a total of two additional tanks or blends
- The three base case tanks plus a total of three additional tanks or blends
- Tanks selected based on the blending driver to determine the optimum blend (allows more than three additional tanks).

5.1.1 Baseline Waste Feeds Plus One Tank/Blend

The first of the three waste feed categories considered includes the base case tanks plus one additional tank or blend. The possible cases in this category are generated in a matrix that assigns all three base case tanks to each case plus all possible combinations of the remaining 69 tanks/blends, taken one at a time. Each case comprises four distinct tanks or blends. Since the base case tanks are all identified in current projects and any additional tank or blend can add only one new project, all combinations of this alternative are within the imposed constraint of a maximum of two new projects.

The total number of viable combinations to be evaluated as HLW feed cases for this category is 69.

5.1.2 Baseline Waste Feeds Plus Two Tanks/Blends

The second case set includes the three base case tanks plus a total of two additional tanks or blends. These possible cases are generated in a matrix that assigns all three base case tanks to each case plus all possible combinations of the remaining 69 tanks/blends, taken two at a time. Since the base case tanks are all identified in current projects and any additional tank or blend can add only one new project, all combinations in this category are within the imposed constraint of a maximum of two new projects.

The total number of viable combinations to be evaluated as HLW feed cases for this category is 2,100.

5.1.3 Baseline Waste Feeds Plus Three Tanks/Blends

The third category includes the three base case tanks plus a total of three additional tanks or blends. The possible cases in this category are generated in a matrix that assigns all three base case tanks to each case plus all possible combinations of the remaining 69 tanks/blends, taken three at a time. Since each tank/blend option can potentially add one new project, many of the cases generated in this category would require three new projects to accommodate retrieval.

After exclusions, the total number of viable combinations to be evaluated as HLW feed cases for this category is 10,257.

5.1.4 Optimum Blended Waste Analysis

This category is comprised of full spectrum analysis of blending of each of the two zirconium-limited waste tanks 241-AW-103 and 241-C-104 with each of five spinel-limited wastes. With glass modeling at each 5-percent increment, a total of 220 individual blends were prepared.

5.2 ALTERNATIVE ONE – LEAST COST PER UNIT PRODUCT

The first alternative considered is that of minimization of the unit product cost that would appear to provide savings in the long term. The short-term and low-volume expectations for the Phase 1 immobilized HLW (IHLW) contract are not necessarily consistent with long-term profit from this approach. Therefore, it may not be in the best interest of the waste vitrification program unless it fulfills other program goals not met by other alternatives. In addition, this analysis method would tend to favor cases in which a higher glass quantity is produced, as this would reduce unit cost.

This alternative is exercised by ranking the cases from lowest to highest cost per canister produced. Costs are based upon BNFL contract maximum product yield and waste retrieval to support each case. Application of safety, retrieval risk, and other programmatic drivers of early SST retrieval or DST space will tend to dismiss certain options.

5.3 ALTERNATIVE TWO – LEAST TOTAL COST

The second alternative considered is that of minimization of the total cost under the contract for the Phase 1 HLW privatization. This type of optimization is generally favored in short-term contracts when the total budget of a task has a rigid ceiling. This economic alternative allows for clear-cut decisions about total cost and is more amenable to common budget and schedule variance analysis tools, such as Estimate at Completion (EAC).

This alternative is exercised by ranking the cases from lowest to highest total case cost. Costs are based upon BNFL contract maximum product yields and waste retrieval to support each case. Cases producing less than 750 model-based canisters of product are screened out as insufficient to meet contract requirements with 25 percent contingency.

Application of this alternative will tend to require avoidance of cases with major safety or retrieval risks. The more easily acquired DST wastes will be preferred, thereby relaxing schedule constraints.

5.4 ALTERNATIVE THREE – LEAST RETRIEVAL COST

The third alternative considered is that of the minimization of retrieval cost. This minimization is consistent with minimizing risk in an uncertain market or upon an uncertain process. It reduces the up-front costs of the buyer and limits the capability to accelerate production to reduce the price per unit. Use of this economic approach discourages the seller (the privatization contractor) from capital investment and the capability to achieve long-term high production.

This alternative is exercised by ranking the cases from lowest to highest retrieval costs. Cases producing less than 750 model-based canisters of product are screened out as insufficient to meet contract requirements with 25 percent contingency.

The more highly ranked cases from the first two alternatives are likely to show up here intermittently. That is, this alternative provides the same first rank as that of the least cost per can case followed by the first rank of least total cost.

The election of least retrieval cost inherently gives a higher preference to those cases with minimal safety or retrieval risks (DSTs) and minimal schedule difficulty. Application of programmatic tank selection criteria other than specification compliance will have negligible effect upon the ranking.

5.5 ALTERNATIVE FOUR – OPTIMUM BLENDING

The fourth alternative considered is that of waste blending selections to maximally use blend agent wastes and the spinel-limited wastes. This minimization is consistent with long-term optimization of absolute quantities of waste products. It would be expected to increase up-front costs for the retrievals resulting in a higher cost per canister (due to lower product mass), but a smaller total number to be disposed. The increased number of retrievals may tax a retrieval schedule.

Certain tanks may only partially be utilized in Phase 1 vitrification. The remainder of these wastes would then be processed in Phase 2.

5.6 OTHER ALTERNATIVES

Few other economic alternatives are available other than revising the base unit definition. In all of the above discussions, the base unit has been the maximum quantity of product that could be contractually produced by the contractor (minimum waste load). This viewpoint provides the maximum total cost in each case. There are potential cost savings if the base unit is defined as the minimum quantity of product that could be produced (highest waste loading). Within each of the first two alternatives described below, a parallel set of data is provided that addresses this form of optimization.

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6.0 ANALYSIS OF ALTERNATIVES

The selection of each viable combination of tanks, a case, was evaluated in terms of the following:

- The tanks that will provide the HLW feed
- The number of glass canisters produced by each combination of tanks
- The capital and operating costs for retrieval of the waste from the tanks in each case
- The production and disposal costs for the retrieved waste.

The data for each case were collected in a consolidated spreadsheet. The cases were then sorted depending upon the cost parameter being investigated. The ranking was assigned sequentially with a rank of 1 being assigned to the most attractive set of tanks. Alternate cases were ranked in ascending order, progressing from the most cost-effective to the least cost-effective. Cases that do not provide sufficient HLW feed to produce at least 750 canisters were screened out.

The cost objectives of the alternatives analyses are discussed below in terms of the criteria that were used to identify the most attractive choices.

6.1 ALTERNATIVE ANALYSES

The optimum set of tanks was identified through stepwise analysis of each case. The following discussion briefly describes the methods that were used in this analysis.

6.1.1 Glass Product Yield

Under terms of the existing contract, BNFL is obliged to produce a minimum of 600 canisters of HLW glass during Phase 1. Two separate models can be used to estimate the amount of glass that can be produced from each tank or combination of tanks (or blends). The first model is based on Specification 1 of the BNFL contract. This specification identifies the limiting composition for the product. Based on the composition of the waste, it is relatively easy to define the allowable amount of glass that can be produced according to this specification. The second model is based on the glass property limits for the melter and product glass. This model really consists of a set of sub-models, each designed to statistically predict a limiting glass property for each waste. The GPM generally indicates the minimum amount of glass that can be produced in a standard melter, while the BNFL specifications show the allowable (and generally maximum) amount of glass that can be produced under terms of the existing contract.

The waste feed consists of a concentrated slurry from caustic leaching of HLW sludge. Waste inventory estimates are based on the Best-Basis Inventory (LHMC 1998). Most of the DST inventory and some of the SST inventory consists of supernates that will be sent to the

LAW melter. The supernate fraction was subtracted from the total inventory to determine the composition of each waste prior to caustic leaching. The caustic leaching process was modeled based on the leach factors developed by Hendrickson (1999). These leach factors were derived from a limited set of experimental results, together with Environmental Simulation Program (ESP) thermodynamic modeling results and chemical analogue comparisons. Caustic washing estimates were used because these estimates are expected to produce the most conservative estimates of glass volume. Glass product specifications for HLW glass are generally expressed in terms of the weight fraction of each waste oxide in the product.

6.1.1.1 Contractual Maximum Yield. BNFL Specification1 identifies the requirements for the IHLW product. Specification 1.2.2.1.6 additionally defines the requirements for product waste loading. According to this specification, the loading of non-volatile components in waste Envelope D "shall be such that the concentration of at least one of the waste components or waste component combinations exceeds the minimum weight percent in HLW glass as defined in Table TS-1.1." This table identifies the minimum component limits in HLW glass.

Table 10 provides a summary of the BNFL glass specifications and shows how these specifications can be used to determine the allowable amount of glass made from tank 241-B-202 waste. The allowable number of canisters can be estimated by calculating the amount of glass produced at the minimum allowable concentration for each waste oxide, and dividing the result by the assumed inventory of 2,895 kg of glass per canister. Based on this approach, Bi_2O_3 is the limiting component and tank 241-B-202 waste will generate approximately 77 canisters of glass.

Table 10. Tank 241-B-202 Contract Allowable Glass Product. (2 Sheets)

Component	Wt. % in HLW Glass	Mass Of HLW Glass, kg	Mass Of HLW Glass, No. Canisters (Largest Value = Allowable)
Fe_2O_3	12.5	9,124.9	3.2
Al_2O_3	11	1,731.4	0.6
Na_2O+K_2O	15	674.1	0.2
ZrO_2	10	8.5	0.0
UO_2	8	404.5	0.1
CaO	7		
MgO	5		
BaO	4		
CdO	3		
NiO	3	1,034.4	0.4
PbO	1	116,634.6	40.3
TiO_2	1		
Bi_2O_3	2	222,865.8	77.0
P_2O_5	3	1,080.2	0.4
F	1.7	324.3	0.1
$Al_2O_3+ZrO_2$	14	1,366.5	0.5

Table 10. Tank 241-B-202 Contract Allowable Glass Product. (2 Sheets)

Component	Wt. % in HLW Glass	Mass Of HLW Glass, kg	Mass Of HLW Glass, No. Canisters (Largest Value = Allowable)
Al_2O_3+ZrO_2+Fe_2O_3	21	6,342.4	2.2
MgO+CaO	8		
Cr_2O_3	0.5	61,034.6	21.1

Similar calculations were performed for all tanks or combination of tanks in this study.

6.1.1.2 Glass Property Model Estimates. The BNFL contract specification does not necessarily define the minimum volume of HLW glass that can be produced in the vitrification process. This volume can usually be estimated by using the HLW GPM developed by the PNNL and described in processibility by Lambert et al. (1996). These models define the glass property limits, such as viscosity, electrical conductivity, liquidus temperature, and sodium PCT release, that are considered to be limiting constraints for the melter and IHLW product. These models appear to be generally reliable for estimating the properties of HLW glass (if the component concentrations fall within the range defined by the composition limits of the models).

The BNFL contract specifications (at that time) and PNNL GPM were each used recently to estimate the volume of HLW glass produced from 28 SSTs and DSTs (Lambert et al. 1996). That group included all tanks in the 200 East Area (except 241-SY-102) that have only a negligible amount of saltcake and have never leaked. This study also assumes that a caustic washing process is used for each waste. The results showed that the BNFL contract specifications would usually over-predict the amount of glass that needed to be produced.

The average production cost for this glass is about $978,000 per canister, while the disposal cost is estimated to be $960,000 per 15-ft. canister (Holton 1998). Based on these figures, the BNFL specifications were expected to result in 4,298 canisters of glass from those tanks, at an aggregate cost of $ 8.33 billion. If the PNNL glass models are used, only 2,268 canisters need be produced, saving about $ 3.93 billion.

The BNFL HLW glass specifications appear to be overly conservative for certain components, including Al, Bi, Fe, Ni, U, and Zr. The Al limit in the PNNL glass models is usually determined by the PCT release characteristics of the glass and by liquidus temperature estimates for spinel, zircon, and zirconia. A maximum concentration of 17-percent Al is acceptable in the PNNL glass (compared to a limit of 11 percent in the BNFL specification). Iron and nickel are usually limited by the liquidus temperature of spinel, with the proviso that the maximum concentration of Fe is less than 15 percent (compared to 12.5 percent in the BNFL specification). The BNFL limits for Bi and U are highly conservative (2 percent and 8 percent, respectively), compared to the upper limits of 15 percent Bi and 15 percent U in the PNNL glass studies. The PNNL models use two separate models to capture the effect of Zr; one model to estimate the liquidus temperature of zircon (zirconium silicate), and a second model to estimate the liquidus temperature of zirconia (zirconium oxide). The PNNL glass models do not necessarily measure the effect of noble metals, which are most aptly controlled by the limits in the BNFL specification. In view of their profound economic impacts, it appears that certain limits in the BNFL specification should be considered for revision or another contractual tool should be developed to provide incentive to reduce the IHLW product volume. The limits subject to review include limits for Fe_2O_3, Al_2O_3, Na_2O+K_2O, ZrO_2, UO_2, CaO, MgO, NiO, PbO, TiO_2, Bi_2O_3, Al_2O_3+ZrO_2, Al_2O_3+ZrO_2+Fe_2O_3, MgO+CaO, single oxide without Si, and the total of all oxides. These constraints are identified in **Table 10.**

The GPM and BNFL specifications can be used to generate two different sets of glass estimates for each case. The GPM generally indicates the minimum amount of glass that can be produced in a standard melter, while the BNFL specifications show the allowable (and generally maximum) amount of glass that can be produced under terms of the existing contract. Table 11 provides a summary of the glass production estimates for each tank or group of tanks considered in this study. Based on a summary of the SSTs and DSTs in this study, the GPM indicates that 2,090 fewer cans could be produced than allowed by contract, with a potential savings of \$4.05 billion. Additional savings could also be realized by blending wastes with compatible property limits. An example is the blending of tank 241-AY-102/241-C-106 waste with tank 241-AW-103 waste. According to the GPMs, tank 241-AY-102/241-C-106 waste is limited by the liquidus temperature of spinel; therefore, the maximum waste loading (and minimum glass volume) is based on the spinel-forming properties of this glass. Tank 241-AW-103, on the other hand, is limited by the liquidus temperature of the zirconium species in the glass. Since different components are involved in the precipitation of spinel and zirconium oxide and silicates, these wastes are excellent candidates for blending. By blending these wastes, the projected glass volume can be reduced from 1,238 canisters to only 823 canisters, with potential savings of \$804 million. Further analysis of glass blends is provided in Section 6.1.1.3.

Table 11. Glass Product Yield Estimates By Waste Stream.

Tank	Blend Tank	Blend Fraction	Waste Oxide (Mg)	BNFL		Glass Property Model	
				Cans	Constraint	Cans	Constraint
241-AZ-101			65.11	85.2	Fe_2O_3	71.0	Cr_2O_3
241-AZ-102			95.01	185.5	Fe_2O_3	154.6	P_2O_5; Cr_2O_3
241-C-106/ 241-AY-102			155.59	235.6	Fe_2O_3	196.3	P_2O_5; Cr_2O_3
241-B-104			87.01	411.0	Bi_2O_3	68.5	Liquidus Temp. (Spinel); P_2O_5; Cr_2O_3
241-B-202			11.23	77.0	Bi_2O_3	21.1	Liquidus Temp. (Spinel); P_2O_5; Cr_2O_3
241-BX-103			36.17	148.3	Cr_2O_3	148.2	Liquidus Temp. (Spinel); P_2O_5; Cr_2O_3
241-BX-104			78.18	172.2	Cr_2O_3	172.1	Liquidus Temp. (Spinel); P_2O_5; Cr_2O_3
241-BX-105			42.05	141.3	Cr_2O_3	141.3	Liquidus Temp. (Spinel); P_2O_5; Cr_2O_3
241-BX-107			163.73	798.5	Bi_2O_3	130.3	P_2O_5; Cr_2O_3

Table 11. Glass Product Yield Estimates By Waste Stream.

Tank	Blend Tank	Blend Fraction	Waste Oxide (Mg)	BNFL		Glass Property Model	
				Cans	Constraint	Cans	Constraint
241-BX-109			63.52	92.4	UO_2	56.7	P_2O_5; Cr_2O_3
241-BX-112			65.10	273.1	Bi_2O_3	58.5	P_2O_5; Cr_2O_3
241-C-102			187.70	163.3	Total of all Oxides	102.7	Liquidus Temp. (Spinel); P_2O_5; Cr_2O_3
241-C-102	241-C-104	10%	195.89	104.1	Al_2O_3+ ZrO_2+ Fe_2O_3	126.4	Liquidus Temp. (Spinel); Viscosity; P_2O_5; Cr_2O_3
241-C-102	241-C-104	20%	219.29	131.2	Al_2O_3+ ZrO_2+ Fe_2O_3	147.6	Liquidus Temp. (Spinel); Viscosity; P_2O_5; Cr_2O_3
241-C-102	241-C-104	30%	242.68	158.3	Al_2O_3+ ZrO_2+ Fe_2O_3	168.3	Viscosity; P_2O_5; Cr_2O_3
241-C-102	241-C-104	40%	266.07	185.5	ZrO_2	188.7	Viscosity; P_2O_5; Cr_2O_3
241-C-102	241-AW-103	10%	227.44	150.9	Al_2O_3+ ZrO_2	155.4	Liquidus Temp. (Spinel); Viscosity; P_2O_5; Cr_2O_3
241-C-102	241-AW-103	20%	267.19	240.5	ZrO_2	201.8	Liquidus Temp. (Spinel); Viscosity; P_2O_5; Cr_2O_3
241-C-102	241-AW-103	30%	306.93	340.8	ZrO_2	270.2	Viscosity; PCT Na; PCT B; P_2O_5; Cr_2O_3
241-C-102	241-AW-103	40%	346.67	441.0	ZrO_2	347.4	Viscosity; PCT Na; PCT B; P_2O_5; Cr_2O_3
241-C-103			130.84	206.6	Fe_2O_3	172.2	P_2O_5; Cr_2O_3
241-C-104			221.45	361.6	ZrO_2	315.6	Liquidus Temp. (Zirc); P_2O_5; Cr_2O_3
241-C-105			27.27	24.7	Cr_2O_3	43.3	Viscosity; Nepheline; P_2O_5; Cr_2O_3
241-C-107			155.07	323.9	Bi_2O_3	150.8	P_2O_5; Cr_2O_3
241-C-108			24.90	42.9	NiO	40.2	P_2O_5; Cr_2O_3
241-C-109			45.47	80.3	P_2O_5	80.4	P_2O_5; Cr_2O_3
241-C-112			113.43	177.3	UO_2	80.2	Liquidus Temp. (Zircon); P_2O_5; Cr_2O_3
241-AN-102			12.94	58.3	Cr_2O_3	57.6	PCT Na; P_2O_5; Cr_2O_3
241-AN-103			9.62	23.0	Al_2O_3	15.1	Liquidus Temp. (Spinel); Nepheline; P_2O_5; Cr_2O_3
241-AN-104			0.10	1.5	Cr_2O_3	1.5	P_2O_5; Cr_2O_3
241-AN-106			0.85	3.1	Cr_2O_3	2.9	Liquidus Temp. (Spinel); P_2O_5; Cr_2O_3
241-AN-107			38.83	53.0	Cr_2O_3	53.0	Liquidus Temp. (Spinel); P_2O_5; Cr_2O_3
241-AW-102			12.07	19.5	UO_2	17.9	P_2O_5; Cr_2O_3
241-AW-103			397.42	1,002.5	ZrO_2	795.7	Liquidus Temp. (Zirc); Cr_2O_3
241-AW-104			76.14	154.6	Cr_2O_3	154.6	Liquidus Temp. (Spinel); Cr_2O_3
241-AW-104	241-C-104	10%	98.28	163.8	Cr_2O_3	163.8	Liquidus Temp. (Spinel); Cr_2O_3

Table 11. Glass Product Yield Estimates By Waste Stream.

Tank	Blend Tank	Blend Fraction	Waste Oxide (Mg)	BNFL		Glass Property Model	
				Cans	Constraint	Cans	Constraint
241-AW-104	241-C-104	20%	120.43	173.0	Cr_2O_3	172.9	Cr_2O_3
241-AW-104	241-C-104	30%	142.57	182.1	Cr_2O_3	182.1	P_2O_5; Cr_2O_3
241-AW-104	241-C-104	40%	164.72	191.3	Cr_2O_3	191.3	P_2O_5; Cr_2O_3
241-AW-104	241-AW-103	10%	115.88	170.8	Cr_2O_3	170.7	Cr_2O_3
241-AW-104	241-AW-103	20%	155.62	204.9	ZrO_2	186.9	Cr_2O_3
241-AW-104	241-AW-103	30%	195.36	305.2	ZrO_2	239.2	Liquidus Temp. (Zirc); Viscosity; PCT Na; PCT B; Cr_2O_3
241-AW-104	241-AW-103	40%	235.11	405.4	ZrO_2	316.3	PCT Na; PCT B; Cr_2O_3
241-AW-105			177.47	376.0	ZrO_2	299.1	Liquidus Temp. (Zirc); Cr_2O_3
241-AW-106			37.56	348.8	Cr_2O_3	349.7	Liquidus Temp. (Spinel); P_2O_5; Cr_2O_3
241-AY-101			114.00	253.1	Cr_2O_3	253.0	P_2O_5; Cr_2O_3
241-AY-101	241-C-104	10%	136.15	262.2	Cr_2O_3	262.2	PCT Na; PCT B; P_2O_5; Cr_2O_3
241-AY-101	241-C-104	20%	158.29	271.4	Cr_2O_3	271.4	Viscosity; PCT Na; PCT B; P_2O_5; Cr_2O_3
241-AY-101	241-C-104	30%	180.44	280.6	Cr_2O_3	280.6	Liquidus Temp. (Spinel); PCT Na; PCT B; P_2O_5; Cr_2O_3
241-AY-101	241-C-104	40%	202.58	289.7	Cr_2O_3	289.7	Viscosity; PCT Na; PCT B; P_2O_5; Cr_2O_3
241-SY-102			25.99	269.3	Cr_2O_3	269.2	P_2O_5; Cr_2O_3
241-SY-102	241-C-104	10%	48.13	278.5	Cr_2O_3	278.4	PCT Na; PCT B; P_2O_5; Cr_2O_3
241-SY-102	241-C-104	20%	70.28	287.6	Cr_2O_3	287.6	PCT Na; PCT B; P_2O_5; Cr_2O_3
241-SY-102	241-C-104	30%	92.42	296.8	Cr_2O_3	296.8	PCT Na; PCT B; P_2O_5; Cr_2O_3
241-SY-102	241-C-104	40%	114.57	305.9	Cr_2O_3	305.9	PCT Na; PCT B; P_2O_5; Cr_2O_3
241-SY-102	241-AW-103	10%	65.73	285.4	Cr_2O_3	285.4	PCT Na; PCT B; P_2O_5; Cr_2O_3
241-SY-102	241-AW-103	20%	105.47	301.6	Cr_2O_3	301.5	Viscosity; PCT Na; PCT B; P_2O_5; Cr_2O_3
241-SY-102	241-AW-103	30%	145.21	317.7	Cr_2O_3	317.7	P_2O_5; Cr_2O_3
241-SY-102	241-AW-103	40%	184.96	401.1	ZrO_2	333.8	Viscosity; P_2O_5; Cr_2O_3
241-AY-101	241-AW-103	10%	153.74	269.2	Cr_2O_3	269.2	P_2O_5; Cr_2O_3
241-AY-101	241-AW-103	20%	193.49	285.4	Cr_2O_3	285.3	P_2O_5; Cr_2O_3
241-AY-101	241-AW-103	30%	233.23	314.1	ZrO_2	301.5	Liquidus Temp. (Zirc); PCT B; P_2O_5; Cr_2O_3
241-AY-102/ 241-C-106	241-AW-103	10%	195.34	236.2	Fe_2O_3	196.8	P_2O_5; Cr_2O_3

Table 11. Glass Product Yield Estimates By Waste Stream.

Tank	Blend Tank	Blend Fraction	Waste Oxide (Mg)	BNFL		Glass Property Model	
				Cans	Constraint	Cans	Constraint
241-AY-102/ 241-C-106	241-AW-103	20%	235.08	262.1	Al_2O_3+ ZrO_2+ Fe_2O_3	213.5	Viscosity; PCT B; P_2O_5; Cr_2O_3
241-AY-102/ 241-C-106	241-AW-103	30%	274.82	310.9	Al_2O_3+ ZrO_2+ Fe_2O_3	282.9	Viscosity; PCT Na; PCT B; P_2O_5; Cr_2O_3
241-AY-102/ 241-C-106	241-AW-103	40%	314.57	403.8	ZrO_2	360.1	Liquidus Temp. (Zirc); Viscosity; PCT Na; PCT B; P_2O_5; Cr_2O_3
241-AY-102/ 241-C-106	241-AW-103	100%	553.02	1,005.3	ZrO_2	823.3	PCT Na; PCT B; P_2O_5; Cr_2O_3
241-AY-102/ 241-C-106	241-C-104	10%	177.74	249.6	Fe_2O_3	208.0	P_2O_5; Cr_2O_3
241-AY-102/ 241-C-106	241-C-104	20%	199.89	263.6	Fe_2O_3	219.6	P_2O_5; Cr_2O_3
241-AY-102/ 241-C-106	241-C-104	30%	222.03	277.6	Fe_2O_3	231.3	P_2O_5; Cr_2O_3
241-AY-102/ 241-C-106	241-C-104	40%	244.18	291.6	Fe_2O_3	243.0	P_2O_5; Cr_2O_3
241-AY-102/241-C-106	241-C-104	100%	377.05	426.4	Al_2O_3+ ZrO_2+ Fe_2O_3	380.3	P_2O_5; Cr_2O_3

Table 12 provides a summary of the coefficients used in the set of smaller models comprising the PNNL GPM (Lambert et al. 1996). The glass viscosity and electrical conductivity models are based on two coefficients (A and B), while the other property models use only one coefficient (C) to represent the behavior of the glass. These coefficients were developed by PNNL from statistical analysis of the glass property data. In most cases, the database consists of hundreds of glass measurements, while the liquidus temperature models are based on a smaller number of measurements. The viscosity and electrical conductivity models are:

$$\text{Property} = \sum_{i=1}^{n} (A + B/T) * (HLW\ oxide\ weight\ fraction)$$

where T is the melter operating temperature in degrees Kelvin.

The other properties, with the exception of nepheline, are:

$$\text{Property} = \sum_{i=1}^{n} C * (HLW\ oxide\ weight\ fraction).$$

Table 12. Glass Model Constraints and Coefficients.

Waste Oxides	HLW Viscosity Terms (Pa.s)		HLW Elec. Cond (S/m)		Liquidus Temperature (K)			Nepheline	PCT Leach			
	A	B	A	B	Spinel	Zirc	Zircon	$SiO_2/(SiO_2+Na_2O+Al_2O_3)$	Si	B	Li	Na
Constraint (min)	4		10					0.62				
Constraint (max)	6		100		1050	1050	1050	0.7	2			2
SiO_2	-11.084036	28539	8.12	-10283	1239.1952	1126	1050		-2.9671	-5.18	-3.2278	-3.26
B2O$_3$	-13.658933	10868	12.82	-15135	-46.89796	1126	695		-0.6148	13.91	10.1496	-2.51
Na_2O	-9.603714	-1217.06	6.05	7089.48	-1848.463	210	-3242		10.7384	20.85	14.0017	19.68
Li_2O	-4.514118	-42288	7.47	22484	-2089.673	-1036	-2811		19.737	23.45	18.4159	22.97
CaO	-22.750189	22522	14.41	-18769	-26205.9	832			-6.0415	14.11	-5.3528	5.37
MgO	-21.104538	25767	10.39	-13414	2602.2183	2432			2.9296	-36.6	7.1181	11.72
Fe_2O_3	-6.403733	8773.9	9.94	-10608	8942.5121	1492			-4.2315	-1.94	-4.5113	-3.93
Al_2O_3	-4.088761	21186	7.14	-8227.18	2623.3395	1199	3995		-17.3377	-44.5	-22.3095	-39.14
ZrO_2	-31.32314	54574	7.93	-9723.86	3990.5564	4086	3915		-10.8139	-10.6	-10.0681	-12.09
Others	-17.017092	23027	18.11	-20653	582.77253	727	3885		-0.7297	2.77	0.6181	0.61
Minor Comp										3.21595		
Cr_2O_3	-17.02	23000	18.11	-20653	7264.7238							
MnO_2	-17.02	23000	18.11	-20653	23902.971							
NiO	-17.02	23000	18.11	-20653								
P_2O_5							2280					
K_2O												4.07727
Total												
SiO_2*CaO					52152.401							
$SiO_2*Fe_2O_3$					-10854.51							
$CaO*Fe_2O_3$					-32058.62							
$ZrO_2*Fe_2O_3$					-29473.69							
Cr_2O_3*CaO					2930959.6							
$(NiO)^2$					-352543.2							
$(B_2O_3)^2$												58.61
B_2O_3*CaO												-71.98
$Li_2O*Al_2O_3$												-44.95
(Al$_2$O3)^2												99.5

6.1.1.3 Waste Blending Analyses One approach that was considered in this study is the blending of compatible waste to reduce the volume of glass. According to the GPMs, spinel-limited waste appears to be an excellent blend stock for zirconium-limited waste. Blending studies were performed to investigate the reduction in glass produced by blending zirconium-rich wastes from tanks 241-AW-103 and 241-C-104 with spinel-limited streams from tanks 241-AY-101, 241-C-102, 241-AW-104, 241-SY-102, and 241-AY-102/241-C-106. These blends were modeled by adding 10-percent increments of the zirconium-limited waste to the spinel-limited streams. Various blends from 10 to 100 percent mixtures were investigated.

The following expression defines "blend product ratio (BPR)." This ratio is a measure of the improvement that can be generated from blending compatible wastes. The lower the BPR, the more attractive a blend becomes.

$$\text{Blend Product Ratio} = \frac{\text{Volume of Glass Produced by Blend}}{\text{Sum of Volumes of Glass of Independent Feed Streams}}$$

Figures 1 through 5 depict the BPR results from this investigation.

Although the single most dramatic option is that of blending tank 241-C-104 with 241-SY-102, the most consistent mimima are those with blends of tank 241-AW-103 waste. Blend results are provided in **Table 13.**

Table 13. Optimum Blend Results.

Spinel Limited Waste (100%)	241-AW-103			241-C-104		
	Blend Used	Blend Yield (cans)	BPR	Blend Used	Blend Yield (cans)	BPR
241-AY-101	35%	320.7	60.3%	90%	335.5	62.5%
241-AY-102/ 241-C-106	20%	213.5	60.7%	65%	272.1	67.8%
241-SY-102	40%	333.8	56.8%	100%	360.9	61.7%
241-AW-104	25%	200.6	56.7%	65%	218.1	60.6%
241-C-102	20%	201.8	77.0%	50%	208.8	79.6%

In view of the potential benefit of blending, 41 different blend streams were included among the 72 streams evaluated in this study. Although extensive blending (e.g. 241-AW-103 distribution as: 20 percent with 241-AY-101, 20 percent with 241-AY-102/241-C-106, 40 percent 241-SY-102, and 20 percent with 241-AW-104) may be most advantageous, schedule logistics may dictate that only simple blending operations are feasible in the field. Retrieval costs are expected to increase with the complexity of the proposed blending operation. In this study, the scope of the blending effort was restricted to two partial blends or one total blend with zirconium-limited waste. These blend combinations were evaluated based on the proposed cost models.

Figure 1. Blending of 241-AY-101.

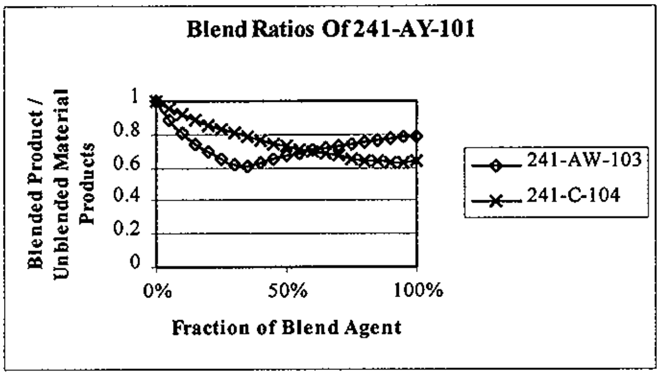


Figure 2. Blending of 241-C-102.

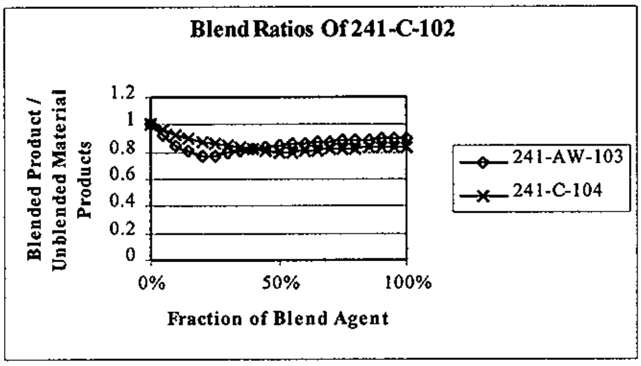


Figure 3. Blending of 241-AY-102/241-C-106.

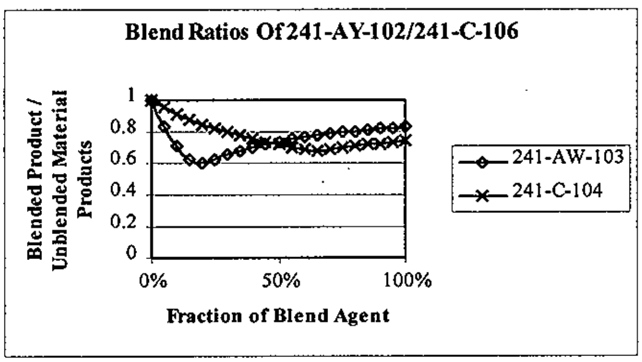


Figure 4. Blending of 241-SY-102.

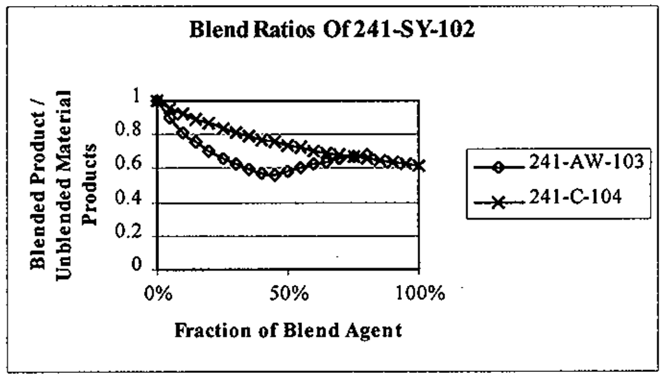
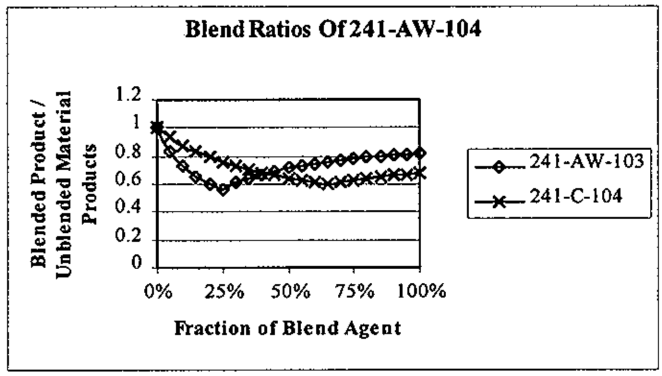


Figure 5. Blending of 241-AW-104.



