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HLW Interim Storage Architecture Selection Decision Report

R. B. Calmus

Westinghouse Hanford Company, Richland, WA 99352

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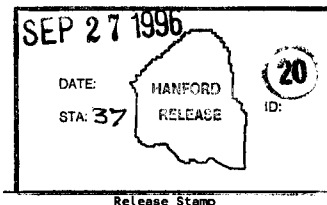
Abstract: The U.S. Department of Energy (DOE) has embarked upon a course to acquire Hanford Site tank waste treatment and immobilization services using privatized facilities. This plan contains a two-phased approach. Phase I is a "proof of principle/commercial demonstration scale" effort and Phase II is a full-scale production effort. Interim storage and disposal of various products from privatized facilities are not included in the privatization scope. Interim storage capabilities are to be DOE furnished. This document provides the decision and decision basis to provide for interim storage of Phase I high-level waste products until it can be transferred to a federal geologic repository for disposal.

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R. B. Calmus
Release Approval

9-27-96
Date



Approved for Public Release

HLW INTERIM STORAGE ARCHITECTURE SELECTION DECISION REPORT

September 1996

R. B. Calmus
Westinghouse Hanford Company
Richland, Washington

Prepared for
U.S. Department of Energy
Richland, Washington

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HLW INTERIM STORAGE ARCHITECTURE SELECTION DECISION REPORT

The following Decision Management Group Participants have participated in the HLW interim storage Decision-Making process and agree with the following HLW interim storage architecture decision:

DECISION

The Phase I HLW Interim storage concept architecture will use Vaults and 2 and 3 of the Hanford Site Spent Nuclear Fuel Canister Storage Building, being located in the Hanford Site 200 East Area, and include features to facilitate addition of one or more vaults at a later date.

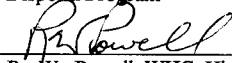
Decision Maker:
(Approval)



R. J. Murkowski, WHC, Director, TWRS Storage and Disposal Program

9/27/96
Date

Decision Board:
(Concurrence)



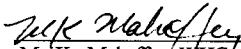
R. W. Powell, WHC, High-Level Waste Program

9/27/96
Date



K. A. Gasper, WHC, Low-Level Waste Program

9/27/96
Date



M. K. Mahaffey, WHC, Spent Nuclear Fuel Project

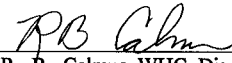
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Date



K. C. Burgard, WHC, HLW Interim Storage Project

9/27/96
Date

Decision Action
Officer:



(Concurrence) R. B. Calmus, WHC, Disposal Engineering

9/27/96
Date

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DECISION SUMMARY

The U.S. Department of Energy (DOE) has embarked upon a course to acquire Hanford Site tank waste treatment and immobilization services using privatized facilities (RL 1996a). This plan contains a two-phased approach. Phase I is a proof-of-principle/commercial demonstration-scale effort and Phase II is a full-scale production effort. In accordance with the planned approach, interim storage and disposal of various products from privatized facilities are to be DOE furnished.

The high-level waste (HLW) interim storage options, or alternative architectures, were identified and evaluated to provide the framework from which to select the most viable method of Phase I HLW interim storage (Calmus 1996). This evaluation, hereafter referred to as the Alternative Architecture Evaluation, was performed to established performance and risk criteria (technical merit, cost, schedule, etc.). Based on evaluation results, preliminary architectures and path forward recommendations were provided for consideration in the architecture decision-making process.

The decision-making process used for selection of a Phase I solidified HLW interim storage architecture was conducted in accordance with an approved Decision Plan (see the attachment). This decision process was based on TSEP-07, *Decision Management Procedure* (WHC 1995). The established decision process entailed a Decision Board, consisting of Westinghouse Hanford Company (WHC) management staff, and included appointment of a WHC Decision Maker.

The Alternative Architecture Evaluation results and preliminary recommendations were presented to the Decision Board members for their consideration in the decision-making process. The Alternative Architecture Evaluation was prepared and issued before issuance of WHC-IP-1231, *Alternatives Generation and Analysis Procedure* (WHC 1996a), but was deemed by the Board to fully meet the intent of WHC-IP-1231. The Decision Board members concurred with the bulk of the Alternative Architecture Evaluation results and recommendations. However, the Board required changes to some criteria definitions and weightings in establishing its own recommendation basis.

This report documents information presented to the Decision Board, and the Decision Board's recommendations and basis for these recommendations. The Board's recommendations were fully adopted by the WHC Decision Maker, R. J. Murkowski, Manager, TWRS Storage and Disposal.

The Decision Board's recommendation is as follows. The Phase I HLW Interim storage concept architecture will use Vaults 2 and 3 of the Hanford Site Spent Nuclear Fuel Canister Storage Building, being located in the Hanford Site 200 East Area, and include features to facilitate addition of one or more vaults at a later date.

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HLW INTERIM STORAGE ARCHITECTURE SELECTION DECISION REPORT

1.0 INTRODUCTION

The U.S. Department of Energy (DOE) has embarked upon a course to acquire Hanford Site tank waste treatment and immobilization services using privatized facilities (i.e., privately developed, financed, constructed, owned, operated, decontaminated, decommissioned, and closed). Successful bidders (i.e., vendor or team of vendors awarded a contract) are to be paid for the immobilized Hanford Site tank waste (product) after it is produced, thereby recouping their investment. This plan contains a two-phased approach. Phase I is a proof-of-principle /commercial demonstration-scale effort and Phase II is a full-scale production effort (RL 1996a).

The primary purpose of Phase I is to demonstrate the technical and business viability of using privatized facilities to treat and immobilize Hanford Site tank waste. This is to be accomplished via a demonstration facility (i.e., low-capacity immobilization plant) based on the successful bidder's design. The purpose of Phase II is to design, construct, and operate a production facility (i.e., high-capacity immobilization plant). The production facility shall provide sufficient capacity to immobilize the bulk of Hanford Site tank waste.

Solicitation of Phase I services encompasses both high-level waste (HLW) and low-level waste (LLW) demonstration plants. Although the Phase I solicitation includes the potential for two or more competing LLW demonstration plants, it infers only one HLW demonstration plant shall be procured. Moreover, the HLW demonstration plant is presented as a solicitation option.

In accordance with the solicitation of Phase I services, interim storage and disposal of various HLW products from the HLW and LLW demonstration plant operations is to be DOE furnished. Provisions must be provided for interim storage of solidified HLW until it can be transferred to a federal geologic repository for disposal. The capability to interim store the Phase I solidified HLW must be provided coincident with initial production of immobilized HLW (glass) canisters from the privatized HLW demonstration plant and cesium containers produced during treatment of feed for the privatized LLW demonstration plants. The HLW interim storage capability must be established by the scheduled radioactive startup date for the HLW and LLW demonstration plants of June 30, 2002.

To provide the HLW interim storage capability by June 2002, an early decision was needed as to the most viable (technical, cost, schedule, etc.) HLW interim storage concept and associated implementation path forward. In support of the decision process, alternative HLW interim storage concepts and associated implementation options (alternative architectures) were defined and evaluated to establish the decision basis. This document provides the information developed for use in the decision process; describes the decision process, basis, and participants; and identifies the selected HLW interim storage architecture and implementation path forward.

2.0 SCOPE AND OBJECTIVE

The scope of this document covers the selected Phase I solidified HLW interim storage architecture, architecture selection process, selection criteria, decision basis, and information used in evaluating alternative architectures. Only efforts relative to providing an architecture for Element 4.2.4.1.2, Interim Store Phase I Solidified HLW, of the TWRS system architecture is documented herein. Element 4.2.4.1.2 is defined in the *Tank Waste Remediation System Functions and Requirements (F&R)* (WHC 1996b).

The primary objective of the Phase I solidified HLW interim storage architecture selection is to provide the most viable alternative (i.e., cost effective, technically feasible, etc.). Element 4.2.4.1.2 requires that the selected architecture provide interim storage of HLW glass canisters produced by the privatized HLW demonstration plant, non-routine HLW generated by the HLW demonstration plant during operation, and cesium containers produced during treatment of feed for the privatized LLW demonstration plants. The selected architecture also shall be capable of providing additional features (functions, requirements, interfaces and architectures) in accordance with the TWRS F&R document. These features are based on information contained within the TWRS requirements database, which is the result of a TWRS program-level systems engineering analysis. This document provides traceability from the TWRS requirements database to the architecture decision. The selected architecture will be included in the TWRS database, thereby providing the basis for out-year planning relative to architecture implementation activities.

