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324 Building Compliance Project

**Selection and Evaluation of
Alternatives for the Removal of
Solid Remote-Handled Mixed
Wastes from the 324 Building**

W. A. Ross
M. C. Bierschbach
J. S. Dukelow, Jr.

M. D. McKinney
J. R. Young

June 1995

Prepared for the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830

Pacific Northwest Laboratory
Operated for the U.S. Department of Energy
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Richland, Washington 99352

EXECUTIVE SUMMARY

Six alternatives for the interim storage of remote-handled mixed wastes from the 324 Building on the Hanford Site have been identified and evaluated. The alternatives focus on the interim storage facility and include use of existing facilities in the 200 Area, the construction of new facilities, and the vitrification of the wastes within the 324 Building to remove the majority of the wastes from under RCRA regulations. The six alternatives are summarized in Table S.1, which identifies the primary facilities to be utilized, the anticipated schedule for removal of the wastes, the costs of the transfer from 324 Building to the interim storage facility (including any capital costs), and an initial risk comparison of the alternatives.

As can be noted in Table S.1, the two PUREX alternatives have the desired characteristics of low cost and early removal of wastes from the 324 Building. Early removal greatly aids in bringing the 324 Building into compliance with the RCRA requirements. A recently negotiated Tri-Party Agreement (TPA) change requires the last of the mixed wastes to be removed by May 1999. The ability to use an existing facility reduces the costs since it eliminates the need for new capital construction.

The basic regulatory approvals for the storage of mixed wastes are in place for the PUREX facility, but the Form III permit will need some minor modifications since the 324 Building wastes have some additional characteristic waste codes and the current permit limits storage of wastes to those from the facility itself. Regulatory reviews have indicated that it will be best to use the tunnels to store the wastes.

The PUREX alternatives will only provide storage for about 65% of the wastes. This results from the current schedule of the B-Cell Clean Out Project, which projects that dispersible debris will continue to be collected in small quantities until the year 2000. The remaining fraction of the wastes will then be stored in another facility. Central Waste Complex (CWC) is currently proposed for that residual waste storage; however, other options may also be available.

The addition of the wastes to the PUREX facility will increase the radionuclide inventory remaining in the facility following transitioning. No factors were identified that would disqualify the option, but a safety analysis still remains to be prepared for the transitioned facility. Transitioning of the PUREX facility is well underway and is proceeding ahead of schedule. It will be vital for the 324 Building wastes to be delivered to the PUREX facility with sufficient time to place them within the facility before the PUREX Canyon overhead crane is taken out of service. This is currently scheduled to occur in February of 1996. Transitioning cannot be delayed since it will cost about \$100,000 per day to maintain PUREX in its operating mode versus its transitioned mode.

As a backup to the PUREX facility it is recommended that further analysis and review be performed to determine if the total curie limits for the Transuranic Metal Box (TMB) can be increased significantly so that the TMB could be used with shielded canisters within the CWC and that the potential use of excess spent fuel casks be further considered for use in the CWC.

By necessity, this analysis has proceeded with incomplete information in several areas. Proceeding with any alternative at this point will involve some risks, as it may later be determined that the recommended alternative is not implementable. However, with the short time period before transitioning of the PUREX facility, additional delays will result in the loss of the alternative. A more detailed effort for the utilization of the PUREX facility should now be developed and implemented.

Table S.1. Primary Characteristics of Alternatives

	PUREX Tunnel and CWC	PUREX Facility and CWC	Central Waste Complex (CWC)	Modified W-272*	New Facility W-349**	Waste Vitrification with W-272
Primary Storage Facility	PUREX Tunnel	PUREX Canyon	CWC	Modified W-272	W-349	W-272
Secondary Storage Facility	CWC	CWC	None	None	None	None
Evaluation Criteria						
Regulatory Aspects						
NEPA Requirements	EA/FONSI	EA/FONSI	CX Possible	Covered under Special Case Waste-EA	Covered under Special Case Waste-EA	EA/FONSI
RCRA Requirements	Permitted, modification needed	Permitted, modification needed	Permitted	Covered under CWC Permit, modifications may be needed	Covered under CWC Permit, modifications may be needed	TBG or TSD Permit Needed
Schedule, Calendar Year						
Initial Waste Shipment from 324	~1996	~1996	~1995	2000	2001	1998
Last Shipment of Wastes	2000	2000	2000	2000	2001	2000
Costs, \$K						
Total Estimated Life Cycle Costs	\$2,500	\$2,600	\$3,500	\$4,000	\$4,000	\$6,200

* W-272 is the project number for the Special Case Solid Waste Temporary Storage Facility.

** W-349 is the project number for the Special Case Mixed Waste Temporary Storage Facility.

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GLOSSARY

BDAT - Best Demonstrated and Available Technology
CH - Contact-Handled
CNS - Chem-Nuclear Systems
CWC - Central Waste Complex
CX - Categorical Exclusion
D&D - Decontamination and Decommissioning
DE - Dose Equivalent
DOE - Department of Energy
DOT - Department of Transportation
dpm - disintegrations per minute
EA - Environmental Assessment
EIS - Environmental Impact Statement
EPA - Environmental Protection Agency
FFTF - Fast Flux Test Facility
FONSI - Finding Of No Significant Impact
FRG - Federal Republic of Germany
HEPA - High-Efficiency Particulate Air
HLV - High-Level Vault
HWVP - Hanford Waste Vitrification Program
LCF - Latent Cancer Fatalities
LEL - Lower Explosive Limit
LLW - Low-Level Waste
MTF - Memo To File
NAC - Nuclear Assurance Corporation
NEPA - National Environmental Policy Act
NLI - National Lead Industries
NRC - Nuclear Regulatory Commission
PNL - Pacific Northwest Laboratory
PUREX - Plutonium/Uranium Extraction
RCRA - Resource Conservation and Recovery Act
REC - Radiochemical Engineering Cells
RFP - Request for Proposal
RH - Remote-Handled
SARP - Safety Analysis Report for Packaging
SCW - Special Case Waste
SEG - Scientific Ecology Group
SPMS - Safety and Performance Measure System
SWB - Standard Waste Box
TBG - Treatment by Generator
TCLP - Toxic Characteristic Leaching Procedure
TIM - Technical Information Memorandum
TMB - Transuranic Metal Box
TPA - Tri-Party Agreement
TRU - Transuranic
TSD - Treatment, Storage, or Disposal

TWRS - Tank Waste Remediation System
VOC - Volatile Organic Compounds
WHC - Westinghouse Hanford Company
WIPP - Waste Isolation Pilot Plant

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1.0 INTRODUCTION

This section provides the purpose, background and scope of this report, identifies the six alternatives analyzed, and describes the contents of the subsequent sections.

1.1 PURPOSE OF REPORT

Solid remote-handled mixed wastes are currently located in the Radiochemical Engineering Hot Cells (REC) in the 324 Building. These wastes need to be removed from the building and placed in permitted storage to bring the building into conformance with the federal Resource Conservation and Recovery Act (RCRA) and Washington State Hazardous Waste Management Act. It is also desirable to move the wastes to a more remote location where they can be indefinitely stored until they can be treated (if needed) and then placed in a disposal facility. The removal of the wastes will reduce the current hazards in the REC and provide the opportunity to use the REC for other Hanford and DOE research and development activities.

The purpose of this report is to identify technically feasible alternatives for removal of these wastes and provide an initial evaluation and recommendation of the preferred alternative(s). This information will be of use to the Department of Energy (DOE), its site contractor for waste operations (Westinghouse Hanford Company [WHC]), Pacific Northwest Laboratory (PNL), and the Washington State Department of Ecology (WDOE), to aid in communications and the selection and implementation of a solution to the current mixed waste storage problems in the 324 Building. While some additional alternatives were identified in the early part of the study, they have not been included in this evaluation since they were eliminated in an initial screening. It is recognized that some adjustments and modifications to the basic alternatives can be made to optimize individual alternatives in the next phase of this project. This is expected to occur as the detailed implementation effort is executed for the selected alternative.

1.2 BACKGROUND

The needs, difficulties, and a brief history of the wastes were recently issued as a white paper entitled "324 REC & HLV Tanks Mixed Waste Compliance Status White Paper."¹ This white paper can be consulted for background information on 324 Building, the generation of the wastes, RCRA compliance needs, and technical issues.

1.3 SCOPE OF STUDY

This study focuses on the solid remote-handled (RH) mixed wastes, which are considered the most difficult wastes in the REC to manage. These wastes are also known as special-case wastes because of their high levels of radioactivity. The liquid wastes in the High Level Vault are not included in the scope of this report because they are expected to be converted into a much lower activity mixed waste and Category 3 low-level wastes. Likewise, other contact-handled mixed solid wastes and special-case wastes from the REC are not analyzed. The main focus is the identification of an alternative(s) for interim

storage of the wastes. Since the requirements for receipt of these types of waste at the repositories (either the commercial repository planned for Nevada or the Waste Isolation Pilot Plant [WIPP] in New Mexico) are being considered for revision, the waste handling needs after the wastes are removed from interim storage in the 200 Area are recognized but only generally considered.

1.4 SELECTED ALTERNATIVES

The six alternatives selected for evaluation in this report are identified below and described in greater detail in Section 4. The alternatives have been grouped into three general approaches to the management of the wastes. The first group is based on the transport of the wastes to an existing facility and includes: 1) the storage of wastes in the PUREX tunnel, 2) the storage of wastes in the PUREX Canyon, and 3) the packaging of the wastes to meet the acceptance requirements of the Central Waste Complex. The second group of alternatives is based on the building of new storage facilities with the current concept of dry storage of commercial spent fuel and includes: 4) modification to the scope of the current special-case waste storage project W-272 to include gas generating mixed wastes, and 5) the development of a new special-case mixed waste storage project (W-349). The third general approach is the treatment of the wastes so that they are no longer a RCRA waste. 6) Vitrification was selected as the treatment approach in the sixth alternative.

1.5 OUTLINE OF REPORT

The report first describes the waste streams, in Section 2. Assumptions and basis necessary to provide the preliminary evaluation are described in Section 3, and then the alternatives are identified and briefly described in Section 4. Section 5 identifies the basic criteria used in the evaluation and provides the preliminary evaluation with respect to the criteria. Section 6 identifies the major uncertainties in the evaluation that may need to be further addressed during implementation. Section 7 contains a summary discussion of the evaluation results. The conclusions and recommendations from the evaluation are contained in Section 8, and the references used in the report are listed in Section 9.

2.0 DESCRIPTION OF WASTE STREAMS

Four different solid waste streams have been identified for inclusion in this study. They are from very different operations and have different characteristics as to physical form, radionuclide content, and hazardous components. Specific radioactivity levels have not been determined for each waste stream, but it is currently estimated that the packaged doses for all of the wastes will be above 2000 R/hr and some containers will be of the order of 100,000 R/hr. Table 2.1 identifies the waste streams and provides a summary of the major characteristics of the wastes. The radiation category for these wastes has been previously identified as special-case wastes rather than the subcategories of transuranic (TRU) waste and low-level waste (LLW) shown in Table 2.1. Additional information on each stream is provided in this section and some generation information is contained in Section 3.

Table 2.1. Remote-Handled Mixed Wastes Included in Study

Waste Stream	Volume	Source/Content	Rad.- Cat*	Contaminants/ Waste Codes
Dispersible Debris	88 ft ³	Cell Floor - Tools, equipment, dust, leaks from process lines	RH-TRU	Cadmium (D006), Chromium (D007), Lead (D008), Selenium (D010) Silver (D011), (WT02) ~1,500,000 Ci
Dried Melter Feed	6 ft ³	Residual removed from process equipment	RH-TRU	Chromium (D007), Lead (D008), (WT01)
Liquid Metal Seal	<7 ft ³	Melter - Low Temp. Alloy	Cat. 3 LLW	Cadmium (D007), Lead (D008), (WT01)
Oil Absorption Material	<7 ft ³	Absorbed window oil on clay	Cat. 3 LLW	Oil (WT02)
* Preliminary categories assumed from available data.				

2.1 DISPERSIBLE DEBRIS

The dispersible debris waste consists of dirt, dust, and process residues and equipment and tools that have been collected and will be collected from the floor of B-Cell. The debris includes tools and equipment that have fallen to the cell floor. The debris by itself does not contain any hazardous components. However, the dispersible particulate has been contaminated with process feed solutions that contained characteristic heavy metals and spent fuel particulate. It has been estimated that the debris contains about 1,500,000 Ci of radioactivity, principally cesium and strontium. With this estimated level

of activity a 3-ft³ canister of waste would have a radiation level of about 100,000 R/hr and would have a heat generation rate of about 300 watts. The TRU level of this waste was measured on one sample to be 17.3 μ Ci/g. Thus, this waste is classified as a TRU waste. Additional compositional data on the one sample of this waste is included in Table 2.2. The total activity measured on this sample was about a factor of 10 below the estimated average for all of the debris. This indicates that there may be considerable heterogeneity within the waste stream. It is estimated that only about 25% of the material is larger than 2.5 inches--large enough to be considered a debris waste under the EPA regulations. This debris fraction is planned to be removed from the remainder of the waste, decontaminated and disposed of as radioactive waste only. About 38 cubic feet of the dispersible debris have been collected from B-Cell and it is estimated that an additional 50 cubic feet remain to be collected.

Table 2.2. First Dispersible Debris Sample Composition (conc. in ppm)

Al	B	Ba	Ca	Cd	Ce	Cr	Cu	Fe	K
15600	870	874	209000	36	74	2500	2910	81000	770

La	Mg	Mn	Mo	Na	Nd	Ni	P	Pb	Ru
142	3700	567	2130	4040	169	14000	2620	1850	54

Si	Sr	Ti	U	Zn	Zr	Cl	F	Br	PO ₄
844	591	233	4450	704	170	1200	300	30	<45

SO ₄	Nitrite	Nitrate
4400	200	200

2.2 DRIED MELTER FEED

This waste is residual feed material removed from processing equipment in B-Cell. It is not clear at this time if the equipment was washed in a final processing at the end of the FRG runs or if the residual slurry was simply left in the equipment. Initial radiation levels on the materials indicate that the equipment was washed to remove most of the activity. The original feed materials were prepared as feed for the glass melter in B-Cell as part of a program to assist the Federal Republic of Germany (FRG) in its repository testing program. The original melter feed contained high levels of ¹³⁷Cs and ⁹⁰Sr to duplicate that expected from spent fuel reprocessing wastes. The melter feed contained low levels of lead, chrome, and plutonium in solution. The water evaporated from the melter feed slurry after the shutdown of the process equipment and the residual dried melter feed was removed from the process equipment. The early estimates were that the dried feed could contain as much as 500,000 curies of Cs and Sr. Current radiation level measurements indicate a content of about 60,000 curies. Additional characterization is needed to confirm contaminant and radionuclide contents. The volume of this waste stream is about 6 cubic feet. Like the dispersible debris wastes it may have a high radiation level and significant heat generation rate.