6.1.2 Retrieval Costs

Table 14 provides a summary of the projected retrieval costs for each tank (including both capital and operating cost). Care was taken in this analysis to eliminate cost redundancies in the model (double accounting of common costs or including costs that are otherwise included in the baseline).

Table 14. Capital and Operating Costs for Retrieval.

Tank	Blend Tank	Blend Fraction	Capital Cost Total	Operating Cost Total	Total Cost
241-AZ-101			$25,000,000	$117,600	$25,117,600
241-AZ-102			$25,000,000	$117,600	$25,117,600
241-C-106/241-AY-102			$25,000,000	$117,600	$25,117,600
241-B-104			$165,208,190	$282,240	$165,490,430
241-B-202			$165,208,190	$282,240	$165,490,430
241-BX-103			$165,208,190	$282,240	$165,490,430
241-BX-104			$165,208,190	$282,240	$165,490,430
241-BX-105			$165,208,190	$282,240	$165,490,430
241-BX-107			$165,208,190	$282,240	$165,490,430
241-BX-109			$165,208,190	$282,240	$165,490,430
241-BX-112			$165,208,190	$282,240	$165,490,430
241-C-102			$49,800,000	$282,240	$50,082,240
241-C-102	241-C-104	10%	$99,600,000	$310,464	$99,910,464
241-C-102	241-C-104	20%	$99,600,000	$338,688	$99,938,688
241-C-102	241-C-104	30%	$99,600,000	$366,912	$99,966,912
241-C-102	241-C-104	40%	$99,600,000	$395,136	$99,995,136
241-C-102	241-AW-103	10%	$74,800,000	$294,000	$75,094,000
241-C-102	241-AW-103	20%	$74,800,000	$305,760	$75,105,760
241-C-102	241-AW-103	30%	$74,800,000	$317,520	$75,117,520
241-C-102	241-AW-103	40%	$74,800,000	$329,280	$75,129,280
241-C-103			$49,800,000	$282,240	$50,082,240
241-C-104			$49,800,000	$282,240	$50,082,240
241-C-105			$49,800,000	$282,240	$50,082,240
241-C-107			$49,800,000	$282,240	$50,082,240
241-C-108			$49,800,000	$282,240	$50,082,240
241-C-109			$49,800,000	$282,240	$50,082,240
241-C-112			$49,800,000	$282,240	$50,082,240
241-AN-102			$25,000,000	$117,600	$25,117,600
241-AN-103			$25,000,000	$117,600	$25,117,600
241-AN-104			$25,000,000	$117,600	$25,117,600
241-AN-106			$25,000,000	$117,600	$25,117,600
241-AN-107			$25,000,000	$117,600	$25,117,600
241-AW-102			$25,000,000	$117,600	$25,117,600
241-AW-103			$25,000,000	$117,600	$25,117,600

Table 14. Capital and Operating Costs for Retrieval.

Tank	Blend Tank	Blend Fraction	Capital Cost Total	Operating Cost Total	Total Cost
241-AW-104			$25,000,000	$117,600	$25,117,600
241-AW-104	241-C-104	10%	$74,800,000	$145,824	$74,945,824
241-AW-104	241-C-104	20%	$74,800,000	$174,048	$74,974,048
241-AW-104	241-C-104	30%	$74,800,000	$202,272	$75,002,272
241-AW-104	241-C-104	40%	$74,800,000	$230,496	$75,030,496
241-AW-104	241-AW-103	10%	$50,000,000	$129,360	$50,129,360
241-AW-104	241-AW-103	20%	$50,000,000	$141,120	$50,141,120
241-AW-104	241-AW-103	30%	$50,000,000	$152,880	$50,152,880
241-AW-104	241-AW-103	40%	$50,000,000	$164,640	$50,164,640
241-AW-105			$25,000,000	$117,600	$25,117,600
241-AW-106			$25,000,000	$117,600	$25,117,600
241-AY-101			$25,000,000	$117,600	$25,117,600
241-AY-101	241-C-104	10%	$74,800,000	$145,824	$74,945,824
241-AY-101	241-C-104	20%	$74,800,000	$174,048	$74,974,048
241-AY-101	241-C-104	30%	$74,800,000	$202,272	$75,002,272
241-AY-101	241-C-104	40%	$74,800,000	$230,496	$75,030,496
241-SY-102			$25,000,000	$117,600	$25,117,600
241-SY-102	241-C-104	10%	$74,800,000	$145,824	$74,945,824
241-SY-102	241-C-104	20%	$74,800,000	$174,048	$74,974,048
241-SY-102	241-C-104	30%	$74,800,000	$202,272	$75,002,272
241-SY-102	241-C-104	40%	$74,800,000	$230,496	$75,030,496
241-SY-102	241-AW-103	10%	$50,000,000	$129,360	$50,129,360
241-SY-102	241-AW-103	20%	$50,000,000	$141,120	$50,141,120
241-SY-102	241-AW-103	30%	$50,000,000	$152,880	$50,152,880
241-SY-102	241-AW-103	40%	$50,000,000	$164,640	$50,164,640
241-AY-101	241-AW-103	10%	$50,000,000	$129,360	$50,129,360
241-AY-101	241-AW-103	20%	$50,000,000	$141,120	$50,141,120
241-AY-101	241-AW-103	30%	$50,000,000	$152,880	$50,152,880
241-AY-102/241-C-106	241-AW-103	10%	$50,000,000	$129,360	$50,129,360
241-AY-102/241-C-106	241-AW-103	20%	$50,000,000	$141,120	$50,141,120
241-AY-102/241-C-106	241-AW-103	30%	$50,000,000	$152,880	$50,152,880
241-AY-102/241-C-106	241-AW-103	40%	$50,000,000	$164,640	$50,164,640
241-AY-102/241-C-106	241-AW-103	100%	$50,000,000	$235,200	$50,235,200
241-AY-102/241-C-106	241-C-104	10%	$74,800,000	$145,824	$74,945,824
241-AY-102/241-C-106	241-C-104	20%	$74,800,000	$174,048	$74,974,048
241-AY-102/241-C-106	241-C-104	30%	$74,800,000	$202,272	$75,002,272
241-AY-102/241-C-106	241-C-104	40%	$74,800,000	$230,496	$75,030,496
241-AY-102/241-C-106	241-C-104	100%	$74,800,000	$399,840	$75,199,840

6.1.2.1 Capital Costs. Capital costs were estimated as described in Section 3.3.3. Table 14 provides a summary of the capital cost estimates for each tank or combination of tanks. Because some combinations can lead to redundant costs, certain deductions were made to account for these differences. For example, costs were reduced to (1) eliminate all overlapping costs for installation of the long-length piping, (2) limit total WRF costs to one WRF unit, and (3) reduce in-farm piping (in a single farm) by (n-1) times the difference in cost between the 280-ft piping and 100-ft piping. Certain deductions were also used to account for potential cost savings for subsequent installation of the same systems (to a lower flat line value) and, as necessary, previous retrieval costs for tank 241-C-106 waste. Cost allowances were also modified to eliminate replicate costs for the retrieval of two of more fractions from the same tank.

6.1.2.2 Operating Costs. Operating costs for each waste stream were calculated as described in Section 3.3.3.3. Unlike construction costs, the operating costs increase in direct proportion to the amount of waste retrieved. Partial retrieval costs are assumed to vary with the amount of waste retrieved from the tank. Operating costs for blends are the sum of the operating cost for each tank.

6.1.3 Total Cost and Cost Per Unit Product

Total cost for each case was estimated from the sum of the retrieval cost, glass production cost, and associated disposal cost. Two separate estimates were generated for each case, one based on the BNFL specification and the other based on the GPM.

Cost per unit product (cost per canister) is the ratio of total cost to the product glass volume (number of canisters produced). Again, two values were generated to represent the range of values that might be expected from the two glass models.

The results are available in the form of electronic tables that compile a complete listing of glass production volume, total cost, and cost per unit of product (cost per canister) for each case. This listing of 12,246 cases is available in spreadsheet form but was not included in this document due to the number of pages of output (approximately 700 pages).

6.2 ALTERNATIVE ONE – LEAST COST PER UNIT PRODUCT

These results were initially ranked by the cost per unit of product (cost per canister). This section provides a brief discussion of these results.

6.2.1 Model Description

This analysis of the 72 waste streams in 12,246 combinaions provided cost estimates for each case. These cases were sorted to identify those cases that produced the least cost per unit of product (least cost per canister). The BNFL glass specifications were used to generate the initial set of results, which included capital and operating costs for retrieval costs as well as BNFL production and DOE disposition costs for the canisters.

The preferred case includes tanks 241-AZ-101, 241-AZ-102, 241-AW-105, and 241-AY-102/241-C-106, and 100 percent of the waste from tank 241-AW-103. This case is ranked tenth in Table 15. This result was achieved by blending zirconium-limited waste in tank 241-AW-103 with the spinel-limited waste in 241-AY-102/241-C-106, and adding the high waste oxide loaded glass from tank 241-AW-105. This case provides the lowest minimum cost based on a unit cost of $2.0157 million per canister for 1,652 canisters. Total project costs for this case are $3.330 billion, including $128.59 million in retrieval costs.

Cases that are ranked one through nine in Table 15 achieved this position by generating a large number of canisters of lower waste oxide loaded glass. The second highest case in preferred ranking includes all of the tanks in the preferred case except tank 241-AW-106, which was substituted for tank 241-AW-105. This case is approximately $23 million more expensive than the primary case.

The top 50 cases are listed in **Table 15.** All blended streams in this upper tier contain a 100 percent blend of tank 241-AW-103 waste with 241-AY-102/241-C-106 waste.

Parallel results were also generated based on the GPM. The GPM ranking results were generally consistent with those provided by the BNFL specification. However, the GPM results favor the direct vitrification of tank 241-AW-106 waste in lieu of tank 241-AW-105 waste and the use of tank 241-SY-102 waste in place of tank 241-AY-101 waste. These differences are due to the increase in glass volume with the same retrieval cost.

6.2.2 Criteria Assessment

This section provides a discussion of compliance with criteria established in Section 4.0 for the least cost per unit product case.

6.2.2.1 Glass Quantity Requirement. The preferred case is expected to produce 1,652 canisters of glass based on the BNFL specification (minimum waste loading) and 1,348 canisters based on GPM. This volume exceeds both the contract minimum feed of 600 canisters and the contingency-based minimum of 750 canisters.

Table 15. Minimum Cost Per Unit Product Ranking.

Minimum BNFL Can Cost ($Millions)

Rank	Case	Tanks[1]	BNFL Cans	BNFL Cans/Mg W. O.[2]	GPM Cans	Retrieval	BNFL Cost	GPM Cost
29	1684	241-AW-103; 241-AW-105	1,885	2.116	1,517	$ 128.59	$3,781	$3,068
30	31	241-AW-103	1,509	2.116	1,218	$ 103.47	$3,027	$2,463
34	1685	241-AW-103; 241-AW-106	1,857	2.474	1,567	$ 128.59	$3,728	$3,166
49	15395	241-SY-102; 241-AW-103; 241-AW-105	2,154	2.350	1,786	$ 153.71	$4,328	$3,615
93	15396	241-SY-102; 241-AW-103; 241-AW-106	2,127	2.738	1,837	$ 153.71	$4,275	$3,713
95	1691	241-AW-103; 241-SY-102	1,778	2.406	1,487	$ 128.59	$3,574	$3,010
96	1686	241-AW-103; 241-AY-101	1,762	2.130	1,471	$ 128.59	$3,543	$2,979
103	15397	241-SY-102; 241-AW-103; 241-AY-101	2,031	2.381	1,740	$ 153.71	$4,090	$3,525
104	1675	241-AW-103; 241-AW-104	1,663	2.107	1,372	$ 128.59	$3,352	$2,788
107	2032	241-AW-105; 241-C-106/241-AY-102 , 241-AW-103 (1)	1,652	1.855	1,348	$ 128.59	$3,330	$2,741
108	8521	241-AN-102; 241-AW-103; 241-AW-105	1,943	2.151	1,574	$ 153.71	$3,919	$3,205
110	2059	241-AW-106; 241-C-106/241-AY-102 , 241-AW-103 (1)	1,625	2.164	1,399	$ 128.59	$3,277	$2,839
121	13079	241-AN-107; 241-AW-103; 241-AW-105	1,938	2.085	1,570	$ 153.71	$3,909	$3,196

Minimum GPM Can Cost ($Millions)

Rank	Case	Tanks	BNFL Cans	GPM Cans	GPM Cans/Mg W. O.	Retrieval	BNFL Cost	GPM Cost
29	1685	241-AW-103; 241-AW-106	1,857	1,567	2.088	$ 128.59	$3,728	$3,166
30	15396	241-SY-102; 241-AW-103; 241-AW-106	2,127	1,837	2.365	$ 153.71	$4,275	$3,713
34	1684	241-AW-103; 241-AW-105	1,885	1,517	1.703	$ 128.59	$3,781	$3,068
49	31	241-AW-103	1,509	1,218	1.707	$ 103.47	$3,027	$2,463
93	15395	241-SY-102; 241-AW-103; 241-AW-105	2,154	1,786	1.948	$ 153.71	$4,328	$3,615
95	1691	241-AW-103; 241-SY-102	1,778	1,487	2.012	$ 128.59	$3,574	$3,010
96	1686	241-AW-103; 241-AY-101	1,762	1,471	1.778	$ 128.59	$3,543	$2,979
103	15397	241-SY-102; 241-AW-103; 241-AY-101	2,031	1,740	2.039	$ 153.71	$4,090	$3,525
104	2059	241-AW-106; 241-C-106/241-AY-102 , 241-AW-103 (1)	1,625	1,399	1.863	$ 128.59	$3,277	$2,839
107	15758	241-SY-102; 241-AW-106; 241-C-106/241-AY-102 , 241-AW-103 (1)	1,894	1,668	2.147	$ 153.71	$3,824	$3,386
108	15386	241-SY-102; 241-AW-103; 241-AW-104	1,933	1,641	2.013	$ 153.71	$3,899	$3,335
110	1675	241-AW-103; 241-AW-104	1,663	1,372	1.739	$ 128.59	$3,352	$2,788
121	8522	241-AN-102; 241-AW-103; 241-AW-106	1,916	1,625	2.128	$ 153.71	$3,867	$3,303

[1] All cases include 241-AZ-101; 241-AZ-102; and 241-C-106/241-AY-102

[2] Product canisters per Mg of waste oxide.

Table 15. Minimum Cost Per Unit Product Ranking.

Minimum BNFL Can Cost ($Millions)									*Minimum GPM Can Cost ($Millions)*								
Rank	Case	Tanks[1]	BNFL Cans	BNFL Cans/Mg W. O.[2]	GPM Cans	Retrieval	BNFL Cost	GPM Cost	Rank	Case	Tanks	BNFL Cans	GPM Cans	GPM Cans/Mg W. O.	Retrieval	BNFL Cost	GPM Cost
124	15386	241-SY-102; 241-AW-103; 241-AW-104	1,933	2.371	1,641	$ 153.71	$3,899	$3,335	124	13080	241-AN-107; 241-AW-103; 241-AW-106	1,910	1,620	2.052	$ 153.71	$3,856	$3,294
126	15732	241-SY-102; 241-AW-105; 241-C-106/241-AY-102 , 241-AW-103 (1)	1,921	2.096	1,617	$ 153.71	$3,877	$3,288	126	15732	241-SY-102; 241-AW-105; 241-C-106/241-AY-102 , 241-AW-103 (1)	1,921	1,617	1.764	$ 153.71	$3,877	$3,288
127	8522	241-AN-102; 241-AW-103; 241-AW-106	1,916	2.509	1,625	$ 153.71	$3,867	$3,303	127	2032	241-AW-105; 241-C-106/241-AY-102 , 241-AW-103 (1)	1,652	1,348	1.514	$ 128.59	$3,330	$2,741
130	13080	241-AN-107; 241-AW-103; 241-AW-106	1,910	2.420	1,620	$ 153.71	$3,856	$3,294	130	2200	241-SY-102; 241-C-106/241-AY-102 , 241-AW-103 (1)	1,545	1,318	1.783	$ 128.59	$3,123	$2,683
133	64	241-C-106/241-AY-102 , 241-AW-103 (1)	1,276	1.789	1,049	$ 103.47	$2,576	$2,136	133	8521	241-AN-102; 241-AW-103; 241-AW-105	1,943	1,574	1.742	$ 153.71	$3,919	$3,205
148	15758	241-SY-102; 241-AW-106; 241-C-106/241-AY-102 , 241-AW-103 (1)	1,894	2.439	1,668	$ 153.71	$3,824	$3,386	148	15783	241-SY-102; 241-AY-101; 241-C-106/241-AY-102 , 241-AW-103 (1)	1,798	1,571	1.841	$ 153.71	$3,639	$3,198
153	10800	241-AN-104; 241-AW-103; 241-AW-105	1,886	2.118	1,518	$ 153.71	$3,809	$3,096	153	13079	241-AN-107; 241-AW-103; 241-AW-105	1,938	1,570	1.689	$ 153.71	$3,909	$3,196
156	1431	241-AN-102; 241-AW-103	1,567	2.158	1,275	$ 128.59	$3,166	$2,600	156	10801	241-AN-104; 241-AW-103; 241-AW-106	1,859	1,569	2.090	$ 153.71	$3,756	$3,194
159	1597	241-AN-107; 241-AW-103	1,562	2.077	1,271	$ 128.59	$3,155	$2,591	159	64	241-C-106/241-AY-102 , 241-AW-103 (1)	1,276	1,049	1.471	$ 103.47	$2,576	$2,136
160	10801	241-AN-104; 241-AW-103; 241-AW-106	1,859	2.476	1,569	$ 153.71	$3,756	$3,194	160	2085	241-AY-101; 241-C-106/241-AY-102 , 241-AW-103 (1)	1,529	1,302	1.574	$ 128.59	$3,092	$2,652
163	2200	241-SY-102; 241-C-106/241-AY-102 , 241-AW-103 (1)	1,545	2.091	1,318	$ 128.59	$3,123	$2,683	163	8528	241-AN-102; 241-AW-103; 241-SY-102	1,836	1,544	2.054	$ 153.71	$3,713	$3,147
164	8528	241-AN-102; 241-AW-103; 241-SY-102	1,836	2.442	1,544	$ 153.71	$3,713	$3,147	164	15148	241-SY-102; 241-AN-102; 241-AW-103	1,836	1,544	2.054	$ 153.71	$3,713	$3,147
166	15148	241-SY-102; 241-AN-102; 241-AW-103	1,836	2.442	1,544	$ 153.71	$3,713	$3,147	166	13086	241-AN-107; 241-AW-103; 241-SY-102	1,831	1,540	1.979	$ 153.71	$3,702	$3,138
176	13086	241-AN-107; 241-	1,831	2.354	1,540	$ 153.71	$3,702	$3,138	176	15310	241-SY-102; 241-	1,831	1,540	1.979	$ 153.71	$3,702	$3,138

Table 15. Minimum Cost Per Unit Product Ranking.

Minimum BNFL Can Cost ($Millions)									Minimum GPM Can Cost ($Millions)								
Rank	Case	Tanks[1]	BNFL Cans	BNFL Cans/Mg W. O.[2]	GPM Cans	Retrieval	BNFL Cost	GPM Cost	Rank	Case	Tanks	BNFL Cans	GPM Cans	GPM Cans/Mg W. O.	Retrieval	BNFL Cost	GPM Cost
		AW-103; 241-SY-102									AN-107; 241-AW-103						
184	15310	241-SY-102; 241-AN-107; 241-AW-103	1,831	2.354	1,540	$ 153.71	$3,702	$3,138	184	8523	241-AN-102; 241-AW-103; 241-AY-101	1,820	1,528	1.819	$ 153.71	$3,681	$3,115
187	1474	241-AN-103; 241-AW-103	1,532	2.119	1,233	$ 128.59	$3,097	$2,518	187	1431	241-AN-102; 241-AW-103	1,567	1,275	1.756	$ 128.59	$3,166	$2,600
190	2085	241-AY-101; 241-C-106/241-AY-102 , 241-AW-103 (1)	1,529	1.849	1,302	$ 128.59	$3,092	$2,652	190	13081	241-AN-107; 241-AW-103; 241-AY-101	1,815	1,524	1.759	$ 153.71	$3,671	$3,106
195	1636	241-AW-102; 241-AW-103	1,528	2.107	1,236	$ 128.59	$3,090	$2,523	195	1597	241-AN-107; 241-AW-103	1,562	1,271	1.690	$ 128.59	$3,155	$2,591
200	8523	241-AN-102; 241-AW-103; 241-AY-101	1,820	2.167	1,528	$ 153.71	$3,681	$3,115	200	10800	241-AN-104; 241-AW-103; 241-AW-105	1,886	1,518	1.705	$ 153.71	$3,809	$3,096
201	13081	241-AN-107; 241-AW-103; 241-AY-101	1,815	2.096	1,524	$ 153.71	$3,671	$3,106	201	15348	241-SY-102; 241-AW-102; 241-AW-103	1,797	1,505	2.003	$ 153.71	$3,637	$3,070
216	1557	241-AN-106; 241-AW-103	1,512	2.117	1,221	$ 128.59	$3,058	$2,494	216	15190	241-SY-102; 241-AN-103; 241-AW-103	1,801	1,502	2.006	$ 153.71	$3,644	$3,064
225	1516	241-AN-104; 241-AW-103	1,510	2.117	1,219	$ 128.59	$3,055	$2,491	225	15271	241-SY-102; 241-AN-106; 241-AW-103	1,781	1,490	2.013	$ 153.71	$3,605	$3,041
256	15190	241-SY-102; 241-AN-103; 241-AW-103	1,801	2.405	1,502	$ 153.71	$3,644	$3,064	256	10807	241-AN-104; 241-AW-103; 241-SY-102	1,780	1,488	2.013	$ 153.71	$3,602	$3,038
258	15783	241-SY-102; 241-AY-101; 241-C-106/241-AY-102 , 241-AW-103 (1)	1,798	2.108	1,571	$ 153.71	$3,639	$3,198	258	15231	241-SY-102; 241-AN-104; 241-AW-103	1,780	1,488	2.013	$ 153.71	$3,602	$3,038
261	15348	241-SY-102; 241-AW-102; 241-AW-103	1,797	2.393	1,505	$ 153.71	$3,637	$3,070	261	1636	241-AW-102; 241-AW-103	1,528	1,236	1.704	$ 128.59	$3,090	$2,523
263	15271	241-SY-102; 241-AN-106; 241-AW-103	1,781	2.407	1,490	$ 153.71	$3,605	$3,041	263	1474	241-AN-103; 241-AW-103	1,532	1,233	1.706	$ 128.59	$3,097	$2,518
265	10807	241-AN-104; 241-AW-103; 241-SY-102	1,780	2.407	1,488	$ 153.71	$3,602	$3,038	265	15453	241-SY-102; 241-AW-104; 241-C-106/241-AY-102 , 241-AW-103 (1)	1,700	1,473	1.806	$ 153.71	$3,448	$3,008
267	15231	241-SY-102; 241-	1,780	2.407	1,488	$ 153.71	$3,602	$3,038	267	6243	241-C-104; 241-AW-	2,219	1,883	1.937	$ 196.57	$4,497	$3,846

Table 15. Minimum Cost Per Unit Product Ranking.

Minimum BNFL Can Cost ($Millions)									Minimum GPM Can Cost ($Millions)								
Rank	Case	Tanks[1]	BNFL Cans	BNFL Cans/Mg W. O.[2]	GPM Cans	Retrieval	BNFL Cost	GPM Cost	Rank	Case	Tanks	BNFL Cans	GPM Cans	GPM Cans/Mg W. O.	Retrieval	BNFL Cost	GPM Cost
		AN-104; 241-AW-103									103; 241-AW-106						
269	10802	241-AN-104; 241-AW-103; 241-AY-101	1,763	2.132	1,472	$ 153.71	$3,571	$3,007	269	10802	241-AN-104; 241-AW-103; 241-AY-101	1,763	1,472	1.780	$ 153.71	$3,571	$3,007
270	6242	241-C-104; 241-AW-103; 241-AW-105	2,246	2.020	1,832	$ 196.57	$4,550	$3,748	270	1557	241-AN-106; 241-AW-103	1,512	1,221	1.710	$ 128.59	$3,058	$2,494
278	6243	241-C-104; 241-AW-103; 241-AW-106	2,219	2.283	1,883	$ 196.57	$4,497	$3,846	278	1516	241-AN-104; 241-AW-103	1,510	1,219	1.709	$ 128.59	$3,055	$2,491
280	8512	241-AN-102; 241-AW-103; 241-AW-104	1,722	2.146	1,430	$ 153.71	$3,490	$2,925	280	8896	241-AN-102; 241-AW-106; 241-C-106/241-AY-102 , 241-AW-103 (1)	1,683	1,456	1.907	$ 153.71	$3,415	$2,976
281	13070	241-AN-107; 241-AW-103; 241-AW-104	1,716	2.073	1,425	$ 153.71	$3,480	$2,916	281	13454	241-AN-107; 241-AW-106; 241-C-106/241-AY-102 , 241-AW-103 (1)	1,678	1,452	1.839	$ 153.71	$3,405	$2,967
292	8869	241-AN-102; 241-AW-105; 241-C-106/241-AY-102 , 241-AW-103 (1)	1,710	1.893	1,406	$ 153.71	$3,468	$2,878	292	1744	241-AW-104; 241-C-106/241-AY-102 , 241-AW-103 (1)	1,431	1,203	1.525	$ 128.59	$2,901	$2,461
301	1744	241-AW-104; 241-C-106/241-AY-102 , 241-AW-103 (1)	1,431	1.813	1,203	$ 128.59	$2,901	$2,461	301	6242	241-C-104; 241-AW-103; 241-AW-105	2,246	1,832	1.648	$ 196.57	$4,550	$3,748
302	13427	241-AN-107; 241-AW-105; 241-C-106/241-AY-102 , 241-AW-103 (1)	1,705	1.834	1,401	$ 153.71	$3,458	$2,869	302	8512	241-AN-102; 241-AW-103; 241-AW-104	1,722	1,430	1.782	$ 153.71	$3,490	$2,925
314	15453	241-SY-102; 241-AW-104; 241-C-106/241-AY-102 , 241-AW-103 (1)	1,700	2.085	1,473	$ 153.71	$3,448	$3,008	314	13070	241-AN-107; 241-AW-103; 241-AW-104	1,716	1,425	1.721	$ 153.71	$3,480	$2,916

6.2.2.2 Retrieval Criteria. This section provides a brief assessment of the highest ranked case compliance with retrieval criteria under the least unit product cost alternative. This case includes tanks 241-AZ-101, 241-AZ-102, 241-AW-105, and 241-AY-102/241-C-106 blended with 100 percent of 241-AW-103. The retrieval operation required for this case includes the baseline retrieval of tanks 241-AZ-101, 241-AZ-102, and 241-C-106/241-AY-102, plus two retrieval operations to recover the wastes in tanks 241-AW-105 and 241-AW-103. The DST retrieval operations will be conducted with the assistance of mixer pumps, and as such, are expected to have only a minimal schedule impact.

6.2.2.2.1 Schedule. The addition of two DST retrievals from 241-AW-105 and 241-AW-103 to the base case tanks is of minimum complexity and is no more complicated that the anticipated retrieval from tanks 241-C-102 and 241-C-104. Selection of this option complies with the schedule criterion.

6.2.2.2.2 Retrieval Risk. Retrievals from tanks 241-AW-105 and 241-AW-103 are expected to be conducted with mixer pump arrangements. These tanks are not SSTs, exhibit little organic vapor generation, and have no history of separable organic layers. The retrieval risk for this case is minimal in terms of contract quantity and schedule, and therefore this case complies with this criterion.

6.2.2.2.3 Waste Retrieval Cost. Retrieval from 241-AW-105 and 241-AW-103 are expected to be accomplished with mixer pump arrangements. These tanks are among the 200 East Area DST farms and supported by those existing ventilation and transfer systems. The retrieval cost estimate of $128.59 million for the entire case is approximately 25 percent greater than the lowest retrieval cost for all of the tanks and tank combinations that were examined. This option complies with the criteria of retrieval cost minimization.

6.2.2.2.4 Availability of Early DST Space. Tanks 241-AW-105 and 241-AW-103 are DSTs. Retrieval of these wastes in Phase 1 treatment complies with the criteria for availability of early DST space. Such compliance will aid in the management of tank space and should ease the difficulties associated with current waste volume projections.

6.2.2.2.5 Early SST Retrieval. Tanks 241-AW-105 and 241-AW-103 are not SSTs, and therefore will not satisfy any criteria related to early demonstration of SST retrieval. However, these goals in part may be satisfied by the initial retrieval of tank 241-C-106 waste. Under these circumstances, the general conditions specified by this criteria have already been met.

6.2.2.2.6 Safety. Wastes in tanks 241-AW-105 and 241-AW-103 are not complexant wastes and have no significant ongoing safety restrictions beyond those imposed in the management of other Hanford tank wastes. No tank safety issue resolution is required. Therefore, this criterion is deemed met.

6.2.2.3 Cost of Product. This case produced the lowest cost per unit product. In large part, this result was achieved by blending the zirconium-limited waste in tank 241-AW-103 with the spinel-limited waste of tank 241-AY-102/241-C-106. This blending maximizes the waste oxide loading of the product glass. The unit cost for this case is $2,015,700 per canister. Total cost based on the BNFL specification is $3.330 billion. Based on the GPM, this cost could be as low as $2.741 billion, yielding a savings of $589 million. Compared to unblended treatment of 241-AW-103 with the base case tanks and 241-AW-105, the blended product saves about $800 million. This option satisfies the criteria for maximum waste loading.

6.2.2.4 Contract Specification. This section provides a brief review of compliance with contract specifications in terms of the impact on existing plans and feed material specifications.

6.2.2.4.1 Impact on Existing Plans. The retrieval of 241-AW-105 and the retrieval and blended treatment of 241-AW-103 wastes with the base case tanks has modest impact upon existing plans. Two additional projects would be required to support the mixer pump installations and retrievals beyond existing plans. Bottlenecks in retrieval are minimal and this retrieval is not clouded with saltwell pumping and transfer issues exhibited with 241-SY-102 wastes. Election of this option will expedite overall TWRS progress meeting this criterion.

6.2.2.4.2 Sludge Composition Compliance. Envelope D specifications for the HLW solids were investigated for wastes of primary interest in this case. Direct waste feed compliance with these specifications is depicted in **Table 16**. The 241-AW-103 waste is directly seen to be out of specification for B, Be, Tl, NH_3, ^{235}U, ^{238}Pu, ^{239}Pu, ^{241}Pu, F, Zr, and total solids. Of particular concern, the fluoride content may require modification of the BNFL off-gas system and the zirconium concentration would drive up the product volume. The 241-AW-105 waste was not directly compared to these specifications, but its material history is similar to tank 241-AW-104. Tank 241-AW-104 is seen to run modestly high in organic content, and as a result, high in actinide content. Both 241-AW-104 and 241-AW-105 are classified as double shell slurry feed wastes with approximately 12 to 14 molar sodium solutions.

The blend of 100 percent of 241-AW-103 in 241-C-106 has been evaluated with its results tabulated in Appendix A, Table 5. Blending of these wastes is not seen to greatly improve the compliance of the feed with the Envelope D specification. Contributions from 241-AY-10/241-C-106 exacerbate specification compliance. Although additional negotiation with BNFL on case-specific waste feed acceptance is expected, no significant physical plant or operational difficulties are foreseen in the vitrification of this blend. This blended case option is deemed to meet the criterion of sludge composition compliance.

Additional specification evaluation of blends of 241-AW-103 and 241-C-104 with 241-AY-102/241-C-106, 241-AW-104, 241-SY-102, 241-AY-101, and 241-C-102 is contained in Appendix A for inspection and application to other cases.

