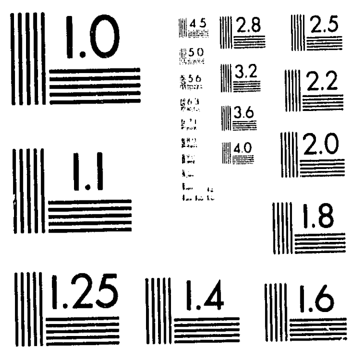
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PRELIMINARY ESTIMATES OF COST SAVINGS FOR DEFENSE HIGH LEVEL WASTE VITRIFICATION OPTIONS

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ABSTRACT

The potential for realizing cost savings in the disposal of defense high-level waste through process and design modifications has been considered. Proposed modifications range from simple changes in the canister design to development of an advanced melter capable of processing glass with a higher waste loading. Preliminary calculations estimate the total disposal cost (not including capital or operating costs) for defense high-level waste to be about $7.9 billion dollars for the reference conditions described in this paper, while projected savings resulting from the proposed process and design changes could reduce the disposal cost of defense high-level waste by up to $5.2 billion.

INTRODUCTION

The U.S. Department of Energy (DOE) plans to convert the defense high-level waste (DHLW) currently stored at three DOE sites into a durable waste form that will be sealed in stainless steel canisters and sent to an underground repository for disposal. At the repository, the canisters will be placed in overpack containers and the resulting waste packages placed in boreholes drilled into the geologic media. The underground repository will be shared by commercial spent fuel and DHLW forms. The costs for construction and operation of the repository will be shared by the waste generators according to the formula set forth in the Federal Register, which allocates costs based largely on the number of waste packages emplaced in the repository (1). This paper identifies process and design modifications with the potential to substantially reduce the number of canisters produced during treatment of DHLW, thereby achieving significant savings in disposal costs. Estimates of potential savings in disposal costs for each site are provided for each proposed modification. Possible effects of these modifications on waste acceptance criteria and on the projects at each of the sites are identified and briefly discussed. It is beyond the scope of this paper to discuss detailed technical issues associated with the proposed modifications or to provide estimates of the costs to implement the proposed modifications. However, some technical issues are identified so the potential savings reported can be balanced against potential difficulties to achieve these savings.

Information from the Integrated Data Base (2) was used to determine the reference number of canisters to be produced at each site. The projections for DHLW canister production used in this report are: 5,400 for Savannah River, 25,000 for Hanford, and 6,900 for Idaho. The total number of canisters at Hanford includes estimated canister production from the single-shell tank wastes. Although this waste is not currently committed for disposal in the repository, the eventual vitrification of much of this waste is considered likely. The reference waste form at Savannah River and Hanford is borosilicate glass, while at Idaho it is a glass-ceramic. Hereafter, the term glass will refer to the waste form from all three sites.

Uncertainties do exist regarding the repository design and operations, and also many aspects of the high level waste treatment process. Changes in the repository design or modifications in the waste treatment processes could significantly affect either the disposal costs or the number of canisters produced, thereby affecting the estimated savings reported in this paper. However, the purpose of this paper is to quantify the magnitude of the potential savings that could be realized through process and design modifications based upon current strategies for treating and disposing of DHLW. The preliminary estimates of cost savings indicate the potential of various modifications to reduce the overall costs of treatment and disposal of DHLW. These estimates could be compared to estimated costs of implementing such changes to assess whether they merit further investigation or action.

PROPOSED MODIFICATIONS

The proposed modifications would reduce the number of disposal packages sent to the repository in two ways: 1) increasing the volume of waste glass in each container buried at the repository through modifications to canister shape and design, and 2) reducing the volume of waste glass produced by increasing the waste loading in the glass. Table 1 summarizes the reference characteristics of the waste form and the proposed modifications considered here.

