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Staging and Storage Facility Feasibility Study Final Report

C.E. Swenson
Westinghouse Hanford Company, Richland, WA 99352
U.S. Department of Energy Contract DE-AC06-87RL10930

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Abstract: This study was performed to investigate the feasibility of adapting the design of the HWVP Canister Storage Building (CSB) to meet the needs of the WHC Spent Nuclear Fuel Project for Staging and Storage Facility (SSF), and to develop Rough Order of Magnitude (ROM) cost and schedule estimates.

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STAGING AND STORAGE FACILITY FEASIBILITY STUDY Final Report

Prepared for
Westinghouse Hanford Company

Prepared By
Fluor Daniel, Inc.
Government Services Operating Company
February 1995

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SSF FEASIBILITY STUDY

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LIST OF ACRONYMS

B&O	Business and Occupation Tax
CEDE	Committed Effective Dose Equivalent
CFD	Computational Fluid Dynamic
CSB	Canister Storage Building
DBA	Design Basis Accident
DBE	Design Basis Earthquake
DBW	Design Basis Wind
ES&H	Environmental, Safety and Health
F&Rs	Functions and Requirements
FHA	Fire Hazards Analysis
HWVP	Hanford Waste Vitrification Plant
ICE	Independent Cost Estimate
ISFSIs	Independent Spent Fuel Storage Installations
K-D	Key Decision
LANL	Los Alamos National Laboratory
MAR	Material At Risk
MCO	Multi-Canister Overpack
MIC	Microbiologically Influenced Corrosion
MOI	Maximum Offsite Individual
NPH	Natural Phenomena Hazards
PHA	Preliminary Hazards Analysis
RCRA	Resource Conservation and Recovery Act
RF	Release Fraction
ROM	Rough Order of Magnitude
RR	Respiration Rate
SAR	Safety Analysis Report
SC	Safety Class
SCT	Shielded Canister Transporter
SNF	Spent Nuclear Fuel
SS	Stainless Steel
SSCs	Structures, Systems and Components
SSF	Staging and Storage Facility
SWP	Special Work Procedure
TSR	Technical Safety Requirements
WAC	Washington Administrative Code
WBS	Work Breakdown Structure
WHC	Westinghouse Hanford Company
TWRS	Tank Waste Remediation System

EXECUTIVE SUMMARY

This study was performed to investigate the feasibility of adapting the design of the HWVP Canister Storage Building (CSB) to meet the needs of the Westinghouse Hanford Company (WHC) Spent Nuclear Fuel Project for a Staging and Storage Facility (SSF) and to develop Rough Order of Magnitude (ROM) cost and schedule estimates. The SSF is to store spent N-Reactor fuel in Multi-Canister Overpacks (MCOs) filled with water until a Stabilization Facility is available to stabilize the fuel. After stabilization of the fuel the MCOs will be returned to the SSF for storage until a geologic repository is available for final disposal. The study investigated two concepts for the SSF which were selected by WHC, 1) the use of water cooling prior to stabilization of the fuel followed by passive dry storage, and 2) the use of refrigerated air cooling prior to stabilization followed by passive dry storage.

The design criteria for the study stipulated that the water temperature in the MCO prior to stabilization is to be limited to 50° F maximum and the fuel centerline temperature after stabilization is to be limited to 400° F maximum.

The study found that it is feasible to adapt the design and partially completed construction of the CSB to meet the functions and requirements of the SSF using either of the specified concepts.

Under Concept 1, the MCOs are stored in racks in a single layer in an open pool of water with a recirculating water treatment system which returns the water to the pool at 44-45° F. This portion of the SSF utilizes approximately 1/3 of the completed CSB foundation. The balance of the facility, which utilizes the remaining 2/3 of the CSB foundation and the design of the CSB dry storage vaults, is constructed so that it is operational at the same time as the Stabilization Facility. After stabilization, the MCOs are returned to the newly constructed dry storage vaults of the SSF, where they remain in passive dry storage until a geologic repository is available for final disposal.