3.0 DECISION PROCESS

The HLW interim storage architecture selection was performed in accordance with the decision management system established in TSEP-9.0, *Decision Management Procedure (DMP)* (WHC 1995). The WHC DMP provides guidance relative to establishing decision objectives; developing appropriate roles and responsibilities of those involved in the decision management process; and planning, managing, and making decisions. This procedure was used in conjunction with guidance provided in TSEP-3.0, *Alternatives Generation and Analysis Procedure* (draft) and TSEP-4.0, *Risk Management Procedure* (draft). The HLW interim storage alternatives analysis and risk analysis were issued as WHC-SD-WM-SP-011, *Solidified High-Level Waste Interim Storage Alternative Analysis and Path Forward Recommendation* (Calmus 1996). Although WHC-SD-WM-SP-011 was completed before the establishment of these draft procedures, it is consistent with the guidance contained within the draft procedures.

3.1 DECISION MANAGEMENT GROUP PARTICIPANTS

The key to successful decision making is selection of appropriate individuals to be involved in the decision management. Roles and responsibilities relevant to the subject decision were developed using the following guiding principles.

- Technical staff develop the detailed technical information needed to discriminate among alternatives.
- Technical staff deliver the developed technical information to the decision maker and other decision management participants.
- The Decision Board (Decision Maker and other decision management participants) consider both technical and programmatic information to form a basis for alternative selection.
- The Decision Board recommends a preferred alternative for Decision Maker concurrence and the Decision Maker declares the preferred alternative.

Technical staff assigned to the HLW Interim Storage Program completed an evaluation of alternate Phase I solidified HLW interim storage architectures based on technical and non-technical selection criteria. This effort is documented in the Alternative Architecture Evaluation report (Calmus 1996). The technical staff submitted the Alternative Architecture Evaluation report to the Decision Board for review and followed with a summary presentation of the evaluation alternatives, assumptions, uncertainties, and conclusions. The presentation material is provided in the attachment.

The Decision Board participants and their respective roles and responsibilities are provided in Table 1. The Decision Maker was responsible for considering all relevant information developed in support of the decision-making process and for declaring the preferred selection from among the alternatives. The Decision Action Officer was responsible for preparing decision plans, obtaining concurrence for those plans from the identified Decision Maker, initiating the decision process, monitoring the decision analysis progress, announcing and documenting any adjustments required to the initial decision plans, preparing the decision analysis information for consideration by the Decision Maker, and documenting the formal decision outcome declaration. The Decision Board was responsible for reviewing information and for recommending the preferred alternative. Technical staff were selected from ongoing Hanford Site disposal projects. The Decision Board members were selected from a cross-section of TWRS Storage and Disposal Programs and the SNF Project.

**Table 1. Phase I Solidified High-Level Waste Interim Storage Architecture
Decision Management Group Participants.**

| Function | Participant/Group Represented | Working Contact |
|-------------------------|---|------------------------------|
| Decision Maker | R. J. Murkowski, WHC, Director (Level III Manager), TWRS Storage and Disposal Program | -- |
| Customer Concurrence | P. E. Lamont, RL, Storage and Disposal Project | D. D. Button |
| Decision Board | R. W. Powell, WHC, High-Level Waste Program K. A. Gasper, WHC, Low-Level Waste Program M. K. Mahaffey, WHC, Spent Nuclear Fuel Project K. C. Burgard, WHC, HLW Interim Storage Project | P. S. Schaus |
| Decision Action Officer | D. J. Washenfelder, WHC, Manager, Disposal Engineering | Delegated to R. B. Calmus |
| Technical Staff | R. B. Calmus, WHC Disposal Engineering (matrixed to HLW Interim Storage Project) | R. B. Calmus |

RL = U.S. Department of Energy, Richland Operations Office

HLW = High-level waste

TWRS = Tank Waste Remediation System

WHC = Westinghouse Hanford Company

3.2 DECISION STRATEGY AND IMPLEMENTATION

The problem statement established by the Decision Management Group is as follows:
Select HLW interim storage path forward that supports successful execution of Phase I privatization of Hanford Site high-level tank waste, based on consideration of cost, schedule, technical viability, regulatory compliance, safety, and associated risks for each of these criteria.

A comparative analysis (against established selection criteria) of the alternative HLW interim storage architectures was performed to identify technically and programmatically defensible options for Phase I HLW Interim Storage. The analysis was performed to assess important performance and risk criteria (technical merit, cost, schedule, etc.) and Stakeholder values. Preliminary recommendations relative to the viable Phase I HLW interim storage architecture and path forward (Calmus 1996) were provided to the decision management group for consideration in the decision process.

To provide the basis for sound decisions, information relative to the Phase I privatization effort and potential HLW interim storage architectures was compiled and/or generated, and comparative assessments were performed. The summary results were presented to the Decision Maker and Decision Board. The Decision Board selected a preferred architecture and submitted their recommendation to the Decision Maker who summarily approved the Decision Boards recommendation. This Decision Report includes the formal documentation of the Decision Maker's approval of the HLW interim storage architecture decision and concurrence with the contents of Decision Report (see approval page). In addition, concurrence of the Decision Board members and with the decision and decision basis presented in this report is also included (see approval page). It should be recognized that formal RL direction relative to implementation of the selected architecture is required before incorporation of this decision into the Tank Waste Remediation System (TWRS) system engineering and work planning processes. Formal RL direction will be provided from RL to Westinghouse Hanford Company (WHC) subsequent to transmittal of this Decision Report to RL.

Four decision meetings were held to allow interactions among the Decision Management Group participants. The primary focus of the first meeting was to present summary architecture analysis information. The second and third meetings were held to discuss issues, identify action items, and status previously assigned tasks. The final meeting was held to resolve comments on the Draft Decision Report.

4.0 DECISION BASIS

The basis for the HLW interim storage architecture decision is derived predominately from information provided in the WHC HLW interim storage Alternative Architecture Evaluation, WHC-SD-WM-SP-011, *Solidified High-Level Waste Interim Storage Alternative Analysis and Path Forward Recommendation* (Calmus 1996). The following information is included in the Alternative Architecture Evaluation:

- Scope and objective of alternative analysis
- Functional criteria, including functions, performance requirements, constraints, schedule, and assumptions

- Selection criteria
- Identification and evaluation of potentially viable HLW interim storage concepts including documented search and evaluation of potential HLW interim storage facilities and facility sites
- Alternative architecture evaluations including engineering feasibility study results for selected storage concept alternatives
- Evaluation and ranking relative to selection criteria
- Phase I HLW interim storage analysis conclusions and preliminary architecture selection recommendation and implementation path forward.

The Decision Board reviewed the information contained in the Alternative Architecture Evaluation and concurred that the content and level of detail were adequate to evaluate and comparably rank the alternative architectures against the selection criteria. The majority of selection criteria and rankings of alternatives provided in the alternatives analysis were also adopted by the Decision Board **with the following exception and clarification:** (1) the selection criterion definition and associated ranking method relative to schedule risk required modification, and (2) the selection criteria required further assessment to provide confidence that they encompassed all implicit and explicit stakeholder values.

4.1 SCHEDULE RISK

Each HLW interim storage architecture was evaluated and ranked relative to five selection criteria. Each major selection criterion was assigned 200 potential points, hereafter referred to as swing points. Where a selection criterion contained sub-elements, the swing points were equally allotted to each sub-element (e.g., for the case of two sub-elements each sub-element was assigned 100 points).

The schedule risk criterion presented in the Alternative Architecture Evaluation contained two sub-elements: independent project/program and concept maturity. The independent project/program sub-element, which was determined by the Decision Board to require revision, was originally based on whether an alternative was considered an independent project/program or whether it was coupled to an existing project/program. The original definition and basis for swing point allotment for this criterion was as follows:

Criterion: Schedule Risk

Sub-Element: Independent Project/Program

Sub-Element Definition: The schedule risk associated with whether an architecture, if implemented, would be an independent project/program or would be coupled to an

existing project/program. The schedule risk is minimized if an alternative is not extensively intertwined with other Hanford Site programs or projects.

Basis of Swing Point Allotment: Alternative architectures dependent on other programs are allotted zero swing points because failure to integrate with the other programs schedule could adversely impact the technical viability and/or cost of these alternatives. Alternative architectures not dependent on other programs are allotted full swing points (200 points).

The Decision Board recognized that the original ranking was performed to provide the Decision Board with a tool in developing their overall recommendation and was not intended to be the sole basis of its recommendation. Although in general agreement with most of the original ranking, the Decision Board **did not agree** that an architecture coupled to an existing program would necessarily be adversely impacted (e.g., technical or cost viability), even if the existing program was assigned a high priority and was being expedited in an accelerated schedule to that of a HLW interim storage architecture. The Decision Board was in general agreement that under some conditions the inverse of this could be true; that once coupled to a high-priority program the probability that architecture implementation will occur is significantly increased. Therefore, those alternative architectures dependent on other programs were allotted 100 points, if the board felt there was enough information to reasonably ensure that adverse impacts due to schedule mismatches would be offset by cost and technical advantage of retrofit to an existing facility.