2.3 LIQUID METAL SEAL

The liquid metal seal is a metal alloy that is reported to contain 50% Bi, 26.7% Pb, 13.3% Sn, and 10% Cd. This alloy has a melting point of 158°F. It was used as a seal material as part of the glass melter. The waste is an inherently hazardous material and as packaged is less than 7 cubic feet in volume. It has been exposed to high levels of radioactive materials and particulates, but the radioactive content has not been characterized. It does not generate any significant amount of heat and would not be considered a heat generating waste as are the two wastes discussed above.

2.4 OIL ABSORPTION MATERIAL

An absorption material was used in B-Cell to clean up oil from a leaking window. The absorption material is a clay-based material like "kitty litter." It is contained within a 55-gallon drum. Its exposure to the cell environment makes it a radioactive waste and the oil designates as a Washington State Toxic designated waste (WT02). It is expected that the radioactive levels will make it either a special-case waste or a category 3 low-level waste. This material may need to be tested to verify that the oil is nonflammable after absorption in the clay-based material to allow its storage in some conditions.

2.5 WASTE AVAILABILITY SCHEDULES AND PACKAGING VOLUMES

The waste volumes as noted in Table 2.1 are for the unpackaged wastes. For the following table it was assumed that about a 25% volume reduction of the dispersible debris waste would be achieved by removal of the large-sized nonhazardous items which are subsequently decontaminated sufficiently that they can be handled as low-level waste. The residuals from this decontamination activity will be recombined with the particulate fraction of the wastes. It was also assumed that all of the wastes would be packaged at 90% efficiency (i.e., wastes would fill 90% of the volume of the canisters). As noted above, the dispersible debris wastes cannot all be collected until equipment in the cell is removed. Thus, the final wastes may not all be available for removal from 324 Building until September 2000. As noted above this schedule is likely to be accelerated to meet the TPA Agreement change. The volumes of wastes available for removal as a function of time are shown in Table 2.3. As can be noted, the majority of the wastes (about 65%) could be made available for removal by the end of 1995.

Table 2.3. Volumes (in cubic feet) of Wastes Available for Transfer to Interim Storage by Calendar Year

<u>Waste Stream</u>	1994	1995	1996	1997	1998	1999	2000	Total
Dispersible Debris	28.5	7.5	17.6	0	11.4	0	1.1	66.2
Dried Melter Feed	6	0	0	0	0	0	0	6
Liquid Metal Seal	7	0	0	0	0	0	0	7
Oil Absorption Material	7	0	0	0	0	0	0	7
Totals	48.5	7.5	17.6	0	11.4	0	1.1	86.2
Cumulative Totals	48.5	56	73.6	73.6	85	85	86.2	
% Collected	56%	65%	85%	85%	99%	99%	100%

3.0 ASSUMPTIONS AND BASIS FOR STUDY

This section identifies the major assumptions and bases that have been established to allow progress on the study. The assumptions and bases include information on the waste characteristics, the schedules for related projects, the final disposal requirements for the wastes, the packaged waste volumes, and transportation requirements and methods.

3.1 BACKGROUND

The packaging, transportation, storage, and eventual disposal of these wastes are not routine activities. Many of the potential pathways that have been identified in this study have not been used previously and even the established pathways will have significant differences because of the unique natures of these wastes. To begin the assessment process it has been necessary to make some engineering and procedural assumptions. The assumptions will be readdressed in the next phase of this study to a higher degree, and hopefully, most of them can be enhanced with additional data and analysis.

3.1.1 Waste Stream Assumptions

The volumes of the wastes are assumed to be as projected. Since the debris waste is not readily available, its volume could be quite different from that shown here.

The assumption is made that the waste constituents are as currently characterized and relatively homogenous within a waste stream. Since the dispersible debris wastes accumulate in specific locations within the cell from specific and different activities at various locations, the wastes could vary quite significantly in composition and content at different locations. Major differences have not been considered and could affect the allowable loadings within specific canisters. Potential limits based on heat or radioactive levels in the containers are possible for some alternatives. The major impacts of this assumption are on the need for additional containers of the waste or the potential need to repackage wastes for shipment to the repository. It does not have major impacts on the implementability of the alternatives.

3.1.2 Project Assumptions

There are increasing efforts being made to accelerate various schedules on the B-Cell Clean out Project and the transitioning of Hanford site facilities. The potential acceleration of schedules could impact the compatibility of the various options. This assessment has been made based on the current plans. As detailed implementation plans are prepared, they will need to assess the potential effects of changes in various facility schedules.

Several efforts in Congress and at the Hanford Project are underway to simplify the regulations and requirements on various activities. It is assumed that conditions will not significantly change with respect to current requirements. Changes to simplify or to increase the need for controls are possible by the time the selected option will be fully implemented.

3.2 FINAL DISPOSAL REQUIREMENTS

The interim storage that is to be utilized for removal of the wastes from the 324 Building is only a temporary solution. The majority of the wastes in the study will require repository disposal. It is assumed that actions taken in this effort will not create a serious problem in the future or make it difficult to prepare the wastes for disposal. It is anticipated that most of the wastes will be TRU wastes and to the extent possible will be packaged to meet waste acceptance requirements at the WIPP.² A discussion of the pertinent requirements from WIPP Waste Acceptance Criteria is provided in Section 5.2.5. As indicated in Section 5.2.5, it is possible that some of the dispersible debris may be at a higher specific activity than can be accepted at WIPP. Unless these wastes are repackaged at lower specific activity, they may have to go to the commercial repository planned for Yucca Mountain, Nevada.

3.3 WASTE PACKAGING

The packaging requirements are based on the capabilities of the systems that will handle the wastes through long-term storage. The final storage facility and the transport casks also provide requirements for waste packaging. It is assumed that the waste packages will be prepared to meet the current WIPP-WAC to the extent possible.

For initial planning it is assumed that the wastes will be repackaged into standard containers as noted in Table 3.1. The package sizes were generally taken from the current plans for packaging the wastes. It is possible that other sizes and shapes may be optimum for some waste streams. The packages will need to be equipped with a NUCFIL vent to allow release of gases and a "recombiner" since radiolysis of water and organic materials will result in the generation of hydrogen and other gases with most of the waste streams. Without the vents and recombiner the gases would pressurize the containers over time and may create a flammable or explosive gas mixture within the containers and possibly the storage facilities. This is addressed in more detail in Section 5.1.3.

For consistency it is assumed that 1 in. of lead shielding will be used on all of the canisters going into PUREX. The shielding will reduce the dose from the canisters to about 1000 R/hr and reduce potential operator doses during handling, storage, and retrieval and make the canisters dose compatible with the WIPP facility. It is further assumed that the lead is on the outside of the 10-in.-diameter containers, but on the inside of the 55-gallon drums. No shielding is provided for the wastes going into W-272 or W-349, since handling and retrieval from these facilities will be simpler. For alternative 6, vitrification, it is assumed that all of the wastes will be packaged into the standard 10in. diameter by 6-ft-long canisters without shielding.

With the waste volumes as noted in Table 2.3, the container sizes as noted in Table 3.1, and the shielding as noted above, the number of containers for each of the alternatives is shown in Table 3.2.

The content of fissile material in the packages can limit handling and storage if it is more than 15 grams per container. Based on the one analysis of the dispersible debris, it is estimated that the Pu content is above this value. Thus, the content of fissile materials will need to be considered as the waste removal activities are implemented.

Table 3.1. Anticipated Waste Packaging

Waste Stream	Package Size	Justification for Size
Dispersible Debris	10" Diameter 6' Long Canister	Heat generation rates necessitate a smaller diameter and canister must fit within planned overpack.
Dried Melter Feed	10" Diameter 6' Long Canister	Similar material concerns to the dispersible debris. Same justification
Liquid Metal Seal	55-Gal Drum	Convenient size with lower heat and radiation levels than the dispersible debris streams
Oil Absorption Material	55-Gal Drum	Convenient size with lower heat and radiation levels than the dispersible debris streams

Table 3.2. Number and Type of Containers for Each Alternative

Alternative	10" Diameter by 6' Long Canisters	55-Gallon Drums
#1 - PUREX Tunnel	26	2
#2 - PUREX Canyon	26	2
#3 - Central Waste Complex	26	2
#4 - Modified W-272	26	2
#5 - W-349	26	2
#6 - Vitrification	24	1

3.4 WASTE TRANSPORTATION

Transportation of the wastes to the 200 Area is a primary requirement for all of the alternatives. The identification of potential transportation casks was a necessary requirement in the development of the alternatives. This section describes several transportation alternatives that were identified as applicable to these wastes and waste packages. The NAC-LWT cask, Transuranic Metal Box (TMB)-III, an undefined storage cask that can pass a Hanford Type "B" equivalency, and the cask to be developed or made available to support the new W-272 special-case waste handling facility were selected for use in this study. Other options are described in this section for future reference and completeness. The reference casks used for analysis in this report, the type of waste canister that can be shipped by those casks, and the number of containers that can be shipped in each cask are summarized in Table 3.3.

Table 3.3. Transportation Casks Used in Study and Their Capacities

	NAC-LWT Cask	Transuranic Metal Box (TMB-III)	Type "B" equivalent Casks	"W-272" Cask
10" dia. by 6' long canister	2	Not Applicable	6	2
55-gal drums	Not Applicable	2	Not Applicable	Not Applicable

There are not any government-owned casks on the Hanford Site to handle the 10-in.-diameter by 6-ft-long canisters; however, there are several commercially available spent fuel casks that have the capability of handling the 10-in.-diameter waste containers. For all of the alternatives the wastes would be loaded into the truck cask in the airlock adjacent to B-Cell in 324 Building. The cask with the wastes would be then loaded onto the transport truck and moved to the 200 Area receiving facility. It would also be possible to reactivate the rail line into the 324 Building, but with the limited number of shipments necessary it appears less expensive to use the truck casks. For the PUREX options the cask would be moved from the truck trailer by a mobile crane to a railcar near the PUREX facility and then taken into the PUREX canyon unloading area. The canisters would then be remotely removed from the casks and placed in the canyon or onto the storage railcar by the canyon crane. The three major technical constraints on the selection of a transportation cask are 1) the crane capacity of 30 tons in the 324 Building, 2) the 6-ft length of the reference canister, and 3) the heat generation of the wastes, which is a maximum of about 300 watts per canister. Brief descriptions of several casks are provided below. Final selection of a cask will depend on cask availability when shipments are planned. The reference cask used for cost calculations for the high heat wastes is the NAC-LWT spent fuel cask. Other potential spent fuel casks that have the needed internal dimensions are the NLI-1/2 and the NLI-6502. The NLI-1/2 cask has been used previously for transporting materials into and out of the 324 Building and is an equivalent choice. Several of these type casks will potentially be purchased by PNL for interim storage of spent fuel. It is possible that they could be used for transport of these wastes before the spent fuel is placed in them for long-term storage.

Several casks were also identified for the shipment of solid wastes packaged in 55-gallon drums. These are the SEG 3-28B cask, the GE-2000 cask, and the CNS 1-13C cask. A Hanford transuranic metal box (TMB) is currently approved for the shipment of lower activity transuranic wastes and as noted above

is the reference used for this study for shipment of the lower activity 55-gallon drums. With additional analysis to increase the allowable curie limit the TMB may also be useful for the shipment of the shielded waste packages. Final selection of the shipping cask will be done in the implementation plan, which will need to consider cask availability as some casks may have existing commitments that will severely limit their availability.

The NAC-LWT cask is a truck cask designed for spent fuel. It has an internal cavity of 13.4 in. diameter and 178 in. length. The external dimensions of the cask body are 200 in. length and 44 in. diameter. With impact limiters it increases to 232 in. length and 65 in. diameter. The cask has a capacity of up to 4000 lb. of spent fuel and has a total weight of 51,200 lb. It should be capable of handling two reference canisters per shipment. The cask is designed for commercial spent fuel heat loads and activity levels and should therefore be adequate for these wastes. The cask is constructed with a 3/4" thick stainless steel inner shell, a 5-3/4 in. thick lead gamma shield, a 1-1/5 in. thick stainless steel outer shell, and a neutron shield tank. The cask is designed to be sealed during transport and is NRC licensed for many spent fuel and spent fuel hardware materials. It may be necessary to get Hanford site approval for shipment of our wastes since they are not currently described in the Certificate of Compliance.³

The TMB has been approved as "Type B equivalent" container for the Hanford Site and is considered for use in the Central Waste Complex (CWC). The TMBs are large metal boxes that range in size from about 3.2 ft x 4.5 ft x 5.7 in. to 5.5 ft x 6.5 ft x 9.3 ft. Shielded 55-gallon drums can be loaded into the boxes with severe limits on total weight. The highest gross weight (including wastes) is 17,000 lb. The safety analysis report for packaging (SARP) for the TMBs provides limits for ¹³⁷Cs and ⁹⁰Sr of 75,000 Ci and 3000 Ci, respectively. With the expected ¹³⁷Cs and ⁹⁰Sr inventories in the dispersible debris, preliminary calculations indicate that more than 200 boxes may be needed for the strontium inventory and about 12 boxes for the cesium inventory. This is not realistic in practice, as it would occupy a large volume of storage and would result in excessive space charges and require a large number of storage containers. It may be possible with additional analysis and testing of our waste forms to increase the current radionuclide limits, but that is beyond the scope of this comparative analysis. The TMBs are planned for use for the less-active wastes. Additional characterization of the wastes will be needed to verify that they are compatible with the current SARP.

The SEG 3-82B cask is also compatible with the 55-gallon drummed wastes. It has shielding consisting of a 3/8-in. steel, 3-3/4-in. lead, and 1-in. outer steel barrier. The cask has a right circular cylinder cask cavity that is 66.25 in. in diameter and 74.5 in. high. The cask shell is surrounded by a 1-in. layer of insulating material in an 11-gauge steel. The cask was designed for transport of dewatered, solid radioactive wastes that are similar to the type of materials that we will be transporting. It could transport both the 10-in. by 6-ft canisters and 55-gallon drum containers. It has a heat loading limit of 34 to 60 watts, which means that it would not be acceptable for the high heat generating dispersible debris or dried melter feed waste streams.

A PNL designed truck cask, the 22.5 Ton Box, is also a potential transportation cask. The 22.5 Ton Box has an internal cavity of 3 ft x 3 ft x 5.5 ft and is too small for the canister used in this study; however, there are some considerations to shortening the 6 ft canister to 5.5 ft to allow use of this transport box because of its ease in handling with the PUREX crane.

The GE-2000 cask is a steel-encased lead shielded cask developed by General Electric Company. The lead shielding is about 4 in. thick. The steel shells add another 2 in. of shielding. The cask cavity is 25.5 in. diameter and 54 in. high and the cask weighs 33,550 lb.

The CNS 1-13C cask was licensed by Chem-Nuclear Systems. It is a steel-encased, lead shielded shipping cask. The packaging is a steel double-walled, lead-filled circular cylinder. The lead shielding ranges between 5 and 6 in. in various parts of the cask. The cask is 39 in. diameter and 68-1/2 in. long. The cask cavity for waste shipments is 26-1/2 in. diameter and 54 in. long. The cask weighs about 26,000 lb. A similar cask, CNS 1-13G, is also potentially available.

