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Idaho Waste Vitrification Facilities Project Vitrified Waste Interim Storage Facility

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Feasibility Study Report

September 2001

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EXECUTIVE SUMMARY

This feasibility study report presents a draft design of the Vitrified Waste Interim Storage Facility (VWISF), which is one of three subprojects of the Idaho Waste Vitrification Facilities (IWVF) project. The primary goal of the IWVF project is to design and construct a treatment process system that will vitrify the sodium-bearing waste (SBW) to a final waste form. The project will consist of three subprojects that include the Waste Collection Tanks Facility, the Waste Vitrification Facility (WVF), and the VWISF. The Waste Collection Tanks Facility will provide for waste collection, feed mixing, and surge storage for SBW and newly generated liquid waste from ongoing operations at the Idaho Nuclear Technology and Engineering Center. The WVF will contain the vitrification process that will mix the waste with glass-forming chemicals or frit and turn the waste into glass. The VWISF will provide a shielded storage facility for the glass until the waste can be disposed at either the Waste Isolation Pilot Plant as mixed transuranic waste or at the future national geological repository as high-level waste glass, pending the outcome of a Waste Incidental to Reprocessing determination, which is currently in progress. A secondary goal is to provide a facility that can be easily modified later to accommodate storage of the vitrified high-level waste calcine.

The objective of this study was to determine the feasibility of the VWISF, which would be constructed in compliance with applicable federal, state, and local laws. This project supports the Department of Energy's Environmental Management missions of safely storing and treating radioactive wastes as well as meeting Federal Facility Compliance commitments made to the State of Idaho.

Two scenarios were evaluated during this study. The first scenario includes individual storage tubes for the vitrified waste canisters (two canisters per tube) and a passive ventilation system. This option is called the "Hanford Option," because it is modeled after the Hanford vitrified waste storage design. The second scenario includes racks for holding the vitrified waste canisters and a mechanical ventilation system. The second option is labeled the "Savannah River Option," since it is modeled after the Savannah River Site's vitrified waste storage facility. The report includes sketches, a description, and cost estimates for each option.

For each vitrified waste storage option, two canister SBW storage capacities were evaluated. The first canister storage capacity was based on a "high" SBW loading in the IWVF melter. The second storage capacity considered basically doubles the SBW canister storage capacity and is considered the "bounding case" for cost-estimating purposes. This is called the "low" waste loading case.

The total project cost of constructing the Hanford Option capable of storing 436 canisters containing vitrified SBW is $46,000,000, with a 65% confidence level. Increasing this option's canister storage capacity to 872 results in a cost increase of $21,600,000, for a total project cost of $67,600,000, with a 65% confidence level.

The total project cost for building the Savannah River Option with a canister capacity associated with the "high" SBW loading is estimated at $35,600,000, with a 65% confidence level. The total project cost increases to $47,300,000, with a 65% confidence if the canister storage capacity is doubled.

The Hanford Option is recommended for the project baseline, because the canister storage duration is uncertain at this time. This option provides lower long-term operating and maintenance costs due to the passive ventilation feature and more conservative secondary confinement in case of a breached canister. If the aforementioned features are not considered to be value-added, then significant cost savings are possible with the Savannah River Option. It is further recommended that the bounding cost estimate of

$67,600,000 be used for planning purposes at this stage. The facility sizing and cost estimate will be further refined during future design stages, as the projected waste loading and estimated canister count are better defined.

For both options, additional storage can be added later for the vitrified calcine, and no major issues were identified that would preclude the successful implementation of this project.

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David Lord, project management

Tom McIntire, environmental

Steve Reese, mechanical engineering

Dan Rowley, design and construction costs

Dave Stevens, structural engineering

Bob Turk, life-cycle costs

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ACRONYMS

AEA	Atomic Energy Act
AHJ	Authority Having Jurisdiction
CAM	Constant Air Monitor
DOE	Department of Energy
DWPF	Defense Waste Processing Facility
ECA	Environmentally Controlled Area
EIS	Idaho High Level Waste and Facilities Disposition Environmental Impact Statement
FM	Factory Mutual
FPR	Fuel Processing Restoration
HPR	Highly Protected Risk
ICPP	Idaho Chemical Processing Plant
INTEC	Idaho Nuclear Technology and Engineering Center
INEEL	Idaho National Engineering and Environmental Laboratory
IWVF	Idaho Waste Vitrification Facility
HLW	high-level waste
MCFL	Maximum Controlled Fire Loss
MPFL	Maximum Probable Fire Loss
NFPA	National Fire Protection Association
NRC	Nuclear Regulatory Commission
OCRWM	Office of Civilian Radioactive Waste Management
PSAR	Preliminary Safety Analysis Report
QA	Quality Assurance
RAM	Radiation Area Monitor

RCRA	Resource Conservation and Recovery Act
ROD	Record of Decision
SBW	sodium-bearing waste
TRU	transuranic waste
UBC	Uniform Building Code
UCNI	Unclassified Controlled Nuclear Information
UL	Underwriters Laboratory
VWISF	Vitrified Waste Interim Storage Facility
WAC	Waste Acceptance Code
WASRD	Waste Acceptance Systems Requirements Document
WVF	Waste Vitrification Facility
WIPP	Waste Isolation Pilot Plant
WIR	waste incidental to reprocessing

VITRIFIED WASTE INTERIM STORAGE FACILITY
Feasibility Study Report

1. PROJECT DESCRIPTION

This document presents a feasibility study for the Idaho Nuclear Technology and Engineering Center (INTEC) Vitrified Waste Interim Storage Facility (VWISF), which is a subproject to the Idaho Waste Vitrification Facility (IWVF) in support of the High-Level Waste (HLW) Program. The overall strategic goals of the HLW Program are to meet the Settlement Agreement objectives. These objectives include:

- Treat the stored sodium-bearing waste (SBW) and cease use of the existing waste 300,000-gal Tank Farm waste storage tanks by December 31, 2012.

- Treat the HLW so that it is ready for disposal and made road-ready for shipment out of Idaho by December 31, 2035.

- Maintain facilities and ongoing activities such as liquid waste management, Resource Conservation and Recovery Act (RCRA) closures.

The VWISF, once constructed, will provide storage capacity at the Idaho National Engineering and Environmental Laboratory (INEEL) for treated wastes prior to their shipment to a permanent disposal site. The VWISF will support the date for treating the HLW to a road-ready form.

The VWISF shall consist of the storage facility and associated waste shipping and receiving area. Administrative support is provided in the IWVF due to its close location. The VWISF shall be designed and constructed according to applicable requirements of the State of Idaho, regional, and national building codes. The VWISF and other facilities that comprise the IWVF project are required to comply with RCRA and the Settlement Agreement. The design and acquisition for the VWISF shall consider the maintainability, operability, life-cycle cost, and configuration integrity.

This feasibility study report presents a preconceptual design for the VWISF. This study examines phased construction so that storage costs for vitrified SBW can be delineated from the costs associated with storing the vitrified calcine. This report describes the design basis, technical requirements, and applicable codes and standards for the VWISF. Risk assessments of the significant technical issues are also discussed.

2. PROJECT BASIS

2.1 Project Background

The current Department of Energy (DOE) mission at INTEC, formerly the Idaho Chemical Processing Plant (ICPP), includes managing radioactive and hazardous waste previously generated from nuclear fuel reprocessing activities. One of the major remaining waste forms at INTEC is liquid mixed transuranic (TRU) waste. This waste is locally defined as SBW due to its high content of sodium and potassium. INTEC also manages/stores approximately 4,400 cubic meters of solid HLW material. In the past, SBW was blended with high-level liquid waste, to dilute the sodium and potassium concentrations so it could be more readily converted to calcine in the New Waste Calcine Facility. Calcine is a dry, granular, concentrated waste form. It is more stable but is still considered to be an intermediate waste that, in the case of HLW, requires further processing for disposal in the national geological repository.