Table 16. High-Level Waste Solids Specification Evaluation – Direct Wastes. (2 Sheets)

Component	Specification (see Table 3)	Specification Compliance (True/False)					Component Concentration (Units of Specification)				
		AW-106	SY-102	AY-101	AW-104	AW-103	AW-106	SY-102	AY-101	AW-104	AW-103
As	0.16	T	T	T	T	T	0	0.001406	0	0	0
B	1.3	T	T	T	T	F	0	0.003031	0	0	6.10642
Be	0.065	T	T	T	T	F	0	0.015814	0	0	0.137584
Ce	0.81	T	T	T	T	T	0	0	0	0	0.25114
Co	0.45	T	T	T	T	T	0	0	0	0	0
Cs	0.58	T	T	T	T	T	0.001166	0.000439	0.001216	0.003086	0.000393
Cu	0.48	T	T	T	T	T	0	0.136174	0	0	0.016371
Hg	0.1	T	T	T	T	T	0	0	0	0	0
La	2.6	T	T	T	T	T	0	0.009905	0.709838	0	0.145887
Li	0.14	T	T	T	T	T	0	0	0	0	0
Mn	6.5	T	T	T	T	T	0.41652	1.359285	2.733488	2.560272	0.11607
Mo	0.65	T	T	T	T	T	0	0.009137	0	0	0.080128
Nd	1.7	T	T	T	T	T	0	0	0	0	0
Pr	0.35	T	T	T	T	T	0	0	0	0	0
Pu	0.054	T	T	T	T	T	0	0	0	0	0
Rb	0.19	T	T	T	T	T	0	0	0	0	0
Sb	0.84	T	T	T	T	T	0	0	0	0	0
Se	0.52	T	T	T	T	T	0	0	0	0	0
Sr	0.52	T	T	T	T	T	0.00117	0.00817	0.003905	1.16E-05	0.045768
Ta	0.03	T	T	T	T	T	0	0	0	0	0
Tc	0.26	T	T	T	T	T	0	0	0	0	0
Te	0.13	T	T	T	T	T	0	0.000307	0	0	0.028041
Th	0.52	T	T	T	T	T	0	0	0	0	0
Tl	0.45	T	T	T	T	F	0	0	0	0	1.467632
V	0.032	T	T	T	T	T	0	0.014496	0	0	0
W	0.24	T	T	T	T	T	0	0	0	0	0
Y	0.16	T	T	T	T	T	0	0	0	0	0
Zn	0.42	T	T	T	T	T	0	0.356074	0	0	0.03811
Cl	0.33	T	T	T	T	T	0	0.000306	0.000114	0	0
CO_3	30	T	T	T	T	T	0.020557	0.094518	0	0.04891	0.019915
$NO_2 + NO_3$	36	T	T	T	T	T	0.246886	0.28666	0.073342	0.233719	0.019915
TOC	11	F	T	F	F	T	16.4899	7.378369	18.01725	70.26562	0
CN	1.6	T	T	T	T	T	0	0	0	0	0
NH_3	1.6	T	T	T	T	F	0.031214	0.572636	0.131009	0.813421	10.60907
^{3}H	0.000065	T	T	T	T	T	0	0	0	0	0
^{14}C	6.5E-06	T	T	F	T	T	1.65E-06	2.64E-07	0.000332	1.75E-09	1.03E-07
^{60}Co	0.01	T	T	F	T	T	0.003129	0.002196	0.020019	9.06E-06	4.63E-05
^{90}Sr	10	T	T	F	T	T	6.761341	1.617749	21.06898	0.055529	0.216336
^{99}Tc	0.015	T	T	T	T	T	0.001354	0.000266	0.004987	0.00088	2.72E-05

Table 16. High-Level Waste Solids Specification Evaluation – Direct Wastes. (2 Sheets)

Component	Specification (see Table 3)	Specification Compliance (True/False)					Component Concentration (Units of Specification)				
		AW-106	SY-102	AY-101	AW-104	AW-103	AW-106	SY-102	AY-101	AW-104	AW-103
^{125}Sb	0.032	T	T	T	T	T	0.020732	0.00084	0.004421	0.000105	0.001815
^{126}Sn	0.00015	F	T	F	T	T	0.000601	3.18E-05	0.000722	6.85E-07	1.24E-06
^{129}I	2.9E-07	T	F	F	T	T	0	1.68E-06	3.2E-06	0	1.56E-08
^{137}Cs	10	T	T	T	T	T	0.20502	1.570342	5.112893	0.488948	0.17152
^{152}Eu	0.00048	F	T	F	T	T	0.000592	2.47E-05	0.001131	1.83E-06	1.75E-05
^{154}Eu	0.052	F	T	F	T	T	0.082772	0.022711	0.07919	0.000109	0.000674
^{155}Eu	0.029	F	T	F	T	T	0.034613	0.020591	0.059234	0.000269	0.003174
^{233}U	9E-07	F	F	F	F	T	9.91E-05	9.9E-05	0.000132	1.24E-06	2.77E-07
^{235}U	2.5E-07	F	F	F	F	F	3.41E-06	4.2E-07	2.19E-06	2.75E-05	1.38E-05
^{237}Np	0.000074	T	T	T	T	T	4.94E-05	1.37E-05	1.91E-05	9.53E-08	3.5E-07
^{238}Pu	0.00035	F	F	F	F	F	0.000387	0.013117	0.002938	0.009187	0.000706
^{239}Pu	0.0031	F	F	F	F	F	0.005248	0.100904	0.02656	0.074125	0.005714
^{241}Pu	0.022	F	T	F	F	F	0.035439	0.000382	0.20491	0.938973	0.072046
^{241}Am	0.09	T	F	F	T	T	0.022168	0.496183	0.143133	3.81E-05	0.000152
$^{243+244}Cm$	0.003	F	F	F	T	T	0.02217	0.496188	0.143157	3.81E-05	0.000152
Ag	0.55	T	T	T	T	T	0	0.067209	0	0	0.135747
Al	14	F	F	T	F	T	29.20223	27.01524	9.912338	23.33624	5.008123
Ba	4.5	T	T	T	T	T	0	0.021085	0	0	0.086841
Bi	2.8	T	T	T	T	T	0	0.10344	0	0	0.043361
Ca	7.1	T	T	T	T	T	4.069578	0.761698	1.121388	5.773054	0.43487
Cd	4.5	T	T	T	T	T	0	0.138327	0	0	0
Cr	0.68	F	F	F	F	T	5.958292	3.002157	1.752678	1.933564	0.637236
F	3.5	T	T	T	F	F	0.643202	0.112675	0.097442	8.033956	18.5655
Fe	29	T	T	T	T	T	1.18109	4.019343	10.96086	7.716794	0.337984
K	1.3	T	T	T	F	T	0.868668	0.621974	0.061357	4.430877	0.380681
Mg	2.1	T	T	T	T	T	0	1.65553	0.310103	0	0.772506
Na	19	T	F	F	T	T	7.491109	21.5318	40.21155	3.92267	2.614077
Ni	2.4	T	T	T	F	T	0.771842	0.038305	0.186731	3.112597	0.036003
P	1.7	T	T	T	T	T	0.698023	0.747267	0.018579	0.152192	0
Pb	1.1	T	T	T	T	T	0.079301	0.082891	0.136044	0.011161	0.20574
Pd	0.13	T	T	T	T	T	0	0	0	0	0
Rh	0.13	T	T	T	T	T	0	0.022139	0	0	0
Ru	0.35	T	T	T	T	T	0	0.000527	0	0	0
S	0.65	T	T	T	T	T	0.450708	0.004276	0.006845	0.240985	0
Si	19	T	T	T	T	T	7.024972	0.673603	0.198645	2.973613	1.82726
Ti	1.3	T	T	T	T	T	0	0.148562	0	0	0.020462
U	14	T	T	T	T	T	0	0	0	0	0
Zr	15	T	T	T	T	F	0.138288	0.013288	0.449121	0.682643	27.8123
Solids		T	T	T	T	F	2.42E+01	5.02E+01	1.23E+02	1.50E+02	2.33E+02

6.2.2.4.3 Supernate Composition Compliance. Envelope A, B, and C specifications for the supernatant liquors separated from the HLW solids were investigated for wastes of primary interest in this case. Direct waste feed compliance with these specifications is depicted in **Table 17. Low-Activity Waste Specification Evaluation – Direct Wastes** with feed concentrations detailed in **Table 18. Low-Activity Waste Specification Evaluation – Direct Waste Concentrations**. The 241-AW-103 waste, as was the case for the sludge, is seen to be out of specification for fluoride.

The blend of 100 percent of 241-AW-103 in 241-AY-102/241-C-106 has been evaluated and the results are tabulated in Appendix B, Tables 9 and 10. Blending of these wastes is not seen to alleviate fluoride compliance of the feed to the Envelope A, B, and C specifications. This case option is marginally deemed to meet the criterion of supernatant composition compliance.

Additional specification evaluation of blends of 241-AW-103 and 241-C-104 with 241-AY-102/241-C-106, 241-AW-104, 241-SY-102, 241-AY-101, and 241-C-102 are contained in Appendix B for inspection and application to other cases.

Table 17. Low-Activity Waste Specification Evaluation – Direct Wastes. (2 Sheets)

Envelope	A					B					C				
Component	AW-106	SY-102	AY-101	AW-104	AW-103	AW-106	SY-102	AY-101	AW-104	AW-103	AW-106	SY-102	AY-101	AW-104	AW-103
Al	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Ba	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Ca	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Cd	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Cl	T	T	F	T	T	T	T	T	T	T	T	T	F	T	T
Cr	T	F	T	T	T	T	T	T	T	T	T	F	T	T	T
F	T	T	T	F	F	T	T	T	T	F	T	T	T	F	F
Fe	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Hg	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
K	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
La	T	T	F	T	T	T	T	F	T	T	T	T	F	T	T
Ni	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
NO_2	T	T	F	T	T	T	T	F	T	T	T	T	F	T	T
NO_3	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Pb	T	T	F	T	T	T	T	F	T	T	T	T	F	T	T
PO_4	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
SO_4	F	F	F	T	T	T	T	T	T	T	T	T	F	T	T
CO_3	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
TOC	T	T	F	T	T	T	T	F	T	T	T	T	F	T	T
U	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
^{137}Cs	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
^{90}Sr	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
^{99}Tc	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
^{60}Co	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T

Table 17. Low-Activity Waste Specification Evaluation – Direct Wastes. (2 Sheets)

Envelope	A					B					C				
Component	AW-106	SY-102	AY-101	AW-104	AW-103	AW-106	SY-102	AY-101	AW-104	AW-103	AW-106	SY-102	AY-101	AW-104	AW-103
$^{154}Eu + ^{155}Eu$	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
TRU	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Na	F	T	T	F	T										

T= Compliant with Specification
F = Non-compliant with Specification.

Table 18. Low-Activity Waste Specification Evaluation – Direct Waste Concentrations.

Component	A	B	C	AW-106	SY-102	AY-101	AW-104	AW-103
Al	0.25	0.25	0.25	0.08192	0.04112	0.00032	0.12758	0.00374
Ba	0.0001	0.0001	0.0001	0.00000	0.00000	0.00000	0.00000	0.00000
Ca	0.04	0.04	0.04	0.00014	0.00022	0.01048	0.00043	0.00064
Cd	0.004	0.004	0.004	0.00000	0.00000	0.00000	0.00000	0.00000
Cl	0.037	0.089	0.037	0.00666	0.01890	0.03945	0.01930	0.00409
Cr	0.0069	0.02	0.0069	0.00241	0.00924	0.00467	0.00170	0.00057
F	0.091	0.2	0.091	0.01559	0.01923	0.01617	0.11451	0.38936
Fe	0.01	0.01	0.01	0.00002	0.00001	0.00002	0.00001	0.00007
Hg	0.000014	0.000014	0.000014	0.00000	0.00000	0.00000	0.00000	0.00000
K	0.18	0.18	0.18	0.00371	0.00863	0.00272	0.04115	0.05994
La	0.000083	0.000083	0.000083	0.00000	0.00000	0.00009	0.00000	0.00000
Ni	0.003	0.003	0.003	0.00000	0.00004	0.00026	0.00003	0.00024
NO_2	0.38	0.38	0.38	0.16651	0.18398	0.55331	0.23336	0.05120
NO_3	0.8	0.8	0.8	0.39906	0.47322	0.20097	0.20633	0.10648
Pb	0.00068	0.00068	0.00068	0.00000	0.00003	0.00127	0.00000	0.00000
PO_4	0.038	0.13	0.038	0.01652	0.02284	0.02078	0.00079	0.00482
SO_4	0.01	0.07	0.02	0.01863	0.01714	0.03738	0.00688	0.00326
CO_3	0.3	0.3	0.3	0.05115	0.06332	0.16841	0.09568	0.02253
TOC	0.5	0.5	0.5	0.03010	0.09404	0.69811	0.04905	0.07150
U	0.0012	0.0012	0.0012	1.22E-05	1.25E-04	8.52E-05	0.00E+00	0.00E+00
^{137}Cs	4.3E+09	2E+10	4.3E+09	2.19E-13	8.82E-09	2.02E-13	4.01E-13	2.91E-13
^{90}Sr	44000000	44000000	8E+08	2.90E-14	2.01E-12	8.70E-16	5.52E-16	1.36E-15
^{99}Tc	7.10E+06	7.10E+06	7.10E+06	2.88E-16	1.62E-14	1.39E-15	3.29E-16	0.00E+00
^{60}Co	6.10E+04	6.10E+04	3.70E+05	5.97E-18	2.74E-15	4.95E-17	2.86E-22	8.34E-18
$^{154}Eu + ^{155}Eu$	1200000	1200000	4300000	1.4E-16	6.39E-14	6.75E-15	6.58E-23	2.17E-17
TRU	480000	480000	3000000	9.1E-17	7.02E-15	1.13E-14	4.85E-16	4.59E-16
Na	3 to 10 M			27.73	3.99	3.26	15.35	6.56

6.2.3 Summary Evaluation of the Alternative

The election of a least unit product cost alternative resulted in the optimum selection for HLW feed to Phase 1 vitrification consisting of the following:

- 241-AZ-101
- 241-AZ-102
- 241-AW-105
- 241-AY-102/241-C-106 blended with 100 percent of 241-AW-103.

This option yields a cost per unit $2.016 million and a total project cost between the BNFL and GPM model costs of $3.330 billion to $2.741 billion. The BNFL glass yield could be as high as 1,652 canisters while the GPM yield is approximately 1,348 canisters. This option meets all criteria of glass quantity, retrieval, product cost, and contract specifications.

6.3 ALTERNATIVE TWO – LEAST TOTAL COST

An analysis of all waste stream cases has been prepared to rank cases by the total cost under the BNFL contract. This section provides a discussion of the merit among cases in this ranking.

6.3.1 Alternative Description

An analysis of the 72 waste streams in 12,426 combinations yielded product and cost estimates for each case. The cases were sorted to rank these cases by minimizing the total cost for DOE under the current BNFL contract. The cost bases assumed that production would be at the maximum BNFL contractual value and account for capital and operating retrieval costs as well as BNFL production and DOE disposition costs for these products.

The highest ranked case in this alternative employs the base case tanks of 241-AZ-101, 241-AZ-102, and 241-AY-102/241-C-106 as well as 30 percent of the waste from 241-AW-103 and all of 241-AY-101. This optimum is achieved by blending 30 percent of the 241-AW-103 zirconium-limited waste with the spinel-limited waste of 241-AY-102/241-C-106 and independently treating wastes from 241-AY-101. This case is the least total cost case and exhibits a unit cost of $2.0527 million per canister for 835 canisters. Total project costs for this case are $1.714 billion, including $96.1 million in retrieval costs.

Subsequent highly ranked cases also include various blends of 241-AW-103 with 241-AY-102/241-C-106 but also include either another tank or another blend of 241-AW-103. For the second through tenth rank, the total cost increases from $1.761 billion to $1.776 billion with an average production yield of 839 cans and average project cost of $1.772 billion. Retrieval costs in these cases were estimated to be $103.5 million to $153.7 million.

The top 50 ranked cases are delineated in **Table 19**. Thirty-two of these cases include one or more blends of 241-AW-103. Three of these cases include a blend of 241-C-104. Other tanks and blends, of increasing schedule complexity and total cost, are present in this upper tier of rankings.

Table 19. Minimum Phase 1 Project Cost Ranking. (5 Sheets)

Minimum BNFL Cost ($Millions)									Minimum GPM Cost ($Millions)								
Rank	Case	Tanks[3]	BNFL Cans	BNFL Cans/Mg W.O.	GPM Cans	Retrieval	BNFL Cost	GPM Cost	Rank	Case	Tanks	BNFL Cans	GPM Cans	GPM Cans/Mg W.O.	Retrieval	BNFL Cost	GPM Cost
29	2083	241-AY-101; 241-C-106/241-AY-102, 241-AW-103 (0.3)	835	1.521	762	$ 128.51	$1,746	$1,604	29	2001	241-AW-104, 241-AW-103 (0.4); 241-C-106/241-AY-102, 241-AW-103 (0.2)	938	755	1.199	$ 128.54	$1,947	$1,593
30	42	241-AW-106	855	2.420	772	$ 103.47	$1,761	$1,599	30	56	241-SY-102, 241-AW-103 (0.4)	907	756	1.510	$ 128.52	$1,887	$1,593
34	1913	241-AW-104, 241-AW-103 (0.1); 241-C-106/241-AY-102, 241-AW-103 (0.4)	845	1.431	756	$ 128.53	$1,767	$1,595	34	2328	241-SY-102, 241-AW-103 (0.4); 241-C-106/241-AY-102, 241-AW-103 (0.1)	908	756	1.399	$ 128.53	$1,888	$1,594
49	8370	241-AN-102; 241-AN-104; 241-SY-102	835	2.355	750	$ 153.71	$1,773	$1,608	49	1913	241-AW-104, 241-AW-103 (0.1); 241-C-106/241-AY-102, 241-AW-103 (0.4)	845	756	1.281	$ 128.53	$1,767	$1,595
93	10606	241-AN-104; 241-AN-102; 241-SY-102	835	2.355	750	$ 153.71	$1,773	$1,608	93	2316	241-SY-102, 241-AW-103 (0.3); 241-C-106/241-AY-102, 241-AW-103 (0.2)	851	757	1.400	$ 128.53	$1,777	$1,595
95	15144	241-SY-102; 241-AN-102; 241-AN-104	835	2.355	750	$ 153.71	$1,773	$1,608	95	42	241-AW-106	855	772	2.184	$ 103.47	$1,761	$1,599
96	11199	241-AN-104; 241-AY-101; 241-C-106/241-AY-102, 241-AW-103 (0.3)	836	1.523	763	$ 153.62	$1,774	$1,632	96	2083	241-AY-101; 241-C-106/241-AY-102, 241-AW-103 (0.3)	835	762	1.387	$ 128.51	$1,746	$1,604
103	8411	241-AN-102; 241-AN-106; 241-SY-102	837	2.354	752	$ 153.71	$1,776	$1,610	103	8370	241-AN-102; 241-AN-104; 241-SY-102	835	750	2.115	$ 153.71	$1,773	$1,608
104	15145	241-SY-102; 241-AN-102; 241-AN-106	837	2.354	752	$ 153.71	$1,776	$1,610	104	10606	241-AN-104; 241-AN-102; 241-SY-102	835	750	2.115	$ 153.71	$1,773	$1,608
107	8485	241-AN-102; 241-AW-102; 241-AY-101	837	1.841	750	$ 153.71	$1,776	$1,608	107	15144	241-SY-102; 241-AN-102; 241-AN-104	835	750	2.115	$ 153.71	$1,773	$1,608
108	2316	241-SY-102, 241-AW-103 (0.3); 241-C-106/241-AY-102, 241-AW-103 (0.2)	851	1.574	757	$ 128.53	$1,777	$1,595	108	8485	241-AN-102; 241-AW-102; 241-AY-101	837	750	1.650	$ 153.71	$1,776	$1,608

[3] All cases include 241-AZ-101; 241-AZ-102; and 241-C-106/241-AY-102

Table 19. Minimum Phase 1 Project Cost Ranking. (5 Sheets)

Minimum BNFL Cost ($Millions)									Minimum GPM Cost ($Millions)								
Rank	Case	Tanks[3]	BNFL Cans	BNFL Cans/Mg W.O.	GPM Cans	Retrieval	BNFL Cost	GPM Cost	Rank	Case	Tanks	BNFL Cans	GPM Cans	GPM Cans/Mg W.O.	Retrieval	BNFL Cost	GPM Cost
110	2342	241-AY-101 , 241-AW-103 (0.1); 241-C-106/241-AY-102 , 241-AW-103 (0.3)	851	1.445	778	$ 128.52	$1,777	$1,636	110	8411	241-AN-102; 241-AN-106; 241-SY-102	837	752	2.114	$ 153.71	$1,776	$1,610
121	2198	241-SY-102; 241-C-106/241-AY-102 , 241-AW-103 (0.3)	851	1.846	778	$ 128.51	$1,778	$1,636	121	15145	241-SY-102; 241-AN-102; 241-AN-106	837	752	2.114	$ 153.71	$1,776	$1,610
124	1228	241-C-105; 241-AY-101 , 241-AW-103 (0.2)	816	1.522	751	$ 196.48	$1,779	$1,651	124	8780	241-AN-102; 241-AW-104 , 241-AW-103 (0.2); 241-C-106/241-AY-102 , 241-AW-103 (0.3)	845	753	1.248	$ 153.65	$1,791	$1,613
126	1223	241-C-105; 241-SY-102 , 241-AW-103 (0.1)	816	1.997	751	$ 196.46	$1,779	$1,651	126	1483	241-AN-103; 241-AW-104 , 241-AW-103 (0.4)	935	753	1.344	$ 153.64	$1,965	$1,614
127	14922	241-SY-102; 241-C-105; 241-AW-102	820	2.151	752	$ 196.57	$1,785	$1,655	127	1498	241-AN-103; 241-SY-102 , 241-AW-103 (0.3)	847	755	1.604	$ 153.62	$1,795	$1,616
130	2055	241-AW-106; 241-C-106/241-AY-102 , 241-AW-103 (0.1)	856	2.177	772	$ 128.48	$1,787	$1,625	130	1645	241-AW-102; 241-AW-104 , 241-AW-103 (0.4)	931	756	1.343	$ 153.64	$1,958	$1,619
133	1660	241-AW-102; 241-SY-102 , 241-AW-103 (0.3)	843	1.783	758	$ 153.62	$1,788	$1,622	133	11117	241-AN-104; 241-AW-104 , 241-AW-103 (0.4); 241-C-106/241-AY-102 , 241-AW-103 (0.2)	940	757	1.201	$ 153.66	$1,975	$1,621
148	1527	241-AN-104; 241-AW-106	857	2.424	773	$ 128.59	$1,789	$1,627	148	1541	241-AN-104; 241-SY-102 , 241-AW-103 (0.4)	909	757	1.512	$ 153.64	$1,915	$1,621
153	1624	241-AN-107; 241-AY-101 , 241-AW-103 (0.2)	845	1.541	760	$ 153.61	$1,790	$1,627	153	1660	241-AW-102; 241-SY-102 , 241-AW-103 (0.3)	843	758	1.602	$ 153.62	$1,788	$1,622
156	1619	241-AN-107; 241-SY-102 , 241-AW-103 (0.1)	845	2.010	760	$ 153.60	$1,791	$1,627	156	11444	241-AN-104; 241-SY-102 , 241-AW-103 (0.4); 241-C-106/241-AY-102 , 241-AW-103 (0.1)	909	758	1.402	$ 153.65	$1,916	$1,622
159	8780	241-AN-102; 241-AW-104 , 241-AW-103 (0.2); 241-C-106/241-AY-102 , 241-AW-103 (0.3)	845	1.400	753	$ 153.65	$1,791	$1,613	159	11029	241-AN-104; 241-AW-104 , 241-AW-103 (0.1); 241-C-106/241-AY-102 , 241-AW-103 (0.4)	847	758	1.283	$ 153.65	$1,795	$1,623

Table 19. Minimum Phase 1 Project Cost Ranking. (5 Sheets)

Minimum BNFL Cost ($Millions)									Minimum GPM Cost ($Millions)								
Rank	Case	Tanks[3]	BNFL Cans	BNFL Cans/Mg W.O.	GPM Cans	Retrieval	BNFL Cost	GPM Cost	Rank	Case	Tanks	BNFL Cans	GPM Cans	GPM Cans/Mg W.O.	Retrieval	BNFL Cost	GPM Cost
160	1568	241-AN-106; 241-AW-106	858	2.423	775	$ 128.59	$1,792	$1,630	160	11432	241-AN-104; 241-SY-102 , 241-AW-103 (0.3); 241-C-106/241-AY-102 , 241-AW-103 (0.2)	852	758	1.403	$ 153.65	$1,805	$1,623
163	13746	241-AN-107; 241-AY-101 , 241-AW-103 (0.2); 241-C-106/241-AY-102 , 241-AW-103 (0.1)	845	1.438	761	$ 153.62	$1,792	$1,628	163	1582	241-AN-106; 241-SY-102 , 241-AW-103 (0.4)	910	759	1.513	$ 153.64	$1,918	$1,624
164	13681	241-AN-107; 241-SY-102 , 241-AW-103 (0.1); 241-C-106/241-AY-102 , 241-AW-103 (0.1)	845	1.838	761	$ 153.61	$1,792	$1,628	164	2055	241-AW-106; 241-C-106/241-AY-102 , 241-AW-103 (0.1)	856	772	1.965	$ 128.48	$1,787	$1,625
166	11029	241-AN-104; 241-AW-104 , 241-AW-103 (0.1); 241-C-106/241-AY-102 , 241-AW-103 (0.4)	847	1.434	758	$ 153.65	$1,795	$1,623	166	12927	241-AN-107; 241-AN-103; 241-SY-102	852	759	1.946	$ 153.71	$1,804	$1,625
176	1498	241-AN-103; 241-SY-102 , 241-AW-103 (0.3)	847	1.800	755	$ 153.62	$1,795	$1,616	176	15188	241-SY-102; 241-AN-103; 241-AN-107	852	759	1.946	$ 153.71	$1,804	$1,625
184	13048	241-AN-107; 241-AW-102; 241-SY-102	848	2.160	762	$ 153.71	$1,797	$1,630	184	1944	241-AW-104 , 241-AW-103 (0.2); 241-C-106/241-AY-102 , 241-AW-103 (0.4)	879	773	1.226	$ 128.54	$1,833	$1,626
187	15309	241-SY-102; 241-AN-107; 241-AW-102	848	2.160	762	$ 153.71	$1,797	$1,630	187	2329	241-SY-102 , 241-AW-103 (0.4); 241-C-106/241-AY-102 , 241-AW-103 (0.2)	934	773	1.332	$ 128.54	$1,938	$1,626
190	8379	241-AN-102; 241-AN-104; 241-AY-101 , 241-AW-103 (0.1)	835	1.731	750	$ 178.72	$1,798	$1,633	190	1527	241-AN-104; 241-AW-106	857	773	2.188	$ 128.59	$1,789	$1,627
195	10615	241-AN-104; 241-AN-102; 241-AY-101 , 241-AW-103 (0.1)	835	1.731	750	$ 178.72	$1,798	$1,633	195	1624	241-AN-107; 241-AY-101 , 241-AW-103 (0.2)	845	760	1.387	$ 153.61	$1,790	$1,627
200	1354	241-C-109; 241-AY-101	840	1.767	755	$ 171.45	$1,799	$1,635	200	2276	241-SY-102 , 241-C-104 (0.4); 241-C-106/241-AY-102 ,	840	751	1.583	$ 171.34	$1,800	$1,627

Table 19. Minimum Phase 1 Project Cost Ranking. (5 Sheets)

Minimum BNFL Cost ($Millions)									Minimum GPM Cost ($Millions)								
Rank	Case	Tanks[3]	BNFL Cans	BNFL Cans/Mg W.O.	GPM Cans	Retrieval	BNFL Cost	GPM Cost	Rank	Case	Tanks	BNFL Cans	GPM Cans	GPM Cans/Mg W.O.	Retrieval	BNFL Cost	GPM Cost
											241-C-104 (0.2)						
201	14952	241-SY-102; 241-C-105; 241-C-106/241-AY-102 , 241-AW-103 (0.2)	827	1.844	752	$ 196.48	$1,799	$1,653	201	1619	241-AN-107; 241-SY-102 , 241-AW-103 (0.1)	845	760	1.809	$ 153.60	$1,791	$1,627
216	2276	241-SY-102 , 241-C-104 (0.4); 241-C-106/241-AY-102 , 241-C-104 (0.2)	840	1.770	751	$ 171.34	$1,800	$1,627	216	13746	241-AN-107; 241-AY-101 , 241-AW-103 (0.2); 241-C-106/241-AY-102 , 241-AW-103 (0.1)	845	761	1.294	$ 153.62	$1,792	$1,628
225	8420	241-AN-102; 241-AN-106; 241-AY-101 , 241-AW-103 (0.1)	837	1.732	752	$ 178.72	$1,801	$1,635	225	13681	241-AN-107; 241-SY-102 , 241-AW-103 (0.1); 241-C-106/241-AY-102 , 241-AW-103 (0.1)	845	761	1.654	$ 153.61	$1,792	$1,628
256	1458	241-AN-102; 241-AY-101 , 241-AW-103 (0.2)	850	1.628	765	$ 153.61	$1,801	$1,636	256	1607	241-AN-107; 241-AW-105	935	774	1.455	$ 128.59	$1,941	$1,629
258	1453	241-AN-102; 241-SY-102 , 241-AW-103 (0.1)	850	2.155	765	$ 153.60	$1,801	$1,636	258	13592	241-AN-107; 241-SY-102; 241-C-106/241-AY-102 , 241-AW-103 (0.2)	855	761	1.655	$ 153.61	$1,811	$1,629
261	9188	241-AN-102; 241-AY-101 , 241-AW-103 (0.2); 241-C-106/241-AY-102 , 241-AW-103 (0.1)	851	1.514	765	$ 153.62	$1,802	$1,637	261	15339	241-SY-102; 241-AN-107; 241-C-106/241-AY-102 , 241-AW-103 (0.2)	855	761	1.655	$ 153.61	$1,811	$1,629
263	9123	241-AN-102; 241-SY-102 , 241-AW-103 (0.1); 241-C-106/241-AY-102 , 241-AW-103 (0.1)	851	1.959	765	$ 153.61	$1,802	$1,637	263	13736	241-AN-107; 241-AY-101 , 241-AW-103 (0.1); 241-C-106/241-AY-102 , 241-AW-103 (0.2)	855	761	1.295	$ 153.62	$1,811	$1,629
265	12927	241-AN-107; 241-AN-103; 241-SY-102	852	2.183	759	$ 153.71	$1,804	$1,625	265	1568	241-AN-106; 241-AW-106	858	775	2.187	$ 128.59	$1,792	$1,630
267	15188	241-SY-102; 241-AN-103; 241-AN-107	852	2.183	759	$ 153.71	$1,804	$1,625	267	1147	241-C-104; 241-AN-103	891	753	1.376	$ 171.45	$1,898	$1,630
269	11432	241-AN-104; 241-SY-102 , 241-AW-103 (0.3); 241-C-106/241-AY-102 , 241-AW-103 (0.2)	852	1.576	758	$ 153.65	$1,805	$1,623	269	13048	241-AN-107; 241-AW-102; 241-SY-102	848	762	1.941	$ 153.71	$1,797	$1,630

Table 19. Minimum Phase 1 Project Cost Ranking. (5 Sheets)

Minimum BNFL Cost ($Millions)									Minimum GPM Cost ($Millions)								
Rank	Case	Tanks[3]	BNFL Cans	BNFL Cans/Mg W.O.	GPM Cans	Retrieval	BNFL Cost	GPM Cost	Rank	Case	Tanks	BNFL Cans	GPM Cans	GPM Cans/Mg W.O.	Retrieval	BNFL Cost	GPM Cost
270	11458	241-AN-104; 241-AY-101 , 241-AW-103 (0.1); 241-C-106/241-AY-102 , 241-AW-103 (0.3)	852	1.448	779	$ 153.64	$1,805	$1,664	270	15309	241-SY-102; 241-AN-107; 241-AW-102	848	762	1.941	$ 153.71	$1,797	$1,630
278	11314	241-AN-104; 241-SY-102; 241-C-106/241-AY-102 , 241-AW-103 (0.3)	852	1.849	779	$ 153.62	$1,806	$1,664	278	2260	241-SY-102 , 241-C-104 (0.3); 241-C-106/241-AY-102 , 241-C-104 (0.3)	845	754	1.588	$ 171.34	$1,809	$1,632
280	15261	241-SY-102; 241-AN-104; 241-C-106/241-AY-102 , 241-AW-103 (0.3)	852	1.849	779	$ 153.62	$1,806	$1,664	280	11199	241-AN-104; 241-AY-101; 241-C-106/241-AY-102 , 241-AW-103 (0.3)	836	763	1.390	$ 153.62	$1,774	$1,632
281	10391	241-AN-104; 241-C-105; 241-AY-101 , 241-AW-103 (0.2)	818	1.524	752	$ 221.59	$1,807	$1,679	281	8379	241-AN-102; 241-AN-104; 241-AY-101 , 241-AW-103 (0.1)	835	750	1.555	$ 178.72	$1,798	$1,633
292	10386	241-AN-104; 241-C-105; 241-SY-102 , 241-AW-103 (0.1)	818	2.001	752	$ 221.58	$1,807	$1,679	292	10615	241-AN-104; 241-AN-102; 241-AY-101 , 241-AW-103 (0.1)	835	750	1.555	$ 178.72	$1,798	$1,633
301	8490	241-AN-102; 241-AW-102; 241-SY-102	853	2.327	767	$ 153.71	$1,808	$1,639	301	1182	241-C-104; 241-C-106/241-AY-102 , 241-AW-103 (0.2)	894	755	1.224	$ 171.36	$1,905	$1,634
302	15147	241-SY-102; 241-AN-102; 241-AW-102	853	2.327	767	$ 153.71	$1,808	$1,639	302	8328	241-AN-102; 241-AN-103; 241-SY-102	857	764	2.097	$ 153.71	$1,814	$1,634
314	15301	241-SY-102; 241-AN-106; 241-C-106/241-AY-102 , 241-AW-103 (0.3)	854	1.849	781	$ 153.62	$1,809	$1,666	314	15143	241-SY-102; 241-AN-102; 241-AN-103	857	764	2.097	$ 153.71	$1,814	$1,634

A parallel data set in **Table 19** is prepared in the same manner but based upon optimum GPM yields. The GPM optimum ranking for least total cost also yields blends of 241-AW-103, but typically with a different integral tank (e.g., 241-AW-104) or two parent tanks applied to the blending. These preferences are generally interpreted to yield the least product volume (high waste oxide loading). These cases approach the blending considerations described in Section 6.1.1.3 as optimum but are ranked to functionally reduce overall Phase 1 product.

6.3.2 Criteria Assessment

This section provides a discussion of compliance with criteria established in Section 4.0 for the least total cost case.

6.3.2.1 Glass Quantity Requirement. The case yields an estimate of 835 canisters of product based upon BNFL contract maximum (minimum waste loading) and a GPM yield of 762 canisters. This yield meets and exceeds both the contract minimum feed of 600 canisters and the contingency-based minimum of 750 canisters. The minimization routine screened out all cases yielding less than 750 GPM canisters, with the case rank of 17. Revision of contingency requirements would result in the preference of other waste stream cases.

6.3.2.2 Retrieval Criteria. This section provides a brief assessment of the highest ranked case in compliance with retrieval criteria under the least total cost alternative. This optimum includes tanks 241-AZ-101, 241-AZ-102, 241-AY-101, and 241-AY-102/241-C-106 blended with 30 percent of 241-AW-103.

The retrievals of this case require the base case retrievals plus the entirety of 241-AY-101 and the fractional retrieval of 241-AW-103 wastes. These two DST waste retrievals with mixer pump arrangements pose an acceptable schedule (modest risk) impact in compliance with this criterion.

6.3.2.2.1 Schedule. The addition of two DST retrievals from 241-AW-103 and 241-AY-101 to the base case tanks is of modest complexity and may offer a slight relaxation in schedule from prior anticipation of the retrieval of both 241-C-102 and 241-C-104. Selection of this case option complies with the schedule criterion.

6.3.2.2.2 Retrieval Risk. The retrieval from 241-AW-103 and 241-AY-101 are expected to be conducted by mixer pump arrangement. These tanks are not SSTs, exhibit little organic vapor generation, and have no history of separable organic layers. In all of these manners, retrieval risk is minimal in terms of contract quantity and schedule, thereby complying with this criterion.

6.3.2.2.3 Waste Retrieval Cost. Retrieval from both 241-AW-103 and 241-AY-101 are expected to be accomplished with mixer pump arrangements. This tank is among the 200 East Area DST farms and is supported by those existing ventilation and transfer systems. The retrieval cost estimate of $128.51 million for the entire case is the least retrieval cost exhibited among all cases yielding the minimum production with 25 percent contingency. This option complies with the criterion of retrieval cost minimization.