Two alternatives were evaluated under Concept 1. Alternative 1 B provides 512 storage tube locations for dry storage in two vaults and does not require any addition to the CSB foundation footprint. Alternative 1 C provides 660 storage tubes and requires the addition of space for another vault to the CSB footprint.

Under Concept 2, the MCOs are stored in two layers in water filled tubes extending into three, below grade, concrete enclosed, shielding vaults cooled by recirculating 35°F refrigerated air. This utilizes the entire foundation and design of the CSB. After stabilization, the storage tubes are drained of water and the MCOs reinstalled. When all the MCOs have been stabilized, the recirculating refrigerated air system is shut down and natural circulation passive air cooling established.

The study also included an evaluation of the use of a Shielded Canister Transporter vs. an overhead cask/crane system to install and remove the MCOs from the storage tubes. This evaluation resulted in the conclusion that the overhead cask/crane system is preferred. Concepts 1 and 2 were therefore both evaluated on the basis of an overhead cask/crane system.

The results of an evaluation of the cost, schedule, safety, technical feasibility and other factors for Alternative 1B, 1C and 2A are presented in Table 1. Other, less costly, alternatives which could be used if the 50°F MCD temperature requirement prior to stabilization were relaxed were also evaluated.

TABLE 1 - EVALUATION OF CONCEPTS 1 AND 2

	ALTERNATIVE 1B		ALTERNATIVE 1C		ALTERNATIVE 2A	
CAPITAL COST (ESCALATED) \$ MILLIONS	PHASE 1 PHASE 2 TOTAL	74.9 40.0 114.9	PHASE 1 PHASE 2 TOTAL	76.1 57.4 133.5	PHASE 1 PHASE 2 TOTAL	137.2 -- 137.2
OPERATING COST DELTA \$ MILLIONS	BASE		BASE		+2.2	
SCHEDULED START OF OPERATIONS	NOVEMBER 1997		NOVEMBER 1997		DECEMBER 1997	
SAFETY	PREFERRED		PREFERRED		LESS DESIRABLE	
TECHNICAL FEASIBILITY	NO FEASIBILITY QUESTIONS		NO FEASIBILITY QUESTIONS		SS CORROSION WITH STAGNANT H ₂ O IN TUBES UNRESOLVED	
OTHER	-ALLOWS DEFERRAL OF PHASE 2 PROCUREMENT AND CONSTRUCTION COST UNTIL FY 2001 -PROVIDES 512 STORAGE TUBES. COULD ACCOMMODATE THE EQUIVALENT OF 1200 MCOs DURING STORAGE BY VOLUME REDUCTION -PROVIDES AVAILABLE POOL STORAGE SPACE FOR OTHER SITE USES AFTER STABILIZATION		-ALLOWS DEFERRAL OF PHASE 2 PROCUREMENT AND CONSTRUCTION COST UNTIL FY 2000 -PROVIDES 660 STORAGE TUBES -PROVIDES AVAILABLE POOL STORAGE SPACE FOR OTHER SITE USES AFTER STABILIZATION		-PROVIDES 660 STORAGE TUBES	

1.0 INTRODUCTION

1.1 BACKGROUND

In October 1994, Westinghouse Hanford Company (WHC) published a report (WHC-EP-0830) entitled Hanford Spent Nuclear Fuel Project Recommended Path Forward. That report described a recommended approach for expedited removal of spent nuclear fuel, including sludge, from the K Basins at Hanford and its placement in a stable dry storage configuration until final disposition is possible. An essential part of the recommended approach was the use of a new facility, called the Staging and Storage Facility (SSF), to perform two principal functions. The first is to provide safe storage for the wet fuel and sludge from the K Basins until it can be dried and passivated in another new facility, the Stabilization Facility. The second principal function of the SSF is to provide passive dry storage of the stabilized fuel and sludge until final disposition.