The primary goal of the IWVF project is to design and construct a treatment process system that will vitrify the SBW to a final waste form. The project will consist of three subprojects that include the Waste Vitrification Facility (WVF), the Waste Collection Tanks Facility, and the Vitrified Waste Interim Storage Facility (VWISF). The WVF will contain the vitrification process that will mix the waste with glass-forming chemicals or frit and turn the waste into glass. The Waste Collection Tanks Facility will provide for waste collection, feed mixing, and surge storage for SBW and newly generated liquid waste from ongoing operations at INTEC. The VWISF will provide a shielded storage facility to interim store the glass until offsite, final disposal is available. A secondary goal is to provide a facility that can be easily modified to accommodate treatment of the HLW calcineat a later time. The Settlement Agreement requires that the calcine be treated by the end of 2035.

The major waste product resulting from the treatment process will be a vitrified waste glass. The glass will be placed in canisters approximately 15 ft long and 2 ft in diameter referred to as "Hanford Canisters." Under a "high" waste loading scenario in the IWVF melter, this will result in approximately 436 canisters of the treated SBW and 4,600 canisters of the treated calcine. At the time of treatment, a designated repository for the treated waste is not expected, so the VWISF will be required to store the treated waste until shipment to the final repository is possible. The waste will ultimately be disposed at either the Waste Isolation Pilot Plant (WIPP) as mixed TRU waste or the national geological repository as HLW. The final waste disposition depends upon the outcome of a Waste Incidental to Reprocessing determination, which is currently in progress

2.2 Project Justification

Failure to construct the VWISF would result in an inability to operate the treatment facilities in compliance with the current Settlement Agreement for treating the HLW and SBW and ceasing use of the existing Tank Farm. Current baseline planning to meet the Settlement Agreement date requires that the VWISF be designed and constructed in time to be operational at the same time as the SBW treatment facility.

2.3 Technical and Functional Requirements

The following is a list of preliminary Technical and Functional Requirements (T&FRs) that were used to develop this feasibility study.

- The facility will be designed for the storage of "Hanford" canisters (15-ft length).
- The facility will include the receiving and shipping support areas and storage for 436 canisters of treated SBW.
- The facility will be designed to be modular and expandable. The facility will ultimately store the treated SBW plus 4,600 canisters of vitrified HLW (calcine).
- The waste storage area will have ventilation for keeping the canisters cool.

- The design life for the structural components shall be 60 years minimum.

- The design lives for the mechanical and electrical systems shall be 20 years minimum.

- The VWISF vaults will be designed to meet the regulatory requirements for high-level waste, by-product materials (as defined by 11.e.2 of the Atomic Energy Act (AEA) of 1954, as amended), and TRU waste.

- The location of the VWISF will be determined to best interface with the waste treatment facilities.

- The VWISF will interface with the new waste treatment facilities through a tunnel system for the transfer of the filled canisters.

- The VWISF will have facilities for off-site shipment of the canisters.

- If any unusual environmental conditions are encountered, these materials shall be handled in accordance with standard Idaho National Engineering and Environmental Laboratory (INEEL) procedures.

- The VWISF will be constructed within the INTEC fence; standard access requirements will apply.

- The facilities shall be designed to withstand the climatic conditions expected for the INTEC.

- All structure openings will extend at least one foot above the peak flood water surface elevation (100 year flood plus Mackay dam failure) of 4916 ft above sea level to prevent floodwater ingress.

- A Preliminary Safety Analysis Report (PSAR) will be written during conceptual design, and a quality level will be established from that document.

- No long lead-time items are anticipated, however, this will be further investigated during design.

- The VWISF will use existing electrical, water, air, and steam utilities. The instrumentation will be tied into the distributed control system for the IWVF.

- Any components requiring periodic maintenance that are located in radioactive areas shall be designed for remote maintenance or replacement.

- Operational and maintenance features shall be consistent with INEEL policies and practices.

2.4 Project Assumptions

The following is a list of project assumptions that were used in conjunction with the T&FRs to develop this feasibility study.

- The initial canister count associated with the “high” waste loading is based upon a 35 weight percent waste loading in WVF melter and an 85% canister filling efficiency.

- The VWISF shall be seismically qualified according to PC-3. This will be confirmed or changed during the preparation of the PSAR.

- If required for excavation, blasting will be allowed with proper approval.
- The Nuclear Regulatory Commission (NRC) does not have regulatory authority in this project.
- There is no Unclassified Controlled Nuclear Information (UCNI) associated with the project.
- All canisters will be shipped off-site by railroad only for final disposal.
- All canisters will be put into top-loading casks for receiving and shipment.
- The VWISF shall be located close to the WVF.
- The waste product canisters shall be decontaminated and certified for shipment prior to their receipt for storage.
- No automatic fire fighting equipment is required.
- The VWISF will be classified as a Hazard Category II facility, according to DOE-STD-1027-92.

3. BASELINE DEVELOPMENT

The base case facility design is similar to a comparable facility, which has been built at Hanford. This design incorporates individual tubes for the storage of the canisters (two canisters stacked vertically in each tube). This facility incorporates a passive ventilation system for cooling the canisters. An alternative facility similar to the Savannah River design, which utilizes racks to hold individual canisters (one high) and requires an active ventilation system, was also evaluated but is not considered to be in the baseline.

3.1 Facility Description (Hanford Option)

3.1.1 Existing Site Conditions

A study was performed in 1997 (Holdren, 1997) that evaluated potential locations for a HLW treatment facility, interim storage facility, and low level waste landfill. The study concluded that the HLW treatment and interim storage facilities should be located at INTEC (then the Idaho Chemical Processing Plant, ICPP). While the processing concept has changed, the conclusions in that report are still valid.

Appendix A contains the site plan sketch that shows the potential location for the VWISF. Use of the Fuel Processing and Restoration (FPR) facility will not be considered because previous studies for similar facilities have shown that this site is not cost effective in this application.

The northeast portion of the plant, as with most of INTEC, consists of an alluvium deposit (well-graded gravel and sand) over basalt bedrock. Depth to bedrock is over 30 ft. The existing elevation of the site is about 4909 ft above sea level and is within the flood plain of the Big Lost River.

There are two environmental control areas (ECAs) in the vicinity of this site, as shown on the reference drawing in Appendix A. These ECAs are:

- CPP-ECA-95 as shown on INEEL Drawing 094752 is a wind blown air borne plume and is within the proposed boundary of the interim storage. This ECA covers all of INTEC and a large amount of land adjacent to INTEC, and is not expected to be restrictive for construction activities.

- CPP-ECA-83 is a perched water table and underlies all of INTEC. This ECA is not expected to be restrictive for construction activities.

3.1.2 Site Design

The interim storage facility will function to store wastes prior to off-site shipment. The first module for the proposed facility has a footprint of approximately 48-ft x 130 ft and a sloped roof reaching approximately 127 ft. The building's footprint increases to 130 ft x 275 ft when the storage modules for the vitrified HLW calcine are added.

The following criteria are considered important for the site design of the interim storage facility:

- Location (proximity to Tank Farm, Bin Sets, and WVF)
- Sufficient space
- Utility availability
- Land Use/Zoning (i.e., being consistent with land use as outlined in the INEEL Facility Land Use and Zoning Plan)
- Railroad access
- Site development.

The proposed interim storage site is located at the northeast corner of INTEC. The area is within the INTEC fenced confines, and so utilities will be available from within the plant. Additional support from plant systems will be available such as bus transportation, cafeteria, crafts/maintenance personnel, fuel supply and emergency services.

The proposed location of the interim facility is consistent with the Idaho HLW and FD EIS, DOE/EIS-0287. The location is also consistent with the INEEL Facility Long-Range Plan.

Currently, there is no railroad access to the proposed location. The location is situated within the INTEC plant in such a way that no major interferences will be encountered and the appropriate turning radius can be maintained for a railroad spur. The railroad access would enter the site from the north side.