6.3.2.2.4 Availability of Early DST Space. Both tanks 241-AW-103 and 241-AY-101 are DSTs. Retrieval of these wastes in Phase 1 treatment complies with the criterion for availability of early DST space. Such compliance will aid TWRS overall waste volume management and ease difficulties associated with current waste volume projections to an extent greater than that provided by the optimum first alternative case.

6.3.2.2.5 Early SST Retrieval. Tanks 241-AW-103 and 241-AY-101 are not SSTs, their retrieval will not satisfy a criterion for the early demonstration of SST retrieval. However, present views exist that the ongoing retrieval of 241-C-106 constitutes that demonstration. In this manner, this criterion is deemed met.

6.3.2.2.6 Safety. Wastes in tanks 241-AW-103 and 241-AY-101 are not complexant wastes and have no significant ongoing safety restrictions beyond those imposed in the management of other Hanford tank wastes. No tank safety issue resolution is required. Therefore, this criterion is deemed met.

6.3.2.3 Cost of Product. The optimum case of this alternative is that of the lowest total cost in Phase 1 vitrification conduct. In large part, this optimum is achieved through the blending of the zirconium-limited waste of tank 241-AW-103 with the spinel-limited waste of tank 241-AY-102/241-C-106 while limiting that blend ratio to 30 percent and addition of the low yield spinel-limited waste of tank 241-AY-101. The blend decreases the waste mass from that described in the first alternative to a level just over the contingency threshold. This blending maximizes the waste loading within this cost optimization alternative but at a waste loading lower than that seen in the first alternative. The unit cost projected in this case is $2,091,020 per canister ($75,300 per canister greater than the optimum case in the first alternative). The overall project cost based upon BNFL contract maximum production is $1.746 billion. At optimum glass yield, this cost may be reduced to $1.604 billion yielding a savings of $132 million. Relative to unblended treatment of 241-AW-103 with the base case tanks and 241-AY-101, the blended product cost saves approximately $274 million. The option meets the criterion for maximum waste loading for this cost alternative.

6.3.2.4 Contract Specification. This section provides a brief review of compliance with contract specifications in terms of the impact on existing plans and feed material specifications.

6.3.2.4.1 Impact on Existing Plans. The retrieval of 241-AY-101 and the retrieval and blended treatment of 241-AW-103 wastes with the base case tanks has modest impact upon existing plans. Two additional projects would be required to support the mixer pump installation and retrieval from 241-AY-101 and 241-AW-103 beyond existing plans. Bottlenecks in retrieval are minimal and this retrieval is not clouded with saltwell pumping and transfer issues exhibited with 241-SY-102 wastes. However, current usage of 241-AY-101 as a dilute waste receiver could not be sustained during the period of retrieval. Election of this option will expedite overall TWRS progress meeting this criterion.

6.3.2.4.2 Sludge Composition Compliance. Envelope D specifications for the HLW solids were investigated for wastes of primary interest in this case. Direct waste feed compliance with these specifications is depicted in **Table 16**. The 241-AW-103 waste is directly seen to be out of specification for B, Be, Tl, NH_3, ^{235}U, ^{238}Pu, ^{239}Pu, ^{241}Pu, F, Zr, and total solids. Of particular concern, the 241-AW-103 fluoride content may require modification of the BNFL off-gas system and the zirconium concentration would drive up the product volume.

Wastes from 241-AY-101 suffer from modestly high organic (approximately 150 percent of specification), sodium (212 percent), and chromium (257 percent) specification non-compliance. The sodium and chromium contents of this waste are relatively unavoidable difficulties in the processing of this waste and will pose modest contractual penalties to DOE. Tank 241-AY-101 also exhibits specification non-compliance for all radionuclides except ^{99}Tc, ^{126}Sb, ^{137}Cs, and ^{237}Np.

The blend of 30 percent of 241-AW-103 in 241-AY-102/241-C-106 has been evaluated with its results tabulated in Appendix A, Table 5. Blending of these wastes is not seen to greatly improve the compliance of the feed with the Envelope D specification for this waste as a result of contaminant contributions from 241-AY-102/241-C-106. Although additional negotiation with BNFL on case-specific waste feed acceptance is expected, no significant physical plant or operational difficulties are foreseen in the vitrification of this blend. Potentially significant physical plant and handling difficulties are foreseen in the vitrification of 241-AY-101 wastes. This case option is marginally deemed to meet the criterion of sludge composition compliance.

Additional specification evaluation of blends of 241-AW-103 and 241-C-104 with 241-AY-102/241-C-106, 241-AW-104, 241-SY-102, 241-AY-101, and 241-C-102 are contained in Appendix A for inspection and application to other cases.

6.3.2.4.3 Supernate Composition Compliance. Envelope A, B, and C specifications for the supernatant liquors separated from the HLW solids were investigated for wastes of primary interest in this case. Direct waste feed compliance with these specifications is depicted in **Table 17** with feed concentrations detailed in **Table 18**. The 241-AW-103 waste, as was the case for the sludge, is seen to be out of specification for fluoride.

The blend of 30 percent of 241-AW-103 in 241-AY-102/241-C-106 has been evaluated with its results tabulated in Appendix B. Blending of these wastes is not seen to improve fluoride compliance of the feed with the Envelope A, B, and C specifications. This case option is deemed to meet the criterion of supernatant composition compliance.

The 241-AY-101 supernatant liquor poses significant composition difficulties including those of high Cl, NO_2, Pb, SO_4, and TOC. The halide and sulfate concentrations will directly affect the processibility of this stream while the lead will consume a significant fraction of the overall waste loading desired to be applied to other constituents. Use of this material poses a moderate risk in criterion compliance.

Additional specification evaluation of blends of 241-AW-103 and 241-C-104 with 241-AY-102/241-C-106, 241-AW-104, 241-SY-102, 241-AY-101, and 241-C-102 are contained in Appendix B for inspection and application to other cases.

6.3.3 Summary Evaluation of the Alternative

The election of a least total cost alternative resulted in the optimum selection for HLW feed to Phase 1 vitrification consisting of:

- 241-AZ-101
- 241-AZ-102
- 241-AY-101
- 241-AY-102/241-C-106 blended with 30 percent of 241-AW-103.

This option yields a cost per unit $2.091 million and a total project cost between the BNFL and GPM model costs of $1.746 billion to $1.604 billion. The BNFL glass yield could be as high as 835 canisters while the GPM yield is approximately 762 canisters. This case option meets all criteria of glass quantity, retrieval, product cost, and contract specifications but is at risk in terms of 241-AY-101 sludge and supernatant liquor feed specification compliance and poses greater schedule risks than the optimum case of the first alternative. Election of least contract liability cases of higher cost than that posed with the treatment of 241-AY-101 do not provide significant relief in these risks.

6.4 ALTERNATIVE THREE – LEAST RETRIEVAL COST

An analysis of all waste stream cases has been prepared to rank cases by the least cost for retrieval (near term project cost) while maintaining a minimum product yield. This section provides a discussion of the merit among cases in this ranking. The optimum case of this alternative is identical to the first alternative optimum.

6.4.1 Alternative Description

An analysis of the 72 waste streams in 12,426 combinations yielded product and cost estimates for each combination (case). The cases were sorted by minimizing the retrieval cost. The cost bases assumed that production would be at the maximum BNFL contractual value and account for capital and operating retrieval costs as well as BNFL production and DOE disposition costs for these products.

The highest ranked case in this alternative, incorporating blending, employs the base case tanks of 241-AZ-101, 241-AZ-102, and 241-AY-102/241-C-106 as well as 100 percent of the waste from 241-AW-103. This optimum is achieved by fully blending all the 241-AW-103 zirconium-limited waste with the spinel-limited waste of 241-AY-102/ 241-C-106. This case is the preferred minimum retrieval cost case and exhibits a unit cost of $2.0189 million per canister for 1,276 canisters. Total project costs for this case are $2.576 billion, including $103.47 million in retrieval costs.

The second through fifth blended ranks in this alternative include one tank directly added plus the minor blending of 241-AW-103. Contrary to the first alternative, the use of 241-AW-105 is preferred over 241-AW-106. Over these ranks the unit price increases from $2.088 million to $2.071 million with an average production yield of 906 cans and average project cost of $1.885 billion. Retrieval costs in each of these cases were estimated to be $128.5 million.

The top 50 ranked cases are delineated in **Table 20**. Thirty-nine of these cases involve the blends of 241-AW-103 with 241-AY-102/241-C-106. No blends of 241-C-104 are observed in the upper tier.

Table 20. Minimum Retrieval Cost Alternative Ranking.

Minimum Retrieval Cost ($Millions)									
Rank	Case	Tanks[4]	BNFL Cans	GPM Cans	Retrieval	BNFL Cost	GPM Cost	BNFL Cans/Mg W.O.	GPM Cans/Mg W.O.
29	31	241-AW-103	1,509	1,218	$103.47	$3,027	$2,463	2.116	1.707
30	64	241-C-106/241-AY-102 , 241-AW-103 (1)	1,276	1,049	$103.47	$2,576	$2,136	1.789	1.471
34	42	241-AW-106	855	772	$103.47	$1,761	$1,599	2.420	2.184
49	2055	241-AW-106; 241-C-106/241-AY-102 , 241-AW-103 (0.1)	856	772	$128.48	$1,787	$1,625	2.177	1.965
93	2056	241-AW-106; 241-C-106/241-AY-102 , 241-AW-103 (0.2)	882	789	$128.49	$1,837	$1,657	2.037	1.823
95	2057	241-AW-106; 241-C-106/241-AY-102 , 241-AW-103 (0.3)	930	858	$128.51	$1,932	$1,792	1.969	1.816
96	2030	241-AW-105; 241-C-106/241-AY-102 , 241-AW-103 (0.3)	958	808	$128.51	$1,984	$1,694	1.564	1.319
103	2198	241-SY-102; 241-C-106/241-AY-102 , 241-AW-103 (0.3)	851	778	$128.51	$1,778	$1,636	1.846	1.687
104	2083	241-AY-101; 241-C-106/241-AY-102 , 241-AW-103 (0.3)	835	762	$128.51	$1,746	$1,604	1.521	1.387
107	2058	241-AW-106; 241-C-106/241-AY-102 , 241-AW-103 (0.4)	1,023	935	$128.52	$2,112	$1,941	1.998	1.826
108	2031	241-AW-105; 241-C-106/241-AY-102 , 241-AW-103 (0.4)	1,051	885	$128.52	$2,164	$1,843	1.611	1.357
110	2199	241-SY-102; 241-C-106/241-AY-102 , 241-AW-103 (0.4)	944	855	$128.52	$1,958	$1,785	1.885	1.708
121	2084	241-AY-101; 241-C-106/241-AY-102 , 241-AW-103 (0.4)	928	839	$128.52	$1,926	$1,754	1.576	1.425
124	2288	241-SY-102 , 241-AW-103 (0.1); 241-C-106/241-AY-102 , 241-AW-103 (0.3)	867	794	$128.52	$1,809	$1,667	1.732	1.586
126	2342	241-AY-101 , 241-AW-103 (0.1); 241-C-106/241-AY-102 , 241-AW-103 (0.3)	851	778	$128.52	$1,777	$1,636	1.445	1.321
127	56	241-SY-102 , 241-AW-103 (0.4)	907	756	$128.52	$1,887	$1,593	1.812	1.510
130	2289	241-SY-102 , 241-AW-103 (0.1); 241-C-106/241-AY-102 , 241-AW-103 (0.4)	960	871	$128.53	$1,989	$1,817	1.776	1.612
133	2343	241-AY-101 , 241-AW-103 (0.1); 241-C-106/241-AY-102 , 241-AW-103 (0.4)	944	855	$128.53	$1,957	$1,785	1.502	1.360
148	2303	241-SY-102 , 241-AW-103 (0.2); 241-C-106/241-AY-102 , 241-AW-103 (0.3)	883	810	$128.53	$1,840	$1,698	1.634	1.499
153	2353	241-AY-101 , 241-AW-103 (0.2); 241-C-106/241-AY-102 , 241-AW-103 (0.3)	867	794	$128.53	$1,809	$1,667	1.380	1.263
156	2316	241-SY-102 , 241-AW-103 (0.3); 241-C-106/241-AY-102 , 241-AW-103 (0.2)	851	757	$128.53	$1,777	$1,595	1.574	1.400
159	1913	241-AW-104 , 241-AW-103 (0.1); 241-C-106/241-AY-102 , 241-AW-103 (0.4)	845	756	$128.53	$1,767	$1,595	1.431	1.281
160	2328	241-SY-102 , 241-AW-103 (0.4); 241-C-106/241-AY-102 , 241-AW-103 (0.1)	908	756	$128.53	$1,888	$1,594	1.680	1.399
163	2304	241-SY-102 , 241-AW-103 (0.2); 241-C-106/241-AY-102 , 241-AW-103 (0.4)	976	887	$128.54	$2,020	$1,848	1.682	1.529
164	2354	241-AY-101 , 241-AW-103 (0.2); 241-C-106/241-AY-102 , 241-AW-103 (0.4)	960	871	$128.54	$1,989	$1,817	1.437	1.304
166	2317	241-SY-102 , 241-AW-103 (0.3); 241-C-106/241-AY-102 , 241-AW-103 (0.3)	899	826	$128.54	$1,871	$1,730	1.550	1.424
176	2363	241-AY-101 , 241-AW-103 (0.3); 241-C-106/241-AY-102 , 241-AW-103 (0.3)	896	810	$128.54	$1,864	$1,698	1.341	1.212
184	2329	241-SY-102 , 241-AW-103 (0.4); 241-C-106/241-AY-102 , 241-AW-103 (0.2)	934	773	$128.54	$1,938	$1,626	1.610	1.332
187	1944	241-AW-104 , 241-AW-103 (0.2); 241-C-106/241-AY-102 , 241-AW-103 (0.4)	879	773	$128.54	$1,833	$1,626	1.395	1.226
190	2001	241-AW-104 , 241-AW-103 (0.4); 241-C-106/241-AY-102 , 241-AW-103 (0.2)	938	755	$128.54	$1,947	$1,593	1.489	1.199
195	2318	241-SY-102 , 241-AW-103 (0.3); 241-C-106/241-AY-102 , 241-AW-103 (0.4)	992	903	$128.55	$2,051	$1,879	1.601	1.457
200	2364	241-AY-101 , 241-AW-103 (0.3); 241-C-106/241-AY-102 , 241-AW-103 (0.4)	989	887	$128.55	$2,044	$1,848	1.396	1.253
201	2330	241-SY-102 , 241-AW-103 (0.4); 241-C-106/241-AY-102 , 241-AW-103 (0.3)	983	842	$128.55	$2,033	$1,761	1.585	1.359
216	2002	241-AW-104 , 241-AW-103 (0.4); 241-C-106/241-AY-102 , 241-AW-103 (0.3)	987	825	$128.55	$2,041	$1,727	1.473	1.231
225	1974	241-AW-104 , 241-AW-103 (0.3); 241-C-106/241-AY-102 ,	980	825	$128.55	$2,027	$1,727	1.462	1.231

[4] All cases include 241-AZ-101; 241-AZ-102; and 241-C-106/241-AY-102

Table 20. Minimum Retrieval Cost Alternative Ranking.

Minimum Retrieval Cost ($Millions)									
Rank	Case	Tanks[a]	BNFL Cans	GPM Cans	Retrieval	BNFL Cost	GPM Cost	BNFL Cans/Mg W.O.	GPM Cans/Mg W.O.
		241-AW-103 (0.4)							
256	2331	241-SY-102 , 241-AW-103 (0.4); 241-C-106/241-AY-102 , 241-AW-103 (0.4)	1,076	920	$128.56	$2,213	$1,911	1.631	1.394
258	2003	241-AW-104 , 241-AW-103 (0.4); 241-C-106/241-AY-102 , 241-AW-103 (0.4)	1,080	902	$128.56	$2,221	$1,877	1.521	1.271
261	1685	241-AW-103; 241-AW-106	1,857	1,567	$128.59	$3,728	$3,166	2.474	2.088
263	1684	241-AW-103; 241-AW-105	1,885	1,517	$128.59	$3,781	$3,068	2.116	1.703
265	1691	241-AW-103; 241-SY-102	1,778	1,487	$128.59	$3,574	$3,010	2.406	2.012
267	1686	241-AW-103; 241-AY-101	1,762	1,471	$128.59	$3,543	$2,979	2.130	1.778
269	2059	241-AW-106; 241-C-106/241-AY-102 , 241-AW-103 (1)	1,625	1,399	$128.59	$3,277	$2,839	2.164	1.863
270	1675	241-AW-103; 241-AW-104	1,663	1,372	$128.59	$3,352	$2,788	2.107	1.739
278	2032	241-AW-105; 241-C-106/241-AY-102 , 241-AW-103 (1)	1,652	1,348	$128.59	$3,330	$2,741	1.855	1.514
280	2200	241-SY-102; 241-C-106/241-AY-102 , 241-AW-103 (1)	1,545	1,318	$128.59	$3,123	$2,683	2.091	1.783
281	2085	241-AY-101; 241-C-106/241-AY-102 , 241-AW-103 (1)	1,529	1,302	$128.59	$3,092	$2,652	1.849	1.574
292	1431	241-AN-102; 241-AW-103	1,567	1,275	$128.59	$3,166	$2,600	2.158	1.756
301	1597	241-AN-107; 241-AW-103	1,562	1,271	$128.59	$3,155	$2,591	2.077	1.690
302	1636	241-AW-102; 241-AW-103	1,528	1,236	$128.59	$3,090	$2,523	2.107	1.704
314	1474	241-AN-103; 241-AW-103	1,532	1,233	$128.59	$3,097	$2,518	2.119	1.706

6.4.2 Criteria Assessment

This section provides a discussion of compliance with criteria established in Section 4.0 for the least retrieval cost alternative.

6.4.2.1 Glass Quantity Requirement. The preferred case yields an estimate of 1,276 canisters of product based upon the BNFL contract maximum (minimum waste loading) and a GPM yield of 1,049 canisters. This yield meets and exceeds both the contract minimum feed of 600 canisters and the contingency-based minimum of 750 canisters. The first 300 cases in this alternative meet these criteria and the first 100 exceed 1,000 GPM canisters.

6.4.2.2 Retrieval Criteria. This section provides a brief assessment of the highest ranked case compliance with retrieval criteria under the least retrieval cost alternative. This optimum defines the preferred treatment as that of 241-AZ-101, 241-AZ-102, and 241-AY-102/241-C-106 blended with 100 percent of 241-AW-103. In calculating the quantity of glass produced in the optimum blend results, the currently estimated retrieval efficiencies (Kirkbride et al. 1997) of waste retrieval from these tanks have been applied.

The retrievals of this case require the base case retrievals plus the single retrieval of 241-AW-103 wastes. This single DST waste retrieval with a mixer pump arrangement poses a minimum schedule impact to compliance with this criterion.

6.4.2.2.1 Schedule. The addition of one DST retrieval from 241-AW-103 to the base case tanks is of minimum complexity and poses schedule relief from prior anticipation of the retrieval of both 241-C-102 and 241-C-104. Selection of this case option complies with the schedule criterion.

6.4.2.2.2 Retrieval Risk. The retrieval from 241-AW-103 is expected to be conducted with a mixer pump arrangement. This tank is not an SST, exhibits little organic vapor generation, and has no history of separable organic layers. In all of these manners, retrieval risk is minimal in terms of contract quantity and schedule, thereby complying with this criterion.

6.4.2.2.3 Waste Retrieval Cost. Retrieval from 241-AW-103 is expected to be accomplished with a mixer pump arrangement. This tank is among the 200 East Area DST farms and is supported by those existing ventilation and transfer systems. The retrieval cost estimate of $103.47 million for the entire case is the least retrieval cost exhibited among all cases. This option complies with the criterion of retrieval cost minimization.

6.4.2.2.4 Availability of Early DST Space. Tank 24-AW-103 is a DST. Retrieval of this waste in Phase 1 treatment complies with the criterion for availability of early DST space. Such compliance will aid TWRS overall waste volume management and ease difficulties associated with current waste volume projections.

6.4.2.2.5 Early SST Retrieval. Tank 241-AW-103 is not an SST. Thus, its retrieval will not satisfy a criterion for the early demonstration of SST retrieval. However, present views exist that the ongoing retrieval of 241-C-106 constitutes that demonstration. In this manner, this criterion is deemed met.

6.4.2.2.6 Safety. Wastes in tank 241-AW-103 are not complexant wastes and have no significant ongoing safety restrictions beyond those imposed in the management of other Hanford tank wastes. No tank safety issue resolution is required. Therefore, this criterion is deemed met.

6.4.2.3 Cost of Product. The optimum case of this alternative is that of lowest retrieval cost yielding the minimum and contingency product quantities. In large part, this optimum is achieved through the blending of the zirconium-limited waste of tank 241-AW-103 with the spinel-limited waste of tank 241-AY-102/241-C-106 and requiring only one additional retrieval over the base case. This blending maximizes the waste loading within this alternative. The unit cost projected in this case is $2,188,100 per canister. The overall project cost based upon BNFL contract maximum production is $2.576 billion. At optimum glass yield, this cost may be reduced to $2.136 billion, yielding a savings of $440 million. Relative to unblended treatment of 241-AW-103 with the base case tanks, an optimum blend product cost saves approximately $800 million. The option meets the criterion for maximum waste loading for this alternative.

6.4.2.4 Contract Specification. This section provides a brief review of compliance with contract specifications in terms of the impact on existing plans and feed material specifications.

6.4.2.4.1 Impact on Existing Plans. The retrieval and blended treatment of 241-AW-103 wastes with the base case tanks has little impact upon existing plans. One additional project would be required to support the mixer pump installation and retrieval from 241-AW-103 beyond existing plans. Bottlenecks in retrieval are minimal and this retrieval is not clouded with saltwell pumping and transfer issues exhibited with 241-SY-102 wastes. Election of this option will expedite overall TWRS progress meeting this criterion.

6.4.2.4.2 Sludge Composition Compliance. Envelope D specifications for the HLW solids were investigated for wastes of primary interest in this alternative. Direct waste feed compliance with these specifications is depicted in **Table 16**. The 241-AW-103 waste is directly seen to be out of specification for B, Be, Tl, NH_3, ^{235}U, ^{238}Pu, ^{239}Pu, ^{241}Pu, F, Zr, and total solids. Of particular concern, the fluoride specification may significantly require modification of the BNFL off-gas system and the zirconium concentration would drive up the product volume.

The blend of 100 percent of 241-AW-103 in 241-AY-102/241-C-106 has been evaluated with its results tabulated in Appendix A, Table 5, above. Blending of these wastes is not seen to greatly improve the compliance of the feed to the Envelope D specification due to the contributions from 241-AY-101/241-C-106. Although additional negotiation with BNFL on case-specific waste feed acceptance is expected, no significant physical plant or operational difficulties are foreseen in the vitrification of this blend. This case option is deemed to meet the criterion of sludge composition compliance.

Additional specification evaluation of blends of 241-AW-103 and 241-C-104 with 241-AY-102/241-C-106, 241-AW-104, 241-SY-102, 241-AY-101, and 241-C-102 are contained in Appendix A for inspection and application to other cases.

6.4.2.4.3 Supernate Composition Compliance. Envelope A, B, and C specifications for the supernatant liquors separated from the HLW solids were investigated for wastes of primary interest in this case. Direct waste feed compliance with these specifications is depicted in **Table 17** with feed concentrations detailed in **Table 18**. The 241-AW-103 waste, as was the case for the sludge, is seen to be out of specification for fluoride.

The blend of 100 percent of 241-AW-103 in 241-AY-102/241-C-106 has been evaluated with its results tabulated in Appendix B, Tables 9 and 10. Blending of these wastes is not seen to improve fluoride compliance of the feed to the Envelope A, B, and C specifications. This case option is deemed to marginally meet the criterion of supernatant composition compliance.

Additional specification evaluation of blends of 241-AW-103 and 241-C-104 with 241-AY-102/241-C-106, 241-AW-104, 241-SY-102, 241-AY-101, and 241-C-102 are contained in Appendix B for inspection and application to other cases.

6.4.3 Summary Evaluation of the Alternative

The election of a least retrieval cost alternative resulted in the optimum selection for HLW feed for Phase 1 vitrification consisting of the following:

- 241-AZ-101
- 241-AZ-102
- 241-AY-102/241-C-106 blended with 100 percent of 241-AW-103.

This option yields a cost per unit of $2.0188 million and a total project cost between the BNFL and GPM model costs of $2.576 billion to $2.136 billion. Retrieval costs are minimized to $103.47 million. The BNFL glass yield could be as high as 1,276 canisters while the GPM yield is approximately 1,049 canisters. This case option meets all criteria of glass quantity, retrieval, product cost, and contract specifications.

6.5 ALTERNATIVE FOUR – OPTIMUM BLENDING

In order to take advantage of optimization, blending has been reviewed beyond the stated constraints of Section 5.1. In that section, the constraint upon the number of tanks in an analysis was three, providing that one was subject to a current retrieval project. Observation of optima within **Table 13**, and Figures 1 through 5, allow one to consider the complete blending of both of the zirconium-limited feed tanks 241-AW-103 and 241-C-104. The use of these materials leads to primary operational optima shown as Cases I and II in [Table 21]. The development of Case III is described below.

The Phase 1 feeds common to all three cases are 241-AZ-101, 241-AZ-102, and 241-AY-102/241-C-106, as blended. Additional benefits of the blending of 241-C-104 wastes with other feed tanks are also detailed in Table 21. The major differences between Case I and Case II are the blend agent for sludges from tanks 241-AW-104, 241-SY-102, and 241-C-102. The blending of 241-SY-102 is a critical choice to differentiate Cases I and II. Case III is seen to be a close relation to Case II but modifies the amount of 241-AW-103 and other wastes used based upon current tank waste retrieval expectations.

Table 21. Optimum Blending of Wastes. (2 Sheets)

Spinel limited waste (100%)	Zirconium limited waste (%)		Unblended BNFL cans	Blended yield (cans)		BPR GPM
	241-AW-103	241-C-104		BNFL	GPM	
Case I						
241-AY-101	35%	0%	603.9	364.2	320.7	60.3%
241-AY-102/ 241-C-106	40%	0%	636.6	403.8	360.1	70.0%
241-AW-104	25%	0%	405.2	255.0	200.6	56.7%
241-SY-102	0%	100%	630.9	361.7	360.9	61.7%
Total	100%	100%	2,276.6	1,384.8	1,242.2	62.9%
Case II						
241-AY-101	35%	0%	603.9	364.2	320.7	60.3%
241-AY-102/ 241-C-106	20%	0%	436.1	262.1	213.5	60.1%
241-AW-104	0%	65%	389.7	154.6	154.6	43.0%
241-SY-102	45%	0%	720.4	451.2	349.6	55.7%
241-C-102	0%	35%	289.8	171.8	178.5	83.7%
Total	100%	100%	2,439.9	1,404.0	1,216.9	60.2%
Case III						
241-AY-101 (0.95)	30%	0%	541.2	313.4	288.8	60.3%
241-AY-102/ 241-C-106	20%	0%	400.8	230.1	198.1	60.8%

Table 21. Optimum Blending of Wastes. (2 Sheets)

	Zirconium limited waste (%)			Blended yield (cans)		
(0.64/0.85)						
241-SY-102 (0.8)	40%	0%	616.4	401.1	310.6	58.2%
Total	90%	0%	1558.4	944.7	797.5	59.6%

Note: Retrieval efficiencies for 241-AY-101, 241-AY-102/241-C-106, 241-SY-102 have been applied in Case III.

Optimization has been described in terms of minimization of glass product (canisters) through blending (Figures 1 through 5). When compounded with an assessment of the waste oxides present in the sludges, one may view this optimization as the derivative of the glass product per mg of waste oxide per unit change in blend. Figures 6 through 10 depict this analysis. In these figures, the vertical axis is the derivative while the horizontal axis is the blend agent fraction. The goal of optimization in these depictions is to maintain a negative derivative to the greatest blend agent fraction. In this way, one can show continuing improvement in waste loading that results in a reduction of glass produced. This improvement can be increased until either the derivative (D) reaches zero or the second derivative (D^2) becomes zero. The first derivative approach to zero represents the minimization of glass product cans over the range of blending. The second derivative becoming zero represents a glass compositional limit and provides an inflection downward in the first derivative curve.

Blends at a D of zero would lead to optimum waste load and higher blends up to the point at which D^2 becomes zero are still beneficial but of decreasing merit. Blends beyond the point at which D^2 becomes zero are penalized with rapidly increasing product yield. D and D^2 are represented mathematically as:

$$D = \frac{d\left(\frac{GPM\ cans}{Mg\ W.O.}\right)}{d(Wt.\ Fraction\ of\ Blend)} = \frac{\left(\left(\frac{GPM\ cans}{Mg\ W.O.}\right)_{i+1} - \left(\frac{GPM\ cans}{Mg\ W.O.}\right)_{i}\right)}{(Wt.\ Fraction\ of\ Blend)_{i+1} - (Wt.\ Fraction\ of\ Blend)_{i}}$$

$$D^2 = \frac{d^2\left(\frac{GPM\ cans}{Mg\ W.O.}\right)}{d(Wt.\ Fraction\ of\ Blend)^2}$$

Figure 6, providing the derivative analysis for blends of 241-AY-101, shows that the greatest slope is that for blends with 241-AW-103. That derivative approaches zero at approximately 35 percent 241-AW-103, corresponding to the Figure 1 minimum BPR for these wastes. Beyond 40 percent, the waste product volume per mass of waste oxide is increasing for each increment of waste oxide, but the decrease (less positive) indicates that the yield rate increase will be slower.

Figure 7, depicting the derivative analysis for blends of 241-C-102, shows that all blends have positive derivatives, thus all blends have continuously decreasing waste load per canister. In the region between 15 percent and 35 percent, the glass waste load rate of change of 241-AW-103 sludge blends goes through two inflections. These inflections are due to a first change from spinel limitation to zirconium limitation (yielding high positive slope), followed by the relaxation of liquidus temperature limits. Tank 241-C-102 is known to contain moderate amounts of iron, nickel and zirconium. The softer inflections of 241-AW-103 blends in Figure 8 are described similarly.

Figure 6. Blend Waste Loading of 241-AY-101.

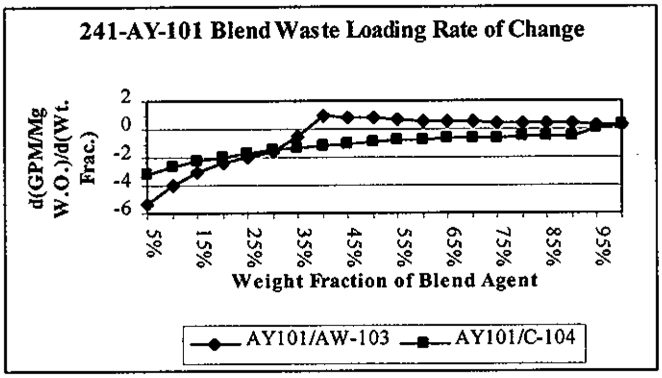


Figure 7. Blend Waste Loading of 241-C-102.

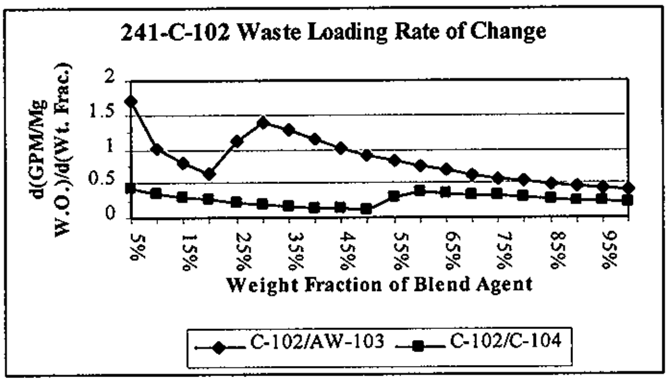


Figure 8. Blend Waste Loading of 241-AY-102/241-C-106

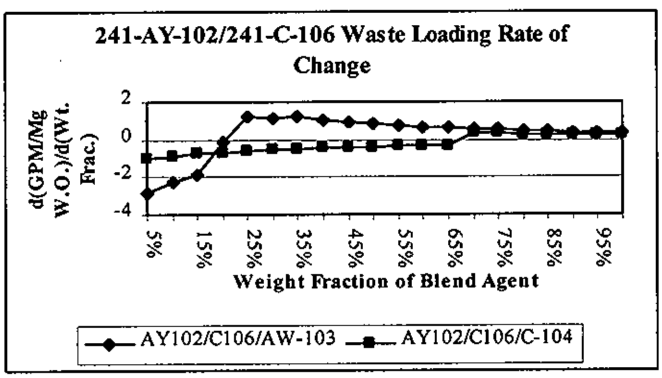


Figure 9. Blend Waste Loading of 241-SY-102

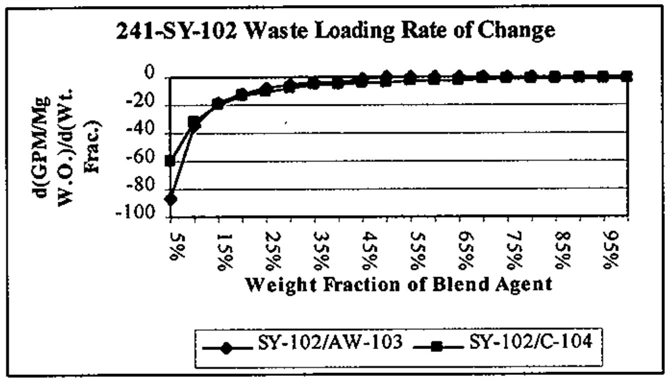
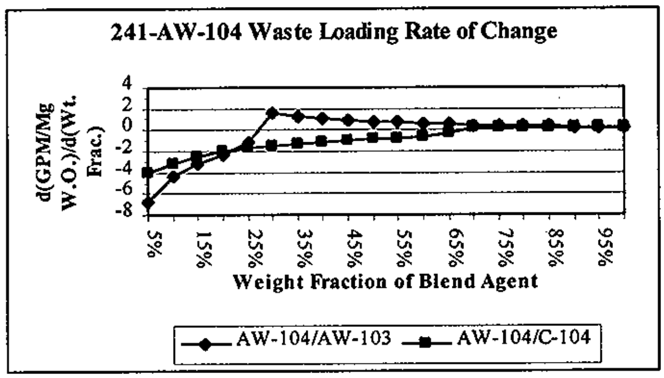


Figure 10. Blend Waste Loading of 241-AW-104.



The derivitive analyses yield Cases I and II as distinct optima. The BPRs for these cases (**Table 21**) show that the Case II blend optimization is better than Case I and would be substantially better without the inclusion of 241-C-102 waste. Case III provides further improvement as described below.