Although the location of these new facilities was not selected, movement of the spent nuclear fuel and sludge away from the Columbia River is an important objective. One of the leading options being considered is the construction of the required facilities within the 200 Area of the Hanford Reservation. This approach is most compatible with current plans to centralize future Hanford Reservation waste operations in the 200 Areas.

Another related project, which had previously been initiated to vitrify Hanford defense liquid high-level wastes into borosilicate glass, is the Hanford Waste Vitrification Plant (HWVP) Project. This project, which was to be located in the 200 East Area, included a Canister Storage Building (CSB) to provide passive dry storage of stainless steel canisters containing the borosilicate glass until they could be sent to a geologic repository. Design of the CSB was complete and construction was underway when the HWVP Project was put on hold in 1993. Figures 1-1 and 1-2 show the status of CSB construction after work was halted in October 1993.

Since the functions of the SSF and CSB are very similar, since the CSB is located in an area that is a prime candidate for the SSF, and since there are no other current plans to resume construction of the HWVP or otherwise utilize the partially completed CSB, it was logical to consider whether the CSB design and construction could be adapted to meet the needs of the SSF. If this were

possible, it could result in significant cost and schedule benefits to the WHC Spent Nuclear Fuel Project. This study was therefore initiated to investigate the technical feasibility of the adaptation and quantify the resultant cost and schedule benefits.

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FIGURE 1-1, CANISTER STORAGE BUILDING CONSTRUCTION, 10/27/93

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FIGURE 1-2, CANISTER STORAGE BUILDING CONSTRUCTION, 11/12/93

1.2 STUDY OBJECTIVES

The objectives of this study were to determine the technical feasibility of adapting the design of the CSB to meet the functions and requirements (F&Rs) of the SSF and to develop rough order of magnitude (ROM) cost and schedule estimates for feasible alternatives.

1.3 SCOPE OF WORK

WHC defined two concepts for evaluation, one using water cooling prior to stabilization and the other using refrigerated air. Both concepts were to use passive dry storage technology after stabilization. The following is the scope of work for the study:

- 1.3.1 Evaluate the technical feasibility of converting the CSB to provide temporary water pool storage of unstabilized N-Reactor fuel contained within multi-canister overpacks (MCO's). Determine if the existing CSB footprint provides adequate pool storage space and if it is practical to convert the facility to passive dry storage of stabilized fuel. Develop conceptual process flow diagrams and facility layout drawings, including the addition of a rail tunnel shipping cask unloading station, for feasible alternatives. In consultation with WHC, select one preferred alternative for evaluation under 1.3.4 and 1.3.5.
- 1.3.2 Evaluate the technical feasibility of converting the CSB to provide temporary refrigerated-air cooled storage of unstabilized N-Reactor fuel contained within MCO's. Determine if the fuel temperatures within the MCO's can be maintained within acceptable limits and if it is practical to convert the facility to passive dry storage of stabilized fuel. Develop conceptual process flow diagrams and facility layout drawings, including the addition of a rail tunnel shipping cask unloading station, for feasible alternatives. In consultation with WHC, select one preferred alternative for evaluation under 1.3.4 and 1.3.5.
- 1.3.3 Perform a parametric qualitative evaluation of the cost of a transporter cask system (similar to HLW canister transporter) versus an overhead crane system as a function of MCO size and weight.
- 1.3.4 Perform a comparative evaluation of the safety issues associated with the selected concepts defined in 1.3.1 and 1.3.2.

- 1.3.5 Using existing CSB estimates and schedules as a basis, develop ROM cost estimates and schedules for the selected concepts defined in 1.3.1 and 1.3.2.
- 1.3.6 Prepare a written report documenting the results of the above investigations.