Several other commercial casks, such as the CNS 10-160B, CNS 4-85, CNS 8-120B, LN 10-135, and NuPac 10-142, are also of potential use. They all have larger diameters and lengths of an internal cavity and as a consequence weigh more than the first three casks described above, but could potentially handle multiple-canister shipments.

4.0 DESCRIPTION OF ALTERNATIVES

At the start of this effort, experts from across the Hanford Site were gathered to identify potential options for waste preparation, transportation, and storage. These meetings identified a number of potential methods for each phase of the effort. From that identification of options it was recognized that there were three general approaches to manage these wastes: 1) transfer of the wastes to an existing facility for continued storage, 2) construct a new facility for storage of the wastes, and 3) treat the wastes to remove them from the RCRA requirements and make them more stable for long-term storage and disposal. It was apparent that the use of an existing facility or facility already underway would likely be the most expeditious, and these alternatives were favored. However, it was desired to maintain a broad perspective at this stage of the analysis, so technically achievable alternatives were selected that addresses all three approaches. Options that have been omitted at this stage were those for which the path forward appeared more difficult and would require either RCRA permitting of old facilities such as REDOX and U-Plant or for which the proposed uses of the facility would be conflicting with the current objective to avoid TRU waste storage (B-Plant and T-Plant). The alternatives have not been specifically optimized, but have been developed with engineering judgment and should be further improved if selected for implementation.

The following sections provide brief descriptions of each alternative. Each alternative requires three basic functions to be accomplished: packaging of the wastes in the 324 Building, transporting the wastes to the 200 Area, and locating the wastes into the interim storage facility. The system components for each alternative are described in the following sections. The general transportation methods were described previously in Section 3.4. The removal of the wastes from interim storage, their potential treatment, and shipment to the repository are recognized as necessary, but detailed descriptions are not included for each alternative, since conditions and requirements may change significantly while the wastes are in interim storage. It is necessary that nothing be done that would make it very difficult or expensive to retrieve and handle the waste containers.

The six alternatives evaluated in the following sections are 1) move the wastes to the PUREX Tunnel, 2) move the wastes to the PUREX Canyon, 3) ship the wastes to the Central Waste Complex, 4) modify the W-272 scope to include mixed wastes, 5) develop a new remote-handled mixed waste storage facility (W-349), and 6) vitrify the wastes to remove them from RCRA controls. The barriers to implement each of the alternatives are discussed in Section 5. The additional needs to allow implementation of the recommended alternatives are discussed in Sections 7 and 8.

4.1 ALTERNATIVE #1 - MOVE WASTES TO THE PUREX TUNNELS

The major activities for this alternative are illustrated in Figure 4.1. The available wastes would be packaged in lightly shielded (1 in. lead) cask liners in the 324 Building hot cells (although there is not a requirement for shielding in the tunnel), the liner would be moved into the air-lock and remotely loaded into a truck cask, the cask loaded onto a truck, and then shipped to a railroad crossing near the PUREX Plant. The cask would then be transferred from the truck to a railcar and the truck cask and railcar would be moved into the PUREX facility. The wastes would then be transferred remotely within the PUREX Plant from the cask to a specially prepared and designed storage railcar. While multiple shipments would be necessary to move the wastes to the facility, it is intended that the wastes could be loaded onto one storage railcar. The storage railcar would then be moved into the storage tunnel for interim storage.

Figure 4.1. Flowchart of Activities for Waste Storage in PUREX Tunnel

The PUREX tunnels are to be closed and transitioned with the PUREX canyon, which is anticipated in early 1997. Transitioning is the shutting down of most active systems within the facility and placing of the facility into condition where it requires minimal maintenance until it can be decontaminated and decommissioned. Thus it can provide a temporary storage location for wastes that will later be removed and managed. For this alternative wastes would have to be loaded into the PUREX tunnels by February 1996 if the PUREX canyon crane is to be used to unload the casks. If the packages are totally shielded and a transportation crane is used instead of the canyon crane, then a later shipment date could be possible.

Some dispersible debris will not be collected by the time the tunnels will be closed and will need to be stored in another facility. For this alternative it is considered that the additional wastes will be placed in CWC as described in alternative 3, but other options are also possible.

The tunnels have a Part B permit (Form III) but are currently permitted to receive only PUREX-discarded equipment. Modifications to the permit will be needed to allow the disposal of additional sources of materials and additional characteristic waste codes. Both DOE and WDOE have indicated a willingness to use the existing facilities for waste storage. The available information on the current waste materials in the tunnels indicates that the total curie content is on the order of 100,000 curies. Since the 324 Building mixed wastes would increase the total radioactivity by over an order of magnitude, this alternative would introduce the need for additional NEPA reviews and safety analysis. Hydrogen and heat evolution and radiation doses outside the tunnel and during loading and unloading would have to be considered. The needs to keep the tunnel open to allow the addition of wastes at a later date would also have to be analyzed and evaluated.

4.2 ALTERNATIVE #2 - MOVE WASTES TO THE PUREX CANYON

This alternative is similar to the previous alternative except that the wastes would be placed into the canyon in the PUREX facility rather than be placed in the tunnel. To make space within the canyon may require that some equipment currently in the canyon be moved into the tunnel. An initial review of

Figure 4.2. Flowchart of Activities for Waste Storage in PUREX Canyon

the canyon cells has indicated that F cell may be a preferred location for the waste storage. The major waste management activities for this option are illustrated in Figure 4.2. The available wastes could be packaged in lightly shielded storage containers in the 324 hot cells, loaded into a truck cask, then the cask loaded onto a truck, and then transported to a railroad crossing near the PUREX Plant. The cask is then transferred from the truck to a railcar and the railcar would be moved into the PUREX facility. The wastes would then be transferred from the cask to within the PUREX facility and placed in their storage location within a cell. F-Cell appears to be one attractive location. This action will require that an area within a cell be cleaned out and the equipment moved to another location within the canyon or possibly to the tunnel. Deactivation of the PUREX canyon crane is currently anticipated in about March 1996. Therefore, all transfers would need to be completed before February 1996.

Some of the dispersible debris will not be collected by the time the wastes need to be in the PUREX Canyon and will need to be stored in another facility. For this alternative it is considered that the additional wastes will be placed in the CWC in shielded containers as described in alternative 3, but other options are also possible.

The PUREX canyon facility has a Form III under the Site Part A that allows up to 567 cubic yards of miscellaneous mixed waste storage in the containment building. It includes waste codes WT01, D006 (cadmium), D008 (lead). The Form III was recently revised to include additional waste codes of WT02, WC02, and D007 (chromium) and will require another revision to add waste codes D005 (barium), D010 (selenium), and D011 (silver), if the 324 Building wastes are to be included. The PUREX Plant is currently undergoing transition to EM-40 to reduce the site operating costs. Storage of the 324 wastes should not significantly delay that transition because of cost impacts of about \$100,000 per day. EM-40 must approve any additional waste as part of the Transition End Point Criteria. A preclosure work plan is now being prepared.

4.3 ALTERNATIVE #3 - SHIP WASTES TO THE CENTRAL WASTE COMPLEX (CWC)

The major characteristics of this alternative are to use the currently available system for storage of contact-handled mixed wastes and to use a Type B cask to allow that system to be used. The CWC has

a RCRA permit for storage of mixed wastes. The major activities for this option are illustrated in Figure 4.3. In this alternative wastes would be packaged into unshielded containers that are then loaded into a Type B cask that provides sufficient shielding for the wastes. The casks are then transported to the existing storage facilities in the CWC and the wastes are left in the casks for storage. The use of Type B packaging is needed since the current curie limits on the facilities cannot reasonably be met. Higher limits are approved if Type B packaging is used since the cask is covered under its own safety analysis and does not then rely on the storage facility for containment. The acceptance criteria for Type A quantities in the storage buildings limit the curie loadings to less than 115 dose equivalent (DE) curies per building. There are an estimated 2800 DE curies in the dispersible debris, with most of the DE curies resulting from strontium. Thus, a major focus of this alternative will be the need for Type B packaging. The generation of radiolytic gases is a current concern with respect to being able to use Type B packaging. It is assumed for this alternative that the Type B packaging will be a set of commercially available Type B casks. The CWC will be a continuing operation for the foreseeable future, so no time limits on the receipt of the wastes were identified. Wastes could be shipped to the facility as they are packaged and the casks are available.

Figure 4.3. Flowchart of Activities for Waste Storage in Central Waste Complex

4.4 ALTERNATIVE #4 - MODIFY W-272 SCOPE TO INCLUDE MIXED WASTES

The W-272 facility (Special Case Solid Waste Temporary Storage Facility) will be designed for storage of special-case wastes (non-mixed, non-gas-generating, remote-handled wastes) from the 324 Building and other Hanford facilities by a commercial supplier. The waste storage will be in a shielded vault commercially constructed and delivered to the Hanford Site and will be based on standard-sized sealed containers that will be inserted into the shielded facility for long-term storage. Most of the design will be the responsibility of the successful bidder on the request for proposal (RFP). The successful bidder is to provide a system that includes the shipping cask and the storage vault. The RFP is expected to be out for bid in July 1995. The current schedule calls for the W-272 facility to begin receiving wastes in 1998.

For this alternative modification, to the current W-272 project design and permitting would be incorporated to allow storage of hazardous, gas-generating, mixed wastes. The wastes being considered in this study are generally hydrogen gas generators rather than the stable vitrified wastes. This could have impacts on safety, design, and DOE approval documentation. It may also require a RCRA permit for waste storage, but the permit may also be covered in the existing general permit for the CWC facilities.

As shown in Figure 4.4, this alternative would package the wastes into an unshielded remote-handled canister in 324 Building, then load the canister directly into a truck shipping cask. The cask would then be loaded onto a truck and transported to the storage vault. At the storage vault the cask would be positioned so that the canister is directly loaded into its storage location. Both the transfers

could be made by locating the cask in a position in the hot cell or storage facility where the canisters could be directly inserted into and removed from the cask. No handling of the canisters in a separate shielded facility would be needed. It is expected that the storage vault configuration (horizontal or vertical) and the number of canisters per storage vault (e.g., two groups of three canisters, or three 55-gallon drums) will be left to the vendor. The wastes would remain in the storage facility until they could be processed as needed and taken to the final disposal facility. With the modifications in scope and permitting requirements it has been estimated that it would probably take at least an additional year before the facility could begin receiving the mixed wastes (~1999). One major concern is that, with the need for new approvals and documentation, the currently approved funding could be delayed with a potential for total loss of funding. This could severely affect the current efforts to remove the other high-activity wastes from the 324 Building.

Figure 4.4. Flowchart of Activities for Waste Storage in a Modified W-272 Storage Facility

4.5 ALTERNATIVE #5 - DEVELOP A NEW REMOTE-HANDLED STORAGE FACILITY (W-349)

The steps in this alternative are quite similar to the previous option and are illustrated in Figure 4.5. Packaging of the wastes in 324 Building and transport of the material to the anticipated 200 Area storage location would be the same as in the previous alternative (W-272). The major difference is the need to develop a totally new remote-handled storage facility. Such a facility has been proposed by WHC as the W-349 (Special Case Solid Mixed Waste Temporary Storage Facility). While it should be possible to use much of the development and design from the W-272 facility, there may be some design changes to meet RCRA standards, and a need to address the hydrogen gas generation issues.

A concern with this alternative is the time it will take to get the facility ready for receipt of the wastes. An initial schedule with the assumption of available funding shows that it will take about six years before the facility could receive the wastes.

Figure 4.5. Flowchart of Activities for Waste Storage in a New Storage Facility

4.6 ALTERNATIVE #6 - VITRIFY WASTES TO REMOVE THEM FROM RCRA CONTROLS

Several treatment options are available to treat the wastes to reduce the leachability of the hazardous components, and to remove most of the waste materials from RCRA controls. A vitrification

treatment method was selected for this alternative since it is a BDAT-specified technology required for disposal of high-level wastes and 324 Building staff have a broad base of experience with the technology, so it should be a relatively easy treatment technology to establish. It is also a recognized method for treatment of solid wastes so that they can pass the TCLP test. Since the wastes are only characteristic wastes, treatment can remove them from the RCRA regulations if the treated wastes can pass the TCLP test. This alternative is illustrated in Figure 4.6. A simple vitrification system such as a small in-can melter⁴ may be an appropriate treatment for the applicable solid wastes. The wastes could be mixed with glass-forming additives and then added directly to the final storage canister in the melter. Any water would be evaporated, the organic materials would be oxidized, and the resultant solids melted with glass-forming additives. Total additives would likely be small since most of the dispersible debris and dried melter feed already contain glass formers. Some additional analysis would be needed to verify the solid waste composition. The assumptions for waste additives and volume reduction can be noted in Table 4.1. A vitrified form would pass the TCLP test to allow the characteristic wastes to be classified as a non-mixed waste. Vitrified forms are highly stable for storage (non-gas generating) and should also be acceptable for final disposal of the wastes. The wastes could then be transported to the W-272 facility without modifications to its current scope, so long as there was sufficient room, or the facility could be extended in size. It may be necessary to ship the untreatable RCRA waste (liquid metal seal and some mixed process wastes) to the Central Waste Complex for interim storage. They would not present the same problem with storage as the dispersible debris since their levels of radioactivity are much lower.

TREATMENT OF DISPERSIBLE DEBRIS, DRIED MELTER FEED, ABSORBED OIL AND HEPA FILTER MEDIA

STORAGE OF LIQUID METAL SEAL AND SOME MIXED PROCESS WASTE

Figure 4.6. Flowchart of Activities for Treatment of Wastes in 324 Building And Storage of Liquid Metal Seal and Some Mixed Process Wastes at the CWC

Table 4.1. Canister Calculations and Assumptions for Vitrification Alternative

Waste Type	Initial Volumes (ft ³)	Initial Density (g/cc)	Initial Mass (kg)	Vitrified Mass (kg)	Vitrified Density (g/cc)	Vitrified Volume (ft ³)	Number of Canisters	Rounded Number of Canisters	Container Type
Dispersible Debris	66.2	1	1875	3749.6	2.3	57.6	19.6	20	10 in. x 6'
Dried Melter Feed	6	1	169.9	169.9	2.3	2.6	0.9	1	10 in. x 6'
Liquid Metal Seal	7			Not Vitrified				2	10 in. x 6'
Oil Absorption Material	7	1	198.2	396.5	2.3	6.1	0.9	1	10 in. x 6'
Totals	86.2	3	2243	4316	6.9	66.3	21.4	24	

Equipment to perform the vitrification treatment can be developed based on past experience and operations of in-can or other melting systems. It would require that the system be specifically designed for these conditions. The system would then need to be fabricated and operated nonradioactively to verify its operability. The design and testing would likely require several years to complete.

A vitrification process would require that suitable equipment be introduced into the cell for off-gas treatment. Such a system would need to provide for control of the major off-gas wastes and their potential recycling and acceptance as a low-activity waste that can be shipped from the 324 Building to the 340 Building. Following treatment operations, the disposal of the in-can melting furnace and off-gas system would be necessary at some point. The wastes would need to be reviewed to verify that the equipment does not become a mixed waste. The costs for this and all alternatives are discussed in Section 5.2.6.