Revision of this sub-element modified the overall ranking of the alternative architectures presented in the Alternative Architecture Evaluation. In the Architecture Analysis Evaluation, Alternative 1a, which entails retrofit of the existing Hanford Site Spent Nuclear Fuel Project (SNF) Canister Storage Building (CSB), was ranked second behind Alternative 3, which entails construction of a new CSB similar to the SNF CSB. Alternative 1a was, nevertheless, the preliminary recommendation in the Alternative Architecture Evaluation due to its low cost and high concept maturity. Numerous detailed engineering studies were available to provide a high confidence that the SNF CSB could be retrofit for a cost significantly less than implementation of Alternative 3. The Schedule Risk Criterion revision invoked by the Decision Board repositioned Alternative 1a as the highest ranked alternative.

This revised ranking did not change the preliminary recommendation but only strengthened the recommendation. The revised rankings were considered in development of the Boards recommendation.

4.2 STAKEHOLDER VALUES

A stakeholder value thought to be a potentially significant differentiator between alternative architectures was the location of the facility (associated with each architecture) relative to the Columbia River. Therefore, a selection criterion was developed to embody this particular stakeholder value, included in the Alternative Architecture Evaluation, and used to rank the various architectures. The Decision Board requested that a review of stakeholder values be

performed to identify any other potential stakeholder values which could influence the subject architecture decision.

In response to the Decision Board request, WHC technical staff further assessed whether other stakeholder values (related to Hanford Site cleanup), not already embodied in the Alternative Architecture Evaluation selection criteria, could be identified as potential differentiators. An integral portion of this assessment was review of a comprehensive set of stakeholder means, objectives, and associated performance objectives. These objectives were used to derive end objectives as reflected in PNNL-10946, *Value-Based Performance Measures for Hanford Tank Waste Remediation System (TWRs) Program* (Keeney and von Winterfeldt 1996). Other than the end objective "protect the Columbia River," which is included in the selection criteria, only the end objective "reduce cost" could be a significant differentiator in the subject architecture decision. This end objective is embodied in the selection criteria "life-cycle cost" in which full swing points are allotted for low-cost architectures. This information was presented to the Decision Board and agreement reached that Hanford Site cleanup stakeholder values are fully considered in the selection criteria.

4.3 ARCHITECTURE DESCRIPTION AND DECISION BOARD RANKING

A brief description of each alternative and the Decision Board rankings is provided in this section. In addition, this section includes description of the selection criteria adopted by the Decision Board, including the new Schedule Risk criteria developed by the Decision Board, and ranking of the alternative architectures to the selection criteria. Detailed evaluation of each alternative to the criteria and assumptions used in the evaluation are provided in the Alternative Architecture Evaluation.

The alternative architectures and a brief description of each is as follows.

Alternatives 1a (Existing) and 1b (Expanded CSB)

An interim storage facility was designed and partially constructed as part of past Hanford Site efforts to immobilize HLW. This facility, termed the CSB, was developed by the Hanford Waste Vitrification Plant (HWVP) Project for vitrified HLW canister interim storage. The CSB design concept includes three shielded vaults. Each vault contains a storage tube matrix of 22 rows by 10 columns for a total of 220 steel storage tubes. Six oversized storage tubes are also provided in each vault to accommodate overpacked canisters. Each tube can hold three standard canisters.

Decay heat from vitrified HLW canisters is removed by natural convection. Cooling air is drawn through an inlet duct into a plenum which feeds a vault, flows across the tubes, and exits through an elevated exhaust stack which serves the vault. The motive force for drawing cooling air through the vault is natural convection caused by a density difference between hot air inside the vault and stack relative to cool intake air.

The CSB was partially constructed (concrete pad and wall section) when the DOE terminated the HWVP Project in 1993. The CSB was subsequently re-scoped to accommodate Hanford Site SNF interim storage. The CSB design is being appropriately modified for SNF interim storage. Construction is scheduled to commence April 1996.

The CSB structure consists of three below-grade, concrete vaults approximately 50 m wide by 55 m long by 14 m deep. An air intake and an exhaust stack are provided only for the vault planned for SNF storage. Based on the design as modified for SNF storage, each vault can accommodate 678 standard immobilized HLW canisters with a heat load of ≤ 300 W per canister (total vault heat load cannot exceed 200 kW). The heat load constraint is the result of concrete temperature limitations.

The CSB structure also contains a 41-m wide by 62-m long by 17-m tall steel shelter. The shelter provides an operating area for load-in/load-out. Mechanical, electrical, and support services are housed in a 15-m wide by 37-m long by 9-m tall metal building.

Although only one-third of the CSB capacity (one vault) is required for SNF, the SNF Project plans to construct all three vaults. All vaults will be supplied with decking, but storage tubes will not be installed in the two excess vaults. Exhaust stacks also will not be provided for the excess vaults. The balance of CSB capacity (Vaults 2 and 3) could be configured for receipt and storage of immobilized HLW canisters or separated cesium containers.

Two alternative architectures were developed based on use of the SNF CSB. Alternative 1a entails use of the two excess (southern most) CSB vaults for Phase I solidified HLW interim storage. This alternative requires modest construction beyond that planned by the SNF Project (i.e., installation of storage tubes, intake stacks, and exhaust stacks in Vaults 2 and 3). Alternative 1b involves use of CSB Vault 3 and construction of a fourth vault south of the CSB. Similar to the case for Alternative 1a, CSB Vault 3 must be outfitted for Phase I solidified HLW interim storage.

Development of Alternative 1b was based on the assumption that Vault 2 might be considered for the storage of cesium/strontium capsules. Subsequent to development and evaluation of Alternative 1b, a commitment was made by RL (RL 1996b) to formally reserve Vaults 2 and 3 for storage of Phase I HLW product. Commitment of Vaults 2 and 3 for storage of HLW obviates Alternative 1b as a viable architecture. Nevertheless, Alternative 1b was still included in the HLW interim storage architecture decision process to provide the full spectrum of possible storage options.

Alternative 2a (T-Plant), 2b (Plutonium-Uranium Extraction Plant), 2c (Fuels and Materials Examination Facility), and 2d (Washington Nuclear Plant-1 Spray Pond)

Alternative 2 entails use of an existing Hanford Site facility. For this activity, a limited number of existing facilities was culled from a broader inventory and evaluation of available facilities. Existing facilities investigated include T Plant (Alternative 2a), Plutonium-Uranium

Extraction (PUREX) Plant (Alternative 2b), Fuels and Materials Examination Facility (FMEF) (Alternative 2c), and the Washington Nuclear Plant-1 (WNP-1) Spray Pond (Alternative 2d).

The **T Plant** in the 200 West Area was constructed in 1944 with initial operations beginning in the same year. The structure contains a large canyon work area, known as the 221-T, and a low-level decontamination building, known as the 2706-T. The primary defense mission of T Plant was terminated in 1956. In 1957, T Plant resumed service as a general decontamination and repair facility. Recently, T Plant has been in a mode of general cleanup to address legacy wastes and equipment that were moved to it for storage. The plant also continues to support site decontamination services.

The **PUREX Plant** in the 200 East Area was constructed in 1953 with initial operations beginning in 1955. The structure consists of three components: a heavily shielded process canyon (202-A); a pipe, sample, and storage gallery; and a steel and transite annex which houses support services. The PUREX Plant defense mission terminated in 1990 and deactivation activities are in progress.

The **FMEF** in the 400 Area was constructed in 1984, but never began operations. Its current status is idle with no mission.

The **WNP-1 Spray Pond** is located on Hanford Site land leased to the Washington Public Power Supply System. The facility was designed as a two-division, safety-related structure. Its purpose was to hold a 30-day supply of water for use following a reactor loss-of-coolant accident. With the termination of the WNP-1 reactor, this structure has no mission.

For the aforementioned canyon facilities, solidified HLW products (immobilized HLW canisters and separated cesium containers) are stored in racks located on the canyon cover blocks. A 30-cm concrete slab is poured over the existing cover blocks to isolate the canyon deck area from the process cells. The storage area is based on an open-bay concept. Canisters and containers are in direct contact with the cooling air. Cooling is via a forced-air ventilation system. Each facility contains existing heating, ventilation, and air conditioning (HVAC) systems that are available for this service. However, these are active systems that require periodic maintenance.

The design concept for FMEF is similar to the canyon facilities. The solidified HLW product is stored in racks located in shielded cells. The storage area is also based on an open-bay concept whereby canisters and containers are in direct contact with cooling air. The exhaust must be subjected to high-efficiency filtration because the cooling air contacts the canisters and containers. The existing HVAC system could supply the necessary cooling air and exhaust filtration services.