1.4 DESIGN BASIS

Many of the design features of the interfacing transportation, packaging and stabilization systems were not defined at the time of this study. In order to establish a common design basis between this study and a parallel study of a greenfield SSF being performed by ICF Kaiser Hanford, WHC provided the functions and requirements information contained in Appendix 1 and the results of a SSF Value Engineering/Study Analysis Session which had been conducted in December 1994 as the basis for this study. Since this design basis did not include definition of the Multi-Canister Overpack (MCO) and transportation cask configurations, it was necessary to perform the study on the basis of assumed characteristics for these components.

2.0 EVALUATION OF ALTERNATIVES

2.1 CONCEPT 1 - POOL/PASSIVE DRY STORAGE

2.1.1 Description of Alternatives Considered

The CSB was designed as vault type, natural convection cooled, storage facility for vitrified high-level radioactive wastes. As shown in Drawings H-2-117795 and H-2-117798, the CSB was divided into three equally sized vaults with common inlet and exhaust plenums. At the time construction was halted, the base mat and portions of the north and east walls had been built. The selection of alternatives to be considered was based on the premise that maximizing reuse of the previously completed engineering and construction would also maximize the cost and schedule savings which could be realized.

The configuration and capacity of the CSB were essentially a perfect match for the passive dry storage phase of SSF utilization. The 660 storage tubes can accommodate 2 MCOs each, giving a total storage capacity slightly in excess of the 1200 MCO design basis. The heat load of the MCOs is significantly less than that of the vitrified glass canisters so cooling was not expected to be a problem. The challenge was to find safe, practical and cost effective ways in which the facility design could be adapted to provide for water cooled storage of the MCOs prior to stabilization of the fuel and conversion of the facility to passive dry storage.

The following is a brief summary description of the four alternatives that were considered:

Alternative 1A Open pool storage of 1200 MCOs in racks in vaults 2 and 3 during staging, with transfer of MCOs in vault 2 to vault 1 passive air cooled storage tubes after stabilization. Vault 2 pool facilities are then converted to passive air cooled vault storage after all MCOs have been removed and receive stabilized MCOs from vault 3. Vaults 1 and 2 contain 512 storage tubes with an overhead crane or 440 storage tubes with a shielded transporter. Vault 3 is retained as a storage pool for other uses after all MCOs have been removed.

Alternative 1B Open pool storage of 1200 MCOs in racks in vault 3 during staging, with transfer of MCOs to passive air cooled storage tubes in vaults 1 and 2 after stabilization. Vaults 1 and 2 contain 512 storage tubes with an overhead crane or 440 storage tubes

with a shielded transporter. Vault 3 is retained as a storage pool for other uses after all MCOS have been removed.

Alternative 1C Open pool storage of 1200 MCOS in vault 3 during staging, with transfer of MCOS to passive air cooled storage tubes in vaults 1, 2 and 4 after stabilization. Vault 4 is a new vault to the north of vault 1 which will be identical to vaults 1 and 2, giving a total of 660 storage tubes. Vault 3 is retained as a storage pool for other uses after all MCOS have been removed.

Alternative 1D Storage of 1200 MCOS in water filled tubes in water filled vaults 1, 2 and 3 during staging. MCOS are removed and returned to the water filled tubes after stabilization. After all fuel is stabilized, the water in the vaults is drained and passive air cooled storage is initiated.

Alternatives 1A and 1B are based on using the existing CSB footprint for the SSF, with two of the three vaults being used for passive dry storage after stabilization. Investigation revealed that it would not be practical to reduce the spacing between storage tubes, so these alternatives provide storage capacity for 1024 MCOS after stabilization instead of the 1200 MCO design basis. In light of the current uncertainty in the number of MCOS required to be stored, this capacity could be adequate for the needs of the project. Furthermore, increasing the number of canisters stored in an MCO after stabilization from 8 to 10 without increasing MCO size (since the water space provided during wet storage would no longer be required), would enable the same amount of fuel stored in 936 MCOS during wet storage to be stored in 749 MCOS after stabilization. Reducing the number of MCOS required by 187 in this manner, would enable the same amount of fuel and sludge stored in 1200 MCOS before stabilization to be stored in 1013 MCOS after stabilization. This is within the storage capacity of Alternatives 1A and 1B.

