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Technical Feasibility of Transuranic Tank Waste Processing in High-Level Waste Vitrification Facility

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**TECHNICAL FEASIBILITY OF
TRANSURANIC TANK WASTE
PROCESSING IN A HIGH-LEVEL
WASTE VITRIFICATION FACILITY**

July 1996

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LIST OF TERMS

CFR	Code of Federal Regulations
CH	Contact handled
CWBS	Contract Work Breakdown Structure
HLW	High-level waste
HVAC	Heating, Ventilation, and Air Conditioning
HWVP	Hanford Waste Vitrification Plant
OD	Outer Diameter
RCRA	<i>Resource Conservation and Recovery Act of 1976</i>
RH	Remote handled
SC	Safety Class
TOE	Total Operating Efficiency
TRU	Transuranic
TSD	Treatment, Storage, and Disposal
TWRS	Tank Waste Remediation System
WAC	Washington Administrative Code
WHC	Westinghouse Hanford Company
WIPP	Waste Isolation Pilot Plant

TECHNICAL FEASIBILITY OF TRANSURANIC TANK WASTE PROCESSING IN A HIGH-LEVEL WASTE VITRIFICATION FACILITY

1.0 OBJECTIVE

The objective of this study is to determine the technical feasibility of processing transuranic (TRU) tank waste in a high-level waste (HLW) vitrification facility. This is achieved by performing an impact assessment of a reference case HLW facility modified to separately process TRU waste. Data are presented for Hanford Site TRU wastes and are compared against established waste acceptance criteria for the Waste Isolation Pilot Plant (WIPP) program. Schedule and cost impacts are evaluated for the proposed TRU campaign.

1.1 BACKGROUND AND SCOPE

TRU wastes at the Hanford Site account for approximately 8 percent of the estimated volume of HLW proposed for vitrification at the reference case 20 MT/day facility. If this waste volume is campaigned and processed separately from the HLW, packaged TRU waste could ultimately be transported to the WIPP.

A 20-MT/day HLW vitrification facility is considered as the reference case for this study. The reference case has been documented in previous phases of the *Tank Waste Remediation System Facility Configuration Study* (Boomer et al. 1994) and is discussed in the *Alternatives for High-Level Waste Forms, Containers, and Container Processing Systems* (Crawford 1995).

To assess the impact of processing a separate TRU waste campaign to the reference case, it is assumed that only those operations down stream of the melter require conversion. This implies that melter feed, melter, and melter offgas operations remain independent of the product campaign conversion. Hence, to evaluate this impact, only modifications to the canister and overpack processing systems must be developed for the remote handled canister configuration acceptable to WIPP. From this information, an assessment relative to the reference case can be made.

Selection criteria are identified as a basis for evaluation. The set of categories include: process flowsheet/facility design impact, operability/complexity, maintainability, maturity of technology, schedule impact, regulatory impact, safety, and capital cost.

1.2 PURPOSE AND NEED

The development and evaluation of alternatives provides a basis for future selection of desired concepts. The intent of this study is to provide data specific to modifying a 20-MT/day HLW facility to campaign both HLW and TRU waste glass forms. The data presented describe and evaluate this modification against the criteria set forth in Section 1.1. The data presented in this report are considered supplemental, and will support future decision processes in the development of a TRU processing strategy and a HLW vitrification facility.

2.0 SUMMARY

It is technically feasible to process transuranic (TRU) tank waste in a high-level waste vitrification facility based on the results of this study. The study evaluates the impact of modifying a reference case HLW facility to process TRU waste. It is assumed that facility modifications are necessary only downstream of the melter system to accommodate a different type of product canister.

It is recommended the TRU waste be campaigned at plant startup to allow for immediate conversion of the HLW campaign following the TRU campaign without requiring system flushing or increasing the waste volume. Two other cases for campaigning TRU waste were evaluated and found to be less desirable.

The radiation dose rate of the product TRU waste glass requires it to be handled as remote handled (RH) TRU waste. The waste would meet all of WIPP's waste acceptance criteria for RH-TRU waste. An estimated volume of between 1,000 m³ and 2,000 m³ of RH TRU glass will be produced, depending on the glass formulation and the amount of blending of the TRU tanks before vitrification. However, it should be noted that an unquantified degree of uncertainty exists as to the availability of the WIPP for Hanford Site vitrified TRU wastes.

The total amount of TRU and HLW glass that would be produced in a modified HLW vitrification facility is between 20,000 MT and 26,000 MT, or approximately 3 percent to 13 percent more than the reference case depending on the glass formulation and blending decisions. The impact of this additional glass production on operating costs is not addressed in this study.

An analysis of process flowsheet/facility design impacts, operability/complexity, maintainability, maturity of technology, schedule impacts, regulatory impacts, safety, and cost impact supports the technical feasibility of processing TRU waste in a HLW vitrification facility.

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3.0 TECHNICAL FINDINGS AND CONCLUSIONS

Three cases were considered for campaigning TRU waste in a reference case vitrification plant.

- Case 1: Campaign TRU wastes at plant start up
- Case 2: Campaign TRU wastes after a melter change out
- Case 3: Campaign TRU wastes at any plant operating point immediately following HLW.

Both Cases 2 and 3 require dedicated facility features to flush the feed preparation systems and the melter vessel before the conversion from a HLW campaign to a TRU campaign. System flushing will either generate lower waste loadings in the HLW glass, which in effect reduces plant total operating efficiency (TOE) as well as generates more waste volume for ultimate disposal, or will require processing some amount of TRU waste as HLW until the glass chemistry meets WIPP requirements. Case 1 allows for immediate conversion of the HLW campaign following the TRU campaign without requiring system flushing or increasing the waste volume. Additionally, Case 1 allows for the procurement of a reduced capacity melter and a single canister/overpack processing line. This defers procurement of the 20 MT/day melter and the redundant canister/overpack processing system until several years after plant startup. This implies a scheduled melter conversion before campaigning HLW.

Cases 2 and 3 offer no clear advantages in terms of maintainability compared with Case 1. However, if the facility is constructed with no modification as the reference plant (i.e., 20 MT/day melter and 2 canister/overpack process lines), the operability of the second canister/overpack process line after it has set idle for the TRU campaign (approximately 4 years) is questionable.

The single canister/overpack system operations required for the TRU campaign suggest that remote maintenance concepts would be more easily developed and demonstrated at reduced plant capacity. Developed remote maintenance concepts could then be applied to full scale production activities with a high degree of assurance. This maintenance feature is facilitated by Case 1.

Significant schedule issues for processing TRU and HLW in the same facility include *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1994) (referred to as Tri-Party Agreement) milestones and the WIPP waste emplacement phase schedule. It is demonstrated that all Tri-Party Agreement milestones can be met since the total volume of wastes can be vitrified in 14 years at a significantly reduced plant production rate. However, the WIPP schedule limits the TRU waste acceptance to the year 2018.

Appendix C shows the waste emplacement phase of TRU containers at the WIPP is 20 years in duration beginning in fiscal year (FY) 1998 and continuing through FY 2018. During this period, approximately 7,080 m³ of remote-handled (RH) TRU canisters will be accepted by the repository. An estimated volume of between 1,000 m³ and 2,000 m³ of RH TRU glass will be produced, depending on the glass formulation and the amount of blending of the TRU tanks before vitrification.

It is technically feasible to process transuranic (TRU) tank waste in a high-level waste vitrification facility based on the results of this study. The study evaluates the impact of modifying a reference case HLW facility to process TRU waste. Analysis indicates that facility modifications are necessary only downstream of the melter system to accommodate a different type of product canister.

4.0 DESIGN CONCEPTS

4.1 REFERENCE DESIGN

A 20-MT/day HLW vitrification facility producing monolithic waste forms is the reference case for this study. The following sections describe the reference case.

4.1.1 Packaging Configuration

The reference case high-level vitrification facility is designed to fill small unshielded metal canisters then seal them in a 4-pack metal overpack. The overpack is placed into a shielded concrete cask for interim storage at the Hanford Site. The paragraphs below offer a process description for the reference case.

Figure 4-1 shows a conceptual sketch of a small unshielded canister filled with HLW monolithic glass. This canister is similar to the Hanford Waste Vitrification Plant (HWVP) canister with slightly modified dimensions. The canister is 4.57 m tall and 0.68 m in diameter, and is made of 0.95-cm thick stainless steel on all surfaces. The calculated empty weight of the canister is 785 kg.

The following assumptions are made for the monolithic glass in the canister:

- The canister is filled with glass to approximately 89 cm from the top of the fill neck of the canister.
- The specific density of the waste glass is 2,643 kg/m³ irrespective of waste oxide loading.

Based on these assumptions, the total quantity of glass per canister is 1.26 m³ with a weight of 3.33 MT. The dose rate on the outer surface of a canister is estimated to be 22.73 Sv/h (2,273 rem/h).

Each of the two canister handling lines in the reference facility are designed to process one canister every 8 hours for a total of four canisters in 16 hours. Once four canisters have been processed and have passed all inspections, they are loaded into a 4-pack overpack. One overpack is therefore produced every 16 hours.

Figure 4-1. Unshielded Small Canisters (Monolith).

**Stainless Steel
Canisters
Wall Thickness
0.95cm**

Two glass formulations are being considered for the HLW facility, one using High-Level Vitrification Plant (HWVP) limits and the other using Composition Variation Study (CVS) limits. These limits are described in Appendix A. Manuel calculated glass volumes and waste oxide loadings based on the *TWRS Process Flowsheet*, Rev. 1 (Orme 1995) and different glass compositions suitable for different melter types. Details of the calculations are provided in Appendix A. Using the CVS limits will permit a 59 percent waste oxide loading while the HWVP limits will only permit 51 percent waste oxide loading. However, use of the CVS limits has some technical problems, that are beyond the scope of this study, that must be resolved before they can be used. The HWVP limits are the current TWRS baseline (Orme 1995). The total number of canisters produced over the life of the plant will range between 5,940 canisters with CVS limits or 6,860 canisters with HWVP limits.

Figure 4-2 shows a sketch of a concrete storage cask for an unshielded 4-pack overpack that contains four canisters of glass as illustrated in the previous figure. It is assumed that the cask is a cylinder with a flat bottom and flat bolt-on top. The cask's 70-cm thick wall yields a radiation dose rate of 0.1 mSv/h at the outer surface of the cask. The calculated empty weight of the cask is 90 MT. The weight of a cask that contains an overpack loaded with four canisters filled with monolithic glass is 112.96 MT. Based on the canister processing rate discussed above, a full cask is produced every 16 hours. The total number of overpacks produced over the life of the plant will vary between 1,485 and 1,715 depending on the glass formulation.

4.1.2 Facility Description

A plan and two elevations views of the reference HLW vitrification facility are contained in Appendix B. The vitrification building features a modular design reflecting an anticipated need for process flexibility and periodic large component replacement.

The melter cell depicted is configured for a joule-heated melter. Molten glass is gravity poured through an opening in the melter cell floor into a 4.57-m tall stainless steel canister. The canister is located at a fill station underneath the melter cell. The melter cell also contains the close-coupled quench tower, venturi scrubber, and chiller of the melter offgas system. The remaining remote portions of the melter offgas system are contained in the metal filter area in the chemical process cell.

The canister processing area contains two basement level compartments for filling, welding, decontaminating, and smear testing for both canisters and overpacks. There are two independent canister processing cells and a single canister overpack cell. The canister handling cells are located adjacent to the melter cell at the side of the building.

Figure 4-2. Concrete Shielded Casks for Unshielded 4-Pack Overpack Canisters (Monolith).

4.1.3 Canister, Overpack, and Cask Handling System Descriptions

Figure 4-3 depicts a block flow diagram of the canister, overpack, and cask handling operations. Rail cars or trucks transport the canisters and overpacks to the vitrification plant site. A modified fork lift unloads empty canisters from rail cars and transports them to the Canister/Cask Handling Annex. A modified fork lift or gantry crane unloads empty overpacks and moves them into separate staging areas within the Annex. Overhead cranes are used to manage the canister, overpack, and cask inventory in the annex.

The Canister/Cask Handling Annex is an annex to the HLW vitrification facility. The canisters, overpacks, and casks move from receiving areas into the Canister/Cask Handling Annex for unpacking, inspection, lag storage, and movement to the appropriate load-in station. The annex ensures quality control over the canister/cask and reduces the exposure to the external environment by maintaining a shielded lag storage area for filled concrete casks awaiting transfer from the facility. Canister/ overpack load-in stations and the overpack load-out station are integral to the Annex. Overhead cranes are used to move canisters, overpacks, and casks in the facility.

Empty canisters are introduced into the load-in station in the vitrification building from the Canister/Cask Handling Annex. The canister processing cell contains two parallel cart track systems for processing canisters through the stations. The carts ride on rails for load-in, fill, and unloading at the cooling rack, and are provided with a support basket used to lift the heated canisters after fill operations. Empty baskets are placed back into carts which then back up to the canister load-in station where they are staged to receive the next empty canister. Once a canister is loaded onto a cart, the cart transfers the canister to the fill station beneath the melter. The cart transports the filled canisters into the canister cooling cell where a weld plug is inserted. A canister handling robot lifts the basket (canister inside of it) out of the cart and places it into one of the available cooling positions in the 36-position cooling rack. Canisters are cooled in separate, insulated racks. The robot's operation is completely automated. Sixteen of the rack's 36 positions are for cooling and 20 positions are for lag storage. After each canister is cooled for approximately 50 hours, the canister handling robot moves the canister through a hatch and onto an empty cart on the next transfer system.

The cart transports cooled canisters to the weld and inspection stations. After welding and inspection, the canister is moved into the decontamination station. Decontamination operations are performed by another canister handling robot. The canister handling robot places the canister into a decontamination tank. Once the canister has completed decontamination operations, the canister handling robot moves the canister into the rinse and dry tank. The empty cart backs up to the load/unload position where it is staged to receive the next cooled canister.

Figure 4-3. Canister, Overpack and Case Handling Systems Block Flow Diagram.

From the rinse tank, the canister is lifted through a hatch by another canister handling robot and, if required, smear tested. However, normal operations are not expected to require smear testing, so canisters are lowered through another hatch directly into a metal overpack in the overpack station. Each overpack is loaded with four canisters. The overpacks are brought into the overpack area on carts. The cart system is considered to be a "clean system" and is contact maintained. After the fourth canister is placed into an overpack and the lid is placed, the cart transports the overpack to a weld and inspection area. After a successful weld and inspection is performed, the cart moves the overpack into a smear test area. An overpack handling robot then picks up the overpack from the cart and places it on the smear test turntable. The empty cart then returns to receive another overpack.

Upon completing a successful smear test, the handling robot transports the overpack into the load-out area. If the overpack fails smear testing, it is lowered through a hatch into the overpack decontamination cell. After decontamination, the overpack is transferred back to the smear test station for another smear test. The overpack leaves the smear test area via the handling robot. The robot places the metal overpack on a stand that is located beneath the overpack load-out hatch. An overhead bridge crane, located in the cask loading room, lifts the metal overpack off of the stand and into the cask loading room; a shielded area integral to the Canister/Cask Handling Annex. Inside the cask loading room, the crane places the metal overpack into a concrete cask, places a concrete lid onto the cask, then bolts down the lid before cask removal. The cask is moved by a cask transporter into the staging area. An empty cask is brought into the cask loading room by the cask transporter for continued operations. Filled casks are staged in the Canister/Cask Handling Annex until such time that they are transferred to a storage location. The staging area of the Annex requires only light shielding since the casks are designed to reduce dose rates from the "worst case" canisters to 10 mrem/h. This annex is contact maintained.

4.2 TRANSURANIC WASTE VITRIFICATION, REFERENCE CASE CONVERSIONS

This section identifies those systems of the reference HLW vitrification facility that would be affected by a conversion to TRU waste vitrification campaign. The reference case HLW vitrification facility assumed a total of between 20,000 MT and 23,000 MT of glass was required to be produced over the lifetime of the plant, again depending on the glass formulation selected. For the conversion case, the total volume of glass to be produced over the lifetime of the plant changes due to waste blending, addition of glass formers, etc. The estimated amount of HLW glass to be produced in the conversion plant is between 18,000 and 20,000 MT, and the amount of TRU glass to be produced is between 2,600 MT and 5,300 MT depending on the glass formulation selected and whether TRU wastes are blended before vitrification or not. Hence, the total amount of glass required to be produced in the conversion plant is between 20,000 MT and 26,000 MT, approximately 3 percent to 13 percent more than the reference case depending on the glass formulation and blending decisions. Table 4-1 illustrates this data.

Table 4-1. High-Level Waste and Transuranic Waste Estimates (MT of Glass).

Glass Formulation ^b	High-level waste processing only	Blending of transuranic waste ^a	Transuranic processing		
			High-level waste	Transuranic	Total
HWVP	22,845	No	20,481	5,252	25,733
CVS	19,781		17,683	4,456	22,139
HWVP	N/A	Yes	20,481	3,427	23,908
CVS	N/A		17,683	2,634	20,317

^aWithout blending, the transuranic waste oxide loading is more severely limited by the solubility of ZrO_2 , Cr_2O_3 , and/or P_2O_5 .

^bCVS limits allow greater waste oxide loading than HWVP limits.

It is assumed that only the operations down stream of the melter require conversion for TRU waste processing. This implies the feed preparation and melter systems are not impacted by the conversion. This assumption clearly attempts to minimize facility and operational impacts of the reference case during the conversion of waste product campaigns. This is referred to as the minimal impact scenario. Other melter types such as those with a steep sloped wall and bottom pour required for producing a crystalline waste product, are not specifically addressed in this report.

4.2.1 Packaging Configuration, Modifications

The quantity of HLW glass produced in the conversion plant will decrease by approximately 10 percent due to the separate TRU campaign. This implies that the number of HLW packages discussed in Section 4.1.1 required to package all HLW will decrease. The previous section identified between 18,000 MT and 20,000 MT of HLW to be vitrified in the conversion plant. This figure implies that between 5,310 and 6,150 canisters and between 1,330 and 1,540 overpacks and concrete casks will be produced during the HLW campaign.

Figure 4-4 illustrates a modified HLW canister that may be used during the production of TRU monoliths. The TRU canister will be 2.91-m tall and 0.64 m in diameter. The canister is made of stainless steel and is assumed to be 0.95-cm thick on all surfaces. The calculated empty weight of the canister 0.4 MT. The pintle design of the TRU canister is identical to the HLW canister design. This design feature allows the melter fill system (pour spout interface to the canister) and canister handling robots to remain independent of the canister/campaign conversion and will not affect plant TOE during the change in waste campaigns.

Figure 4-4. Unshielded Transuranic Canisters (Monolith).

The following assumptions are made for the monolithic glass in the canister:

- The canister is filled with glass to approximately 55 cm from the top of the canister.
- The specific density of the waste glass is 2,643 kg/m³ irrespective of waste oxide loading.

Based on these assumptions, the total quantity of glass per TRU canister is 0.71 m³ with a weight of 1.88 MT, or approximately 58 percent of that held in a HLW canister. For a total TRU production of between 2,634 MT and 5,252 MT, the number of TRU canisters will be between 1,401 and 2,794.

Figure 4-5 illustrates a sketch of the RH TRU canister that will be used as an overpack for the TRU canister shown in Figure 4-4. The RH TRU canister overpack will be constructed to meet structural requirements and design conditions for Type A packaging specified in 49 CFR 173.412. Additionally, the RH TRU canister overpack will be certified to the WIPP-approved specifications. The overpack is 3.07 m in length, 0.66 m in outside diameter with a wall thickness of 0.64 cm, and is constructed out of ASTM A516 Grade 55, a carbon steel with improved notch toughness. The RH TRU canister overpack is assumed to be a cylinder with a flat bottom and reverse flanged head. The head configuration, consisting of the flange and axial lifting pintle, is welded onto the overpack cylinder after it is overpacked with the TRU canister.

Current WIPP acceptance criteria requires the pintle assembly to be fitted with a carbon composite high-efficiency air (HEPA) filter system with a minimum airflow of 3,000 cc/min. This requirement exists since current WIPP qualified waste forms may generate gases inside the canister. Since none of the qualified waste forms considered are vitrified glass, the HEPA filter would not be expected as a requirement for RH TRU canisters as vitrified waste forms are proposed to the WIPP. The RH TRU canister overpack assumed for this study does not include a canister filter system.

The calculated empty weight of the overpack is 0.39 MT. The weight of an overpack containing a canister filled with monolithic glass is 2.66 MT. This weight is below the limit of the WIPP acceptance criteria for remote handled canisters of 3.34 MT.

Figure 4-6 shows a conceptual sketch of a TRU shielded concrete storage cask. This cask will contain 4 unshielded RH TRU canisters in interim storage until such time that they are prepared for transfer to the WIPP. It is assumed that the cask is a cylinder with a flat bottom and flat bolt-on top. The cask's 49-cm thick wall yields a radiation dose rate of 0.1 mSv/h at the outer surface of the cask. The calculated empty weight of the cask is 35.98 MT. The weight of a cask that contains four RH TRU canisters overpacked with monolithic glass is 46.62 MT.

Figure 4-5. Unshielded Remote Handled Transuranic Canisters Overpack.

Figure 4-6. Concrete Shielded 4-Pack for Unshielded Remote Handled Transuranic Canister Overpacks (Monolith).

4.2.2 Transuranic Waste Processing

Conversion from a HLW campaign to a TRU waste campaign will require minimal modifications to the reference facility. As discussed in Section 4.2, the minimal facility impact scenario requires that any TRU waste campaign impose limited modifications to the existing reference facility.

For reference overpack contains four canisters. This 4:1 canister to overpack ratio allows up to 16 hours to process an overpack in order to meet plant design capacity of 20-MT/day (the rate at which canisters are produced is two every 8 hours). Since the TRU overpack configuration assumes a 1:1 canister to overpack ratio, and considering that 2 canister processing lines converge to a single overpack line, an overpack would have to be processed in the one half the time it takes a canister to be processed (i.e., 4 hours) in order to maintain the plant design capacity during the TRU campaign. This is not considered likely, so the minimal impact scenario does not assume plant design capacity is maintained during the TRU waste campaign.

Conservatively, it is assumed that a TRU canister could be processed at an equivalent rate as the larger HLW canisters; one every 8 hours on each canister processing line. Furthermore, it is assumed that an overpack could be processed in the same amount of time that it takes to process a canister, or 8 hours. Given the 1:1 canister to overpack process timing ratio, only one of the canister process lines are required to operate for the minimal impact scenario during the TRU campaign.

For this campaign, the plant output of vitrified TRU product is 5.6 MT/day, or approximately 28 percent the reference plant's design capacity. This is a result of the single canister and overpack lines, as well as the reduced glass volume of the TRU canister (approximately 56 percent of the volume). The total number of TRU canisters and overpacks produced over the life of the facility is between 1,401 and 2,794. Since four overpacks will be loaded into each cask, between 350 and 699 overpacks will be produced.

4.2.3 Transuranic Waste Form Process Description

The minimal impact scenario requires limited facility modifications to produce monolithic TRU waste forms and package them. As discussed in the previous section, a reduced capacity plant would involve a single canister processing line and the overpack line, and assume similar time requirements for canister processing. As a result, facility modifications for the TRU campaign affect these systems minimally.

Figure 4-3 depicts a block flow diagram of the canister and overpack handling systems for the reference case. During a TRU campaign, the TRU canister and overpacks will be processed similarly using the same transfer systems and canister/overpack operations. The following paragraphs discuss the primary modifications required to the reference systems during a conversion in waste form campaigns.

Only a single track in the canister processing cell will be required for processing TRU canisters through the stations. The carts, not requiring modification, ride on the same rail system for load-in, fill, and unloading at the cooling rack. However, the support baskets used to lift the heated canisters after filling, require modification to ensure that melter fill operations are not affected by the TRU canister change over (recall that it is shorter than the reference canister). The primary modification to the basket requires that the pintle of the TRU canister be at the same elevation as the reference case canister. This is easily accomplished by adjusting the base of the basket. Hence, load-in, fill and unloading operations, as well as all basket transfer operations by the canister handling robot are performed similarly, independent of the TRU canister.

Once cooled, the canister handling robot uses a pintle grapple and lifts the TRU canister from the cooling rack and places it on the cart system traveling to the weld and inspection stations. Minor modifications to the transfer carts (or replacement) are required to maintain the same elevation of the TRU canister as the reference case. Welding and inspection for the TRU canister are essentially the same as for the reference case since the canister material and geometry (around the weld area) are the same.

After welding and inspection, the TRU canister is moved into the decontamination station. Decontamination operations are performed by the bridge mounted canister handling robot used in the reference case. The canister handling robot lifts the TRU canister into a decontamination tank. Minor adjustments to the decontamination tank (e.g., canister rack), or reprogramming the canister handling robot are required for the placing the different sized TRU canister into the decontamination tank. Once the canister has completed decontamination operations, the canister handling robot moves the TRU canister into the rinse/dry tank. The empty cart backs up to the load/unload position where it is staged to receive the next cooled TRU canister.

From the rinse/dry tank, the TRU canister is lifted through a hatch by the canister handling robot and, if required, smear tested. However, normal operations do not require smear testing, so TRU canisters are lowered through another hatch directly into a RH TRU canister overpack in the overpack station. The RH TRU canister overpack is brought into the overpack area on a specially modified railed cart (modified from the reference case). The cart system is still considered to be a "clean system" during the TRU campaign.

After the TRU canister is placed into an overpack, a cart transports the overpack to the weld and inspection area. Since the weld parameters have changed considerably with the change in overpack, the weld head assembly must be replaced before the TRU campaign. This activity is easily accomplished since the overpack area is considered a "clean system" and can be routinely scheduled. After a successful weld and inspection is performed, the cart moves the RH TRU canister overpack into a smear test area. The overpack handling robot picks up the overpack and places it on the smear test turntable. This robot's grappling mechanism will have to be modified to interface with the TRU overpacks. The empty cart then returns to receive another overpack. Although the smear test station is designed for the reference case overpack, it is assumed to be reprogrammable to survey the RH TRU canister

overpack. WIPP surface contamination limits for RH TRU canisters are 50 pCi/100 cm² alpha, and 450 pCi/100 cm² beta-gamma.