The feasibility of carrying out any of the modifications will clearly differ at each of the sites. Changes at Savannah River would be the most difficult and expensive since construction of that site's Defense Waste Processing Facility (DWPF) is complete. Extensive facility and in-cell modifications would be necessary for many of the changes proposed, which in turn would lead to significant impacts on the waste form qualification. Schedule impacts could possibly be reduced through parallel development of alternatives while processing according to the reference conditions. The modifications could then be implemented during regular maintenance and down time. At Hanford, design of the Hanford Waste Vitrification Project (HWVP) is currently underway. Implementing changes would be less costly and complicated than at the DWPF since changes could be made in the design rather than to existing facilities. Parallel development could minimize delays in the existing schedule. Although relatively few canisters are currently committed to production, the vitrification of some or all of the single-shell tank wastes is a strong possibility; therefore, this waste is included in the production total for Hanford. At the Idaho Chemical Processing Plant (ICPP), the treatment facility, and even the waste form, are still in early stages of development and would be the least affected by any of these modifications. The results presented here can help to direct the development at ICPP to minimize the ultimate disposal costs.

EVALUATION OF POTENTIAL DISPOSAL COST SAVINGS

The savings estimated in this paper arise from reduced disposal costs following a reduction in the number of waste packages to be delivered to the repository. Savings are determined by multiplying the disposal cost per canister by the reduction (from the reference case) in the number of canisters requiring disposal. The number of disposal packages resulting from each of the modifications was estimated by multiplying the reference number of canisters by the ratio of the amount of waste in the reference canister to that in the modified canister. The total life cycle costs for the disposal of DHLW were calculated for PNL by Roy G. Weston for an assumed range of 6,500 to 28,500 DHLW packages. The calculations were carried out using the cost sharing formula set forth by the Office of Civilian Radioactive Waste Management (OCRWM). The total life cycle cost determined from these calculations is plotted versus the total number of waste packages in Figure 1. This figure shows that the total disposal costs for DHLW decrease as the number of waste packages placed in the repository decreases. Figure 2 presents the disposal cost per waste package as calculated from Figure 1 plotted versus the total number of waste packages. It can be seen that the cost per package increases as the number of packages decreases; however, the total costs decrease. A fit of a curve to the data in Figure 2 gives the relationship between the total number of waste packages and the disposal cost per package. This relationship is given by the following equation:

$$\frac{\text{Disposal Cost (\$)}}{\text{Package}} = \frac{5.78 * 10^{8}}{\text{TNP}} + 1.68 * 10^{5} \quad (1)$$

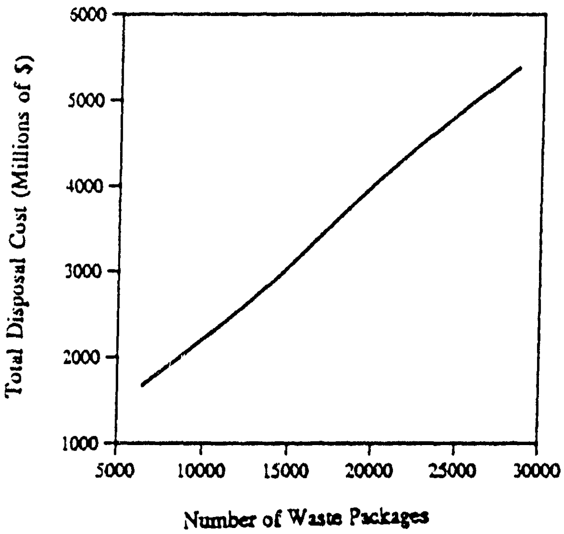
where TNP is the total number of DHLW packages placed in the repository from all sites.

Since the disposal cost is relatively insensitive to the number of waste packages at the high end of this range, significant error is not expected from extrapolating to higher numbers of waste packages than were considered in the above analysis. The above analysis was also carried out assuming that the construction of a second repository will be required. If two repositories are constructed, the disposal costs increase by about 50%. For the purpose of this report, the single repository scenario is used, thereby providing a lower estimate of potential disposal cost savings.