Alternative 1C was defined to investigate the impact of increasing the footprint of the CSB to provide the capability to store 1200 MCOS after stabilization. Two ways of doing this were considered. The first was the addition of space for an additional vault, identical to vaults 1 and 2, to the footprint as described above. The second variation was the extension of vaults 1 and 2 to the east, or west, by a sufficient amount to provide space for a total of 600 storage tubes. These two approaches were judged to have about the same cost, so the first approach was selected for evaluation since it utilizes the thoroughly tested and evaluated CSB natural convection cooling design.

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NOTE:
1. FOR GENERAL NOTES AND LEGEND SEE DRAWING H-2-117794.

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MINISTER STORAGE BLDG
BUILDING SECTION

U.S. DEPARTMENT OF ENERGY

FLUOR DANIEL, INC.
ADVANCED TECHNOLOGY DIVISION

BUILDING SECTION

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Alternative 1D was defined to evaluate an approach which minimizes the changes to the CSB design by storing the MCOs in the same storage tubes during both the water cooled and air cooled phases of the project. This results in a non-traditional approach to water cooled storage, which warrants consideration for the unique requirements of the SSF. In order to achieve the 50 F MCO temperature requirement for pool temperatures above 32 F it is necessary for the storage tubes to be filled with water.

2.1.2 Evaluation and Selection of Alternatives

In accordance with the Scope of Work, one of the above alternatives was to be selected for further evaluation under this study.

Comparison of Alternatives 1A and 1B led to the conclusion that Alternative 1A was clearly more complex and costly than Alternative 1B and therefore did not warrant further evaluation. Since it was possible to store all 1200 MCOs in the space previously occupied by a single vault, there was no advantage to utilizing two vaults for this purpose initially and then having to convert one of the vaults to dry storage. Alternative 1A was therefore dropped from further consideration.

Alternatives 1B, 1C and 1D were then compared with respect to cost, schedule, technical feasibility and other factors as shown in Table 2-1. The estimates and comments in Table 2-1 are intended to identify and evaluate the differentiators between the alternatives being considered for selection purposes and do not reflect features which are common to all three alternatives. All cost figures in Table 2-1 are preliminary rough order of magnitude estimates expressed in millions of dollars.

The cost comparison in Table 2-1 reveals that Alternative 1D will cost about \$22 million more than Alternative 1B and \$14 million more than Alternative 1C. The need to change the storage tube material from Corten to stainless steel is the principal reason for this difference. Corten is not a recommended material for submerged service as it will experience a high rate of corrosion underwater, which will be exacerbated by galvanic corrosion when in wetted contact with the stainless steel MCOs.

The schedule comparison is based on the time required for the facility to be ready to receive fuel and sludge from the K Basins. Alternatives 1B and 1C will be constructed in two phases. The first phase for these two alternatives will include only those facilities necessary for operation of the storage pool, and will take the same amount of time for both 1B and 1C. Construction of the remaining portions of Alternatives 1B and 1C for post stabilization storage will be deferred to allow startup of this second phase to coincide with the schedule for startup of the Stabilization Facility. Construction of Alternative 1D will take

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TABLE 2-1 - EVALUATION OF ALTERNATIVES
CONCEPT 1 - POOL/PASSIVE DRY STORAGE