Upon completing a smear test, the handling robot transfers the RH TRU canister overpack into a decontamination area. The overpack is decontaminated only if the smear test shows unacceptable contamination levels. If an overpack requires decontamination, it is moved back to the smear test station for a final smear test after the decontamination process is completed. The RH TRU canister overpack leaves the decontamination area via the handling robot. The robot places the overpack on a stand that is located beneath the cask loading room hatch. The lifting device on the bridge crane located in the cask loading room has been changed to lift the RH TRU canister overpack by the axial lifting pintle. Four RH TRU canister overpacks are loaded into a TRU shielded concrete cask in the Canister/Cask Handling Annex as discussed in Section 4.1.3 above. The casks are identified as containing TRU materials, and are staged until such time that they either go to interim site storage or are processed for transfer to the WIPP repository.

4.3 SUMMARY OF TRANSURANIC CAMPAIGN FACILITY IMPACT

The minimal impact scenario imposes only minor changes to the reference design as described below. A single canister processing line and the overpack line are required to process vitrified TRU waste form packages at approximately 28 percent of plant design capacity, or roughly at 5.6 MT/day. All transfer systems and canister/overpack functions remain unchanged during the TRU campaign conversion. Physical changes will be required for the lifting baskets, canister and overpack transfer carts, overpack handling robot interface devices, weld head for the RH TRU canister overpack, and programming logic changes for the several functions (e.g., decontamination, smear testing, overpacking, etc.). The following points are noted for the minimal impact scenario:

- TRU wastes can be processed in the reference facility without interrupting melter operations.
- If HLW operations begin before TRU processing, the melter feed system and the melter vessel will have to be flushed.
- TRU wastes can be processed in the reference facility without materially increasing the total amount of glass produced.
- The canister interface with the fill system (pour spout) remains unchanged during the campaign conversion.
- The canister processing/handling systems require only modification before the TRU waste campaign.

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5.0 OPTION ANALYSIS

The following sections evaluate a conversion of a reference HLW plant to campaign TRU wastes with minimal impact to the reference design. The assessment categories are introduced in Section 1.1 and include: process flowsheet/facility design impact, operability/complexity, maintainability, maturity of technology, schedule impact, regulatory impact, safety and cost. Although this study assumes minimal impact to the reference facility, three cases are considered for which a TRU campaign can be run:

- Case 1: Campaign TRU wastes at plant start up.
- Case 2: Campaign TRU wastes after melter change out.
- Case 3: Campaign TRU wastes at any plant operating point immediately following HLW.

Two other sets of alternatives are also evaluated. The melter can be either high temperature or low temperature. High temperature melters allow a higher waste oxide loading and therefore less total glass production for both HLW and TRU. TRU processing has little input to the high versus low temperature decision, but that decision has financial impacts on the TRU processing evaluation.

In the second alternative, the TRU waste located in the underground tanks can be either blended together before processing or processed tank by tank. If processing is performed tank by tank, solubility limits are reached by certain chemical species before the maximum waste oxide loading is reached. Each tank contains different chemical species, so that blending all of the tanks before vitrification dilutes the concentration of each of them, thus allowing the maximum waste oxide limit to be reached. Blending, therefore, has the effect of reducing the total amount of TRU glass that must be produced.

The economics of the two bounding alternatives are evaluated to look at the sensitivity of these decisions on the outcome of this study:

- Alternative 1: High temperature melter and full blending to obtain the least amount of glass.
- Alternative 2: Low temperature melter and no blending to obtain the maximum amount of glass.

The following evaluation will consider impact of each case to the reference facility. Both processing alternatives will be considered in the cost analysis section.

5.1 PROCESS FLOWSHEET/FACILITY DESIGN IMPACT

Both cases 2 and 3 require that the feed system and melter vessel be flushed of HLW before TRU processing begins. These cases require dedicated facilities/systems to flush, catch, test and recycle feed product, or to flush, test, and vitrify feed product before processing TRU wastes. The alternative to flushing and catching feed product during the TRU conversion is to process nonradioactive feed and produce extra low concentrate HLW monoliths during the system flush. This method of flushing is assumed to have a smaller impact on the design of the facility.

5.2 OPERABILITY/COMPLEXITY

Case 1 does not require a flush system on the feed preparation system. Since flushing is not required, this option minimizes the operational impact of the TRU conversion. Immediately following the TRU campaign, HLW can be introduced into the feed systems without an interruption in plant schedule. This case represents the optimal case (given the assumptions of this study) between maximizing plant TOE and minimizing glass volumes (reduces flush volume).

The primary operational issue for all cases is the operation of the melter during the TRU campaign. For the minimal impact scenario, the reference plant is modified to vitrify and package TRU waste. Since the converted plant is limited by its overpacking capability, output during TRU processing is approximately 25 percent of the rated design capacity. This requires the reference case 20-MT/day melter to be operated at approximately 5-MT/day for the TRU campaign. Several alternatives exist for this operation:

- The 20-MT/day melter is designed to operate at a reduced capacity for the TRU campaign.
- The 20-MT/day melter is operated in batch mode. That is, the melter fills TRU canisters until all lag storage positions in the canister cooling rack are occupied. The melter is idled until all TRU canisters are processed by the canister/overpack lines.
- A 5-MT/day melter is procured specifically for the minimal impact scenario and is changed-out after the TRU campaign.

Although these options are not discussed in detail, the last alternative has some cost advantages and is discussed briefly in Section 5.8.

Case 2 requires flushing the feed preparation system before processing TRU wastes after a melter change out. In this case, the glass volume inside the "old" melter may or may not be included in the flushing since it may be a scheduled or unscheduled melter change-out event. In the event where it is a scheduled change-out, the feed preparation system and

melter will be flushed, processed, and vitrified; the flush product will be categorized as HLW glass (with diluted oxide loading).

In the event where melter change-out is unscheduled, the feed preparation system could be flushed, processed, and maintained. Vitrification of the flush product would occur after the melter has been replaced. After the flush product and entire volume of TRU waste has been vitrified, the plant may resume a HLW campaign. (No flushing is required for this campaign conversion.) The volume of glass inside the "old" melter would be recovered by systems in the melter cut up cell for later recycle.

Case 3 campaigns TRU wastes at any time during the lifetime of the reference plant and includes the melter as integral to the system requiring flushing. This campaign conversion would be considered a scheduled event, where flushing, processing and vitrification of the flush product would be similar to Case 2 above with the melter on-line. A desirable alternative to this option would be to campaign TRU wastes following vitrification of all HLW volumes. Before processing TRU waste forms in the canister/overpack process areas, the melter may be required to idle while minimal hardware modifications and independent verifications are made to the canister/overpack processing lines. This method affects plant TOE and increases disposal costs by increasing the volume of vitrified HLW. During the TRU campaign, the second (and unused) canister processing line could be used as a back-up system, or for spare parts. The second canister processing line would not require restart after the TRU campaign.

5.3 MAINTAINABILITY

In general, all cases that campaign TRU wastes before HLW imply that one of the two canister processing lines sit idle during the TRU campaign. This suggests that the idle canister processing line is expected to restart after the TRU campaign so the reference facility can assume its rated production capacity. In all such cases, this operating scenario presents a high degree of uncertainty as to the availability considerations for the idle canister processing line during start-up and normal operations. On the other hand, this scenario does imply that the availability of the TRU canister process line, given a backup system is on stand-by, is very high (with the exception of shared material handling devices).

Case 1 requires processing TRU wastes at the beginning of plant life. This offers some advantages over other alternatives. For instance, the minimal impact scenario requires only a single canister processing line for the TRU campaign at approximately 25 percent plant design capacity. Assuming the other processing line remains unused, any decontamination activities for scheduled or unscheduled contact maintenance activities is facilitated. Additionally, the reduced capacity of the TRU campaign is ideal for the development and demonstration of remote and semi-remote maintenance concepts (smaller source terms and less contamination) to be used during full-scale production activities.

5.4 MATURITY OF TECHNOLOGY

Maturity of technology is not considered an issue since both campaigns use similar technologies.

5.5 SCHEDULE IMPACTS

Processing TRU waste in the HLW vitrification plant will increase the completion date of HLW processing by 2.3 years if HWVP limits are used, and by only 1.6 years if CVS limits are used. A melter using HWVP limits is expected to allow a 52 percent HLW waste oxide loading and a melter using CVS limits is expected to allow a 60 percent HLW waste oxide loading.

A letter from Mark W. Frei, Office of Waste Management Projects, to Mr. Jack Schultz, U.S. Government Accounting Office, May 13, 1992, states the disposal phase of TRU containers at the WIPP is 20 years in duration beginning in FY 1998 and continuing through FY 2018 (see Appendix C). According to information provided in the Federal Facility Agreement and Consent Order Change Control Form, M-51-93-01, January 25, 1994, milestone M-51-03 establishes the initiation of hot operations of the HLW vitrification facility in December of 2009. Milestone M-51-00 completes the vitrification of Hanford high-level tank waste in December of 2028. Imposing the vitrification milestone schedule onto the WIPP waste emplacement schedule, packaged vitrified Hanford TRU waste could be available to be sent to the WIPP during the period of 2010 to 2018.

An unquantified degree of uncertainty exists as to the acceptability of immobilized tank waste to the WIPP. This uncertainty must consider the minimal volume allotted for RH TRU waste disposal at the WIPP repository (7,075 m³, or approximately 5 percent the total volume for waste disposal), the considerable volume of RH TRU glass produced at the Hanford vitrification facility (at least 1,973 m³, or almost 30 percent available volume at the WIPP repository), the lag time between the Hanford vitrification schedule and the WIPP disposal phase, as well as any contractual arrangements that may be necessary before ultimate disposal.

For the cases discussed in Section 5.0, Case 1 campaigns TRU wastes at plant start-up. At the schedule noted above, all TRU waste can be vitrified, packaged, and sent to the WIPP repository by the year 2015. This leaves the remaining period of 2016 to 2018, when the repository disposal phase ends, as margin to slip the TRU schedule. Case 2 requires TRU to be processed after a melter changeout. Assuming an average life of a melter as 5 years, the TRU campaign could start by the year 2014. This is a similar schedule as Case 1, however, there is more uncertainty associated with this case since the lifetime of the melter is not known. Case 3 requires processing TRU immediately following the HLW campaign. If the HLW is campaigned at the planned production rate, the TRU campaign could start in the year 2015 or 2016 depending on the type of melter. Since the WIPP waste receiving phase concludes in 2018, no margin exists for schedule slippage. However, operating the

vitrification plant less than its design capacity during any of the HLW campaign would reduce the volume of RH TRU wastes that could be sent to the WIPP repository since its disposal phase is scheduled to end in 2018.

5.6 REGULATORY IMPACTS

It is assumed that the waste package requirements for transportation of RH TRU wastes will be finalized and the RH Cask Safety Analysis Report for Packaging approved by the U.S. Nuclear Regulatory Commission before initiating the TRU campaign.

The TRU concentrations of the three HLW waste types were compared to the acceptance criteria in *Waste Acceptance Criteria for the Waste Isolation Pilot Plant*, WIPP-DOE-069, Revision 4.0, UC-70, December 1991. The criteria in Paragraph 3.3.6.1 cover the specific activity criteria for acceptance of TRU waste.

For both contact-handled (CH) and RH waste, a lower limit of > 100 nCi/g of TRU radionuclides in the waste matrix exists for purposes of TRU waste classification. The radionuclide concentration was determined for the three waste sources and the results are shown below in Table 5-1.

Table 5-1. Minimum Transuranic Activity for Contact-Handled/
Remote-Handled Transuranic Waste Matrix.

Waste source	Ci/m ³ (transuranic only)	Ci/kg	nCi/g
AW	1.201	0.455	455,000
SY	134.4	50.9	50,900,000
T	4.504	1.71	1,710,000

Acceptance Criteria (WIPP, 1991): Must be > 100 nCi/g

The product from each waste source is seen to have a TRU concentration greater than the minimum value of 100 nCi/g, and therefore, each waste product meets this minimum TRU concentration criterium.

The criterion for the maximum activity concentration for a RH TRU waste package is 23 Ci/L. The maximum activities for the three waste sources were calculated, and the results are shown below in Table 5-2.

Table 5-2. Maximum Activity for Remote-Handled Transuranic Waste Matrix.

Waste source	Total Ci per canister	Ci/m ³	Ci/L
AW	157	124	0.124
SY	675	536	0.536
T	129	102	0.102

Acceptance criterion (WIPP, 1991): cannot exceed 23 Ci/L.

Since the concentrations of the three waste sources do not exceed 23 Ci/L, they each meet this acceptance criterion.

5.7 SAFETY

This section evaluates glass waste dose rates and criticality concerns for radionuclide concentrations presented in Appendix A. The glass waste dose rates based on radionuclide concentration are calculated for comparison against the waste acceptance criteria for RH TRU waste. If the dose rate does not initially meet the criteria for RH TRU, the preferred dose rate reduction technique (i.e., reducing the glass waste oxide loading content or increasing the pretreatment DF) will be evaluated. The radionuclide concentrations in various configurations is evaluated to determine the likelihood of criticality occurring in process tanks or the melter.

To perform the various tasks outlined above, three candidate TRU waste tank sources were selected for analysis. Each of these three TRU waste tank sources are presented in Appendix A. The three waste tank sources selected are divided into three streams (#1, #344, and #441 labeled Feed, HLW, and LLW respectively in Appendix A). For the purposes of this study, only the #1 and #344 streams are considered. These combined three tanks and two streams represent six different waste source terms. Stream #1 (soluble + insoluble) is used for in-facility shielding analysis. Stream #344 is used to evaluate the HLW glass product for WIPP TRU waste acceptance criteria.

The following paragraphs outline the analysis approach taken for each of the main four tasks and the results.

5.7.1 Glass Waste Dose

The first step involved calculating the radiation dose rate at distances of 1 cm, 30 cm, and 100 cm from the outer surface of the glass waste canister for the three types of TRU waste. This analysis determines the "hottest" TRU tank source in the form of the final glass product.

The next step is to then determine the minimum steel shield thickness on the outside of the HLW steel canister that will provide a dose rate of just less than 200 mrem/h. This shield thickness will then suffice for all of the HLW RH TRU wastes and a standard TRU waste canister can be used.

5.7.1.1 Stream #1: In-Facility Shielding. Given the relatively low amounts of Sr/Y in the four wastes, the shielding radiation dose rates can be well approximated by only the gamma-ray source spectra. Thus, MicroShield-4.10 is well suited for the shielding analysis for both the stream #1 feed (0.0038 m³ source), the HLW canister of solid glass and the 1.0 m³ of glass cullet (arbitrary volume). Table 5-3 presents the results of the radiation dose rate calculations for stream #1 of each of the TRU waste tank sources.

Table 5-3. Feed #1 Shielding Radiation Dose Rates (0.0038 m³).

Transuranic waste	Calculated dose rates (mR/h)				
	@ 1 cm	@ 30 cm	@ 100 cm	Rank	Comments
TRU-AW	1916.	137.7	17.01	2	
TRU-SY	3465.	250.2	30.89	1	Hottest
TRU-T	8.237	0.5934	0.0733	3	Coldest

5.7.1.2 Stream #344: High-Level Waste. The volume of glass in the HLW canister is 1.26 m³. It is assumed (based on lack of specific finalized HLW canister size and shape) that this 1.26 m³ is in an unshielded HWVP style canister 61-cm O.D. with a 0.95-cm thick stainless steel wall. The glass height is calculated to be such that the HLW solid glass volume is 1.26 m³. The calculation gives a solid glass height of 460.0 cm. Table 5-4 gives the results of the radiation dose rate analysis.

Table 5-4. Shielding Dose Rates (1.26-m³ Canister).

Transuranic waste	Calculated dose rates (mR/h)				
	@ 1 cm	@ 30 cm	@ 100 cm	Rank	Comments
TRU-AW	4,717.	2,087.	899.1	2	
TRU-SY	11,430.	5,058.	2,178.	1	Hottest
TRU-T	2,625.	1,162.	500.3	3	Coldest

Based on the above results, the steel shielding that is needed to bring the bare HLW canister to either 200 mrem/h @ 1 cm or 5 rem/h @ 100 cm is calculated for the hottest canister (TRU-SY). Note that the bare canister already meets the railroad dose rate limit of 5 rem/h (5,000 mrem/h) at the 100 cm distance (2,178 mrem/h).

Therefore, the contact (1.0 cm) dose rate is calculated to determine the steel shielding required to bring the surface contact dose rate down to 200 mrem/h. The results of the Microshield 4.10 calculations show that about 6.7 cm thickness of steel shield gives a dose rate of just under 200 mrem/h at 1.0 cm from the outer surface of the shield.

5.7.2 Criticality Concerns

As part of the vitrification plant studies, the criticality safety of the waste streams from tanks designated as TRU as opposed to HLW tanks was investigated. The three potential waste streams were designated as TRU-AW (NCRW), TRU-SY (PFP), and TRU-T (T201-T204). The three waste streams were examined for fissile radionuclides, which are those radionuclides that will fission upon capture of a neutron. The ratio of ^{239}Pu activity (Ci) to the total waste volume was examined for each waste stream. TRU-SY has the greatest ^{239}Pu density ratio while TRU-AW has the lowest ratio (TRU-SY has 17.3 times the ratio of TRU-AW). However, TRU-AW has 250 kg of ^{235}U (26 mt of UO_2 enriched to an estimated 1.114 percent) while TRU-SY does not show any ^{235}U . The inventory of ^{239}Pu is 17 kg in TRU-AW and 29.6 kg in TRU-SY. Therefore, TRU-AW has the greatest fissile inventory and was chosen as the starting basis for the criticality studies.

The total amount of the TRU-AW waste was modeled with MCNP to determine k_{eff} . The waste was placed in a sphere calculated to contain the water. The density was then calculated with the soluble and insoluble components uniformly distributed throughout the sphere. The sphere was then surrounded by a spherical shell of water 2 m thick to provide neutron reflection. The calculated k_{eff} was 0.00586. (Criticality is achieved at a value of 1.00.) Therefore, a criticality problem would not exist using the total TRU-AW waste stream in a worst-case geometry. The possibility of Pu or U concentrating in the glass melter is not addressed in this analysis.

The various waste streams go through a number of processes before ultimately being vitrified into glass. Therefore, a reasonable condition would be to remove water from the waste stream and examine the resulting criticality. Five cases were examined with the remaining percentages of water as 1, 10, 25, 50, and 75 percent of the water in the initial waste. The spherical radius and density were adjusted as appropriate and presented in Figures 5-1, 5-2, and 5-3 plotting radius versus water content and density versus water content. The volume and density of the sphere were based on the volume of water for all cases except for the 1 percent water. The 1 percent water content case used a spherical radius calculated to give a density of approximately 4.0 g/cc. All cases used the 2 m. spherical water reflector. The k_{eff} for each of the reduced water cases are presented in

Figures 5-1, 5-2, and 5-3 labeled Pu Factor=1. In all cases, the value of k_{eff} remained below 0.1.

One of the constantly fluctuating, and open for debate, items is the source terms in nuclear material processing plants. A further study was conducted using increasing amounts of Pu in the TRU-AW waste stream since the exact value may be open to debate. This was accomplished by using a Pu Factor greater than one and increasing both the ^{239}Pu and ^{240}Pu contents. The resulting k_{eff} calculated values are presented for the various Pu Factors of 1, 10, 100, 400, and 500. As can be seen in the figure, the value of k_{eff} does not exceed 1.00 until the water content is reduced to 1 percent and the Pu Factor is 400. A last case with the Pu Factor of 400 and a 10 percent water content was calculated to establish that the removal of water increased the k_{eff} value at higher Pu content values.

Within the parameters examined in the referenced study, it does not appear that there is a potential criticality problem with the TRU waste streams. However, if the ^{239}Pu or ^{235}U contents significantly increase or the water content is drastically reduced, the criticality of the configuration should be revisited in a more specific criticality analysis.

5.8 COST IMPACT

This section describes the methodology for preparing the capital cost analysis for the TRU processing in the HLW vitrification facility. This analysis was performed to aid in the evaluation of the feasibility of processing transuranic wastes as a separate campaign in the HLW vitrification facility. An analysis of life-cycle cost is reported in the *Cost Benefit Analysis of Transuranic Tank Waste Disposal* (Crawford et al. 1996).

5.8.1 Capital Costs

Facility modifications, as discussed in Section 4.2.3, are not expected to have significant costs associated with the glass campaign conversion. Hardware items required to be replaced (e.g., weld head, transfer carts) are expected to total less than a percent of the direct costs of the reference facility. Additionally, storage pad costs are not expected to change significantly with the modified reference plant since the RH TRU canister overpacks are required to be transferred to the WIPP during the time period discussed in Section 5.5. An allowance of \$1 million in direct costs plus construction management, project management, contingency, and engineering was made to cover the capital cost of the conversion. The total capital cost is rounded to \$2 million.

The cost analysis assumed that TRU would be processed before HLW processing begins. This scenario is considered to have the least capital cost for conversion of the three cases considered.

Figure 5-1. Water Content Density Dependency.

Figure 5-2. Sphere Radius Dependency.

Figure 5-3. Criticality Dependency.

5.8.2 Container Costs

Canister, overpack, and cask costs are summarized in Table 5-5 for both HLW containers and TRU containers. All containers are estimated on a fabricated per mass basis in 1994 dollars. Stainless steel containers are estimated at \$10.45 per kilogram; carbon steel containers are estimated at \$3.48 per kilogram; and concrete containers are estimated at \$1.10 per kilogram. Allowances for such as contingency, project management, and construction management are included in the unit material prices. State tax of 7.8 percent is added to the total.

Table 5-5. High-level Waste and Transuranic Container Costs.

Waste form container	Stainless steel wt. MT	Carbon steel wt. MT	Concrete wt. MT	Unit price each
High-level waste containers (4-packs)	9.64	N/A	90.0	\$215,000
Transuranic containers	0.4	0.4	36.0	\$48,700

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WHC-SD-WM-ES-386
Revision 0

APPENDIX A

**TRANSURANIC WASTE VOLUME
PROJECTIONS (REVISION 2)**

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**Westinghouse
Hanford Company**

**Internal
Memo**

From: TWRS Process Engineering
Phone: 376-2279 H5-49
Date: March 19, 1996
Subject: TRU WASTE VOLUME PROJECTIONS - REVISION 2

74A20-96-001

To: T. W. Crawford H5-49
W. J. Powell H5-49

cc: w/o attachments
A. L. Boldt H5-49
K. D. Boomer H5-61
J. S. Garfield H5-49
A. F. Manuel H5-49
J. P. Sloughter R2-54
AFM File/LB

- References: (1) Internal Memo, L. W. Shelton to R. M. Orme, "Chemical and Radionuclide Inventory for Single and Double-Shell Tanks," dated August 7, 1995.
- (2) WHC-SD-WM-TI-613, TWRS Process Flowsheet, Revision 1, dated August 14, 1995.
- (3) WHC-SD-HWV-DP-001, Hanford Waste Vitrification Plant Project Technical Data Package, Revision 6, dated February 1994.
- (4) PNL-10359, Property/Composition Relationships for Hanford High-Level Waste Glasses Melting at 1150°C, Volume 1, dated December 1994.
- (5) RHO-SD-WM-TI-057, Preliminary Estimation of the Waste Inventories in Hanford Tanks Through 1980, Revision 0-A, dated October 13, 1993.

As requested, mass balance calculations using Revision 1 of the TWRS Process Flowsheet (Reference 2) and current chemical and radionuclide inventory assumptions (Reference 1) have been performed for the tank waste inventories of 10 tanks which have been identified to contain transuranic (TRU) wastes. These wastes are being evaluated for their potential for disposal at the Waste Isolation Pilot Plant (WIPP) as an alternative to the high-level waste (HLW) repository. To assist in this evaluation, calculations of HLW and low-level waste (LLW) volumes have been performed.

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The contents of three double-shell tanks (DSTs) and seven single-shell tanks (SSTs) have been identified as TRU wastes:

241-AW-103	241-T-110	241-T-201	241-T-204
241-AW-105	241-T-111	241-T-202	
241-SY-102	241-T-112	241-T-203	

Process flowsheet simulation runs are performed for 4 different tank groupings:

- 1) the total blend (177 tanks);
- 2) the 10 TRU tanks blended together;
- 3) the 10 TRU tanks blended into 3 blends by farm; and
- 4) the blend of the remaining 167 non-TRU tanks.

Each blend is run through 4 different HLW glass formulations (see Model Assumptions below). Estimates of immobilized HLW and LLW volumes and compositions produced by the Tank Waste Remediation System (TWRS) are provided for each of these blends.

Chemical and Radionuclide Inventory Assumptions

- (1) SST chemical inventory assumptions as of August 7, 1995, including the Los Alamos National Laboratory (LANL) update for chemicals normalized to the 1985 Hanford Defense Waste Environmental Impact Statement (EIS) totals (Reference 1);
- (2) DST chemical inventory estimates based upon analytical data from Tank Characterization Reports (Reference 1) and additional inventory assumptions as of August 7, 1995;
- (3) Radionuclide inventories for both SSTs and DSTs based upon Track Radioactive Components (TRAC) data and analytical data sources including Tank Characterization Reports (Reference 5);
- (4) Miscellaneous facility waste input streams are not included in these projections.