The approximate elevation at the proposed location is 4,909 ft above sea level. This is below the required elevation of 4,917 ft. Since the elevation of the existing site is below the elevation of 4,917 ft, the exterior grade of the vitrification facility would be built up to an elevation of 4,917 ft.

3.1.3 Architectural

Drawings of the VWISF design that were modeled from the Hanford design are located in Appendix B.

The baseline VWISF is designed as a passive ventilated storage facility to safely store the HLW canisters for both SBW and calcine at INTEC. The overall footprint of the facility is approximately 130 x 275 ft and slopes up to 127 ft at the highest point. The elevation for the ground floor of the VWISF will be above the 100-year flood plain and accommodate future shipments to final repository by rail. The bottom portion of the facility consists of massive concrete walls for shielding while the upper portion is of lightweight steel frame construction, similar to that of a warehouse. It has a sloped shed like roof leading up to a high continuous flu or stack running the entire length of the facility.

The passive design storage vaults, as configured in the facility, allow convection air to travel through the storage vaults cooling its stored contents in the process. This is done by air entering near the ground on one side of the building through a concrete labyrinth (for shielding), then passing through an array of stored canisters to the other side of the building. Since the canisters heat the air as it flows by the stored canisters, it becomes less dense than the incoming ambient air. This density gradient causes the air to flow up through the building's cooling air outlet stack and out of the facility.

In order to develop a life-cycle cost estimate for the facility, the following design life parameters were assigned:

- The design life of the facility and equipment shall be a minimum of 60 years.

- All mechanical and electrical systems shall have a 20-year design life and a maintainable or replaceable life of 100 years.

The VWISF consists of three major areas. These include:

- The "charge house"

- The storage vault modules

- The shipping and receiving module.

The storage vault and shipping/receiving modules are constructed of massive reinforced concrete elements due to shielding requirements of the stored HLW and are separated from the charge house above by concrete shielding in a floor called the "charge face."

The charge house is the top story of the VWISF and is located 37 ft above grade. The completed facility will enclose a space of 130 ft x 275 ft with a minimum height of 35 ft for operational clearances of the gantry crane.

The charge house is basically a large warehouse providing only a weather tight enclosure function with economy in mind for the taxpayer. It consists of steel braced frame construction with prefinished metal roofing and siding, with some modest amount of insulation. The charge house is designed for human occupancy with monitoring capabilities. However, the number of occupants and their stay of duration are anticipated to be minimal, due to the daily rate receipt of the HLW canisters.

The charge house is not designed for conventional heating and cooling because of the anticipated occupancy durations and desire to minimize life-cycle costs. In addition, the heat discharged by the stored canisters will be dissipated using a passive air cooling system as previously described.

There are also no support areas or functions such as offices and restrooms. These services will be available in the adjacent WVF.

The floor of the charge house, referred to as the "charge face" consists of a suspended reinforced concrete slab, approximately 3 ft thick and is perforated with an indexed array of holes and shield plugs designed for placement and storage of the canisters. Each canister is inserted below the charge face and stacked two deep within individual insert tubes for interim storage.

The VWISF design includes only one gantry crane and one transporter without redundancy. The basis for this design is because there is sufficient canister lag storage in the IWVF that could be used in case of a crane failure and essential spare parts will be readily available so that operations could be back on line in a reasonable time frame (two weeks). This avoids the expense for redundant gantry crane equipment and the space required to house the spare crane system. The gantry crane is arranged to clear span the series of modular storage vaults below the charge face with capabilities of travelling the entire length of the charge hall without any direct load bearing onto the charge face floor.

The transporter is a device that is manipulated by the gantry crane. The transporter is used to receive each canister remotely through a port above the transfer tunnel from the IWVF. Once loaded with the canister, the gantry crane located above the charge face lifts the transporter to an indexed position for canister storage. The transporter remotely removes the shield plug from that indexed position and stores the plug while it moves laterally over the center of the hole and places the canister into the insert sleeve storage position below the charge face. Once the canister is stored, the transporter replaces the shield plug. The storage density is such that the canisters can be stacked two high in each insert tube. There are crush pads located at the bottom of each tube and spacers (impact inhibitor blocks) that keep the two canisters from damaging one another in case the canisters are dropped into the tubes.

The insert tubes are approximately 34 ft high and provide the structural support for the charge face. The tubes are arranged in a modular array in each storage vault directly below each array of the shield plugs in the charge face. The balance of the charge face is supported at the perimeter of each individual vault. The insert sleeves also provide secondary containment in case a canister is breached and has provisions for air monitoring and sampling. The insert sleeves not only serve as a rack support for the canisters, but are fabricated with an interior rim located at mid-height to support an impact inhibitor block for the upper canister to rest upon. This is done so that no load or impact from the upper canister is imposed onto the canister stored in the lower position.

The number of HLW canisters anticipated for storage is 4,600 canisters, and by storing the canisters two deep reflects approximately 2,300 storage positions within the facility. Thus, the total canister storage capacity for SBW and HLW glass is 5,036 with 2,518 storage positions.

The concept of supporting the dead load of the charge face with the distributed columns of the insert sleeves and keeping the transporter off of the charge face minimizes the required thickness and weight of the charge face, thus reducing cost. The approach of using the insert sleeves as distributed columns as well shoring for the concrete pour of the charge face simplifies the construction process of filling in a lid over each vault. The elimination of the shoring by the insert sleeves also removes the problems of its removal from a vault after the charge face is poured.

There are two diameters in the shield plugholes so that a stepped shield plug can be used to minimize the potential of radiation "shine" coming through the charge face. This plug hole configuration requires two concrete pours would be made. The first pour would correspond to the step in the hole or plug and the final pour would finish at the top of the charge face. Each tubular steel insert would be blocked to insure quality control of tolerances and precisely welded as indexed in the design to a base metal plate (see lessons learned from SAR of DWPF, Savannah River Site). After precise fabrication and blocking to insure tolerances, this "honeycomb" fabrication is cast in place forming the precise holes needed in the charge face.

Typically, the modular storage vaults are located at grade and are approximately 45 x 100 x 34 ft. The first module contains the shipping and receiving bay and storage for the SBW canisters. One initial module is provided with the shipping and receiving bay combined with a smaller vault for the SBW canisters. Five additional modules are required to store the HLW calcine. Historically, DOE's direction at other sites such as Hanford and Savannah River is to build not only in modules, but also in phases only as needed. The VWISF baseline preconceptual design allows for modular and/or phasing construction.

The shipping bay is approximately 100 ft long and varies in width from 17 to 30 ft with 12 ft x 18-ft overhead doors at each end. The headroom in the bay is approximately 34 ft high with anticipation that the space will be needed in the future to upright a shipping cask off of the rail car. Currently, there is no shipping cask for the canister (15 ft long) being considered. The assumed design basis for the shipping of canisters is that they will be shipped by rail in a cask that can hold multiple Hanford type (15 ft, 4.5 m) canisters. If desired, the shipping bay could accommodate truck shipments since the equipment space requirements are smaller than that necessary for rail car loading.

Although off-site shipments are not anticipated in the short-term and issues concerning the shipping cask design are undefined, a scenario for loading the rail car has been developed. Once the "road grime" and impact inhibitors have been removed from the rail car, the shipping cask (estimated at 150 tons) would be up-righted with a crane and seated against the underside of the charge face shipping port(s). The transporter above would then charge the cask with the number of canister(s) through a number of port(s) to fill cask. The lifting device or transfer head beneath the charge face shipping port(s) would need to have the capabilities like a "double door transfer" port to remove and replace the cask lid remotely. A future lightweight structure that extends the shipping bay would be constructed for housing the equipment needed to remove "road grime." This building would be constructed at approximately the same time that the new rail spur would be built.

Access into the VWISF is at grade and only through the shipping and receiving bay. An enclosed stairwell provides access for the operations crew to go up approximately 37 ft to the charge house level to receive and transfer canisters into storage. Exit doors, landings, and caged ladders are provided from the "charge house" at opposite ends of the facility.