Given the WNP-1 Spray Pond is essentially a partially constructed building (essentially a floor and surrounding walls), various configurations are conceptually possible. For this evaluation the WNP-1 Spray Pond, as modified for solidified HLW interim storage, is presumed to entail open-bay storage with forced air ventilation.

The proposed operating scenario for all sub-alternatives is that the solidified HLW product (immobilized HLW canister or separated cesium container) is transported to the interim storage facility in an onsite transportation cask. The cask transporter is a diesel-powered tractor/trailer. The cask is removed from the trailer and moved to the canyon deck or cell area via the normal canyon/cell access mode for the respective facility. The canyon or cell crane remotely unbolts the cask lid, extracts the solidified HLW product, transports the solidified HLW to the appropriate storage location, and emplaces the solidified HLW into storage.

Alternate 3 (CSB Modules)

If programmatic or technical considerations prevent use of the CSB, a logical alternative is construction of a facility similar to the CSB. Alternative 3 entails such a CSB-type facility, hereafter referred to as a CSB module. The CSB module includes several shielded vaults, each containing steel storage tubes. Decay heat from the solidified HLW product is removed by natural convection. Cooling air is drawn around the storage tube exterior by natural convection. The storage tube interior is isolated from the environment by a plug inserted in the tube opening. The plug provides shielding and sealing functions. The structure is similar to the CSB except its vault capacity, number of vaults, and operating area shelter size are different. A support services building is also provided.

There is likely a limit to the number of vaults that can be housed in a continuous structure. Therefore, Alternative 3 consists of several independent CSB modules constructed in a phased approach, as required to accommodate solidified HLW production during Phases I and II. The group of CSB modules is generically referred to as a solidified HLW interim storage complex.

The CSB module proposed for Phase I evaluation consists of two below-grade, concrete vaults approximately 30 m wide by 55 m long by 14 m deep; a 41-m wide by 42-m long by 17-m steel shelter; one air intake; and one exhaust stack. The shelter provides an operating area for load-in/load-out. The single air intake and exhaust stack provide for cooling of both vaults. The support services area is a steel building about 14 m wide by 30 m long by 9 m tall.

The solidified HLW product is transported to the CSB module in an onsite transportation cask. The cask transporter is a diesel-powered tractor/trailer. At the CSB module unloading station the onsite transportation cask, containing the solidified HLW product, is removed from the trailer and lowered into a shielded pit. Once emplaced in the pit, the cask is opened. A dedicated crane removes the solidified HLW from the cask, transports the solidified HLW to the appropriate storage tube, and emplaces the solidified HLW into storage.

A second concept was initially considered, but quickly eliminated from further development or evaluation. This concept was based on the Fort Saint Vrain Modular Vault Dry Storage Facility. The concept was rejected because the Fort Saint Vrain Facility represents, with minor variations, the same fundamental concept as the CSB: modular dry storage vaults with passive ventilation. The only significant difference is that the CSB vaults are below grade and the Fort Saint Vrain vaults are above grade. Moreover, the Fort Saint Vrain Modular Vault Dry Storage Facility design is tailored for SNF bundles with characteristics unique to the Fort Saint Vrain reactor. Significant redesign is required to adapt the Fort Saint Vrain Modular Vault Dry

Storage Facility for the specific characteristics of solidified HLW. The CSB module concept is, however, tailored for immobilized HLW canister storage.

Alternative 4 (Pad Storage)

Alternative 4 consists of a pad storage concept. Numerous commercially available pad storage systems exist. The pad storage system selected for evaluation is the NUHOMS.¹ The basis for this selection was the NUHOMS system's low cost and high degree of commercialization relative to other pad storage concepts.

A NUHOMS facility consists of a concrete pad, a fenced perimeter, and several modular prefabricated bunkers (vaults), termed horizontal storage modules. Each vault holds a single dry shielded container (DSC). The DSC is a type of multipurpose canister, which has been approved by the U.S. Nuclear Regulatory Commission for either SNF-monitored retrievable storage, or SNF permanent disposal at the geologic repository. The DSC is a cylindrical metal container 1.71 m diameter by 4.51 m long. The storage vault is 3.0 m wide by 5.8 m long by 4.6 m tall. Each vault sits on a concrete pad approximately 3 m wide by 12 m long by 30.5 cm thick.

Decay heat from the DSC content is removed by natural convection. Cooling air is drawn through inlet ducts into a vault, flows around the DSC, and exits through outlet ducts. Each DSC is limited to 24 kW of total decay heat removal. The DSC usable internal cavity is approximately 1.7 m diameter by 4.5 m long.

The available DSC space envelope is sufficient for 4 standard canisters or 39 cesium containers. Based on NUHOMS DSC/vault heat load limitations, a DSC is limited to about 16 HLW canisters or cesium containers (1.5 kW per canister or container). For immobilized HLW canisters the DSC is space limiting. For separated cesium containers the DSC could be heat load limiting. For this alternative, each DSC is expected to accommodate 39 separated cesium containers at 0.5 kW per container, or 4 standard immobilized HLW canisters at 1.5 kW per canister.

Immobilized HLW canisters and separated cesium containers are received from the production facilities as a single canister or container loaded within an onsite shipping cask. At the solidified HLW interim storage complex support building, the solidified HLW is placed in lag storage until a suitable number of canisters or containers are available for overpacking in the DSC. Given the DSC provides minimal shielding, the overpack operations must be performed by remote means. After being loaded with solidified HLW packages and sealed (welded) the DSC is transported to a concrete storage vault. The DSC is transported by truck using a specially designed transport trailer, which contains a shield cask and loading mechanism.

¹NUHOMS is a trademark of Vectra Technologies, Inc.

Alternatives 5a (Dual-Stack Bore Holes) and 5b (Four-Pack Bore Holes)

Alternative 5 is based on a bore hole (or dry well) concept. Bore holes are essentially storage tubes, similar to those of CSB-type alternatives, embedded in the ground. A bore hole consists of a 1.25-cm thick steel liner surrounded by about 15 cm of non-shrink grout which fills the space between the steel liner and adjacent soil. Each bore hole is capped with a shield plug and a cover plate.

Bore holes are spaced to accommodate heat transfer, and canister transporter size and weight. Analysis indicates that bore holes spaced 6 m apart are capable of dissipating the decay heat from two 1-kW standard canisters. Canister transporter consideration may, however, dictate a wider spacing.

Bore hole spacing must be such that the wheels of the canister transporter do not travel over any bore hole cover plates (i.e., the transporter must straddle the bore hole while not intruding onto other surrounding bore holes). The weight of a canister transporter approaches 200 MT. Cover plates could be designed to withstand this load, but repetitive loading due to transporter travel over a bore hole would tend to push the entire bore hole into the ground. Based on the aforementioned considerations, a preliminary estimate is that bore holes require an approximate 7.6-m spacing.

Based on the preceding discussion, two bore hole sub-alternatives were developed. Alternative 5a entails bore holes filled with canisters stacked two high (dual-stack) and Alternative 5b entails bore holes filled with a single overpack containing four canisters (four-pack).

The solidified HLW product is emplaced in an onsite transportation cask at the production facilities and transported by truck/trailer to a support building located at the solidified HLW interim storage complex. The solidified HLW is removed from the transportation cask at the support building and, for Alternative 5a, is immediately loaded in an interim storage site transporter. The transporter contains a bottom-loaded cask. The canister or container is subsequently transported to the designated storage location and lowered into the bore hole. Sealing the bore hole with a plug completes the operation.

For Alternative 5b, the immobilized HLW canisters or separated cesium containers are, upon receipt, first overpacked at the support building. The overpack is seal-welded and loaded into the interim storage site transporter. The overpack is subsequently transported to the designated storage location and emplaced in the bore hole.

The solidified HLW interim storage complex support building provides remote operation features necessary for the aforementioned handling activities. Under Alternative 5b, the individual solidified HLW must also be lag stored until a suitable number of canisters or containers are available for overpacking. The support building provides shielded locations for the lag storage.

The following is a discussion of the multi-attribute decision analysis and alternative architecture rankings adopted/developed by the Decision Board.

Table 2 summarizes the results of the multi-attribute decision analysis for Phase I alternatives. Based on this analysis, Alternative 1a (Existing CSB) is the top contender of the alternatives (including other CSB alternatives 1b and 3) due to its low cost, schedule advantage and concept maturity. In general, the canyon facilities were downgraded due to their physical limitations, age of facilities, or numerous unknowns associated with retrofit of these contaminated facilities. The NUHOMS system and bore hole alternatives were ranked moderately lower because of deficiencies in their concept maturity and high construction cost. Modest additional engineering concept development of the NUHOMS and borehole concepts could enhance their ranking. It is unlikely, however, that the capital cost of other alternatives would best the existing CSB. A significant fraction of the existing CSB construction cost is being borne by the SNF Project, thereby providing an essentially free service to Phase I solidified HLW interim storage.

