Low-Level and Transuranic Waste Transportation, Disposal, and Facility Decommissioning Cost Sensitivity Analysis

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ABSTRACT

The Systems Design Study (SDS) identified technologies available for the remediation of low-level and transuranic waste stored at the Radioactive Waste Management Complex's Subsurface Disposal Area at the Idaho National Engineering Laboratory. The SDS study intentionally omitted the costs of transportation and disposal of the processed waste and the cost of decommissioning the processing facility. This report provides a follow-on analysis of the SDS to explore the basis for life-cycle cost segments of transportation, disposal, and facility decommissioning; to determine the sensitivity of the cost segments; and to quantify the life-cycle costs of the 10 ex situ concepts of the Systems Design Study.

SUMMARY

The purpose of this study is to develop a basis for low-level waste (LLW) and transuranic (TRU) waste transportation, disposal and facility decommissioning costs for the 10 ex situ Systems Design Study (SDS) concepts and combine these costs with the SDS life-cycle costs to reflect an improved life-cycle estimate.

This study involves a survey of Department of Energy (DOE) facilities and other sources to determine the current costs associated with transportation, disposal, and facility decommissioning of the follow 10 ex situ processing system concepts described in the SDS report:

- Melting/incineration with LLW presort (2 EG-1)
- In situ vitrification and retrieval processing (3 EB-3)
- Melting/incineration with LLW postsort (2 EG-4)
- Thermal treatment/solidification with LLW presort (3 IT-1)
- Thermal treatment/solidification with LLW presort (3 IT-3)
- Pyrolysis/acid leach with plutonium extraction (3 EB-6)
- Molten salt oxidation (3 BE-7)
- Chemical oxidation/solidification (3 IT-8)
- Sort, treat, and repackage (4 BE-2)
- Volume reduction and repackage system (4 BE-4).

Factors considered in the development of transportation costs included product density, transportation unit rates, rail versus trucks, and container size and container weight limitations. The expected transportation rates for LLW and TRU are \$1.71/ft³ and \$16.15/ft³, respectively.

DOE sites of the Idaho National Engineering Laboratory, Lawrence Livermore National Laboratory, Nevada Test Site, Hanford, Savannah River Site, Waste Isolation Pilot Plant (TRU only), Rocky Flats Plant, Sandia National Laboratory, and Oak Ridge National Laboratory were surveyed to obtain expected disposal costs for LLW and TRU waste. Input was also obtained from commercial facilities and State Compacts. The expected disposal rates for LLW and TRU are \$150/ft³ and \$740/ft³, respectively.

Facility decommissioning costs are based on the square footage of the facility and are expected to be approximately \$450/ft².

The study shows that disposal costs are an important factor in the evaluation of processing system concepts, while the costs of transportation and facility decommissioning are relatively insignificant. Although the in situ vitrification and retrieval processing system results in greater quantities of waste products, the low development, capital, and operating costs result in lowest life-cycle costs.

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ACRONYMS

D&D	decontamination and decommissioning
DOE	Department of Energy
DT&E	demonstration, testing, and evaluation
LLW	low-level waste
INEL	Idaho National Engineering Laboratory
ISV	in situ vitrification
RWMC	Radioactive Waste Management Complex
SDA	Subsurface Disposal Area
SDS	Systems Design Study
SWB	standard waste box
TRU	transuranic
WIPP	Waste Isolation Pilot Plant

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1. INTRODUCTION

A Systems Design Study (SDS)¹ was conducted by the Waste Technology Development Department at the Idaho National Engineering Laboratory (INEL) for the Department of Energy's (DOE's) Office of Technology Development to identify technologies available for the remediation of hazardous and transuranic (TRU) buried waste at the Radioactive Waste Management Complex (RWMC) Subsurface Disposal Area (SDA) at the INEL. This study is also expected to be relevant to remediation of other DOE sites with buried waste.

The purpose of the SDS included evaluation of competing technologies and system concepts for implementability, effectiveness, and cost. The SDS resulted in the development of technology requirements including demonstration, testing, and evaluation (DT&E) activities needed to implement each concept.