The transfer tunnel is a design element that the VWISF must coordinate with IWVF. Although the tunnel is part of the IWVF work scope, it must interface with the VWISF. The tunnel will be located at grade and completely shielded. All canister transfers from the tunnel will occur through a port in the charge face floor. Design issues concerning the details for lifting the Hanford type canister approximately 37 ft has not been determined but it is assumed that the gantry crane located in the charge hall can be used. The tunnel and crane /canister attachment area will need cameras and/or observation shield windows with potential stairway access. The exact configuration of the transfer cart, the number of canisters it holds, and the crane/canister attachment mechanisms are unknown issues that will be addressed during conceptual design.

3.1.4 Civil

The proposed location of the interim facility will require some site development. The site is located within the flood plain with an existing elevation of 4909 ft. One alternative, which would allow the site to be developed, is to use imported fill to raise the site grade above the floodplain elevation.

The proposed location of interim storage facility should also accommodate standard sloping at excavations. In general, the subsurface profile consists of three material types. The first layer is an alluvium deposit with an approximate depth of 35 ft and classified as SW-GW (well graded sand – well graded gravel). The second layer is an old alluvium deposit with an approximate depth of 1 ft to 17.5 ft and classified as ML (silts and very fine sand). The bottom layer is basalt. The approximate elevation of basalt in this area is 4871 ft. This depth to rock would require little to no rock excavation.

Pavement of staging areas and entrance roads will also be necessary, as existing roads at the proposed facility are gravel. The installation of the railroad spur will also require earthwork to prepare the ground/base for train railcar loads.

3.1.5 Structural

The building structural system includes a reinforced concrete storage vault and the structural steel framing for the upper enclosure of the operating floor.

3.1.5.1 Storage Vault

The storage vault consists of a vault floor (basemat), vault exterior and interior compartment walls, and a vault ceiling that is also the operating floor for the storage facility. The storage vault will have sufficient height to store two 15-ft canisters. The exterior vault walls and the vault ceiling are concrete of thickness necessary to provide radiation shielding for personnel.

The vault floor is a reinforced concrete slab. It is also the basemat for the building. The thickness is presently assumed to be 3 ft. This may change as the design progresses and the loading becomes more defined.

The exterior vault walls are assumed to be 2.5-ft thick reinforced concrete supported by the vault floor. The wall thickness is based on preliminary estimates of the thickness required for shielding. Reinforcement and final thickness will be determined by subsequent design. Interior reinforced concrete walls are also necessary in some locations.

The vault ceiling is an elevated reinforced concrete slab. It is also the operating floor for the facility and contains the access openings for the steel storage tubes. This design uses the storage tubes as well as the concrete walls to provide support for the slab.

3.1.5.2 Enclosure Building

The upper enclosure building framing consists of braced structural steel main frames secondary steel framing for support of the building siding and roof decking. The frames include a deep steel truss for the top member. Much of the secondary framing will be cold formed steel purlins and girts commonly used for metal buildings.

3.1.5.3 Floor Plugs and Steel Storage Tubes

The storage tubes are large diameter carbons steel pipe. They will have sufficient wall thickness to withstand the imposed loads with some extra allowance for corrosion during the expected life of the facility.

The floor plugs or shield plugs are normal weight concrete with steel reinforcement. Some of the shield plug surfaces will be made of steel in order to resist damage from the handling operations and also to provide sealing surfaces.

3.1.6 Mechanical

To move the transporter from the transfer tunnel to the charge face and from the charge face to the shipping station, a gantry crane will be necessary. Preliminary estimates indicate that the crane will need a lifting capacity of 100 tons and a rail to rail span of 130 ft. As the weight of the canisters are more accurately determined and the radiation fields from the vitrified waste are also more accurately known, the weight of the transporter and its load can be determined. It is likely that the capacity of the crane will need to be greater than 50 tons. The current method of crane operation will have the operators at the charge face and near the transporter. Under this method of operation, the operator can position the crane and transporter. An indexing system will be used that mates the transporter to the charge face. To allow the operator to carefully position the transporter, the crane will have a radio control that may be easily carried by the operator. In addition to the radio control, the crane will have a backup pendant control.

3.1.7 Heating, Ventilating, and Air Conditioning

Since the VWISF will only have personnel during the charge and removal of waste canisters, no heating or cooling will be required for personnel comfort in the charge hall. Since the canisters have no constituents that require freeze protection, no heating will be required for the storage vaults. The canisters will require cooling. This cooling will be accomplished with a passive system that is self-regulating. The natural buoyancy of the warmer air will drive the airflow and no fans will be required to force the airflow. To regulate this airflow some controls may be necessary. This would be accomplished by sensing temperatures and flows within the VWISF and adjusting the inlet and outlet louvers to control the airflow. Controls for the VWISF airflow would be performed by the distributed control system located in the WVF.

3.1.8 Electrical

The electrical loads of the VWISF will consist primarily of the charge hall overhead lighting and the 100-ton gantry crane. Because the VWISF has passive cooling with no heating, mechanical cooling, or forced ventilation required, very little electrical power will be required for these services.

3.1.8.1 SBW Only

The following electrical loads are estimated for the Hanford Option that is designed to store the SBW canisters:

Connected Loads

Load	kVA
Lighting 6,300 ft2 x 1VA/ft2	6.3
Miscellaneous 6,300 ft2 x 0.5VA/ft2	3.2
100-ton gantry crane would need approximately	110.0

Load	kVA
Total Connected Load	119.5

Demand Loads

Load	kVA
Lighting 6,300 ft2 x 1VA/ft2 x 100%	6.3
Miscellaneous 6,300 ft2 x 0.5VA/ft2 x 100%	3.2
100-ton gantry crane would need approximately	33.0
Total Demand Load	41.5

3.1.8.2 SBW & Calcine

The following electrical loads are expected for the full-size facility:

Connected Loads

Load	kVA
Lighting (275ft x 130ft) x 1VA/ft^2	31
Miscellaneous (275ft x 130ft) x 0.5 VA/ft2	16
100-ton gantry crane would need approximately	110
Total Connected Load	157

Demand Loads

Load	kVA
Lighting (275ft x 130ft) x 1VA/ft^2	31
Miscellaneous (275ft x 130ft) x 0.5 VA/ft2	16
100-ton gantry crane would need approximately	33
Total Demand Load	80

While the electrical loads listed above may be existent, the crane and miscellaneous loads are intermittent and may not exist for much of the time. Therefore, a continuous load of less than 10 kVA are expected.

Since the VWISF will be built near the WVF and the VWISF has relatively small loads compared to that of the vitrification facility, the VWISF would receive its power from the electrical distribution system of the WVF. This will be in the form of 480/277 Vac. The gantry crane and lights will operate at 480 V and the charge hall metal halide lights will operate at 277 V. A small transformer will be located at the building outdoor electrical panel to supply any 120 Vac loads. No standby power will be necessary for the VWISF.

3.1.9 Site Utilities

The proposed location for the interim storage facility is in an area with several underground interferences (see Appendix A for drawing). Provisions to relocate the underground utilities will be made. Utilities, which need to be rerouted, include a 12-in. fire water main, and a cathodic protection system. Above ground interferences will need to be rerouted or moved to allow adequate space for the interim storage facility. The above ground interferences include the INTEC Storm Drainage System, two facility gravel roads, and a monitoring well that needs to be capped.

3.1.10 Fire Protection

The VWISF in general terms is a radioactive waste canister storage vault. Although the proposed product being stored is highly radioactive, it is not considered combustible or flammable being in the vitrified glass form stored in steel canisters. Because the occupancy (materials being stored) is considered noncombustible, the facility can be designed and constructed using mostly or only passive fire protection methods and systems. Using passive fire protection systems for construction can minimize and eliminate the more expensive active forms of fire protection. Passive fire protection systems make use of firewalls, noncombustible materials for construction, and in some places detection systems. Where as active fire protection systems are those like automatic ceiling sprinklers and automatic gaseous fire protection type systems.