5.0 CRITERIA FOR EVALUATION OF ALTERNATIVES

Several criteria were established as the basis for defining and comparing the alternatives examined in this study. These criteria were divided into two categories: 1) requirements that define mandatory characteristics of the waste packages and handling, and 2) desirable characteristics of the waste management system. Each criterion is assigned to one of the categories. The criteria are described in the following sections.

5.1 REQUIREMENTS FOR THE ALTERNATIVES

The following criteria must be satisfied. They are defined by the permissible waste package designs for the candidate waste storage facilities and the related regulatory requirements.

5.1.1 Permissible Canister Radiation Levels

The permissible radiation levels for the waste canisters are limited by the Hanford storage facility maximum permissible radiation levels for waste containers received at those facilities. These limits are established primarily to help minimize the radiation doses for the personnel handling the wastes in the storage facilities and monitoring the waste during storage. All handling and storage of these wastes must be done remotely and in such a manner that they do not result in significant exposure to those handling the wastes or operating the remote equipment and to any individual who may be exposed to the wastes in the future. The facilities selected and the method envisioned are in accordance with these guidelines.

Table 5.1 records the current maximum permissible waste package surface radiation levels for each of the alternative waste disposal locations. The selection of the potential needs for shielding for this study is based on an estimate that the surface dose on a canister of dispersible debris is in the order of magnitude of 100,000 R/hr. The only facility with established radiation limits is the CWC. For the benefit of retrieval, it is planned to shield the canisters to less than a 1000 R/hr. Approximately one inch of lead shielding is needed to reduce the surface dose to 1000 R/hr. In order to achieve the normal 0.1 R/hr surface dose at the CWC, about four inches of lead shielding would be needed. Such shielding could be provided by the waste package or by the storage container. No limits for W-272 and W-349 are shown because the final storage module designs are consistent with the FRG radiation source canisters, which have doses of greater than 300,000 R/hr. The FRG canisters are expected to generate the limiting dose. No canister shielding is needed or planned for those facilities, as it will be provided by the storage module.

Treatment by vitrification would not significantly change the canister surface radiation doses. Since the wastes would be stored in the currently planned W-272, no canister shielding would be needed.

5.1.2 Waste Package Physical Design Limits

Each waste storage facility has physical design limits for the waste packages. These limits are based on the dimensions of the storage locations and the capacity of the waste handling equipment (cranes, forklifts, etc.). These design limits have been selected such that they minimize the costs for the storage facilities and the radiation doses to the operating personnel during handling of the wastes during waste emplacement and monitoring of the wastes during storage.

Table 5.1. Maximum Permissible Waste Package Radiation Levels at Contact

Alternative	Maximum Radiation Level	Package Shielding Comments
PUREX Tunnel	None formally established. One item currently stored within the tunnels is estimated to have a surface dose of about 500,000 R/hr.	Dose calculations indicate acceptable external radiation levels even with no additional waste package shielding. The addition of shielding to the waste package should simplify the retrieval of the wastes in the future.
PUREX Canyon	None formally established	The addition of shielding to the waste package should simplify the retrieval of the wastes in the future.
Central Waste Complex	0.2 R/hr maximum with special handling 0.1 R/hr normal maximum	Shielding to be provided by Type "B" Package.
Modified W-272	Designed for FRG Canister (>300,000 R/hr)	Facility to be designed for canisters having a contact radiation level of 300,000 R/hr.
W-349	Designed for FRG Canister (>300,000 R/hr)	Facility to be designed for canisters having a contact radiation level of 300,000 R/hr.
Vitrification	Designed for FRG Canister (>300,000 R/hr)	Facility to be designed for canisters having a contact radiation level of 300,000 R/hr.

Table 5.2 records the physical design limits for each of the alternative waste disposal locations. The waste package characteristics for process buildings are limited only by the standard capacities for rail cars and the process cranes. The storage railcars are 40 feet in length. The CWC package characteristics are only limited by the dimensions of the storage facility doors and the floor loading limit. The W-272 and W-349 package characteristics are being established by discussions between PNL and WHC. It appears likely that the limiting facility will be the 324 Building (i.e., the diameter of the canister transfer port from the airlock to the cask handling area or the airlock doors to the REC. The airlock transfer port is about 14 in. diameter and the airlock doors are about 6 ft wide and 18 ft high. The cask handling area/truck lock crane has a capacity of 30 tons. These limit the size and weight of shipment casks.

Table 5.2. Receiving Facility Maximum Permissible Waste Package Physical Characteristics

Alternative	Maximum Package Dimensions* (Length x Width x Height)	Package Weight	Comments
PUREX Tunnel	40' x 10' x 10'	40 tons	Railcar deliveries
PUREX Canyon	10' x 10' x 10'	40 tons	Railcar and crane capacity and building design
Central Waste Complex	10' x 10' x 10'	1 ton/ sq. ft.	Building door size
Modified W-272	15' length x 12" Diameter	System design to be based on PNL requirements	
W-349	15' length x 12" Diameter	System design to be based on PNL requirements	
Vitrification	Not established, but expected to be limited by vitrification unit.	System design to be based on PNL requirements	

*Nominal package dimensions to demonstrate the large sizes that could be stored. As described in Sections 3.3, 5.1.4 and 5.1.7, the waste packages are expected to be much smaller than these maximum dimensions to avoid undesirable waste temperatures or radionuclide contents in excess of the maximum permissible amounts.

One of the waste acceptance requirements for CWC storage⁵ is that the wastes meet the WIPP-WAC² or have a waiver. The current requirements for the WIPP and likely impacts are summarized in Table 5.3. As can be noted in a review of the table, the wastes and their packaging can be designed to meet all of the requirements except the requirement of maximum specific activity of 23 curies/liter. This requirement will need to be waived for CWC storage and ultimately for disposal at WIPP.

Table 5.3. Major WIPP Waste Acceptance Criteria and Potential Impacts on Waste Packaging

Criteria	Requirement	Potential Impacts
Waste containers	1. Noncombustible. 2. Meet DOT Type A requirements.	None
Approved containers	1. Remote-handled (RH) waste canister 2. For contact-handled (CH) wastes a standard 55-gal drum or standard waste box (SWB)	Size must be less than RH canister. Nominally 26" diameter and 10' length.
Waste package size	1. CH-TRU waste packages or package assemblies shall not exceed 12 x 8 x 8.5 ft (L x W x H). 2. RH-TRU canisters shall be no larger than 26 in. diameter by 10 ft long, including lifting pintle.	External shielded 55-gal drums may not be compatible with the 26-in.-diameter container limits. Three unshielded or internally shielded 55-gal drums can be loaded into one RH container.
Immobilization	Immobilization required if >1% by weight particulates <10 microns or if >15% is <200 microns in diameter.	Particle size analysis of dispersible debris is needed to allow evaluation.
TRU mixed wastes	1. Hazardous wastes allowed only if co-contaminants. 2. RCRA wastes must meet requirements of WIPP RCRA Part A and Part B permit applications.	Reviews of WIPP Part A and B permits needed.
Ignitable, corrosive, and reactive wastes	Ignitable, corrosive, and reactive wastes are not acceptable.	Radiolytic hydrogen gas will require control.
Waste package weight	1. 1000 lb/55-gal drum or 4000 lb/SWB. 2. TRUPACT-II payload limit is 7265 lb. 3. RH-TRU waste package weight limit is 8,000 lb.	Self-shielded package sizes will in many cases be limited by allowable weight.
Surface dose rate	1. CH-TRU drums and SWBs <200 mrem/hr at surface and 10 mrem/hr at 2 m. 2. RH-TRU waste packages <1000 rem/hr. Neutron contribution <270 mrem/hr.	Shielding will be needed for the highest activity wastes.

Table 5.3 Continued

Criteria	Requirement	Potential Impacts
Specific Activity	A limit of 23 curies/liter of waste.	This limit is well below the calculated specific activity of the dried melter feed and the dispersible debris. A waiver for storage at the CWC will be needed. It may require that the wastes be processed and diluted or shipped to the commercial repository.
Surface contamination	Removable surface contamination limits: alpha - 50 pCi (100 dpm)/100 cm ² beta-gamma - 450 pCi (1000 dpm)/100 cm ² .	Containers will likely require decontamination before shipment.
Thermal power	1. Thermal wattage limits for waste packages are contained in TRUPACT-II SARP and is 40 W. 2. RH-TRU limit is 300 W/package.	Heat loads of some of the dispersible debris will need to be measured and controlled to stay within these limits.
Gas generation	1. No sealed containers >1 gal. 2. Various requirements for volatile organic compounds (VOCs). 3. Chemicals/materials >1wt% must be evaluated for compatibility with waste form and TRUPACT-II materials. 4. Real-time radiography or equivalent examination plus visual characterization for 10 specific materials. 5. Waste containers with waste that could potentially generate gases shall be vented. 6. All waste packages shipped in TRUPACT-II require filters that meet specifications listed in TRUPACT-II SARP. 7. Cannot exceed 50% of the LEL for hydrogen and methane gases in any layer of confinement.	1. Vented containers are necessary. 2. No VOCs present. 3. Most likely compatible. 4. Examination or documentation of canister contents may be required. 5. Packaging must consider venting requirements. Venting requirements for RH-TRU shipping containers not yet defined. 6. Packages most likely not to be shipped in TRUPACT-II. Filters required. 7. Control or hydrogen levels may be needed to meet specification.

5.1.3 Hydrogen Gas Generation

Radiation from the wastes reacts with water and organic materials in the wastes to produce hydrogen and oxygen. Preliminary calculations for the dispersible debris indicate that with sufficient water availability, the gas generation rates could exceed 8 liters/hr/canister. The lower flammability limit for hydrogen is 4% in air, and the lower explosive limit is 18% in air; either concentration could rapidly occur in a waste container with high gas generation rates. However, it has also been calculated that the high hydrogen generation rate could not be sustained since it would deplete the hydrogen source material rapidly. For example, if there were 5% water and organic in the waste and generation occurred at the 8 liter/hr rate, then it would only take about a month for all of the water to be dissociated and effectively removed. Most of the removal is expected to occur during the holding period within the 324 Building before the wastes are shipped to the 200 Areas. It is recognized that the generation rate will decrease rapidly with time and will not be a continuing problem in the storage system. The CWC requires NUCFIL filters be used with gas generating wastes and hydrogen-oxygen recombiners, if there is a potential for hydrogen gas generation in a waste package. It was assumed that our waste packages would also contain a filter and a recombiner to maintain the hydrogen concentration at a safe concentration.

There is also concern about hydrogen gas buildups within the interim storage facility. Conditions must be maintained within the facility so that hydrogen levels do not increase to a dangerous condition. Recombiners will prevent a hazardous condition within a canister; however, if there is a material that getters the oxygen in the canister, then hydrogen may be released from the canister and such hydrogen would need to be considered in facility operations. Most of the facilities would have air flow in them to remove a reasonable amount of hydrogen. The current plan for the PUREX Tunnel is not to have an active ventilation system. Calculations again indicate that even with 5% water in the wastes that the tunnel would only obtain a maximum concentration of a little over 1% hydrogen if all of the hydrogen was released in the tunnel and there was no diffusion of hydrogen from the tunnel. The radiolysis of existing materials (e.g., railroad ties) and moisture within the tunnels has not yet been considered. Based on our preliminary calculations it appears that hydrogen from our wastes would not be a major safety concern and that hydrogen generation will not limit the choice of the storage location, however additional analyses and review of current analyses will be needed before movement of the wastes.

5.1.4 Waste Temperature Limits During Storage

Radiation absorbed in a waste package heats the waste. The equilibrium maximum temperature at the center of the waste package depends on the package dimensions, the thermal conductivity of the waste, the radiation levels, and the heat transfer characteristics of the waste package surface and the surrounding air flow and support structures. The maximum permissible temperature depends on the characteristics of the waste and is usually selected to be low enough to prevent melting, thermal decomposition, or significant outgassing of the waste. Preliminary calculations indicate that centerline temperatures of 200-250 °C could be obtained for the dispersible debris and the dried melter feed. Heat generation would not be a concern for the liquid metal seal or the oil absorption material. These temperatures should be acceptable for the wastes in any of the facilities. An overall heat transfer analysis for the PUREX tunnel would be needed because of the anticipated shut down of the ventilation system and the potential for heat buildup within the facility. Additional thermal calculations will be needed to verify the acceptability of the final configuration to be used for the waste storage.

5.1.5 Risks to Workers and the Public

This section describes the calculations of worker and public risks from: continued storage of wastes in 324 Building, the packaging of the wastes, the transportation of the wastes to the 200 Area, the receipt and handling of the wastes, and the continued waste storage in the 200 Area facility. A 25-year period is considered for all of the alternatives. Table 5.4 provides estimates of the worker and public risk associated with the six alternatives. This table shows that risks will generally be lowest for those alternatives that move the wastes from the 324 Building in the near term. Risk to the public, in particular, is dominated by the duration of storage in the 300 Area, because of a low-probability seismic accident scenario, which carries high consequences due to the proximity of the city of Richland to the 300 Area.

Table 5.4. Risk Estimates for Alternatives in Total Fatalities in the 25-Year Period

Alternative/Location	324 Building Storage	324 Building Processing	Transport to 200 Areas	200 Area Receiving	200 Area Storage	Total Risk
#1 - PUREX Tunnel						
Worker	0.006	0.0086	0	0.008	0.018	0.04
Public	0.002	0.00086	0	0	0.00002	0.0029
	1 year	1 year	13 shipments	1 year	22 years	
#2 - PUREX Canyon						
Worker	0.006	0.0086	0	0.008	0.062	0.084
Public	0.002	0.00086	0	0	0.00022	0.0031
	1 year	1 year	13 shipments	1 year	22 years	
#3 - CWC						
Worker	0.003	0.0086	0	0.008	0.032	0.051
Public	0.001	0.00086	0	0	0.0023	0.0041
	0.5 years	1 year	6 shipments	1 year	22.5 years	
#4 - Modified-272						
Worker	0.024	0.0086	0	0.008	0.027	0.067
Public	0.008	0.00086	0	0	0.0019	0.011
	4 years	1 year	14 shipments	1 year	19 years	
#5 - W-349						
Worker	0.03	0.0086	0	0.008	0.025	0.072
Public	0.01	0.00086	0	0	0.0018	0.013
	5 years	1 year	14 shipments	1 year	18 years	
#6 - Vitrification						
Worker	0.018	0.0086	0	0.008	0.014	0.17
Public	0.006	0.00086	0	0	0.002	0.0089
	3 years	1 year	12 shipments	1 year	20 years	

The highest estimated worker risk is for the five above-ground storage options. This risk is dominated by the assumed higher worker risk for above ground storage in the 200 Area and by the length of time waste is maintained in the 324 Building before it can be moved.

The highest estimated public risk is for three of the above-ground options; this risk is strongly dominated by higher public risk for storage in the 324 Building and the length of time the waste stays in the 324 Building.