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Flowsheet Model Assumptions

- (1) Tank waste batches are processed through Revision 1 of the TWRS Process Flowsheet model (Reference 2);
- (2) In the "baseline" case, the Hanford Waste Vitrification Plant (HWVP) glass formulation for HLW glass melting below 1150°C (Reference 3) is assumed. These composition criteria are also referred to as low temperature HWVP glass limits and are identical to the baseline assumptions for HLW vitrification used in the TWRS Process Flowsheet;
- (3) As an alternative, flowsheet cases are included using the Composition Variation Study (CVS) glass composition region of testing for HLW glass melting at 1150 °C (Reference 4) and are referred to as low temperature CVS glass limits. A separate evaluation has yet to be conducted to evaluate the physical properties of the glass formulations calculated in this study. The CVS limits are planned to be included in a future revision of the flowsheet;
- (4) Two additional TRU cases are run using HLW glass formulations which satisfy only the minimum composition requirements for B_2O_3 , Li_2O , and SiO_2 . In other words, only the lower composition constraints in Table A-1 are satisfied for the HWVP and CVS cases. These cases are run to determine the sensitivity of TRU waste glass volumes on the selected glass formulation. Since WIPP has less constraining waste form requirements than the HLW repository, a glass formulation producing less glass may be possible. This assumes an acceptable glass product viscosity and easy removal from the melter.
- (5) The alternative glass formulation assumptions for the HWVP and CVS low temperature melters are summarized in Table A-1.

Table A-1. Low Temperature High-Level Waste Glass Formulations.

Oxide Component	HWVP Limits (<1150 °C)		CVS Limits (1150 °C)	
	Lower Limit	Upper Limit	Lower Limit	Upper Limit
Single-Component Constraints				
SiO ₂	46.0	56.0	42.0	57.0
B ₂ O ₃	7.0	17.0	5.0	20.0
Na ₂ O + K ₂ O	7.0	12.5	5.0	20.0
Li ₂ O	2.0	6.0	1.0	7.0
CaO	0.0	7.0	0.0	10.0
MgO	0.0	5.0	0.0	8.0
Fe ₂ O ₃	4.0	12.0	2.0	15.0
Al ₂ O ₃	1.0	11.0	0.0	15.0
ZrO ₂	--	10.0	--	13.0
Others	2.5	8.0	1.0	10.0
Multiple-Component Constraints				
Viscosity: (Li ₂ O + Na ₂ O)/SiO ₂ + Al ₂ O ₃ + ZrO ₂	0.152	0.342	0.152	0.342
Crystallinity:				
SiO ₂ /Al ₂ O ₃	4.5	--	3.0	--
MgO + CaO	--	8.0	--	10.0
Al ₂ O ₃ + ZrO ₂	--	14.0	--	16.0
Fe ₂ O ₃ + Al ₂ O ₃ + ZrO ₂ + Others	--	21.0	--	24.0
Solubility Limits				
Cr ₂ O ₃	--	0.5	--	0.5
F	--	1.7	--	1.7
P ₂ O ₅	--	1.0	--	1.0
Rh ₂ O ₃ + PdO + Ru ₂ O ₃	--	0.25	--	0.25
SO ₃	--	0.5	--	0.5
Redox constraints				
Reductants (formic acid, oxalic acid, and sugar)	TBD	--	TBD	--

Conclusions

Alternative HLW glass formulations for the processing of TRU waste streams could lead to significant reductions in glass volumes. The most significant reductions occur when only the lower limits for SiO_2 , B_2O_3 , and Li_2O are used in the glass formulation. For the TRU blended case, a reduction in TRU glass volume of 31% is possible using a glass formulation which meets only the minimum composition constraints for the vitrified HLW. Glass volumes may be reduced even further if the minimum limits for the CVS glass composition region (low temperature melter) are utilized, resulting in a 41% decrease from the baseline case (see Table 1).

Blending of TRU wastes could also decrease TRU glass volumes. In the baseline case (HWVP limits), the volume of glass can be expected to decrease 35% if the TRU tanks are blended together rather than processed by farm. A complete blend of TRU waste would require the consolidation of approximately 280,000 gallons of washed solids. The effects of blending will be less pronounced if one of the alternative glass formulations is used.

If desired, the tables can be revised for issuance at a later date as new information becomes available. Please contact me at (509) 376-2279 if you have any questions.

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TWRS Process Engineering

Attachments (2)

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ATTACHMENT 1

TRU WASTE VOLUME PROJECTIONS (REVISION 2)

HLW and LLW Glass Volume Production Summary Table
Low Temperature HWVP Glass Formulation
Low Temperature HWVP Glass Formulation (Lower Limits Only)
Low Temperature CVS Glass Composition
Low Temperature CVS Glass Composition (Lower Limits Only)

Consisting of 13 pages

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Table 1. Projected HLW/LLW Glass Production from TRU Waste - Large Canister (1.26-m³) Equivalents

Melter Temperature/Glass Formulation	Total Blend (177 Blended SSTs and DSTs)					Remaining Non-TRU Tanks (167 Blended SSTs and DSTs)					TRU Tanks (Blended)				
	HLW	WOL	LIM	%DIF	LLW	HLW	WOL	LIM	%DIF	LLW	HLW	WOL	LIM	%DIF	LLW
Low (<1150°C) HWVP Limits (Base Case)	6,860	51%	Frit	—	43.2	6,150	52%	Frit	—	42.1	1,029	32%	ZrO ₂	—	1.2
High (>1150°C) CVS Limits	5,940	59%	Frit	13%	43.2	5,310	60%	Frit	14%	42.1	791	42%	ZrO ₂	23%	1.2
Low (<1150°C) Lower Limits Only	—	—	—	—	—	—	—	—	—	—	707	47%	Frit	31%	1.2
High (>1150°C) Lower Limits Only	—	—	—	—	—	—	—	—	—	—	609	55%	Frit	41%	1.2

Melter Temperature/Glass Formulation	TRU Tanks in AW Farm (Blended)					TRU Tank in SY Farm					TRU Tanks in T Farm (Blended)					Sum of TRU Tanks Blended by Farm				
	HLW	WOL	LIM	%DIF	LLW	HLW	WOL	LIM	%DIF	LLW	HLW	WOL	LIM	%DIF	LLW	HLW	WOL	LIM	%DIF	LLW
Low (<1150°C) HWVP Limits (Base Case)	1,030	19%	ZrO ₂	—	0.6	177	18%	Cr ₂ O ₃	—	0.1	370	30%	P ₂ O ₅	—	0.5	1,577	21%	N/A	—	1.2
High (>1150°C) CVS Limits	791	24%	ZrO ₂	23%	0.6	177	18%	Cr ₂ O ₃	0%	0.1	370	30%	P ₂ O ₅	0%	0.5	1,337	25%	N/A	15%	1.2
Low (<1150°C) Lower Limits Only	456	42%	Frit	56%	0.6	62	51%	Frit	65%	0.1	237	46%	Frit	36%	0.5	755	44%	N/A	52%	1.2
High (>1150°C) Lower Limits Only	370	52%	Frit	64%	0.6	54	59%	Frit	70%	0.1	198	55%	Frit	46%	0.5	622	53%	N/A	61%	1.2

HLW = High Level Waste (# of 1.26-m³ Canisters)
 WOL = Waste Oxide Loading
 LIM = Limiting Glass Oxide
 %DIF = Percent Decrease in HLW Volume from Base Case
 LLW = Low Level Waste (# of 5300-m³ Vials)

Table 2. Projected HLW & TRU Glass Production from Segregating TRU Tank Waste - Large HLW Canisters and Small RH-TRU Canisters

Melter Temperature/Glass Formulation	# of HLW Canisters (1)		Number of RH-TRU Canisters (2)				
	Total Blend (Base Case)	Remaining Non-TRU Tanks	TRU Tanks (Blended)	TRU Tanks in AW Farm (Blended)	TRU Tank in SY Farm (Blended)	TRU Tanks in T Farm (Blended)	Sum of TRU Tanks Blended by Farm
Low (<1150°C) HWVP Limits (Base Case)	6,860	6,150	1,827	1,828	313	657	2,796
High (>1150°C) CVS Limits	5,940	5,310	1,403	1,403	313	657	2,373
Low (<1150°C) Lower Limits Only	—	—	1,255	810	110	420	1,341
High (>1150°C) Lower Limits Only	—	—	1,080	657	95	352	1,104

(1) Baseline Hanford HLW canisters are 0.86-m diameter by 4.57-m high and contain 1.26-m³ or 3,330 kg of glass
 (2) Inner canisters that fit inside of WPPPs current RH-TRU canister design will have the following dimensions and capacity:
 0.64-m diameter by 2.61-m high (outside dimensions); each would contain 0.71 m³ or 1,880 kg of glass

Table 3. Projected HLW & TRU Glass Production from Segregating TRU Tank Waste - Glass Volumes

Melter Temperature/Glass Formulation	HLW Glass Volume (m ³)		RH-TRU Glass Volume (m ³)					Sum of HLW & Blended TRU Volume (m ³)	Sum of HLW & Unblended TRU Volume (m ³)
	Total Blend (Base Case)	Remaining Non-TRU Tanks	TRU Tanks (Blended)	TRU Tanks in AW Farm (Blended)	TRU Tank in SY Farm (Blended)	TRU Tanks in T Farm (Blended)	Sum of TRU Tanks Blended by Farm		
Low (<1150°C) HWVP Limits (Base Case)	8,644	7,749	1,297	1,298	223	466	1,987	9,046	9,736
High (>1150°C) CVS Limits	7,484	6,691	996	996	223	466	1,685	7,987	8,376
Low (<1150°C) Lower Limits Only	—	—	891	575	78	298	952	8,640	8,701
High (>1150°C) Lower Limits Only	—	—	767	466	68	250	784	7,458	7,474

Table 2. TRU Waste Volume Projections (Rev. 2) - Low Temperature Glass Formulation

Stream #	Total Blend			TRU Tanks			Remaining Tanks			TRU AW Tanks			TRU SY Tank			TRU T Tanks		
	Feed	HLW	LLW	Feed	HLW	LLW	Feed	HLW	LLW	Feed	HLW	LLW	Feed	HLW	LLW	Feed	HLW	LLW
Soluble Components																		
Total Mass Flow (MT)	7.30E+05			1.64E+04			7.19E+05			7.68E+03			5.15E+03			6.67E+03		
Volume (L)	5.89E+08			1.48E+07			5.80E+08			7.17E+06			4.94E+06			5.74E+06		
Specific Gravity	1.24E+00			1.11E+00			1.24E+00			1.07E+00			1.04E+00			1.16E+00		
Radionuclides (Ci)																		
Am-241	7.82E+03			1.90E+01			7.82E+03									1.95E+01		
C-14	3.31E+03			1.18E+00			3.31E+03									1.88E+01		
Cm-244	7.70E+00			1.97E+02			7.63E+00			1.02E+02			9.71E+01			9.52E+03		
Cs-137	3.17E+07			2.13E+05			3.15E+07			1.51E+05			6.14E+04			8.68E+02		
Ba-137	3.01E+07			2.03E+05			2.99E+07			1.44E+05			5.83E+04			8.25E+02		
Np-237	1.80E+03			3.84E+01			1.66E+03									3.84E+01		
Pu-238	1.88E+06			2.36E+02			1.88E+06									2.36E+02		
Y-90	1.84E+06			2.36E+02			1.88E+06									2.36E+02		
Tc-99	2.27E+04			1.84E+01			2.27E+04									1.84E+01		
Total Curies	6.57E+07			4.16E+05			6.52E+07			2.85E+05			1.20E+05			2.24E+03		
Chemicals (MT)																		
Ag	3.20E-01			4.85E-05			3.20E-01						4.85E-05					
Am-3	2.28E-03			5.66E-06			2.28E-03									5.66E-06		
As-5	4.05E-05						4.05E-05											
B-3	3.43E-02			2.43E-02									3.43E-02					
Ba-2	7.81E-01			5.50E-04			7.80E-01						5.50E-04					
Be-2	2.43E-05			2.43E-05									2.43E-05					
Bk-3	1.18E+01			4.39E-01			1.14E+01									4.39E-01		
Ca-2	1.65E+01			8.81E-02			1.67E-01			3.68E-02			4.29E-02			8.54E-03		
Cd-2	1.74E-01			6.58E-02			2.37E-02						6.58E-02					
Ca-3	2.37E+00						5.42E-08											
Cm-3	8.50E-06			2.43E-10			1.67E+00			1.25E-10			3.48E-03			1.17E-10		
Cs-4	1.84E+00			1.04E-02			8.65E-02			6.91E-03			4.39E-04			1.00E-05		
Cu-2	8.84E-02			4.28E-04			3.12E+01						2.38E-03					
Fe-3	3.19E+01			6.15E-01			5.84E-02									6.12E-01		
Hg-2	5.84E-02						5.16E-02									1.43E+00		
K-	5.89E-02			7.37E+01			2.29E-01			6.38E+01			8.33E+00			9.76E-03		
La-3	2.38E-01			9.76E-03									1.46E-04					
Mg-2	1.46E-04			1.46E-04									4.85E-05					
Mn-2	4.85E-05			4.85E-05														
Mn-4	1.01E-01			1.91E-04			1.01E-01									1.91E-04		
Mn-6	7.23E-03			7.23E-03									7.23E-03					
Na-	6.77E-04			1.13E+03			6.86E-04			3.90E+02			1.18E+02			6.60E+02		
Ni-3	8.14E+00			1.51E-02			8.12E+00						2.14E-03			1.30E-02		
Np-4	9.85E-03			1.02E-03			9.85E-03						1.02E-03					
Pd-4	5.18E+00			6.20E-04			5.18E+00											
Pu-4	2.73E-02			2.58E-03			2.67E-02									6.20E-04		
Re-7	9.78E-05			9.78E-05									9.78E-05					
Rh-3	8.27E-04			8.27E-04									8.27E-04					
Ru-3	1.17E-03			1.17E-03									1.17E-03					
Si-4	1.35E-04						1.35E-04											
Si-6	1.59E-01			2.73E+00			1.32E-01			2.33E+00			4.03E-01					
Si-2	3.80E-01			1.87E-01			1.94E-01									1.87E-01		
Te-6	8.27E-04			8.27E-04									8.27E-04					
UD-2	4.28E-02			2.58E-03			4.28E+02									2.58E-03		
Zn-2	7.78E-04			7.78E-04									7.78E-04					
Zr-4	2.43E-05			2.43E-05			6.95E+03						2.43E-05					
Al(OH) ₃	6.96E-03			1.51E-01			6.72E+02			4.42E+00			1.07E-01			3.66E+00		
CL	6.78E-02			6.64E+00			3.08E-03			1.17E+00			1.81E+00			1.31E+01		
CO ₃ -2	3.10E+03			2.51E-01			3.08E-02			1.20E+01			7.80E+00			2.70E-01		
Cr(OH) ₃	4.46E-02			8.12E+00			8.07E+02			2.40E+02			3.42E+00			8.23E-01		
F-	1.13E+03			3.26E+02														
I-	9.07E-02						9.07E-02											
NO ₂ -	9.42E+03			2.74E+01			9.42E+03			3.81E+00			2.36E+01					
NO ₃ -	1.06E+05			5.86E-02			1.05E+05			1.47E+01			1.16E+02			5.56E+02		
OH-	1.43E-04			3.04E+02			1.40E+04			6.89E+01			3.83E+01			1.96E+02		
PO ₄ -3	3.12E+03			1.33E+02			2.98E+03						1.10E+01			4.32E+00		
SO ₄ -2	2.02E+03			1.03E+01			2.01E+03			9.85E-01			5.01E+00			1.69E+03		
TCO ₄	2.21E+00			1.80E-03			2.21E+00											
H ₂ O	5.13E+05			1.37E+04			5.04E+05			6.91E-03			4.80E-03			5.03E+03		
Organic Carbon	1.05E+03			1.07E+01			1.05E+03			5.42E+00			7.97E-01			4.48E+00		
ZrO ₂ .2H ₂ O	7.53E+00						7.53E+00											

Table 2. TRU Waste Volume Projections (Rev. 2) - Low Temperature Glass Formulation

Stream #	Total Blend			TRU Tanks			Remaining Tanks			TRU AW Tanks			TRU SY Tanks			TRU T Tanks		
	Feed	HLW	LLW	Feed	HLW	LLW	Feed	HLW	LLW	Feed	HLW	LLW	Feed	HLW	LLW	Feed	HLW	LLW
Probable Components																		
Total Mass Flow (MT)	1.96E+04	2.30E+04	5.69E+05	1.50E+03	3.45E+03	1.61E+04	1.81E+04	2.06E+04	5.54E+05	6.53E+02	3.44E+03	1.30E+03	1.94E+02	5.62E+02	1.94E+03	4.57E+02	1.24E+03	7.22E+05
Radionuclides (Ci)																		
Am-241	8.72E+04	9.60E+04	9.10E+03	1.19E+04	1.17E+04	1.75E+02	8.54E+04	8.43E+04	8.94E+03	3.50E+02	3.45E+02	4.60E+00	1.13E+04	1.12E+04	1.49E+02	1.75E+02	1.73E+02	2.17E+01
Cm-244	2.19E+03			2.15E+03			2.19E+03						2.13E+04			1.90E+03		
Cm-240	1.42E+03	1.40E+03	2.64E+01	2.95E+01	2.91E+01	4.08E+01	1.39E+03	1.38E+03	2.59E+01			6.52E+05	1.01E+07	2.66E+01	2.83E+01	3.76E+01	9.45E+01	9.33E+01
Ba-137	3.01E+06	3.44E+07	3.08E+05	1.52E+05	1.52E+05	3.78E+03	2.88E+06	3.41E+07	3.01E+05	1.51E+05	1.50E+05	3.25E+03	9.20E+02	1.04E+03	5.25E+02	2.89E+02	2.89E+02	1.10E+01
Ba-137	2.86E+06	3.27E+07	2.90E+05	1.45E+05	1.44E+05	3.60E+03	2.72E+06	3.24E+07	2.86E+05	1.44E+05	1.43E+05	3.08E+03	8.74E+02	9.83E+02	5.25E+02	2.74E+02	2.74E+02	1.05E+01
Np-237	6.27E+01	6.19E+01	7.78E+00				6.27E+01	6.19E+01	7.78E+00									
Pu-238	2.42E+04	2.44E+04	2.02E+03	5.18E+03	5.11E+03	1.06E+02	1.96E+04	1.93E+04	1.91E+03	1.22E+03	1.20E+03	1.60E+01	2.08E+03	2.05E+03	2.73E+01	1.88E+03	1.88E+03	6.30E+01
Pu-240	6.26E+03	6.17E+03	6.23E+01				6.26E+03	6.17E+03	6.23E+01									
Pu-244	6.86E+04	6.86E+04	9.14E+02				6.85E+04	6.86E+04	9.14E+02									
Sr-90	5.18E+07	5.13E+07	2.37E+06	1.19E+05	1.18E+05	1.76E+03	5.17E+07	5.12E+07	2.37E+06	5.10E+04	5.04E+04	6.71E+02	4.46E+04	4.40E+04	5.85E+02	2.34E+04	2.31E+04	5.20E+02
Y-90	5.18E+07	5.13E+07	2.37E+06	1.19E+05	1.18E+05	1.76E+03	5.17E+07	5.12E+07	2.37E+06	5.10E+04	5.04E+04	6.71E+02	4.46E+04	4.40E+04	5.85E+02	2.34E+04	2.31E+04	5.20E+02
Tc-99	8.32E+03	8.12E+03	2.28E+04	4.44E+01	4.33E+01	1.65E+01	8.23E+03	8.03E+03	2.28E+04	2.98E+05	2.95E+05	7.69E+03	1.04E+05	1.03E+05	2.37E+03	4.94E+04	4.88E+04	1.16E+03
Total Curies	1.10E+08	1.70E+08	5.37E+06	5.53E+05	5.48E+05	1.12E+04	1.09E+08	1.69E+08	5.36E+06	2.98E+05	2.95E+05	7.69E+03	1.04E+05	1.03E+05	2.37E+03	4.94E+04	4.88E+04	1.16E+03
Chemicals (MT)																		
Ag+	1.48E+00			1.56E+01			1.32E+00						1.58E+01					
Al+3	2.32E+03			3.22E+01			2.28E+03			1.27E+01			1.95E+01					
Am+3	2.63E+02			3.46E+03			2.49E+02			1.02E+04			3.30E+03				5.11E+05	
Am+5	2.26E+03			2.26E+03									2.26E+03					
Ba+2	3.74E+00			7.42E+01			3.00E+00			6.81E+01			6.20E+02				1.01E+06	
Ba+2	3.06E+03			3.06E+03									3.08E+03					
BH3	2.51E+02			4.35E+01			2.08E+02										4.32E+01	
Ca+2	1.37E+02			1.77E+01			1.20E+02			1.79E+00			5.04E+00				1.05E+01	
Ca+2	6.55E+00			3.27E+01			6.22E+00						3.27E+01				1.05E+01	
Ce+3	2.35E+02			2.35E+02			2.35E+02											
Cm+3	1.75E+05			3.65E+07			1.72E+05						3.63E+07				1.17E+08	
Cm+3	1.49E+06			1.01E+06			1.45E+06						5.51E+00				1.01E+06	
Ce+3	1.60E+02			7.10E+00			1.53E+02			1.05E+00			5.22E+05				5.34E+01	
Cu+	2.96E+01			6.87E+03			1.99E+01			6.51E+03			1.85E+01				3.33E+06	
Cu+2	1.86E+01			1.85E+01									1.85E+01					
Fe+3	7.60E+02			8.05E+01			6.80E+02			1.92E+00			1.80E+01				6.06E+01	
Hg+2	8.81E+02						8.81E+02											
K+	2.96E+01			2.43E+01			5.33E+00			1.81E+01			5.36E+00				9.16E+01	
La+3	2.30E+01			2.38E+00			2.06E+01			1.35E+00			5.32E+02				5.66E+01	
Mg+2	8.73E+01			8.73E+01									8.73E+01					
Mn+4	1.34E+02			3.79E+01			5.59E+01			9.50E+01							3.70E+01	
Mo+6	3.21E+02			3.21E+02									3.21E+02					
Na+	7.78E+02			1.17E+02			6.01E+02			1.37E+02			1.32E+01				2.75E+01	
Ni+3	2.07E+02			1.65E+01			1.89E+02			4.29E+01			4.54E+01				1.56E+01	
Np+4	8.90E+02						8.90E+02											
Pb+4	2.94E+01			1.36E+00			2.80E+01						1.36E+00					
Pu+4	4.27E+01			8.35E+02			3.44E+01			1.96E+02			3.35E+02				3.03E+02	
Rh+3	1.93E+01			1.93E+01									1.93E+01					
Se+6	3.32E+00			2.59E+00			7.20E+01			2.59E+00								
Si+4	2.30E+02			2.43E+01			2.06E+02			9.33E+00			5.99E+00				8.55E+00	
Sr+2	3.66E+01			1.86E+01			1.80E+01			1.36E+03			9.79E+02				1.65E+01	
Th+4	2.79E+00			2.79E+00									2.79E+00					
Ti+4	1.55E+01			1.55E+01									1.55E+01					
UO2+2	1.54E+03			2.84E+01			1.51E+02			2.54E+01							4.80E+02	
Zn+2	5.06E+01			5.06E+01									5.06E+01					
Cl-	8.99E+00	8.92E+00		2.34E+01	2.66E+01		8.73E+00	8.99E+00		3.60E+02	4.30E+02		5.72E+03	9.43E+03		1.53E+01	2.05E+01	
CO3-2	1.09E+02			1.02E+01			9.07E+01			3.00E+00			1.42E+01				1.04E+00	
F-	6.82E+01	6.80E+01		2.24E+01	2.38E+01		4.58E+01	4.64E+01		1.81E+01	1.54E+01		1.40E+02	2.09E+02		4.33E+00	4.80E+00	
Li-	1.39E+03						1.39E+03											
NO2-	6.18E+01			9.55E+01			6.08E+01			8.90E+01			6.33E+02					
NO3-	9.85E+02			1.22E+01			9.76E+02			8.28E+00			2.62E+01				3.60E+00	
OH-	5.62E+03			2.70E+02			5.35E+03			1.48E+02			1.81E+01				3.96E+01	
PO4-3	1.85E+03			1.85E+02			1.66E+03			4.57E+01			6.38E+00				1.62E+02	
SO4-2	2.56E+01			1.37E+00			2.42E+01			1.25E+00			1.89E+02				8.81E+02	
TiO4	9.07E+01			4.32E+03			8.99E+01						8.42E+03				1.60E+03	
Carboxylic	2.70E+02						2.70E+02											
MnO2	7.58E+00	2.17E+02	1.85E+01	7.58E+00	6.67E+01	8.85E+01	1.50E+02	1.80E+01		1.48E+00	1.88E+02	7.58E+00	7.48E+00	9.86E+02			5.78E+01	7.70E+01
Organic Carbon	8.73E+01			5.90E+02			7.84E+01			5.42E+00			2.96E+00				4.87E+01	
2,2,2-TriF2O	1.19E+03			1.52E+02			7.44E+02			4.51E+02			5.72E+01					
Ag2O	1.57E+00	3.64E+01		1.68E+01	2.28E+03		1.40E+00	3.62E+01					1.68E+01	2.28E+03			1.24E+01	2.73E+02
Al2O3	2.24E+03	2.16E+04		2.45E+01	6.10E+02		2.22E+03	2.10E+04		3.44E+01	2.77E+02		3.58E+03	4.77E+06			5.54E+05	6.56E+06
Am2O3	3.08E+02	2.91E+03		3.75E+03	5.62E+05		2.70E+02	2.86E+03		1.11E+04	1.47E+06		3.48E+03	6.77E+06				
As2O3	3.43E+03	1.08E+04		3.43E+03	1.54E+05		9.06E+04	6.21E+05					3.43E+03	1.08E+04				
B2O3	1.61E+03	9.03E+00		3.48E+03	3.61E+01		1.44E+03	8.67E+00		5.85E+02	1.14E+01		1.01E+02	1.41E+01			1.27E+02	1.13E+01
BaO	4.12E+00	9.36E+01		6.18E+01	1.20E+02		3.31E+00	9.34E+01		7.50E+01	5.99E+03		6.84E+02	1.87E+03			1.11E+06	1.48E+00
BeO	8.42E+03	1.79E+04		8.42E+03	1.78E+04													
B2O3	2.77E+02	1.69E+01		4.78E+01	1.12E+00		2.29E+02	1.58E+01									4.78E+01	1.12E+00
CaO	1.80E+02	4.35E+04		2.45E+01	1.22E+03		1.68E+02	4.21E+04		2.47E+00	5.55E+02		6.95E+00	1.48E+02			1.80E+01	5.49E+02
Ca2O3	2.72E+02	6.39E+00		1.68E+01	1.24E+02		2.72E+02	6.39E+00					3.68E+01	1.24E+02				
Cm2O3	1.80E+05	3.57E+07		3.59E+07	5.52E+09		1.86E+05	3.51E+07		8.83E+03	1.37E+01		3.83E+07	5.10E+09			1.26E+06	2.67E+10
Co2O3	2><																	