Table 2 presents the estimated reduction in disposal costs for the various modifications previously discussed. The current reference conditions are also included to provide a baseline for comparison. The total disposal costs are estimated to be just under $8 billion, while estimate reductions range from $291 million for a decrease in the wall thickness to $5.2 billion for all the modifications combined. Therefore, the gross disposal costs could be decreased by as much as 65% by implementing of all the modifications proposed.

Figure 1. Total Disposal Cost (Millions of $) Versus Number of DHLW Packages Placed in the Repository

Figure 2. Disposal Cost per Package Versus the Total Number of Waste Packages Placed in the Repository



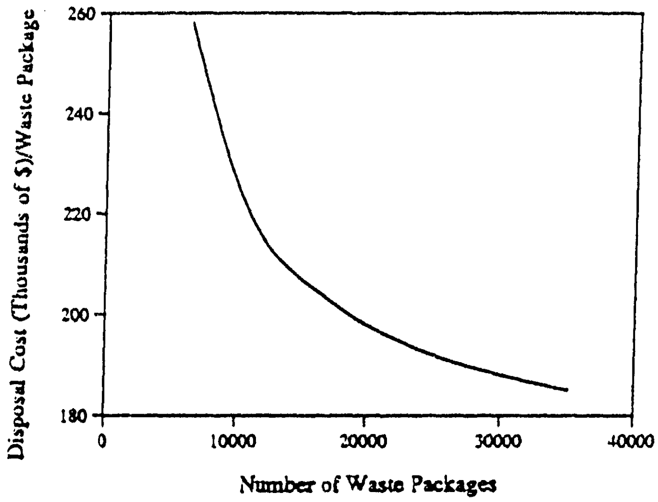


Table 1. Some Characteristics of the Reference Defense High Level Waste Canistered Waste Form and Proposed Modifications.

Characteristic	Reference Condition	Proposed Modification
Length	3.05 m	Lengthen to 4.57 m by stacking 2.29 m canisters.
Diameter	0.61 m	Increase to 0.66 m.
Shape	DWPF design, narrow neck	Increase the diameter and shorten the length of the neck, similar to the West Valley design.
Wall Thickness	9.5 mm	Decrease to 3.4 mm.
Waste Loading	25% at HWVP 28% at DWPF 70% at ICPP	Increase to 45% at Savannah River and Hanford. Effect a similar increase at Idaho through removal of non-hazardous constituents
Fill Fraction	85% of canister volume filled	Increase to 95%

Table 2. Reduction in Disposal Costs for Various Modifications to the Defense High-Level Waste Canistered Waste Form

	Site	Disposal Packages	Disposal Cost per Package ($)	Change in Packages	Reference Costs in millions of $
Reference Conditions	DWPF	5,400	212,962		1,150
	HWVP	25,000	212,962		5,324
	ICPP	6,900	212,962		1,469
	Total	**37,300**			7,944
Proposed Modification					**Gross Savings**
Nested Canisters	DWPF	3,672	221,415	-1,728	**337**
	HWVP	17,000	221,415	-8,000	**1,560**
	ICPP	4,692	221,415	-2,208	**431**
	Total	25,364		-11,936	**2,328**
Increase Canister Diameter	DWPF	4,590	216,132	-810	**158**
	HWVP	21,250	216,132	-3,750	**731**
	ICPP	5,865	216,132	-1,035	**202**
	Total	31,705		-5,595	**1,091**
Increased Neck Diameter	DWPF	5,022	214,314	-378	**74**
	HWVP	23,250	214,314	-1,750	**341**
	ICPP	6,417	214,314	-483	**94**
	Total	34,689		-2,611	**509**
Decreased Wall Thickness	DWPF	5,184	213,711	-216	**42**
	HWVP	24,000	213,711	-1,000	**195**
	ICPP	6,624	213,711	-276	**54**
	Total	35,808		-1,492	**291**
Increased Fill Fraction	DWPF	4,806	215,183	-594	**116**
	HWVP	22,250	215,183	-2,750	**536**
	ICPP	6,141	215,183	-759	**148**
	Total	33,197		-4,103	**800**
Increased Waste Loading	DWPF	3,359	226,809	-2,041	**388**
	HWVP	13,875	226,809	-11,125	**2,177**
	ICPP	3,830	226,809	-3,071	**601**
	Total	21,063		-16,237	**3,166**
All Modifications Combined	DWPF	1,566	256,940	-3,834	**748**
	HWVP	7,250	256,940	-17,750	**3,461**
	ICPP	2,001	256,940	-4,899	**955**
	Total	**10,817**		**-26,483**	**5,164**