5.0 RECOMMENDATION AND DECISION APPROVAL

The Decision Board's recommendation is as follows: The Phase I HLW Interim storage concept architecture will use Vaults 2 and 3 of the Hanford Site SNF CSB, being located in the Hanford Site 200 East Area, and include features to facilitate addition of one of more vaults at a later date.

This document serves as the formal documentation of the Decision Boards recommendation and confirms Decision-Maker approval and (see approval sheet at front of document). Issuance of this document also constitutes the basis for planning the selected architecture implementation. Implementation will start with incorporation of the selected architecture in the TWRS Functions and Requirements Document (WHC 1995) and inclusion of this architecture and path forward in the *TWRS FY 1997 Multi-Year Work Plan (MYWP)* (WHC 1996c). For the selected architecture, use of a modified CSB for HLW interim storage, the path forward is to initiate conceptual design of the CSB retrofit and include design and construction activities in the FY 1997 MYWP.

The successful implementation of the selected architecture is based on the following premises: (1) this architecture is included in DOE/EIS-0189, *Final Environmental Impact Statement for the Tank Waste Remediation System* (DOE 1996), and (2) the Memorandum of Agreement (RL 1996b) established between the HLW Interim Storage Project and SNF Project which reserves CSB Vaults 2 and 3 for HLW interim storage. It should be noted that the final TWRS environmental impact statement was issued September 1996 and the use of the CSB for HLW interim storage is included as an option.

Table 2. Phase I Multi-Attribute Decision Analysis.

| Alternative | 1a | 1b | 2a | 2b | 2c | 2d | 3 | 4 | 5a | 5b |
|---------------------------------|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Selection criterion | | | | | | | | | | |
| Minimize schedule risk | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Independent project/program | 100 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Concept maturity | 100 | 100 | 0 | 0 | 0 | 0 | 100 | 0 | 0 | 0 |
| Minimize life-cycle cost | 200 | 183 | 196 | 199 | 0 | 0 | 157 | 112 | 165 | 82 |
| Minimize HS&E risk | 200 | 200 | 0 | 0 | 0 | 0 | 200 | 200 | 200 | 200 |
| Maximize stakeholder confidence | 200 | 200 | 200 | 200 | 0 | 0 | 200 | 200 | 200 | 200 |
| Optimize technical performance | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Capacity flexibility | 100 | 100 | 0 | 0 | 0 | 0 | 100 | 100 | 100 | 100 |
| Operating life flexibility | 100 | 100 | 0 | 0 | 100 | 100 | 100 | 100 | 100 | 100 |
| Total swing points | 1000 | 983 | 396 | 399 | 100 | 100 | 857 | 712 | 765 | 682 |
| Swing rank | 1 | 2 | 8 | 7 | 9 | 9 | 3 | 5 | 4 | 6 |

1a = Existing Canister Storage Building

1b = Expanded Canister Storage Building

2a = T Plant

2b = Plutonium-Uranium Extraction Plant

2c = Fuels and Materials Examination Facility

2d = Washington Nuclear Plant-1 Spray Pond

3 = Canister Storage Building module

4 = NUHOMS system by Vectra Technologies, Inc.

5a = Dual-stack bore hole

5b = Four-pack bore hole

HS&E = Health, safety, and environmental

6.0 REFERENCES

Calmus, R. B., 1996, *Solidified High Level Waste Interim Storage Alternative Analysis and Recommendation*, WHC-SD-WM-SP-011, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

DOE, 1996, *Final Environmental Impact Statement for the Tank Waste Remediation System*, DOE/EIS-0189, U.S. Department of Energy, Washington, D.C.

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- WHC, 1996a, *Alternatives Generation and Analysis Procedure*, WHC-IP-1231, Westinghouse Hanford Company, Richland, Washington.
- WHC, 1996b, *Tank Waste Remediation System Functions and Requirements*, WHC-SD-WM-FRD-020, Rev. 0, Westinghouse Hanford Company, Richland, Washington.
- WHC, 1996c, *TWRS FY 1997 Multi-Year Work Plan (MYWP)*, Westinghouse Hanford Company, Richland, Washington.

7.0 ATTACHMENT

Decision Board Meeting Supplemental Summary Information Presentation

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Interim Storage Architecture and Path Forward

May 28, 1996

**R. B. (Ron) Calmus
Disposal Engineering**

**K. C. (Ken) Burgard
Interim Storage Subproject**

Mission Statement

Provide safe and cost effective interim storage of Hanford Site solidified HLW (immobilized vitreous product and secondary solid waste and other identified solid HLW) starting in FY 2002 and maintain until such a time as the HLW can be transported to a permanent HLW geologic repository.

Decision Statement

Select HLW interim storage architecture and path forward that supports successful execution of Phase I privatization of Hanford HLW treatment.

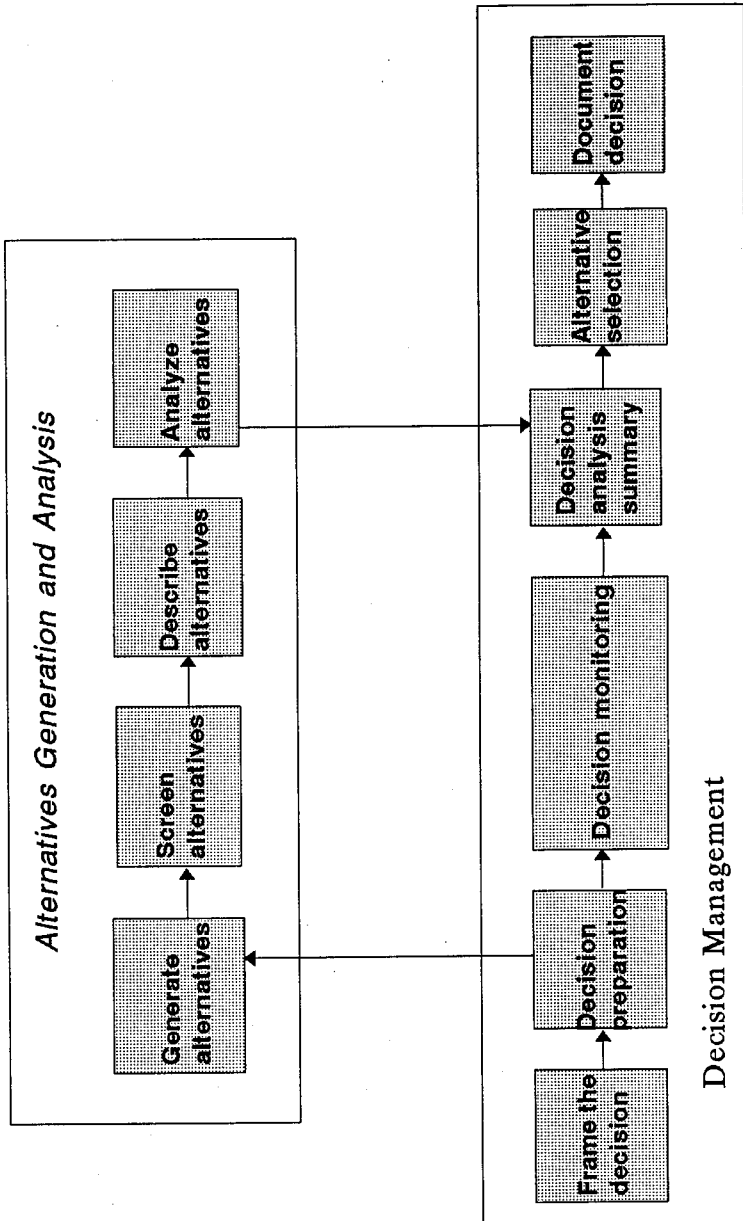
Decision Maker and Board

- **Decision Maker**
 - Russ Murkowski, Manager (level 3), TWRS Storage and Disposal Project
- **DOE concurrence**
 - Phil LaMont, Project Director, Storage and Disposal Division
- **Decision board members**
 - Rod Powell, Manager, TWRS HLW Project
 - Ken Gasper, Manager, TWRS LLW Project
 - Gary Dunford, Manager, TWRS Safety and Integration
 - Ken Burgard, Manager, TWRS Interim Storage Subproject
 - Dennis Washenfelter, Manager, TWRS Disposal Engineering
 - M. K. Mahaffey, Manager, Spent Nuclear Fuel Project

Agenda

- **Decision process procedure and decision report requirements**
- **Assumptions**
- **Functions and requirements**
- **Architecture analysis and path forward recommendations**
 - Selection and evaluation criteria
 - Concept alternatives
 - Alternative architecture evaluation
 - Alternative selection
 - Selection summary
 - Path forward recommendations

interaction of decision mgmt (kcb5-28)