Of the various assumed risks, those for 324 Building operations and worker risk from transportation have some calculational basis tied to data in the SAR or previous studies of transportation risk. The other estimates are simply based on engineering judgment at this time, and are subject to modification when additional information becomes available.

324 Building Worker Risk and Public Risk

The source for data and analysis on 324 Building risks is the Draft 1992 Safety Analysis Report,⁶ with some additional information on normal industrial occupational safety statistics.⁷

National Safety Council data for 1993 gives raw fatality rates for various classifications of workers. The overall average rate is 8 fatalities/100,000 workers per year; the corresponding rate for manufacturing workers is 4 per 100,000 per year and for government workers is 11 per 100,000 per year.

In addition, information from the DOE SPMS data base shows four Hanford Site fatalities in the years 1990-1994; assuming an average workforce of 15,000 during that time period would lead to an estimate of 6.6 fatalities per 100,000 per year. Assuming that only 5,000 of the Hanford Site employees are exposed to industrial hazards would lead to an estimate of 20 fatalities per 100,000 per year.

For estimating occupational fatalities rates for 324 Building operations, we assumed a raw rate of 4 fatalities per year per 100,000 workers and assumed 50 324 Building employees exposed to that hazard for a total risk of $2.0\text{E-}3$ 324 Building fatalities per year from normal industrial hazards.

On top of the normal industrial hazards, we computed impact on 324 Building and 300 Area workers and on the public from certain 324 Building accidents analyzed in the Draft 324 Building SAR.

The bounding accident is a design basis earthquake with a simultaneous (or concomitant) process upset. The associated frequency of occurrence is $3.1\text{E-}5/\text{year}$. The consequences calculated in the SAR are an exposure of 6.9 rem, for a person in North Richland. Assume that 10,000 people in North Richland are exposed to 6.9 rem for a total population exposure of $6.9\text{E}4$ person-rem. Using the standard conversion factor of $5\text{E-}4$ latent cancer fatalities (LCFs) per person-Rem of exposure, we obtain consequences of 34.5 LCFs for this accident. Since the frequency of occurrence is $3.1\text{E-}5/\text{year}$, the overall risk to the public from this accident is $1.1\text{E-}3$ LCF/year.

Similarly, we can estimate the worker risk from this accident. Since it occurs suddenly and unexpectedly, we will assume that there are about 20 fatalities from the 324 Building operations personnel in the accident and, using calculation exposures from the SAR, assume that 25% of the 2,500 300 Area workers are exposed to 50 rem from the resulting plume of radioactive material. This results in 31,250 person-Rem of exposure and 12.5 LCFs, with a corresponding risk of $3.9\text{E-}4$ LCFs/year and $20 \times 3.1\text{E-}5 = 6.2\text{E-}4$ acute fatalities per year.

For both worker and public risk, we double the estimates derived from the above calculation to account for 1) the assumption that 324 Building operation is more hazardous than average industrial hazards, 2) the other accidents analyzed in the SAR, and 3) the fact that a spectrum of beyond design basis earthquakes can occur with lower frequencies but potentially higher consequences, as well as more frequent earthquakes with smaller, but still significant consequences.

Transportation Risks

Estimates of the frequency and severity of transportation accidents were obtained from the WHC transportation report.⁸ We use a value of $2.5E-7$ accidents per vehicle-km (derived from Table 4-6, Reference 7) and a conditional probability of $1.84E-3$ that such an accident will be Severity 3 or greater (that is, an accident severe enough to damage the cask and release a significant fraction of the cask contents). In addition, we assume each trip with cask is 30 km one-way and arbitrarily assume 1 worker death per event and zero public health impact. The resulting transportation risks are four or five orders of magnitude smaller than other contributions to the total risks; they are therefore shown as zero in Table 5.4.

300 Area Processing and 200 Area Receiving Risks

For the time being, we are arbitrarily assuming fixed worker and public risks associated with the processing required in the 300 Area to prepare the wastes and load them for transport and similarly for the worker and public risks associated with the 200 Area receiving and emplacement of the wastes. These assumptions are:

	300 Area Processing	200 Area Receiving
Worker risk	0.0086	0.008
Public risk	0.00086	0

200 Area Storage Risks

These risk estimates are also somewhat arbitrary, being based upon assumptions about the incremental worker radiation dose due to monitoring and maintenance of the stored wastes. These assumptions are:

PUREX or B-Plant		
worker risk	0.0028 fatalities/yr (500 mrem/yr dose to 10 workers)	
public risk	1.0E-5 LCF/yr	
PUREX tunnels		
worker risk	0.0008 fatalities/yr (200 mrem/yr dose to 5 workers)	
public risk	1.0E-6 LCF/yr	

Above-ground buildings

worker risk	0.007 fatalities/yr (500 mrem/yr dose to 25 workers)
public risk	1.0E-4 LCF/yr

5.1.6 Conformance to Regulatory Requirements

This section addresses the Resource Conservation and Recovery Act (RCRA) and National Environmental Policy Act (NEPA) status and needs for each alternative.

5.1.6.1 Overview of RCRA and NEPA Requirements

Designation, classification, treatment, transportation, storage, and disposal options all are impacted by statutory and regulatory requirements. All of the alternatives considered in this study share several regulatory compliance issues that must be considered during the selection and implementation of any of the proposed actions. The RCRA is the statutory basis for managing hazardous and mixed waste at the Hanford Site. The EPA has been given the responsibility for implementing the Act, but has the authority to delegate that responsibility to the various states. The State of Washington has been delegated authority for implementing the Act in the state. The 324 Building Mixed Waste Compliance Report¹ has a more detailed discussion on the RCRA's requirements that are driving the development and analysis of these alternatives.

Almost every project undertaken by the DOE requires some form of NEPA evaluation. Any of the alternatives discussed in this study will require analysis under NEPA. NEPA requires an agency planning a project to determine if it is a major action that could significantly affect the environment. If it is, the agency must prepare an environmental impact statement. For those actions which may not be considered "major" or for which there may not be a significant effect to the environment, an environmental assessment may be used in order to determine either that an EIS is required or that there will not be a significant impact from the activity (finding of no significant impact [FONSI]). Following promulgation of its NEPA regulations, DOE adopted the use of categorical exclusions (CX). For some routine actions, DOE, like other agencies, has determined that such actions by their very nature are categorically excluded from the NEPA documentation requirements. Before the use of these exclusions, DOE utilized what was called "Memorandum-to-File" (MTF) reviews for such actions. The specific scope of the NEPA documentation required for the alternatives varies with the scope of that alternative and is discussed below by operational activities.

5.1.6.2 General Collection and Packaging

Collection and packaging of the materials in 324's hot cells have already been addressed in a NEPA document. In 1990, the DOE approved an MTF, certifying that hot-cell cleanout activities in the 324 and 325 Buildings are excluded from the need for further NEPA evaluation. Specifically, the MTF covers "Cleanout and decontamination for future use of Building 324 hot cells A and B.... Hot-cell cleanout and waste packaging techniques will be dictated by the contamination levels and types found in each cell." The MTF goes on to further define what cleanout and decontamination mean:

"The Cleanout effort involves: 1) removal of obsolete equipment which was previously used for radiochemical processing demonstrations and nuclear waste form characterization; 2)

decontamination of the floors, walls, and ceilings of the emptied hot cells; 3) packaging and transfer of low-level radioactive mixed and transuranic waste generated from cell cleanout and decontamination to disposal or storage at the Hanford 200 Area; and 4) packaging of special-case waste for removal at some future date."

The special-case waste (SCW) referred to in this MTF includes some of the materials being considered for removal in this study. Since DOE promulgated its NEPA procedures as rules in 1992, MTFs are no longer used. However, those approved before the adoption of the DOE NEPA regulations are still considered valid.

In addition to NEPA considerations, RCRA will also impact the packaging of the materials. RCRA specifically requires proper labeling and identification of package contents. RCRA regulations found in 40 CFR 262.30 - 34 place packaging and labeling requirements on DOE and PNL. These labels and marks include proper Department of Transportation (DOT) shipping names, content descriptions as well as accumulation date(s). These requirements complement the transportation requirements discussed below.

5.1.6.3 Vittrification of Waste

If vittrification is to be used to treat the wastes prior to storage and disposal, significant regulatory issues surface. The existing NEPA documentation (MTF, CX, etc.) that can be used for collection and packaging discussed above would probably not be applicable. The MTF and the potential CXs all address R&D and "testing" sorts of systems. The treatment through vittrification would need to be considered R&D to qualify. Development of an environmental assessment would be required, and DOE-RL may even consider such treatment activities to rise to the level of an EIS. The Appendix to the DOE NEPA regulations identifies construction and operation of a facility to treat HLW and/or spent fuel as the type of action that would typically require an EIS. This discussion appears to address a new TSD facility and not the short-term, small-scale operation needed in B-Cell; however, the similarity between that action(s) and what would be required to vittrify the solids in B-Cell supports the need to prepare an environmental assessment.

Vittrification of the wastes would normally be considered "treatment" under RCRA. Treatment by generator (TBG) or treatment under a Part B are the two methods that can be considered under RCRA to allow vittrification. The TBG exemption requires the treatment to be accomplished in a tank or in a container. A process such as in-can melting may thus be applicable; however, the guidance issued on the use of the TBG exemption specifically prohibits treatments such as incineration or other treatments that generate high heat. Thus it is uncertain that vittrification could qualify as a TBG. WDOE has indicated a negative opinion toward issuing a Part B permit for the 324 Building. It is anticipated that it would take 4-6 years and a significant cost to obtain a treatment permit, if one could be obtained. Thus the only real option is to seek TBG agreement without a high probability of success of obtaining the agreement.

5.1.6.4 Transportation

There are several regulatory requirements applicable to transporting RH mixed waste and radioactive waste. On-site shipments of waste will still require NEPA analysis and coverage. For waste determined to be LLW and not SCW, the MTF currently in existence for cleanout of the cells includes transportation to a 200 Area storage facility. Thus, no additional NEPA coverage is required for those materials. However, most materials being addressed by this study are considered SCW and their

transportation is excluded under the MTF. The current position from DOE-RL is not quite clear on the level of documentation and analysis required for shipment of such waste. However, language from the DOE NEPA regulations indicates that transportation may be covered if the categorical exclusion is used. The NEPA regulations state:

"A class of actions includes activities foreseeable necessary to proposals encompassed within the class of actions (such as associated transportation activities and award of implementing grants and contracts)..." 10 CFR 1021.410(d)

If it is determined that the cleanout does not come under the B6.1 categorical exclusion, then the transportation issues would have to be included in the environmental assessment.

In addition to NEPA, the shipping casks or packages would need to meet the performance and design requirements for the Hanford Site. If the shipment containers met the requirements in 10 CFR 71, "Packaging and Transportation of Radioactive Materials," the shipment can be made without site controls. With site controls, licensing by the NRC would not be required. In addition to the 10 CFR 71 requirements, the DOT has adopted regulations applicable to transporting hazardous materials (49 CFR, parts 100 - 199, *Transportation*). The DOE has chosen to comply to the extent possible with the DOT regulations that address shipping and transporting of hazardous materials.⁹ The NAC and NLI casks either have or have had NRC approvals; however, since the contents may be different from that considered in the licensing, some modifications or additional analysis may be needed.

5.1.6.5 Receiving/Storage Facility

Multiple requirements must be addressed for the facility receiving and storing the materials. Receipt and storage of the type and source of materials must have been included in existing NEPA documentation and analysis for that particular facility. None of the existing facilities which are being considered in this study have current NEPA coverage for the SCW materials. Some of the facilities would be covered to accept and store non-SCW that comes out of the hot cell. PUREX Tunnels/Canyon and the CWC have existing NEPA documentation. It is anticipated that the CWC permit will cover operation of the W-272 and W-349 projects; however, the permit may need slight modification to recognize the type and amounts of wastes that will be contained in the facilities. PUREX documents are fairly dated and cover operations at the facility that would include storage of their wastes, not others. PUREX did have an EA prepared which allowed FFTF materials to be shipped to it and stored in the facility; however, the language in the document is specific to FFTF materials and would not apply to 324 Building materials.¹⁰ Additional NEPA reviews will be needed for the PUREX options.

For the planned facilities, W-272 and W-349, an environmental assessment¹¹ is being prepared by WHC. This assessment is intended to pick up where the hot-cell cleanout MTF left off. The scope of the assessment is intended to address the safety issues that are of concern in the 324 hot cells as well as with other SCW in the 300 Area. The EA covers the construction of a facility capable of storing both radioactive waste and mixed waste, as well as the shipping, receipt, and storage of the SCW in the 300 Area. The draft EA is expected to be submitted for comment in the next few months. The analysis in this EA may be useful to support activities under other alternatives.

All of the facilities identified in this study (with the exception of those not yet constructed) hold the necessary RCRA permit to accept and store mixed waste; however, some revisions to the permits will be needed in most cases to permit the additional hazardous metals identified in the 324 Building wastes.

Such revisions can generally be obtained within 6 months. According to WHC personnel, the permits are generally written to allow wastes identified in the site waste acceptance criteria.⁵ In those situations where the shipment cannot meet the criteria, a waiver can be obtained with DOE-RL approval.

5.1.6.6 Summary of NEPA and RCRA Requirements

Table 5.5 is a summary of the NEPA and RCRA status and needs for each of the alternatives. It also includes estimates of the cost and time required to meet the respective regulatory needs. Time estimates are somewhat shorter than normal with the recognition that times can be modified based on urgency of the action and the desire of the parties to complete that action.

Table 5.5. Summary of Regulatory Requirements

	PUREX Tunnel/Canyon	CWC	Modified- 272	W-349	Vitrification
NEPA	EA/FONSI Cost: \$50K+ Schedule: ~6 months	CX possible- - 1 month & \$5K Probable: EA/FONSI Cost: \$50K+ Schedule: ~6 months	SCW-EA Schedule: An EA document for W-272 has been prepared. Six months anticipated for approval Cost: \$50K	SCW-EA Schedule: An EA document for W-272 has been prepared. Six months anticipated for approval Cost: \$50K	EA/FONSI Cost: \$50K+ Schedule: ~6 months
RCRA	Permitted, but revision to Form III needed to include additional waste codes. A Part B is being prepared for the tunnels.	Permitted	Permitted as part of the CWC.	Permitted as part of the CWC.	Need TBG agreement or TSD Permit: Cost: \$200K to write, \$50- \$100K per year until approved 2-5 years

5.2 DESIRABLE ALTERNATIVE CHARACTERISTICS

This section of the report addresses those characteristics that are neither a "go" or "no-go" situation. The characteristics are discussed for each of the alternatives, and quantitative and qualitative measures have been selected to allow discussion of the alternatives. For this phase of the study, only qualitative ranking methods have been used. It is recognized that numerical methods with various weighing schemes are often used to evaluate alternatives. However, for this set of alternatives it was not considered necessary.

5.2.1 Waste Storage as Soon as Possible

Because of the desire to be in conformance with the RCRA and the closeness of the 324 Building to the Columbia River and to the city of Richland, it is desirable to move the wastes to a temporary storage location in the 200 Area as soon as possible. The recent negotiation for modifications to the TPA and the inclusion of Milestone M-89 specify that the mixed wastes be removed from the 324 Building by May 1999.