EFFECTS OF MODIFICATIONS

The proposed modifications are likely to have a variety of effects at the different sites. Most significant is the potential for significantly reducing disposal costs since fewer canisters would be produced. Implementation of these changes, however, requires that both technical and procedural issues be addressed. Technical issues include modifications to equipment and processes, while procedural issues include waste form qualification and schedule impacts. At DWPF, physical modifications to existing equipment may be required, while at HWVP, design changes prior to fabrication and installation will be necessary. Implementing any modification will not be a simple process, but the implementation costs should be carefully compared to the potential reduction in disposal costs.

Canister Length

It is proposed that the current reference canister length of 3.05 m (10 ft) be increased to 4.57 m (15 ft) by stacking two 2.27 m (7.5 ft) canisters within a lengthened overpack container. This arrangement would increase the amount of waste glass in each disposal package by 46%. Nesting of canisters is technically feasible and is currently used at temporary storage facilities in France and Belgium, and proposed for use in Japan. Two short canisters are suggested rather than a single longer canister because of height limitations at DWPF and HWVP. Major components affected at the DWPF include the turntable, transfer carts, decontamination chamber, and the welder. A potential solution requiring minimal modification to existing facilities would be to design a spacer that would fit into existing equipment and raise the shorter canister to the same level as the 10 ft canister. A greater number of canisters would be produced within the facility, but the number of waste packages at the repository would decrease since two canisters would be disposed in each overpack container. A secondary issue is the ability of the DWPF process to handle an increase in the number of canisters within the facility, i.e., to decontaminate and seal weld more canisters.

The effect of nested canisters on shipping and repository operations was considered in a recent report which concluded that the greatest optimization in the repository operations would come from producing a DHLW canister whose length (single canister or two in tandem) is the same as that of spent fuel (3). This report also concluded that these changes should likely not be made at the DWPF because of construction and operating schedules; however, the potential savings from reduced disposal costs were not considered.