Selective use of noncombustible construction and noncombustible occupancy enables this facility to have an inherent advantage to make use of mostly passive fire protection systems to satisfy fire protection requirements. The VWISF buildings fire protection systems whether passive or active shall in the event of an anticipated or expected fire, be designed to:

- Allow Occupants adequate time and minimize distance of travel to evacuate safely,
- Allow first response and fire service personnel adequate time and provide necessary building equipment for them to undertake fire fighting and rescue operations,
- Minimize damage and help avoid collapse of the building and any consequential damage to adjacent properties,
- Qualify the entire facility as per DOE Order 420.1 as a Highly Protected Risk (HPR) or Improved risk by minimizing expected fire damage using fire protection systems (passive or active) throughout the facility
- Have both the passive and active fire protection systems and components to meet all applicable D.O.E. Orders, guidelines, standards, and all other applicable governing Fire Codes used at the INEEL for new building construction. In addition, they shall meet all State of Idaho and local Authority Having Jurisdiction (AHJ) requirements.

The present proposed construction and occupancy allows possible elimination of automatic sprinkler protection in most or all areas of the facility. However, strict controls during design and construction of the VWISF are required to insure that noncombustible materials are used throughout all areas.

To eliminate the need for active fire protection systems, equipment rooms like the fan and electrical distribution areas would require firewalls and ceilings construction to separate them from the other areas of the building. Any associated computer rooms may require special protection fire systems. However, the current design indicates that the computer rooms could be installed in the main vitrification or other associated buildings, which would have active fire sprinkler protection available.

Listed below are some of the identified areas of construction that should be specifically addressed during design and construction to ensure that noncombustible materials are used:

- Insulation Materials should be noncombustible (i.e., use rock wool instead of fiberglass batting)

- Duct work and duct work insulation should be of all noncombustible construction

- Metal sandwich construction panels should be Factory Mutual approved for use without sprinkler protection being installed.

- Rigid conduit and high-temperature rated cable should be used for all the electrical installations. Trays used should have electrical cables installed in rigid conduit.

- Any roofing materials should be of noncombustible construction or rating.

- Transient combustible load should be minimized. Specific determined amounts (like any fuel or hydraulic oils) of combustibles should be used in the design of the fire rating for the concrete and reinforcement used.

- The machinery used like the overhead crane should not contribute to a fire load. Electrical wiring should be high temperature rated and noncombustible hydraulic and lubrication oils should be used if they cannot be eliminated.

The Fire Protection systems for the facility shall be designed and installed in accordance with the following governing codes, standards, guidelines and the local Authority having Jurisdiction (AHJ):

- Uniform Building Code (UBC)

- National Fire Protection Agency (NFPA)

- DOE Orders

- DOE-ID Architectural Engineering Standards

- Factory Mutual Standards (FM)

- Underwriters Laboratory (UL) Standards

- AHJ Facility Fire Protection Engineer and Building Safety Managers

In addition, the geographical location of the VWISF dictates the fire protection systems need to be designed for freezing and earthquake exposures.

3.1.10.1 Exemption Request from DOE for Noninstallation of Ceiling Automatic Sprinklers

DOE requires automatic sprinkler fire protection be installed throughout the building on all facilities being constructed over 5000 sq. ft. Because this facility will be constructed to provide the same level of protection without installing the fire sprinklers an exemption request to DOE should be applied for and approved prior to design.

3.1.10.2 Maximum Fire Loss

In addition, DOE requires that a redundant fire protection system be installed if the Maximum Probable Fire Loss (MPFL) exceeds $50 Million. Therefore, the design shall use passive and/or active fire protection methods where needed to adhere to this requirement. Attention to the design effort shall minimize any permanent and transient combustibles that could be in or pass through the building

The MPFL is defined as the maximum fire, which would be anticipated to occur with active fire suppression out-of-service, a delayed fire department response, and a sole reliance upon the physical construction and fire resistance of the building. In this condition, only 2-hr rated fire resistive construction or space separation between combustibles can be used to mitigate the loss. This concept is applied to limit the overall risk of a facility. The MPFL is the value of property within a fire area, unless a fire hazards analysis demonstrates a lesser (or greater) loss potential. This assumes the failure of all automatic fire suppression systems and manual fire fighting efforts.

The Maximum Controlled Fire Loss (MCFL) is defined as the maximum fire that would occur with active fire suppression in service and operating as currently maintained, a delayed fire department response, and the actual maximum anticipated fire loads of each building occupancy in place. This concept is applied to set an objective limit of fire protection engineering design elements, assuming all elements operate as designed

In this design it is feasible that the MPFL and MCFL will equal each other.

3.1.10.3 Radioactive Material Fire Protection

Special fire protection systems and equipment shall be provided for those areas of the building, which will be handling radioactive materials. The building's passive and active fire protection systems are to be designed to meet those required of a radioactive material handling facility. DOE orders specify to use radioactive material handling guidelines, codes and HPR standards. The following codes should also be met for radioactive material handling:

- NFPA Standard 801
- Factory Mutual Data Sheet 7-61
- DOE Standards including 6430.1A and 1066-99
- DOE-ID A&E Standards

3.1.10.4 Fire Water Containment

Firewater shall be contained to meet time/duration amounts to DOE, NFPA, and FM requirements. DOE orders and standards require that firewater runoff containment shall be addressed due to possible hazardous or radioactive contamination. It is possible that firewater may only consist of manual hose streams for this facility. Hose stream firewater applied inside the building should have runoff designs that meet:

- DOE orders and standards
- NFPA standards
- Factory Mutual Standards and guidelines

3.1.10.5 Fire Rated Structures

Fire rated walls, and fire resistance of roof structures shall meet noncombustible requirements. Coverings shall be designed and installed to match the system that passed the listing service approval process.

3.1.10.6 Underground Water Supply and Hydrants

For manual fire fighting efforts, an underground fire main is to be provided around the facility providing each building with adequate hydrants placed for easy access and good fire hose lay down. This underground fire water main will also provide lead-in water supply lines for the buildings overhead fire suppression systems. The underground fire mains shall be installed around all buildings and all outdoor work and outdoor storage areas. The underground fire water supply shall be a looped water supply using a 12-in. diameter underground pipe and connected to a gridded water supply.

Water supplies and reliability of water supplies should meet:

- DOE standards
- Factory Mutual Standards
- NFPA standards
- Local AHJ standards
- UBC standards

3.1.10.7 Fire Extinguishers

Fire extinguishers shall be provided throughout the facility using the above NFPA 10 standards and guidelines. Types of fire extinguishers used will match the occupancy exposure present.

3.1.10.8 Alarms, Emergency Communication and Egress Exiting

An alarm system and emergency communication system shall be installed in strategic locations of facility conforming to NFPA and other applicable DOE and INEEL guidelines. Egress and exits shall be arranged in accordance with NFPA 101 “Life Safety Code” and the UBC.

3.1.11 Monitoring and Control System

The radiation monitoring system of the VWISF will consist of primarily of constant air monitors (CAM) and radiation area monitors (RAM). It is anticipated that a series of CAMS will be needed at the ventilation outlet of the storage vaults to detect any airborne contamination that may be leaving the building. Such airborne contamination is considered very unlikely.

As discussed in other parts of this feasibility study, controls for the VWISF are limited and simple. The cooling and ventilation of the waste canisters will be accomplished with a passive system. Still the storage areas will require temperature monitoring. Control of the ventilation and cooling can only be managed with adjustments to the inlet and outlet louvers. While this seems limited, experiments and modeling have proven that the passive system will provide the necessary cooling.

Since the VWISF will normally have operators only during canister charges and removal, a CCTV system should be installed in the VWISF to monitor for any abnormal events such as wild bats and rabbits flying/running around. In addition to these wild critters, as a minimum, the VWISF should have cameras for the charge hall and for the transfer tunnel. The monitors for these cameras will be located in the control room of the WVF.