Assumptions

Phase I

● Acceptance specification

- Phase I privatization plants generate HLW products including immobilized glass HLW canisters; separated Cs containers and other miscellaneous HLW and mixed HLW canisters (e.g., disassembled failed equipment)
- HLW packaged in standard canister (3.0 m long and 0.61 m dia.); 80 percent fill volume
- Cs packaged in 0.33 m dia. x 1.37 m long container; single-contained Cs container may not be acceptable for CSB storage, therefore, an overpack operation may be required
- Secondary HLW packaged in standard canister

25

● Facility Operating Basis

- Storage capacity will provide storage and all Phase I HLW wastes
- Minimum order quantity generated 599 canisters, maximum generates 1,137 canisters
- Number of Cs canisters ranges from 53 at 1.5 kW to 158 at 0.5 kW per container
- Secondary HLW canister count is 53

Assumptions (cont'd)

Phase II

- **Acceptance specification**

- Phase II immobilization plant generates glass product and secondary HLW. No separated Cs product is produced in Phase II
- HLW packaged in large canister (0.61 m dia. x 4.5 m long); 80 percent fill volume
- Secondary HLW packaged in long canisters

- **Facility Operating Basis**

- HLW interim storage capacity must accommodate Phase II-generated HLW (7,592 to 21,726 large canisters; upper bound equates to 36,444 standard canisters)

Assumptions (cont'd)

Phase I HLW Demonstration Facility

- **Facility operating basis**

- One private contractor will operate one HLW demonstration facility
- Minimum order quantity is 245 MT of waste oxide processed from June 2002 to June 2007
- Maximum order quantity is 465 MT of waste oxide processed to June 2011
- Phase I glass product is an average of 25 percent by weight of nonvolatile waste oxides (excluding Si and Na)
- Glass density is 2,640 kg/m³
- Standard canister is identical to the DWPF canister design such that 85 percent of internal volume is 0.62 m³
- HLW interim storage provided for 40 years. Approved TWRS database is 40 years. Major portion of CSB designed for 75 years (SNF)

Assumptions (cont'd)

Phase II HLW Production Facility

- One private contractor will operate one HLW production facility
- Production facility will be operated from June 2013 to December 2028 and produce from 7,592 to 21,726 large canisters
- Phase II glass product is an average of 25 percent by weight on nonvolatile waste oxides (excluding Si and Na)
- Large canister is an elongated DWPF canister design such that 80 percent fill volume is 1.04 m³
- Assumption reflects HLW repository will received first Hanford HLW canister shipments in 2035. Perceived stakeholder value to provide integrated Phase II vit plant repository and HLW interim storage capacity

Functions and Requirements

Figure 3-1,2 and Table 3-4

- Functions
- Interfaces
- Requirements allocation - To function/input and outputs
- Architecture
 - Architecture definition (Phase I and II)
 - Alternatives considered
 - Rationale for selection
 - Enabling assumptions
 - Required analyses
 - Requirements satisfied
- Requirements definition
 - Constraints
 - Performance requirements

figure 3-1, function hierarchy to level 4

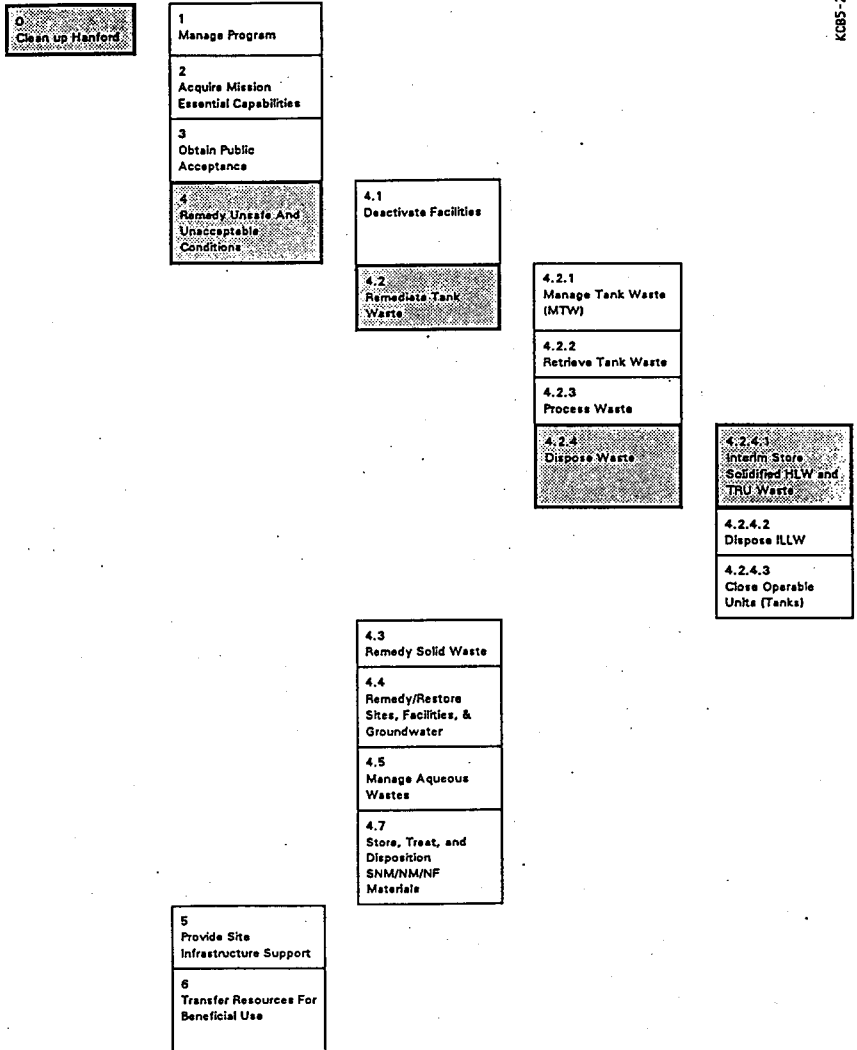
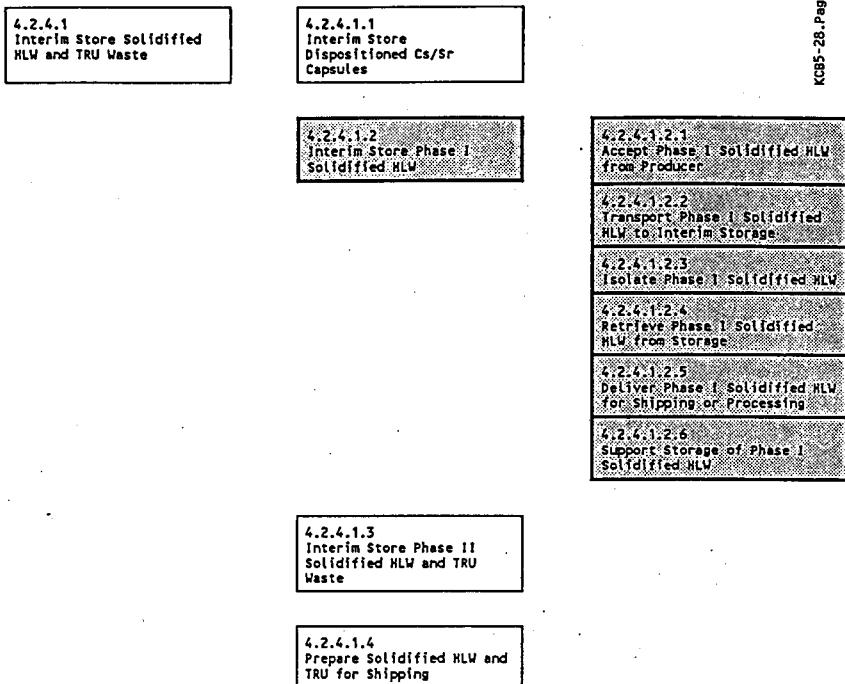


figure 3-2, decomposition of function 4.2.4.1



 To be addressed in Phase I Solidified HLW Interim Storage System DRD.