In all of the analyses described thus far the waste retrieval efficiency has been taken to be 100 percent with retrieval risks countered by a 25 percent production contingency. The expected practical retrieval efficiencies are less than 100 percent. The retrieval efficiencies expected by the TWRSO&UP (Kirkbride et al. 1997) (listed in parentheses in **Table 21**) have been applied to Case II yielding the optimization presented in Case III.

The expected waste retrieval efficiency of 241-AW-103 is 90 percent. This is countered in Case III by reducing its proportions blended with 241-AY-101 and 241-SY-102. The Case III waste combination is termed the 'practical blend.' Tanks 241-C-102 and 241-C-104 have not been included within the 'practical blend' scenario because of schedule and composition difficulties as stated in Section 5.1. Case III is chosen as the optimum blending scenario.

Selection of this optimum blending waste feed case includes 241-AZ-101, 241-AZ-102, 241-AY-101 blended with 30 percent of 241-AW-103, 241-AY-102/ 241-C-106 blended with 20 percent of 241-AW-103, and 241-SY-102 blended with 40 percent of 241-AW-103 waste. This scenario yields a total of 1,215 BNFL cans or 1,023 GPM cans. The total cost in the BNFL case would be $2.508 billion ($2.065 million/can), including $153.7 million for retrieval. Production based upon the GPM would yield a total cost of $2.136 billion ($2.088 million/can).

If these wastes were treated unblended, additional canisters would be produced; 613 BNFL cans or 542 GPM cans.

6.5.1 Alternative Description

This alternative is derived from analysis of optimum blending and the utilization of entire tanks. Although the preferred case does not use all of the optima suggested, it does more readily support schedules and address retrieval risk while reserving some blending benefit for Phase 2 vitrification. This preferred case of this alternative includes:

- 241-AZ-101
- 241-AZ-102
- 241-AY-102/241-C-106 blended with 20 percent of 241-AW-103
- 241-AY-101 blended with 30 percent of 241-AW-103
- 241-SY-102 blended with 40 percent of 241-AW-103.

This case exhibits a unit cost of $2.065 million, a retrieval cost of $153.7 million, and a total project cost of $2.508 billion.

6.5.2 Criteria Assessment

This section provides a discussion of compliance with criteria established in Section 4.0 for the optimum glass production.

6.5.2.1 Glass Quantity Requirement. The preferred case yields an estimate of 1,215 canisters based upon BNFL contract maxima (minimum waste loading) and a GPM yield of 1,023 canisters. This yield meets and exceeds both the contract minimum feed of 600 canisters and the contingency-based minimum of 750 canisters.

6.5.2.2 Retrieval Criteria. This section provides a brief discussion of the highest ranked case compliance with retrieval criteria under the optimum blending alternative. This optimum defines the preferred treatment as that of 241-AZ-101, 241-AZ-102, 241-AY-101 blended with 30 percent of 241-AW-103, 241-AY-102/241-C-106 blended with 20 percent of 241-AW-103, and 241-SY-102 blended with 40 percent of 241-AW-103.

The retrievals of this case require the base case retrievals plus three DST mixer pump retrievals. These retrievals pose a minor schedule impact in compliance with this criterion.

6.5.2.2.1 Schedule. The addition of three DST retrievals from 241-AY-101, 241-AW-103, and 241-SY-102 to the base case tanks is of some complexity but may pose schedule relief from prior anticipation of the retrieval of both 241-C-102 and 241-C-104. Selection of this case option complies with the schedule criterion and may be beneficial if the supernatant contents of 241-SY-102 are to be removed for Phase 1 LAW treatment.

6.5.2.2.2 Retrieval Risk. The retrievals from 241-AY-101, 241-AW-103, and 241-SY-102 are to be conducted with mixer pumps. These tanks are not SST, they exhibit little organic vapor generation, and have no history of separable organic layers. In all of these manners, retrieval risk is minimal in terms of contract quantity and schedule thereby complying with this criterion. The number and location of waste feed tanks recommended improves the reliability of HLW feed delivery by providing continual backup staged feed capability from independent tank farms. The recommended tanks, that are DSTs, provide an increased probability of meeting project schedules since they are much newer than SSTs.

6.5.2.2.3 Waste Retrieval Cost. Retrievals from 241-AY-101, 241-AW-103, and 241-SY-102 are expected to be accomplished with mixer pumps. These tanks are among the 200 Area DST farms and are supported by the existing ventilation and transfer system. The retrieval cost estimate of $153.7 million is slightly greater than that for other preferred cases in the first three alternatives. This option complies with the criterion of retrieval cost minimization but will also require use of the cross-site slurry transfer line.

6.5.2.2.4 Availability of Early DST Space. Tanks 241-AW-103, 241-AY-101, and 241-SY-102 are DSTs. Retrieval of this waste in Phase 1 treatment complies with the criterion for availability of early DST space. Such compliance will aid TWRS overall waste management and ease difficulties associated with current waste volume projections and with transuranium uptake upon transfer of complexant waste through 241-SY-102.

6.5.2.2.5 Early SST Retrieval. None of 241-AW-103, 241-AY-101, and 241-SY-102 are SSTs, their retrieval will not satisfy a criterion for the early demonstration of SST retrieval. However, present views exist that the ongoing retrieval of 241-C-106 constitutes that demonstration. The subsequent near-term treatment of that 241-C-106 material will aid such arguments. In these manners, this criterion is deemed met. In addition, the removal of transuranic sludges from 241-SY-102 would be expected to facilitate early complexant waste retrieval from the West Area tank farms.

6.5.2.2.6 Safety. Wastes in 241-AW-103, 241-AY-101, and 241-SY-102 are not complexed and have no significant ongoing safety restrictions beyond those imposed in the management of other Hanford tank wastes. Should complexant wastes be transferred through 241-SY-102 prior to the sludge retrieval, some significant transuranium uptake would be expected. No tank safety issue resolution is required; thus this criterion is deemed met.

6.5.2.3 Cost of Product. The optimum case of this alternative provides maximum benefit from blending in the near-term. The unit cost projected in this case is $2.065 million per canister. The overall project cost based upon BNFL contract maximum production is $2.508 billion. At GPM glass yield, this cost may be reduced to $2.136 billion, yielding a savings of $372 million. This option meets the criterion for maximum waste loading for this alternative.

6.5.2.4 Contract Specifications. This section provides a brief review of compliance with contract specifications in terms of the impact on existing plans and feed material specifications.

6.5.2.4.1 Impact on Existing Plans. The retrieval and blended treatment of 241-AW-103 wastes with 241-AY-102/241-C-106, 241-SY-102, and 241-AY-101 has an impact upon existing plans. Three additional projects would be required to support mixer pump installations and retrievals these tanks. Bottlenecks may be avoided by early establishment of another dilute waste receiver to replace 241-AY-101 during retrieval and by rapid evolution of the 241-SY-102 retrieval to minimize salt well pumping activities. Election of this option will expedite overall TWRS progress meeting this criterion.

6.5.2.4.2 Sludge Composition Compliance. Sludge composition compliance was described above for 241-AY-102/241-C-106 blends with 241-AW-103. Such evaluations, including those with blends with 241-AY-101 are contained in Appendix A. It is noted that the 30 percent blend with 241-AY-101 returns chromium content within the specification. Although additional negotiation with BNFL on case-specific waste feed acceptance is expected, no significant physical plant or operational difficulties are foreseen in the vitrification of these blends that were not evident with the 241-AY-102/241-C-106 blends.

6.5.2.4.3 Supernate Composition Compliance. Fluoride and sulfate composition of the 241-AY-101 blends with 241-AW-103 are a difficulty of Envelope A and C wastes. Beyond those difficulties, no major stumbling blocks exist with this blend. Fluoride and TRU constituents pose the greatest difficulties with 241-SY-102 blends of 241-AW-103. This case option is deemed to meet the criterion of supernatant composition compliance.

Additional specification evaluation of blends of 241-AW-103 with these wastes is provided in Appendix B, Tables 1, 2, 5, 6, 9, and 10.

6.5.3 Summary Evaluation of the Alternative

The optimum for this alternative was chosen to utilize DST wastes at optimum blending while allowing for continued efficiencies in early Phase 2 vitrification. The highly desirable blend of 241-C-104 and 241-SY-102 was not admitted to this case due to retrieval issues and bottlenecks dealing with these wastes. The blend of 241-AW-104 and 241-AW-103 was not incorporated in order to obtain the greatest amount of 241-AW-103 into the treatment stream and the schedule difficulty that would be posed to handle so many streams.

The optimum case yields an expectation of 1,215 BNFL cans to as few as 1,023 GPM cans. The total cost is estimated to be $2.508 billion including $153.7 million in retrieval costs.

6.6 MERIT OF ALTERNATIVES

The alternative cost models have been described in Section 5.1 and the benefit of blending discussed in Sections 6.1.1.3 and 6.5. The optimum choice includes the following tanks:

- 241-AZ-101
- 241-AZ-102

- 241-AY-102/241-C-106 blended with 20 percent of 241-AW-103
- 241-AY-101 blended with 30 percent of 241-AW-103
- 241-SY-102 blended with 40 percent of 241-AW-103.

The optimum result from each of the alternative cost models appears to be feasible. However, the second alternative, to minimize total cost, incurs much greater retrieval risk, the possibility of specification non-compliance, and lower cost effectiveness than the other alternatives.

If the 25 percent contingency requirement is relaxed, the choice of the optimum set of tanks will not change. Moreover, the cases which have the same retrieval cost may not meet the minimum production requirement of 600 canisters. Finally, if the 25 percent contingency requirement is relaxed, there would be added risk in meeting current schedule compliance.

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7.0 RECOMMENDATIONS FOR FUTURE ANALYSES

Section 6.5 presents a synopsis of the analysis and gives the preferred tank set selection. Recommendations for longer-term application of this cost-based AGA method, and the utility of the tools generated are given. The structure of spreadsheets created for the AGA is broad and versatile. Consequently, effects of changes in feed stream data, e.g., waste retrieval efficiencies, are easily evaluated.

This AGA is based on the best TWRS operations information and cost estimates currently available. The composition and inventory estimates of wastes are being revised periodically and actual costs of retrieval projects are becoming available. It is important to note that as new data becomes available, a similar AGA should be conducted to determine any changes in the optimum selection of feed streams. The updated AGA should incorporate results of any laboratory testing, such as treatability tests, that may be performed by BNFL.

Feedback from the vitrification plant operations may result in adjustments being made to feed streams. A collaborative effort with BNFL is recommended to further improve expected waste oxide loadings. This work may consider parameters such as the retrieval efficiency range expected for each tank, the composition range for key glass-limiting compounds in delivered solids, the composition range for key compounds in washed solids, and interactions in glass of dominant limiting species due to blending.

The GPM and BNFL specifications can be used to generate two different sets of glass estimates for each case. The BNFL HLW glass specifications appear to be overly conservative for certain components, including Al, Bi, Fe, Ni, U, and Zr. In view of their potential large economic impacts, it appears that certain limits in the BNFL specification should be considered for revision or another contractual tool should be developed to provide incentive to reduce the IHLW product volume.

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APPENDIX A

BLENDED WASTE HIGH-LEVEL WASTE SPECIFICATION COMPLIANCE EVALUATION

(ENVELOPE D)

LIST OF TABLES

Table 1. High-Level Waste Solids Specification Evaluation - 241-AY-101 with Blends of 241-AW-103.

Specification		Compliance flag					Concentration (units of specification)				
Analyte	Tank blend	0.1	0.2	0.3	0.4	1	0.1	0.2	0.3	0.4	1
As	0.16	F	F	F	F	F	2.535265	2.170176	1.921979	1.742283	1.233855
B	1.3	F	F	F	F	T	2.535265	2.170176	1.921979	1.742283	1.233855
Be	0.065	F	F	F	F	F	2.535265	2.170176	1.921979	1.742283	1.233855
Ce	0.81	T	T	T	T	T	0	0	0	0	0
Co	0.45	T	T	T	T	T	3.49E-05	2.82E-05	2.37E-05	2.04E-05	1.12E-05
Cs	0.58	F	F	F	T	T	0.850106	0.717099	0.626678	0.561212	0.375985
Cu	0.48	F	F	F	F	T	0.850106	0.717099	0.626678	0.561212	0.375985
Hg	0.1	T	T	T	T	T	0	0	0	0	0
La	2.6	T	T	T	T	T	0.902977	0.74862	0.643684	0.56771	0.352751
Li	0.14	F	F	F	F	F	0.902977	0.74862	0.643684	0.56771	0.352751
Mn	6.5	T	T	T	T	T	1.348756	1.097269	0.926302	0.80252	0.452295
Mo	0.65	F	F	F	F	T	1.348756	1.097269	0.926302	0.80252	0.452295
Nd	1.7	F	F	F	F	F	8.320543	6.787309	5.744977	4.99032	2.855116
Pr	0.35	T	T	T	T	T	0.048327	0.039116	0.032854	0.02832	0.015493
Pu	0.054	T	T	T	T	T	0.048327	0.039116	0.032854	0.02832	0.015493
Rb	0.19	T	T	T	T	T	0.048327	0.039116	0.032854	0.02832	0.015493
Sb	0.84	T	T	T	T	T	0.048327	0.039116	0.032854	0.02832	0.015493
Se	0.52	T	T	T	T	T	0.048327	0.039116	0.032854	0.02832	0.015493
Sr	0.52	T	T	T	T	T	0.008995	0.010888	0.012176	0.013108	0.015745
Ta	0.03	T	T	T	T	T	0.008995	0.010888	0.012176	0.013108	0.015745
Tc	0.26	T	T	T	T	T	0.008995	0.010888	0.012176	0.013108	0.015745
Te	0.13	T	T	T	T	T	0.008995	0.010888	0.012176	0.013108	0.015745
Th	0.52	F	F	F	F	F	3.111708	4.740933	5.848522	6.650425	8.919309
Tl	0.45	T	T	T	T	T	0.008995	0.010888	0.012176	0.013108	0.015745
V	0.032	F	F	F	F	F	2.104773	2.364062	2.540333	2.667955	3.029045
W	0.24	F	F	F	F	F	3.111708	4.740933	5.848522	6.650425	8.919309
Y	0.16	F	F	F	F	F	2.104773	2.364062	2.540333	2.667955	3.029045
Zn	0.42	F	F	F	F	F	2.104773	2.364062	2.540333	2.667955	3.029045
Cl	0.33	T	T	T	T	T	3.49E-05	2.82E-05	2.37E-05	2.04E-05	1.12E-05
CO3	30	T	T	T	T	T	0.001297	0.002099	0.002645	0.00304	0.004157
NO2 + NO3	36	T	T	T	T	T	0.031423	0.026483	0.023125	0.020694	0.013815
TOC	11	T	T	T	T	T	1.934899	1.566107	1.315393	1.133874	0.62029
3H	0.000065	T	T	T	T	T	0	0	0	0	0
14C	6.5E-06	T	T	T	T	T	2.95E-06	2.39E-06	2.01E-06	1.73E-06	9.48E-07
60Co	0.01	T	T	T	T	T	0.000179	0.000145	0.000121	0.000105	5.74E-05
90Sr	10	T	T	T	T	T	0.189323	0.153428	0.129026	0.111358	0.06137
99Tc	0.015	T	T	T	T	T	4.47E-05	3.62E-05	3.04E-05	2.62E-05	1.44E-05
125Sb	0.032	T	T	T	T	T	4.14E-05	3.51E-05	3.08E-05	2.77E-05	1.9E-05
126Sn	0.00015	T	T	T	T	T	6.43E-06	5.2E-06	4.37E-06	3.77E-06	2.06E-06
129I	2.9E-07	T	T	T	T	T	2.9E-08	2.35E-08	1.98E-08	1.7E-08	9.35E-09
137Cs	10	T	T	T	T	T	0.045295	0.036812	0.031044	0.026869	0.015055

Table 1. High-Level Waste Solids Specification Evaluation - 241-AY-101 with Blends of 241-AW-103.

Specification		Compliance flag					Concentration (units of specification)				
Analyte	Tank blend	0.1	0.2	0.3	0.4	1	0.1	0.2	0.3	0.4	1
152Eu	0.00048	T	T	T	T	T	1.01E-05	8.2E-06	6.9E-06	5.96E-06	3.29E-06
154Eu	0.052	T	T	T	T	T	0.000707	0.000573	0.000482	0.000416	0.000229
155Eu	0.029	T	T	T	T	T	0.000533	0.000434	0.000367	0.000318	0.000181
233U	9E-07	F	T	T	T	T	1.09E-06	8.8E-07	7.4E-07	6.38E-07	3.49E-07
235U	2.5E-07	T	T	T	T	T	3.46E-08	4.01E-08	4.39E-08	4.66E-08	5.44E-08
237Np	0.000074	T	T	T	T	T	1.7E-07	1.38E-07	1.16E-07	1.01E-07	5.57E-08
238Pu	0.00035	T	T	T	T	T	2.71E-05	2.25E-05	1.95E-05	1.72E-05	1.09E-05
239Pu	0.0031	T	T	T	T	T	0.000243	0.000201	0.000173	0.000153	9.56E-05
241Pu	0.022	T	T	T	T	T	0.001905	0.001605	0.001401	0.001254	0.000836
241Am	0.09	T	T	T	T	T	0.001239	0.001003	0.000842	0.000726	0.000398
243+244Cm	0.003	T	T	T	T	T	0.001239	0.001003	0.000842	0.000726	0.000398
Ag	0.55	F	F	F	F	F	3.111708	4.740933	5.848522	6.650425	8.919309
Al	14	T	T	T	T	T	2.535265	2.170176	1.921979	1.742283	1.233855
Ba	4.5	T	T	T	T	T	2.535265	2.170176	1.921979	1.742283	1.233855
Bi	2.8	T	T	T	T	T	0.009807	0.015875	0.020001	0.022987	0.031438
Ca	7.1	T	T	T	T	T	0.42047	0.355596	0.311493	0.279562	0.189217
Cd	4.5	T	F	F	F	F	3.111708	4.740933	5.848522	6.650425	8.919309
Cr	0.68	F	F	T	T	T	0.850106	0.717099	0.626678	0.561212	0.375985
F	3.5	T	T	T	T	T	0.399054	0.632588	0.791351	0.906296	1.23152
Fe	29	T	T	T	T	T	5.488597	4.458992	3.759041	3.25227	1.818427
K	1.3	T	T	T	T	T	0.037527	0.043409	0.047408	0.050303	0.058495
Mg	2.1	T	T	T	T	T	0.902977	0.74862	0.643684	0.56771	0.352751
Na	19	T	T	T	T	T	8.320543	6.787309	5.744977	4.99032	2.855116
Ni	2.4	T	T	T	T	T	0.100237	0.082983	0.071254	0.062762	0.038734
P	1.7	T	T	T	T	T	0.015761	0.012757	0.010715	0.009236	0.005053
Pb	1.1	T	T	T	T	T	0.298014	0.278553	0.265324	0.255745	0.228645
Pd	0.13	F	F	F	F	F	0.298014	0.278553	0.265324	0.255745	0.228645
Rh	0.13	T	T	T	T	T	0.048327	0.039116	0.032854	0.02832	0.015493
Ru	0.35	T	T	T	T	T	0.048327	0.039116	0.032854	0.02832	0.015493
S	0.65	T	T	T	T	T	0.005881	0.00476	0.003998	0.003446	0.001885
Si	19	T	T	T	T	T	0.105433	0.130292	0.147191	0.159426	0.194045
Ti	1.3	T	T	T	T	T	0.008995	0.010888	0.012176	0.013108	0.015745
U	14	T	T	T	T	T	2.104773	2.364062	2.540333	2.667955	3.029045
Zr	15	T	T	T	T	T	3.111708	4.740933	5.848522	6.650425	8.919309

Table 2. High-Level Waste Solids Specification Evaluation - 241-AW-104 with Blends of 241-AW-103.

Specification		Compliance flag					Concentration (units of specification)				
Analyte	Tank blend	0.1	0.2	0.3	0.4	1	0.1	0.2	0.3	0.4	1
As	0.16	F	F	F	F	F	2.319606	1.835658	1.566207	1.394519	0.990749
B	1.3	F	F	F	F	T	2.319606	1.835658	1.566207	1.394519	0.990749
Be	0.065	F	F	F	F	F	2.319606	1.835658	1.566207	1.394519	0.990749
Ce	0.81	T	T	T	T	T	0	0	0	0	0
Co	0.45	T	T	T	T	T	0	0	0	0	0
Cs	0.58	T	T	T	T	T	0.391402	0.32332	0.285415	0.261262	0.20446
Cu	0.48	T	T	T	T	T	0.391402	0.32332	0.285415	0.261262	0.20446
Hg	0.1	T	T	T	T	T	0	0	0	0	0
La	2.6	T	T	T	T	T	0.037068	0.053029	0.061916	0.067579	0.080895
Li	0.14	T	T	T	T	T	0.037068	0.053029	0.061916	0.067579	0.080895
Mn	6.5	T	T	T	T	T	0.474455	0.347718	0.277154	0.232192	0.126452
Mo	0.65	T	T	T	T	T	0.474455	0.347718	0.277154	0.232192	0.126452
Nd	1.7	T	T	T	T	T	0.406361	0.369329	0.34871	0.335572	0.304675
Pr	0.35	T	T	T	T	T	0.145976	0.104415	0.081276	0.066531	0.031857
Pu	0.054	F	F	F	F	T	0.145976	0.104415	0.081276	0.066531	0.031857
Rb	0.19	T	T	T	T	T	0.145976	0.104415	0.081276	0.066531	0.031857
Sb	0.84	T	T	T	T	T	0.145976	0.104415	0.081276	0.066531	0.031857
Se	0.52	T	T	T	T	T	0.145976	0.104415	0.081276	0.066531	0.031857
Sr	0.52	T	T	T	T	T	0.00754	0.010783	0.012588	0.013739	0.016445
Ta	0.03	T	T	T	T	T	0.00754	0.010783	0.012588	0.013739	0.016445
Tc	0.26	T	T	T	T	T	0.00754	0.010783	0.012588	0.013739	0.016445
Te	0.13	T	T	T	T	T	0.00754	0.010783	0.012588	0.013739	0.016445
Th	0.52	F	F	F	F	F	4.845727	6.785678	7.865796	8.554026	10.17258
Tl	0.45	T	T	T	T	T	0.00754	0.010783	0.012588	0.013739	0.016445
V	0.032	F	F	F	F	F	6.266623	5.469027	5.024945	4.741984	4.07653
W	0.24	F	F	F	F	F	4.845727	6.785678	7.865796	8.554026	10.17258
Y	0.16	F	F	F	F	F	6.266623	5.469027	5.024945	4.741984	4.07653
Zn	0.42	F	F	F	F	F	6.266623	5.469027	5.024945	4.741984	4.07653
Cl	0.33	T	T	T	T	T	0	0	0	0	0
CO3	30	T	T	T	T	T	0.011837	0.010035	0.009031	0.008392	0.006888
NO2 + NO3	36	T	T	T	T	T	0.039739	0.029993	0.024566	0.021109	0.012977
TOC	11	T	T	T	T	T	2.776824	1.986244	1.546068	1.265596	0.605996
3H	0.000065	T	T	T	T	T	0	0	0	0	0
14C	6.5E-06	T	T	T	T	T	1.95E-10	2.75E-10	3.19E-10	3.47E-10	4.14E-10
60Co	0.01	T	T	T	T	T	1.14E-07	1.42E-07	1.58E-07	1.68E-07	1.91E-07
90Sr	10	T	T	T	T	T	0.000579	0.000698	0.000764	0.000806	0.000905
99Tc	0.015	T	T	T	T	T	2.93E-06	2.13E-06	1.69E-06	1.4E-06	7.37E-07
125Sb	0.032	T	T	T	T	T	3.67E-06	5E-06	5.74E-06	6.22E-06	7.33E-06
126Sn	0.00015	T	T	T	T	T	4.53E-09	4.86E-09	5.05E-09	5.16E-09	5.44E-09
129I	2.9E-07	T	T	T	T	T	2.84E-11	4.07E-11	4.75E-11	5.18E-11	6.2E-11
137Cs	10	T	T	T	T	T	0.001919	0.001597	0.001417	0.001303	0.001033
152Eu	0.00048	T	T	T	T	T	3.81E-08	5.02E-08	5.69E-08	6.12E-08	7.13E-08

Table 2. High-Level Waste Solids Specification Evaluation - 241-AW-104 with Blends of 241-AW-103.

Specification		Compliance flag					Concentration (units of specification)				
Analyte	Tank blend	0.1	0.2	0.3	0.4	1	0.1	0.2	0.3	0.4	1
154Eu	0.052	T	T	T	T	T	1.59E-06	2.02E-06	2.26E-06	2.41E-06	2.77E-06
155Eu	0.029	T	T	T	T	T	6.69E-06	8.93E-06	1.02E-05	1.1E-05	1.29E-05
233U	9E-07	T	T	T	T	T	4.57E-09	3.63E-09	3.11E-09	2.77E-09	1.99E-09
235U	2.5E-07	T	T	T	T	T	1.16E-07	1.01E-07	9.26E-08	8.74E-08	7.5E-08
237Np	0.000074	T	T	T	T	T	9.53E-10	1.14E-09	1.24E-09	1.31E-09	1.46E-09
238Pu	0.00035	T	T	T	T	T	3.15E-05	2.34E-05	1.9E-05	1.61E-05	9.41E-06
239Pu	0.0031	T	T	T	T	T	0.000255	0.00019	0.000154	0.000131	7.62E-05
241Pu	0.022	T	T	T	T	T	0.003216	0.002394	0.001937	0.001646	0.000961
241Am	0.09	T	T	T	T	T	4.03E-07	4.87E-07	5.34E-07	5.64E-07	6.34E-07
243+244Cm	0.003	T	T	T	T	T	4.04E-07	4.88E-07	5.34E-07	5.64E-07	6.34E-07
Ag	0.55	F	F	F	F	F	4.845727	6.785678	7.865796	8.554026	10.17258
Al	14	T	T	T	T	T	2.319606	1.835658	1.566207	1.394519	0.990749
Ba	4.5	T	T	T	T	T	2.319606	1.835658	1.566207	1.394519	0.990749
Bi	2.8	T	T	T	T	T	0.016576	0.023713	0.027687	0.030219	0.036174
Ca	7.1	T	T	T	T	T	0.793193	0.590171	0.477134	0.405108	0.235722
Cd	4.5	F	F	F	F	F	4.845727	6.785678	7.865796	8.554026	10.17258
Cr	0.68	T	T	T	T	T	0.391402	0.32332	0.285415	0.261262	0.20446
F	3.5	T	T	T	T	T	1.148975	1.284307	1.359656	1.407668	1.520578
Fe	29	T	T	T	T	T	1.453409	1.064293	0.847642	0.709597	0.384947
K	1.3	T	T	T	T	T	0.597095	0.446568	0.362759	0.309357	0.18377
Mg	2.1	T	T	T	T	T	0.037068	0.053029	0.061916	0.067579	0.080895
Na	19	T	T	T	T	T	0.406361	0.369329	0.34871	0.335572	0.304675
Ni	2.4	T	T	T	T	T	0.605126	0.435608	0.341225	0.281086	0.139653
P	1.7	T	T	T	T	T	0.047608	0.034054	0.026507	0.021698	0.01039
Pb	1.1	T	T	T	T	T	0.085571	0.116986	0.134477	0.145622	0.171833
Pd	0.13	T	T	F	F	F	0.085571	0.116986	0.134477	0.145622	0.171833
Rh	0.13	F	T	T	T	T	0.145976	0.104415	0.081276	0.066531	0.031857
Ru	0.35	T	T	T	T	T	0.145976	0.104415	0.081276	0.066531	0.031857
S	0.65	T	T	T	T	T	0.076142	0.054464	0.042394	0.034703	0.016617
Si	19	T	T	T	T	T	0.368666	0.330854	0.309801	0.296387	0.264839
Ti	1.3	T	T	T	T	T	0.00754	0.010783	0.012588	0.013739	0.016445
U	14	T	T	T	T	T	6.266623	5.469027	5.024945	4.741984	4.07653
Zr	15	T	T	T	T	T	4.845727	6.785678	7.865796	8.554026	10.17258

Table 3. High-Level Waste Solids Specification Evaluation - 241-SY-102 with Blends of 241-AW-103.

Specification		Compliance Flag					Concentration (units of Specification)				
Analyte	Tank Blend	0.1	0.2	0.3	0.4	1	0.1	0.2	0.3	0.4	1
As	0.16	F	F	F	F	F	3.812119	2.904795	2.399084	2.076655	1.317767
B	1.3	F	F	F	F	F	3.812119	2.904795	2.399084	2.076655	1.317767
Be	0.065	F	F	F	F	F	3.812119	2.904795	2.399084	2.076655	1.317767
Ce	0.81	T	T	T	T	T	0	0	0	0	0
Co	0.45	T	T	T	T	T	5.31E-05	3.8E-05	2.96E-05	2.42E-05	1.16E-05
Cs	0.58	F	F	T	T	T	0.825926	0.634461	0.527744	0.459705	0.299562
Cu	0.48	F	F	F	T	T	0.825926	0.634461	0.527744	0.459705	0.299562
Hg	0.1	T	T	T	T	T	0	0	0	0	0
La	2.6	T	T	T	T	T	0.043731	0.057771	0.065596	0.070586	0.082329
Li	0.14	T	T	T	T	T	0.043731	0.057771	0.065596	0.070586	0.082329
Mn	6.5	T	T	T	T	T	0.37793	0.278844	0.223616	0.188405	0.105529
Mo	0.65	T	T	T	T	T	0.37793	0.278844	0.223616	0.188405	0.105529
Nd	1.7	F	F	T	T	T	2.539122	1.895979	1.537513	1.308964	0.771038
Pr	0.35	F	F	F	F	T	1.06794	0.76441	0.595232	0.487369	0.233496
Pu	0.054	F	F	F	F	F	1.06794	0.76441	0.595232	0.487369	0.233496
Rb	0.19	F	F	F	F	F	1.06794	0.76441	0.595232	0.487369	0.233496
Sb	0.84	F	T	T	T	T	1.06794	0.76441	0.595232	0.487369	0.233496
Se	0.52	F	F	F	T	T	1.06794	0.76441	0.595232	0.487369	0.233496
Sr	0.52	T	T	T	T	T	0.012301	0.014185	0.015235	0.015905	0.017481
Ta	0.03	T	T	T	T	T	0.012301	0.014185	0.015235	0.015905	0.017481
Tc	0.26	T	T	T	T	T	0.012301	0.014185	0.015235	0.015905	0.017481
Te	0.13	T	T	T	T	T	0.012301	0.014185	0.015235	0.015905	0.017481
Th	0.52	F	F	F	F	F	4.635711	6.63204	7.744724	8.454144	10.12388
Tl	0.45	T	T	T	T	T	0.012301	0.014185	0.015235	0.015905	0.017481
V	0.032	F	F	F	F	F	1.491666	2.052572	2.365202	2.564527	3.03367
W	0.24	F	F	F	F	F	4.635711	6.63204	7.744724	8.454144	10.12388
Y	0.16	F	F	F	F	F	1.491666	2.052572	2.365202	2.564527	3.03367
Zn	0.42	F	F	F	F	F	1.491666	2.052572	2.365202	2.564527	3.03367
Cl	0.33	T	T	T	T	T	5.31E-05	3.8E-05	2.96E-05	2.42E-05	1.16E-05
CO3	30	T	T	T	T	T	0.030023	0.023055	0.019171	0.016695	0.010867
NO2 + NO3	36	T	T	T	T	T	0.073453	0.054141	0.043378	0.036515	0.020363
TOC	11	T	T	T	T	T	0.434294	0.310859	0.24206	0.198196	0.094955
3H	0.000065	T	T	T	T	T	0	0	0	0	0
14C	6.5E-06	T	T	T	T	T	1.49E-09	1.2E-09	1.04E-09	9.36E-10	6.96E-10
60Co	0.01	T	T	T	T	T	1.09E-05	7.83E-06	6.14E-06	5.07E-06	2.54E-06
90Sr	10	T	T	T	T	T	0.007873	0.005918	0.004829	0.004135	0.0025
99Tc	0.015	T	T	T	T	T	1.36E-06	1.01E-06	8.11E-07	6.87E-07	3.95E-07
125Sb	0.032	T	T	T	T	T	7.44E-06	7.7E-06	7.84E-06	7.93E-06	8.15E-06
126Sn	0.00015	T	T	T	T	T	1.58E-07	1.15E-07	9.07E-08	7.53E-08	3.9E-08
129I	2.9E-07	T	T	T	T	T	7.93E-09	5.7E-09	4.45E-09	3.66E-09	1.79E-09
137Cs	10	T	T	T	T	T	0.008848	0.006557	0.005279	0.004465	0.002549
152Eu	0.00048	T	T	T	T	T	1.53E-07	1.32E-07	1.21E-07	1.14E-07	9.64E-08
154Eu	0.052	T	T	T	T	T	0.000113	8.19E-05	6.44E-05	5.33E-05	2.72E-05

Table 3. High-Level Waste Solids Specification Evaluation - 241-SY-102 with Blends of 241-AW-103.