The SDS, using specific technologies, identified two in situ and 10 ex situ system concepts for treating the buried waste and surrounding contaminated soil. Preliminary life-cycle costs including DT&E, process construction, and annual operating costs were developed for each of the system and subsystem concepts. The life-cycle costs did not include costs for transportation and disposal or facility decontamination and decommissioning (D&D). For the systems retrieving the buried waste, the life-cycle costs included waste retrieval, treatment, and packing for disposal.

1.1 Purpose

The life cycle cost estimate contained in the original study intentionally omitted the cost of transportation for disposal and facility D&D. The technologies evaluated in the original study produce various amounts of low-level waste (LLW) and TRU waste for disposal. Thus, a more complete cost perspective is gained when estimates of costs for transportation, disposal, and D&D are added to the facility life-cycle costs of the original study. Even given the substantial uncertainty in these additional cost components, the resultant cost estimates are more complete.

Thus, the purpose of this study is to develop a basis for transportation, disposal, and D&D costs for the system and subsystem concepts that involve processing, transporting, and disposing of waste. These costs are combined with the SDS life-cycle costs to reflect an improved life-cycle estimate.

1.2 Scope

This study involves a survey of DOE facilities to determine the current cost elements for transportation and disposal of the following 10 ex situ processing system concepts described in the SDS report (see Reference 1):

- Melting/incineration with LLW presort (2-EG-1)
- In situ vitrification (ISV) and retrieval processing (3-EB-3)
- Melting/incineration with LLW postsort (2-EG-4)
- Thermal treatment/solidification with LLW presort (3-IT-1)
- Thermal treatment/solidification with LLW presort (3-IT-3)
- Pyrolysis/acid leach with plutonium extraction (3-EB-6)
- Molten salt oxidation (3-BE-7)
- Chemical oxidation/solidification (3-IT-8)
- Sort, treat, and repackage (4-BE-2)
- Volume reduction and repackage system (4-BE-4).

The process unit rates in lb/hr of LLW and TRU from each of the above technologies may be found in Table 1 and the Waste Input/Output Diagrams for each in Appendix A.

1.3 Assumptions and Basis of Cost Data

The assumptions for this study are summarized below. The assumptions identified in Volume II, Section 4, of the SDS (see Reference 1) also apply to the extent relevant.

- Three types of LLW, which are soil, waste, and metal, all need to be transported and disposed
- Cost sensitivities are studied for the following variables:
 - Disposal Unit Rates: Low, Medium, and High
 - Transportation Unit Rates: Low, Medium, and High
 - Disposal Site Distance: 30 miles (INEL Site), 300 miles (an unspecified off-site location), and 500 miles (an unspecified off-site location)
- All costs are present day and unescalated
- TRU waste will be packaged in a Waste Isolation Pilot Plant (WIPP) bin or drum and shipped to WIPP in accordance with the WIPP Waste Acceptance Criteria
- The LLW packaging costs (ranging from \$7 to \$11 per ft³) and TRU packaging costs (about \$28/ft³) are included in the previous study
- Waste processing time is assumed to be 10 years
- DOE's objective is to complete remediation by the year 2019
- The transportation, disposal, and D&D cost data are based on personal conversations with a number of people in DOE site and commercial waste management organizations. In most cases the numbers represent a very rough estimate and require further refinement by future studies.

Table 1. SDS system concept waste output stream flow rates subsystem processing.

System Concept	Number	LLW Soil lbs/hr	LLW Dry lbs/hr	LLW Metal lbs/hr	Process Facility		
					LLW lbs/hr	TRU lbs/hr	
Melting/Incineration with LLW Presort	2-EG-1	17,000	575	334	-	1,284	
ISV and Retrieval	2-EB-3	-	-	-	38,800	9,000	
Melting/Incineration with LLW Postsort	2-EG-4	17,000	-	334	712	1,067	
Thermal Treat/Solidif with LLW Presort	3-IT-1	17,000	575	334	-	1,732	
Thermal Treat/Solidif with LLW Postsort	3-IT-3	17,000	-	334	2,025	675	
Chemical Oxidation/ Solidification	3-IT-8	17,000	-	334	2,751	919	
Pyrolysis & Acid Leach Pu Extraction	3-EB-6	17,000	-	334	480	1,448	
Molten Salt Oxidation	3-BE-7	17,000	-	334	542	2,581	
Waste Solidification and Packaging	4-BE-2	17,000	-	334	675	1,353	
Waste Volume Reduction & Packaging	4-BE-4	17,000	575	334	-	1,482	