The controls for the transporter and gantry crane will be dedicated local controls. In other words, the crane will be a portable wireless unit while the transporter will have controls mounted on the transporter itself. Interlocks between the transporter, crane, and ports will ensure operator and equipment safety.

3.2 Alternative Description (Savannah River Option)

3.2.1 General

The alternative design for this facility is similar to the Savannah River Site Glass Waste Storage Building. The main differences between this alternative and the baseline described earlier in this report are:

- Canisters will be stored in a single height vertical configuration.
- The canister will not be stored within a sealed tube but will be held in place by a rack or fixture.
- An active ventilation system will be used to provide any necessary cooling for the canisters.

3.2.2 Civil

The site development for this alternative is assumed to be very similar to the work necessary for the baseline. The exceptions are changes that will be necessary because of a larger building footprint.

3.2.3 Architectural

The alternative design for this facility has an overall footprint of approximately 130 x 550 ft. The total building height is approximately 65 ft. A rendering sketch of the facility is located in Appendix D.

The charge house will be similar in design to the baseline alternative. Rooms for the ventilation equipment and HEPA filters will be required with some additional space for operational and maintenance support of the ventilation system.

3.2.4 Structural

The building structural system includes a reinforced concrete storage vault and the structural steel framing for the upper enclosure of the operating floor.

3.2.4.1 Storage Vault

The storage vault for the alternative is similar to the baseline design described herein except as noted hereafter.

The storage vault for this alternative will have sufficient height to store one 15-ft long canister.

The vault ceiling is an elevated reinforced concrete slab. This slab will consist of precast concrete slabs topped with cast-in-place reinforced concrete. Concrete walls and columns will support the slab.

3.2.4.2 Enclosure Building

The upper enclosure building framing consists of braced structural steel frames. These frames include deep steel truss for the top member. The framing for the charge house (enclosure building) is similar to the baseline concept except that the extensive exhaust airshafts are not required.

3.2.5 Mechanical

The mechanical equipment and systems required for this alternative are more extensive than the baseline due to the HVAC systems required. There are also differences for the carne transporter equipment due to the single canister per storage location concept.

3.2.5.1 HVAC Systems

3.2.5.1.1 Storage Vault Ventilation

An active ventilation system is required for this alternative. The design assumes that fans will be required in order to provide sufficient airflow through the required filters to provide cooling of the canisters. This includes ductwork, fans, HEPA filters, roughing filters and the instrumentation and controls associated with the system. A stack or exhaust shaft will also be required for each module.

3.2.5.1.2 Enclosure Building Ventilation

The charge house or enclosure building will have a small ventilation system to provide enough outside are for occasional building occupancy.

3.2.5.1.3 Heating Systems

No heating systems are presently anticipated. However, heat may be desirable for some maintenance activities associated with the ventilation systems. It is recommended that future design studies investigate the need for heat in limited locations.

3.2.6 Fire Protection Systems

It is anticipated that an automatic fire protection system will be required for the ventilation equipment rooms in the Savannah River Option.

3.2.7 Electrical Systems

The electrical loads of the Savannah River Option will be similar to the Hanford Option except more power is required for the forced ventilation.

3.2.7.1 SBW Only

The following electrical loads have been estimated for the Savannah River Option designed to store the SBW canisters. As shown in the tables below, the ventilation adds approximately 100 kVA to the electrical demand. Still this load can be supported by the electrical distribution system of the WVF. The one substantial addition to the electrical distribution system for this alternative will be a motor control center for the fans.

Connected Loads

Load	kVA
Lighting 9,100 ft2 x 1VA/ft2	9.1
Miscellaneous 9,100 ft2 x 0.5VA/ft2	4.6
100-ton gantry crane would need approximately	110.0
Supply air fans 9,100/37,500 x 160 Hp x 0.746/0.9	32.2
Exhaust air fans 9,100/37,500 x 452 Hp x 0.746/0.9	91.2
Total Connected Load	247

Demand Loads

Load	kVA
Lighting 9,100 ft2 x 1VA/ft2 x 100%	9.1
Miscellaneous 9,100 ft2 x 0.5VA/ft2 x 100%	4.6
100-ton gantry crane	33.0
Supply air fans 67% x Connected Load	21.6
Exhaust air fans 67% x Connected Load	61
Total Demand Load	129.3

3.2.7.2 SBW & Calcine

The following connected loads are expected for the full-size Savannah River Option facility:

Connected Loads

Loads	kVA
Lighting (550 x 130 ft) x 1VA/ft^2	72
Miscellaneous (550 x 130 ft) x 0.5 VA/ft2	36
100-ton gantry crane	110
Supply air fans 71,500/37500 x 160 hp x 0.746/0.9	252
Exhaust air fans 71,500/37500 x 452 hp x 0.746/0.9	723
Total	1183

While the electrical loads listed above may be connected, the actual power requirements will be less. The crane and miscellaneous loads are intermittent and may not exist for much of the time. Also, the fans are normally operated with a ratio of two running and one on standby. With this in mind, an estimated continuous load of 707 kVA is expected. This estimation is presented below.

Demand Loads

Loads	kVA
Lighting 72 kVA x 90%	65
Miscellaneous 36 x 75%	27
100-ton gantry crane would need approximately 110 x 30%	33
Supply air fans 67% x Connected Load	169
Exhaust air fans 67% x Connected Load	478
Total	772

With a demand of 772 kVA, this alternative would likely have its own feed from the WVF substation. Using 480 V from a WVF load center would require oversized conductors to ensure that voltage drops do not occur. This alternative, like the one previously, would also require at least one or perhaps two motor control centers for the operation of fan motors.

4. PROJECT, LIFE-CYCLE AND D&D COST ESTIMATES

4.1 Options

4.1.1 Hanford Option

4.1.1.1 SBW Storage Only – High Waste Loading

Although the VWISF will store the vitrified products for both the SBW and the calcine, the base case construction scenario and life-cycle costs reported here are for building only the storage area and supporting structure necessary to handle the vitrified SBW (i.e., 436 canisters). The supporting structures include the shipping and receiving stations, gantry crane and transporter.

The total estimated project cost for designing and constructing a facility for receiving, shipping and storing the vitrified SBW is $46,000,000, at a 65% confidence level. The detailed cost estimate is contained in Appendix F. This case represents the minimum cost for storing the vitrified SBW in a storage facility modeled after the Hanford design. Listed below in Table 4-1 is the summary cost estimate.

Table 4-1. Project Summary Cost Estimate

Operating Funded	**Cost Range**
Conceptual Design Activities	$2.42M to $2.94M
Project Acceptance	$.58M to $.76M
Total Operating Cost (OPC)	$3.00M to $3.70M
Capital Funded	**Cost Range**
Project Management / Administration	$2.28M to $2.73M
Project Support / System Development	$3.70M to $4.43M
Safety / Quality Assurance	$2.03M to $2.40M
Title I Design	$.91M to $1.12M
Title II Design	$1.76M to $2.05M
Construction Design Engineering Support	$.23M to $.26M
Construction Subcontracts	$19.50M to $23.00M

Construction Support	$1.21M to $1.56M
Construction Quality Control	$.19M to $.19M
Construction Document Verification	$.10M to $.13M
Construction Management	$2.07M to $2.83M
G&A / Procurement	$1.11M to 1.42M
Total Capital Cost (TEC)	$34.91M to $42.95M
Total Project Cost (TPC)	$37.91M to $46.64M

A life-cycle cost (LCC) analysis was performed using the following design, construction, and operating schedule:

Conceptual Design	FY 2003
Title Design	FY 2005 – 2006
Construction	FY-2011 – 2013
Fill Storage Facility	FY-2015 – 2020
Maintain Storage Facility	FY-2021 – 2060
Load-out and Ship SBW to Permanent Depository	FY-2061 – 2071
DD&D Storage Facility	FY- 2072

The discounted LCC for the storage of SBW only using the Hanford Option is $41,000,000. The assumptions and details for the LCC analysis are presented in Appendix F.