Specification		Compliance Flag					Concentration (units of Specification)				
Analyte	Tank Blend	0.1	0.2	0.3	0.4	1	0.1	0.2	0.3	0.4	1
155Eu	0.029	T	T	T	T	T	0.000107	8.08E-05	6.61E-05	5.68E-05	3.48E-05
233U	9E-07	T	T	T	T	T	6.75E-07	4.83E-07	3.77E-07	3.09E-07	1.49E-07
235U	2.5E-07	T	T	T	T	T	2.74E-08	3.77E-08	4.34E-08	4.71E-08	5.57E-08
237Np	0.000074	T	T	T	T	T	7.49E-08	5.41E-08	4.25E-08	3.51E-08	1.76E-08
238Pu	0.00035	T	T	T	T	T	6.56E-05	4.79E-05	3.8E-05	3.17E-05	1.69E-05
239Pu	0.0031	T	T	T	T	T	0.000507	0.00037	0.000294	0.000246	0.000131
241Pu	0.022	T	T	T	T	T	0.000133	0.000189	0.000221	0.000241	0.000288
241Am	0.09	T	T	T	T	T	0.002419	0.001731	0.001348	0.001104	0.000529
243+244Cm	0.003	T	T	T	T	T	0.002419	0.001731	0.001348	0.001104	0.000529
Ag	0.55	F	F	F	F	F	4.635711	6.63204	7.744724	8.454144	10.12388
Al	14	T	T	T	T	T	3.812119	2.904795	2.399084	2.076655	1.317767
Ba	4.5	T	T	T	T	T	3.812119	2.904795	2.399084	2.076655	1.317767
Bi	2.8	T	T	T	T	T	0.122566	0.099566	0.086747	0.078574	0.059338
Ca	7.1	T	T	T	T	T	0.181569	0.15273	0.136656	0.126408	0.102287
Cd	4.5	F	F	F	F	F	4.635711	6.63204	7.744724	8.454144	10.12388
Cr	0.68	F	T	T	T	T	0.825926	0.634461	0.527744	0.459705	0.299562
F	3.5	T	T	T	T	T	0.655467	0.930833	1.084312	1.182167	1.412483
Fe	29	T	T	T	T	T	1.134631	0.836783	0.670772	0.564928	0.315807
K	1.3	T	T	T	T	T	0.146338	0.124183	0.111835	0.103962	0.085432
Mg	2.1	T	T	T	T	T	0.043731	0.057771	0.065596	0.070586	0.082329
Na	19	T	T	T	T	T	2.539122	1.895979	1.537513	1.308964	0.771038
Ni	2.4	T	T	T	T	T	0.01488	0.013412	0.012593	0.012072	0.010844
P	1.7	T	T	T	T	T	0.348296	0.249303	0.194128	0.15895	0.076152
Pb	1.1	T	T	T	T	T	0.162037	0.171665	0.177032	0.180453	0.188507
Pd	0.13	F	F	F	F	F	0.162037	0.171665	0.177032	0.180453	0.188507
Rh	0.13	F	F	F	F	F	1.06794	0.76441	0.595232	0.487369	0.233496
Ru	0.35	F	F	F	F	T	1.06794	0.76441	0.595232	0.487369	0.233496
S	0.65	T	T	T	T	T	0.002015	0.001442	0.001123	0.00092	0.000441
Si	19	T	T	T	T	T	0.18643	0.200478	0.208307	0.2133	0.225049
Ti	1.3	T	T	T	T	T	0.012301	0.014185	0.015235	0.015905	0.017481
U	14	T	T	T	T	T	1.491666	2.052572	2.365202	2.564527	3.03367
Zr	15	T	T	T	T	T	4.635711	6.63204	7.744724	8.454144	10.12388

Table 4. High-Level Waste Solids Specification Evaluation - 241-C-102 with Blends of 241-AW-103.

Specification		Compliance Flag					Concentration (units of Specification)				
Analyte	Tank Blend	0.1	0.2	0.3	0.4	1	0.1	0.2	0.3	0.4	1
As	0.16	F	F	F	F	F	5.960974	5.390904	4.930787	4.55161	3.193418
B	1.3	F	F	F	F	F	5.960974	5.390904	4.930787	4.55161	3.193418
Be	0.065	F	F	F	F	F	5.960974	5.390904	4.930787	4.55161	3.193418
Ce	0.81	T	T	T	T	T	0	0	0	0	0
Co	0.45	T	T	T	T	T	0	0	0	0	0
Cs	0.58	T	T	T	T	T	0.053905	0.064404	0.072878	0.079861	0.104875
Cu	0.48	T	T	T	T	T	0.053905	0.064404	0.072878	0.079861	0.104875
Hg	0.1	T	T	T	T	T	0.01156	0.010326	0.00933	0.008509	0.00557
La	2.6	T	T	T	T	T	0.024096	0.031464	0.037411	0.042312	0.059866
Li	0.14	T	T	T	T	T	0.024096	0.031464	0.037411	0.042312	0.059866
Mn	6.5	T	T	T	T	T	0.166044	0.15145	0.139671	0.129964	0.095193
Mo	0.65	T	T	T	T	T	0.166044	0.15145	0.139671	0.129964	0.095193
Nd	1.7	F	F	T	T	T	1.888951	1.71683	1.577907	1.463422	1.053343
Pr	0.35	T	T	T	T	T	0.186493	0.166588	0.150523	0.137283	0.089861
Pu	0.054	F	F	F	F	F	0.186493	0.166588	0.150523	0.137283	0.089861
Rb	0.19	T	T	T	T	T	0.186493	0.166588	0.150523	0.137283	0.089861
Sb	0.84	T	T	T	T	T	0.186493	0.166588	0.150523	0.137283	0.089861
Se	0.52	T	T	T	T	T	0.186493	0.166588	0.150523	0.137283	0.089861
Sr	0.52	T	T	T	T	T	0.009177	0.010218	0.011058	0.01175	0.014231
Ta	0.03	T	T	T	T	T	0.009177	0.010218	0.011058	0.01175	0.014231
Tc	0.26	T	T	T	T	T	0.009177	0.010218	0.011058	0.01175	0.014231
Te	0.13	T	T	T	T	T	0.009177	0.010218	0.011058	0.01175	0.014231
Th	0.52	F	F	F	F	F	1.949249	2.985643	3.822142	4.511491	6.980702
Tl	0.45	T	T	T	T	T	0.009177	0.010218	0.011058	0.01175	0.014231
V	0.032	F	F	F	F	F	1.408692	1.62818	1.805335	1.951326	2.474258
W	0.24	F	F	F	F	F	1.949249	2.985643	3.822142	4.511491	6.980702
Y	0.16	F	F	F	F	F	1.408692	1.62818	1.805335	1.951326	2.474258
Zn	0.42	F	F	F	F	F	1.408692	1.62818	1.805335	1.951326	2.474258
Cl	0.33	T	T	T	T	T	0	0	0	0	0
CO3	30	T	T	T	T	T	0.179619	0.161036	0.146037	0.133677	0.089402
NO2 + NO3	36	T	T	T	T	T	0.179619	0.161036	0.146037	0.133677	0.089402
TOC	11	T	T	T	T	T	0.074982	0.066979	0.060519	0.055196	0.03613
3H	0.000065	T	T	T	T	T	0	0	0	0	0
14C	6.5E-06	T	T	T	T	T	5.46E-10	5.38E-10	5.32E-10	5.27E-10	5.09E-10
60Co	0.01	T	T	T	T	T	3.18E-05	2.84E-05	2.57E-05	2.34E-05	1.54E-05
90Sr	10	T	T	T	T	T	0.01156	0.010432	0.009522	0.008772	0.006086
99Tc	0.015	T	T	T	T	T	2.18E-08	3.29E-08	4.18E-08	4.91E-08	7.55E-08
125Sb	0.032	T	T	T	T	T	9.98E-07	1.78E-06	2.42E-06	2.94E-06	4.81E-06
126Sn	0.00015	T	T	T	T	T	4.36E-09	4.5E-09	4.62E-09	4.71E-09	5.05E-09
129I	2.9E-07	T	T	T	T	T	1.05E-10	1.01E-10	9.83E-11	9.59E-11	8.74E-11
137Cs	10	T	T	T	T	T	0.001109	0.001075	0.001047	0.001024	0.000942
152Eu	0.00048	T	T	T	T	T	7.64E-08	7.68E-08	7.72E-08	7.75E-08	7.85E-08
154Eu	0.052	T	T	T	T	T	6.24E-06	5.9E-06	5.63E-06	5.41E-06	4.61E-06

Table 4. High-Level Waste Solids Specification Evaluation - 241-C-102 with Blends of 241-AW-103.

Specification		Compliance Flag					Concentration (units of Specification)				
Analyte	Tank Blend	0.1	0.2	0.3	0.4	1	0.1	0.2	0.3	0.4	1
155Eu	0.029	T	T	T	T	T	7.67E-06	8.41E-06	9.01E-06	9.5E-06	1.13E-05
233U	9E-07	T	T	T	T	T	1.93E-07	1.72E-07	1.56E-07	1.42E-07	9.35E-08
235U	2.5E-07	T	T	T	T	T	7.61E-09	1.36E-08	1.84E-08	2.24E-08	3.67E-08
237Np	0.000074	T	T	T	T	T	7.55E-10	8.46E-10	9.2E-10	9.8E-10	1.2E-09
238Pu	0.00035	T	T	T	T	T	1.14E-05	1.05E-05	9.83E-06	9.25E-06	7.17E-06
239Pu	0.0031	T	T	T	T	T	0.000384	0.000346	0.000315	0.00029	0.000199
241Pu	0.022	T	T	T	T	T	0.000889	0.000829	0.000781	0.000741	0.0006
241Am	0.09	T	T	T	T	T	9.06E-05	8.1E-05	7.32E-05	6.69E-05	4.4E-05
243+244Cm	0.003	T	T	T	T	T	9.07E-05	8.11E-05	7.34E-05	6.7E-05	4.41E-05
Ag	0.55	F	F	F	F	F	1.949249	2.985643	3.822142	4.511491	6.980702
Al	14	T	T	T	T	T	5.960974	5.390904	4.930787	4.55161	3.193418
Ba	4.5	F	F	F	F	T	5.960974	5.390904	4.930787	4.55161	3.193418
Bi	2.8	T	T	T	T	T	0.271777	0.247215	0.22739	0.211053	0.152533
Ca	7.1	T	T	T	T	T	0.53189	0.48367	0.444751	0.412678	0.297794
Cd	4.5	T	T	T	F	F	1.949249	2.985643	3.822142	4.511491	6.980702
Cr	0.68	T	T	T	T	T	0.053905	0.064404	0.072878	0.079861	0.104875
F	3.5	T	T	T	T	T	0.194079	0.346729	0.469937	0.571471	0.935161
Fe	29	T	T	T	T	T	0.956736	0.863875	0.788924	0.727157	0.505914
K	1.3	T	T	T	T	T	0.05055	0.052454	0.05399	0.055257	0.059793
Mg	2.1	T	T	T	T	T	0.024096	0.031464	0.037411	0.042312	0.059866
Na	19	T	T	T	T	T	1.888951	1.71683	1.577907	1.463422	1.053343
Ni	2.4	T	T	T	T	T	0.696515	0.623212	0.564048	0.515291	0.340646
P	1.7	T	T	T	T	T	0.060822	0.054331	0.049091	0.044773	0.029307
Pb	1.1	T	T	T	T	T	0.107137	0.116612	0.12426	0.130562	0.153137
Pd	0.13	T	T	T	F	F	0.107137	0.116612	0.12426	0.130562	0.153137
Rh	0.13	F	F	F	F	T	0.186493	0.166588	0.150523	0.137283	0.089861
Ru	0.35	T	T	T	T	T	0.186493	0.166588	0.150523	0.137283	0.089861
S	0.65	T	T	T	T	T	0.006439	0.005752	0.005197	0.00474	0.003103
Si	19	T	T	T	T	T	3.151943	2.840706	2.589499	2.382482	1.64096
Ti	1.3	T	T	T	T	T	0.009177	0.010218	0.011058	0.01175	0.014231
U	14	T	T	T	T	T	1.408692	1.62818	1.805335	1.951326	2.474258
Zr	15	T	T	T	T	T	1.949249	2.985643	3.822142	4.511491	6.980702

Table 5. High-Level Waste Solids Specification Evaluation - 241-AY-106/241-C-106 with Blends of 241-AW-103.

Specification		Compliance flag					Concentration (units of specification)				
Analyte	Tank blend	0.1	0.2	0.3	0.4	1	0.1	0.2	0.3	0.4	1
As	0.16	F	F	F	F	F	3.512897	3.135456	2.845134	2.614888	1.850731
B	1.3	F	F	F	F	F	3.512897	3.135456	2.845134	2.614888	1.850731
Be	0.065	F	F	F	F	F	3.512897	3.135456	2.845134	2.614888	1.850731
Ce	0.81	T	T	T	T	T	0	0	0	0	0
Co	0.45	T	T	T	T	T	2.23E-05	1.94E-05	1.71E-05	1.53E-05	9.47E-06
Cs	0.58	T	T	T	T	T	0.093792	0.101422	0.10729	0.111945	0.127391
Cu	0.48	T	T	T	T	T	0.093792	0.101422	0.10729	0.111945	0.127391
Hg	0.1	T	T	T	T	T	0.002931	0.002549	0.002255	0.002021	0.001247
La	2.6	T	T	T	T	T	0.069921	0.072949	0.075278	0.077125	0.083255
Li	0.14	T	T	T	T	T	0.069921	0.072949	0.075278	0.077125	0.083255
Mn	6.5	T	T	T	T	T	0.249131	0.220452	0.198393	0.180898	0.122836
Mo	0.65	T	T	T	T	T	0.249131	0.220452	0.198393	0.180898	0.122836
Nd	1.7	F	F	F	F	F	9.927145	8.668075	7.699613	6.931556	4.38247
Pr	0.35	F	F	F	F	F	1.052327	0.915038	0.809437	0.725688	0.447737
Pu	0.054	F	F	F	F	F	1.052327	0.915038	0.809437	0.725688	0.447737
Rb	0.19	F	F	F	F	F	1.052327	0.915038	0.809437	0.725688	0.447737
Sb	0.84	F	F	T	T	T	1.052327	0.915038	0.809437	0.725688	0.447737
Se	0.52	F	F	F	F	T	1.052327	0.915038	0.809437	0.725688	0.447737
Sr	0.52	T	T	T	T	T	0.014622	0.015184	0.015617	0.015959	0.017097
Ta	0.03	T	T	T	T	T	0.014622	0.015184	0.015617	0.015959	0.017097
Tc	0.26	T	T	T	T	T	0.014622	0.015184	0.015617	0.015959	0.017097
Te	0.13	T	T	T	T	T	0.014622	0.015184	0.015617	0.015959	0.017097
Th	0.52	F	F	F	F	F	1.802128	3.088152	4.077346	4.861846	7.465502
Tl	0.45	T	T	T	T	T	0.014622	0.015184	0.015617	0.015959	0.017097
V	0.032	F	F	F	F	F	0.819741	1.164867	1.430334	1.640868	2.339603
W	0.24	F	F	F	F	F	1.802128	3.088152	4.077346	4.861846	7.465502
Y	0.16	F	F	F	F	F	0.819741	1.164867	1.430334	1.640868	2.339603
Zn	0.42	F	F	F	F	F	0.819741	1.164867	1.430334	1.640868	2.339603
Cl	0.33	T	T	T	T	T	2.23E-05	1.94E-05	1.71E-05	1.53E-05	9.47E-06
CO3	30	T	T	T	T	T	0.084935	0.074573	0.066602	0.060281	0.039301
NO2 + NO3	36	T	T	T	T	T	0.105805	0.09272	0.082655	0.074673	0.048181
TOC	11	T	T	T	T	T	1.123189	0.976656	0.863944	0.774556	0.477887
3H	0.000065	T	T	T	T	T	0	0	0	0	0
14C	6.5E-06	T	T	T	T	T	5.93E-10	5.77E-10	5.65E-10	5.56E-10	5.25E-10
60Co	0.01	T	T	T	T	T	3.53E-05	3.07E-05	2.72E-05	2.44E-05	1.51E-05
90Sr	10	T	T	T	T	T	0.589567	0.512781	0.453718	0.406877	0.251417
99Tc	0.015	T	T	T	T	T	1.52E-05	1.32E-05	1.17E-05	1.05E-05	6.54E-06
125Sb	0.032	T	T	T	T	T	0.000163	0.000142	0.000127	0.000115	7.4E-05
126Sn	0.00015	T	T	T	T	T	2.61E-06	2.27E-06	2.01E-06	1.8E-06	1.11E-06
129I	2.9E-07	T	T	T	T	T	4.67E-09	4.07E-09	3.61E-09	3.24E-09	2.03E-09
137Cs	10	T	T	T	T	T	0.020768	0.018161	0.016156	0.014566	0.009288
152Eu	0.00048	T	T	T	T	T	5.93E-06	5.17E-06	4.58E-06	4.12E-06	2.57E-06

Table 5. High-Level Waste Solids Specification Evaluation - 241-AY-106/241-C-106 with Blends of 241-AW-103.

Specification		Compliance flag					Concentration (units of specification)				
Analyte	Tank blend	0.1	0.2	0.3	0.4	1	0.1	0.2	0.3	0.4	1
154Eu	0.052	T	T	T	T	T	0.000589	0.000513	0.000454	0.000407	0.000253
155Eu	0.029	T	T	T	T	T	0.000263	0.00023	0.000205	0.000186	0.00012
233U	9E-07	T	T	T	T	T	8.56E-09	7.61E-09	6.88E-09	6.3E-09	4.37E-09
235U	2.5E-07	T	T	T	T	T	1.46E-08	2.1E-08	2.59E-08	2.98E-08	4.28E-08
237Np	0.000074	T	T	T	T	T	2.39E-08	2.1E-08	1.88E-08	1.7E-08	1.11E-08
238Pu	0.00035	T	T	T	T	T	2.36E-05	2.1E-05	1.89E-05	1.73E-05	1.19E-05
239Pu	0.0031	T	T	T	T	T	0.000226	0.0002	0.00018	0.000164	0.000111
241Pu	0.022	T	T	T	T	T	0.000859	0.00079	0.000737	0.000695	0.000556
241Am	0.09	T	T	T	T	T	0.000324	0.000281	0.000249	0.000223	0.000138
243+244Cm	0.003	T	T	T	T	T	0.000324	0.000282	0.000249	0.000224	0.000138
Ag	0.55	F	F	F	F	F	1.802128	3.088152	4.077346	4.861846	7.465502
Al	14	T	T	T	T	T	3.512897	3.135456	2.845134	2.614888	1.850731
Ba	4.5	T	T	T	T	T	3.512897	3.135456	2.845134	2.614888	1.850731
Bi	2.8	T	T	T	T	T	0.006825	0.011368	0.014862	0.017633	0.02683
Ca	7.1	T	T	T	T	T	0.358255	0.321967	0.294054	0.271918	0.198449
Cd	4.5	T	T	T	F	F	1.802128	3.088152	4.077346	4.861846	7.465502
Cr	0.68	T	T	T	T	T	0.093792	0.101422	0.10729	0.111945	0.127391
F	3.5	T	T	T	T	T	0.255565	0.434134	0.571488	0.680419	1.041947
Fe	29	T	T	T	T	T	4.914354	4.284526	3.80007	3.415863	2.140727
K	1.3	T	T	T	T	T	0.083888	0.081866	0.080311	0.079077	0.074983
Mg	2.1	T	T	T	T	T	0.069921	0.072949	0.075278	0.077125	0.083255
Na	19	T	T	T	T	T	9.927145	8.668075	7.699613	6.931556	4.38247
Ni	2.4	T	T	T	T	T	0.07425	0.06583	0.059354	0.054218	0.037172
P	1.7	T	T	T	T	T	0.343204	0.298429	0.263988	0.236675	0.146024
Pb	1.1	T	T	T	T	T	0.168427	0.172013	0.174771	0.176958	0.184218
Pd	0.13	F	F	F	F	F	0.168427	0.172013	0.174771	0.176958	0.184218
Rh	0.13	F	F	F	F	F	1.052327	0.915038	0.809437	0.725688	0.447737
Ru	0.35	F	F	F	F	F	1.052327	0.915038	0.809437	0.725688	0.447737
S	0.65	T	T	T	T	T	0.026334	0.022898	0.020255	0.01816	0.011204
Si	19	T	T	T	T	T	1.668926	1.481965	1.338156	1.224106	0.845589
Ti	1.3	T	T	T	T	T	0.014622	0.015184	0.015617	0.015959	0.017097
U	14	T	T	T	T	T	0.819741	1.164867	1.430334	1.640868	2.339603
Zr	15	T	T	T	T	T	1.802128	3.088152	4.077346	4.861846	7.465502

Table 6. High-Level Waste Solids Specification Evaluation - 241-AY-101 with Blends of 241-C-104.

Specification		Compliance flag					Concentration (units of specification)				
Analyte	Tank blend	0.1	0.2	0.3	0.4	1	0.1	0.2	0.3	0.4	1
As	0.16	F	F	F	F	F	3.371285	3.521213	3.622147	3.69473	3.89788
B	1.3	F	F	F	F	F	3.371285	3.521213	3.622147	3.69473	3.89788
Be	0.065	F	F	F	F	F	3.371285	3.521213	3.622147	3.69473	3.89788
Ce	0.81	T	T	T	T	T	0	0	0	0	0
Co	0.45	T	T	T	T	T	3.45E-05	2.78E-05	2.32E-05	2E-05	1.08E-05
Cs	0.58	F	F	F	T	T	0.827201	0.682257	0.584678	0.514507	0.31811
Cu	0.48	F	F	F	F	T	0.827201	0.682257	0.584678	0.514507	0.31811
Hg	0.1	T	T	T	T	T	0.00186	0.002993	0.003756	0.004304	0.00584
La	2.6	T	T	T	T	T	0.873437	0.703423	0.588967	0.50666	0.276295
Li	0.14	F	F	F	F	F	0.873437	0.703423	0.588967	0.50666	0.276295
Mn	6.5	T	T	T	T	T	1.420079	1.215877	1.078404	0.979545	0.702854
Mo	0.65	F	F	F	F	F	1.420079	1.215877	1.078404	0.979545	0.702854
Nd	1.7	F	F	F	F	F	9.165154	8.169918	7.499906	7.018091	5.669561
Pr	0.35	T	T	T	T	T	0.084949	0.098196	0.107113	0.113526	0.131475
Pu	0.054	F	F	F	F	F	0.084949	0.098196	0.107113	0.113526	0.131475
Rb	0.19	T	T	T	T	T	0.084949	0.098196	0.107113	0.113526	0.131475
Sb	0.84	T	T	T	T	T	0.084949	0.098196	0.107113	0.113526	0.131475
Se	0.52	T	T	T	T	T	0.084949	0.098196	0.107113	0.113526	0.131475
Sr	0.52	T	T	T	T	T	0.005498	0.005232	0.005053	0.004924	0.004563
Ta	0.03	T	T	T	T	T	0.005498	0.005232	0.005053	0.004924	0.004563
Tc	0.26	T	T	T	T	T	0.005498	0.005232	0.005053	0.004924	0.004563
Te	0.13	T	T	T	T	T	0.005498	0.005232	0.005053	0.004924	0.004563
Th	0.52	F	F	F	F	F	1.516932	2.149551	2.575442	2.881706	3.738895
Tl	0.45	T	T	T	T	T	0.005498	0.005232	0.005053	0.004924	0.004563
V	0.032	F	F	F	F	F	1.712824	1.729321	1.740427	1.748413	1.770766
W	0.24	F	F	F	F	F	1.516932	2.149551	2.575442	2.881706	3.738895
Y	0.16	F	F	F	F	F	1.712824	1.729321	1.740427	1.748413	1.770766
Zn	0.42	F	F	F	F	F	1.712824	1.729321	1.740427	1.748413	1.770766
Cl	0.33	T	T	T	T	T	3.45E-05	2.78E-05	2.32E-05	2E-05	1.08E-05
CO3	30	T	T	T	T	T	0.018062	0.029069	0.03648	0.041809	0.056723
NO2 + NO3	36	T	T	T	T	T	0.047904	0.053083	0.05657	0.059077	0.066094
TOC	11	T	T	T	T	T	2.025641	1.717751	1.510473	1.361416	0.944229
3H	0.000065	T	T	T	T	T	0	0	0	0	0
14C	6.5E-06	T	T	T	T	T	2.93E-06	2.36E-06	1.97E-06	1.69E-06	9.21E-07
60Co	0.01	T	T	T	T	T	0.000182	0.00015	0.000129	0.000114	7.14E-05
90Sr	10	T	T	T	T	T	0.192662	0.159348	0.136919	0.120791	0.07565
99Tc	0.015	T	T	T	T	T	4.43E-05	3.57E-05	2.99E-05	2.57E-05	1.4E-05
125Sb	0.032	T	T	T	T	T	3.92E-05	3.16E-05	2.65E-05	2.29E-05	1.26E-05
126Sn	0.00015	T	T	T	T	T	6.62E-06	5.53E-06	4.79E-06	4.26E-06	2.79E-06
129I	2.9E-07	T	T	T	T	T	2.88E-08	2.33E-08	1.96E-08	1.69E-08	9.38E-09
137Cs	10	T	T	T	T	T	0.045258	0.036881	0.031241	0.027185	0.015834
152Eu	0.00048	T	T	T	T	T	1.02E-05	8.34E-06	7.11E-06	6.22E-06	3.73E-06
154Eu	0.052	T	T	T	T	T	0.000719	0.000594	0.00051	0.00045	0.000281

Table 6. High-Level Waste Solids Specification Evaluation - 241-AY-101 with Blends of 241-C-104.

Specification		Compliance flag					Concentration (units of specification)				
155Eu	0.029	T	T	T	T	T	0.000536	0.000441	0.000376	0.00033	0.000201
233U	9E-07	F	F	F	F	F	1.79E-06	2.01E-06	2.16E-06	2.27E-06	2.57E-06
235U	2.5E-07	T	T	T	T	T	2.62E-08	2.65E-08	2.68E-08	2.69E-08	2.74E-08
237Np	0.000074	T	T	T	T	T	1.69E-07	1.36E-07	1.14E-07	9.83E-08	5.4E-08
238Pu	0.00035	T	T	T	T	T	2.87E-05	2.52E-05	2.28E-05	2.12E-05	1.64E-05
239Pu	0.0031	T	T	T	T	T	0.000294	0.000284	0.000278	0.000273	0.00026
241Pu	0.022	T	T	T	T	T	0.001987	0.001742	0.001576	0.001458	0.001125
241Am	0.09	T	T	T	T	T	0.001313	0.001125	0.000999	0.000908	0.000654
243+244Cm	0.003	T	T	T	T	T	0.001313	0.001125	0.000999	0.000908	0.000654
Ag	0.55	F	F	F	F	F	1.516932	2.149551	2.575442	2.881706	3.738895
Al	14	T	T	T	T	T	3.371285	3.521213	3.622147	3.69473	3.89788
Ba	4.5	T	T	T	T	T	3.371285	3.521213	3.622147	3.69473	3.89788
Bi	2.8	T	T	T	T	T	3.58E-05	5.77E-05	7.24E-05	8.29E-05	0.000113
Ca	7.1	T	T	T	T	T	0.441236	0.390002	0.355511	0.330708	0.261287
Cd	4.5	T	T	T	T	T	1.516932	2.149551	2.575442	2.881706	3.738895
Cr	0.68	F	F	T	T	T	0.827201	0.682257	0.584678	0.514507	0.31811
F	3.5	T	T	T	T	T	0.016399	0.013197	0.01104	0.00949	0.00515
Fe	29	T	T	T	T	T	5.948119	5.214189	4.720093	4.364781	3.370317
K	1.3	T	T	T	T	T	0.038889	0.045511	0.04997	0.053176	0.062149
Mg	2.1	T	T	T	T	T	0.873437	0.703423	0.588967	0.50666	0.276295
Na	19	T	T	T	T	T	9.165154	8.169918	7.499906	7.018091	5.669561
Ni	2.4	T	T	T	T	T	0.136254	0.141212	0.144549	0.14695	0.153667
P	1.7	T	T	T	T	T	0.027705	0.032025	0.034934	0.037025	0.042879
Pb	1.1	T	T	T	T	T	0.261535	0.22014	0.192272	0.172232	0.116143
Pd	0.13	F	F	F	F	T	0.261535	0.22014	0.192272	0.172232	0.116143
Rh	0.13	T	T	T	T	F	0.084949	0.098196	0.107113	0.113526	0.131475
Ru	0.35	T	T	T	T	T	0.084949	0.098196	0.107113	0.113526	0.131475
S	0.65	T	T	T	T	T	0.005825	0.004687	0.003922	0.003371	0.001829
Si	19	T	T	T	T	T	0.194347	0.273011	0.32597	0.364053	0.470642
Ti	1.3	T	T	T	T	T	0.005498	0.005232	0.005053	0.004924	0.004563
U	14	T	T	T	T	T	1.712824	1.729321	1.740427	1.748413	1.770766
Zr	15	T	T	T	T	T	1.516932	2.149551	2.575442	2.881706	3.738895

Table 7. High-Level Waste Solids Specification Evaluation - 241-AW-104 with Blends of 241-C-104.

Specification		Compliance flag					Concentration (units of specification)				
Analyte	Tank blend	0.1	0.2	0.3	0.4	1	0.1	0.2	0.3	0.4	1
As	0.16	F	F	F	F	F	3.72697	3.846265	3.911987	3.953607	4.050706
B	1.3	F	F	F	F	F	3.72697	3.846265	3.911987	3.953607	4.050706
Be	0.065	F	F	F	F	F	3.72697	3.846265	3.911987	3.953607	4.050706
Ce	0.81	T	T	T	T	T	0	0	0	0	0
Co	0.45	T	T	T	T	T	0	0	0	0	0
Cs	0.58	T	T	T	T	T	0.360209	0.280533	0.236638	0.20884	0.143988
Cu	0.48	T	T	T	T	T	0.360209	0.280533	0.236638	0.20884	0.143988
Hg	0.1	T	T	T	T	T	0.003123	0.004437	0.005161	0.00562	0.00669
La	2.6	T	T	T	T	T	0.001188	0.001689	0.001964	0.002139	0.002546
Li	0.14	T	T	T	T	T	0.001188	0.001689	0.001964	0.002139	0.002546
Mn	6.5	T	T	T	T	T	0.60809	0.540452	0.503189	0.479592	0.424539
Mo	0.65	T	T	T	T	T	0.60809	0.540452	0.503189	0.479592	0.424539
Nd	1.7	F	F	F	F	F	1.950193	2.563775	2.90181	3.115877	3.615298
Pr	0.35	T	T	T	T	T	0.205928	0.190537	0.182058	0.176688	0.164161
Pu	0.054	F	F	F	F	F	0.205928	0.190537	0.182058	0.176688	0.164161
Rb	0.19	F	F	T	T	T	0.205928	0.190537	0.182058	0.176688	0.164161
Sb	0.84	T	T	T	T	T	0.205928	0.190537	0.182058	0.176688	0.164161
Se	0.52	T	T	T	T	T	0.205928	0.190537	0.182058	0.176688	0.164161
Sr	0.52	T	T	T	T	T	0.00169	0.002399	0.002789	0.003036	0.003612
Ta	0.03	T	T	T	T	T	0.00169	0.002399	0.002789	0.003036	0.003612
Tc	0.26	T	T	T	T	T	0.00169	0.002399	0.002789	0.003036	0.003612
Te	0.13	T	T	T	T	T	0.00169	0.002399	0.002789	0.003036	0.003612
Th	0.52	F	F	F	F	F	2.140101	2.89759	3.314907	3.579181	4.195735
Tl	0.45	T	T	T	T	T	0.00169	0.002399	0.002789	0.003036	0.003612
V	0.032	F	F	F	F	F	5.542439	4.458008	3.860573	3.482236	2.599571
W	0.24	F	F	F	F	F	2.140101	2.89759	3.314907	3.579181	4.195735
Y	0.16	F	F	F	F	F	5.542439	4.458008	3.860573	3.482236	2.599571
Zn	0.42	F	F	F	F	F	5.542439	4.458008	3.860573	3.482236	2.599571
Cl	0.33	T	T	T	T	T	0	0	0	0	0
CO3	30	T	T	T	T	T	0.039824	0.049842	0.055362	0.058857	0.067011
NO2 + NO3	36	T	T	T	T	T	0.067284	0.069351	0.07049	0.071211	0.072893
TOC	11	T	T	T	T	T	2.915862	2.201609	1.808112	1.558923	0.977561
3H	0.000065	T	T	T	T	T	0	0	0	0	0
14C	6.5E-06	T	T	T	T	T	9.02E-10	1.28E-09	1.48E-09	1.62E-09	1.92E-09
60Co	0.01	T	T	T	T	T	8.49E-06	1.2E-05	1.4E-05	1.52E-05	1.81E-05
90Sr	10	T	T	T	T	T	0.009179	0.012915	0.014973	0.016276	0.019317
99Tc	0.015	T	T	T	T	T	2.89E-06	2.09E-06	1.65E-06	1.38E-06	7.28E-07
125Sb	0.032	T	T	T	T	T	5.35E-07	5.19E-07	5.1E-07	5.05E-07	4.92E-07
126Sn	0.00015	T	T	T	T	T	4.24E-07	6.01E-07	6.98E-07	7.6E-07	9.04E-07
129I	2.9E-07	T	T	T	T	T	1.93E-10	2.74E-10	3.18E-10	3.47E-10	4.13E-10
137Cs	10	T	T	T	T	T	0.002545	0.002492	0.002463	0.002445	0.002403
152Eu	0.00048	T	T	T	T	T	3.23E-07	4.54E-07	5.27E-07	5.73E-07	6.8E-07
154Eu	0.052	T	T	T	T	T	3.31E-05	4.68E-05	5.43E-05	5.91E-05	7.02E-05

Table 7. High-Level Waste Solids Specification Evaluation - 241-AW-104 with Blends of 241-C-104.

Specification		Compliance flag					Concentration (units of specification)				
Analyte	Tank blend	0.1	0.2	0.3	0.4	1	0.1	0.2	0.3	0.4	1
155Eu	0.029	T	T	T	T	T	2.05E-05	2.85E-05	3.29E-05	3.57E-05	4.23E-05
233U	9E-07	F	F	F	F	F	1.2E-06	1.7E-06	1.98E-06	2.15E-06	2.56E-06
235U	2.5E-07	T	T	T	T	T	1E-07	7.93E-08	6.78E-08	6.05E-08	4.34E-08
237Np	0.000074	T	T	T	T	T	9.01E-10	1.06E-09	1.15E-09	1.2E-09	1.34E-09
238Pu	0.00035	T	T	T	T	T	3.41E-05	2.74E-05	2.36E-05	2.13E-05	1.58E-05
239Pu	0.0031	T	T	T	T	T	0.000341	0.000313	0.000298	0.000288	0.000266
241Pu	0.022	T	T	T	T	T	0.003333	0.002579	0.002164	0.001901	0.001287
241Am	0.09	T	T	T	T	T	0.000144	0.000204	0.000238	0.000259	0.000308
243+244Cm	0.003	T	T	T	T	T	0.000144	0.000205	0.000238	0.000259	0.000308
Ag	0.55	F	F	F	F	F	2.140101	2.89759	3.314907	3.579181	4.195735
Al	14	T	T	T	T	T	3.72697	3.846265	3.911987	3.953607	4.050706
Ba	4.5	T	T	T	T	T	3.72697	3.846265	3.911987	3.953607	4.050706
Bi	2.8	T	T	T	T	T	6.02E-05	8.55E-05	9.94E-05	0.000108	0.000129
Ca	7.1	T	T	T	T	T	0.822158	0.6359	0.533286	0.468305	0.316701
Cd	4.5	T	T	T	T	T	2.140101	2.89759	3.314907	3.579181	4.195735
Cr	0.68	T	T	T	T	T	0.360209	0.280533	0.236638	0.20884	0.143988
F	3.5	T	T	T	T	T	0.494488	0.351306	0.272424	0.22247	0.105928
Fe	29	T	T	T	T	T	2.289062	2.260426	2.24465	2.234659	2.211352
K	1.3	T	T	T	T	T	0.59051	0.440603	0.358016	0.305717	0.183701
Mg	2.1	T	T	T	T	T	0.001188	0.001689	0.001964	0.002139	0.002546
Na	19	T	T	T	T	T	1.950193	2.563775	2.90181	3.115877	3.615298
Ni	2.4	T	T	T	T	T	0.657607	0.513996	0.434878	0.384775	0.267884
P	1.7	T	T	T	T	T	0.067161	0.062141	0.059376	0.057625	0.053539
Pb	1.1	T	T	T	T	T	0.027679	0.034021	0.037515	0.039727	0.044889
Pd	0.13	T	T	T	T	T	0.027679	0.034021	0.037515	0.039727	0.044889
Rh	0.13	F	F	F	F	F	0.205928	0.190537	0.182058	0.176688	0.164161
Ru	0.35	T	T	T	T	T	0.205928	0.190537	0.182058	0.176688	0.164161
S	0.65	T	T	T	T	T	0.074935	0.053237	0.041283	0.033713	0.016052
Si	19	T	T	T	T	T	0.513807	0.537935	0.551227	0.559645	0.579284
Ti	1.3	T	T	T	T	T	0.00169	0.002399	0.002789	0.003036	0.003612
U	14	T	T	T	T	T	5.542439	4.458008	3.860573	3.482236	2.599571
Zr	15	T	T	T	T	T	2.140101	2.89759	3.314907	3.579181	4.195735

Table 8. High-Level Waste Solids Specification Evaluation - 241-SY-102 with Blends of 241-C-104.