About 65% of the total wastes are expected to be collected and placed in temporary storage containers in the REC by the end of 1995, as noted in Section 2.7, which described when the wastes would be available for packaging and shipment.

The dates for the initial and final shipments from the 324 Building for the alternative storage sites are shown in Table 5.6. The initial shipment dates are determined primarily by the availability of the facilities for receipt of the wastes and construction times for future facilities. The dates for the last waste shipments are determined either by the initial availability of the facility or by the date for the final collection of the wastes in 324 Building. Currently, the completion date for waste removal from 324 Building in the TPA change request is 1999; however, the current schedule for the B-Cell project is still officially based on removal in 2000 and that date is being used in the report. This difference will need to be resolved in actions independent of this report. The B-Cell project date may be accelerated by as much as two years, depending on several factors.

Table 5.6. Time Schedules for Shipment and Receipt of RH Mixed Wastes (Calendar Years)

Alternative	#1 - PUREX Tunnel	#2 - PUREX Canyon	#3 - CWC	#4 - Modified W-272	#5 - W-349	#6 - Vitrification
Initial Waste Shipment from 324	~1995	~1995	~1995	1998	1999	1998
Last Shipment of Wastes*	2000	2000	2000	2000	2001	2000
Last Available Date for Primary Facility	~1996**	~1996**	No Specified Closure Date	No Specified Closure Date	No Specified Closure Date	No Specified Closure Date
* Schedule for waste removal could be accelerated by up to two years. ** Secondary Facility Needed						

The two scenarios using the PUREX facility require the use of a second storage location. It is currently planned to deactivate the PUREX canyon crane in February 1996. After that time waste cannot be brought into the canyon. Although it might be possible to store wastes in the PUREX tunnel after February 1996, it has been assumed that the tunnels will be transitioned at some point during 1996. Secondary storage locations could be the CWC, the Modified W-272, W-349, or even direct shipments to WIPP if it should be available on an accelerated schedule. For the interim it is assumed that the CWC will be utilized.

5.2.2 Minimize Costs

This section presents a cost comparison among the alternatives and discusses the bases used to calculate costs. The total cost for each alternative is determined by summing the cost of the following factors: treatment in 324 Building, packaging in 324 Building, transportation to 200 Area, receiving and storage at the 200 Area facility, removal from storage, repackaging for WIPP, transportation to WIPP, receipt and disposal at WIPP, and regulatory costs. These factors are discussed below. A comparison of these factors for each alternative is given in Table 5.7. As the table shows, the minimum cost options are alternatives 1 and 2.

Treatment in 324 Building. For alternative 6, the treatment cost consists of the design, construction, and operation of a small in-can melter and off-gas system. No waste treatment in the 324 building is required for the other alternatives.

Packaging in 324 Building. Two types of containers are considered in this study: a 10-inch-diameter by 6-foot-long steel cylinder (canister) and a 55-gallon drum (drum). See Section 3.3 for additional details. Two drums will be placed in one TMB III container. For alternatives 1 and 2, twenty-one shielded canisters in overpacks (\$4.7K ea.) will go to PUREX before February 1996. After PUREX is closed in 1997, five unshielded canisters in overpacks (\$4.2K ea.) will go to the CWC. These five canisters will be shipped in one special dual-use Type B container estimated to cost \$500K. Finally, the oil absorption and metal seal waste will be placed in two shielded drums (\$1K each). The two drums will be stored at the CWC in a single TMB III box (\$2K). Total packaging cost for the two PUREX options is therefore $21 \times \$4.7K$ (shielded canisters) + $5 \times \$4.2K$ (canisters) + \$500K (Type B dual-use container) + $2 \times \$1K$ (drums) + $1 \times \$2K$ (TMB Box) = \$624K.

Packaging costs for alternatives 4 and 5 are similar, except that all 26 canisters are unshielded and no special Type B container will be needed for CWC storage. Total packaging cost for these alternatives is $26 \times \$4.2K$ (canisters) + $2 \times \$1K$ (drums) + $1 \times \$2K$ (TMB Box) = \$113K.

The packaging cost for alternative 3 includes all the costs for alternatives 4 and 5, but will also include \$2,500K for the five special dual-use containers needed to store the 26 canisters at the CWC. (One dual-use container will be projected to hold six unshielded, overpacked canisters.) Thus, the packaging cost for this alternative is \$2,613K.

Alternative 6 has no 324 Building packaging costs associated with it.

Table 5.7. Life Cycle Costs for Management of 324 Building RH Mixed Wastes
(Table Entries are in Thousands of Dollars)

	#1 - PUREX Tunnel - (Post 1997 Waste sent to CWC)	#2 - PUREX Canyon - (Post 1997 Waste sent to CWC)	#3 - CWC with Dual- use Type B Packaging	#4 - Modified W-272	#5 - W-349	#6 - Vitrification
Treatment in 324	NA	NA	NA	NA	NA	\$2,000
Packaging in 324	\$624	\$624	\$2,613	\$113	\$113	NA
Transportation to 200 Area	\$477	\$477	\$168	\$432	\$432	\$399
Receiving and Storage	\$165	\$210	\$191	\$2,271	\$2,271	\$2,021
Removal from Storage	\$220	\$320	\$50	\$130	\$130	\$120
Repackaging for WIPP	NA	NA	NA	\$100	\$100	\$100
Transportation to WIPP	\$515	\$515	\$32	\$515	\$515	\$485
Receipt and Disposal at WIPP	\$422	\$422	\$365	\$426	\$426	\$394
Regulatory Costs	\$50	\$50	\$55	\$50	\$50	\$650
Rounded Totals	\$2,500	\$2,600	\$3,500	\$4,000	\$4,000	\$6,200

Transportation to the 200 Area. These costs include cask loadout costs (\$30K each), truck transportation charges (\$3K each trip, including road closures) and NAC-LWT cask rental charges (sliding scale, depending on number of days of rental). In calculating transportation charges, it is assumed that the NAC-LWT cask will hold one package consisting of two unshielded canisters placed end to end inside a steel overpack. The postulated Type B dual-use container is assumed to hold 3 packages (6 canisters).

For alternatives 1 and 2, there will be eleven cask loadout operations for the packages going to PUREX and a single loadout into the dual-use container for the packages going to the CWC. These loadouts will cost $12 \times \$30K = \$360K$. The eleven trips to PUREX will require 15 calendar days of

NAC-LWT rental. This will cost \$77.5K. Truck transportation costs will be 11 trips x \$3K/trip = \$33K. Truck transportation for the dual-use container and the TMB box will be 2 trips x \$3K/trip = \$6K. Adding these costs gives the total transportation charges for these alternatives: \$360K + \$77.5K + \$33K + \$6K = \$477K.

Alternative 3 will require 5 loadouts into 5 dual-use containers = \$30K/loadout x 5 loadouts = \$150K. The cost of transporting the 5 containers and one TMB box is 6 trips x \$3K/trip = \$18K. Total transportation cost for this alternative = \$150K + \$18K = \$168K.

Alternatives 4 and 5 will require 13 loadouts and 13 trips for the canisters at a cost of (\$30K/loadout x 13 loadouts) + (\$3K/trip x 13 trips) = \$429K. In addition, 1 trip will be needed to transport the TMB to the CWC (\$3K). The total cost for these alternatives will be \$432K. Alternative 6 is similar to 4 and 5, except that only 12 loadouts will be required due to the smaller waste volume. Thus alternative 6 will cost \$399K.

Receiving and Storage. These costs cover facility modification or construction, if applicable, unloading and handling costs at a facility, and any charges assessed for storing waste.

For alternative 1, eleven cask unloading operations at PUREX will be required. At an estimated cost of \$10K for each unloading operation, this will cost \$110K. The handling cost at the CWC for the dual-use container is estimated to be \$10K. It is assumed there will be no charge for handling the TMB III. Storage costs at the CWC are based on waste volume. The volume of a dual-use Type B container is estimated to be 126 ft³, the volume of a TMB is 112 ft³. Assuming that the CWC storage charge is \$190/ft³, storage costs at the CWC will be 190 x (1 x 126 + 1 x 112) = \$45K. Thus the total receiving and storage charges for alternative 1 are \$110K (cask unloading) + \$10K (dual-use container) + \$45K (CWC storage) = \$165K.

Alternative 2 is the same, but there will be an additional charge of \$45K to cover the cost of moving equipment into the tunnel to free up space for storing waste. The cost for alternative 2 is therefore \$210K.

For alternative 3, five dual-use containers and one TMB III will be required, for a total storage cost of 190 x (5 x 126 + 1 x 112) = \$141K. The handling charge for the 5 dual-use containers is \$50K, assuming \$10K for each handling operation. Total cost for this alternative is \$141K + \$50K = \$191K.

Alternative 4 will require changes to the mission of W-272 to include storage of mixed wastes. Because this would have significant impacts on safety, design, and approved NEPA documentation and DOE approval documentation, only rough cost estimates for this alternative are possible, but costs should be similar to alternative 5. Facility costs for alternative 5, construction of a new mixed waste storage facility (W-349), have been based on the contract for the FFTF spent fuel storage. These costs have been estimated at \$250K for each storage cask and a facility design and construction cost of about \$1,000K. With this basis, the cost of constructing W-349 and a modified W-272 would be on the order of \$2,250K, assuming that five storage casks are required. In addition to these costs, \$21K (\$190/ft³ x 112ft³) will be needed for storage of the TMB at the CWC. Total receiving and storage costs for these alternatives are \$2,271K.

Alternative 6 is similar to alternatives 4 and 5, but since only four storage casks will be required, the receiving and storage costs for this alternative would be reduced to \$2,021.

Removal from Storage. For alternative 1, because removal of wastes from the tunnel will involve removal of all of the wastes from the transistioned facility, it is assumed for purposes of this analysis that waste retrieval costs would be twice as high as the original storage costs. For alternative 2, it is further assumed that the removal from the PUREX canyon will also be during the final decontamination and decommissioning of the PUREX facility. Removing waste at this time would incur an estimated incremental cost of \$100K. For alternative 3, removal costs would be \$50K, assuming a handling cost of \$10K for each dual-use container. For alternatives 4 and 5, 13 cask loading operations would be required. At an assumed cost of \$10K for each loading operation, the total cost would be \$130K. For alternative 6, with only 12 packages to be loaded, the cost would be \$120K.

Repackaging for WIPP. In order to meet the 1,000 R/hr WIPP dose rate limit, the waste for alternatives 4, 5, and 6 will have to be put in overpacks with shielding. This cost is estimated to be \$100K for each of these alternatives. Alternatives 1, 2, and 3 are packaged with shielding in the 324 Building and costs for shielding are included in the 324 Building packaging costs above.

Transportation to WIPP. This cost item consists of the following:

- (a) Labor and permit charges for (1) NAC-LWT cask shipments to WIPP with pickup and drop-off costs and/or (2) legal weight truck (LWT) shipments for TMBs and/or (3) over-weight truck (OWT) shipments for the dual-use containers.
 - Alternatives 1, 2, 4 & 5: 13 NAC-LWT and 1 LWT shipment = \$142K
 - Alternative 3: 5 OWT shipments and 1 LWT shipment = \$32K
 - Alternative 6: 12 NAC-LWT shipments and 1 TMB = \$132K.
- (b) NAC-LWT cask rental charges.
 - Alternatives 1, 2, 4 & 5: 115 days = \$373K
 - Alternatives 3: 0 days = \$0K
 - Alternative 6: 107 days = \$353K.

Receipt and Disposal at WIPP. The assumption is made that the receiving and handling charges at WIPP are \$10K for each NAC-LWT package and each dual-use container. It is also assumed that WIPP will charge \$5K for each TMB.

Disposal costs are assumed to be \$75K/m³ for the RH waste in canisters and \$25K/m³ for CH waste in drums. Using a burial volume of 0.144 m³ for each canister and 0.2 m³ for each drum, the unit burial costs are \$10.8K/canister and 5K/drum. Canisters will not be removed from the dual-use containers. This implies that the burial cost per unit volume for the dual-use container will be lower even though the burial volume will be higher. For the purposes of this study, it will be assumed that the burial cost of a dual-use container is \$60K. Using all these assumptions, the receiving and disposal costs for the various alternatives are:

Alternatives 1, 2:	Handling: (11 NAC-LWT packages + 1 dual-use container) x \$10K + (1 TMB) x \$5K = \$125K
	Disposal: (21 canisters x \$10.8K/canister) + (1 dual-use container x \$60K) + (2 drums x 5K/drum) = \$297K
	Total: \$422K

Alternative 3: Handling: $(5 \text{ dual-use containers} \times \$10K) + (1 \text{ TMB} \times \$5K) = \$55K$

Disposal: $(5 \text{ dual-use containers} \times \$60K) + (2 \text{ drums} \times \$5K/\text{drum}) = \$310K$

Total: \$365K

Alternatives 4, 5: Handling: $(13 \text{ NAC-LWT packages}) \times \$10K + (1 \text{ TMB} \times \$5K) = \$135K$

Disposal: $(26 \text{ canisters} \times \$10.8K/\text{canister}) + (2 \text{ drums} \times \$5K/\text{drum}) = \$291K$

Total: \$426K

Alternative 6: Handling: $(12 \text{ NAC-LWT packages}) \times \$10K + (1 \text{ TMB} \times \$5K) = \$125K$

Disposal: $(24 \text{ canisters} \times \$10.8K/\text{canister}) + (2 \text{ drums} \times \$5K/\text{drum}) = \$269K$

Total: \$394.

Regulatory Costs. The estimated regulatory costs for each alternative are given below

Alternatives 1, 2: \$50K (EA/FONSI)

Alternative 3: $\$5K \text{ (CX)} + \$50K \text{ (EA/FONSI)} = \$55K$

Alternatives 4, 5: \$50K (EA)

Alternatives 6: $\$50K \text{ (EA/FONSI)} + \$600K \text{ (RCRA - \$200K} + \$100K/\text{yr} \times 4 \text{ years)} = \$650K$ (This assumes that an EIS (\$500K) will not be needed).

5.2.3 Minimum Impacts on Other Hanford Activities

This section addresses programmatic impacts that may result from the implementation of alternatives on activities and programs in the 324 Building, the receiving facility, and other Hanford activities. The impacts are summarized in Table 5.8.

5.2.4 Minimize Generation of Secondary Wastes

The secondary wastes are expected to be low-level wastes (LLW) generated primarily by operation and disposal of special equipment for treatment of the wastes in B-Cell or generated during placing the wastes in containers and then in the transportation casks. This study does not include the secondary wastes generated during the cleanup of the B-Cell and placing the wastes in temporary storage in the B-Cell.