table 3-1, functions and input/outputs

| 4.2.4.1 Interim Store Solidified HLW and TRU Waste | |
|--|---|
| Inputs: | Outputs: |
| Cesium Product for Storage | Cesium Product for Processing |
| Dispositioned Cs/Sr Capsules for Storage | Cesium Product Transport Mechanism |
| Dispositioned Cs/Sr Capsules for Shipping Mechanism | Dispositioned Cs/Sr Capsules for Shipment |
| IHLW for Storage | Dispositioned Cs/Sr Capsules Transport Mechanism |
| Phase I IHLW for Storage | IHLW for Shipment |
| Phase II IHLW for Storage | IS Solidified HLW and TRU Excess Facilities |
| IHLW Repository Shipping Mechanism | IS Dispositioned Cs/Sr Capsules Excess Facilities |
| Infrastructure Support for IS Solidified HLW and TRU | IS Phase I Solidified HLW Excess Facilities |
| Infrastructure Support for IS Dispositioned Cs/Sr Capsules | IS Phase II Solidified HLW and TRU Excess Facilities |
| Infrastructure Support for IS Phase I Solidified HLW | Prepare Solidified HLW and TRU for Shipment Excess Facilities |
| Infrastructure Support for IS Phase II Solidified HLW | IS Solidified HLW and TRU Garbage |
| Infrastructure Support for Prepare Solidified HLW for Shipment | IS Dispositioned Cs/Sr Capsules Garbage |
| ITRU Repository Shipping Mechanism | IS Phase I Solidified HLW Garbage |
| ITRU Waste for Storage | IS Phase II Solidified HLW and TRU Garbage |
| Raw Materials for IS Solidified HLW and TRU | Prepare Solidified HLW and TRU for Shipment Garbage |
| Raw Materials for IS | IS Solidified HLW and TRU Hazardous Waste |
| Dispositioned Cs/Sr Capsules Raw Materials for IS Phase I | IS Dispositioned Cs/Sr Capsules Hazardous Waste |
| Solidified HLW | IS Phase I Solidified HLW Hazardous Waste |
| Raw Materials for IS Phase II | IS Phase II Solidified HLW and TRU Hazardous Waste |
| Solidified HLW | Prepare Solidified HLW and TRU for Shipment Hazardous Waste |
| Raw Materials for Prepare Solidified HLW for Shipment | |

Selection and Evaluation Criteria

Multi-attribute decision analysis criteria

- **Schedule risk**
 - Alternatives not coupled to other Program/Projects are at low risk
 - Alternatives with mature concept development are at low risk
- **Life cycle cost**
 - Design, construction, operation, and D&D costs
 - Two subelements: initial capital cost and operating cost (including D&D)
 - Alternates with minimum capital and operating costs are rated high
- **Health, safety, and environmental risks**
 - Minimize risk to public, workers, and environment
 - Alternatives with low impacts relative to public, worker, and environment are rated high

Performance Objectives and Measures for TWRS Decisions

| PERFORMANCE OBJECTIVES AND MEASURES | |
|---|---|
| PERFORMANCE OBJECTIVES | PERFORMANCE MEASURES |
| <ul style="list-style-type: none"> Do no harm during cleanup or with new development <ul style="list-style-type: none"> a, b, c will be satisfied in design of any of the alternative architecture, therefore, not applicable architecture selection criteria; not a difference in selecting HLW interim storage architecture Relative to c) - A separate criteria was established to reflect stakeholder value to "protect the Columbia River." Emphasis on criteria on 200 Area plateau d) is not applicable | <ul style="list-style-type: none"> a) Worker exposure, normal operations (worker-remS) b) Worker exposure, accidents (worker-remS) c) Public exposure, accidents (public-remS) d) LLW left onsite (volume in metric tons, waste form, curies) |

| PERFORMANCE OBJECTIVES AND MEASURES | |
|--|--|
| PERFORMANCE OBJECTIVES | PERFORMANCE MEASURES |
| <ul style="list-style-type: none"> Transport waste safely and be prepared inherent to the HLW interim storage function is the preparation (adequate capacity performance shipping documentation attributes) for Phase I and IHLW canisters produced during vit plant operations. Facility architecture selection is not dependent on offsite transportation cask design | Amount of waste shipped offsite (metric tons) |
| <ul style="list-style-type: none"> Achieve substantive progress in a timely manner <ul style="list-style-type: none"> Not applicable to HLW interim storage facility function or requirements | Time to interim stabilization of tanks (years)* Time to closure of tanks (years)* |
| <ul style="list-style-type: none"> Reduce cost <ul style="list-style-type: none"> Embodied in specific cost and schedule criteria | Total life cycle cost (constant year dollars) Largest annual cost (constant year dollars) |

* Other dates may be more relevant for specific decision problems

Selection and Evaluation Criteria (cont'd)

- **Stakeholder confidence (other stakeholder values embodied in remaining criteria)**
 - Protect the Columbia River (establish Phase I HLW interim storage site or 200 Area plateau)
- **Technical performance**
 - Technical solution must provide flexibility because required capacity and storage duration are uncertain
 - Two subelements: capability flexibility and operating life flexibility

Concept Alternatives

- **Standalone storage building**
 - Building concept include use of existing Hanford Site buildings or new building construction
- **Pad storage**
 - Pad storage concepts consist of concrete pads supporting modular pre-fabricated bunkers (vaults) of various vendor designs modified for HLW interim storage
- **Bore hole storage (or dry well)**
 - Bore hole storage consists of multi-pack or single-pack bore holes constructed using stainless steel liners with nonshrink grout poured between the liner and soil

Concept Evaluation - Standalone Storage Building

Existing facility

A) CSB - Alternative 1

- Shielded vaults (three), natural convection cooling, below grade vault design; currently being designed to store SNF in vault 1; each vault consists of 226 storage tubes capable of handling 30 feet of canisters; partial construction for SNF mission
 - . Alternative 1a - Retrofit CSB vaults 2 and 3 with flexibility for additional vaults
 - . Alternative 1b - Retrofit vaults 3 and add additional vault(s) (maximum of two)

Concept Evaluation - Standalone Storage Building (cont'd)

Existing facility

B) Other than CSB - Alternative 2

- Alternative 2a, T Plant
 - . Large canyon work area and low-level decontamination building/being cleaned to address legacy waste stored in it; currently used for general decontamination and repair facility
- Alternative 2b, PUREX Plant
 - . Heavily shielded process canyon, pipe and storage gallery, and steel support services annex; currently being deactivated
- Alternative 2c, FMEF
 - . Large shielded bay, class I nuclear designed facility; never put into operation; no current mission
- Alternative 2d, WNP 1 Spray Pond
 - . Concrete pond constructed to hold a 30-day supply of water following a reactor loss-of-coolant accident; no current mission

Concept Evaluation - Standalone Storage Building (cont'd)

New building

- Construction of new facility similar to CSB design - Alternative 3
 - Several shielded below-grade vaults constructed in modules to facilitate Phases I and II HLW interim storage
 - . Phase I vault consists of two CSB-sized vaults

Concept Evaluation - Page Storage

Commercially available pad storage system - Alternative 4

- Numerous storage pad concepts evaluated in scoping study (WHC-SD-WM-ES-374, Rev. 0, "TWRs High-Level Waste Interim Storage Facility Search and Evaluation")
- NUHOMS system selected as representative (low cost and high degree of commercialization) relative to other concepts
- NUHOMS system consists of concrete pad, fenced perimeter, and several prefabricated bunkers (vaults). Each vault holds a single dry shielded container (DSC)
- Each DSC limited to 24 kW per DSC
 - Based on volume, DSC limited to four HLW canisters
 - Based on heat load, DSC limited to 16 Cs container (1.5 kW max) or 39 containers a 0.5 kW each

Concept Evaluation - Bore Hole (Dry Well) Storage

CSB type storage tubes embedded in the ground -
Alternative 5

- **Alternative 5a - Dual stack bore holes**
 - Phase I - Assuming two glass canisters and three separated Cs containers per bore hole, 648 bore holes are required
 - Phase II - Number of bore holes range from 3,796 to 10,863 bore holes
- **Alternative 5b - Single stack, four-pack**
 - Phase I - Assuming four glass canisters and nine separated Cs containers per bore hole, 303 bore holes are required
 - Phase II - Number of bore holes range from 1,898 to 5,432 (large canisters) or up to 9,111 (standard canisters)

Cost

| CAPITAL COST COMPARISON FOR PHASE I | | |
|-------------------------------------|-----------------------|--------------|
| Alternative | Total Estimated Cost* | Swing Points |
| 1a - Existing CSB | \$22,932 | 200 |
| 1b - Expanded CSB | \$44,448 | 183 |
| 2a - T Plant | \$28,500 | 196 |
| 2b - PUREX Plant | \$24,800 | 199 |
| 2c - FMEF | N/A | 0 |
| 2d - WNP-1 Spray Pond | \$271,300 | 0 |
| 3 - CSB modules | \$76,176 | 157 |
| 4 - NUHOMS | \$132,470 | 112 |
| 5a - Dual-stack bore holes | \$66,056 | 165 |
| 5b - Four-pack bore holes | \$169,181 | 82 |

* All cost figures are in thousands of 1995 dollars

Cost

| PHASE II - CAPITAL COST COMPARISON | | |
|------------------------------------|-----------------------|--------------|
| Alternative | Total Estimated Cost* | Swing Points |
| 3 - CSB modules | \$1,651,369 | 91 |
| 4 - NUHOMS | \$2,151,347 | 28 |
| 5a - Dual-stack bore holes | \$782,566 | 200 |
| 5b - Four-pack bore holes | \$2,376,144 | 0 |