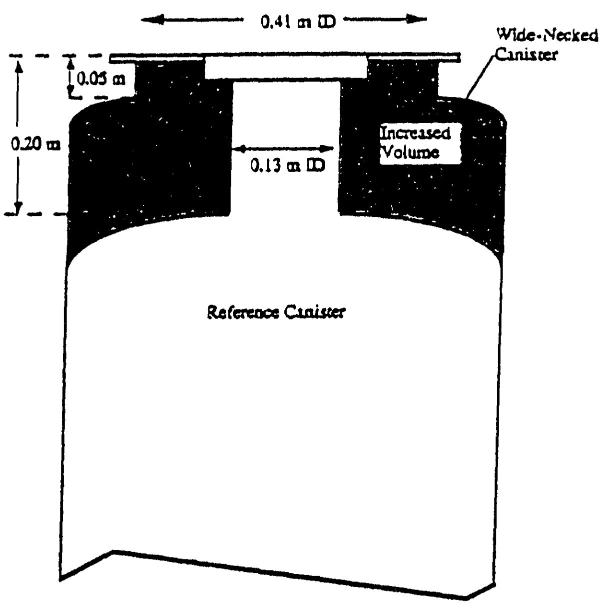
Canister Diameter

An increase in the canister diameter from the current reference of 0.61 m (24 in.) to 0.66 m (26 in.) would increase the waste glass per waste package by 18%. At DWPF, the major components involving canister handling, such as the turntable and transfer carts as well as the decontamination chamber, would require modification or replacement. The original selection of the canister diameter was influenced by the need to cool at a sufficient rate to prevent crystal formation. The proposed change would increase the cooling time by about 20% from the reference case. The effect of a longer cooling period on the extent of devitrification of the glass must be determined.

Canister Shape

The current design for the canister neck superimposed on the design for a wider necked canister is shown in Figure 3. The wide-necked design provides an 8% increase in the volume of glass in each canister (assuming an 85% fill volume). In addition, the wider opening reduces the possibility of spills during filling. To make this change at the DWPF would require modification of filling, handling, and closure methods, and of decontamination equipment to interface with the modified canister neck. Qualification of the canister would be required; however, since the modified design is similar to that of the previously approved West Valley canister, qualification is not expected to be an impediment.

Figure 3. Reference Canister Design Superimposed on the Proposed Wide Mouth Canister Showing the Increased Volume Used



Canister Wall Thickness

A reduction in the wall thickness from 9.5 mm to 3.4 mm will result in a modest 4% increase in the amount of glass per container. This change could be achieved without modifying any of the existing equipment or facilities. Qualification of the thin-walled canister would be required. The current reference canister design at West Valley includes a 3.4 mm wall thickness, although thicker walls are also being tested.

Fill Fraction

Another means of increasing the amount of glass in each canister is to decrease the void space in the filled canister by increasing the fill fraction. The current reference value is 0.85. Increasing this value to 0.95 would result in a 12% increase in the glass in each canister. At the DWPF reference pour rate of 5.4 in./hr, a 0.95 fill fraction provides a 38 minute margin of error before the glass level reaches the bottom of the canister neck, while glass pouring is designed to be stopped almost immediately. A fill fraction of up to 0.97 has been considered at DWPF once experience in pouring has been gained (4). Implementing this modification could require upgrading or redesign of the level detection systems to reduce the risk of overfilling.

Waste Loading

It is proposed that the reference waste loading be increased from 25% at HWVP and 28% at DWPF to 45% through the development of an advanced high temperature melter. At ICPP, where the reference waste loading is 70%, a proportional increase in effective waste loading could possibly be achieved through pre-treatment to remove nonradioactive materials from the waste. This change increases the amount of waste in each canister by 80% for HWVP and 61% for DWPF. In addition to decreasing the number of canisters of waste, an increase in waste loading actually decreases the amount of waste glass produced. Therefore, increasing the waste loading reduces disposal costs and minimizes waste.

Current limits on waste loading at DWPF and HWVP are based on producing a borosilicate glass with specified durability at 1150 C. A considerable amount of experimental work has been reported that indicates that waste loading in glass can be increased significantly without adversely affecting glass properties (5 - 8).

At DWPF, it has been found that waste loading could be increased to 35% without adversely affecting viscosity at operating temperature (5). Increases in waste loading of up to 50% improved the glass durability, although viscosity and spinel formation increased for a constant melting temperature of 1150 C (6). At Hanford, minor effects on leachability up to a waste loading of 50% have also been found (7). In cases where increased waste loading causes increased viscosity, increasing the melter operating temperature could be accommodated by redesigning the melter using commercial glass melting technology (8).

A melter suitable for operation at temperatures between 1300 C and 1500 C would expand the melter operability limits to a wider range of waste loadings in the glass while increasing glass durability. Such a melter does not represent a great leap in technology since commercial glass melters regularly operate near 1500 C. Some experience with high temperatures has also been obtained in vitrifying HLW. From 1978 to 1982 at Hanford, the high temperature ceramic melter successfully vitrified simulated Hanford waste while operating at temperatures ranging from 1350 to 1450 C. The high temperature melter currently being constructed at PNL will operate at temperatures up to 1550 C. Preliminary glass formulation work for the HTM has achieved a 45% waste loading of NCAW a high temperature glass.