Table 5.8. Programmatic Impacts on Other Hanford Activities

Alternative	324 Building	Receiving Facility	Other
#1 - PUREX Tunnel	Early removal of the wastes would allow timely resolution of the B-Cell RCRA and safety issues and would allow use of the REC for other activities such as support of TWRS processing.	The increased radionuclide inventory may make it necessary to increase documentation for transition. It may impact the final D&D of PUREX.	
#2 - PUREX Canyon	Same as above.	Same as above.	
#3 - Central Waste Complex	This option would allow transfer of the wastes as they can be collected and packaged and allow timely resolution of the B-Cell RCRA and safety issues and maximize the availability of the REC.		Use of available space for these wastes may have a minor impact on the availability of space for other wastes.
#4 - Modified W-272	Modification of the current W-272 scope has a potential to result in the delay of the project, which may delay the removal of other wastes from the REC.	Modification of the scope and design of this project will delay the availability of storage capacity for special-case wastes.	This activity would establish a facility for SCW and RMW storage that could be shared with other Hanford programs.
#5 - W-349	This alternative would require storage in the REC for long periods of time and reduce the availability of the REC for other activities.		This activity would establish a facility for RMW storage that could be shared with other Hanford programs.
#6 - Vitrification	Would commit cell space to waste treatment activities that could provide valuable input to the TWRS program.	Would reduce the need to modify facility design to consider effects of storage of gas generating wastes.	Would provide a resource for treatment of other similar wastes.

The estimated quantity of these wastes from each of the alternatives is shown in Table 5.9. LLW is expected to be generated from: placing the wastes in the container, decontaminating those containers, and then placing them in the transportation casks. Total waste generation is estimated at one drum per shipment. Additional wastes are expected from waste vitrification. The related LLW would be primarily the used equipment, consisting of the vitrification furnace, the off-gas equipment, and the utility connections. An order-of-magnitude estimate is ten drums of low-level waste.

Table 5.9. Estimated Amounts of Low-Level Wastes

Alternative	Amount of LLW (55-gal drums)
#1 - PUREX Tunnel/B-Plant	13
#2 - PUREX Canyon/B-Plant	13
#3 - Central Waste Complex	6
#4 - Modified W-272	14
#5 - W-349	14
#6 - Vitrification	22

5.2.5 Packaging Wastes in a Form Acceptable for Repository Disposal

It is expected that these mixed wastes will be eventually retrieved from the interim storage facilities in the 200 Area and shipped to either the commercial spent fuel and high-level waste repository or the WIPP. If the wastes were placed in containers that meet the current waste package criteria for these repositories, the future costs for repackaging the wastes could be avoided. However, with the long period of anticipated storage, the waste package criteria for the repositories may be significantly different. Table 5.3, shown previously, contains the significant current criteria for waste packages placed in WIPP. If it is necessary to ship the wastes to the commercial HLW repository, then significant treatment and extensive characterization of the waste may be needed. The only waste forms currently acceptable at the commercial repository are borosilicate glass and spent fuel. Thus alternative 6, Vitrification, could have a significant future advantage with respect to final disposal.

The major actions that are recommended to aid in future waste acceptance are: package in less than maximum-sized containers with appropriate handling capabilities, keep heat loadings below the allowed limits, provide some shielding to reduce radiation doses to allowable levels, packages to keep the specific activity of the waste below limits, and address the hydrogen generation issues to allow transportation.

5.2.6 Minimum Cost and Risk for Subsequent Storage, Treatment and Disposal

After the wastes have been stored in the 200 Area, it is expected that they will be retrieved from the storage and shipped to either the commercial HLW repository or WIPP. Any needed repackaging or treatment could occur either at Hanford or at the permanent storage facility.

It is desirable where practical that the waste packages are designed to provide minimum cost and risk during these subsequent activities. As mentioned in Section 5.2.5, above, the packages should be packaged in a form acceptable for repository disposal. In addition, the packages (and any further storage facilities such as W-349) should be designed such that the packages can be readily retrieved from the temporary storage in the 200 Area, transferred to the transportation casks, and transferred from these casks to the repository facilities at the lowest reasonable cost and risk. This requires attention to the design of the packages and the storage facilities in the 200 Area such that the packages can be easily retrieved with minimum radiation doses. It should also be noted that repackaging to add shielding will be necessary for the unshielded containers in alternatives 4-6, and possibly alternative 3, if the storage cask cannot be shipped directly to the repository.

6.0 UNCERTAINTIES FOR THE ALTERNATIVES

This study has required certain assumptions regarding the wastes and the waste management systems at Hanford. The use of assumptions leads to some uncertainties that may need to be addressed in further studies. It is the intent of this section to identify the information needs that should be addressed in the next phase of management of these wastes.

6.1 REQUIREMENTS FOR STORAGE IN EXISTING FACILITIES

The existing facilities considered in this study are the PUREX Tunnel, the PUREX Canyon, and CWC. While the requirements for storage in CWC are available,⁵ the requirements for storage of this type of waste in the process buildings have not been fully defined. The type of information specified for the CWC that may be needed for the PUREX facility includes: maximum permissible waste package surface radiation dose, maximum permissible waste package dimensions, maximum permissible waste package weight, and total radioactivity. This information will be obtained on the packages and maintained for future use in the retrieval and disposal of the wastes.

6.2 FUTURE WASTE DISPOSAL

Without final waste acceptance requirements and some knowledge about when the wastes could be sent to the repository, it cannot be determined what the final disposition will be. With the inability of the concentrated dispersible debris and dried melter feed to meet the specific activity limit at the WIPP, either some type of waiver will need to be granted for these high specific activity wastes, the wastes will need to be diluted with other wastes, a major fraction of the activity removed, or the wastes will need to be prepared for the commercial repository, possibly by treatment of the high activity fraction of the wastes in the Hanford Waste Vittrification Program (HWVP). The anticipated disposal location for the conforming fraction of these wastes is the WIPP repository. Waste Acceptance Criteria noted in Section 5.1.2 are based on the current WIPP requirements. However, it is recognized that the WIPP is not currently operating and one of the issues that is keeping the repository from opening is concern about the forms of the wastes that are anticipated for disposal in the repository. It has also been historical experience that the requirements for waste disposal continue to increase with time. Thus it is likely that when the wastes are removed from their interim storage location, the requirements may be quite different from those identified in this study. Future changes could make it more difficult (or possibly easier) to dispose of these wastes. Until the repositories are available and final waste acceptance requirements are in place there, uncertainties of final disposal requirements will continue to exist.

6.3 WASTE VOLUMES AND CLASSIFICATIONS

Additional characterization information and analyses are expected to be necessary for the implementation effort, where it will be necessary to determine final volumes of the wastes, actual shielding requirements, and identify specific locations for the wastes within the storage facilities. For this study the major impact of different waste volumes would be on the costs for the alternatives, but since all alternatives would be impacted in a similar manner, improvements in waste characterization information at this stage are not expected to change the overall recommendations from the study.

The volume of the remaining dispersible debris on the B-Cell floor is uncertain because it is under racks and equipment and must be estimated visually. The dispersible debris contains tools and other metallic materials that can be sorted out, decontaminated, and disposed of as low-level waste, thus reducing its volume and providing some potential for compaction of the dust and residuals.

6.4 HYDROGEN GENERATION RATES

The generation of hydrogen is a continual concern when materials that will undergo decomposition by radiolysis (e.g., organic materials, water, and some anions) come into contact with highly radioactive materials. It was recently a major issue for the handling of ion exchange materials from K-Basin.¹² It was assumed for this study that the use of vents and recombiners would eliminate major concerns about hydrogen generation. This issue should be revisited with additional analysis related to the specific location where the wastes will be stored and the measured generation rates from the wastes.

Water and organic materials subject to high levels of radiation decompose to produce hydrogen and oxygen and miscellaneous organic gases. Hydrogen mixed with oxygen or air is of particular concern because the lower flammability limit is 4% hydrogen and the lower explosion limit is 18% hydrogen. Estimating the actual lower limit in a canister is difficult because the explosion limit varies with the temperature and concentration of the oxygen. It is not known what the oxygen concentration will be within containers because radiolytic oxygen (often as peroxide) may be reacting with the other components of the dispersible debris and dried melter feed.

An additional uncertainty is the concentration of hydrogenous materials in the waste and how long hydrogen would be generated before the source is destroyed. Preliminary calculations indicate that the hydrogen generation rate could be several liters per hour, assuming that a significant hydrogen source exists in the waste. If the hydrogen were generated at that rate, the canister would rapidly fill with hydrogen, and the potential source of hydrogen can be rapidly depleted. Hydrogen measurements are anticipated to be made on the waste canisters in the 324 Building as part of their characterization before shipment to the storage facility.

6.5 THERMAL PROPERTIES OF THE DISPERSIBLE DEBRIS

A requirement for design of the waste packages is that the maximum temperature of the waste not exceed a maximum permissible temperature. The centerline temperatures of the waste containers depend primarily on the thermal conductivity of the wastes and the radioactivity levels which correspond to heat generation levels. Neither of these values is known precisely. For thermal calculations the assumption has been made that the thermal conductivity is similar to calcined wastes, which is expected to be conservative. The use of a low value of thermal conductivity can result in the requirement of a smaller canister diameter than is necessary. This could increase the number of canisters required, the number of waste shipments, and both the costs and risks for the waste shipments. Overestimation of the thermal conductivity could result in higher than expected centerline temperatures and sintering of the waste materials and the generation of gases. Thermal measures of the wastes in canisters would improve the information available and reduce uncertainties in thermal calculations. It would also aid in verifying that the heat loads within the canisters are acceptable.

6.6 SCHEDULES FOR WASTE GENERATION AND FACILITY CLOSURE

The currently anticipated waste collection schedule was given in Section 3.7. This schedule is based on the current schedule for the Hot Cell Cleanout, which is subject to change due to technical breakthroughs or problems, programmatic revisions, and funding availability. These changes could accelerate or delay the availability of the wastes.

6.7 COST ESTIMATES

Current cost estimates have high uncertainty (probably a factor of 2 for overall costs) because they are based on preliminary information. The cost uncertainties result from the uncertainties for the design of the containers, the volumes of the wastes, the shielding required for the containers, the designs of casks required for the waste shipments, the number of shipments, the need for hydrogen recombiners in the waste packages, the necessary sizes for those recombiners, the need and costs for alterations of the storage facilities to accommodate the wastes, the required design for future waste shipments to the repositories, and the design and cost for the waste vitrification equipment. These uncertainties will need to be further addressed in the implementation of the selected alternative.

6.8 STORAGE PERIOD REQUIREMENTS

The length of the storage period for the wastes depends on the date of future availability of disposal at WIPP and/or the commercial repository, the final D&D of the storage facility, and the need for and availability of a waste treatment facility. None of the dates have been firmly established and are subject to future modification. The availability date for shipment of Hanford mixed wastes will be determined by the initial availability for those facilities and then the priority schedule for the wastes to be placed there. Many other wastes, such as spent fuel from nuclear power plants and the retrievable stored TRU wastes, will probably have a much higher priority than these wastes at the commercial repository. Thus they may be in storage for long periods of time, possibly 30 to 50 years. Long storage periods increase the risks from the wastes and the potential for the plugging of vents and the loss of efficiency of hydrogen recombiners and other safety features. It may be possible that if the wastes go into PUREX, they may reside there during the operating period of the repository. It is anticipated that the WIPP repository will only have a 25-year operating period. If the WIPP was to open as currently projected in 1998 and it was more than 30 years before D&D of PUREX was started, then the wastes may not be available during the WIPP operating window.

6.9 WASTE RETRIEVAL FROM STORAGE AND PREPARATION FOR SHIPMENT

There have also been some proposals that process equipment and materials not be removed from the canyon facilities, but that the process facility and all of the wastes be entombed within a grout or cement fill. The inclusion of these wastes into the PUREX facilities could potentially impact the decision and future risk of entombing the facilities. It has not been possible to identify the likely inventory of radioactive wastes within these facilities and how the storage of these wastes could impact that inventory—and therefore potential future actions.

It is recommended that the wastes go into storage with the anticipation that they will be retrieved and shipped to a repository. As many of the requirements as possible should be met by packaging and characterization before the wastes go into storage, so that they can be more readily shipped when the repository is available. It is expected that the unshielded wastes from the W-272 and W-349 would need to be overpacked with shielding to allow them to meet the radiation dose requirements for the repository.

6.10 FUTURE CHANGES IN REQUIREMENTS AND REGULATIONS

Many of the equipment designs and procedures used in this study are based on the requirements in the DOE, state and federal regulations, and the TPA. The current institutional climate emphasizes reductions and consolidation of the regulations and requirements. Elimination of some of these regulations could significantly reduce or alter some of the activities necessary for shipping and storing the wastes. It currently is assumed that there will be no changes in the requirements and regulations that would have a significant effect on equipment and procedures used in this study, even though the final shipment of some of the wastes to interim storage may not occur until 2001. Based on the history of waste management it could also be expected that the requirements will continue to become more restrictive and that additional treatment of the wastes will be needed before disposal.

7.0 DISCUSSION AND SUMMARY OF EVALUATION RESULTS

This section provides a discussion of each of the alternatives and a summary of the information contained in the report. A discussion of the major advantages, disadvantages, and further actions needed for each of the alternatives is summarized in Sections 7.1 through 7.6. Section 7.7 provides a comparison of the characteristics of the alternatives.

7.1 ALTERNATIVE #1 - MOVE WASTES TO THE PUREX TUNNEL

Two of the major advantages of this alternative are that it is timely and cost-effective. The 324 Building can show significant progress in meeting the RCRA requirements for the majority of the wastes. About 65% of the wastes could be packaged and transported to the PUREX facility before it is transitioned in early 1996. The wastes will then remain in interim storage until D&D of the facility. The tunnels provide adequate access and have adequate shielding for all of the wastes. The loading method should also make it relatively easy to remove the wastes when necessary. There do not appear to be any major cost items other than transportation that will make this alternative unduly expensive. It provides a low risk to both the public and the workers since it moves the wastes from the 324 Building early, which has been considered to be the high-risk location. It also maximizes the availability of the REC for other Hanford activities.

The major disadvantage of this alternative is that a separate location will need to be established to store the remaining wastes (about 35%) when they are finally collected and packaged in B-Cell. Inclusion of the 324 Building wastes in the tunnels will significantly increase the total curie loading of the tunnels and may increase the difficulty of documentation of an adequate safety analysis report. An additional concern is that the transitioning of the PUREX facility is ahead of schedule and the schedule acceleration may not allow sufficient time to get the wastes into the facility. With the high costs of maintaining PUREX as an operating facility, delays in the transition schedule cannot be tolerated.

Major activities that will need to be completed to facilitate the acceptance of this alternative include 1) getting DOE, WDOE, and WHC agreements to support this alternative, 2) the completion of SAR, NEPA, and RCRA permit modifications, 3) the testing of the oil absorption material to determine its flammability status, and 4) arrangements for the packaging, transportation, and transfer of the wastes.

7.2 ALTERNATIVE #2 - MOVE WASTES TO THE PUREX CANYON

The major advantages of this alternative are similar to the previous alternative. The major difference from alternative #1 is that the use of the canyon facility with its high integrity concrete structure will provide better containment of the wastes and provide adequate shielding of the public and maintenance workers. The maintenance of the ventilation system would also provide enhanced safety in lessening any risk from hydrogen generation from the wastes and its buildup in the storage location. Removal of the wastes may be more difficult, but it would be much less complex than removal of the remaining equipment and piping in the canyon.