Table 2. TRU Waste Volume Projections (Rev. 2) - Low Temperature Glass Formulation

Stream #	Total Blend			TRU Tanks			Remainder Tanks			TRUAW Tanks			TRU SY Tanks			TRU T Tanks		
	Feed	MLW	LLW	Feed	MLW	LLW	Feed	MLW	LLW	Feed	MLW	LLW	Feed	MLW	LLW	Feed	MLW	LLW
Chemicals Cont'd																		
La2O3		2.66E+01	6.33E-01		2.75E+00	4.80E-02		2.36E-01	5.85E-01		1.56E+00	2.08E-02		6.16E-02	8.21E-04		1.12E+00	2.63E-02
Li2O		4.60E-02	3.14E+00		6.90E+01	8.98E-02		4.12E-02	3.10E+00		8.79E+01	4.08E-02		3.55E-01	1.09E-02		2.47E+01	4.04E-02
MgO		1.43E+00	6.56E-01		1.43E+00	3.72E-02			6.20E-01					1.43E+00	2.14E-02			8.08E-02
MnO		9.72E-08	6.25E-05		3.32E-07	6.23E-05								1.29E-07	6.25E-05			
MnO3		4.76E-02	1.15E-02		4.76E-02	1.14E-02		2.28E+03	1.05E+05		2.41E+02	1.39E+03		4.76E-02	1.15E-02			
Ni2O		2.55E+03	1.08E+05		2.57E+02	3.05E+03		2.63E-02	1.49E+01		5.97E-01	7.95E-03		4.14E-01	3.69E+02		8.66E+01	1.37E+03
NiO3		2.87E-02	1.53E+01		2.29E+01	3.27E-01								6.31E-01	1.14E-02		2.17E+01	3.06E-01
NpO2		9.97E-02	1.25E-02					9.97E-02	1.25E-02									
P2O5		3.78E+02	3.34E+03		3.87E+01	2.02E+02		3.38E-02	3.13E+03		9.21E-02	7.50E-01		1.30E+00	1.17E+01		3.71E+01	1.90E-02
PbO2		3.35E+01	6.41E+00		1.54E+00	2.18E-02		3.19E+01	6.39E+00					1.54E+00	2.18E-02			
PuO2		4.76E+01	3.73E-02		9.34E-02	1.94E-03		3.84E-01	5.53E-02		2.20E-02	2.92E-04		3.75E-02	5.00E-04			
Ra2O7		1.97E-07	1.27E-04		6.73E-07	1.26E-04								2.62E-07	1.27E-04			
Rh2O3		2.35E-01	4.14E-03		2.35E-01	4.14E-03								2.35E-01	4.14E-03			
Ru2O3		2.24E-06	1.44E-03		7.65E-06	1.44E-03								2.98E-06	1.44E-03			
SeO3		5.26E+00	7.03E-02		4.11E+00	5.48E-02		1.14E+00	1.54E-02		4.11E+00	5.48E-02		3.32E-02	8.48E-02			
SiO2		1.06E-04	2.53E-05		1.93E-03	7.00E-03		9.48E-03	2.46E-05		1.93E-03	5.25E-03					6.93E-03	3.08E-03
SO3		1.21E+01	1.68E-03		5.91E-01	8.54E-00		1.15E+01	1.68E-03		5.24E-01	8.29E-01		1.34E-02	4.17E+00		4.36E-02	3.59E+00
SiO		4.25E+01	9.69E-01		2.16E+01	4.85E-01		2.09E+01	4.84E-01		1.59E-03	2.11E-05		1.14E+01	1.52E-03		2.15E+01	4.84E-01
Tc2O7		8.44E-01	2.11E+00		4.01E-03	1.57E-03		8.36E-01	2.11E+00					2.52E-03	3.40E-08			
TiO3		1.77E-06	1.14E-03		6.03E-06	1.13E-03								2.35E-06	1.14E-03			
ThO2		3.13E+00	4.17E-02		3.13E+00	4.17E-02								3.13E+00	4.17E-02			
ThO		2.55E-01	3.39E-03		2.55E-01	3.39E-03								2.55E-01	3.39E-03			
UO3		1.61E+02	4.74E+02		3.07E+01	4.12E-01		1.58E+03	4.73E+02		3.07E+01	4.09E-01		6.22E-01	9.25E-03		5.12E-02	3.40E-03
ZnO		6.22E-01	9.25E-03		6.22E-01	9.25E-03								4.37E-01	5.85E-03			
ZrO2		9.10E-02	1.80E-01		3.45E-03	4.60E-03		5.68E-02	1.34E+01		3.44E+02	4.59E+00						
Dicyclopentadiene			1.27E-03			9.62E-01			1.54E-03			2.03E-01			1.16E+01			4.33E-01
Oligomer			1.27E-03			9.62E-01			1.54E-03			2.03E-01			1.16E+01			4.33E-01
Sulfur			1.34E+05			3.66E-03			1.30E+05			1.71E+03			4.42E+02			1.64E+03

Na2O : 2,550 MT

2,280 MT

Table 3. TRU Waste Volume Projections (Rev. 2) - Low Temperature Glass Formulation (Lower Limits Only)

Stream #	Total Blend			TRU Tanks			Remaining Tanks			TRU AW Tanks			TRU SY Tank			TRU T Tanks		
	Feed	HLW	LLW	Feed	HLW	LLW	Feed	HLW	LLW	Feed	HLW	LLW	Feed	HLW	LLW	Feed	HLW	LLW
Soluble Components																		
Total Mass Flow (MT)	7.30E+05			1.64E+04			7.19E+05			7.68E+05			5.15E+05			6.67E+05		
Volume (L)	5.89E+06			1.48E+07			5.89E+06			7.17E+06			4.84E+06			5.74E+06		
Spectro Gravity	1.24E+00			1.11E+00			1.24E+00			1.07E+00			1.04E+00			1.19E+00		
Radionuclides (Ci)																		
Am-241	7.82E+03			1.95E+01			7.82E+03						9.71E+01			1.85E+01		
C-14	3.31E+03			1.16E+00			3.31E+03									1.88E+01		
Co-54	7.70E+00			1.97E+02			7.83E+00			1.02E+02						9.52E+03		
Cs-137	3.17E+07			2.13E+05			3.15E+07			1.51E+05			6.14E+04			6.88E+02		
Ba-137	3.01E+07			2.03E+05			2.99E+07			1.44E+05			5.63E+04			8.25E+02		
Np-237	6.94E+00						6.94E+00									3.84E+01		
Pu-238	1.89E+03			3.84E+01			1.89E+03									2.36E+02		
Ba-99	1.88E+06			2.36E+02			1.88E+06									2.36E+02		
Y-90	1.88E+06			2.36E+02			1.88E+06									2.36E+02		
Tc-99	2.27E+04			1.64E+01			2.27E+04			2.95E+05			1.20E+05			1.64E+01		
Total Curies	6.57E+07			4.16E+05			6.52E+07									2.24E+03		
Chemicals (MT)																		
Ag+	3.20E-01			4.85E-05			3.20E-01			4.85E-05						5.68E-06		
Am+3	2.28E-03			5.68E-06			2.28E-03											
As+5	4.05E-05			4.05E-05			4.05E-05											
B+3	3.43E-02			3.43E-02			3.43E-02			3.43E-02								
Ba+2	7.91E-01			9.50E-04			7.90E-01									4.39E-01		
Ba+2	2.43E-05			2.43E-05												2.43E-05		
Bi+3	1.18E+01			4.39E-01			1.14E+01											
Ca+2	1.65E+01			8.81E-02			1.64E+01			3.66E-02			4.29E-02			4.54E-03		
Cd+2	1.74E-01			6.58E-03			1.67E-01						6.58E-03					
Ce+3	2.37E+00			2.43E-10			2.37E+00									1.17E-10		
Cr+3	9.50E-06			1.04E-02			9.42E-06			1.25E-10						1.00E-05		
Cs+	1.84E+00			4.39E-04			1.87E+00			6.91E-03			3.45E-03			4.39E-04		
Cu+2	9.94E-02			8.15E-01			9.85E-02						2.38E-03			6.12E-01		
Fe+3	3.19E+01			7.37E+01			3.12E+01											
Hg+2	5.84E-02			9.76E-03			5.84E-02			6.39E-01			8.33E+00			1.43E+00		
K+	2.39E+01			1.46E-04			2.29E+01									9.76E-03		
Mg+2	1.46E-04			4.85E-05			1.46E-04						4.85E-05					
Mn+2	4.85E-05			1.91E-04			4.85E-05									1.91E-04		
Mn+4	1.01E+01			7.23E-03			1.01E+01						7.23E-03					
Ni+2	6.77E-04			1.13E-03			6.66E-04			3.50E-02			1.18E+02			6.60E+02		
Ni+3	8.14E+00			1.51E-02			8.12E+00						2.14E-03			1.30E-02		
Np+4	9.65E-03			1.02E-03			9.65E-03						1.02E-03					
Pb+4	5.18E+00			8.20E-04			5.18E+00									8.20E-04		
Pu+4	2.73E-02			9.76E-05			2.67E-02						9.76E-05					
Ra+7	9.76E-05			8.27E-04			9.76E-05						8.27E-04					
Rh+3	8.27E-04			1.17E-03			8.27E-04						1.17E-03					
Ru+3	1.17E-03						1.35E-04											
Sr+6	1.35E-04			2.73E-00			1.32E+01			2.33E+00			4.03E-01			1.87E-01		
Sr+2	3.80E-01			1.67E-01			1.94E-01											
Te+6	8.27E-04			8.27E-04									8.27E-04					
UO2+2	4.26E+02			2.58E-03			4.26E+02									2.58E-03		
Zn+2	7.78E-04			2.43E-05			7.78E-04						7.78E-04					
Zr+4	2.43E-05			1.51E+01			6.95E+03			4.42E+00			1.07E+01			3.66E+00		
Al(OH)3	6.78E+02			6.84E+00			6.72E+02						1.17E+00					
CO3-2	3.10E+03			2.51E+01			3.06E+03			1.20E+01						1.31E+01		
Cr(OH)3	4.46E+02			8.12E+00			4.38E+02			4.98E+02			7.80E+00			2.70E+01		
F-	1.13E+03			3.26E+02			8.07E+02			2.40E+02			3.42E+00			8.23E+01		
H+	9.07E+02			2.74E+01			8.07E+02											
NO2-	9.42E+03			6.86E+02			9.42E+03			3.81E+00			2.36E+01					
NO3-	1.06E+05			1.05E+05			1.05E+05			1.47E+01			1.66E+02			5.56E+02		
OH-	1.43E+04			3.04E+02			1.40E+04			6.89E+01			3.65E+01			1.96E+02		
PO4-3	3.12E+03			1.33E+02			2.88E+03						1.10E+01			1.22E+02		
SO4-2	2.62E+03			1.03E+01			2.62E+03			9.85E+01			5.01E+00			4.32E+00		
TiO4	2.21E+00			1.60E+03			2.21E+00									1.60E+03		
N2O	5.13E+05			1.37E+04			5.04E+05			6.91E+03			4.80E+03			5.03E+03		
Organic Carbon	1.05E+03			1.07E+01			1.05E+03			5.42E+00			7.97E-01			4.48E+00		
ZrO2·2H2O	7.53E+00						7.53E+00											

Revision 0

Stream #	Total Blend			TRU Tanks			Remaining Tanks			TRU AW Tanks			TRU ST Tanks			TRU T Tanks		
	Feed	HLW	LLW	Feed	HLW	LLW	Feed	HLW	LLW	Feed	HLW	LLW	Feed	HLW	LLW	Feed	HLW	LLW
Insoluble Components																		
Total Mass Flow (MT)	1.86E+04	2.30E+04	5.69E+05	1.50E+03	2.37E+03	1.61E+04	1.61E+04	2.06E+04	5.54E+03	6.53E+02	1.53E+03	1.30E+03	1.94E+02	2.08E+02	1.94E+03	4.37E+02	7.94E+02	7.22E+03
Radionuclides (Ci)																		
Am-241	9.72E+04	8.60E+04	9.10E+03	1.19E+04	1.17E+04	1.75E+02	8.54E+04	8.43E+04	8.94E+03	3.50E+02	3.45E+02	4.60E+00	1.13E+04	1.12E+04	1.49E+02	1.75E+02	1.73E+02	2.17E+01
C-14	2.19E+03			2.19E+03			2.19E+03						2.13E+01					1.90E+03
Cm-244	1.42E+03	1.40E+03	2.64E+01	2.95E+01	2.91E+01	8.06E+01	1.39E+03	1.36E+03	2.59E+01		8.52E+05	1.01E+02	2.86E+03	2.83E+01	3.76E+01	9.43E+01	8.33E+01	2.19E+02
Co-60	3.01E+06	3.44E+07	2.05E+05	1.63E+05	1.74E+05	3.78E+03	1.86E+04	1.81E+04	3.01E+05	1.51E+05	1.50E+05	3.25E+03	9.20E+02	1.04E+03	2.58E+02	2.89E+02	2.89E+02	1.10E+01
Ba-137	2.86E+06	3.27E+07	2.90E+05	1.45E+05	1.44E+05	3.60E+03	2.72E+06	2.72E+06	2.86E+05	1.44E+05	1.43E+05	3.08E+03	8.74E+02	9.83E+02	4.99E+02	2.74E+02	2.74E+02	1.05E+01
Np-237	6.27E+01	2.41E+01	7.76E+00				8.27E+01	6.19E+01	7.76E+00									
Pu-238	2.48E+04	2.44E+04	2.02E+03	5.18E+03	5.11E+03	1.06E+02	1.96E+04	1.93E+04	1.91E+03	1.22E+03	1.20E+03	1.60E+01	2.08E+03	2.05E+03	2.73E+01	1.88E+03	1.86E+03	6.30E+01
U-234	6.25E+03	6.17E+03	8.22E+01				6.26E+03	6.17E+03	8.22E+01									
Pu-241	8.95E+04	8.86E+04	9.14E+02				8.95E+04	8.86E+04	9.14E+02									
Y-90	5.18E+07	5.13E+07	2.37E+06	1.19E+05	1.18E+05	1.78E+03	5.17E+07	5.12E+07	2.37E+06	5.10E+04	5.04E+04	8.71E+02	4.46E+04	4.40E+04	5.86E+02	2.34E+04	2.31E+04	5.20E+02
Si-80	5.18E+07	5.13E+07	2.37E+06	1.19E+05	1.18E+05	1.78E+03	5.17E+07	5.12E+07	2.37E+06	5.10E+04	5.04E+04	8.71E+02	4.46E+04	4.40E+04	5.86E+02	2.34E+04	2.31E+04	5.20E+02
Ti-99	9.32E+03	9.12E+03	2.28E+04	4.43E+04	4.35E+04	1.85E+01	9.32E+03	9.12E+03	2.28E+04	4.43E+04	4.35E+04	1.85E+01	9.32E+03	9.12E+03	2.28E+04	4.43E+04	4.35E+04	1.85E+01
Total Curies	1.10E+08	1.70E+08	6.37E+06	5.55E+05	5.48E+05	1.12E+04	1.09E+08	1.09E+08	3.26E+06	3.86E+05	3.85E+05	7.69E+03	1.04E+05	1.02E+05	2.37E+04	4.64E+04	4.60E+04	1.16E+03
Chemicals (MT)																		
Ag+	1.48E+00			1.50E+01			1.32E+00						1.58E+01					
Al+3	2.32E+03			3.22E+01			2.26E+03					1.27E+01	1.95E+01					
Am+3	2.63E+02			3.46E+03			2.45E+02					1.02E+04	3.30E+03			5.11E+05		
As+																		

Table 3. TRU Waste Volume Projections (Rev. 2) - Low Temperature Glass Formulation (Lower Limits Only)

Stream #	Total Blend			TRU Tanks			Remaining Tanks			TRU AW Tanks			TRU SY Tank			TRU T Tanks		
	Feed	HLW	LLW	Feed	HLW	LLW	Feed	HLW	LLW	Feed	HLW	LLW	Feed	HLW	LLW	Feed	HLW	LLW
Chemical Cont'd																		
La2O3	2.66E-01	6.53E-01		2.75E+00	4.06E-02		2.34E+01	5.85E-01		1.56E+00	2.08E-02		6.16E-02	8.27E-04		1.12E+00	2.63E-02	
Li2O	4.60E-02	3.14E-00		4.74E-01	8.84E-02		4.12E-02	3.10E+00		3.06E+01	4.08E-02		4.16E-01	1.09E-02		1.59E+01	4.04E-02	
MgO	1.43E+00	6.54E-01		1.43E+00	3.72E-02			8.20E-01			8.16E-03		1.43E+00	2.14E-02				
MnO	9.72E-08	6.25E-05		3.32E-07	6.23E-05								1.29E-07	6.25E-05				
MoO3	4.76E-02	1.15E-02		4.76E-02	1.14E-02								4.78E-02	1.15E-02				
Na2O	2.55E+03	1.04E+05		2.57E+02	3.68E+03		2.28E+03	1.05E+05		1.83E+02	1.39E+03		2.10E+01	3.69E-02		5.56E+01	1.37E+03	
ND2O3	2.87E+02	1.53E+01		2.29E+01	3.27E-01		2.63E+02	1.46E+01		5.97E-01	7.95E-03		6.31E-01	1.14E-02		2.17E+01	3.08E-01	
Np2O3	9.97E-02	1.25E-02					9.97E-02	1.25E-02										
P2O5	3.76E+02	3.34E+03		3.87E+01	2.02E+02		3.38E+02	3.13E+03		9.21E-02	2.50E-01		1.30E+00	1.17E+01		3.71E+01	1.90E-02	
Pu2O3	3.35E+01	6.41E+00		1.54E+00	2.18E-02		3.19E+01	6.39E+00					1.54E+00	2.10E-02				
Pu2O2	4.78E-01	3.73E-02		9.34E-02	1.94E-03		3.84E-01	3.53E-02		2.20E-02	2.62E-04		3.75E-02	5.00E-04		3.39E-02	1.15E-03	
Re2O7	1.87E-07	1.27E-04		6.73E-07	1.26E-04								2.62E-07	1.27E-04				
Rh2O3	2.35E-01	4.14E-03		2.35E-01	4.14E-03								2.35E-01	4.14E-03				
Ru2O3	2.24E-06	1.44E-03		7.65E-06	1.44E-03								2.38E-06	1.44E-03				
Sa2O3	9.24E+00	7.03E-02		4.11E+00	5.48E-02		1.14E+00	1.54E-02		4.11E+00	5.48E-02							
SiO2	1.06E+04	2.83E+05		1.06E+03	7.00E-03		9.48E+03	2.46E+05		7.03E-02	3.25E+03		9.58E+01	8.48E+02		3.65E+02	3.06E+03	
SO3	1.21E+01	1.82E+03		5.91E+01	1.54E+00		1.15E+01	1.68E+03		5.24E-01	8.29E-01		1.34E-02	4.17E+00		4.36E-02	3.59E+00	
SrO	4.25E+01	8.69E-01		2.16E+01	4.83E-01		2.09E+01	4.84E-01		1.59E-02	2.11E-05		1.14E+01	1.52E-03		2.15E+01	4.84E-01	
Ta2O7	8.44E-01	2.11E+00		4.01E-03	1.57E-03		8.36E-01	2.11E+00					2.52E-03	3.40E-05		1.49E-03	1.53E-05	
Ta2O5	1.77E-06	1.14E-03		6.03E-06	1.13E-03								2.52E-03	3.40E-05				
ThO2	3.13E+00	4.17E-02		3.13E+00	4.17E-02								2.52E-03	3.40E-05				
TiO2	2.65E-01	3.39E-03		2.55E-01	3.39E-03								3.13E+00	4.17E-02				
UO3	1.61E+03	4.74E+02		3.07E+01	4.12E-01		1.58E+03	4.73E+02		3.07E+01	4.09E-01		2.55E-01	3.39E-03		5.12E-02	3.40E-03	
ZnO	6.22E-01	9.25E-03		6.22E-01	9.25E-03		5.68E-02	1.34E-01					6.22E-01	9.25E-03				
ZrO2	9.10E-02	1.80E-01		3.45E-02	4.50E+00								4.37E-01	1.16E+01				
Cyclopentadiene		1.27E+03			8.62E+01			1.54E+03		3.44E+02	4.59E+00			1.16E+01			4.33E+01	
Oligomer		1.27E+03			8.62E+01			1.54E+03			4.37E+01			1.16E+01			4.33E+01	
Sulfur		1.34E+05			3.66E+03			1.30E+05			1.66E+03			4.42E+02			1.64E+05	

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Table 2. TRU Waste Volume Projections (Rev. 2) - High Temperature Glass Formulation

Stream #	Total Blend			TRU Tanks			Remainder Tanks			TRU AW Tanks			TRU SY Tank			TRU Y Tanks		
	Feed	HLW	LLW	Feed	HLW	LLW	Feed	HLW	LLW	Feed	HLW	LLW	Feed	HLW	LLW	Feed	HLW	LLW
Soluble Components																		
Total Mass Flow (MT)	7.30E+05			1.64E+04			7.18E+05			7.68E+03			5.15E+03			6.67E+03		
Volume (L)	5.88E+04			1.48E+07			8.80E+06			7.17E+06			4.84E+06			5.74E+06		
Specific Gravity	1.24E+00			1.11E+00			1.24E+00			1.07E+00			1.04E+00			1.18E+00		
Radionuclides (Ci)																		
Am-241	7.82E+03			1.85E+01			7.82E+03									1.85E+01		
C-14	3.31E+03			1.16E+00			3.31E+03						8.71E-01			1.86E-01		
Cm-244	7.70E+00			1.87E-02			7.63E+00			1.02E-02						9.52E-03		
Co-137	3.17E+07			2.13E+05			3.15E+07			1.51E+05			6.14E+04			8.66E+02		
Be-137	3.01E+07			2.03E+05			2.99E+07			1.44E+05			5.83E+04			8.25E+02		
Np-237	6.94E+00						6.84E+00											
Pu-238	1.69E+03			3.84E+01			1.66E+03									3.84E+01		
Si-90	1.88E+06			2.38E+02			1.88E+06									2.38E+02		
Y-90	1.88E+06			2.38E+02			1.88E+06									2.38E+02		
Tc-99	2.27E+04			1.64E+01			2.27E+04									1.64E+01		
Total Curies	6.57E+07			4.16E+05			6.52E+07			2.95E+05			1.20E+05			3.24E+03		
Chemicals (MT)																		
Ag+	3.20E-01			4.85E-05			3.20E-01						4.85E-05					
Am+3	2.28E-03			5.68E-06			2.28E-03									5.68E-06		
As+5	4.05E-05						4.05E-05											
B+3	3.43E-02			3.43E-02									3.43E-02					
Ba+2	7.61E-01			9.50E-04			7.50E-01						9.50E-04					
Be+2	2.43E-05			2.43E-05									2.43E-05					
Bh+3	1.18E-01			4.38E-01			1.14E+01									4.38E-01		
Ca+2	1.85E-01			8.81E-02			1.64E+01			3.66E-02			4.29E-02			8.54E-03		
Co+2	1.74E-01			6.58E-03			1.67E-01											
Co+3	2.37E+00						2.37E+00											
Cm+3	9.50E-08			2.43E-10			9.42E-08			1.25E-10						1.17E-10		
Cs+	1.88E+00			1.04E-02			1.87E+00			6.91E-03			3.49E-03			1.00E-05		
Cu+2	9.94E-02			4.39E-04			9.85E-02						4.39E-04					
Fe+3	3.19E-01			6.15E-01			3.12E+01						2.38E-03			6.12E-01		
Hg+2	5.84E-02			5.84E-02			5.84E-02											
K+	5.85E+02			7.37E+01			5.16E+02			6.38E-01			6.33E+00			1.43E+00		
La+3	2.35E-01			9.76E-03			2.25E-01									9.76E-03		
Mg+2	1.46E-04			1.46E-04									1.46E-04					
Mn+2	4.85E-05			4.85E-05									4.85E-05					
Mo+4	1.01E-01			1.91E-04			1.01E-01									1.91E-04		
Mo+6	7.23E-03			7.23E-03									7.23E-03					
Na+	6.77E+04			1.13E+03			6.66E+04			3.50E-02			1.18E-02			6.60E+02		
NH+3	8.14E+00			1.51E-02			8.12E+00						2.14E-03			1.30E-02		
Np+4	9.85E-03			1.02E-03			9.85E-03						1.02E-03					
Pu+4	2.73E-02			6.20E-04			2.67E-02									6.20E-04		
Ra+7	9.76E-05			9.76E-05									9.76E-05					
Rh+3	8.27E-04			8.27E-04									8.27E-04					
Ru+3	1.17E-03			1.17E-03									1.17E-03					
Sa+6	1.35E-04						1.35E-04											
Si+4	1.56E+01			2.73E+00			1.32E+01			2.33E+00			4.03E-01					
Si+2	3.80E-01			1.87E-01			1.94E-01									1.87E-01		
Ta+6	8.27E-04			8.27E-04									8.27E-04					
UO2+2	4.28E-02			2.58E-02			4.28E-02									2.58E-02		
Zn+2	7.78E-04			7.78E-04									7.78E-04					
Zr+4	2.43E-05			2.43E-05									2.43E-05					
Al(OH)3	6.86E+02			1.51E-01			6.95E+03			4.42E+00			1.07E-01					
Cl-	6.78E+02			6.64E+00			6.72E+02			1.17E+00			1.81E+00			3.65E+00		
CO3-2	3.10E+03			2.51E-01			3.05E+03			1.20E+01						1.31E+01		
Cr(OH)3	4.46E+02			8.12E+00			4.38E+02			4.98E+02			7.80E+00			2.70E+01		
F-	1.13E+03			3.26E+02			8.07E+02			2.40E+02			3.42E+00			8.23E+01		
	9.07E-02						9.07E-02											
NO2-	9.42E+03			2.74E+01			5.42E+03			3.81E+00			2.36E+01					
NO3-	1.06E+05			6.86E+02			1.05E+05			1.47E+01			1.16E+02			5.56E+02		
OH-	1.43E+04			3.04E+02			1.40E+04			6.89E+01			3.85E+01			1.96E+02		
PO4-3	3.12E+03			1.33E+02			2.86E+02						1.10E+01			1.22E+02		
SO4-2	2.02E+03			1.03E+01			2.01E+03			9.85E-01			5.01E+00			4.32E+00		
TcO4-	2.21E+00			1.60E+03			2.21E+00									1.60E+03		
H2O	5.13E+05			1.37E+04			5.04E+05			6.91E+03			4.80E+03			5.03E+03		
Organic Carbon	1.05E+03			1.07E+01			1.05E+03			5.42E+00			7.57E-01			4.48E+00		
2O2:2H2O	7.53E+00						7.53E+00											