2. TRANSPORTATION COSTS

The following factors may affect costs associated with the transportation of both LLW and TRU wastes:

- **Product Density**—The waste products resulting from the system concepts are assumed to have the densities shown in Table 2.
- **Transportation Unit Rates**—The principal carrier for LLW is Tri-State Motor Transit.² The LLW transportation rates vary with distance, e.g., the rate, \$/mi, decreases by about a factor of 2 for a distance increase from 100 to 500 miles one way.

TRU waste must be shipped to WIPP, which is about 1,550 miles from the INEL. TRU shipment costs recently experienced at WIPP have risen from \$1.81/mile to \$2.01/mile as a result of state permit requirements and added fuel costs.^a

- **Rail versus Truck**—Rail shipment, while accommodating heavier and bulkier loads, usually requires truck loading and off loading (piggy backing, i.e., truck trailers on rail flatbed). Rail shipment to the disposal site was not considered for this study. The envelope of dimensions for truck shipment is 7 ft 6 in. wide by 40 ft long by 14 ft high (including 3 ft 6 in. height of trailer bed). Dimensions beyond this are designated oversize loads with travel only during daylight hours and special routing.
- **Container Size**—Containers can be procured in almost any size and usually consist of 17H 55-gallon drums or B-25 boxes. These containers are used for LLW. For TRU waste, containers may be 17H 55-gallon drums or a standard waste box (SWB). The TRU containers are placed within the TRUPAC container. The TRUPAC containers can hold 14 drums or 2 SWB boxes.

Table 2. Waste product densities.

Waste Product Type	Density (lb/ft ³)
LLW Soil Subsystem	147
LLW Processing Subsystem	128
LLW Metal Subsystem (compacted)	200
LLW & TRU System Process	
Concrete	112
Melting	187
ISV	156
Molten Salt	131

a. Private communication with Kevin Donovan, Waste Isolation Pilot Plant, November 5, 1991.

- **Container Weight Limitations**—Trucks are limited to a gross load of 83,500 lbs with a net weight of 43,000 lbs of waste and container. Typical container weights are:

- 17H 55-gallon drum - empty 54 lb; filled max wt 700 lb
- CTC B25 box - empty 640 lb; filled max wt 10,000 lb.

TRU shipments have a net waste weight limitation (excluding containers) of 12,500 lbs per shipment.

As noted above, shipping costs depend on a number of parameters. For purposes of this study, several assumptions were made to arrive at a transportation cost in $\$/\text{ft}^3$. These assumptions are as follows:

- LLW is shipped without a cask and TRU is shipped within a TRUPAC
- Three distances were chosen for LLW transportation, 30 miles (burial on the site), 300 miles (no specific destination), and 500 miles (no specific destination); TRU waste must be shipped to WIPP which is about 1,550 miles from the INEL
- Tri-State Motor Transit rates (see Reference 2) were chosen for the 300 mile (medium) and 500 mile (high) distances resulting in a mileage rates of \$3.08/mile and \$2.44/mile, respectively, for one-way
- The LLW transported will not require any special surcharges for oversize loads, special routing, etc., and all state permits are included in the cost per mile transportation rate
- For on-site LLW disposal, the travel distance is 30 miles and existing trucks and personnel will be used for transportation resulting in a cost of $\$/\text{ft}^3$ based on INEL experience^b
- For LLW, the truck can transport six, B-25 boxes of 90 ft^3 each, but is limited to a gross weight of about 43,000 lbs for the weight of the waste plus the container
- For TRU waste, the truck can transport three TRUPACs with two Standard Waste Boxes (each 64 ft^3) per TRUPAC and with a net weight (excluding the container) of less than 12,500 lb.