4.1.1.2 SBW Storage Only – Low Waste Loading

Since the number of canisters to be stored is a strong function of the waste loading in the VWF's melter, a second cost estimate was made for storing twice as many canisters (872). This was made to assess the sensitivity of the cost to the number to storage containers. Doubling the container storage capacity for the Hanford Option increases the cost to $67,600,000 at the 65% confidence level. This is a 47 % increase from the high waste loading case. The discounted LCC for this case is $58,000,000.

4.1.1.3 Vitrified SBW and Calcine Storage

The total estimated project cost for designing and constructing a Hanford Option facility for receiving, shipping and storing the vitrified SBW and the vitrified calcine is $291,000,000, at a 65% confidence level. The discounted LCC for the storage of SBW and calcine is $210,000,000.

4.1.2 Savannah River Option

4.1.2.1 SBW Storage Only – High Waste Loading

The construction scenario and life-cycle costs reported here are for building only the storage area and supporting structure necessary to handle the vitrified SBW (i.e., 436 canisters). The supporting structures include the shipping and receiving stations, gantry crane and transporter.

The total estimated project cost for designing and constructing a facility for receiving, shipping and storing the vitrified SBW is $35,600,000, at a 65% confidence level. The cost estimate for a vitrified product storage facility similar to the Savannah River Site is located in Appendix F. The discounted LCC for the storage of SBW only is $35,000,000.

4.1.2.2 SBW Storage Only – Low Waste Loading

Doubling the canister storage capacity using the Savannah River Option, increases the total project cost to $47,300,000 at a 65% confidence level. On a percentage basis, this is a 33% increase compared to the high waste loading case. The discounted LCC for this case is $47,000,000.

4.1.2.3 Vitrified SBW and Calcine Storage (Savannah River Option)

The total project cost estimated for designing and constructing a facility for receiving, shipping and storing the vitrified SBW and the vitrified calcine is $161,000,000, at a 65% confidence level. The primary reason for the significant cost savings when comparing it to the Hanford Option is because this storage design does not stack the canisters containing the vitrified waste in secondary containment tubes. Rather, the canisters are directly stored in a single layer using a rack design to hold them vertical. The discounted LCC for the storage of SBW and calcine is $133,000,000.

4.2 Project Summary Schedule

The summary schedule for the VWISF is:

CD-0 Approval – Start Conceptual Design	January 1, 2003
CD-1 Approval – Start Title I Design	January 1, 2005
CD-2 Approval – Start Title II Design	January 1, 2006
CD-3 Approval – Start Construction	January 1, 2011
CD-4 Approval – Start Operations	January 1, 2015

5. ALTERNATIVES CONSIDERED

5.1 Evaluation Criteria

Both design alternatives assume that the following criteria applies:

- Secondary confinement of the waste products primarily confined by the stainless steel canisters is required.
- The canisters must be protected from the effects of natural phenomena (earthquakes, wind, flood, wild fire, etc.)
- Some type of monitoring for integrity of the canisters is required.
- The canisters must be cooled.

5.1.1 Alternatives Analysis

The baseline alternative (Hanford Option) uses steel storage tubes for secondary confinement. It also provides tertiary confinement by means of the reinforced concrete storage vault. The Savannah River Option does not provide tertiary confinement. It depends on the storage vault and the ducts and filters in the ventilation system for secondary confinement. The Hanford Option also limits any possible contamination from the failure of a canister to a single storage tube. Failure of a canister in the Savannah River Option would contaminate a much larger area within the storage building.

The Hanford Option provides three physical barriers between the waste and floodwater, fires exterior to the building and wind blown missiles. The Savannah River Option provides only two barriers. Both options will provide support and protection for the canisters in the event of any earthquake. The ability of either option to comply with monitoring requirements depends on what type of monitoring will be acceptable to the approving agencies. The tubes in the Hanford Option make a visual (by camera or other means) inspection of the canister more difficult than the Savannah River Option. However, the tube may make monitoring of some parameters easier. For example, an air sample from a tube may be a better indicator of possible canister failure than air samples from the vault storage area. Further study of the monitoring requirements for the facility are required.

The Hanford Option uses passive airflow around the storage tubes to cool and tube and therefore keep the canisters below the temperatures that may damage them or the facility. The Savannah River Option allows air to directly flow over the canister surface. This should allow better direct cooling of the canister. However, the Savannah River secondary confinement requires HEPA filtering and thus a forced air ventilation system.

When considering adding the storage for the HLW glass produced from the calcine, then the Savannah River Option is favored due to the lower capital cost. Although the Hanford Option has lower operating and maintenance costs, they are not sufficient to match the LCC for the Savannah River Option.

6. PROJECT ACQUISITION STRATEGY

INEEL engineering personnel will perform the advanced conceptual and title design for the new facility. A subcontractor selected by competitive bid will perform the construction. The subcontractor will procure standard components during the construction work period. Any long-delivery or specially engineered components identified during the design process will be procured as Government-Furnished Equipment. The figure below gives the preliminary work breakdown structure:

7. WASTE ACCEPTANCE REQUIREMENTS

The Waste Acceptance Criteria (WAC) for Yucca Mountain and WIPP were reviewed for potential applicability to the VWISF. As mentioned under project assumptions, the vitrified waste and canisters will be certified ready for shipment prior to receipt at the VWISF. However, the VWISF must be designed and operated such that it will not impede the waste certification process nor cause any containerized waste to become unacceptable due improper storage conditions.

7.1 Yucca Mountain Waste Acceptance Requirements

The following interim storage requirements for the vitrified waste were obtained from reviewing the Waste Acceptance Systems Requirements Document (WASRD) for the Yucca Mountain disposal facility. Specifically, the following set of excerpts is from a U.S. Department of Energy, Office of Civilian Radioactive Waste Management (OCRWM) Program-level controlled document, DOE/RW-0351, Rev 04D, Civilian Radioactive Waste Management System "Waste Acceptance System Requirements Document," February 2000.

7.1.1 Compliance with Hazardous Waste Regulations

The CRWMS shall only accept SNF and HLW that are not subject to regulation as hazardous waste under the Resource Conservation and Recovery Act of 1978 (RCRA) Subtitle C for the first geologic repository licensed by the NRC under the NWPA.

7.1.2 Physical Condition of Canisters at Time of Delivery

Once cooled, the phase structure and composition of the vitrified HLW glass shall be preserved by maintaining the waste form at a temperature below 400°C to ensure the glass-transition temperature is not exceeded.

7.1.3 Dimensional and Weight Envelopes for Loaded HLW Canisters

The following are applicable for sizing the VWISF and the canister handling equipment.

The loaded HLW canisters, including the lifting flange and canister neck, shall have the capability to stand upright without support on a flat horizontal surface and shall have:

- a maximum diameter of 24.6 in. (62.5 cm) and a maximum length of 118.138 in. (3.005 m) for the "short" canisters
- a maximum diameter of 24.6 in. (62.5 cm) and a maximum length of 177.4 in. (4.505 m) for the "long" canisters (both "long" canister dimensions TBV-X08)
- a minimum diameter of 23.6 in. (60.0 cm) and a minimum length of 117.3 in. (2.980 m) for the "short" canister
- a minimum diameter of 23.6 in. (60.0 cm) and a minimum length of 176.4 in. (4.480 m) for the "long" canister.

The canister shall have a maximum cylindricity such that it is capable of fitting without forcing (when lowered vertically) into a right-circular cylindrical cavity whose dimensions are:

- 25.20 in. (64.00 cm) diameter by 118.50 in. (3.01 m) length for the "short" canister

- 25.59 in. (65.00 cm) diameter by 181 in. (4.60 m) length for the “long” canister (both “long” canister dimensions TBV-X08).

The loaded HLW canister shall have a weight not to exceed:

- 5,512 lb (2,500 kg) for the “short” canister
- 9,260 lb (4,200 kg) for the “long” canister.