Specification		Compliance flag					Concentration (units of specification)				
Analyte	Tank blend	0.1	0.2	0.3	0.4	1	0.1	0.2	0.3	0.4	1
As	0.16	F	F	F	F	F	5.192572	4.888002	4.720031	4.613595	4.365082
B	1.3	F	F	F	F	F	5.192572	4.888002	4.720031	4.613595	4.365082
Be	0.065	F	F	F	F	F	5.192572	4.888002	4.720031	4.613595	4.365082
Ce	0.81	T	T	T	T	T	0	0	0	0	0
Co	0.45	T	T	T	T	T	5.22E-05	3.71E-05	2.88E-05	2.35E-05	1.12E-05
Cs	0.58	F	F	T	T	T	0.787935	0.584748	0.47269	0.401683	0.235893
Cu	0.48	F	F	T	T	T	0.787935	0.584748	0.47269	0.401683	0.235893
Hg	0.1	T	T	T	T	T	0.003116	0.00443	0.005155	0.005614	0.006686
La	2.6	T	T	T	T	T	0.00783	0.006409	0.005626	0.005129	0.00397
Li	0.14	T	T	T	T	T	0.00783	0.006409	0.005626	0.005129	0.00397
Mn	6.5	T	T	T	T	T	0.512777	0.472805	0.45076	0.436791	0.404176
Mo	0.65	T	T	T	T	T	0.512777	0.472805	0.45076	0.436791	0.404176
Nd	1.7	F	F	F	F	F	4.045597	4.05243	4.056199	4.058587	4.064162
Pr	0.35	F	F	F	F	F	1.11317	0.835546	0.682435	0.585416	0.358889
Pu	0.054	F	F	F	F	F	1.11317	0.835546	0.682435	0.585416	0.358889
Rb	0.19	F	F	F	F	F	1.11317	0.835546	0.682435	0.585416	0.358889
Sb	0.84	F	T	T	T	T	1.11317	0.835546	0.682435	0.585416	0.358889
Se	0.52	F	F	F	F	T	1.11317	0.835546	0.682435	0.585416	0.358889
Sr	0.52	T	T	T	T	T	0.00639	0.005738	0.005379	0.005151	0.00462
Ta	0.03	T	T	T	T	T	0.00639	0.005738	0.005379	0.005151	0.00462
Tc	0.26	T	T	T	T	T	0.00639	0.005738	0.005379	0.005151	0.00462
Te	0.13	T	T	T	T	T	0.00639	0.005738	0.005379	0.005151	0.00462
Th	0.52	F	F	F	F	F	1.939762	2.753899	3.202898	3.487409	4.151703
Tl	0.45	T	T	T	T	T	0.00639	0.005738	0.005379	0.005151	0.00462
V	0.032	F	F	F	F	F	0.844702	1.12007	1.271936	1.368167	1.592853
W	0.24	F	F	F	F	F	1.939762	2.753899	3.202898	3.487409	4.151703
Y	0.16	F	F	F	F	F	0.844702	1.12007	1.271936	1.368167	1.592853
Zn	0.42	F	F	F	F	F	0.844702	1.12007	1.271936	1.368167	1.592853
Cl	0.33	T	T	T	T	T	5.22E-05	3.71E-05	2.88E-05	2.35E-05	1.12E-05
CO3	30	T	T	T	T	T	0.057657	0.062503	0.065176	0.06687	0.070824
NO2 + NO3	36	T	T	T	T	T	0.1004	0.092891	0.088749	0.086125	0.079998
TOC	11	T	T	T	T	T	0.610054	0.56354	0.537887	0.521632	0.483679
3H	0.000065	T	T	T	T	T	0	0	0	0	0
14C	6.5E-06	T	T	T	T	T	2.17E-09	2.18E-09	2.18E-09	2.19E-09	2.19E-09
60Co	0.01	T	T	T	T	T	1.9E-05	1.95E-05	1.98E-05	2E-05	2.04E-05
90Sr	10	T	T	T	T	T	0.016337	0.017997	0.018913	0.019493	0.020848
99Tc	0.015	T	T	T	T	T	1.34E-06	9.94E-07	8.02E-07	6.81E-07	3.97E-07
125Sb	0.032	T	T	T	T	T	4.25E-06	3.16E-06	2.56E-06	2.18E-06	1.29E-06
126Sn	0.00015	T	T	T	T	T	5.74E-07	7.07E-07	7.8E-07	8.27E-07	9.36E-07
129I	2.9E-07	T	T	T	T	T	7.97E-09	5.8E-09	4.61E-09	3.85E-09	2.08E-09
137Cs	10	T	T	T	T	T	0.009362	0.007339	0.006223	0.005516	0.003866
152Eu	0.00048	T	T	T	T	T	4.35E-07	5.34E-07	5.89E-07	6.23E-07	7.04E-07
154Eu	0.052	T	T	T	T	T	0.000143	0.000125	0.000115	0.000108	9.37E-05

Table 8. High-Level Waste Solids Specification Evaluation - 241-SY-102 with Blends of 241-C-104.

Specification		Compliance flag					Concentration (units of specification)				
Analyte	Tank blend	0.1	0.2	0.3	0.4	1	0.1	0.2	0.3	0.4	1
155Eu	0.029	T	T	T	T	T	0.000119	9.87E-05	8.74E-05	8.02E-05	6.35E-05
233U	9E-07	F	F	F	F	F	1.86E-06	2.17E-06	2.34E-06	2.45E-06	2.7E-06
235U	2.5E-07	T	T	T	T	T	1.34E-08	1.76E-08	1.99E-08	2.14E-08	2.48E-08
237Np	0.000074	T	T	T	T	T	7.37E-08	5.28E-08	4.13E-08	3.4E-08	1.7E-08
238Pu	0.00035	T	T	T	T	T	6.77E-05	5.12E-05	4.22E-05	3.64E-05	2.3E-05
239Pu	0.0031	T	T	T	T	T	0.000588	0.000489	0.000434	0.0004	0.000319
241Pu	0.022	T	T	T	T	T	0.000299	0.000423	0.000492	0.000536	0.000637
241Am	0.09	T	T	T	T	T	0.002524	0.001896	0.00155	0.001331	0.000819
243+244Cm	0.003	T	T	T	T	T	0.002524	0.001896	0.00155	0.001331	0.000819
Ag	0.55	F	F	F	F	F	1.939762	2.753899	3.202898	3.487409	4.151703
Al	14	T	T	T	T	T	5.192572	4.888002	4.720031	4.613595	4.365082
Ba	4.5	F	F	F	F	T	5.192572	4.888002	4.720031	4.613595	4.365082
Bi	2.8	T	T	T	T	T	0.104413	0.074272	0.05765	0.047117	0.022524
Ca	7.1	T	T	T	T	T	0.220139	0.208219	0.201645	0.19748	0.187754
Cd	4.5	T	T	T	T	T	1.939762	2.753899	3.202898	3.487409	4.151703
Cr	0.68	F	T	T	T	T	0.787935	0.584748	0.47269	0.401683	0.235893
F	3.5	T	T	T	T	T	0.010322	0.007338	0.005693	0.00465	0.002215
Fe	29	T	T	T	T	T	1.973362	2.036035	2.070598	2.0925	2.143637
K	1.3	T	T	T	T	T	0.146898	0.125478	0.113664	0.106179	0.088701
Mg	2.1	T	T	T	T	T	0.00783	0.006409	0.005626	0.005129	0.00397
Na	19	T	T	T	T	T	4.045597	4.05243	4.056199	4.058587	4.064162
Ni	2.4	T	T	T	T	T	0.076573	0.101163	0.114725	0.123318	0.143382
P	1.7	T	T	T	T	T	0.363047	0.272503	0.222568	0.190926	0.117047
Pb	1.1	T	T	T	T	T	0.103072	0.087609	0.079081	0.073678	0.061061
Pd	0.13	T	T	T	T	T	0.103072	0.087609	0.079081	0.073678	0.061061
Rh	0.13	F	F	F	F	F	1.11317	0.835546	0.682435	0.585416	0.358889
Ru	0.35	F	F	F	F	F	1.11317	0.835546	0.682435	0.585416	0.358889
S	0.65	T	T	T	T	T	0.001983	0.00141	0.001094	0.000893	0.000426
Si	19	T	T	T	T	T	0.334112	0.410145	0.452077	0.478647	0.540686
Ti	1.3	T	T	T	T	T	0.00639	0.005738	0.005379	0.005151	0.00462
U	14	T	T	T	T	T	0.844702	1.12007	1.271936	1.368167	1.592853
Zr	15	T	T	T	T	T	1.939762	2.753899	3.202898	3.487409	4.151703

Table 9. High-Level Waste Solids Specification Evaluation - 241-C-102 with Blends of 241-C-104.

Specification		Compliance flag					Concentration (units of specification)				
Analyte	Tank blend	0.1	0.2	0.3	0.4	1	0.1	0.2	0.3	0.4	1
As	0.16	F	F	F	F	F	6.370666	6.124957	5.927987	5.766562	5.194896
B	1.3	F	F	F	F	F	6.370666	6.124957	5.927987	5.766562	5.194896
Be	0.065	F	F	F	F	F	6.370666	6.124957	5.927987	5.766562	5.194896
Ce	0.81	T	T	T	T	T	0	0	0	0	0
Co	0.45	T	T	T	T	T	0	0	0	0	0
Cs	0.58	T	T	T	T	T	0.04606	0.050352	0.053793	0.056612	0.066598
Cu	0.48	T	T	T	T	T	0.04606	0.050352	0.053793	0.056612	0.066598
Hg	0.1	T	T	T	T	T	0.012452	0.011925	0.011502	0.011155	0.009928
La	2.6	T	T	T	T	T	0.013267	0.012127	0.011214	0.010465	0.007813
Li	0.14	T	T	T	T	T	0.013267	0.012127	0.011214	0.010465	0.007813
Mn	6.5	T	T	T	T	T	0.208094	0.226415	0.241102	0.253139	0.295765
Mo	0.65	T	T	T	T	T	0.208094	0.226415	0.241102	0.253139	0.295765
Nd	1.7	F	F	F	F	F	2.350457	2.539693	2.691393	2.815716	3.255993
Pr	0.35	T	T	T	T	T	0.204497	0.198802	0.194237	0.190496	0.177247
Pu	0.054	F	F	F	F	F	0.204497	0.198802	0.194237	0.190496	0.177247
Rb	0.19	F	F	F	F	T	0.204497	0.198802	0.194237	0.190496	0.177247
Sb	0.84	T	T	T	T	T	0.204497	0.198802	0.194237	0.190496	0.177247
Se	0.52	T	T	T	T	T	0.204497	0.198802	0.194237	0.190496	0.177247
Sr	0.52	T	T	T	T	T	0.007393	0.007035	0.006747	0.006511	0.005677
Ta	0.03	T	T	T	T	T	0.007393	0.007035	0.006747	0.006511	0.005677
Tc	0.26	T	T	T	T	T	0.007393	0.007035	0.006747	0.006511	0.005677
Te	0.13	T	T	T	T	T	0.007393	0.007035	0.006747	0.006511	0.005677
Th	0.52	F	F	F	F	F	1.141876	1.539804	1.858799	2.120228	3.046044
Tl	0.45	T	T	T	T	T	0.007393	0.007035	0.006747	0.006511	0.005677
V	0.032	F	F	F	F	F	1.212238	1.276652	1.328289	1.370608	1.520473
W	0.24	F	F	F	F	F	1.141876	1.539804	1.858799	2.120228	3.046044
Y	0.16	F	F	F	F	F	1.212238	1.276652	1.328289	1.370608	1.520473
Zn	0.42	F	F	F	F	F	1.212238	1.276652	1.328289	1.370608	1.520473
Cl	0.33	T	T	T	T	T	0	0	0	0	0
CO3	30	T	T	T	T	T	0.187308	0.174879	0.164916	0.156751	0.127834
NO2 + NO3	36	T	T	T	T	T	0.187308	0.174879	0.164916	0.156751	0.127834
TOC	11	T	T	T	T	T	0.130189	0.165306	0.193457	0.216528	0.298231
3H	0.000065	T	T	T	T	T	0	0	0	0	0
14C	6.5E-06	T	T	T	T	T	7.59E-10	9.17E-10	1.04E-09	1.15E-09	1.52E-09
60Co	0.01	T	T	T	T	T	3.41E-05	3.27E-05	3.15E-05	3.05E-05	2.71E-05
90Sr	10	T	T	T	T	T	0.014118	0.014994	0.015697	0.016273	0.018313
99Tc	0.015	T	T	T	T	T	2.4E-08	3.66E-08	4.67E-08	5.5E-08	8.44E-08
125Sb	0.032	T	T	T	T	T	5.94E-08	1.06E-07	1.43E-07	1.73E-07	2.81E-07
126Sn	0.00015	T	T	T	T	T	1.32E-07	2.31E-07	3.11E-07	3.76E-07	6.07E-07
129I	2.9E-07	T	T	T	T	T	1.54E-10	1.89E-10	2.17E-10	2.4E-10	3.22E-10
137Cs	10	T	T	T	T	T	0.001303	0.00142	0.001513	0.00159	0.001862
152Eu	0.00048	T	T	T	T	T	1.63E-07	2.3E-07	2.85E-07	3.29E-07	4.86E-07
154Eu	0.052	T	T	T	T	T	1.58E-05	2.29E-05	2.86E-05	3.33E-05	4.98E-05

Table 9. High-Level Waste Solids Specification Evaluation - 241-C-102 with Blends of 241-C-104.

Specification		Compliance flag					Concentration (units of specification)				
Analyte	Tank blend	0.1	0.2	0.3	0.4	1	0.1	0.2	0.3	0.4	1
155Eu	0.029	T	T	T	T	T	1.19E-05	1.59E-05	1.91E-05	2.17E-05	3.1E-05
233U	9E-07	T	T	F	F	F	5.54E-07	8.16E-07	1.03E-06	1.2E-06	1.81E-06
235U	2.5E-07	T	T	T	T	T	3.45E-09	6.15E-09	8.31E-09	1.01E-08	1.63E-08
237Np	0.000074	T	T	T	T	T	7.41E-10	8.19E-10	8.82E-10	9.34E-10	1.12E-09
238Pu	0.00035	T	T	T	T	T	1.23E-05	1.21E-05	1.2E-05	1.19E-05	1.15E-05
239Pu	0.0031	T	T	T	T	T	0.00041	0.000391	0.000377	0.000365	0.000323
241Pu	0.022	T	T	T	T	T	0.000935	0.000913	0.000894	0.00088	0.000827
241Am	0.09	T	T	T	T	T	0.000134	0.000158	0.000177	0.000193	0.000249
243+244Cm	0.003	T	T	T	T	T	0.000134	0.000158	0.000177	0.000193	0.000249
Ag	0.55	F	F	F	F	F	1.141876	1.539804	1.858799	2.120228	3.046044
Al	14	T	T	T	T	T	6.370666	6.124957	5.927987	5.766562	5.194896
Ba	4.5	F	F	F	F	F	6.370666	6.124957	5.927987	5.766562	5.194896
Bi	2.8	T	T	T	T	T	0.265535	0.236316	0.212893	0.193697	0.125716
Ca	7.1	T	T	T	T	T	0.54194	0.50197	0.469928	0.443669	0.350675
Cd	4.5	T	T	T	T	T	1.141876	1.539804	1.858799	2.120228	3.046044
Cr	0.68	T	T	T	T	T	0.04606	0.050352	0.053793	0.056612	0.066598
F	3.5	T	T	T	T	T	0	0	0	0	0
Fe	29	T	T	T	T	T	1.212795	1.320403	1.406666	1.477361	1.727722
K	1.3	T	T	T	T	T	0.051181	0.053561	0.055469	0.057032	0.06257
Mg	2.1	T	T	T	T	T	0.013267	0.012127	0.011214	0.010465	0.007813
Na	19	T	T	T	T	T	2.350457	2.539693	2.691393	2.815716	3.255993
Ni	2.4	T	T	T	T	T	0.712006	0.651411	0.602836	0.563026	0.422046
P	1.7	T	T	T	T	T	0.066694	0.064837	0.063348	0.062128	0.057807
Pb	1.1	T	T	T	T	T	0.08946	0.085069	0.08155	0.078665	0.06845
Pd	0.13	T	T	T	T	T	0.08946	0.085069	0.08155	0.078665	0.06845
Rh	0.13	F	F	F	F	F	0.204497	0.198802	0.194237	0.190496	0.177247
Ru	0.35	T	T	T	T	T	0.204497	0.198802	0.194237	0.190496	0.177247
S	0.65	T	T	T	T	T	0.006408	0.005703	0.005137	0.004673	0.003032
Si	19	T	T	T	T	T	3.182607	2.897949	2.669754	2.482741	1.820455
Ti	1.3	T	T	T	T	T	0.007393	0.007035	0.006747	0.006511	0.005677
U	14	T	T	T	T	T	1.212238	1.276652	1.328289	1.370608	1.520473
Zr	15	T	T	T	T	T	1.141876	1.539804	1.858799	2.120228	3.046044

Table 10. High-Level Waste Solids Specification Evaluation - 241-AY-106/241-C-106 with Blends of 241-C-104.

Specification		Compliance flag					Concentration (units of specification)				
Analyte	Tank blend	0.1	0.2	0.3	0.4	1	0.1	0.2	0.3	0.4	1
As	0.16	F	F	F	F	F	4.04149	4.054583	4.064575	4.072451	4.09829
B	1.3	F	F	F	F	F	4.04149	4.054583	4.064575	4.072451	4.09829
Be	0.065	F	F	F	F	F	4.04149	4.054583	4.064575	4.072451	4.09829
Ce	0.81	T	T	T	T	T	0	0	0	0	0
Co	0.45	T	T	T	T	T	2.21E-05	1.91E-05	1.69E-05	1.51E-05	9.23E-06
Cs	0.58	T	T	T	T	T	0.083713	0.083891	0.084028	0.084135	0.084488
Cu	0.48	T	T	T	T	T	0.083713	0.083891	0.084028	0.084135	0.084488
Hg	0.1	T	T	T	T	T	0.004102	0.004581	0.004945	0.005233	0.006177
La	2.6	T	T	T	T	T	0.056063	0.048924	0.043476	0.039181	0.025093
Li	0.14	T	T	T	T	T	0.056063	0.048924	0.043476	0.039181	0.025093
Mn	6.5	T	T	T	T	T	0.301367	0.31119	0.318687	0.324597	0.343983
Mo	0.65	T	T	T	T	T	0.301367	0.31119	0.318687	0.324597	0.343983
Nd	1.7	F	F	F	F	F	10.45743	9.59935	8.944489	8.428301	6.734881
Pr	0.35	F	F	F	F	F	1.069681	0.946519	0.852526	0.778437	0.535378
Pu	0.054	F	F	F	F	F	1.069681	0.946519	0.852526	0.778437	0.535378
Rb	0.19	F	F	F	F	F	1.069681	0.946519	0.852526	0.778437	0.535378
Sb	0.84	F	F	F	T	T	1.069681	0.946519	0.852526	0.778437	0.535378
Se	0.52	F	F	F	F	F	1.069681	0.946519	0.852526	0.778437	0.535378
Sr	0.52	T	T	T	T	T	0.012352	0.011249	0.010406	0.009742	0.007564
Ta	0.03	T	T	T	T	T	0.012352	0.011249	0.010406	0.009742	0.007564
Tc	0.26	T	T	T	T	T	0.012352	0.011249	0.010406	0.009742	0.007564
Te	0.13	T	T	T	T	T	0.012352	0.011249	0.010406	0.009742	0.007564
Th	0.52	F	F	F	F	F	0.790441	1.323127	1.729654	2.050096	3.101345
Tl	0.45	T	T	T	T	T	0.012352	0.011249	0.010406	0.009742	0.007564
V	0.032	F	F	F	F	F	0.576911	0.740837	0.865939	0.96455	1.288056
W	0.24	F	F	F	F	F	0.790441	1.323127	1.729654	2.050096	3.101345
Y	0.16	F	F	F	F	F	0.576911	0.740837	0.865939	0.96455	1.288056
Zn	0.42	F	F	F	F	F	0.576911	0.740837	0.865939	0.96455	1.288056
Cl	0.33	T	T	T	T	T	2.21E-05	1.91E-05	1.69E-05	1.51E-05	9.23E-06
CO3	30	T	T	T	T	T	0.095149	0.092365	0.09024	0.088565	0.083071
NO2 + NO3	36	T	T	T	T	T	0.115893	0.110323	0.106072	0.102721	0.091727
TOC	11	T	T	T	T	T	1.186103	1.087112	1.011566	0.952017	0.75666
3H	0.000065	T	T	T	T	T	0	0	0	0	0
14C	6.5E-06	T	T	T	T	T	8.59E-10	1.04E-09	1.18E-09	1.28E-09	1.64E-09
60Co	0.01	T	T	T	T	T	3.83E-05	3.59E-05	3.41E-05	3.27E-05	2.81E-05
90Sr	10	T	T	T	T	T	0.589286	0.513097	0.454952	0.40912	0.258762
99Tc	0.015	T	T	T	T	T	1.51E-05	1.31E-05	1.16E-05	1.04E-05	6.39E-06
125Sb	0.032	T	T	T	T	T	0.00016	0.000139	0.000123	0.00011	6.72E-05
126Sn	0.00015	T	T	T	T	T	2.75E-06	2.52E-06	2.35E-06	2.21E-06	1.75E-06
129I	2.9E-07	T	T	T	T	T	4.71E-09	4.14E-09	3.7E-09	3.36E-09	2.24E-09
137Cs	10	T	T	T	T	T	0.020892	0.018403	0.016504	0.015007	0.010095

Table 10. High-Level Waste Solids Specification Evaluation - 241-AY-106/241-C-106 with Blends of 241-C-104.

Specification		Compliance flag					Concentration (units of specification)				
Analyte	Tank blend	0.1	0.2	0.3	0.4	1	0.1	0.2	0.3	0.4	1
152Eu	0.00048	T	T	T	T	T	6.01E-06	5.3E-06	4.77E-06	4.35E-06	2.96E-06
154Eu	0.052	T	T	T	T	T	0.000598	0.000528	0.000475	0.000434	0.000296
155Eu	0.029	T	T	T	T	T	0.000266	0.000237	0.000215	0.000197	0.000139
233U	9E-07	T	T	F	F	F	4.63E-07	7.95E-07	1.05E-06	1.25E-06	1.9E-06
235U	2.5E-07	T	T	T	T	T	9.35E-09	1.18E-08	1.37E-08	1.52E-08	2.02E-08
237Np	0.000074	T	T	T	T	T	2.37E-08	2.08E-08	1.85E-08	1.67E-08	1.08E-08
238Pu	0.00035	T	T	T	T	T	2.47E-05	2.28E-05	2.14E-05	2.03E-05	1.66E-05
239Pu	0.0031	T	T	T	T	T	0.000259	0.000257	0.000256	0.000254	0.000251
241Pu	0.022	T	T	T	T	T	0.000918	0.000893	0.000873	0.000858	0.000808
241Am	0.09	T	T	T	T	T	0.000376	0.000373	0.000371	0.000369	0.000363
243+244Cm	0.003	T	T	T	T	T	0.000377	0.000373	0.000371	0.000369	0.000363
Ag	0.55	F	F	F	F	F	0.790441	1.323127	1.729654	2.050096	3.101345
Al	14	T	T	T	T	T	4.04149	4.054583	4.064575	4.072451	4.09829
Ba	4.5	T	T	T	T	T	4.04149	4.054583	4.064575	4.072451	4.09829
Bi	2.8	T	T	T	T	T	0.000596	0.000536	0.00049	0.000454	0.000335
Ca	7.1	T	T	T	T	T	0.371907	0.345983	0.326198	0.310602	0.25944
Cd	4.5	T	T	T	T	T	0.790441	1.323127	1.729654	2.050096	3.101345
Cr	0.68	T	T	T	T	T	0.083713	0.083891	0.084028	0.084135	0.084488
F	3.5	T	T	T	T	T	0.011788	0.010204	0.008996	0.008043	0.004919
Fe	29	T	T	T	T	T	5.211606	4.805756	4.496025	4.251883	3.450942
K	1.3	T	T	T	T	T	0.084479	0.08291	0.081712	0.080768	0.077672
Mg	2.1	T	T	T	T	T	0.056063	0.048924	0.043476	0.039181	0.025093
Na	19	T	T	T	T	T	10.45743	9.59935	8.944489	8.428301	6.734881
Ni	2.4	T	T	T	T	T	0.097434	0.106058	0.11264	0.117828	0.134847
P	1.7	T	T	T	T	T	0.348863	0.308696	0.278041	0.253878	0.174607
Pb	1.1	T	T	T	T	T	0.145887	0.132951	0.123078	0.115296	0.089767
Pd	0.13	F	F	T	T	T	0.145887	0.132951	0.123078	0.115296	0.089767
Rh	0.13	F	F	F	F	F	1.069681	0.946519	0.852526	0.778437	0.535378
Ru	0.35	F	F	F	F	F	1.069681	0.946519	0.852526	0.778437	0.535378
S	0.65	T	T	T	T	T	0.026175	0.022659	0.019976	0.017861	0.010922
Si	19	T	T	T	T	T	1.716335	1.566	1.45127	1.360834	1.06415
Ti	1.3	T	T	T	T	T	0.012352	0.011249	0.010406	0.009742	0.007564
U	14	T	T	T	T	T	0.576911	0.740837	0.865939	0.96455	1.288056
Zr	15	T	T	T	T	T	0.790441	1.323127	1.729654	2.050096	3.101345

APPENDIX B

BLENDED WASTE LAW SPECIFICATION COMPLIANCE EVALUATION

(ENVELOPES A, B, C)

LIST OF TABLES

Table 1. Liquid Specification Flags – 241-AY-101 with Blends of 241-AW-103.

Compliant = T	A					B					C				
Liquid Specification/ Tank Blend	0.1	0.2	0.3	0.4	1	0.1	0.2	0.3	0.4	1	0.1	0.2	0.3	0.4	1
Al	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Ba	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F
Ca	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Cd	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Cl	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Cr	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
F	T	F	F	F	F	T	T	T	T	F	T	F	F	F	F
Fe	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Hg	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
K	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
La	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Ni	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
NO2	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
NO3	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Pb	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
PO4	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
SO4	F	F	F	F	F	T	T	T	T	T	F	F	F	F	T
CO3	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
TOC	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
U	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
137Cs	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
90Sr	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
99Tc	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
60Co	F	T	T	T	T	F	T	T	T	T	T	T	T	T	T
154Eu + 155Eu	F	F	T	T	T	F	F	T	T	T	T	T	T	T	T
TRU	F	F	F	F	F	F	F	F	F	F	T	T	T	T	T

Table 2. Specification Evaluation of Alternate Liquid Wastes - 241-AY-101 with Blends of 241-AW-103

Liquid Specification/ Blend	A	B	C	0.1	0.2	0.3	0.4	1
Al	0.25	0.25	0.25	0.00114	0.00152	0.00180	0.00202	0.00271
Ba	0.0001	0.0001	0.0001	0.00114	0.00152	0.00180	0.00202	0.00271
Ca	0.04	0.04	0.04	0.00179	0.00163	0.00150	0.00140	0.00110
Cd	0.004	0.004	0.004	0.00104	0.00166	0.00212	0.00248	0.00362
Cl	0.037	0.089	0.037	0.00839	0.00777	0.00730	0.00694	0.00579
Cr	0.0069	0.02	0.0069	0.00235	0.00209	0.00190	0.00175	0.00127
F	0.091	0.2	0.091	0.06898	0.11541	0.15011	0.17702	0.26270
Fe	0.01	0.01	0.01	0.00004	0.00005	0.00005	0.00005	0.00006
Hg	0.000014	0.000014	0.000014	0.00000	0.00000	0.00000	0.00000	0.00000
K	0.18	0.18	0.18	0.01331	0.02005	0.02509	0.02899	0.04143
La	0.000083	0.000083	0.000083	0.00002	0.00001	0.00001	0.00001	0.00001
Ni	0.003	0.003	0.003	0.00008	0.00011	0.00012	0.00014	0.00018
NO2	0.38	0.38	0.38	0.36990	0.32379	0.28934	0.26262	0.17755
NO3	0.8	0.8	0.8	0.20730	0.19272	0.18182	0.17336	0.14646
Pb	0.00068	0.00068	0.00068	0.00021	0.00018	0.00015	0.00014	0.00008
PO4	0.038	0.13	0.038	0.00608	0.00589	0.00576	0.00565	0.00532
SO4	0.01	0.07	0.02	0.02879	0.02510	0.02234	0.02020	0.01338
CO3	0.3	0.3	0.3	0.27240	0.23626	0.20925	0.18831	0.12162
TOC	0.5	0.5	0.5	0.19019	0.17301	0.16018	0.15023	0.11854
U	0.0012	0.0012	0.0012	5.37E-04	5.29E-04	5.23E-04	5.18E-04	5.02E-04
137Cs	4.3E+09	2E+10	4.3E+09	5.11E+08	4.95E+08	4.82E+08	4.73E+08	4.43E+08
90Sr	44000000	44000000	8E+08	2.22E+06	2.17E+06	2.13E+06	2.10E+06	2.01E+06
99Tc	7.10E+06	7.10E+06	7.10E+06	3.08E+05	2.63E+05	2.30E+05	2.04E+05	1.22E+05
60Co	6.10E+04	6.10E+04	3.70E+05	6.74E+04	5.93E+04	5.33E+04	4.86E+04	3.36E+04
154Eu + 155Eu	1200000	1200000	4300000	1495407.8	1283370	1124927	1002039	610817.4
TRU	480000	480000	3000000	2612417	2325295	2110747	1944344	1414589
Na	3 to 10 M			9.58	3.27	27.07	12.72	9.79

Table 3. Liquid Specification Flags - 241-AW-104 with Blends of 241-AW-103.

Compliant = T	A					B					C				
Liquid Specification/Tank Blend	0.1	0.2	0.3	0.4	1	0.1	0.2	0.3	0.4	1	0.1	0.2	0.3	0.4	1
Al	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Ba	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F
Ca	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Cd	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Cl	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Cr	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
F	T	F	F	F	F	T	T	T	T	T	T	F	F	F	F
Fe	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Hg	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
K	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
La	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Ni	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
NO2	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
NO3	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Pb	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
PO4	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
SO4	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
CO3	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
TOC	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
U	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
137Cs	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
90Sr	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
99Tc	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
60Co	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
154Eu + 155Eu	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
TRU	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T

Table 4. Specification Evaluation of Alternate Liquid Wastes - 241-AW-104 with Blends of 241-AW-103.

Liquid specification	A	B	C	0.1	0.2	0.3	0.4	1
Al	0.25	0.25	0.25	0.07505	0.07160	0.06848	0.06562	0.05268
Ba	0.0001	0.0001	0.0001	0.07505	0.07160	0.06848	0.06562	0.05268
Ca	0.04	0.04	0.04	0.00027	0.00029	0.00030	0.00032	0.00038
Cd	0.004	0.004	0.004	0.00035	0.00059	0.00081	0.00101	0.00191
Cl	0.037	0.089	0.037	0.01296	0.01253	0.01214	0.01178	0.01017
Cr	0.0069	0.02	0.0069	0.00096	0.00094	0.00092	0.00091	0.00084
F	0.091	0.2	0.091	0.08901	0.10355	0.11676	0.12880	0.18341
Fe	0.01	0.01	0.01	0.00001	0.00001	0.00002	0.00002	0.00003
Hg	0.000014	0.000014	0.000014	0.00000	0.00000	0.00000	0.00000	0.00000
K	0.18	0.18	0.18	0.02551	0.02717	0.02868	0.03006	0.03630
La	0.000083	0.000083	0.000083	0.00000	0.00000	0.00000	0.00000	0.00000
Ni	0.003	0.003	0.003	0.00003	0.00004	0.00005	0.00006	0.00010
NO2	0.38	0.38	0.38	0.18070	0.17444	0.16876	0.16358	0.14008
NO3	0.8	0.8	0.8	0.21809	0.21269	0.20780	0.20333	0.18308
Pb	0.00068	0.00068	0.00068	0.00000	0.00000	0.00000	0.00000	0.00000
PO4	0.038	0.13	0.038	0.00182	0.00197	0.00210	0.00222	0.00276
SO4	0.01	0.07	0.02	0.00718	0.00699	0.00682	0.00666	0.00595
CO3	0.3	0.3	0.3	0.11908	0.11442	0.11018	0.10632	0.08881
TOC	0.5	0.5	0.5	0.03042	0.03240	0.03420	0.03585	0.04330
U	0.0012	0.0012	0.0012	2.89E-04	2.98E-04	3.06E-04	3.14E-04	3.49E-04
137Cs	4.3E+09	2E+10	4.3E+09	3.95E+08	3.96E+08	3.96E+08	3.96E+08	3.96E+08
90Sr	44000000	44000000	8E+08	6.77E+05	7.35E+05	7.87E+05	8.35E+05	1.05E+06
99Tc	7.10E+06	7.10E+06	7.10E+06	2.45E+05	2.33E+05	2.23E+05	2.13E+05	1.68E+05
60Co	6.10E+04	6.10E+04	3.70E+05	5.80E+02	1.10E+03	1.58E+03	2.01E+03	3.98E+03
154Eu + 155Eu	1200000	1200000	4300000	1507.708	2869.639	4105.998	5233.387	10347.41
TRU	480000	480000	3000000	398399.4	409480.2	419539.3	428711.8	470319.7
Na	3 to 10 M			31.91	9.79	74.21	32.39	18.83

Table 5: Liquid Specification Flags - 241-SY-102 with Blends of 241-AW-103.