Based on these assumptions, the LLW transportation costs (all inclusive) in $\$/\text{ft}^3$ for 30 miles, 300 miles, and 500 miles are $\$/\text{ft}^3$, $\$1.71/\text{ft}^3$ and $\$2.26/\text{ft}^3$, respectively (see Appendix B).

b. Personal communication with Don Pound, EG&G Idaho, Inc., Idaho Falls, Idaho November 5, 1991.

The transportation cost (all inclusive) in $\$/\text{ft}^3$ for TRU is expected to be $\$16.15/\text{ft}^3$ based on a recent transportation study by WIPP.^c For comparison purposes, a cost of $\$5/\text{ft}^3$ based on data from Rocky Flats is used for TRU transport to the INEL.

Table 3 summarizes the ranges of LLW and TRU transportation costs for each system concept and Figures 1 and 2 provide a graphical representation.

c. Personal communication with Kevin Donovan, Waste Isolation Pilot Plant, November 5, 1991.

Table 3. LLW and TRU transportation costs.

System Concept	LLW Transportation Costs			TRU Transportation Costs		
	Low (x10 ⁶) \$/ft ³	Medium (x10 ⁶) \$/ft ³	High (x10 ⁶) \$/ft ³	Low (x10 ⁶) \$/ft ³	High (x10 ⁶) \$/ft ³	
Melting/Incineration with LLW Presort	4.9	8.4	11.1	1.4	4.5	
ISV and Retrieval	5.0	8.6	11.3	5.8	18.8	
Melting/Incineration with LLW Postsort	4.9	8.3	11.0	1.2	3.7	
Thermal Treat/Solidif with LLW Presort	4.9	8.4	11.1	3.1	10.1	
Thermal Treat/Solidif with LLW Postsort	5.4	9.3	12.2	1.2	3.9	
Chemical Oxidation/ Solidification	5.7	9.7	12.8	1.7	5.3	
Pyrolysis & Acid Leach Pu Extraction	4.9	8.4	11.0	2.6	8.4	
Molten Salt Oxidation	4.9	8.4	11.0	4.0	12.8	
Waste Solidification and Packaging	5.0	8.5	11.2	2.4	7.9	
Waste Volume Reduction & Packaging	4.9	8.4	11.1	2.7	8.6

Figure 1. LLW transportation cost sensitivity.

Figure 2. TRU transportation cost sensitivity.

3. DISPOSAL COSTS

Several DOE sites, including the Idaho National Engineering Laboratory, Lawrence Livermore National Laboratory, Nevada Test Site, Hanford, Savannah River Site, Rocky Flats Plant, and Sandia and Oak Ridge National Laboratories, were surveyed to obtain current actual and future expected disposal costs for their LLW and TRU waste. Also, cost data were obtained from four existing and two future disposal sites for LLW waste and from WIPP for TRU waste.

The four existing LLW disposal sites include commercial and DOE sites, namely, U.S. Ecology Washington Nuclear Center (Hanford), U.S. Ecology Nevada Nuclear Center (Beatty), Barnwell Low-Level Radioactive Waste Management Facility, and the Nevada Test Site. Two future commercial disposal sites include the Central Interstate Compact and California LLW Disposal Site.

Current published burial charges for the U.S. Ecology Washington and Nevada centers and for the Barnwell Facility are included in References 3 and 4. These charges range from \$32.11 to \$55.00/ft³ depending on waste content and the site. There is a significant surcharge for compliance to the LLW compact legislation for disposal by facilities outside the compact.

Furthermore, surcharges need to be applied to these rates to account for liners, special containers and overpacks, heavy objects, Special Nuclear Materials, Curie content, and non-routine man-Rem exposure. There are also additional fees for cask handling, decontamination services, and any required special handling or special site set-up for waste disposal. Following is a summary of disposal cost surcharge data obtained from the above listed sites:

- **U.S. Ecology Washington Nuclear Center**—Published basic disposal costs for solid LLW vary from \$32.11 to \$48.83/ft³ depending on radiation dose (0.20 to 40.00 REM/hr). Hanford estimated that the cost of disposal of LLW at the U.S. Ecology Center is \$68.62/ft³ with typical surcharges applied (see References 3 and 4).^d
- **U.S. Ecology Nevada Nuclear Center**—Published basic disposal costs for solid LLW vary from \$32.11 to \$55.00/ft³ depending on radiation dose (0.20 to 40.00 REM/hr) (see References 3 and 4).
- **Chem-Nuclear Systems, Inc.; Barnwell Low-Level Radioactive Waste Management Facility**—The published basic disposal cost for solid LLW is \$41.03/ft³. Weight surcharges, varying from \$585 to \$3,640 per container, apply to containers weighing from less than 1,000 lbs to 50,000 lbs. Also, surcharges of \$3,615 to \$32,500 have to be added to the basic rate for Curie content per shipment (see Reference 3).
- **Nevada Test Site**—Lawrence Livermore National Laboratory (LLNL) data on disposal costs show a basic rate of \$11.00/ft³ for their LLW to be disposed at the Nevada Test Site.^e

d. Personal communication with Tom Pauly, Hanford, October 29, 1991.

e. Private communication with Roland Quong, Lawrence Livermore National Laboratory, October 29, 1991.

- **Central Interstate Compact**—Future disposal costs at this commercial site, which is under design, are estimated based on the cost of the facilities plus future costs, divided by the total capacity of the site. A current estimate, calculated in this manner, shows \$577/ft³ as projected disposal costs for LLW.^f
- **California LLW Disposal Facility**—Future disposal costs at this commercial site, which is in the design phase, are estimated based on the cost of the facilities plus future costs, divided by the total capacity of the site. A current estimate, calculated in this manner, shows \$150/ft³ as projected disposal costs for LLW.^g At this stage of design, this is a very approximate estimated cost.
- **Savannah River Site**—Current estimate for future disposal costs at this DOE site are as follows: \$25/ft³ for LLW and \$380/ft³ for TRU waste (at WIPP). These rough estimates were prepared recently for the site waste minimization program.^h
- **Waste Isolation Pilot Plant (WIPP)**—Although the WIPP facility is not open at this time, WIPP is designated as the future storage facility for TRU waste (>100 nanoCuries/gm). Estimates obtained during the survey of disposal costs of TRU waste at WIPP varied from a low of \$150/ft³ to \$1500/ft³. The DOE has not established a disposal cost for TRU waste at the WIPP facility.ⁱ

The above data shows that the disposal costs at future commercial sites will be substantially higher than the current costs at DOE sites and current commercial sites. The costs of future commercial facilities are driven by licensing costs, both at Federal and local levels. Also, current disposal cost data for such DOE disposal sites as the Nevada Test Site probably do not reflect all the original costs of the disposal facility.

Future commercial facilities, such as the Central Interstate Compact, are not located in a desert site and require sophisticated concrete disposal vaults instead of simple in-ground disposal. This factor drastically effects the disposal costs and contributes to the wide range of costs obtained in this survey. The disposal costs for LLW vary from \$11 to \$577/ft³. For the purpose of the sensitivity analysis, a low number of \$11, medium number of \$150 (per CA LLW), and high number of \$500 per cubic foot for disposal of LLW were used in this study.

f. Private communication with Miles Sabbe, Bechtel National, Inc., October 30, 1991.

g. Private communication with Gary Young, U.S. Ecology, October 30, 1991.

h. Private communication with Kevin Donovan, Waste Isolation Pilot Plant, November 5, 1991.

i. Private communication with Milt Gordon, Savannah River Site, November 7, 1991.

The disposal costs for TRU waste have not been established. Public policy dictates that all TRU waste be stored at the WIPP facility. For the purpose of the sensitivity analysis, a low number of \$150/ft³, a medium number of \$300/ft³ and a high number of \$740/ft³ (see Appendix B) are used in this study. The latter number is based on WIPP capital costs plus 25-year operating costs of WIPP and the WIPP storage capacity (see Appendix B).

Table 4 summarizes the ranges of LLW and TRU disposal costs for each system concept and Figures 3 and 4 provide a graphical representation.

Table 4. LLW and TRU disposal costs.