7.1.4 External Contamination

The level of nonfixed (removable) radioactive contamination on external HLW canister surfaces at the time of loading into transport casks shall not exceed:

- <220 dpm/100 cm^2 for alpha emitting radionuclides (TBV-X03)
- <2,200 dpm/100 cm^2 for beta and gamma emitting radionuclides (TBV-X03).

7.1.5 Dimensional and Weight Envelopes for Loaded HLW Casks

The following restrictions are applicable for sizing the VWISF shipping system and cask handling equipment.

7.1.5.1 Combined Cask/Carrier Dimensions

Loaded rail carriers shall have a maximum size of:

- 67.5 ft (20.6 m) in length (excluding couplers)
- 144 in. (3.66 m) in width
- 181 in. (4.60 m) in height (vertical clearance).

7.1.5.2 Combined Cask/Carrier Weight Limits

The combined loaded rail cask package (waste, canister, cask, and impact limiters) shall not exceed 150 tons (136 metric tons).

7.1.6 Storage and Shipping Records

Storage and Shipping Records are the documents that describe the physical attributes of the canistered waste forms. The records also identify any unexpected events, such as thermal excursions, which have occurred during storage. The purpose for the records is to indicate that the vitrified HLW did not exceed 400°C after initial cool-down to ensure the glass transition temperature was not exceeded.

7.2 WIPP Waste Acceptance Criteria

The following information was taken from the remote handled RH-WAC, Rev. 0, DOE/WIPP Draft 16-3123).

7.2.1 Payload Container Acceptance Criteria

Each waste payload container and any sealed secondary containers greater than 4 liters in size overpacked in the payload container must have one or more filter vents. Filter vents are optional on metal secondary containers containing solid inorganic waste only.

The payload container shall be DOT Type A or equivalent and meet requirements of the RH-TRU 72-B Cask SAR. Weight of loaded DOT Type A container must not exceed the tested values; 5,250 lb when direct loaded or 5,980 lb when loaded in three 55-gal drums or 30-gal drums prior to placement in the RH canister. Higher weight limits will be allowed upon appropriate testing. (Reference 6)

The payload containers shall be DOT Type A or equivalent and meet requirements of the CNS 10-160B Cask SAR.

Weight of contents, shoring, secondary containers, and optional shield insert must not exceed 14,500 lb.

Sealed containers > 4 liters are prohibited except for metal containers packaging solid inorganic waste.

Hazardous wastes are limited to those having hazardous waste codes listed in Attachment O of the WIPP Hazardous Waste Facility Permit.

7.2.1.1 External Contamination

- >200 mrem/hr and ≤1000 rem/hr at the surface of the payload container
- ≤200 mrem/hr at the surface of the shipping cask
- ≤ 10 mrem/hr at 1 m from the surface of the shipping cask

7.2.1.1.1 Removable surface contamination

- < 20 disintegrations per minute (dpm)/ 100 cm^2 for alpha
- < 200 dpm/ 100 cm^2 for beta-gamma

Fixing of surface contamination is prohibited.

8. PROJECT RISKS

The project team identified the technical risks associated with the VWISF using the criteria provided in PLN-909, *Risk Management Plan for the Idaho Waste Vitrification Facilities Project*. The risks that were rated "high" are discussed below. The complete list of VWISF Project risks is contained in Appendix G.

8.1 Technical Risks

8.1.1 Project Interfaces

The shipping cask necessary to ship the canistered waste offsite has not yet been designed. Therefore, the shipping cask requirements and interfaces with the VWISF structures, systems, and components are not identified or defined. It is not expected that these interfaces will be available in time to support Title I design.

RECOMMENDED RESOLUTION: Generic space for the shipping bay has been included within the facility. An estimate of the costs for the interfaces has been included. The latest information at the time of design will be used to design the cask handling system.

8.1.2 Number of SBW Canisters

Assuming a waste loading of 35 wt %, the number of SBW canisters have been estimated to be 436. However, if the waste loading decreases, then the number of canisters increases. If the number of SBW canisters to be stored in the VWISF increases after CD-1 due to a reduction in the waste loading at the melter, the cost for the increased storage could be significant.

RECOMMENDED RESOLUTION: The current design and estimate is based upon the best data to date. The facility is designed to be expandable, so there is no real technical risk if the number of canisters to be stored increases, however a significant cost increase will occur as described earlier in this report.

8.1.3 Quality Assurance Requirements

Depending upon the final WIR determination for the SBW, the VWISF Quality Assurance (QA) requirements may change from NQA-1 to 0333P (NRC).

RECOMMENDED RESOLUTION: The quality assurance should meet 0333P so not to preempt the facility's future expansion and ability to store vitrified calcine. Since calcine is an HLW, it must meet NRC requirements for ultimate disposal at Yucca Mountain.

The primary change would be an increase in paperwork associated with the more stringent requirements. This would result in a cost increase, but no change to the technical basis of the design.

8.1.4 Condensation in the Storage Tubes

It is speculated that condensation could occur in the annular space between the canister and storage tubes. The seasonal changes in the ambient air temperature and humidity could cause this phenomenon. If the water accumulates in the VWISF vaults or storage tubes it could corrode the storage tubes significantly and adversely effect the building's structural integrity.

RECOMMENDED RESOLUTION: Water accumulation in the vault should not be a long-term problem. The constant flow of ventilation air for cooling the vault should keep the vault dry. The radioactive decay heat from the stored canisters should keep the tubes dry for the design life of the facility; however, this could be a problem after the canisters have been stored for some time. Other possibilities include the use of stainless steel liners (which would greatly increase the cost) or include drains from the liners to a sump. This is an advantage for the alternative Savannah River design since there are no storage tubes to collect the water.

9. CONSTRUCTABILITY REVIEW

The construction of the VWISF will involve standard industrial construction materials and methods. Further constructability review will be performed during future design stages.

10. RECOMMENDATIONS

The following items were identified as requiring additional study during further feasibility studies and/or conceptual design.

10.1 Recommended Option

It is recommended that the Hanford Option be retained as the project baseline because the canister storage duration is uncertain at this time. This option also provides lower long-term operating and maintenance costs due to the passive ventilation feature and more conservative secondary confinement in case of a breached canister. If the aforementioned features are not considered to be value-added, then significant cost savings are possible with the Savannah River Option. It is further recommended that the bounding cost estimate of $67,600,000 be used for planning purposes at this stage in the project. The facility sizing and cost estimate will be further refined during future design stages, as the projected waste loading and estimated canister count are better defined.

10.1.1 Passive Ventilation

The canister cooling and building cooling design for the Hanford Option requires a detailed analysis. The analysis should also indicate whether condensation in the storage tubes would be a problem.

10.2 Savannah River Option

The Savannah River Option should be examined more extensively if the project believes that the storage facility is indeed “temporary.” The study should include detail on this option’s HVAC requirements and associated life-cycle costs.

10.3 Canister Examination Room

The Savannah River Site’s interim storage facility provides a canister examination facility. The needs and costs for this capability should be examined and evaluated for both options.

10.4 Fire Protection

A petition should be made to DOE to exempt the VWISF from using a preemptive fire protection system in the canister storage area. If this petition is unsuccessful, significant costs will be added to the project.

11. REFERENCES

Rawlins, J. K., "Interim Storage Study Report," INEEL/EXT-97-01393, February 1998.

October 17, 1995, *Consent Order and Settlement Agreement between DOE and the State of Idaho Regarding Spent Fuel and Nuclear Waste Issues.*

Snedden, M. S. et al., "HLW Vitrification Facility Siting Study," EDF-2704, August 2001.

12. APPENDICES

A Site Location Plan
B Drawings for SBW (Hanford Option)
C Drawings for SBW and Calcine (Hanford Option)
D Sketches (Rendering) for SBW and Calcine (Savannah River Option)
E Cost Estimates
G Risk Assessment