The issue of waste loading at HWVP is complicated by the variety of potential feed streams expected and the uncertainty of pretreatment processes. Some waste streams may be limited to waste loadings as low as 10%, depending on pretreatment processes. Whatever the ultimate loading is for each waste stream, a high temperature glass typically allows this limit to be increased, thereby reducing the ultimate number of waste packages. For example, the HWVP limit for chromia has been set at 0.5 wt% for an 1150 C melt temperature. At a melt temperature of 1500 C, the solubility of chromia can be increased to more than 1.5 wt%, thereby tripling the maximum waste loading if chromia is a limiting constituent of the waste. The savings estimated in this paper are therefore based on the assumption that an advanced melter design can increase the waste loading for all the waste types proportionally to the assumed increase for the reference case (NCAW waste).

In order to implement this modification, a melter development program would need to be initiated to design and test the melter and to develop appropriate waste glass compositions. Such a program would carry a risk that improvements as dramatic as those assumed might not be obtained; however, the potential benefits are great. Any modified melter could be designed to fit within existing or currently designed facilities. Development in parallel with existing schedules would minimize or eliminate delays, allowing installation during normally scheduled melter replacement. Modifications to the feed preparation systems would be necessary to support an increase in waste loading. Also, due to the increased waste loading, additional shielding might be required, depending on safety margins currently designed into the facilities.

EFFECTS ON WASTE ACCEPTANCE CRITERIA

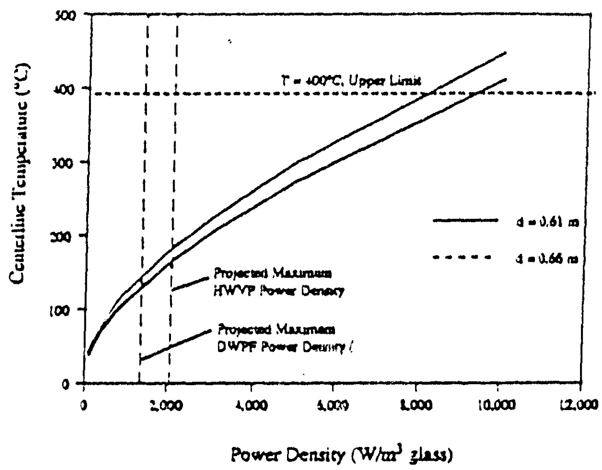
A major concern of the proposed modifications is their potential effects on the waste acceptance criteria identified in the Code of Federal Regulations (10 CFR 60) and on the requirements imposed by the repository to allow safe handling. Specific criteria for the DWPF are contained in the Waste Acceptance Preliminary Specifications (WAPS), which provide guidance as to the legally required characteristics of the waste form and the required characteristics to ensure that the vitrified product can be safely handled at the repository (9). Areas of the waste acceptance criteria which could be significantly affected by the proposed changes are briefly discussed below.

The repository is required by Subparts 113 and 135(a) of 10 CFR 60 to account for all chemical and radiochemical species within the repository, and to ensure that none of these species impairs the waste isolation capability of the repository. This requires an inventory of the chemical and radiochemical species and testing to characterize the phase structure, release properties, and phase stability of glass. Inventory of species will be required regardless of any modifications implemented. Testing and characterization of the glass to assure that the waste acceptance criteria are met would be a requirement of any advanced melter development. At the DWPF, substantial work characterizing the waste glass has been performed, and additional testing would be required if the proposed modifications affected the above criteria. At the HWVP, although significant characterization of the glass has been performed, it has been limited mainly to a small fraction of the potential waste. Characterization of the glass for the majority of the waste to be produced at the HWVP has not yet been addressed.