The major disadvantages of this alternative are similar to alternative #1 except that the residual radionuclide inventories are expected to be higher in the canyon than in the tunnel, and therefore inclusion of the wastes should be less of an impact on the safety of the transitioned facility. An additional disadvantage of this alternative is that modification of RCRA existing permit will be more difficult to obtain and could delay use of the facility.

The remaining activities to facilitate the storage of the wastes in the PUREX canyon are also similar to those identified for alternative #1 plus the possible need to arrange for the removal and storage of the current equipment in the PUREX canyon cells, which can be accomplished quite quickly and easily based on discussions with the facility operations.

7.3 ALTERNATIVE #3 - SHIP WASTES TO THE CENTRAL WASTES COMPLEX

The major advantages of the use of the CWC are 1) that it is the recognized storage system for mixed wastes; 2) like the two PUREX alternatives it would allow early receipt of the wastes; and 3) it could continue to receive wastes into the foreseeable future. Thus, only one facility would be needed. It could take the wastes on an early schedule if suitable casks can be identified or constructed. It may be possible to utilize some existing casks that are no longer being maintained as active commercial casks, if agreements on their use were obtained. This may reduce the current costs of this alternative and make it more attractive.

The major disadvantage of the use of the CWC is that the wastes have much higher activity than the wastes that are currently stored in the facility. This necessitates the use of the Type B casks and makes the alternative expensive. As noted above, if used out-of-service casks were sufficiently available, the costs may decrease significantly. It is also possible that the shielding requirements are not as high as anticipated and thus costs may be lower. Additional characterization of the wastes will be needed to design or select the best storage casks. The potential need to repackage the wastes following their removal from the CWC will require a hot cell complex to remove the wastes from the high-level shielding. However, it may be possible to ship some the wastes to WIPP in their Type B package which would avoid any repackaging needs. This will be dependant on the transportation requirements at the time of shipment.

The next step for implementing this alternative is identifying/designing the casks to be used for storage. This should include further evaluation of the TMB shipping containers. The NEPA requirements would also need to be reviewed. Agreements with DOE, WDOE, and WHC would also be needed for a variety of actions, including permits and funding.

7.4 ALTERNATIVE #4 - MODIFY W-272 SCOPE TO INCLUDE MIXED WASTES

The major advantage of modification of the W-272 scope is that the facility planning is well underway. It provides some schedule advantage to the start of the totally new facility (Alternative #5). It also has the advantage compared to alternatives 1 and 2, in that the wastes are more easily retrieved from their interim storage location and facility. The design of the storage facility can be customized for the actual waste streams, thus improving the handling of the wastes and reducing any transfer risks.

The major disadvantages of the modified W-272 facility are those of timing and costs. It will be three years before significant progress could be made on the removal of the wastes from the 324 Building. It will also be rather expensive with the need to design a unique storage cask and procure the storage casks in sufficient number. It would also delay the removal of other special-case wastes from the 324 Building, which is planned for the current schedule and scope of the W-272 facility.

A major activity for the continuation of this alternative is to work with a vendor to identify potential packaging methods for the wastes to minimize the size and number of storage units. Agreements on funding, revised schedules and approvals by DOE, WDOE, and WHC are also needed.

7.5 ALTERNATIVE #5 - DEVELOP A NEW REMOTE-HANDLED STORAGE FACILITY (W-349)

The major advantage of a new facility is that compatibility between the wastes and the facility is enhanced and the facility can be designed to provide the highest levels of containment and access. Also, it does not rely on any other program or project for success.

The major disadvantages of a new facility are that it will delay removal of the wastes from 324 Building and that it is rather costly. This option has the longest schedule before it could accept the wastes. It is the farthest from approval and funding and therefore has the longest schedule.

To implement this alternative would require additional efforts in getting the facility approved and funded. It will also require that the necessary permits and approvals be obtained. The cooperation of DOE, WDOE, and WHC will be necessary to establish this option.

7.6 ALTERNATIVE #6 - VITRIFY WASTES TO REMOVE THEM FROM RCRA CONTROLS

The major advantages of the vitrification alternative are that the wastes are stabilized, will present less hazard during storage, and will likely not need treatment for future transportation or disposal operations. The vitrification option would also be the option with the lowest final waste volume. Vitrification would eliminate any concerns about gas generation. It would also provide a treatment resource that may be useful to the site for treatment of other wastes.

The major disadvantages of vitrification are the need for a treatment permit (either a TBG or a Part B), the cost of installing a vitrification unit in the cells, and the delays before the wastes could be removed from the building.

The key constraint that exists for this option is the obtaining of a treatment permit. It should be a major emphasis early in any further development of this alternative. This alternative would also require the integration of efforts by DOE, WDOE, WHC and PNL to fully plan the activities and ensure that the schedule is established and followed by all parties. Future use of the treatment capabilities would also need to be agreed upon.

7.7 SUMMARY OF EVALUATION RESULTS

The significant information on the alternatives is summarized in Table 7.1. The table is a

summary of characteristics of each of the alternatives from Sections 3 and 4, a summary of the required characteristics from Section 5.1, and the desired characteristics from Section 5.2. The specific sections can be reviewed for additional details of the information that is summarized in the table.

The major focus of this report has been on the higher activity wastes (dispersible debris and dried melter feed). It is recognized that the other wastes identified in Section 2 have lower activity and will require less shielding and fewer controls in waste handling, transportation, and storage. However, for this report all of the wastes are considered to be treated in the same manner, since no major drivers were identified that would provide incentives to manage individual waste streams differently. It is possible that as the implementation effort is established that such advantages may be identified.

A review of the alternative characteristics in Table 7.1 shows that there are significant differences in the design and operation of the various alternatives. The two alternatives utilizing PUREX will be able to move the majority of the wastes into PUREX but will need a supplemental facility to take the residual wastes that will be collected in the later years. The CWC or the W-272 facility are considered for that supplemental facility at this time. Other options may also be possible and can be the subject of additional analysis while allowing progress in the near term. It can be noted that the vitrification option will provide volume reduction of the wastes and minimize the number of containers, whereas the need to provide shielding for the waste containers in the existing facilities results in a slightly larger number of containers and the largest number of waste shipments.

The summary of the required criteria information in Table 7.1 shows that the two PUREX alternatives have the lowest risks to both workers and the public. This results from the early movement of the wastes from the 324 Building, which is an active facility, to an inactive facility in the more remote 200 Area. From a regulatory perspective, it would be the most difficult to implement the vitrification alternative. The two new facilities would also require the longest period to get the regulatory requirements satisfied. The use of the Central Waste Complex would be simplest from a regulatory perspective. The use of PUREX does not appear to be a serious regulatory problem.

The comparison of the desired characteristics in Table 7.1 includes the most significant characteristics of schedule and cost. The summary schedules indicate that the alternatives with the potential for the earliest removal of a significant fraction of the wastes are the two PUREX facilities and the Central Waste Complex. The cost estimates, however, indicate that the CWC could be a more expensive alternative with the requirement to provide Type B containers for the wastes. The use of the PUREX canyon will require that the wastes be received before the canyon crane is shut down.

With further analysis CWC may be more attractive. The current CWC alternative requires the use of commercial Type B casks. Such commercial containers are very expensive and drive the cost of this option. It may be possible to significantly reduce the cost of the CWC alternative if the TMBs that have Hanford Type B equivalent approvals could be reanalyzed to allow much higher radiation limits for the boxes or if the existing old spent fuel casks could be used. An analysis on the use of the TMBs is currently being done for several cesium capsules for which treatment is also being considered. The success of this analysis is highly questionable for dispersible debris and dried melter feed wastes with the current inability to treat them to improve their stability and reduce their dispersability.

With the characteristics of the ability to remove most of the wastes from 324 Building by the end of 1996, low costs, low risk, and minimum impacts, the PUREX canyon and tunnel alternatives are the most attractive.

Table 7.1. Summary of Alternative Evaluation

	PUREX Tunnel and CWC	PUREX Canyon and CWC	Central Waste Complex	Modified W-272	New Facility W-349	Waste Vitrification with W-272
<u>Alternative Characteristics</u>						
Solid Waste Treatment	None	None	None	None	None	Vitrification
200 Area Storage Facilities						
Primary Facility	PUREX Tunnel	PUREX Canyon	CWC	Modified W-272	W-349	W-272
Secondary Facility	CWC	CWC	None	None	None	None
Percent of Wastes to Primary Facility	~65%	~65%	100%	100%	100%	100%
Number of 10 in. x 6 in. Canisters	26	26	26	26	26	24
Number of 55-Gal Drums	2	2	2	2	2	1
Container Shielding Utilized	1 in. Lead	1 in. Lead	None	None	None	None
Number of Shipments	13	13	6	14	14	12
<u>Required Criteria</u>						
Canister Radiation Levels	Satisfactory	Satisfactory	Type B Packaging Necessary	Satisfactory	Satisfactory	Satisfactory
Waste Package Physical Design Limits	Satisfactory	Satisfactory	Satisfactory	Satisfactory	Satisfactory	Satisfactory
Hydrogen Gas Generation	Recombiner Included	Recombiner Included	Recombiner Included	Recombiner Included	Recombiner Included	No Recombiner Needed
Thermal Stability Requirements	Appears Satisfactory, but Additional Analysis Needed.	Satisfactory	Satisfactory	Satisfactory	Satisfactory	Satisfactory

Table 7.1 Continued

	PUREX Tunnel and CWC	PUREX Canyon and CWC	Central Waste Complex	Modified W-272	New Facility W-349	Waste Vitrification with W-272
Risks to 2020, Fatalities						
Worker	0.04	0.084	0.051	0.067	0.072	0.063
Public	0.0029	0.0031	0.0041	0.011	0.013	0.0089
Regulatory Aspects						
NEPA Requirements	EA/FONSI	EA/FONSI	CX Possible	Covered under SCW-EA	Covered under SCW-EA	EA/FONSI
RCRA Requirements	Permitted	Permitted	Permitted	Permit Needed	Permit Needed	TBG or TSD Permit Needed
Time Requirements for NEPA/RCRA Actions	~6 Months	~6 Months	~6 Months	~6 Months	~6 Months	2-5 Years
Desirable Characteristics						
Schedule, Calendar Year						
Initial Waste Shipment from 324	~1995	~1995	~1995	1999	2000	1998*
Last Shipment of Wastes	2001	2001	2000	2000	2000	2000
Last Available Date for Primary Facility	~1996	~1996	Unlimited	Unlimited	Unlimited	Unlimited

Table 7.1 Continued

	PUREX Tunnel and CWC	PUREX Canyon and CWC	Central Waste Complex	Modified W-272	New Facility W-349	Waste Vitrification with W-272
Costs, \$K						
324 Building Treatment	N/A	N/A	N/A	N/A	N/A	\$2,000
324 Building Packaging	\$624	\$624	\$2,613	\$113	\$113	N/A
Transportation to 200 Area	\$477	\$477	\$168	\$432	\$432	\$399
Receiving and Storage	\$165	\$210	\$191	\$2,271	\$2,271	\$2,021
Removal from Storage	\$220	\$320	\$50	\$130	\$130	\$120
Repackaging for WIPP	N/A	N/A	N/A	\$100	\$100	\$100
Transportation to WIPP	\$515	\$515	\$32	\$515	\$515	\$485
Receipt and Disposal at WIPP	\$422	\$422	\$365	\$515	\$515	\$485
Regulatory Costs	\$50	\$50	\$55	\$50	\$50	\$650
Total Life Costs	\$2,500	\$2,600	\$3,500	\$4,000	\$4,000	\$6,200
Impact on Hanford Activities						
324 Building	Aids REC cleanup and utilization	Aids REC cleanup and utilization	Aids REC cleanup and utilization	Would delay removal of SCW from REC	Requires longer term storage of RED wastes	Commits REC to waste treatment activities
Receiving Facility	Increases radionuclide inventory	Increases radionuclide inventory	Will consume currently available CWC space	May delay scheduled availability for SCS		
Other			Will consume currently available CWC space	New facility may be useful to others	New facility may be useful to others	Treatment of other streams possible
Secondary Waste Generation - Number of 55-Gal Drums of LLW	13	13	6	14	14	22

8.0 CONCLUSIONS AND RECOMMENDATIONS

A series of alternatives was identified that appears to offer promising routes for the removal of mixed RH-TRU wastes from the 324 Building, even though there remains some uncertainty with respect to details of the wastes and their handling. Each alternative provides its own advantage and may be most attractive under specific conditions. With the current situation in the 324 Building and the desire to bring the waste storage into compliance with RCRA as soon as possible, those alternatives that provide the earliest opportunities for removal of the wastes from the REC need to be examined most closely. These alternatives are PUREX facility, the PUREX tunnel, and the use of the Central Wastes Complex. When considering the other characteristics of the alternatives (with emphasis on costs and risks), it is recommended that primary effort be focused on the two PUREX alternatives.

The major tradeoffs between the two PUREX alternatives are 1) there will continue to be some ventilation of the PUREX canyon facility, whereas the current plans do not anticipate ventilation control of the tunnel (ventilation increases the safety of storing hydrogen-generating wastes), 2) the tunnels will have a longer period for acceptance of wastes since storage within the canyon will require the use of the canyon crane, whereas wastes could be directly loaded onto a railcar and placed into the tunnel without use of the crane, 3) the canyon environment provides a higher level of containment and protection to the wastes than the tunnels, and 4) permitting of the tunnel appears to be the most straightforward and the more likely to be successfully implemented. Either option can be utilized. For the interim, emphasis will be given to the tunnel.

As a backup to the PUREX facility, we recommended that further analysis and review be performed to determine if the total curie limits for a TMB can be increased significantly so that the TMB could be used with shielded canisters within the CWC. We also recommend that the potential use of older excess spent fuel casks be further considered for use in the CWC.

It is recommended that additional data on the thermal conductivity of the dispersible debris and its potential for radiolytic gas generation be measured. Measurements of the radiation levels and chemical content are also needed to enhance the preliminary calculations done for this study. With this information further optimization of the waste package could then be performed that may further reduce the costs. As the wastes are packaged, it will be important to ensure that heating rates, radiation doses, and specific activity of the wastes will be within acceptance limits. We also recommend that both hydrogen recombiners and NUCFIL vents be incorporated into the waste packages to reduce future hydrogen problems and concerns.

Shielding of the containers so that the maximum dose is less than 1000 R/hr is also recommended for the PUREX alternatives. This will facilitate their storage, simplify future handling, and meet WIPP waste acceptance criteria. Meeting the WIPP criteria now may avoid the need for repackaging of the wastes before they are sent to the repository. The limitation on heat loading should also be controlled for the canisters. The need to meet the specific activity limits for the WIPP should also be addressed.

With the short time period before transitioning of the PUREX facility, it is recommended that a more detailed implementation effort for the use of PUREX facility be developed as soon as possible and that WHC and DOE be involved in the development and execution of that effort.

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