Table 2. TRU Waste Volume Projections (Rev. 2) - High Temperature Glass Formulation

Stream #	Total Blend			TRU Tanks			Remaining Tanks			TRU AW Tanks			TRU SY Tank			TRU T Tanks		
	Feed	HLW	LLW	Feed	HLW	LLW	Feed	HLW	LLW	Feed	HLW	LLW	Feed	HLW	LLW	Feed	HLW	LLW
Insoluble Components																		
Total Mass Flow (MT)	1.96E+04	1.99E+04	5.69E+05	1.50E+03	2.65E+03	1.61E+04	1.81E+04	1.78E+04	5.54E+05	8.53E+02	2.65E+03	7.30E+03	1.94E+02	5.92E+02	1.54E+03	4.57E+02	1.24E+03	7.22E+03
Radionuclides (Ci)																		
Am-241	9.72E+04	9.60E+04	5.10E+03	1.19E+04	1.17E+04	1.75E+02	8.54E+04	8.43E+04	8.84E+03	3.50E+02	3.45E+02	4.80E+00	1.13E+04	1.12E+04	1.49E+02	1.75E+02	1.73E+02	2.17E+01
Ci-16	2.19E+03			2.19E+03			2.19E+03											
Cm-244	1.42E+03	1.40E+03	2.84E+01	2.84E+01	2.84E+01	2.84E+01	1.42E+03	1.40E+03	2.84E+01	1.42E+03	1.40E+03	2.84E+01	1.42E+03	1.40E+03	2.84E+01	1.42E+03	1.40E+03	2.84E+01
Ce-137	3.91E+06	3.44E+07	3.05E+05	1.53E+05	1.52E+05	7.80E+03	2.86E+06	3.41E+07	3.01E+05	1.51E+05	1.50E+05	3.25E+03	8.20E+02	1.04E+03	5.25E+02	2.89E+02	2.89E+02	1.10E+01
Ba-137	2.86E+06	3.27E+07	2.90E+05	1.45E+05	1.44E+05	3.60E+03	2.72E+06	3.24E+07	2.86E+05	1.44E+05	1.43E+05	3.08E+03	8.74E+02	9.89E+02	4.99E+02	2.74E+02	2.74E+02	1.05E+01
Np-237	6.27E+01	6.19E+01	7.76E+00	7.76E+00	7.76E+00	7.76E+00	6.27E+01	6.19E+01	7.76E+00	6.27E+01	6.19E+01	7.76E+00	6.27E+01	6.19E+01	7.76E+00	6.27E+01	6.19E+01	7.76E+00
Pu-238	2.48E+04	2.44E+04	2.02E+03	5.18E+03	5.11E+03	1.06E+02	1.96E+04	1.93E+04	1.91E+03	1.22E+03	1.20E+03	1.60E+01	2.08E+03	2.05E+03	2.73E+01	1.88E+03	1.88E+03	6.30E+01
Pu-240	8.26E+03	8.17E+03	8.22E+01	8.22E+01	8.22E+01	8.22E+01	8.26E+03	8.17E+03	8.22E+01	8.26E+03	8.17E+03	8.22E+01	8.26E+03	8.17E+03	8.22E+01	8.26E+03	8.17E+03	8.22E+01
Pu-241	6.95E+04	6.86E+04	9.14E+02	9.14E+02	9.14E+02	9.14E+02	6.95E+04	6.86E+04	9.14E+02	6.95E+04	6.86E+04	9.14E+02	6.95E+04	6.86E+04	9.14E+02	6.95E+04	6.86E+04	9.14E+02
Str-90	5.18E+07	5.13E+07	2.27E+06	1.19E+05	1.14E+05	1.78E+03	5.17E+07	5.12E+07	2.37E+06	5.10E+04	5.04E+04	6.71E+02	4.48E+04	4.40E+04	5.86E+02	2.34E+04	2.31E+04	5.20E+02
Y-80	5.18E+07	5.13E+07	2.27E+06	1.19E+05	1.14E+05	1.78E+03	5.17E+07	5.12E+07	2.37E+06	5.10E+04	5.04E+04	6.71E+02	4.48E+04	4.40E+04	5.86E+02	2.34E+04	2.31E+04	5.20E+02
Tc-99	9.32E+03	9.12E+03	2.23E+04	4.44E+01	4.33E+01	8.99E+01	9.23E+03	9.03E+03	2.26E+04	9.32E+03	9.12E+03	2.23E+04	4.44E+01	4.33E+01	8.99E+01	9.23E+03	9.03E+03	2.26E+04
Total Curies	1.10E+08	1.70E+08	5.37E+06	5.53E+05	5.18E+05	1.12E+04	1.09E+08	1.69E+08	5.36E+06	3.98E+05	3.95E+05	7.69E+03	1.04E+05	1.03E+05	2.37E+03	4.94E+04	4.85E+04	1.16E+03
Chemicals (MT)																		
Ag+	1.48E+00			1.58E+01			1.32E+00						1.58E+01					
Al+3	2.32E+03			3.22E+01			2.28E+03			1.27E+01			1.95E+01					
Am+3	2.83E+02			3.46E+03			2.49E+02			1.02E+04			3.30E+03			5.11E+05		
As+5	2.26E+03			2.26E+03									2.26E+03					
Ba+2	3.74E+00			7.42E+01			3.00E+00			6.81E+01			6.20E+02			1.01E+06		
Ba+2	3.98E+03			3.08E+03									3.08E+03					
Ba+3	2.51E+02			4.35E+01			2.08E+02									4.35E+01		
Ca+2	1.37E+02			1.77E+01			1.20E+02			1.79E+00			5.04E+00			1.09E+01		
Ca+2	6.55E+00			3.27E+01			6.22E+00						3.27E+01					
Ce+3	2.35E+02						2.35E+02											
Cm+3	1.75E+05			3.65E+07			1.72E+05						3.65E+07			1.17E+08		
Cm+3	1.49E+06			1.01E+06			1.49E+06			1.05E+00			5.51E+00			1.01E+09		
Cr+3	1.60E+02			7.10E+00			1.53E+02						5.51E+00			3.34E+01		
Ca+	2.05E+01			6.57E+03			1.99E+01			6.91E+03			5.22E+05			3.33E+06		
Cu+2	1.88E+01			1.88E+01									1.88E+01					
Fe+3	7.60E+02			8.65E+01			6.80E+02			1.92E+00			1.80E+01			6.06E+01		
Hg+2	8.81E+02						8.81E+02											
K+	2.96E+01			2.43E+01			5.33E+00			1.81E+01			5.36E+00			9.16E+01		
Li+3	2.30E+01			2.38E+00			2.06E+01			1.35E+00			3.32E+02			5.66E+01		
Mg+2	8.73E+01			8.73E+01			9.59E+01			9.50E+01						3.70E+01		
Mn+4	1.34E+02			3.78E+01			9.59E+01			9.50E+01								
Mo+6	3.21E+02			3.21E+02									3.21E+02					
N+	7.78E+02			1.77E+02			6.01E+02			1.37E+02			1.32E+01			2.75E+01		
NH3	2.07E+02			1.65E+01			1.65E+02			4.26E+01			4.54E+01			1.56E+01		
Np+4	8.90E+02						8.90E+02											
Pb+4	2.84E+01			1.36E+00			2.80E+01			3.44E+01			1.36E+00					
Pu+4	4.27E+01			8.35E+02						1.96E+02			3.35E+02			3.03E+02		
Rh+3	1.93E+01			1.93E+01									1.93E+01					
Se+6	3.32E+00			2.95E+00			7.20E+01			2.56E+00								
Si+4	2.30E+02			2.43E+01			2.06E+02			9.33E+00			5.98E+00			8.55E+00		
Si+2	3.66E+01			1.86E+01			1.80E+01			1.36E+03			9.79E+02			1.85E+01		
Th+4	2.79E+00			2.79E+00									2.79E+00					
Th+4	1.55E+01			1.55E+01									1.55E+01					
UO2+2	1.54E+02			2.84E+01			1.51E+03			2.94E+01						4.90E+02		
Zn+2	5.06E+01			5.06E+01									5.06E+01					
Cl-	8.99E+00	9.92E+00		2.34E+01	2.66E+01		8.73E+00	9.59E+00		3.60E+02	4.30E+02		9.43E+03			1.53E+01	2.05E+01	
CO3-2	1.09E+02			1.82E+01			9.07E+01			3.00E+00			1.42E+01			1.04E+00		
Fe+3	6.82E+01	6.90E+01		2.24E+01	2.38E+01		4.58E+01	4.64E+01		1.81E+01	1.94E+01		1.40E+02	2.09E+02		4.33E+00	4.60E+00	
NO2-	1.39E+03						1.39E+03											
NO2-	6.18E+01			6.59E+01			6.08E+01			8.80E+01			6.33E+02					
NO3-	9.45E+02			1.22E+01			9.76E+02			8.26E+00			2.82E+01			3.80E+00		
OH-	5.67E+03			2.70E+02			5.35E+03			1.44E+02			8.18E+01			3.58E+01		
PO4-3	1.15E+02			1.89E+02			1.66E+03			4.57E+01			6.38E+00			1.82E+02		
SO4-2	2.56E+01			1.37E+00			2.42E+01			1.25E+00			1.69E+02			8.81E+02		
TeO4	9.07E+01			4.32E+03			8.96E+01						2.72E+03			1.60E+03		
Carborane	2.70E+03						2.70E+03											
MnO2	7.54E+02	2.17E+02	1.85E+01	7.58E+00	6.67E+01	8.85E+01	1.50E+02	1.80E+01		1.48E+00	1.96E+02	7.58E+00	7.45E+00	9.96E+02		5.78E+01	7.70E+01	
Organic Carbon	8.73E+01			8.60E+00			7.84E+01			5.42E+00			2.96E+00			4.97E+01		
ZrO2·2H2O	1.19E+03			4.52E+02			7.44E+02			4.51E+02			5.72E+01					
Ag2O	1.57E+00	3.64E+01		1.68E+01	2.28E+03		1.40E+00	3.62E+01					1.68E+01	2.28E+03				
Al2O3	2.24E+03	2.16E+04		2.00E+01	6.10E+02		2.22E+03	2.10E+04		7.88E+00	2.77E+02		1.21E+01	3.73E+01				2.75E+02
Am2O3	3.08E+02	2.81E+03		3.75E+03	5.62E+05		2.70E+02	2.86E+03		1.11E+04	1.47E+06		3.58E+03	4.77E+05		5.54E+05	6.95E+06	
As2O5	3.43E+03	1.08E+04		3.43E+03	4.56E+05		9.06E+08	6.21E+05					3.43E+03	4.56E+05				
B2O3	9.84E+03	9.90E+00		1.33E+02	3.61E+01		8.62E+03	8.67E+00		4.40E+02	1.14E+01		1.18E+02	1.41E+01		1.64E+02	1.13E+01	
BaO	4.12E+00	3.98E+01		6.18E+01	1.20E+02		3.31E+00	9.24E+01		7.50E+01	9.95E+03		6.84E+02	1.97E+03		1.11E+06	1.48E+08	
BaO	8.42E+03	1.76E+04		6.44E+03	1.79E+04								8.42E+03	1.76E+04				
Bi2O3	2.77E+02	1.69E+01		4.78E+01	1.12E+00		2.29E+02	1.58E+01								4.78E+01	1.12E+00	
CaO	1.92E+02	4.33E+04		2.45E+01	1.22E+03		1.68E+02	4.21E+04		2.47E+00	5.55E+02		6.33E+00	1.48E+02		1.50E+01	5.49E+03	
CaO	6.42E+02			3.66E+01	1.24E+02		2.78E+02	8.35E+00										
CaCO3																		

Table 2. TRU Waste Volume Projections (Rev. 2) - High Temperature Glass Formulation

Stream #	Total Blend			TRU Tanks			Remaining Tanks			TRU AW Tanks			TRU SY Tank			TRU T Tanks		
	Feed	HLW	LLW	Feed	HLW	LLW	Feed	HLW	LLW	Feed	HLW	LLW	Feed	HLW	LLW	Feed	HLW	LLW
Chemicals Cont'd																		
La2O3	2.66E+01	6.33E-01		2.75E+00	4.60E-02		3.34E+01	3.85E-01		1.56E+00	2.08E-02		6.16E-02	8.27E-04		1.12E+00	2.63E-02	
Li2O	1.99E+02	3.18E+00		2.65E+01	8.89E-02		1.78E+02	3.10E+00		2.65E+01	4.08E-02		3.46E-01	1.09E-02		1.24E+01	4.04E-02	
MgO	1.43E+00	6.56E-01		1.43E+00	3.72E-02			6.20E-01			8.16E-03		1.43E+00	2.14E-02				8.06E-03
MnO	9.72E-06	6.25E-05		3.32E-07	6.23E-05								1.29E-07	6.25E-05				
MoO3	4.76E-02	1.15E-02		4.76E-02	1.14E-02		2.28E+03	1.05E+05		1.83E+02	1.39E+03		4.76E-02	1.15E-02		6.18E+01	1.37E-02	
Na2O	2.55E+03	1.08E+05		2.57E+02	3.05E+03		2.63E+02	1.49E+01		5.97E-01	7.95E-03		2.96E-01	3.69E+02		2.17E+01	3.08E-01	
NiO	2.87E+02	1.55E+01		2.29E+01	3.27E-01								6.31E-01	1.14E-02				
NpO2	9.97E-02	1.25E-02					9.97E-02	1.25E-02										
P2O5	3.76E+02	3.34E+03		3.87E+01	2.02E+02		3.34E+02	3.13E+03		8.21E-02	2.50E-01		1.30E+00	1.17E+01		3.71E+01	1.90E-02	
PbO2	3.35E+01	6.41E+00		1.54E+00	2.19E-02		3.19E+01	6.39E+00					1.54E+00	2.18E-02				
PuO2	4.78E-01	3.73E-02		9.34E-02	1.94E-03		3.84E-01	3.53E-02		2.20E-02	2.92E-04		3.75E-02	5.00E-04		3.39E-02	1.15E-03	
Ru2O7	1.97E-07	1.27E-04		6.73E-07	1.26E-04								2.62E-07	1.27E-04				
Rh2O3	2.35E-01	4.14E-03		2.35E-01	4.14E-03								2.35E-01	4.14E-03				
Ru2O3	2.24E-06	1.44E-03		7.65E-06	1.44E-03								2.98E-06	1.44E-03				
SrO3	5.26E+00	7.03E-02		4.11E+00	5.46E-02		1.14E+00	1.54E-02		4.11E+00	5.46E-02							
SiO2	8.35E+03	2.53E+05		1.43E+03	7.00E+03		7.48E+03	2.46E+05		1.51E+03	3.25E+03		3.37E+02	8.48E+02		7.05E+02	3.09E+03	
SO3	1.21E+01	1.68E+03		5.61E-01	8.54E+00		1.15E+01	1.68E+03		5.24E-01	8.29E-01		1.34E+02	4.17E+00		4.36E+02	3.59E+00	
SrO	4.23E+01	8.69E-01		2.16E+01	4.85E-01		2.09E+01	4.84E-01		1.59E+03	2.11E+05		1.14E+01	1.52E+03		2.15E+01	4.84E-01	
Ta2O7	8.44E+01	2.11E+00		4.01E+03	1.57E+03		8.36E-01	2.11E+00					2.52E+03	3.40E+05		1.49E+03	1.53E-02	
TaO3	1.77E-06	1.14E-03		6.03E-06	1.13E-03								2.35E-06	1.14E-03				
ThO2	3.13E+00	4.17E-02		3.13E+00	4.17E-02								3.13E+00	4.17E-02				
TiO2	2.55E+01	3.39E-03		2.55E-01	3.39E-03		1.58E+03	4.73E+02		3.07E+01	4.09E-01		2.55E-01	3.39E-03		5.12E-02	3.40E-03	
UO3	1.61E+03	4.74E+02		3.07E+01	4.12E-01					3.44E+02	4.59E+00		6.22E-01	9.25E-03				
ZnO	6.22E-01	5.25E-01		6.22E-01	9.25E-03		5.68E+02	1.34E+01					4.37E-01	1.16E+01		4.33E+01		
ZrO2	9.10E+02	1.80E+01		3.45E+02	4.60E+00								4.37E-01	1.16E+01		4.23E+01		
Dicyclopentadiene		5.22E+03			6.62E+01			3.32E+03			4.37E+01			1.16E+01				
Oligomer		5.22E+03			6.62E+01			3.32E+03			4.37E+01			1.16E+01				
Sulfur		1.26E+05			3.66E+03			1.26E+05			1.66E+03			4.42E+02				

Table 3. TRU Waste Volume Projections (Rev. 2) - High Temperature Glass Formulation (Lower Limits Only)

Stream #	Total Blend			TRU Tanks			Remaining Tanks			TRU AW Tanks			TRU SY Tank			TRU T Tanks		
	Feed	HLW	LLW	Feed	HLW	LLW	Feed	HLW	LLW	Feed	HLW	LLW	Feed	HLW	LLW	Feed	HLW	LLW
Soluble Components																		
Total Mass Flow (MT)	7.30E+05			1.64E+04			7.19E+05			7.68E+03			5.15E+03			6.67E+03		
Volume (L)	5.88E+06			1.48E+07			5.80E+06			7.17E+06			4.84E+06			5.74E+06		
Specific Gravity	1.24E+00			1.11E+00			1.24E+00			1.07E+00			1.04E+00			1.16E+00		
Radionuclides (Ci)																		
Am-241	7.82E+03			1.95E+01			7.82E+03									1.85E+01		
C-14	3.31E+03			1.16E+00			3.31E+03						9.71E-01			1.88E-01		
Cm-244	7.70E+00			1.97E-02			7.63E+00			1.02E-02						9.52E-03		
Cs-137	3.17E+07			2.13E+05			3.15E+07			1.51E+05			6.14E+04			8.68E+02		
Ba-137	3.01E+07			2.03E+05			2.99E+07			1.44E+05			5.83E+04			8.25E+02		
Np-237	6.94E+00						6.94E+00											
Pu-238	1.69E+03			3.84E+01			1.66E+03									3.84E+01		
Sr-90	1.88E+06			2.36E+02			1.88E+06									2.36E+02		
Y-90	1.88E+06			2.36E+02			1.88E+06									2.36E+02		
Tc-99	2.27E+04			1.64E+01			2.27E+04									1.64E+01		
Total Curies	6.57E+07			4.16E+05			6.52E+07			2.95E+05			1.70E+05			2.24E+03		
Chemicals (MT)																		
As+	3.20E-01			4.65E-05			3.20E-01						4.85E-05					
Am+3	2.28E-03			5.68E-06			2.28E-03									5.68E-06		
As+5	4.05E-05						4.05E-05											
B-3	3.43E-02			3.43E-02									3.43E-02					
Ba+2	7.91E-01			9.50E-04			7.90E-01						9.50E-04					
Ba+2	2.43E-05			2.43E-05									2.43E-05					
Bi+3	1.18E-01			4.39E-01			1.14E+01									4.39E-01		
Ca+2	1.65E+01			8.81E-02			1.64E+01			3.66E-02			4.29E-02			8.54E-03		
Co+2	1.74E-01			8.88E-03			1.67E-01						6.58E-03					
Ce+3	2.37E+06						2.37E+06											
Cm+3	9.50E-08			2.43E-10			9.42E-08									1.17E-10		
Ce+	1.88E+00			1.04E-02			1.87E+00			1.25E-10			3.49E-03			1.00E-05		
Cu+2	9.94E-02			4.39E-04			9.85E-02			8.91E-03			4.39E-04					
Fe+3	3.19E+01			6.15E-01			3.12E+01						2.38E-03			6.12E-01		
Hg+2	5.84E-02						5.84E-02											
K+	5.89E-02			7.37E-01			5.16E-02			6.39E-01			8.33E-00			1.43E+00		
La+3	2.35E-01			9.76E-03			2.29E-01						1.46E-04			9.76E-03		
Mg+2	1.46E-04			1.46E-04									4.65E-05					
Mn+2	4.85E-05			4.85E-05														
Mn+4	1.01E+01			1.91E-04			1.01E+01									1.91E-04		
Mo+6	7.23E-03			7.23E-03									7.23E-03					
Na+	6.77E+04			1.13E+02			6.66E+04			3.50E+02			1.18E+02			6.60E+02		
Ni+3	9.14E+00			1.51E-02			8.12E+00						2.14E-03			1.50E-02		
Np+4	8.85E-03						8.85E-03											
Pb+4	5.18E+00			1.02E-03			5.18E+00						1.02E-03					
Pu+4	2.73E-02			6.20E-04			2.67E-02						9.76E-05			6.20E-04		
Ra+7	9.76E-05			9.76E-05									9.27E-04					
Rn+3	8.27E-04			8.27E-04									1.17E-02					
Ru+3	1.17E-03			1.17E-03														
Se+5	1.35E-04						1.35E-04			2.33E+00			4.03E-01					
Si+4	1.59E+01			2.73E+00			1.32E+01									1.87E-01		
Si+2	3.80E-01			1.87E-01			1.94E-01						8.27E-04					
Ta+6	8.27E-04			8.27E-04														
UC2+2	4.28E+02			2.58E-03			4.28E+02									2.58E-03		
Zn+2	7.78E-04			7.78E-04									7.78E-04					
Zr+4	2.43E-05			2.43E-05									2.43E-05					
Al(OH)3	6.96E-03			1.51E-01			6.95E-03			4.42E+00			1.07E-01					
Cl-	6.78E-02			6.64E+00			6.72E-02			1.17E+00			1.81E+00			3.66E+00		
CO3-2	3.10E+03			2.51E+01			3.08E+03			1.20E+01						1.31E+01		
Cr(OH)3	4.46E+02			8.12E+00			4.38E+02			4.96E+02			7.80E+00			2.70E+01		
F-	1.13E+03			3.26E+02			8.07E+02			2.40E+02			3.42E+00			8.23E+01		
I-	9.07E-02						9.07E-02											
NO2-	9.42E-03			2.74E+01			9.42E-03			3.81E+00			2.95E+01					
NO3-	1.06E+05			6.65E+02			1.05E+05			1.47E+01			1.16E+02			5.56E+02		
OH-	1.43E+04			3.04E+02			1.40E+04			6.89E+01			3.85E+01			1.22E+02		
PO4-3	3.12E+03			1.33E+02			2.84E+03						1.10E+01			4.32E+00		
SO4-2	2.02E+03			1.03E+01			2.01E+03			9.85E-01			5.01E+00			1.60E+03		
TeO4	2.21E+00			1.60E-03			2.21E+00									5.03E+03		
H2O	5.13E+05			1.37E+04			5.04E+05			6.91E+03			4.80E+03			4.48E+00		
Organic Carbon	1.05E+03			1.07E+01			1.05E+03			5.42E+00			7.97E-01					
ZrO2·2H2O	7.53E+00						7.53E+00											