An additional criterion for phase stability is that the maximum centerline temperature be 100 C less than the glass transition temperature of the vitrified waste product. For current HLW glasses, the transition temperature is about 500 C (10), and preliminary calculations show a canister heat loading of up to 6,500W would be required to exceed this limit. Estimates of the maximum centerline temperatures at DWPF and HWVP that could result from any of the proposed modifications are given in Figure 4. The waste loading is taken into account in this figure by plotting the centerline temperature as a function of the power density of the waste, which will increase with increased waste loading. Higher temperature glasses that would be required to achieve higher waste loadings would have a higher transition temperature, and could therefore tolerate an even higher canister heat loading.

The heat generation rate is of major concern to ensure that temperatures in the disposal packages or host rock do not increase to the point of reducing performance capabilities of the repository. A limit of 800 W/canister is required by the WAPS for the DWPF; however, 10 CFR 60 makes no mention of a specific value for the maximum heat loading. Much higher heat loadings have been considered at Hanford for disposal of the Cs/Sr wastes. Each site is to receive approval from the repository for the maximum heat loading they intend to produce. The maximum heat loading projected

Figure 4. Centerline Temperature as a Function of the Power Density of the Waste Glass



for the reference canister and each of the modifications is detailed in Table 3. These values are based on current levels of activity. The actual values at the time of shipment to the repository will be much less due to decay of the activity. The effect of proposed modifications on the canister heat loading needs to be addressed, but does not appear to be an unduly stringent limit.

Table 3. Maximum Heat Loading Projected for the Proposed Modifications to the Canistered Waste Form (W/Canister).

Modification	DWPF	HWVP	ICPP
Reference (4,10,11)	690	816	360
Length	1,014	1,200	529
Diameter	814	966	425
Wall thickness	720	852	376
Shape	745	881	389
Fill fraction	771	912	402
Waste loading	1,109	1,469	648

The maximum gamma and neutron surface dose rates are not specified in 10 CFR 60, but specific values must be provided to the repository to allow for shielding design. The limits specified in the WAPS are an order of magnitude greater than the maximum projected gamma dose rate for the reference waste form from any of the sites, and the proposed modifications do not increase the dose rate sufficiently to approach the limit (Table 4). At DWPF, the projected neutron dose rate of 0.004 Sv/hr is orders of magnitude less than the limit of 10 Sv/hr (4). At HWVP and ICPP, inventories of neutron producing elements are less than at DWPF, suggesting even lower neutron dose rates.

Table 4. Maximum Projected Gamma Surface Dose Rates for Proposed Modifications to the Canistered Waste Form (Sv/hr).

Modification	DWPF	HWVP	ICPP
Reference(4,10,11)	55.7	110.0	37.5
Length	83.0	163.9	55.9
Diameter	68.5	135.1	46.0
Wall thickness	58.1	114.7	39.1
Shape	60.2	118.8	40.5
Fill fraction	62.9	124.1	42.3
Waste loading	98.5	217.8	48.2

Requirements in 10 CFR 60.131(b)(7) require that the effective multiplication factor for criticality be at least 5% below unity. Reported values for DWPF show a large margin of subcriticality [5], and since inventories of fissionable elements at HWVP and ICPP are lower than at DWPF, an even greater margin is expected. The proposed modifications will not significantly affect the effective multiplication factor.

The canister dimensions and weight are not specified by 10 CFR 60 but are required to assure that the repository has the capability to handle the canistered waste form. The DWPF canister design has been approved, and HWVP has determined to use the same design to simplify canister qualification. This design, however, is not required by the repository as evidenced by approval of a different canister design for the West Valley demonstration project. Nevertheless, changes to the existing design would likely require requalification of the canister. Since the repository will be principally designed to handle spent fuel packages, any changes to the HLW canister design should keep the ultimate disposal package within the limits of the spent fuel waste package (nominal 26 in. diameter and 15 ft length, maximum weight of 5990 kg (3)). All of the proposed modifications keep the waste package within these limits.