Compliant = T	A					B					C				
Liquid Specification/ Tank Blend	0.1	0.2	0.3	0.4	1	0.1	0.2	0.3	0.4	1	0.1	0.2	0.3	0.4	1
Al	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Ba	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F
Ca	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Cd	T	T	T	T	F	T	T	T	T	F	T	T	T	T	F
Cl	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Cr	F	F	T	T	T	T	T	T	T	T	F	F	T	T	T
F	F	F	F	F	F	T	T	F	F	F	F	F	F	F	F
Fe	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Hg	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
K	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
La	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Ni	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
NO2	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
NO3	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Pb	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
PO4	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
SO4	F	T	T	T	T	T	T	T	T	T	T	T	T	T	T
CO3	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
TOC	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
U	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
137Cs	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
90Sr	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
99Tc	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
60Co	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
154Eu + 155Eu	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
TRU	F	F	F	F	F	F	F	F	F	F	F	F	T	T	T

Table 6. Specification Evaluation of Alternate Liquid Wastes - 241-SY-102 with Blends of 241-AW-103

Liquid Specification/ Tank Blend	A	B	C	0.1	0.2	0.3	0.4	1
Al	0.25	0.25	0.25	0.01779	0.01460	0.01260	0.01121	0.00760
Ba	0.0001	0.0001	0.0001	0.01779	0.01460	0.01260	0.01121	0.00760
Ca	0.04	0.04	0.04	0.00072	0.00070	0.00069	0.00068	0.00066
Cd	0.004	0.004	0.004	0.00156	0.00241	0.00295	0.00332	0.00428
Cl	0.037	0.089	0.037	0.01532	0.01278	0.01117	0.01007	0.00718
Cr	0.0069	0.02	0.0069	0.01023	0.00804	0.00666	0.00571	0.00322
F	0.091	0.2	0.091	0.12959	0.18860	0.22580	0.25140	0.31838
Fe	0.01	0.01	0.01	0.00004	0.00005	0.00005	0.00006	0.00006
Hg	0.000014	0.000014	0.000014	0.00000	0.00000	0.00000	0.00000	0.00000
K	0.18	0.18	0.18	0.03088	0.03745	0.04160	0.04446	0.05192
La	0.000083	0.000083	0.000083	0.00000	0.00000	0.00000	0.00000	0.00000
Ni	0.003	0.003	0.003	0.00016	0.00018	0.00019	0.00020	0.00022
NO2	0.38	0.38	0.38	0.15645	0.13260	0.11756	0.10721	0.08013
NO3	0.8	0.8	0.8	0.37441	0.31369	0.27541	0.24907	0.18015
Pb	0.00068	0.00068	0.00068	0.00000	0.00000	0.00000	0.00000	0.00000
PO4	0.038	0.13	0.038	0.02849	0.02313	0.01974	0.01742	0.01133
SO4	0.01	0.07	0.02	0.01141	0.00957	0.00840	0.00760	0.00550
CO3	0.3	0.3	0.3	0.07880	0.06606	0.05802	0.05250	0.03803
TOC	0.5	0.5	0.5	0.06042	0.06293	0.06450	0.06559	0.06843
U	0.0012	0.0012	0.0012	1.54E-04	2.28E-04	2.74E-04	3.06E-04	3.90E-04
137Cs	4.3E+09	2E+10	4.3E+09	2.36E+08	2.73E+08	2.96E+08	3.12E+08	3.53E+08
90Sr	44000000	44000000	8E+08	5.65E+05	8.60E+05	1.05E+06	1.17E+06	1.51E+06
99Tc	7.10E+06	7.10E+06	7.10E+06	1.51E+05	1.16E+05	9.50E+04	8.01E+04	4.14E+04
60Co	6.10E+04	6.10E+04	3.70E+05	3.53E+03	5.32E+03	6.45E+03	7.23E+03	9.25E+03
154Eu + 155Eu	1200000	1200000	4300000	277891.51	221642.9	186178.6	161775.1	97927.09
TRU	480000	480000	3000000	4022706.1	3253314	2768218	2434417	1561077
Na	3 to 10 M			5.53	2.09	18.52	9.15	8.15

Table 7. Liquid Specification Flags - 241-C-102 with Blends of 241-AW-103.

Compliant = T	A					B					C				
Liquid Specification/ Tank Blend	0.1	0.2	0.3	0.4	1	0.1	0.2	0.3	0.4	1	0.1	0.2	0.3	0.4	1
Al	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Ba	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F
Ca	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Cd	T	T	T	T	F	T	T	T	T	F	T	T	T	T	F
Cl	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Cr	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
F	F	F	F	F	F	T	T	F	F	F	F	F	F	F	F
Fe	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Hg	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F
K	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
La	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Ni	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
NO2	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
NO3	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Pb	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
PO4	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
SO4	F	T	T	T	T	T	T	T	T	T	T	T	T	T	T
CO3	F	T	T	T	T	F	T	T	T	T	F	T	T	T	T
TOC	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
U	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
137Cs	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
90Sr	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
99Tc	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
60Co	F	T	T	T	T	F	T	T	T	T	T	T	T	T	T
154Eu + 155Eu	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
TRU	F	F	F	F	F	F	F	F	F	F	T	T	T	T	T

Table 8. Specification Evaluation of Alternate Liquid Wastes - 241-C-102 with Blends of 241-AW-103

Liquid Specification	A	B	C	0.1	0.2	0.3	0.4	1
Al	0.25	0.25	0.25	0.03985	0.03345	0.02898	0.02568	0.01603
Ba	0.0001	0.0001	0.0001	0.03985	0.03345	0.02898	0.02568	0.01603
Ca	0.04	0.04	0.04	0.00130	0.00118	0.00110	0.00104	0.00086
Cd	0.004	0.004	0.004	0.00182	0.00244	0.00287	0.00319	0.00412
Cl	0.037	0.089	0.037	0.01284	0.01129	0.01020	0.00940	0.00707
Cr	0.0069	0.02	0.0069	0.00120	0.00108	0.00101	0.00095	0.00078
F	0.091	0.2	0.091	0.14199	0.18592	0.21663	0.23930	0.30555
Fe	0.01	0.01	0.01	0.00003	0.00004	0.00004	0.00005	0.00006
Hg	0.000014	0.000014	0.000014	0.00008	0.00007	0.00006	0.00005	0.00003
K	0.18	0.18	0.18	0.01831	0.02568	0.03083	0.03463	0.04575
La	0.000083	0.000083	0.000083	0.00000	0.00000	0.00000	0.00000	0.00000
Ni	0.003	0.003	0.003	0.00056	0.00050	0.00046	0.00044	0.00035
NO2	0.38	0.38	0.38	0.09212	0.08486	0.07979	0.07605	0.06512
NO3	0.8	0.8	0.8	0.21273	0.19391	0.18075	0.17104	0.14265
Pb	0.00068	0.00068	0.00068	0.00009	0.00007	0.00006	0.00005	0.00003
PO4	0.038	0.13	0.038	0.02215	0.01908	0.01693	0.01535	0.01072
SO4	0.01	0.07	0.02	0.01020	0.00897	0.00812	0.00748	0.00563
CO3	0.3	0.3	0.3	0.34634	0.28898	0.24888	0.21928	0.13278
TOC	0.5	0.5	0.5	0.02561	0.03373	0.03941	0.04361	0.05586
U	0.0012	0.0012	0.0012	2.18E-04	2.64E-04	2.96E-04	3.20E-04	3.90E-04
137Cs	4.3E+09	2E+10	4.3E+09	3.80E+08	3.83E+08	3.85E+08	3.87E+08	3.92E+08
90Sr	44000000	44000000	8E+08	3.53E+07	2.94E+07	2.52E+07	2.22E+07	1.32E+07
99Tc	7.10E+06	7.10E+06	7.10E+06	7.06E+03	5.81E+03	4.93E+03	4.29E+03	2.40E+03
60Co	6.10E+04	6.10E+04	3.70E+05	6.97E+04	5.94E+04	5.22E+04	4.68E+04	3.13E+04
154Eu + 155Eu	1200000	1200000	4300000	6392.5436	10519.92	13404.91	15535.07	21758.95
TRU	480000	480000	3000000	556127.33	568804.3	577665.3	584208	603324.2
Na	3 to 10 M			7.53	2.67	22.73	10.91	8.96

Table 9. Liquid Specification Flags - 241-AY-102/241-C-106 with Blends of 241-AW-103.

Compliant = T	A					B					C				
Liquid Specification/ Tank Blend	0.1	0.2	0.3	0.4	1	0.1	0.2	0.3	0.4	1	0.1	0.2	0.3	0.4	1
Al	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Ba	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F
Ca	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Cd	T	T	T	T	F	T	T	T	T	F	T	T	T	T	F
Cl	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Cr	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
F	F	F	F	F	F	T	F	F	F	F	F	F	F	F	F
Fe	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Hg	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
K	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
La	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Ni	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
NO2	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
NO3	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Pb	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
PO4	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
SO4	F	F	F	F	T	T	T	T	T	T	F	T	T	T	T
CO3	F	F	F	F	T	F	F	F	F	T	F	F	F	F	T
TOC	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
U	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
137Cs	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
90Sr	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
99Tc	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
60Co	F	F	F	F	T	F	F	F	F	T	T	T	T	T	T
154Eu + 155Eu	F	F	F	F	T	F	F	F	F	T	T	T	T	T	T
TRU	F	F	F	F	F	F	F	F	F	F	F	F	F	F	T

Table 10. Specification Evaluation of Alternate Liquid Wastes - 241-AY-102/241-C-106 with Blends of 241-AW-103.

Liquid Specification/ Tank Blend	A	B	C	0.1	0.2	0.3	0.4	1
Al	0.25	0.25	0.25	0.00227	0.00270	0.00294	0.00309	0.00343
Ba	0.0001	0.0001	0.0001	0.00227	0.00270	0.00294	0.00309	0.00343
Ca	0.04	0.04	0.04	0.00033	0.00042	0.00047	0.00050	0.00057
Cd	0.004	0.004	0.004	0.00233	0.00321	0.00369	0.00399	0.00469
Cl	0.037	0.089	0.037	0.02000	0.01532	0.01276	0.01116	0.00744
Cr	0.0069	0.02	0.0069	0.00161	0.00130	0.00114	0.00103	0.00079
F	0.091	0.2	0.091	0.17292	0.23681	0.27164	0.29356	0.34431
Fe	0.01	0.01	0.01	0.00006	0.00006	0.00007	0.00007	0.00007
Hg	0.000014	0.000014	0.000014	0.00000	0.00000	0.00000	0.00000	0.00000
K	0.18	0.18	0.18	0.03423	0.04179	0.04591	0.04850	0.05450
La	0.000083	0.000083	0.000083	0.00000	0.00000	0.00000	0.00000	0.00000
Ni	0.003	0.003	0.003	0.00038	0.00034	0.00032	0.00030	0.00027
NO2	0.38	0.38	0.38	0.19476	0.15250	0.12946	0.11496	0.08138
NO3	0.8	0.8	0.8	0.06151	0.07475	0.08196	0.08651	0.09702
Pb	0.00068	0.00068	0.00068	0.00005	0.00004	0.00003	0.00002	0.00001
PO4	0.038	0.13	0.038	0.02317	0.01776	0.01482	0.01297	0.00868
SO4	0.01	0.07	0.02	0.02194	0.01644	0.01344	0.01156	0.00719
CO3	0.3	0.3	0.3	0.86708	0.61850	0.48298	0.39768	0.20021
TOC	0.5	0.5	0.5	0.31880	0.24600	0.20631	0.18133	0.12349
U	0.0012	0.0012	0.0012	3.90E-04	4.16E-04	4.31E-04	4.40E-04	4.61E-04
137Cs	4.3E+09	2E+10	4.3E+09	8.91E+08	7.46E+08	6.67E+08	6.17E+08	5.02E+08
90Sr	44000000	44000000	8E+08	1.46E+07	1.08E+07	8.79E+06	7.51E+06	4.54E+06
99Tc	7.10E+06	7.10E+06	7.10E+06	4.67E+05	3.30E+05	2.55E+05	2.08E+05	9.83E+04
60Co	6.10E+04	6.10E+04	3.70E+05	2.23E+05	1.61E+05	1.27E+05	1.05E+05	5.60E+04
154Eu + 155Eu	1200000	1200000	4300000	3979339.5	2816772	2182962	1784012	860469.1
TRU	480000	480000	3000000	6929703.3	5074721	4063421	3426860	1953264
Na	3 to 10 M			3.88	1.61	15.04	7.70	7.48

Table 11. Liquid Specification Flags - 241-AY-101 with Blends of 241-C-104.

Compliant = T	A					B					C				
Liquid Specification/ Tank Blend	0.1	0.2	0.3	0.4	1	0.1	0.2	0.3	0.4	1	0.1	0.2	0.3	0.4	1
Al	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Ba	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F
Ca	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Cd	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Cl	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Cr	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
F	T	T	T	F	F	T	T	T	T	T	T	T	T	F	F
Fe	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Hg	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
K	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
La	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Ni	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
NO2	F	F	F	T	T	F	F	F	T	T	F	F	F	T	T
NO3	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Pb	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
PO4	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
SO4	F	F	F	F	F	T	T	T	T	T	F	F	F	F	F
CO3	F	F	T	T	T	F	F	T	T	T	F	F	T	T	T
TOC	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
U	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
137Cs	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
90Sr	F	F	F	F	F	F	F	F	F	F	T	T	T	T	T
99Tc	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
60Co	F	F	F	F	F	F	F	F	F	F	T	T	T	T	T
154Eu + 155Eu	F	F	F	F	T	F	F	F	F	T	T	T	T	T	T
TRU	F	F	F	F	F	F	F	F	F	F	T	T	T	T	T

Table 12. Specification Evaluation of Alternate Liquid Wastes - 241-AY-101 with Blends of 241-C-104.

Liquid Specification/ Tank Blend	A	B	C	0.1	0.2	0.3	0.4	1
Al	0.25	0.25	0.25	0.00131	0.00190	0.00241	0.00285	0.00467
Ba	0.0001	0.0001	0.0001	0.00131	0.00190	0.00241	0.00285	0.00467
Ca	0.04	0.04	0.04	0.00187	0.00174	0.00162	0.00152	0.00110
Cd	0.004	0.004	0.004	0.00016	0.00015	0.00014	0.00013	0.00010
Cl	0.037	0.089	0.037	0.00895	0.00868	0.00845	0.00824	0.00740
Cr	0.0069	0.02	0.0069	0.00255	0.00241	0.00229	0.00218	0.00175
F	0.091	0.2	0.091	0.03184	0.05597	0.07685	0.09509	0.16949
Fe	0.01	0.01	0.01	0.00003	0.00003	0.00003	0.00003	0.00003
Hg	0.000014	0.000014	0.000014	0.00000	0.00000	0.00000	0.00000	0.00000
K	0.18	0.18	0.18	0.00371	0.00361	0.00353	0.00345	0.00315
La	0.000083	0.000083	0.000083	0.00002	0.00002	0.00001	0.00001	0.00001
Ni	0.003	0.003	0.003	0.00008	0.00011	0.00013	0.00015	0.00022
NO2	0.38	0.38	0.38	0.41528	0.39860	0.38417	0.37155	0.32012
NO3	0.8	0.8	0.8	0.21730	0.20829	0.20050	0.19369	0.16592
Pb	0.00068	0.00068	0.00068	0.00024	0.00024	0.00024	0.00023	0.00022
PO4	0.038	0.13	0.038	0.00631	0.00630	0.00628	0.00627	0.00622
SO4	0.01	0.07	0.02	0.03217	0.03062	0.02928	0.02810	0.02332
CO3	0.3	0.3	0.3	0.31350	0.30515	0.29792	0.29161	0.26586
TOC	0.5	0.5	0.5	0.20431	0.19572	0.18828	0.18178	0.15528
U	0.0012	0.0012	0.0012	5.09E-04	4.75E-04	4.45E-04	4.19E-04	3.13E-04
137Cs	4.3E+09	2E+10	4.3E+09	5.24E+08	5.15E+08	5.08E+08	5.02E+08	4.75E+08
90Sr	44000000	44000000	8E+08	1.15E+08	2.12E+08	2.95E+08	3.68E+08	6.66E+08
99Tc	7.10E+06	7.10E+06	7.10E+06	3.57E+05	*3.46E+05*	*3.36E+05*	*3.27E+05*	*2.92E+05*
60Co	6.10E+04	6.10E+04	3.70E+05	8.19E+04	8.45E+04	8.68E+04	8.88E+04	9.69E+04
154Eu + 155Eu	1200000	1200000	4300000	1654210.2	1534798	1431465	1341168	972933.2
TRU	480000	480000	3000000	2793546.2	2602838	2437810	2293602	1705511
Na	3 to 10 M			8.63	2.72	21.06	9.38	5.95

Table 13. Liquid Specification Flags - 241-AW-104 with Blends of 241-C-104.

Compliant = T	A					B					C				
Liquid Specification/ Tank Blend	0.1	0.2	0.3	0.4	1	0.1	0.2	0.3	0.4	1	0.1	0.2	0.3	0.4	1
Al	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Ba	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F
Ca	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Cd	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Cl	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Cr	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
F	T	T	F	F	F	T	T	T	T	T	T	T	F	F	F
Fe	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Hg	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
K	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
La	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Ni	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
NO2	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
NO3	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Pb	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
PO4	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
SO4	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
CO3	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
TOC	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
U	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
137Cs	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
90Sr	T	F	F	F	F	T	F	F	F	F	T	T	T	T	T
99Tc	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
60Co	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
154Eu + 155Eu	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
TRU	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T

Table 14. Specification Evaluation of Alternate Liquid Wastes - 241-AW-104 with Blends of 241-C-104.

Liquid Specification/ Tank Blend	A	B	C	0.1	0.2	0.3	0.4	1
Al	0.25	0.25	0.25	0.07736	0.07592	0.07454	0.07321	0.06627
Ba	0.0001	0.0001	0.0001	0.07736	0.07592	0.07454	0.07321	0.06627
Ca	0.04	0.04	0.04	0.00024	0.00024	0.00023	0.00023	0.00020
Cd	0.004	0.004	0.004	0.00009	0.00009	0.00008	0.00008	0.00008
Cl	0.037	0.089	0.037	0.01325	0.01308	0.01292	0.01276	0.01193
Cr	0.0069	0.02	0.0069	0.00097	0.00096	0.00096	0.00095	0.00091
F	0.091	0.2	0.091	0.07927	0.08536	0.09119	0.09679	0.12611
Fe	0.01	0.01	0.01	0.00001	0.00001	0.00001	0.00001	0.00001
Hg	0.000014	0.000014	0.000014	0.00000	0.00000	0.00000	0.00000	0.00000
K	0.18	0.18	0.18	0.02320	0.02276	0.02234	0.02193	0.01980
La	0.000083	0.000083	0.000083	0.00000	0.00000	0.00000	0.00000	0.00000
Ni	0.003	0.003	0.003	0.00003	0.00004	0.00004	0.00005	0.00009
NO2	0.38	0.38	0.38	0.18756	0.18749	0.18742	0.18735	0.18701
NO3	0.8	0.8	0.8	0.22121	0.21847	0.21586	0.21334	0.20019
Pb	0.00068	0.00068	0.00068	0.00000	0.00001	0.00001	0.00002	0.00003
PO4	0.038	0.13	0.038	0.00176	0.00185	0.00194	0.00202	0.00246
SO4	0.01	0.07	0.02	0.00746	0.00753	0.00759	0.00766	0.00799
CO3	0.3	0.3	0.3	0.12584	0.12737	0.12884	0.13024	0.13760
TOC	0.5	0.5	0.5	0.02946	0.03064	0.03178	0.03287	0.03857
U	0.0012	0.0012	0.0012	2.73E-04	2.68E-04	2.63E-04	2.59E-04	2.34E-04
137Cs	4.3E+09	2E+10	4.3E+09	3.96E+08	3.96E+08	3.96E+08	3.96E+08	3.97E+08
90Sr	44000000	44000000	8E+08	3.21E+07	6.23E+07	9.12E+07	1.19E+08	2.64E+08
99Tc	7.10E+06	7.10E+06	7.10E+06	2.57E+05	2.56E+05	2.55E+05	2.53E+05	2.48E+05
60Co	6.10E+04	6.10E+04	3.70E+05	2.57E+03	5.03E+03	7.38E+03	9.64E+03	2.15E+04
154Eu + 155Eu	1200000	1200000	4300000	0.0509434	0.050162	0.049413	0.048694	0.044931
TRU	480000	480000	3000000	381047.36	376177.6	371510.4	367033.3	343583.2
Na	3 to 10 M			30.96	9.24	68.20	29.05	14.99

Table 15. Liquid Specification Flags - 241-SY-102 with Blends of 241-C-104.

Compliant = T	A					B					C				
Liquid Specification/ Tank Blend	0.1	0.2	0.3	0.4	1	0.1	0.2	0.3	0.4	1	0.1	0.2	0.3	0.4	1
Al	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Ba	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F
Ca	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Cd	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Cl	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Cr	F	F	F	F	T	T	T	T	T	T	F	F	F	F	T
F	T	F	F	F	F	T	T	T	T	F	T	F	F	F	F
Fe	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Hg	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
K	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
La	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Ni	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
NO2	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
NO3	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Pb	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
PO4	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
SO4	F	F	F	F	F	T	T	T	T	T	T	T	T	T	T
CO3	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
TOC	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
U	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
137Cs	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
90Sr	F	F	F	F	F	F	F	F	F	F	T	T	T	T	F
99Tc	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
60Co	T	T	T	T	F	T	T	T	T	F	T	T	T	T	T
154Eu + 155Eu	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
TRU	F	F	F	F	F	F	F	F	F	F	F	F	F	F	T

Table 16. Specification Evaluation of Alternate Liquid Wastes - 241-SY-102 with Blends of 241-C-104.

Liquid Specification/ Tank Blend	A	B	C	0.1	0.2	0.3	0.4	1
Al	0.25	0.25	0.25	0.02154	0.02000	0.01881	0.01786	0.01468
Ba	0.0001	0.0001	0.0001	0.02154	0.02000	0.01881	0.01786	0.01468
Ca	0.04	0.04	0.04	0.00065	0.00056	0.00050	0.00045	0.00028
Cd	0.004	0.004	0.004	0.00001	0.00001	0.00001	0.00002	0.00002
Cl	0.037	0.089	0.037	0.01781	0.01620	0.01495	0.01396	0.01063
Cr	0.0069	0.02	0.0069	0.01224	0.01076	0.00961	0.00869	0.00563
F	0.091	0.2	0.091	0.07216	0.10974	0.13880	0.16194	0.23936
Fe	0.01	0.01	0.01	0.00003	0.00003	0.00003	0.00003	0.00003
Hg	0.000014	0.000014	0.000014	0.00000	0.00000	0.00000	0.00000	0.00000
K	0.18	0.18	0.18	0.01643	0.01463	0.01324	0.01213	0.00842
La	0.000083	0.000083	0.000083	0.00000	0.00000	0.00000	0.00000	0.00000
Ni	0.003	0.003	0.003	0.00017	0.00020	0.00023	0.00025	0.00031
NO2	0.38	0.38	0.38	0.19776	0.19603	0.19469	0.19362	0.19006
NO3	0.8	0.8	0.8	0.42786	0.38499	0.35184	0.32544	0.23712
Pb	0.00068	0.00068	0.00068	0.00003	0.00005	0.00007	0.00008	0.00012
PO4	0.038	0.13	0.038	0.03358	0.03007	0.02735	0.02518	0.01794
SO4	0.01	0.07	0.02	0.01419	0.01374	0.01339	0.01312	0.01219
CO3	0.3	0.3	0.3	0.11614	0.12659	0.13466	0.14109	0.16261
TOC	0.5	0.5	0.5	0.06015	0.06336	0.06585	0.06782	0.07443
U	0.0012	0.0012	0.0012	2.12E-05	2.28E-05	2.40E-05	2.50E-05	2.82E-05
137Cs	4.3E+09	2E+10	4.3E+09	2.04E+08	2.29E+08	2.49E+08	2.65E+08	3.18E+08
90Sr	44000000	44000000	8E+08	2.13E+08	3.72E+08	4.94E+08	5.92E+08	9.18E+08
99Tc	7.10E+06	7.10E+06	7.10E+06	2.11E+05	2.10E+05	2.08E+05	2.07E+05	2.04E+05
60Co	6.10E+04	6.10E+04	3.70E+05	1.76E+04	3.05E+04	4.04E+04	4.84E+04	7.49E+04
154Eu + 155Eu	1200000	1200000	4300000	324947.02	283399.7	251272.4	225687.5	140097.9
TRU	480000	480000	3000000	4656103.5	4080175	3634825	3280168	2093724
Na	3 to 10 M			4.58	1.53	12.51	5.81	4.30

Table 17. Liquid Specification Flags – 241-C-102 with Blends of 241-C-104.

Compliant = T	A					B					C				
Liquid Specification/ Tank Blend	0.1	0.2	0.3	0.4	1	0.1	0.2	0.3	0.4	1	0.1	0.2	0.3	0.4	1
Al	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Ba	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F
Ca	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Cd	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Cl	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Cr	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
F	F	F	F	F	F	T	T	T	T	F	F	F	F	F	F
Fe	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Hg	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F
K	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
La	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Ni	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
NO2	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
NO3	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Pb	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
PO4	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
SO4	F	F	F	F	F	T	T	T	T	T	T	T	T	T	T
CO3	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F
TOC	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
U	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
137Cs	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
90Sr	F	F	F	F	F	F	F	F	F	F	T	T	T	T	T
99Tc	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
60Co	F	F	F	F	F	F	F	F	F	F	T	T	T	T	T
154Eu + 155Eu	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
TRU	F	T	T	T	T	F	T	T	T	T	T	T	T	T	T

Table 18. Specification Evaluation of Alternate Liquid Wastes - 241-C-102 with Blends of 241-C-104.

Liquid Specification/ Tank Blend	A	B	C	0.1	0.2	0.3	0.4	1
Al	0.25	0.25	0.25	0.04565	0.04230	0.03952	0.03717	0.02833
Ba	0.0001	0.0001	0.0001	0.04565	0.04230	0.03952	0.03717	0.02833
Ca	0.04	0.04	0.04	0.00133	0.00121	0.00111	0.00102	0.00069
Cd	0.004	0.004	0.004	0.00078	0.00071	0.00065	0.00060	0.00042
Cl	0.037	0.089	0.037	0.01421	0.01338	0.01268	0.01210	0.00989
Cr	0.0069	0.02	0.0069	0.00129	0.00123	0.00118	0.00113	0.00097
F	0.091	0.2	0.091	0.10377	0.12808	0.14826	0.16528	0.22939
Fe	0.01	0.01	0.01	0.00002	0.00002	0.00002	0.00002	0.00003
Hg	0.000014	0.000014	0.000014	0.00009	0.00008	0.00008	0.00007	0.00005
K	0.18	0.18	0.18	0.00643	0.00605	0.00574	0.00547	0.00448
La	0.000083	0.000083	0.000083	0.00000	0.00000	0.00000	0.00000	0.00000
Ni	0.003	0.003	0.003	0.00063	0.00061	0.00059	0.00058	0.00053
NO2	0.38	0.38	0.38	0.11160	0.11833	0.12392	0.12863	0.14638
NO3	0.8	0.8	0.8	0.22664	0.21422	0.20390	0.19519	0.16242
Pb	0.00068	0.00068	0.00068	0.00012	0.00013	0.00013	0.00014	0.00016
PO4	0.038	0.13	0.038	0.02478	0.02305	0.02161	0.02040	0.01583
SO4	0.01	0.07	0.02	0.01196	0.01185	0.01175	0.01166	0.01135
CO3	0.3	0.3	0.3	0.41095	0.39120	0.37480	0.36097	0.30888
TOC	0.5	0.5	0.5	0.02040	0.02641	0.03140	0.03561	0.05146
U	0.0012	0.0012	0.0012	1.34E-04	1.25E-04	1.17E-04	1.11E-04	8.60E-05
137Cs	4.3E+09	2E+10	4.3E+09	3.78E+08	3.80E+08	3.82E+08	3.84E+08	3.91E+08
90Sr	44000000	44000000	8E+08	1.88E+08	3.06E+08	4.03E+08	4.85E+08	7.94E+08
99Tc	7.10E+06	7.10E+06	7.10E+06	2.84E+04	4.43E+04	5.74E+04	6.85E+04	1.10E+05
60Co	6.10E+04	6.10E+04	3.70E+05	8.91E+04	9.18E+04	9.40E+04	9.59E+04	1.03E+05
154Eu + 155Eu	1200000	1200000	4300000	0.002509	0.003586	0.00448	0.005235	0.008075
TRU	480000	480000	3000000	497198.073	465184.8	438600.9	416173	331729.9
Na	3 to 10 M			6.58	2.12	16.72	7.57	5.11

Table 19. Liquid Specification Flags - 241-AY-102/241-C-106 with Blends of 241-C-104.

Compliant = T	A					B					C				
Liquid Specification/ Tank Blend	0.1	0.2	0.3	0.4	1	0.1	0.2	0.3	0.4	1	0.1	0.2	0.3	0.4	1
Al	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Ba	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F
Ca	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Cd	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Cl	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Cr	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
F	F	F	F	F	F	T	T	T	F	F	F	F	F	F	F
Fe	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Hg	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
K	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
La	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Ni	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
NO2	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
NO3	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Pb	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
PO4	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
SO4	F	F	F	F	F	T	T	T	T	T	F	F	F	F	T
CO3	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F
TOC	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
U	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
137Cs	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
90Sr	F	F	F	F	F	F	F	F	F	F	T	T	T	T	F
99Tc	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
60Co	F	F	F	F	F	F	F	F	F	F	T	T	T	T	T
154Eu + 155Eu	F	F	F	F	F	F	F	F	F	F	F	T	T	T	T
TRU	F	F	F	F	F	F	F	F	F	F	F	F	F	F	T

Table 20. Specification Evaluation of Alternate Liquid Wastes - 241-AY-102/241-C-106 with Blends of 241-C-104.

Liquid Specification/ Tank Blend	A	B	C	0.1	0.2	0.3	0.4	1
Al	0.25	0.25	0.25	0.00312	0.00430	0.00512	0.00571	0.00740
Ba	0.0001	0.0001	0.0001	0.00312	0.00430	0.00512	0.00571	0.00740
Ca	0.04	0.04	0.04	0.00008	0.00007	0.00006	0.00005	0.00003
Cd	0.004	0.004	0.004	0.00015	0.00013	0.00011	0.00010	0.00007
Cl	0.037	0.089	0.037	0.02540	0.02164	0.01906	0.01718	0.01180
Cr	0.0069	0.02	0.0069	0.00196	0.00171	0.00154	0.00142	0.00106
F	0.091	0.2	0.091	0.09732	0.14735	0.18168	0.20669	0.27821
Fe	0.01	0.01	0.01	0.00004	0.00004	0.00004	0.00004	0.00004
Hg	0.000014	0.000014	0.000014	0.00000	0.00000	0.00000	0.00000	0.00000
K	0.18	0.18	0.18	0.01277	0.01083	0.00950	0.00853	0.00576
La	0.000083	0.000083	0.000083	0.00000	0.00000	0.00000	0.00000	0.00000
Ni	0.003	0.003	0.003	0.00047	0.00046	0.00045	0.00045	0.00044
NO2	0.38	0.38	0.38	0.27159	0.25532	0.24416	0.23603	0.21278
NO3	0.8	0.8	0.8	0.04379	0.05287	0.05910	0.06363	0.07661
Pb	0.00068	0.00068	0.00068	0.00011	0.00013	0.00014	0.00014	0.00017
PO4	0.038	0.13	0.038	0.02938	0.02505	0.02207	0.01990	0.01370
SO4	0.01	0.07	0.02	0.02967	0.02613	0.02371	0.02194	0.01689
CO3	0.3	0.3	0.3	1.18009	0.99723	0.87176	0.78034	0.51896
TOC	0.5	0.5	0.5	0.40188	0.34294	0.30249	0.27302	0.18877
U	0.0012	0.0012	0.0012	2.59E-04	2.17E-04	1.88E-04	1.67E-04	1.07E-04
137Cs	4.3E+09	2E+10	4.3E+09	1.05E+09	9.32E+08	8.50E+08	7.89E+08	6.17E+08
90Sr	44000000	44000000	8E+08	3.51E+08	5.56E+08	6.97E+08	7.99E+08	1.09E+09
99Tc	7.10E+06	7.10E+06	7.10E+06	6.64E+05	5.77E+05	5.18E+05	4.75E+05	3.51E+05
60Co	6.10E+04	6.10E+04	3.70E+05	3.16E+05	2.79E+05	2.54E+05	2.36E+05	1.83E+05
154Eu + 155Eu	1200000	1200000	4300000	5249003	4271812	3601359	3112808	1716045
TRU	480000	480000	3000000	8857518	7236780	6124786	5314492	2997865
Na	3 to 10 M			2.94	1.05	9.03	4.36	3.64

DISTRIBUTION SHEET

To	From	Page 1 of 1
Distribution	T. W. Crawford, 376-8676	Date 05/21/99
Project Title/Work Order		EDT No.
Alternatives Generation And Analysis For Phase 1 High-Level Waste Feed Tanks Selection, HNF-4219, Rev. 0		ECN No. 627126

Name	MSIN	Text w/ All Attach	Text w/out ESP Output	Attach/ Appendix Only	EDT/ ECN Only
Central Files	B1-07	X			
DOE Reading Room	H2-53	X			
DIMC	H7-15	X			
J. H. Baldwin	R3-73	X			
R. K. Biyani	H3-26	X			
H. L. Boston	R2-53	X			
A. F. Choho	R3-73	X			
T. W. Crawford (10)	R3-73	X			
R. A. Dodd	R3-72	X			
J. S. Garfield	R3-73	X			
K. A. Gasper	A3-03	X			
C. C. Haass	R2-89	X			
J. O. Honeyman	R2-58	X			
J. Jo	R3-73	X			
N. W. Kirch	R2-11	X			
R. A. Kirkbride	R3-73	X			
J. G. Kristofzski	R2-58	X			
S. L. Lambert	R3-75	X			
C. E. Leach	R1-49	X			
R. E. Lerch	A4-70	X			
M. J. O'Neill	R3-75	X			
R. M. Orme	R3-73	X			
D. E. Place	R3-73	X			
R. W. Powell	R3-75	X			
W. T. Thompson	R3-73	X			
R. L. Treat	R3-75	X			
D. J. Washenfelder	A3-03	X			
K. D. Wiemers	A0-21	X			
R. D. Wojtasek	R2-53	X			