* All cost figures are in thousands of 1995 dollars

Cost

| FLEXIBILITY COST COMPARISON | | | |
|-----------------------------|-----------------------|--------------|--|
| Alternative | Total Estimated Cost* | Swing Points | |
| 3 - CSB modules | \$1,844,580 | 159 | |
| 4 - NUHOMS | \$3,599,474 | 27 | |
| 5a - Dual-stack bore holes | \$1,298,749 | 100 | |
| 5b - Four-pack bore holes | \$3,959,184 | 9 | |

* All cost figures are in thousands of 1995 dollars

Multi-attribute Decision Analysis (Alternatives 1a - 3) - Phase I

| Alternative | 1a | 1b | 2a | 2b | 2c | 2d | 3 | 4 | 5a | 5b |
|---|---------|---------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| Selection criterion | | | | | | | | | | |
| Minimize schedule risk - Independent project/ program | -- 0 | -- 0 | -- 100 | -- 100 | -- 100 | -- 100 | -- 100 | -- 100 | -- 100 | -- 100 |
| - Concept maturity | 100 | 100 | 0 | 0 | 0 | 0 | 100 | 0 | 0 | 0 |
| Minimize life cycle cost | 200 | 183 | 196 | 199 | 0 | 0 | 157 | 112 | 165 | 82 |
| Minimize HS&E risk | 200 | 200 | 0 | 0 | 0 | 0 | 200 | 200 | 200 | 200 |
| Maximize stakeholder confidence | 200 | 200 | 200 | 200 | 0 | 0 | 200 | 200 | 200 | 200 |
| Optimize technical performance | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| - Capability flexibility | 100 | 100 | 0 | 0 | 0 | 0 | 100 | 100 | 100 | 100 |
| - Operating life flexibility | 100 | 100 | 0 | 0 | 100 | 100 | 100 | 100 | 100 | 100 |
| Total swing points | 900 | 883 | 496 | 499 | 200 | 200 | 957 | 812 | 865 | 782 |
| Swing rank | 2 | 3 | 8 | 7 | 9 | 9 | 1 | 5 | 4 | 6 |

1a - Existing CSB

1b - Expanded CSB

2a - T Plant

2c - FMEF

2d - WNP Spray Pond

Multi-attribute Decision Analysis (Alternatives 3 - 5b) - Phase II

| Alternative | 3 | 4 | 5a | 5b |
|--|------------------|-----------------|------------------|----------------|
| Selection criterion | | | | |
| Minimize schedule risk - Independent project/program - Concept maturity | -- 100 100 | -- 100 0 | -- 100 0 | -- 100 0 |
| Minimize life cycle cost | 91 | 28 | 200 | 0 |
| Minimize HS&E risk | 200 | 200 | 200 | 200 |
| Maximize stakeholder confidence | 200 | 200 | 200 | 200 |
| Optimize technical performance - Capability flexibility - Operating life flexibility | -- 159 100 | -- 27 100 | -- 100 100 | -- 0 100 |
| Total swing points | 950 | 655 | 900 | 600 |
| Swing rank | 2 | 3 | 1 | 4 |

- 3 - CSB module
4 - NUHOMS system by
Vectra Technologies, Inc.
5a - Dual-stack bore hole
5b - Four-pack bore hole

Recommendations

Phase I

- **Pursue alternative 1a as primary option - Retrofit CSB vaults 2 and 3 with flexibility for additional vaults**
 - Alternative 1a recommended based on relative high multi-attribute decision analysis ranking and exceptionally low capital cost
 - To ensure alternative 1a remains viable, several near-term activities need to be performed
 - Development of detailed thermal analysis to identify design modification required to support higher heat loads (vs. SNF) impact on CSB vault
 - Identification of design modifications that must be implemented in the SNF CSB design effort
 - Development of design features to support canister rework and a method for implementing such features before receipt of solidified HLW at the CSB
 - Development of regulatory approach including preparation of RCRA-based permit application

Recommendations (cont'd)

Phase II

- **All identified alternatives are potentially viable, but more work needs to be performed to allow proper discrimination between alternatives**
 - **Basic concept features must be refined and finalized especially for handling operations, transport, overpacking method, land availability and facility siting**
 - **Life cycle costs, occupational exposure, public exposures, environmental impacts need to be developed for alternatives**
 - **Only significant life cycle cost discriminator is that related to overpack operation for those that alternatives that require this function**

Recommendations (cont'd)

General

- **Issues requiring further evaluation**
 - Use of large canister (0.61 m dia. by 4.5 m long) proposed for Phases I and II
 - Volume of separated Cs requiring interim storage

Evaluation Results (Advantages/disadvantages/issues)

CSB - Alternative 1

- **Advantages**
 - Passive cooling system; low maintenance
 - Partially constructed under SNF Project
 - Flexible capacity for Phase I
 - Lowest relative capital cost
- **Disadvantages**
 - Tied to SNF construction/operating schedule (increased risk caused by integrating process)
 - Insufficient storage capacity for Phase II
- **Issues**
 - Additional detailed thermal analysis required to fully identify and finalize required CSB modifications
 - Some CSB modifications must be implemented in the very near term

Evaluation Results (Advantages/disadvantages/issues) (cont'd)

Other than CSB (existing facilities) - Alternative 2

Canyon Facilities (T-Plant [Alt. 2a], PUREX [Alt. 2b])

- **Advantages**
 - Ample Phase I capacity in T-plant and Purex
 - Safety class structure (FMEF)
- **Disadvantages**
 - Age of facilities (T Plant and PUREX)
 - Forced air ventilation system; high maintenance
 - shared storage space; cross contamination
 - Inadequate Phase II capacity
 - T-Plant and PUREX not seismically qualified; insufficient drawings rendering detailed structural analysis very difficult if not impossible

Evaluation Results (Advantages/disadvantages/issues) (cont'd)

Other than CSB - Alternative 2 (cont'd)

FMEF (Alt. 2c)

- Advantages
 - Safety class structure
- Disadvantages
 - Not in 200 Area buffer zone
 - Inadequate Phase I capacity

Evaluation Results (Advantages/disadvantages/issues) (cont'd)

Other than CSB - Alternative 2 (cont'd)

WNP 1 Spray Pond (Alt. 2d)

- **Advantages**
 - Safety class structure
- **Disadvantages**
 - Extensive modification required
 - Not in 200 Area buffer zone
 - Overcapacity for Phase I, insufficient capacity for Phase II
 - Large relative cost
 - New unloading station required

Evaluation Results (Advantages/disadvantages/issues) (cont'd)

New Building - Alternative 3

- **Advantages**
 - Optimized for required capacity
 - Designed for flexible capacity expansion
 - Proven design concept; minimal schedule risk
- **Disadvantages**
 - Moderate relative cost
- **Issue**
 - Optimum module size

Evaluation Results (Advantages/disadvantages/issues) (cont'd)

Pad Storage (NUHOMS) - Alternative 4

- **Advantages**
 - Commercially available
 - Complies with all safety/environmental requirements for SNF dry storage
 - Time-phased capital cost expenditure (i.e., modular construction)
 - No critical path schedule impacts
- **Disadvantages**
 - High relative cost
 - Requires support building for lag storage and features to remotely place HLW canisters in DSC and to load DSC into transporter
- **Issues**
 - NUHOMS specifically designed for SNF not HLW; detailed thermal analysis required
 - Little concept development on placing canisters in DSC
 - Requires specially designed transporter trailer; transportation considerations require further evaluation

Evaluation Results (Advantages/disadvantages/issues) (cont'd)

Bore Holes - Alternative 5

Dual Stack (Alt. 5a)

- **Advantages**
 - Time-phased capital cost expenditure
 - Potentially low relative cost
- **Disadvantages**
 - Development concept does not provide for drainage of accumulated liquid in a bore hole; further concept development required
 - Ability to dissipate heat is limited; pushes concept beyond demonstrated ability to dissipate heat
- **Issues**
 - Sufficient land for Phase II capacity needs to be performed
 - Detailed thermal analysis required to ensure centerline temperatures
 - Specially designed transporter required
 - Significant further concept development and detailed analysis required (e.g., siting, space allocation, function and cost of support buildings, etc.)

Evaluation Results (Advantages/disadvantages/issues) (cont'd)

Bore Holes - Alternative 5 (cont'd)

Four Pack (Alt. 5b)

- **Advantages**
 - Time-phased capital cost expenditure
- **Disadvantages**
 - High relative cost
 - Balance same as for Alt. 5a
- **Issues**
 - Essentially same as for Alt. 5a

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Author

Addressee

Correspondence No.

R. B. Calmus, 376-5017

Mr. P. E. LaMont, RL

9654461

Subject: HIGH-LEVEL WASTE INTERIM STORAGE ARCHITECTURE SELECTION DECISION
REPORT

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