System Concept	LLW Disposal Costs			TRU Disposal Costs		
	Low (x10 ⁶) \$11/ft ³	Medium (x10 ⁶) \$150/ft ³	High (x10 ⁶) \$500/ft ³	Low (x10 ⁶) \$150/ft ³	Medium (x10 ⁶) \$300/ft ³	High (x10 ⁶) \$740/ft ³
Melting/Incineration with LLW Presort	53.9	735	2,450	42.0	83	205
ISV and Retrieval	55.2	752	2,507	174	349	861
Melting/Incineration with LLW Postsort	53.5	730	2,432	35.0	69	170
Thermal Treat/Solidif with LLW Presort	53.9	735	2,450	94.0	187	461
Thermal Treat/Solidif with LLW Postsort	59.5	812	2,706	36.0	73	180
Chemical Oxidation/Solidification	62.3	849	2,830	50.0	99	245
Pyrolysis & Acid Leach Pu extraction	53.7	733	2,442	78.0	156	386
Molten Salt Oxidation	53.7	733	2,443	119	238	588
Waste Solidification and Packaging	54.5	743	2,475	73.0	146	360
Waste Volume Reduction & Packaging	53.9	735	2,450	80.0	160	395

Figure 3. LLW disposal cost sensitivity.

Figure 4. TRU Disposal Cost sensitivity.

4. DECONTAMINATION AND DECOMMISSIONING COSTS

Upon completion of the remediation activities, the waste processing facilities will have to be decontaminated and decommissioned. The decontamination and decommissioning activities are assumed to include the following:

- Decommissioning planning
- Radiological characterization
- Contracting and procurement
- Dismantlement of heavy process equipment
- Decontamination, volume reduction, and segregation
- Packaging
- Transportation and disposal of LLW
- Facility decontamination
- Radiological surveillance and technical support
- Final surveys, reports, and independent verification
- Building demolition
- Rubble disposal
- Site restoration (to natural environment).

All costs for these activities are based on the square footage of the facility and run about \$450/ft² (based on D&D of the GA Fuel Fabrication Facility in San Diego.^j For purposes of the sensitivity study, the D&D costs are doubled to show the effect of increased D&D costs. Table 5 summarizes the system concept facility area and decontamination and decommissioning costs and Figure 5 provides a graphical representation.

j. Private communication with Bob Levesque, Bechtel National, Inc., October 29, 1991.

Table 5. System concept decontamination and decommissioning costs.

Systems Concept	Facility Area ft ²	D&D Costs	
		(x10 ⁶) \$450/ft ²	(x10 ⁶) \$900/ft ²
Melting/Incineration with LLW Presort	120,000	54	108
ISV and Retrieval	96,300	43.3	86.7
Melting/Incineration with LLW Postsort	150,000	67.5	135
Thermal Treat/Solidif with LLW Presort	149,600	67.3	135
Thermal Treat/Solidif with LLW Postsort	114,400	51.5	103
Chemical Oxidation/Solidification	71,000	31.9	63.9
Pyrolysis & Acid Leach Pu extraction	50,900	22.9	45.8
Molten Salt Oxidation	111,100	50	100
Waste Solidification and Packaging	67,300	30.3	60.6
Waste Volume Reduction & Packaging	85,600	38.5	77

Figure 5. Decontamination and decommissioning cost sensitivity.

5. COST SENSITIVITY ANALYSIS

A survey was conducted of DOE facilities to determine the experience base and/or projections for transportation and disposal cost elements. The results of the survey are summarized at the end of the respective sections for transportation and disposal costs. System concept life-cycle costs are summarized using values for DT&E, process construction and 10-year operating (five years for ISV) costs from Table II-10-1 of the Systems Design Study Assessment Report (see Reference 1). Costs for D&D (\$450/ft²), LLW transport (\$1.71/ft³), TRU transport (\$16.15/ft³), LLW disposal (\$150/ft³), and TRU disposal (\$740/ft³) are based on the results of this report. The system concept life-cycle costs are summarized in Table 6 and include the following cost segments.

- Development, test, and evaluation
- Process construction
- Operating costs for a 10-year period
- Facility decontamination and decommissioning
- Waste product transportation
- Waste product disposal.

Figure 6 is a histogram showing the life-cycle cost segments for each system concept.

Table 6. Life-cycle segments for SDS system concepts.