DISCUSSION

The above results indicate that the potential for tremendous cost savings exists in the disposal of DHLW. Savings of billions of dollars may be achievable if some of the modifications proposed here are incorporated into the plan for DHLW disposal. It must be realized, however, that the gross savings estimated in this paper are based solely on a reduction in disposal costs from a reduced number of waste packages to be placed in the repository. The two major uncertainties in the reported savings are the technical feasibility of the proposed modifications and the repository fee structures (disposal cost per waste package). The disposal cost is based on estimates by the contractor performing the yearly estimates for OCRWM and is believed to be the best estimate available. The technical issues have been identified and were briefly discussed in this paper. Within the accuracy of the assumptions that the current cost sharing formula represents the actual disposal costs for DHLW and that the technical issues for the stated modifications can be resolved, the gross savings reported in Table 2 are representative of the savings that would actually be realized by implementing the proposed changes. The cost to achieve these savings (hence the net savings) must be examined for each proposed modification at each site.

A great potential for savings exists at ICPP, where the early stage of development will allow these considerations to be incorporated in the original design. Other means of reducing the number of canisters may also arise as the process for treating the ICPP waste is better defined. The costs to achieve these savings would be small since the modifications would be incorporated into the development at a very early stage in the process.

At HWVP, projected savings are very large because of the large number of canisters to be produced from the single-shell tank waste. A reduction in wall thickness yields potential savings of $195 million. An increase in waste loading would save $2.2 billion, while incorporating all the modifications together could save $3.5 billion. Costs to implement the modifications should be relatively modest compared to the DWPF since the facility is at an early stage in the design. Given the fact that the facility is still in the design stages, significant cost savings could be achieved without major schedule impact.

At the DWPF, gross savings of up to $388 million are estimated for an increase in the waste loading, or up to $748 million if all the modifications are implemented; however, two points should be noted. First, because of the advanced state of the DWPF, implementation costs for the changes are likely to be high. Second, this analysis assumes that all DWPF canisters will be produced with the particular modification considered. Schedule considerations, however, show that several years of production at the reference conditions could take place before certain changes could be made. The gross savings for a change to the nested canisters ($337 million) or 45% waste loading ($388 million) are about one-third to one-half of the capital cost for the complete plant. The magnitude of these potential savings implies that even if the cost to implement the proposed modifications is in the tens of millions of dollars, substantial savings could still be realized.

CONCLUSIONS

From the analysis considered in this paper, it is clear that substantial savings in disposal costs can potentially be achieved through modifications to the reference DHLW canister or process to reduce the number of waste packages placed in the repository. It is acknowledged that some or all of these changes involve added costs, potential schedule impacts, and possible technical risks. It is also acknowledged that changes in the method of cost sharing for the HLW repository may significantly affect the estimated savings reported. However, using the current method for calculating disposal costs, the simple analysis described in this paper indicates the potential for tremendous reductions in DHLW disposal costs. The magnitude of these savings is sufficiently large that implementing these changes may be economically rewarding in spite of the significant costs that may be incurred. A more detailed consideration of the costs to modify equipment and designs and to repeat some qualification activities, along with an assessment of the risks and technical feasibility of the proposed modifications, will allow the potential net savings to be determined.

A preliminary assessment of the proposed modifications indicates that while some changes in the current versions of the waste acceptance plans may be required, there do not appear to be requirements that the modified waste forms and canisters could not meet. Changes to the canister have the most significant impact at the DWPF, requiring modifications to equipment, while at HWVP it is a matter of changes to the design. Modifications to increase the waste loading hold the most significant risk since the highest waste loading that can be obtained needs to be demonstrated; however, the potential reward is the greatest.

ACKNOWLEDGEMENT

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