Revision 0

Stream #	Total Blend			TRU Tanks			Remaining Tanks			TRU AV Tanks			TRU ST Tanks			TRU T Tanks		
	Feed	HLW	LLW	Feed	HLW	LLW	Feed	HLW	LLW	Feed	HLW	LLW	Feed	HLW	LLW	Feed	HLW	LLW
Insoluble Components																		
Total Mass Flow (MT)	1.95E+04	1.99E+04	5.65E+05	1.50E+03	2.04E+03	1.61E+04	1.81E+04	1.78E+04	5.54E+03	5.53E+02	1.24E+03	7.30E+03	1.54E+03	1.80E+02	1.54E+03	4.57E+02	6.85E+02	7.22E+02
Radionuclides (Ci)																		
Am-241	8.72E+04	9.60E+04	9.10E+03	1.19E+04	1.17E+04	1.75E+02	1.54E+04	8.43E+03	8.94E+03	3.50E+02	3.45E+02	4.60E+02	1.13E+04	1.12E+04	1.45E+02	1.75E+02	1.73E+02	2.17E+01
C-14	2.19E+03			2.15E+01			2.19E+03						2.13E+01			1.90E+03		
Cm-244	1.42E+03	1.40E+03	2.84E+01	2.89E+01	2.91E+01	4.08E+01	1.39E+03	1.36E+03	2.59E+01		6.52E+05	1.01E+02	2.86E+01	2.83E+01	3.76E+01	9.45E+01	9.33E+01	2.19E+02
Co-60	3.01E+06	3.44E+07	3.08E+03	1.33E+03	1.52E+03	3.78E+03	2.86E+06	3.41E+07	3.01E+06	1.51E+05	1.50E+05	3.25E+03	9.20E+02	1.04E+03	5.95E+02	2.89E+02	2.89E+02	1.10E+01
Ba-137	2.86E+06	3.17E+07	2.90E+05	1.45E+05	1.44E+05	3.80E+05	1.72E+06	3.24E+07	2.86E+05	1.14E+05	1.43E+05	3.08E+03	8.74E+02	9.83E+02	7.74E+02	2.74E+02	2.74E+02	1.05E+01
Np-237	6.27E+01	6.18E+01	7.76E+00				6.27E+01	6.18E+01	7.76E+00									
Pu-238	2.48E+04	2.44E+04	7.02E+03	5.18E+03	5.11E+03	1.06E+02	1.98E+04	1.83E+04	8.21E+01	1.22E+03	1.20E+03	1.60E+01	2.08E+03	2.05E+03	2.73E+01	1.88E+03	1.86E+03	6.30E+01
Pu-239	6.28E+03	6.17E+03	8.23E+01				6.28E+03	6.17E+03	8.23E+01									
Pu-241	6.89E+04	6.86E+04	9.14E+02				6.89E+04	6.86E+04	9.14E+02									
Sr-90	5.18E+07	5.13E+07	2.37E+06	1.19E+05	1.18E+05	1.78E+05	5.17E+07	5.12E+07	2.37E+06	5.10E+04	5.04E+04	6.71E+02	4.46E+04	4.40E+04	5.85E+02	2.34E+04	2.31E+04	5.20E+02
U-235	5.18E+07	5.13E+07	2.37E+06	1.19E+05	1.18E+05	1.78E+05	5.17E+07	5.12E+07	2.37E+06	5.10E+04	5.04E+04	6.71E+02	4.46E+04	4.40E+04	5.85E+02	2.34E+04	2.31E+04	5.20E+02
U-238	9.32E+03	9.12E+03	2.28E+04	4.44E+03	4.33E+03	1.02E+03	1.93E+03	1.93E+03	2.28E+04				2.04E+01	2.72E+01	3.67E+01	1.64E+01	1.60E+01	1.66E+01
Tc-99	1.10E+06	1.70E+07	6.57E+06	5.53E+05	5.48E+05	1.12E+04	1.09E+06	1.69E+06	5.36E+04	3.96E+05	3.95E+05	7.69E+03	1.28E+05	1.03E+05	2.37E+03	6.54E+04	4.88E+04	1.18E+03
Total Curies																		
Am-241	1.48E+00			1.58E+01			1.32E+00						1.58E+01					
Am-243	3.23E+03			3.22E+01			2.28E+03			1.27E+01			1.95E+01					
Am-244	2.83E+02			3.45E+03			2.49E+02			1.02E+04			3.30E+03			5.11E+05		
Am-245	2.26E+03			2.26E+03									2.26E+03					
Ba-137	3.74E+00			7.42E+01			3.00E+00			6.81E+01			6.20E+02			1.01E+06		
Ba-138	3.08E+03			3.08E+03									3.08E+03					
Ba-139	2.51E+03																	

Table 3. TRU Waste Volume Projections (Rev. 2) - High Temperature Glass Formulation (Lower Limits Only)

Stream #	Total Blend			TRU Tanks			Remaining Tanks			TRU AW Tanks			TRU SY Tank			TRU Y Tanks		
	Feed	HLW	LLW	Feed	HLW	LLW	Feed	HLW	LLW	Feed	HLW	LLW	Feed	HLW	LLW	Feed	HLW	LLW
Chemicals Cont'd																		
La2O3	2.66E+01	6.33E-01		2.75E+00	4.80E-02		2.33E+01	5.55E-01		1.56E+00	2.08E-02		6.16E-02	6.21E-04		1.12E+00	2.63E-02	
Li2O	1.99E+02	3.18E+00		2.04E+01	8.98E-02		1.78E+02	3.10E+00		1.24E+01	4.08E-02		1.80E+00	1.09E-02		6.65E+00	4.04E-02	
MgO	1.43E+00	6.56E-01		1.43E+00	3.72E-02		6.20E-01				8.19E-03		1.43E+00	2.14E-02				8.08E-03
MnO	9.72E-08	6.25E-05		3.32E-07	6.23E-05								1.29E-07	6.25E-05				
MoO3	4.76E-02	1.15E-02		4.76E-02	1.14E-02								4.76E-02	1.15E-02				
Na2O	2.55E+03	1.08E+05		2.57E+02	3.55E+03		2.28E+03	1.05E+05		1.63E+02	1.39E+03		2.18E+01	3.69E+02		5.22E+01	1.37E+03	
Ni2O3	2.87E+02	1.53E+01		2.29E+01	3.27E-01		2.63E+03	1.49E+01		5.97E-01	7.95E-03		6.31E-01	1.14E-02		2.17E+01	3.08E-01	
Np2O2	9.97E-02	1.25E-02					8.97E-02	1.25E-02										
P2O5	3.76E+02	3.34E+03		3.87E+01	2.02E+02		3.38E+02	3.13E+03		9.21E-02	2.50E-01		1.30E+00	1.17E+01		3.71E+01	1.80E+02	
PbO2	3.35E+01	6.41E+00		1.54E+00	2.18E-02		3.19E+01	6.39E+00					1.54E+00	2.18E-02				
PuO2	4.78E-01	3.73E-02		9.34E-02	1.94E-03		3.84E-01	3.53E-02		2.20E-02	2.92E-04		3.75E-02	5.00E-04		3.39E-02	1.15E-03	
Ra2O7	1.97E-07	1.27E-04		6.73E-07	1.26E-04								2.62E-07	1.27E-04				
Rh2O3	2.35E-01	4.14E-03		2.35E-01	4.14E-03								2.35E-01	4.14E-03				
Ru2O3	2.24E-06	1.44E-03		7.65E-06	1.44E-03								2.96E-06	1.44E-03				
SaO3	5.28E+00	7.03E-02		4.11E+00	5.88E-02		1.14E+00	1.54E-02		4.11E+00	5.48E-02		7.57E+01	8.46E-02		2.78E+02	3.09E-03	
SiO2	8.35E+03	2.53E+05		8.58E+02	7.00E+03		7.49E+03	2.45E+05		5.20E+02	3.25E+03		1.34E+02	4.17E+00		4.36E+03	3.59E+00	
SO3	1.21E-01	1.68E+03		5.91E-01	5.54E+00		1.15E-01	1.68E+03		5.24E-01	8.29E-01		1.14E-01	1.52E+03		2.15E+01	4.84E-01	
SrO	4.25E+01	8.69E-01		2.16E+01	4.85E-01		2.09E+01	4.84E-01		1.59E+03	2.11E+05							
Tc2O7	8.44E-01	2.11E+00		4.01E-03	1.57E-03		8.36E-01	2.11E+00					2.52E-03	3.40E-05		1.49E-03	1.53E-03	
ThO3	1.77E-06	1.14E-03		6.03E-06	1.13E-03								2.35E-06	1.14E-03				
ThO2	3.13E+00	4.17E-02		3.13E+00	4.17E-02								3.13E+00	4.17E-02				
ThO2	2.55E-01	3.39E-03		2.55E-01	3.39E-03								2.55E-01	3.39E-03				
UO3	1.61E+03	4.74E+02		3.07E+01	4.12E-01		1.56E+03	4.73E+02		3.07E+01	4.09E-01		6.22E-01	9.25E-03		5.12E-02	3.40E-03	
ZnO	6.22E-01	9.25E-03		6.22E-01	9.25E-03		5.68E-02	1.34E-01		3.44E-02	4.59E-00		4.37E-01	5.65E-03				
ZrO2	9.10E+02	1.80E+01		9.45E+02	1.60E+00													
Dicyclopentadiene		5.22E-03			5.62E-01												4.33E-01	
Oligomer		5.22E-03			5.62E-01												4.33E-01	
Sulfur		1.26E-05			1.26E-05												1.64E-03	

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74A20-96-001

ATTACHMENT 2

TRU Waste Volume Projections (Revision 2)
HLW Glass Formulation Output Data

Low Temperature HWVP Glass Formulation
Low Temperature HWVP Glass Formulation (Lower Limits Only)
Low Temperature CVS Glass Composition
Low Temperature CVS Glass Composition (Lower Limits Only)

Consisting of 25 pages,
including cover page

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TRU Waste Volume Projections (Rev. 2) - Low Temperature HLW Glass Formulation

9-Nov-95

09:51:20

* TWRS REFERENCE FLOWSHEET OUTPUT RESULTS *

HLW GLASS FORMULATION - ALL TANKS

THE WT % OF CL- IS: .04%
 THE WT % OF F- IS: .30%
 THE WT % OF S03 IS: .05%
 THE WT % OF AL203 IS: 9.74%
 THE WT % OF B203 IS: 7.00%
 THE WT % OF CAO IS: .84%
 THE WT % OF CR203 IS: .37%
 THE WT % OF FE203 IS: 4.67%
 THE WT % OF LI20 IS: 2.00%
 THE WT % OF MGO IS: .01%
 THE WT % OF NA20 IS: 11.08%
 THE WT % OF P205 IS: 1.64%
 THE WT % OF SIO2 IS: 46.00%
 THE WT % OF UO3 IS: 7.00%
 THE WT % OF ZR02 IS: 3.96%
 THE WT % OF AL203 + ZR02 IS: 13.71%
 THE WT % OF AL203 + FE203 + ZR02 IS: 18.37%
 THE WT % OF CAO + MGO IS: .84%
 THE WT % OF RH203 + RU203 IS: .00%

THE HL WASTE OXIDE LOADING IS: 51.3%

THE WT % OF AL203 IN THE FRIT IS: .00%
 THE WT % OF B203 IN THE FRIT IS: 14.35%
 THE WT % OF FE203 IN THE FRIT IS: .00%
 THE WT % OF LI20 IN THE FRIT IS: 4.10%
 THE WT % OF NA20 IN THE FRIT IS: .00%
 THE WT % OF SIO2 IN THE FRIT IS: 81.55%

THIS PRODUCES 13933.2 0.62-M^3 HLW CANISTERS

THIS PRODUCES 6856.0 1.26-M^3 HLW CANISTERS

THE HLW GLASS IS FRIT LIMITED.

THIS SIMULATION WAS RUN USING HWVP LIMITS AND
 GLASS FORMERS.

ENHANCED IN-TANK SLUDGE WASHING IS FOLLOWED BY
 THREE DILUTE CAUSTIC WASHES.

TRU Waste Volume Projections (Rev. 2) - Low Temperature HLW Glass Formulation

9-Nov-95

09:18:35

* TWRS REFERENCE FLOWSHEET OUTPUT RESULTS *

HLW GLASS FORMULATION - TRU TANKS

THE WT % OF CL- IS: .01%
 THE WT % OF F- IS: .69%
 THE WT % OF SO3 IS: .02%
 THE WT % OF AL2O3 IS: 1.00%
 THE WT % OF B2O3 IS: 10.09%
 THE WT % OF CAO IS: .71%
 THE WT % OF CR2O3 IS: .11%
 THE WT % OF FE2O3 IS: 4.00%
 THE WT % OF LI2O IS: 2.00%
 THE WT % OF MGO IS: .04%
 THE WT % OF NA2O IS: 7.44%
 THE WT % OF P2O5 IS: 1.12%
 THE WT % OF SIO2 IS: 56.00%
 THE WT % OF UO3 IS: .89%
 THE WT % OF ZRO2 IS: 10.00%
 THE WT % OF AL2O3 + ZRO2 IS: 11.00%
 THE WT % OF AL2O3 + FE2O3 + ZRO2 IS: 15.00%
 THE WT % OF CAO + MGO IS: .75%
 THE WT % OF RH2O3 + RU2O3 IS: .01%

THE HL WASTE OXIDE LOADING IS: 32.4%

THE WT % OF AL2O3 IN THE FRIT IS: .62%
 THE WT % OF B2O3 IN THE FRIT IS: 14.90%
 THE WT % OF FE2O3 IN THE FRIT IS: 1.04%
 THE WT % OF LI2O IN THE FRIT IS: 2.95%
 THE WT % OF NA2O IN THE FRIT IS: .00%
 THE WT % OF SIO2 IN THE FRIT IS: 80.48%

THIS PRODUCES 2092.2 0.62-M^3 HLW CANISTERS

THIS PRODUCES 1029.5 1.26-M^3 HLW CANISTERS

THE HLW GLASS IS ZRO2 LIMITED.

THIS SIMULATION WAS RUN USING HWVP LIMITS AND
GLASS FORMERS.

ENHANCED IN-TANK SLUDGE WASHING IS FOLLOWED BY
THREE DILUTE CAUSTIC WASHES.

TRU Waste Volume Projections (Rev. 2) - Low Temperature HLW Glass Formulation

9-Nov-95

09:59:46

* TWRS REFERENCE FLOWSHEET OUTPUT RESULTS *

HLW GLASS FORMULATION - REMAINING TANKS

THE WT % OF CL- IS: .05%
 THE WT % OF F- IS: .22%
 THE WT % OF SO3 IS: .06%
 THE WT % OF AL2O3 IS: 10.76%
 THE WT % OF B2O3 IS: 7.00%
 THE WT % OF CAO IS: .82%
 THE WT % OF CR2O3 IS: .40%
 THE WT % OF FE2O3 IS: 4.66%
 THE WT % OF LI2O IS: 2.00%
 THE WT % OF MGO IS: .00%
 THE WT % OF NA2O IS: 11.06%
 THE WT % OF P2O5 IS: 1.64%
 THE WT % OF SiO2 IS: 46.00%
 THE WT % OF UO3 IS: 7.67%
 THE WT % OF ZRO2 IS: 2.76%
 THE WT % OF AL2O3 + ZRO2 IS: 13.51%
 THE WT % OF AL2O3 + FE2O3 + ZRO2 IS: 18.17%
 THE WT % OF CAO + MGO IS: .82%
 THE WT % OF RH2O3 + RU2O3 IS: .00%

THE HL WASTE OXIDE LOADING IS: 51.8%

THE WT % OF AL2O3 IN THE FRIT IS: .00%
 THE WT % OF B2O3 IN THE FRIT IS: 14.49%
 THE WT % OF FE2O3 IN THE FRIT IS: .00%
 THE WT % OF LI2O IN THE FRIT IS: 4.14%
 THE WT % OF NA2O IN THE FRIT IS: .00%
 THE WT % OF SiO2 IN THE FRIT IS: 81.38%

THIS PRODUCES 12497.4 0.62-M^3 HLW CANISTERS

THIS PRODUCES 6149.5 1.26-M^3 HLW CANISTERS

THE HLW GLASS IS FRIT LIMITED.

THIS SIMULATION WAS RUN USING HWVP LIMITS AND
GLASS FORMERS.

ENHANCED IN-TANK SLUDGE WASHING IS FOLLOWED BY
THREE DILUTE CAUSTIC WASHES.

TRU Waste Volume Projections (Rev. 2) - Low Temperature HLW Glass Formulation

9-Nov-95

09:20:29

* TWRS REFERENCE FLOWSHEET OUTPUT RESULTS *

HLW GLASS FORMULATION - TRU AW TANKS

THE WT % OF CL- IS: .00%
 THE WT % OF F- IS: .56%
 THE WT % OF SO3 IS: .02%
 THE WT % OF AL2O3 IS: 1.00%
 THE WT % OF B2O3 IS: 17.00%
 THE WT % OF CAO IS: .07%
 THE WT % OF CR2O3 IS: .02%
 THE WT % OF FE2O3 IS: 4.00%
 THE WT % OF LI2O IS: 2.55%
 THE WT % OF MGO IS: .00%
 THE WT % OF NA2O IS: 7.00%
 THE WT % OF P2O5 IS: .00%
 THE WT % OF SIO2 IS: 56.00%
 THE WT % OF UO3 IS: .89%
 THE WT % OF ZRO2 IS: 10.00%
 THE WT % OF AL2O3 + ZRO2 IS: 11.00%
 THE WT % OF AL2O3 + FE2O3 + ZRO2 IS: 15.00%
 THE WT % OF CAO + MGO IS: .07%
 THE WT % OF RH2O3 + RU2O3 IS: .00%

THE HL WASTE OXIDE LOADING IS: 18.8%

THE WT % OF AL2O3 IN THE FRIT IS: .95%
 THE WT % OF B2O3 IN THE FRIT IS: 20.89%
 THE WT % OF FE2O3 IN THE FRIT IS: 4.82%
 THE WT % OF LI2O IN THE FRIT IS: 3.14%
 THE WT % OF NA2O IN THE FRIT IS: 2.08%
 THE WT % OF SIO2 IN THE FRIT IS: 68.12%

THIS PRODUCES 2088.2 0.62-M^3 HLW CANISTERS

THIS PRODUCES 1027.5 1.26-M^3 HLW CANISTERS

THE HLW GLASS IS ZRO2 LIMITED.

THIS SIMULATION WAS RUN USING HWVP LIMITS AND GLASS FORMERS.

ENHANCED IN-TANK SLUDGE WASHING IS FOLLOWED BY
 THREE DILUTE CAUSTIC WASHES.

TRU Waste Volume Projections (Rev. 2) - Low Temperature HLW Glass Formulation

9-Nov-95

09:23:23

* TWRS REFERENCE FLOWSHEET OUTPUT RESULTS *

HLW GLASS FORMULATION - TRU SY TANK

THE WT % OF CL- IS: .00%
 THE WT % OF F- IS: .00%
 THE WT % OF S03 IS: .00%
 THE WT % OF AL203 IS: 3.88%
 THE WT % OF B203 IS: 17.00%
 THE WT % OF CAO IS: 1.18%
 THE WT % OF CR203 IS: .50%
 THE WT % OF FE203 IS: 4.28%
 THE WT % OF LI20 IS: 6.00%
 THE WT % OF MGO IS: .24%
 THE WT % OF NA20 IS: 7.00%
 THE WT % OF P205 IS: .22%
 THE WT % OF SIO2 IS: 56.00%
 THE WT % OF UO3 IS: .00%
 THE WT % OF ZR02 IS: .07%
 THE WT % OF AL203 + ZR02 IS: 3.96%
 THE WT % OF AL203 + FE203 + ZR02 IS: 8.24%
 THE WT % OF CAO + MGO IS: 1.42%
 THE WT % OF RH203 + RU203 IS: .04%

THE HL WASTE OXIDE LOADING IS: 18.1%

THE WT % OF AL203 IN THE FRIT IS: 2.24%
 THE WT % OF B203 IN THE FRIT IS: 20.72%
 THE WT % OF FE203 IN THE FRIT IS: .00%
 THE WT % OF LI20 IN THE FRIT IS: 7.31%
 THE WT % OF NA20 IN THE FRIT IS: 4.05%
 THE WT % OF SIO2 IN THE FRIT IS: 65.66%

THIS PRODUCES 358.9 0.62-M^3 HLW CANISTERS

THIS PRODUCES 176.6 1.26-M^3 HLW CANISTERS

THE HLW GLASS IS CR203 LIMITED.

THIS SIMULATION WAS RUN USING HWVP LIMITS AND
 GLASS FORMERS.

ENHANCED IN-TANK SLUDGE WASHING IS FOLLOWED BY
 THREE DILUTE CAUSTIC WASHES.

TRU Waste Volume Projections (Rev. 2) - Low Temperature HLW Glass Formulation

9-Nov-95

09:26:06

* TWRS REFERENCE FLOWSHEET OUTPUT RESULTS *

HLW GLASS FORMULATION - TRU T TANKS

THE WT % OF CL- IS: .02%
 THE WT % OF F- IS: .37%
 THE WT % OF SO3 IS: .00%
 THE WT % OF AL2O3 IS: 1.00%
 THE WT % OF B2O3 IS: 10.24%
 THE WT % OF CAO IS: 1.22%
 THE WT % OF CR2O3 IS: .02%
 THE WT % OF FE2O3 IS: 6.91%
 THE WT % OF LI2O IS: 2.00%
 THE WT % OF MGO IS: .00%
 THE WT % OF NA2O IS: 7.00%
 THE WT % OF P2O5 IS: 3.00%
 THE WT % OF SIO2 IS: 56.00%
 THE WT % OF UO3 IS: .00%
 THE WT % OF ZRO2 IS: .00%
 THE WT % OF AL2O3 + ZRO2 IS: 1.00%
 THE WT % OF AL2O3 + FE2O3 + ZRO2 IS: 7.91%
 THE WT % OF CAO + MGO IS: 1.22%
 THE WT % OF RH2O3 + RU2O3 IS: .00%

THE HL WASTE OXIDE LOADING IS: 29.7%

THE WT % OF AL2O3 IN THE FRIT IS: 1.42%
 THE WT % OF B2O3 IN THE FRIT IS: 14.53%
 THE WT % OF FE2O3 IN THE FRIT IS: .00%
 THE WT % OF LI2O IN THE FRIT IS: 2.84%
 THE WT % OF NA2O IN THE FRIT IS: 3.95%
 THE WT % OF SIO2 IN THE FRIT IS: 77.27%

THIS PRODUCES 749.8 0.62-M³ HLW CANISTERSTHIS PRODUCES 368.9 1.26-M³ HLW CANISTERS

THE HLW GLASS IS P2O5 LIMITED.

THIS SIMULATION WAS RUN USING HWVP LIMITS AND
GLASS FORMERS.

ENHANCED IN-TANK SLUDGE WASHING IS FOLLOWED BY
THREE DILUTE CAUSTIC WASHES.

TRU Waste Volume Projections (Rev. 2) - Low Temperature HLW Glass Formulation
(Lower Limits Only)

9-Nov-95

13:52:44

* TWRS REFERENCE FLOWSHEET OUTPUT RESULTS *

HLW GLASS FORMULATION - ALL TANKS

THE WT % OF CL- IS: .04%
 THE WT % OF F- IS: .30%
 THE WT % OF SO3 IS: .05%
 THE WT % OF AL2O3 IS: 9.74%
 THE WT % OF B2O3 IS: 7.00%
 THE WT % OF CAO IS: .84%
 THE WT % OF CR2O3 IS: .37%
 THE WT % OF FE2O3 IS: 4.67%
 THE WT % OF LI2O IS: 2.00%
 THE WT % OF MGO IS: .01%
 THE WT % OF NA2O IS: 11.08%
 THE WT % OF P2O5 IS: 1.64%
 THE WT % OF SiO2 IS: 46.00%
 THE WT % OF UO3 IS: 7.00%
 THE WT % OF ZRO2 IS: 3.96%
 THE WT % OF AL2O3 + ZRO2 IS: 13.71%
 THE WT % OF AL2O3 + FE2O3 + ZRO2 IS: 18.37%
 THE WT % OF CAO + MGO IS: .84%
 THE WT % OF RH2O3 + RU2O3 IS: .00%

THE HL WASTE OXIDE LOADING IS: 51.3%

THE WT % OF AL2O3 IN THE FRIT IS: .00%
 THE WT % OF B2O3 IN THE FRIT IS: 14.35%
 THE WT % OF FE2O3 IN THE FRIT IS: .00%
 THE WT % OF LI2O IN THE FRIT IS: 4.10%
 THE WT % OF NA2O IN THE FRIT IS: .00%
 THE WT % OF SiO2 IN THE FRIT IS: 81.55%

THIS PRODUCES 13933.2 0.62-M^3 HLW CANISTERS

THIS PRODUCES 6856.0 1.26-M^3 HLW CANISTERS

THE HLW GLASS IS FRIT LIMITED.

THIS SIMULATION WAS RUN USING HWVP LIMITS AND
GLASS FORMERS.

ENHANCED IN-TANK SLUDGE WASHING IS FOLLOWED BY
THREE DILUTE CAUSTIC WASHES.

TRU Waste Volume Projections (Rev. 2) - Low Temperature HLW Glass Formulation
(Lower Limits Only)

9-Nov-95

14:07:10

* TWRS REFERENCE FLOWSHEET OUTPUT RESULTS *

HLW GLASS FORMULATION - TRU TANKS

THE WT % OF CL- IS: .01%
 THE WT % OF F- IS: 1.01%
 THE WT % OF SO3 IS: .02%
 THE WT % OF AL2O3 IS: 1.00%
 THE WT % OF B2O3 IS: 7.00%
 THE WT % OF CAO IS: 1.03%
 THE WT % OF CR2O3 IS: .16%
 THE WT % OF FE2O3 IS: 4.80%
 THE WT % OF LI2O IS: 2.00%
 THE WT % OF MGO IS: .06%
 THE WT % OF NA2O IS: 10.84%
 THE WT % OF P2O5 IS: 1.63%
 THE WT % OF SiO2 IS: 46.00%
 THE WT % OF UO3 IS: 1.30%
 THE WT % OF ZRO2 IS: 14.57%
 THE WT % OF AL2O3 + ZRO2 IS: 15.57%
 THE WT % OF AL2O3 + FE2O3 + ZRO2 IS: 20.37%
 THE WT % OF CAO + MGO IS: 1.09%
 THE WT % OF RH2O3 + RU2O3 IS: .01%

THE HL WASTE OXIDE LOADING IS: 47.1%

THE WT % OF AL2O3 IN THE FRIT IS: .29%
 THE WT % OF B2O3 IN THE FRIT IS: 13.21%
 THE WT % OF FE2O3 IN THE FRIT IS: .00%
 THE WT % OF LI2O IN THE FRIT IS: 3.77%
 THE WT % OF NA2O IN THE FRIT IS: .00%
 THE WT % OF SiO2 IN THE FRIT IS: 82.72%

THIS PRODUCES 1435.9 0.62-M^3 HLW CANISTERS

THIS PRODUCES 706.6 1.26-M^3 HLW CANISTERS

THE HLW GLASS IS FRIT LIMITED.