System Concept	Number	DT&E (\$ x 10 ⁶)	Product Construction (\$ x 10 ⁶)	10 Years Operation (\$ x 10 ⁶)	Waste Transport (\$ x 10 ⁶)	Waste Disposal (\$ x 10 ⁶)	Facility D&D (\$ x 10 ⁶)	Total Life Cycle (\$ x 10 ⁶)
Melting/Incineration with LLW Presort	2-EG-1	293	777	1,030	12.9	940	54.0	3,157
ISV and Retrieval	2-EB-3	59	210	180	27.4	1,613	43.3	2,133
Melting/Incineration with LLW Postsort	2-EG-4	258	667	900	12.0	900	67.5	2,805
Thermal Treatment with LLW Presort	3-IT-1	299	1,043	1,310	18.5	1,196	67.3	3,934
Thermal/Solidification with LLW Postsort	3-IT-3	276	833	1,080	13.2	992	51.5	3,246
Chemical Oxidation/ Solidification	3-IT-8	330	705	1,050	15.0	1,093	31.9	3,225
Pyrolysis & Acid Leach Pu Extraction	3-EB-6	229	545	1,020	16.8	1,119	22.9	2,953
Molten Salt Oxidation	3-BE-7	268	691	1,750	21.2	1,321	50.0	4,101
Waste Solidification and Packaging	4-BE-2	249	597	1,590	16.4	1,103	30.3	3,586
Waste Volume Reduction & Packaging	4-BE-4	284	817	1,830	17.0	1,130	38.5	4,117

Figure 6. Life-cycle cost segments for SDS system concepts.

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6. Evaluation of the Effectiveness and Feasibility of the WIPP Engineering Alternative, DOE/WIPP 91-007, Rev. 0, p. 3-1, July 1991.

Appendix A

System Design Study Waste Input/Output Diagrams

Input/Output Waste Diagram Melting/Incineration With
LLW Presort System (2-EG-1)

Waste Input/Output Diagram
ISV and Retrieval Processing System (2-EB-3)

Input/Output Waste Diagram
Melting/Incineration with LLW Postsort System (2-EG-4)

Waste Input/Output Diagram
Waste Solidification and Packaging System (4-BE-2)

Appendix B

Cost Basis for TRU Disposal at WIPP

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Cost Basis for TRU Disposal at WIPP

While there are no published costs for TRU disposal at WIPP, the disposal costs are developed based on personal communication with WIPP.

Estimated WIPP capital costs to date	\$1,000,000,000
Projected WIPP operating costs for 25 years	<u>\$3,750,000,000</u>
Total	\$4,750,000,000

Capacity for TRU storage at WIPP Facility	6,450,000 ft ³
Projected TRU waste to be disposed at WIPP	4,200,000 ft ³

$$\text{Estimated TRU disposal cost at WIPP} = \frac{\$4.75 \times 10^9}{6.5 \times 10^6 \text{ ft}^3} = \$736/\text{ft}^3 \text{ (round to } \$740/\text{ft}^3)$$

COST BASIS FOR LLW TRANSPORTATION

See Reference 6; Tri-State Motor Transit Co. mileage rates with destination west of Mississippi.

$$\begin{aligned} 300 \text{ miles @ } \$3.08/\text{mi} &= \$924/\text{shipment} \\ 500 \text{ miles @ } \$2.44/\text{mi} &= \$1,120/\text{shipment} \end{aligned}$$

Shipment of 6, B-25 boxes at 90 ft³ each or 540 ft³ per shipment with weight within 43,000 pounds for waste plus container LLW transportation cost \$/ft³.

$$\begin{aligned} 300 \text{ miles } \$924/540 \text{ ft}^3 &= \$1.71/\text{ft}^3 \\ 500 \text{ miles } \$1,120/540 \text{ ft}^3 &= \$2.07/\text{ft}^3 \end{aligned}$$

COST BASIS FOR TRU TRANSPORTATION

Personal communication with WIPP indicated that TRU transportation costs are \$2.01/mi (all in costs) from the INEL to WIPP round trip 3,100 miles = \$6,200/trip, three TRUPACs per trailer; 6 boxes 64 ft³ each.

$$\frac{\$6,200}{(6)(64 \text{ ft}^3)} = \$16.15/\text{ft}^3$$

END

**DATE
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