THIS SIMULATION WAS RUN USING HWVP LIMITS AND
GLASS FORMERS.

ENHANCED IN-TANK SLUDGE WASHING IS FOLLOWED BY
THREE DILUTE CAUSTIC WASHES.

TRU Waste Volume Projections (Rev. 2) - Low Temperature HLW Glass Formulation
(Lower Limits Only)

9-Nov-95

14:01:09

* TWRS REFERENCE FLOWSHEET OUTPUT RESULTS *

HLW GLASS FORMULATION - REMAINING TANKS

THE WT % OF CL- IS: .05%
 THE WT % OF F- IS: .22%
 THE WT % OF SO3 IS: .06%
 THE WT % OF AL2O3 IS: 10.76%
 THE WT % OF B2O3 IS: 7.00%
 THE WT % OF CAO IS: .82%
 THE WT % OF CR2O3 IS: .40%
 THE WT % OF FE2O3 IS: 4.66%
 THE WT % OF LI2O IS: 2.00%
 THE WT % OF MGO IS: .00%
 THE WT % OF NA2O IS: 11.06%
 THE WT % OF P2O5 IS: 1.64%
 THE WT % OF SiO2 IS: 46.00%
 THE WT % OF UO3 IS: 7.67%
 THE WT % OF ZRO2 IS: 2.76%
 THE WT % OF AL2O3 + ZRO2 IS: 13.51%
 THE WT % OF AL2O3 + FE2O3 + ZRO2 IS: 18.17%
 THE WT % OF CAO + MGO IS: .82%
 THE WT % OF RH2O3 + RU2O3 IS: .00%

THE HL WASTE OXIDE LOADING IS: 51.8%

THE WT % OF AL2O3 IN THE FRIT IS: .00%
 THE WT % OF B2O3 IN THE FRIT IS: 14.49%
 THE WT % OF FE2O3 IN THE FRIT IS: .00%
 THE WT % OF LI2O IN THE FRIT IS: 4.14%
 THE WT % OF NA2O IN THE FRIT IS: .00%
 THE WT % OF SiO2 IN THE FRIT IS: 81.38%

THIS PRODUCES 12497.4 0.62-M^3 HLW CANISTERS

THIS PRODUCES 6149.5 1.26-M^3 HLW CANISTERS

THE HLW GLASS IS FRIT LIMITED.

THIS SIMULATION WAS RUN USING HWVP LIMITS AND
GLASS FORMERS.

ENHANCED IN-TANK SLUDGE WASHING IS FOLLOWED BY
THREE DILUTE CAUSTIC WASHES.

TRU Waste Volume Projections (Rev. 2) - Low Temperature HLW Glass Formulation
(Lower Limits Only)

9-Nov-95

14:09:02

* TRWS REFERENCE FLOWSHEET OUTPUT RESULTS *

HLW GLASS FORMULATION - TRU AW TANKS

THE WT % OF CL- IS: .00%
 THE WT % OF F- IS: 1.27%
 THE WT % OF SO3 IS: .03%
 THE WT % OF AL2O3 IS: 1.00%
 THE WT % OF B2O3 IS: 7.00%
 THE WT % OF CAO IS: .16%
 THE WT % OF CR2O3 IS: .04%
 THE WT % OF FE2O3 IS: 4.00%
 THE WT % OF LI2O IS: 2.00%
 THE WT % OF MGO IS: .00%
 THE WT % OF NA2O IS: 11.96%
 THE WT % OF P2O5 IS: .01%
 THE WT % OF SiO2 IS: 46.00%
 THE WT % OF UO3 IS: 2.01%
 THE WT % OF ZRO2 IS: 22.53%
 THE WT % OF AL2O3 + ZRO2 IS: 23.53%
 THE WT % OF AL2O3 + FE2O3 + ZRO2 IS: 27.53%
 THE WT % OF CAO + MGO IS: .16%
 THE WT % OF RH2O3 + RU2O3 IS: .00%

THE HL WASTE OXIDE LOADING IS: 42.1%

THE WT % OF AL2O3 IN THE FRIT IS: .83%
 THE WT % OF B2O3 IN THE FRIT IS: 12.07%
 THE WT % OF FE2O3 IN THE FRIT IS: 6.59%
 THE WT % OF LI2O IN THE FRIT IS: 3.45%
 THE WT % OF NA2O IN THE FRIT IS: .00%
 THE WT % OF SiO2 IN THE FRIT IS: 77.06%

THIS PRODUCES 926.8 0.62-M^3 HLW CANISTERS

THIS PRODUCES 456.1 1.26-M^3 HLW CANISTERS

THE HLW GLASS IS FRIT LIMITED.

THIS SIMULATION WAS RUN USING HWVP LIMITS AND
GLASS FORMERS.

ENHANCED IN-TANK SLUDGE WASHING IS FOLLOWED BY
THREE DILUTE CAUSTIC WASHES.

TRU Waste Volume Projections (Rev. 2) - Low Temperature HLW Glass Formulation
(Lower Limits Only)

9-Nov-95

14:11:46

* TRWS REFERENCE FLOWSHEET OUTPUT RESULTS *

HLW GLASS FORMULATION - TRU SY TANK

THE WT % OF CL- IS: .00%
 THE WT % OF F- IS: .01%
 THE WT % OF SO3 IS: .01%
 THE WT % OF AL2O3 IS: 5.80%
 THE WT % OF B2O3 IS: 7.00%
 THE WT % OF CAO IS: 3.34%
 THE WT % OF CR2O3 IS: 1.42%
 THE WT % OF FE2O3 IS: 12.18%
 THE WT % OF LI2O IS: 2.00%
 THE WT % OF MGO IS: .69%
 THE WT % OF NA2O IS: 10.44%
 THE WT % OF P2O5 IS: .62%
 THE WT % OF SiO2 IS: 46.00%
 THE WT % OF UO3 IS: .00%
 THE WT % OF ZRO2 IS: .21%
 THE WT % OF AL2O3 + ZRO2 IS: 6.01%
 THE WT % OF AL2O3 + FE2O3 + ZRO2 IS: 18.19%
 THE WT % OF CAO + MGO IS: 4.03%
 THE WT % OF RH2O3 + RU2O3 IS: .11%

THE HL WASTE OXIDE LOADING IS: 51.2%

THE WT % OF AL2O3 IN THE FRIT IS: .00%
 THE WT % OF B2O3 IN THE FRIT IS: 14.31%
 THE WT % OF FE2O3 IN THE FRIT IS: .00%
 THE WT % OF LI2O IN THE FRIT IS: 4.09%
 THE WT % OF NA2O IN THE FRIT IS: .00%
 THE WT % OF SiO2 IN THE FRIT IS: 81.61%

THIS PRODUCES 126.3 0.62-M³ HLW CANISTERSTHIS PRODUCES 62.1 1.26-M³ HLW CANISTERS

THE HLW GLASS IS FRIT LIMITED.

THIS SIMULATION WAS RUN USING HWVP LIMITS AND
GLASS FORMERS.ENHANCED IN-TANK SLUDGE WASHING IS FOLLOWED BY
THREE DILUTE CAUSTIC WASHES.

TRU Waste Volume Projections (Rev. 2) - Low Temperature HLW Glass Formulation
(Lower Limits Only)

9-Nov-95

14:14:33

* TWRS REFERENCE FLOWSHEET OUTPUT RESULTS *

HLW GLASS FORMULATION - TRU T TANKS

THE WT % OF CL- IS: .03%
 THE WT % OF F- IS: .58%
 THE WT % OF SO3 IS: .01%
 THE WT % OF AL2O3 IS: 1.00%
 THE WT % OF B2O3 IS: 7.00%
 THE WT % OF CAO IS: 1.89%
 THE WT % OF CR2O3 IS: .04%
 THE WT % OF FE2O3 IS: 10.76%
 THE WT % OF LI2O IS: 2.00%
 THE WT % OF MGO IS: .00%
 THE WT % OF NA2O IS: 7.00%
 THE WT % OF P2O5 IS: 4.67%
 THE WT % OF SiO2 IS: 46.00%
 THE WT % OF UO3 IS: .01%
 THE WT % OF ZRO2 IS: .00%
 THE WT % OF AL2O3 + ZRO2 IS: 1.00%
 THE WT % OF AL2O3 + FE2O3 + ZRO2 IS: 11.76%
 THE WT % OF CAO + MGO IS: 1.89%
 THE WT % OF RH2O3 + RU2O3 IS: .00%

THE HL WASTE OXIDE LOADING IS: 46.1%

THE WT % OF AL2O3 IN THE FRIT IS: 1.85%
 THE WT % OF B2O3 IN THE FRIT IS: 12.95%
 THE WT % OF FE2O3 IN THE FRIT IS: .00%
 THE WT % OF LI2O IN THE FRIT IS: 3.70%
 THE WT % OF NA2O IN THE FRIT IS: .80%
 THE WT % OF SiO2 IN THE FRIT IS: 80.70%

THIS PRODUCES 481.5 0.62-M^3 HLW CANISTERS

THIS PRODUCES 236.9 1.26-M^3 HLW CANISTERS

THE HLW GLASS IS FRIT LIMITED.

THIS SIMULATION WAS RUN USING HWVP LIMITS AND
GLASS FORMERS.

ENHANCED IN-TANK SLUDGE WASHING IS FOLLOWED BY
THREE DILUTE CAUSTIC WASHES.

WHC-SD-WM-ES-386
Revision 0

TRU Waste Volume Projections (Rev. 2) - High Temperature HLW Glass Formulation

9-Nov-95

10:11:18

* TWRS REFERENCE FLOWSHEET OUTPUT RESULTS *

HLW GLASS FORMULATION - ALL TANKS

THE WT % OF CL- IS: .05%
THE WT % OF F- IS: .35%
THE WT % OF SO3 IS: .06%
THE WT % OF AL2O3 IS: 11.26%
THE WT % OF B2O3 IS: 5.00%
THE WT % OF CAO IS: .97%
THE WT % OF CR2O3 IS: .43%
THE WT % OF FE2O3 IS: 5.40%
THE WT % OF LI2O IS: 1.00%
THE WT % OF MGO IS: .01%
THE WT % OF NA2O IS: 12.80%
THE WT % OF P2O5 IS: 1.89%
THE WT % OF SiO2 IS: 42.00%
THE WT % OF UO3 IS: 8.09%
THE WT % OF ZRO2 IS: 4.58%
THE WT % OF AL2O3 + ZRO2 IS: 15.84%
THE WT % OF AL2O3 + FE2O3 + ZRO2 IS: 21.23%
THE WT % OF CAO + MGO IS: .97%
THE WT % OF RH2O3 + RU2O3 IS: .00%

THE HL WASTE OXIDE LOADING IS: 59.3%

THE WT % OF AL2O3 IN THE FRIT IS: .00%
THE WT % OF B2O3 IN THE FRIT IS: 12.25%
THE WT % OF FE2O3 IN THE FRIT IS: .00%
THE WT % OF LI2O IN THE FRIT IS: 2.45%
THE WT % OF NA2O IN THE FRIT IS: .00%
THE WT % OF SiO2 IN THE FRIT IS: 85.30%

THIS PRODUCES 12057.6 0.62-M^3 HLW CANISTERS

THIS PRODUCES 5933.1 1.26-M^3 HLW CANISTERS

THE HLW GLASS IS FRIT LIMITED.

THIS SIMULATION WAS RUN USING CVS LIMITS AND
GLASS FORMERS.

ENHANCED IN-TANK SLUDGE WASHING IS FOLLOWED BY
THREE DILUTE CAUSTIC WASHES.

TRU Waste Volume Projections (Rev. 2) - High Temperature HLW Glass Formulation

9-Nov-95

12:56:38

* TWRS REFERENCE FLOWSHEET OUTPUT RESULTS *

HLW GLASS FORMULATION - TRU TANKS

THE WT % OF CL- IS: .01%
 THE WT % OF F- IS: .90%
 THE WT % OF SO3 IS: .02%
 THE WT % OF AL2O3 IS: .75%
 THE WT % OF B2O3 IS: 5.00%
 THE WT % OF CAO IS: .92%
 THE WT % OF CR2O3 IS: .14%
 THE WT % OF FE2O3 IS: 4.28%
 THE WT % OF LI2O IS: 1.00%
 THE WT % OF MGO IS: .05%
 THE WT % OF NA2O IS: 9.67%
 THE WT % OF P2O5 IS: 1.46%
 THE WT % OF SiO2 IS: 53.99%
 THE WT % OF UO3 IS: 1.16%
 THE WT % OF ZRO2 IS: 13.00%
 THE WT % OF AL2O3 + ZRO2 IS: 13.75%
 THE WT % OF AL2O3 + FE2O3 + ZRO2 IS: 18.03%
 THE WT % OF CAO + MGO IS: .98%
 THE WT % OF RH2O3 + RU2O3 IS: .01%

THE HL WASTE OXIDE LOADING IS: 42.1%

THE WT % OF AL2O3 IN THE FRIT IS: .00%
 THE WT % OF B2O3 IN THE FRIT IS: 8.61%
 THE WT % OF FE2O3 IN THE FRIT IS: .00%
 THE WT % OF LI2O IN THE FRIT IS: 1.72%
 THE WT % OF NA2O IN THE FRIT IS: .00%
 THE WT % OF SiO2 IN THE FRIT IS: 89.67%

THIS PRODUCES 1609.4 0.62-M^3 HLW CANISTERS

THIS PRODUCES 791.9 1.26-M^3 HLW CANISTERS

THE HLW GLASS IS ZRO2 LIMITED.

THIS SIMULATION WAS RUN USING CVS LIMITS AND
GLASS FORMERS.

ENHANCED IN-TANK SLUDGE WASHING IS FOLLOWED BY
THREE DILUTE CAUSTIC WASHES.

TRU Waste Volume Projections (Rev. 2) - High Temperature HLW Glass Formulation

9-Nov-95

10:19:37

* TWRS REFERENCE FLOWSHEET OUTPUT RESULTS *

HLW GLASS FORMULATION - REMAINING TANKS

THE WT % OF CL- IS: .05%
 THE WT % OF F- IS: .26%
 THE WT % OF SO3 IS: .06%
 THE WT % OF AL2O3 IS: 12.43%
 THE WT % OF B2O3 IS: 5.00%
 THE WT % OF CAO IS: .94%
 THE WT % OF CR2O3 IS: .46%
 THE WT % OF FE2O3 IS: 5.38%
 THE WT % OF LI2O IS: 1.00%
 THE WT % OF MGO IS: .00%
 THE WT % OF NA2O IS: 12.78%
 THE WT % OF P2O5 IS: 1.89%
 THE WT % OF SiO2 IS: 42.00%
 THE WT % OF UO3 IS: 8.87%
 THE WT % OF ZR02 IS: 3.18%
 THE WT % OF AL2O3 + ZR02 IS: 15.62%
 THE WT % OF AL2O3 + FE2O3 + ZR02 IS: 20.99%
 THE WT % OF CAO + MGO IS: .94%
 THE WT % OF RH2O3 + RU2O3 IS: .00%

THE HL WASTE OXIDE LOADING IS: 59.8%

THE WT % OF AL2O3 IN THE FRIT IS: .00%
 THE WT % OF B2O3 IN THE FRIT IS: 12.41%
 THE WT % OF FE2O3 IN THE FRIT IS: .00%
 THE WT % OF LI2O IN THE FRIT IS: 2.48%
 THE WT % OF NA2O IN THE FRIT IS: .00%
 THE WT % OF SiO2 IN THE FRIT IS: 85.11%

THIS PRODUCES 10815.1 0.62-M³ HLW CANISTERSTHIS PRODUCES 5321.7 1.26-M³ HLW CANISTERS

THE HLW GLASS IS FRIT LIMITED.

THIS SIMULATION WAS RUN USING CVS LIMITS AND GLASS FORMERS.

ENHANCED IN-TANK SLUDGE WASHING IS FOLLOWED BY THREE DILUTE CAUSTIC WASHES.

TRU Waste Volume Projections (Rev. 2) - High Temperature HLW Glass Formulation

9-Nov-95

12:58:32

* TWRS REFERENCE FLOWSHEET OUTPUT RESULTS *

HLW GLASS FORMULATION - TRU AW TANKS

THE WT % OF CL- IS: .00%
 THE WT % OF F- IS: .73%
 THE WT % OF SO3 IS: .02%
 THE WT % OF AL2O3 IS: .30%
 THE WT % OF B2O3 IS: 16.62%
 THE WT % OF CAO IS: .09%
 THE WT % OF CR2O3 IS: .02%
 THE WT % OF FE2O3 IS: 2.00%
 THE WT % OF LI2O IS: 1.00%
 THE WT % OF MGO IS: .00%
 THE WT % OF NA2O IS: 6.90%
 THE WT % OF P2O5 IS: .00%
 THE WT % OF SiO2 IS: 57.00%
 THE WT % OF UO3 IS: 1.16%
 THE WT % OF ZRO2 IS: 13.00%
 THE WT % OF AL2O3 + ZRO2 IS: 13.30%
 THE WT % OF AL2O3 + FE2O3 + ZRO2 IS: 15.30%
 THE WT % OF CAO + MGO IS: .09%
 THE WT % OF RH2O3 + RU2O3 IS: .00%

THE HL WASTE OXIDE LOADING IS: 24.4%

THE WT % OF AL2O3 IN THE FRIT IS: .00%
 THE WT % OF B2O3 IN THE FRIT IS: 21.94%
 THE WT % OF FE2O3 IN THE FRIT IS: 2.50%
 THE WT % OF LI2O IN THE FRIT IS: 1.32%
 THE WT % OF NA2O IN THE FRIT IS: .00%
 THE WT % OF SiO2 IN THE FRIT IS: 74.24%

THIS PRODUCES 1606.3 0.62-M^3 HLW CANISTERS

THIS PRODUCES 790.4 1.26-M^3 HLW CANISTERS

THE HLW GLASS IS ZRO2 LIMITED.

THIS SIMULATION WAS RUN USING CVS LIMITS AND
 GLASS FORMERS.

ENHANCED IN-TANK SLUDGE WASHING IS FOLLOWED BY
 THREE DILUTE CAUSTIC WASHES.

TRU Waste Volume Projections (Rev. 2) - High Temperature HLW Glass Formulation

9-Nov-95

13:01:26

* TWRS REFERENCE FLOWSHEET OUTPUT RESULTS *

HLW GLASS FORMULATION - TRU SY TANK

THE WT % OF CL- IS: .00%
 THE WT % OF F- IS: .00%
 THE WT % OF SO3 IS: .00%
 THE WT % OF AL2O3 IS: 2.04%
 THE WT % OF B2O3 IS: 20.00%
 THE WT % OF CAO IS: 1.18%
 THE WT % OF CR2O3 IS: .50%
 THE WT % OF FE2O3 IS: 4.28%
 THE WT % OF LI2O IS: 5.84%
 THE WT % OF MGO IS: .24%
 THE WT % OF NA2O IS: 5.00%
 THE WT % OF P2O5 IS: .22%
 THE WT % OF SIO2 IS: 57.00%
 THE WT % OF UO3 IS: .00%
 THE WT % OF ZRO2 IS: .07%
 THE WT % OF AL2O3 + ZRO2 IS: 2.12%
 THE WT % OF AL2O3 + FE2O3 + ZRO2 IS: 6.40%
 THE WT % OF CAO + MGO IS: 1.42%
 THE WT % OF RH2O3 + RU2O3 IS: .04%

THE HL WASTE OXIDE LOADING IS: 18.1%

THE WT % OF AL2O3 IN THE FRIT IS: .00%
 THE WT % OF B2O3 IN THE FRIT IS: 24.38%
 THE WT % OF FE2O3 IN THE FRIT IS: .00%
 THE WT % OF LI2O IN THE FRIT IS: 7.12%
 THE WT % OF NA2O IN THE FRIT IS: 1.62%
 THE WT % OF SIO2 IN THE FRIT IS: 66.88%

THIS PRODUCES 358.9 0.62-M^3 HLW CANISTERS

THIS PRODUCES 176.6 1.26-M^3 HLW CANISTERS

THE HLW GLASS IS CR2O3 LIMITED.

THIS SIMULATION WAS RUN USING CVS LIMITS AND
 GLASS FORMERS.

ENHANCED IN-TANK SLUDGE WASHING IS FOLLOWED BY
 THREE DILUTE CAUSTIC WASHES.

TRU Waste Volume Projections (Rev. 2) - High Temperature HLW Glass Formulation

9-Nov-95

13:04:16

* TWRS REFERENCE FLOWSHEET OUTPUT RESULTS *

HLW GLASS FORMULATION - TRU T TANKS

THE WT % OF CL- IS: .02%
 THE WT % OF F- IS: .37%
 THE WT % OF SO3 IS: .00%
 THE WT % OF AL2O3 IS: .00%
 THE WT % OF B2O3 IS: 13.24%
 THE WT % OF CAO IS: 1.22%
 THE WT % OF CR2O3 IS: .02%
 THE WT % OF FE2O3 IS: 6.91%
 THE WT % OF LI2O IS: 1.00%
 THE WT % OF MGO IS: .00%
 THE WT % OF NA2O IS: 5.00%
 THE WT % OF P2O5 IS: 3.00%
 THE WT % OF SIO2 IS: 57.00%
 THE WT % OF UO3 IS: .00%
 THE WT % OF ZRO2 IS: .00%
 THE WT % OF AL2O3 + ZRO2 IS: .00%
 THE WT % OF AL2O3 + FE2O3 + ZRO2 IS: 6.91%
 THE WT % OF CAO + MGO IS: 1.22%
 THE WT % OF RH2O3 + RU2O3 IS: .00%

THE HL WASTE OXIDE LOADING IS: 29.7%

THE WT % OF AL2O3 IN THE FRIT IS: .00%
 THE WT % OF B2O3 IN THE FRIT IS: 18.78%
 THE WT % OF FE2O3 IN THE FRIT IS: .00%
 THE WT % OF LI2O IN THE FRIT IS: 1.42%
 THE WT % OF NA2O IN THE FRIT IS: 1.11%
 THE WT % OF SIO2 IN THE FRIT IS: 78.69%

THIS PRODUCES 749.8 0.62-M^3 HLW CANISTERS

THIS PRODUCES 368.9 1.26-M^3 HLW CANISTERS

THE HLW GLASS IS P2O5 LIMITED.

THIS SIMULATION WAS RUN USING CVS LIMITS AND
GLASS FORMERS.

ENHANCED IN-TANK SLUDGE WASHING IS FOLLOWED BY
THREE DILUTE CAUSTIC WASHES.

WHC-SD-WM-ES-386
Revision 0

TRU Waste Volume Projections (Rev. 2) - High Temperature HLW Glass Formulation
(Lower Limits Only)

9-Nov-95

13:32:24

* TWRS REFERENCE FLOWSHEET OUTPUT RESULTS *

HLW GLASS FORMULATION - ALL TANKS

THE WT % OF CL- IS: .05%
THE WT % OF F- IS: .35%
THE WT % OF SO3 IS: .06%
THE WT % OF AL2O3 IS: 11.26%
THE WT % OF B2O3 IS: 5.00%
THE WT % OF CAO IS: .97%
THE WT % OF CR2O3 IS: .43%
THE WT % OF FE2O3 IS: 5.40%
THE WT % OF LI2O IS: 1.00%
THE WT % OF MGO IS: .01%
THE WT % OF NA2O IS: 12.80%
THE WT % OF P2O5 IS: 1.89%
THE WT % OF SiO2 IS: 42.00%
THE WT % OF UO3 IS: 8.09%
THE WT % OF ZRO2 IS: 4.58%
THE WT % OF AL2O3 + ZRO2 IS: 15.84%
THE WT % OF AL2O3 + FE2O3 + ZRO2 IS: 21.23%
THE WT % OF CAO + MGO IS: .97%
THE WT % OF RH2O3 + RU2O3 IS: .00%

THE HL WASTE OXIDE LOADING IS: 59.3%

THE WT % OF AL2O3 IN THE FRIT IS: .00%
THE WT % OF B2O3 IN THE FRIT IS: 12.25%
THE WT % OF FE2O3 IN THE FRIT IS: .00%
THE WT % OF LI2O IN THE FRIT IS: 2.45%
THE WT % OF NA2O IN THE FRIT IS: .00%
THE WT % OF SiO2 IN THE FRIT IS: 85.30%

THIS PRODUCES 12057.6 0.62-M^3 HLW CANISTERS

THIS PRODUCES 5933.1 1.26-M^3 HLW CANISTERS

THE HLW GLASS IS FRIT LIMITED.

THIS SIMULATION WAS RUN USING CVS LIMITS AND
GLASS FORMERS.

ENHANCED IN-TANK SLUDGE WASHING IS FOLLOWED BY
THREE DILUTE CAUSTIC WASHES.

WHC-SD-WM-ES-386
Revision 0

TRU Waste Volume Projections (Rev. 2) - High Temperature HLW Glass Formulation
(Lower Limits Only)

9-Nov-95

13:10:39

* TRWS REFERENCE FLOWSHEET OUTPUT RESULTS *

HLW GLASS FORMULATION - TRU TANKS

THE WT % OF CL- IS: .01%
THE WT % OF F- IS: 1.17%
THE WT % OF SO3 IS: .03%
THE WT % OF AL2O3 IS: .98%
THE WT % OF B2O3 IS: 5.00%
THE WT % OF CAO IS: 1.20%
THE WT % OF CR2O3 IS: .19%
THE WT % OF FE2O3 IS: 5.56%
THE WT % OF LI2O IS: 1.00%
THE WT % OF MGO IS: .07%
THE WT % OF NA2O IS: 12.57%
THE WT % OF P2O5 IS: 1.89%
THE WT % OF SIO2 IS: 42.00%
THE WT % OF UO3 IS: 1.50%
THE WT % OF ZRO2 IS: 16.89%
THE WT % OF AL2O3 + ZRO2 IS: 17.87%
THE WT % OF AL2O3 + FE2O3 + ZRO2 IS: 23.44%
THE WT % OF CAO + MGO IS: 1.27%
THE WT % OF RH2O3 + RU2O3 IS: .01%

THE HL WASTE OXIDE LOADING IS: 54.6%

THE WT % OF AL2O3 IN THE FRIT IS: .00%
THE WT % OF B2O3 IN THE FRIT IS: 10.99%
THE WT % OF FE2O3 IN THE FRIT IS: .00%
THE WT % OF LI2O IN THE FRIT IS: 2.20%
THE WT % OF NA2O IN THE FRIT IS: .00%
THE WT % OF SIO2 IN THE FRIT IS: 86.81%

THIS PRODUCES 1238.3 0.62-M^3 HLW CANISTERS

THIS PRODUCES 609.3 1.26-M^3 HLW CANISTERS

THE HLW GLASS IS FRIT LIMITED.

THIS SIMULATION WAS RUN USING CVS LIMITS AND
GLASS FORMERS.

ENHANCED IN-TANK SLUDGE WASHING IS FOLLOWED BY
THREE DILUTE CAUSTIC WASHES.

TRU Waste Volume Projections (Rev. 2) - High Temperature HLW Glass Formulation
(Lower Limits Only)

9-Nov-95

13:40:54

* TRWS REFERENCE FLOWSHEET OUTPUT RESULTS *

HLW GLASS FORMULATION - REMAINING TANKS

THE WT % OF CL- IS: .05%
 THE WT % OF F- IS: .26%
 THE WT % OF SO3 IS: .06%
 THE WT % OF AL2O3 IS: 12.43%
 THE WT % OF B2O3 IS: 5.00%
 THE WT % OF CAO IS: .94%
 THE WT % OF CR2O3 IS: .46%
 THE WT % OF FE2O3 IS: 5.38%
 THE WT % OF LI2O IS: 1.00%
 THE WT % OF MGO IS: .00%
 THE WT % OF NA2O IS: 12.78%
 THE WT % OF P2O5 IS: 1.89%
 THE WT % OF SiO2 IS: 42.00%
 THE WT % OF UO3 IS: 8.87%
 THE WT % OF ZRO2 IS: 3.18%
 THE WT % OF AL2O3 + ZRO2 IS: 15.62%
 THE WT % OF AL2O3 + FE2O3 + ZRO2 IS: 20.99%
 THE WT % OF CAO + MGO IS: .94%
 THE WT % OF RH2O3 + RU2O3 IS: .00%

THE HL WASTE OXIDE LOADING IS: 59.8%

THE WT % OF AL2O3 IN THE FRIT IS: .00%
 THE WT % OF B2O3 IN THE FRIT IS: 12.41%
 THE WT % OF FE2O3 IN THE FRIT IS: .00%
 THE WT % OF LI2O IN THE FRIT IS: 2.48%
 THE WT % OF NA2O IN THE FRIT IS: .00%
 THE WT % OF SiO2 IN THE FRIT IS: 85.11%

THIS PRODUCES 10815.1 0.62-M³ HLW CANISTERS

THIS PRODUCES 5321.7 1.26-M³ HLW CANISTERS

THE HLW GLASS IS FRIT LIMITED.

THIS SIMULATION WAS RUN USING CVS LIMITS AND
GLASS FORMERS.

ENHANCED IN-TANK SLUDGE WASHING IS FOLLOWED BY
THREE DILUTE CAUSTIC WASHES.

TRU Waste Volume Projections (Rev. 2) - High Temperature HLW Glass Formulation
(Lower Limits Only)

9-Nov-95

13:12:30

* TWRs REFERENCE FLOWSHEET OUTPUT RESULTS *

HLW GLASS FORMULATION - TRU AW TANKS

THE WT % OF CL- IS: .00%
 THE WT % OF F- IS: 1.56%
 THE WT % OF SO3 IS: .04%
 THE WT % OF AL2O3 IS: .64%
 THE WT % OF B2O3 IS: 5.00%
 THE WT % OF CAO IS: .20%
 THE WT % OF CR2O3 IS: .05%
 THE WT % OF FE2O3 IS: 2.00%
 THE WT % OF LI2O IS: 1.00%
 THE WT % OF MGO IS: .00%
 THE WT % OF NA2O IS: 14.76%
 THE WT % OF P2O5 IS: .01%
 THE WT % OF SiO2 IS: 42.00%
 THE WT % OF UO3 IS: 2.48%
 THE WT % OF ZRO2 IS: 27.80%
 THE WT % OF AL2O3 + ZRO2 IS: 28.44%
 THE WT % OF AL2O3 + FE2O3 + ZRO2 IS: 30.44%
 THE WT % OF CAO + MGO IS: .20%
 THE WT % OF RH2O3 + RU2O3 IS: .00%

THE HL WASTE OXIDE LOADING IS: 51.9%

THE WT % OF AL2O3 IN THE FRIT IS: .00%
 THE WT % OF B2O3 IN THE FRIT IS: 10.38%
 THE WT % OF FE2O3 IN THE FRIT IS: 3.70%
 THE WT % OF LI2O IN THE FRIT IS: 2.08%
 THE WT % OF NA2O IN THE FRIT IS: .00%
 THE WT % OF SiO2 IN THE FRIT IS: 83.85%

THIS PRODUCES 751.0 0.62-M^3 HLW CANISTERS

THIS PRODUCES 369.5 1.26-M^3 HLW CANISTERS

THE HLW GLASS IS FRIT LIMITED.

THIS SIMULATION WAS RUN USING CVS LIMITS AND
GLASS FORMERS.

ENHANCED IN-TANK SLUDGE WASHING IS FOLLOWED BY
THREE DILUTE CAUSTIC WASHES.

TRU Waste Volume Projections (Rev. 2) - High Temperature HLW Glass Formulation
(Lower Limits Only)

9-Nov-95

13:15:15

* TWRS REFERENCE FLOWSHEET OUTPUT RESULTS *

HLW GLASS FORMULATION - TRU SY TANK

THE WT % OF CL- IS: .01%
 THE WT % OF F- IS: .01%
 THE WT % OF SO3 IS: .01%
 THE WT % OF AL2O3 IS: 6.71%
 THE WT % OF B2O3 IS: 5.00%
 THE WT % OF CAO IS: 3.86%
 THE WT % OF CR2O3 IS: 1.64%
 THE WT % OF FE2O3 IS: 14.07%
 THE WT % OF LI2O IS: 1.00%
 THE WT % OF MGO IS: .79%
 THE WT % OF NA2O IS: 12.07%
 THE WT % OF P2O5 IS: .72%
 THE WT % OF SiO2 IS: 42.00%
 THE WT % OF UO3 IS: .00%
 THE WT % OF ZRO2 IS: .24%
 THE WT % OF AL2O3 + ZRO2 IS: 6.95%
 THE WT % OF AL2O3 + FE2O3 + ZRO2 IS: 21.02%
 THE WT % OF CAO + MGO IS: 4.65%
 THE WT % OF RH2O3 + RU2O3 IS: .13%

THE HL WASTE OXIDE LOADING IS: 59.1%

THE WT % OF AL2O3 IN THE FRIT IS: .00%
 THE WT % OF B2O3 IN THE FRIT IS: 12.20%
 THE WT % OF FE2O3 IN THE FRIT IS: .00%
 THE WT % OF LI2O IN THE FRIT IS: 2.44%
 THE WT % OF NA2O IN THE FRIT IS: .00%
 THE WT % OF SiO2 IN THE FRIT IS: 85.36%

THIS PRODUCES 109.3 0.62-M³ HLW CANISTERS

THIS PRODUCES 53.8 1.26-M³ HLW CANISTERS

THE HLW GLASS IS FRIT LIMITED.

THIS SIMULATION WAS RUN USING CVS LIMITS AND
GLASS FORMERS.

ENHANCED IN-TANK SLUDGE WASHING IS FOLLOWED BY
THREE DILUTE CAUSTIC WASHES.

TRU Waste Volume Projections (Rev. 2) - High Temperature HLW Glass Formulation
(Lower Limits Only)

9-Nov-95

13:18:01

* TWRS REFERENCE FLOWSHEET OUTPUT RESULTS *

HLW GLASS FORMULATION - TRU T TANKS

THE WT % OF CL- IS: .03%
 THE WT % OF F- IS: .69%
 THE WT % OF SO3 IS: .01%
 THE WT % OF AL2O3 IS: .00%
 THE WT % OF B2O3 IS: 5.00%
 THE WT % OF CAO IS: 2.26%
 THE WT % OF CR2O3 IS: .04%
 THE WT % OF FE2O3 IS: 12.84%
 THE WT % OF LI2O IS: 1.00%
 THE WT % OF MGO IS: .00%
 THE WT % OF NA2O IS: 7.84%
 THE WT % OF P2O5 IS: 5.58%
 THE WT % OF SiO2 IS: 42.00%
 THE WT % OF UO3 IS: .01%
 THE WT % OF ZRO2 IS: .00%
 THE WT % OF AL2O3 + ZRO2 IS: .00%
 THE WT % OF AL2O3 + FE2O3 + ZRO2 IS: 12.84%
 THE WT % OF CAO + MGO IS: 2.26%
 THE WT % OF RH2O3 + RU2O3 IS: .00%

THE HL WASTE OXIDE LOADING IS: 54.9%

THE WT % OF AL2O3 IN THE FRIT IS: .00%
 THE WT % OF B2O3 IN THE FRIT IS: 11.07%
 THE WT % OF FE2O3 IN THE FRIT IS: .00%
 THE WT % OF LI2O IN THE FRIT IS: 2.21%
 THE WT % OF NA2O IN THE FRIT IS: .00%
 THE WT % OF SiO2 IN THE FRIT IS: 86.71%

THIS PRODUCES 403.4 0.62-M^3 HLW CANISTERS

THIS PRODUCES 198.5 1.26-M^3 HLW CANISTERS

THE HLW GLASS IS FRIT LIMITED.

THIS SIMULATION WAS RUN USING CVS LIMITS AND
GLASS FORMERS.

ENHANCED IN-TANK SLUDGE WASHING IS FOLLOWED BY
THREE DILUTE CAUSTIC WASHES.

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APPENDIX B

DRAWING ES-ALT3X-01

**HIGH-LEVEL WASTE 20 MT/DAY STANDALONE
WITH JOULE-HEATED MELTER**

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Figure B-1. High-Level Waste
20 MT/Day Standalone with
Joule Heated Melter.
(Sheet 1 of 3)

DETACHED PLAN
EL. -6.86M (-22'-6")

PLAN AT EL. 0.00M (0'-0")

NO.	DATE	REVISION	PROJECT
ALC138XA			2B18MJC2-10.C2-SS
ENGINEERING RELEASE			
REV	DATE		
END			
ISSUED	BY		
DATE			
E-MAIL
FLUOR DANIEL, INC. ADVANCED TECHNOLOGY DIVISION			
PROJECT: PLAN AT EL. 0.00M (0'-0") HIGH LEVEL WASTE 20MT/D STANDALONE WITH JOULE HEATED MELTER			
DESIGN NO.			
TITLE: HAZ. WASTE HEATING SYSTEM DRAWING NO. 4-03-80		DATE: 11-03-83 BY: J. SCHILLING	
DATE	BY	DATE	BY
NONE		NONE	

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Figure B-1. High-Level Waste
20 MT/Day Standalone with
Joule Heated Melter.
(Sheet 2 of 3)

B-5/B-6

SECTION A
SHT. 1 & 2

REV. NO.	DATE	DESCRIPTION	APPROVAL
001	11/18/80	ALTSK05B	
ENGINEERING RELEASE		2818M/AC02:10.C2:SS	
REV.	DATE	U.S. DEPARTMENT OF ENERGY	
001		Richard F. O'Neil	
FLUOR DANIEL, INC.		ADVANCED TECHNOLOGY DIVISION	
SECTION A			
HIGH LEVEL WASTE			
20MT/D STANDALONE			
WITH JOULE HEATED MELTER			
TANK WASTE REMEDIATION SYSTEM		436303	
DESIGN	11/18/80	DATE	11/18/80
BY	J. SCHILLING	DATE	11/18/80
BY	11/18/80	DATE	11/18/80
NEXT USED ON			
REFERENCE DRAWINGS			

Figure B-1. High-Level Waste
20 MT/Day Standalone with
Joule Heated Melter.
(Sheet 3 of 3)

B-7/B-8

SECTION B
SHT. 1

REFERENCE DRAWINGS
NEXT USED ON

REV	DATE	DESCRIPTION
1		ENGINEERING RELEASE
2		REV
3		END
U.S. DEPARTMENT OF ENERGY		
Fluor Daniel, Inc. Advanced Technology Division		
SECTION B HIGH LEVEL WASTE 20MT/D STANDALONE WITH JOULE HEATED MELTER		
DATE	REV	DATE
1993	1	1993
2003	2	2003
2013	3	2013
2023	4	2023
2033	5	2033
2043	6	2043
2053	7	2053
2063	8	2063
2073	9	2073
2083	10	2083
2093	11	2093
2103	12	2103
2113	13	2113
2123	14	2123
2133	15	2133
2143	16	2143
2153	17	2153
2163	18	2163
2173	19	2173
2183	20	2183
2193	21	2193
2203	22	2203
2213	23	2213
2223	24	2223
2233	25	2233
2243	26	2243
2253	27	2253
2263	28	2263
2273	29	2273
2283	30	2283
2293	31	2293
2303	32	2303
2313	33	2313
2323	34	2323
2333	35	2333
2343	36	2343
2353	37	2353
2363	38	2363
2373	39	2373
2383	40	2383
2393	41	2393
2403	42	2403
2413	43	2413
2423	44	2423
2433	45	2433
2443	46	2443
2453	47	2453
2463	48	2463
2473	49	2473
2483	50	2483
2493	51	2493
2503	52	2503
2513	53	2513
2523	54	2523
2533	55	2533
2543	56	2543
2553	57	2553
2563	58	2563
2573	59	2573
2583	60	2583
2593	61	2593
2603	62	2603
2613	63	2613
2623	64	2623
2633	65	2633
2643	66	2643
2653	67	2653
2663	68	2663
2673	69	2673
2683	70	2683
2693	71	2693
2703	72	2703
2713	73	2713
2723	74	2723
2733	75	2733
2743	76	2743
2753	77	2753
2763	78	2763
2773	79	2773
2783	80	2783
2793	81	2793
2803	82	2803
2813	83	2813
2823	84	2823
2833	85	2833
2843	86	2843
2853	87	2853
2863	88	2863
2873	89	2873
2883	90	2883
2893	91	2893
2903	92	2903
2913	93	2913
2923	94	2923
2933	95	2933
2943	96	2943
2953	97	2953
2963	98	2963
2973	99	2973
2983	100	2983
2993	101	2993
3003	102	3003
3013	103	3013
3023	104	3023
3033	105	3033
3043	106	3043
3053	107	3053
3063	108	3063
3073	109	3073
3083	110	3083
3093	111	3093
3103	112	3103
3113	113	3113
3123	114	3123
3133	115	3133
3143	116	3143
3153	117	3153
3163	118	3163
3173	119	3173
3183	120	3183
3193	121	3193
3203	122	3203
3213	123	3213
3223	124	3223
3233	125	3233
3243	126	3243
3253	127	3253
3263	128	3263
3273	129	3273
3283	130	3283
3293	131	3293
3303	132	3303
3313	133	3313
3323	134	3323
3333	135	3333
3343	136	3343
3353	137	3353
3363	138	3363
3373	139	3373
3383	140	3383
3393	141	3393
3403	142	3403
3413	143	3413
3423	144	3423
3433	145	3433
3443	146	3443
3453	147	3453
3463	148	3463
3473	149	3473
3483	150	3483
3493	151	3493
3503	152	3503
3513	153	3513
3523	154	3523
3533	155	3533
3543	156	3543
3553	157	3553
3563	158	3563
3573	159	3573
3583	160	3583
3593	161	3593
3603	162	3603
3613	163	3613
3623	164	3623
3633	165	3633
3643	166	3643
3653	167	3653
3663	168	3663
3673	169	3673
3683	170	3683
3693	171	3693
3703	172	3703
3713	173	3713
3723	174	3723
3733	175	3733
3743	176	3743
3753	177	3753
3763	178	3763
3773	179	3773
3783	180	3783
3793	181	3793
3803	182	3803
3813	183	3813
3823	184	3823
3833	185	3833
3843	186	3843
3853	187	3853
3863	188	3863
3873	189	3873
3883	190	3883
3893	191	3893
3903	192	3903
3913	193	3913
3923	194	3923
3933	195	3933
3943	196	3943
3953	197	3953
3963	198	3963
3973	199	3973
3983	200	3983
3993	201	3993
4003	202	4003
4013	203	4013
4023	204	4023
4033	205	4033
4043	206	4043
4053	207	4053
4063	208	4063
4073	209	4073
4083	210	4083
4093	211	4093
4103	212	4103
4113	213	4113
4123	214	4123
4133	215	4133
4143	216	4143
4153	217	4153
4163	218	4163
4173	219	4173
4183	220	4183
4193	221	4193
4203	222	4203
4213	223	4213
4223	224	4223
4233	225	4233
4243	226	4243
4253	227	4253
4263	228	4263
4273	229	4273
4283	230	4283
4293	231	4293
4303	232	4303
4313	233	4313
4323	234	4323
4333	235	4333
4343	236	4343
4353	237	4353
4363	238	4363
4373	239	4373
4383	240	4383
4393	241	4393
4403	242	4403
4413	243	4413
4423	244	4423
4433	245	4433
4443	246	4443
4453	247	4453
4463	248	4463
4473	249	4473
4483	250	4483
4493	251	4493
4503	252	4503
4513	253	4513
4523	254	4523
4533	255	4533
4543	256	4543
4553	257	4553
4563	258	4563
4573	259	4573
4583	260	4583
4593	261	4593
4603	262	4603
4613	263	4613
4623	264	4623
4633	265	4633
4643	266	4643
4653	267	4653
4663	268	4663
4673	269	4673
4683	270	4683
4693	271	4693
4703	272	4703
4713	273	4713
4723	274	4723
4733	275	4733
4743	276	4743
4753	277	4753
4763	278	4763
4773	279	4773
4783	280	4783
4793	281	4793
4803	282	4803
4813	283	4813
4823	284	4823
4833	285	4833
4843	286	4843
4853	287	4853
4863	288	4863
4873	289	4873
4883	290	4883
4893	291	4893
4903	292	4903
4913	293	4913
4923	294	4923
4933	295	4933
4943	296	4943
4953	297	4953
4963	298	4963
4973	299	4973
4983	300	4983
4993	301	4993
5003	302	5003
5013	303	5013
5023	304	5023
5033	305	5033
5043	306	5043
5053	307	5053
5063	308	5063
5073	309	5073
5083	310	5083
5093	311	5093
5103	312	5103
5113	313	5113
5123	314	5123
5133	315	5133
5143	316	5143
5153	317	5153
5163	318	5163

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APPENDIX C

**TRANSURANIC WASTE DISPOSAL AT
WASTE ISOLATION PILOT PLANT**

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Department of Energy
Washington, DC 20585

May 13, 1992

Mr. Jack Schultz
Senior Evaluator
U.S. Government Accounting Office
Room E-172
U.S. Department of Energy
Washington, D.C. 20585-0002

S. Lott

Dear Mr. Schultz:

As you indicated in previous telephone conversations with my staff, the General Accounting Office is evaluating alternatives for the management of Rocky Flats Plant residues. One such alternative being discussed, as I understand, is declaring the residues transuranic (TRU) waste and disposing them in the Waste Isolation Pilot Plant (WIPP).

To support your evaluation, you requested an estimate of the cost to dispose of a container of TRU waste at WIPP. Attachment 1 is a rough order-of-magnitude estimate of the WIPP life-cycle costs developed by my staff. This information was used to determine the cost information you requested. As you can see, the cost to dispose of one container of TRU waste at WIPP is approximately \$7,000. The assumptions used to develop this estimate are shown in Attachment 2.

For comparison, the life-cycle disposal cost of a container of high-level waste on an equivalent volume basis is approximately \$100,000. This information was extracted from Department of Energy (DOE) publication DOE/RW-0295P, Preliminary Estimates of the Total-System Cost for the Restructured Program, dated December 1990. You should contact the Office of Civilian Radioactive Waste Management if you are interested in high-level waste disposal costs.

If you have any questions, please contact Ed Wade of my staff on 903-7207.

Sincerely,

Mark W. Frei
Mark W. Frei, Director
Office of Waste Management Projects
Office of Waste Management
Environmental Restoration
and Waste Management

2 Attachments

cc w/attachments:
C. Conner, RW-133
J. Rhoderick, EM-351
P. Bubar, EM-323
J. Arthur, WPIO
A. Hunt, WPSO
G. Daly, BDM

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Attachment 1

APRIL 22, 1992

WIPP LIFE-CYCLE COST ESTIMATE

	(MILLIONS OF FY 1992 DOLLARS)							
	CAPITAL CONSTRUCT.	PLANT OPS.	TEST PROGRAM	INSTIT. & REG.	IMPACT ASSIST.	D&D	TRANS- PORT.	TOTAL
PRIOR	434	275	295	100	20	0	0	1,124
FY 1992	0	80	62	0	0	0	0	142
FY 1993	0	80	65	20	20	0	0	185
FY 1994	0	90	74	20	20	0	0	204
FY 1995	0	100	90	20	20	0	0	230
FY 1996	0	100	100	20	20	0	0	240
FY 1997	0	100	100	20	20	0	0	240
FY 1998	0	100	50	20	20	0	6	196
FY 1999	0	100	5 **	20	20	0	11	156
FY 2000	0	100	5	20	20	0	11	156
FY 2001	0	100	5	20	20	0	11	156
FY 2002	0	100	5	20	20	0	11	156
FY 2003	0	100	5	20	20	0	11	156
FY 2004	0	100	5	20	20	0	11	156
FY 2005	0	100	5	20	20	0	11	156
FY 2006	0	100	5	20	20	0	11	156
FY 2007	0	100	5	20	20	0	11	156
FY 2008	0	100	5	20	20	0	11	156
FY 2009	0	100	5	20	20	0	11	156
FY 2010	0	100	5	20	20	0	11	156
FY 2011	0	100	5	20	20	0	11	156
FY 2012	0	100	5	20	20	0	11	156
FY 2013	0	100	5	20	20	0	11	156
FY 2014	0	100	5	20	20	0	11	156
FY 2015	0	100	5	20	20	0	11	156
FY 2016	0	100	5	20	20	0	11	156
FY 2017	0	100	5	20	20	0	11	156
FY 2018	0	50	5	20	20	50	6	151
FY 2019	0	0	0	10	13	100	0	123
FY 2020	0	0	0	10	13	100	0	123
FY 2021	0	0	0	10	13	100	0	123
FY 2022	0	0	0	10	13	100	0	123
FY 2023	0	0	0	10	13	50	0	73
	434	2,875	936	670	605	500	226	6,245
CH	6.20E+06	CU.FT.	8.44E+05	CONTAINERS				
RH	2.50E+05	CU.FT.	3.40E+04	CONTAINERS				
	6.45E+06	CU.FT.	8.78E+05	CONTAINERS			\$7,118	\$/CONTAIN

* Disposal decision made in 12/97

** Performance confirmation costs begin in FY 1999

Attachment 2

April 22, 1992

WIPP CONTAINER COST ESTIMATE ASSUMPTIONS

- o Prior year costs for Capital Construction represent the actual total estimated cost (TEC) of the project.
- o Prior year costs for Capital Construction and Plant Operations represent the actual total project cost (TPC) of the project.
- o The FY 1992 costs are consistent with the current FY 1992 appropriation.
- o The FY 1993 costs are consistent with the pending Congressional budget request.
- o The FY 1994 and out-year costs are planning levels, which are subject to change.
- o The Test Phase with radioactive waste begins in FY 1992 and continues into FY 1998.
- o The Disposal Phase is 20 years in duration, beginning in FY 1998 and continuing into FY 2018. It is assumed that the decision on WIPP's suitability for disposal is made in December 1997.
- o Decontamination and Decommissioning will occur during a five year period following the Disposal Phase, beginning in 2018.
- o Test Program costs from FY 1999 through FY 2018 are for a performance confirmation program.
- o Institutional and Regulatory costs include DOE oversight and integration, support of external review groups, emergency preparedness, regulators, and public outreach.
- o Impact assistance costs, consistent with provisions of S. 1671, are payments to New Mexico to cover impacts from WIPP operations.
- o Costs for shipping waste to WIPP for disposal are included. These costs include amortized costs for additional TRUPACT-IIIs.
- o The total cost does not include any waste characterization or treatment costs performed by generator sites prior to shipment for disposal.
- o The quantity of waste containers (drum equivalents) is equal to the WIPP design capacity for contact-handled (CH) and remote-handled (RH) waste.

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