	ALT B		ALT C		ALT D	
	DELETE 1 BAY Tubes Deck	-4.4 -1.9			SS TUBE ^Δ (52-20K) 660	+21.1
	ADD POOL SS Liner C&C System Delete Interior Walls	+3.1 Same -0.1.	ADD POOL Slab & Walls SS Liner C&C System	+1.5 +3.1 Same	EPOXY LINE VAULT	+0.6
	STRENGTHEN OUTER POOL WALLS	+0.2	STRENGTHEN OUTER POOL WALLS	+0.2	LARGER C&C SYSTEM	TBD
	RE ENG ^Δ	+2.5	RE ENG ^Δ	+2.5	ADDED HVAC OP COST (3XSIZE- 6 YR)	+0.1
	POOL CRANE	+1.0	POOL CRANE	+1.0	STRENGTHEN 2 INTERIOR WALLS	+0.2
	POOL RACKS	+3.0	POOL RACKS	+3.0	TUBE H ₂ O MAINTENANCE OP COST	TBD
	MCO SERV ^Δ	Neg	MCO SERV DELTA	Neg	ACCELERATED CONSTRUCTION SCHEDULE	+1.0
					6 MONTH ADDED CONSTRUCTION	+2.0

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TABLE 2-1 - EVALUATION OF ALTERNATIVES
(CONTD.)
CONCEPT 1 - POOL/PASSIVE DRY STORAGE

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	ALT B		ALT C		ALT D	
					DECON TUBES FOR CONVERSION	+0.1
					TRANSPORTER H ₂ O RECOVERY FEATURES	+0.1
					MCO SERVICING FACILITY	+0.1
	TOTAL	+3.4	TOTAL	+11.3	TOTAL	+25.3+TBDS
SCHEDULE	BASE		BASE		+ 6 MONTHS	
TECHNICAL FEASIBILITY					SS corrosion with stagnant H ₂ O	
OTHER	-Allows construction of 2 vaults tubes, 1 deck & metal building to be deferred -Double pool liner for RCRA would add +3.0 -Provides 512 tubes, could accommodate equivalent of 1200 MCOs during storage by volume reduction -Pool provides capability for MCO servicing underwater		-Allows construction of 3 vaults tubes, 2 decks and metal building to be deferred. -Double pool liner for RCRA would add +3.0. -Pool provides capability for MCO servicing underwater		-SS Liner for vault would add 10.0 -Requires provisions to preclude explosive hydrogen concentrations inside tube	

considerably longer since the entire facility must be constructed when fuel and sludge from the K Basins are initially received. Construction of the three vaults will be a time consuming operation, even if they are all constructed in parallel instead of in series as previously scheduled for the CSB. Comparison of the schedules for these alternatives revealed that even with accelerated construction, alternative 1D will require about 6 months more to be operational than alternatives 1B or 1C.

From a technical feasibility standpoint, Alternative 1D has a potential microbiologically influenced corrosion (MIC) problem. As described in the June 1990 issue of Power article, "Avoid MIC-Related Problems in Nuclear Cooling Systems", stainless steel in contact with stagnant water which contains corrosive microorganisms has been found to be susceptible to this type of corrosion. Prevention of this problem with Alternative 1D will require some as yet unidentified means of treating the stagnant water inside the tubes or other means to prevent MIC from occurring.

The Other factors noted in Table 2-1 identify various other considerations which influence the selection of Alternatives. The cost for Alternative D is based on using an epoxy lined vault. If a stainless steel liner is required, the cost of Alternative 1D would increase by about \$10 million. The release of hydrogen inside the confined space within a storage tube also results in the potential for developing explosive hydrogen concentrations. This will require some means of maintaining an inert gas space within the storage tube and periodically relieving the pressure build up.

Review of the above data resulted in the decision to drop Alternative 1D from further consideration. In light of the current uncertainty in the number of MCOs to be stored, it was decided to continue to evaluate both Alternatives 1B and 1C since they are very similar and evaluation of both required very little additional effort.

2.2 CONCEPT 2 - REFRIGERATED AIR/PASSIVE DRY STORAGE

2.2.1 Description of Alternatives Considered

Concept 2 allows the existing CSB configuration to be used virtually unchanged. The refrigeration and forced air recirculation systems and equipment will be located outside of the existing CSB building envelope for this concept. The principal challenge is meeting the requirement for a 50 F temperature inside the MCOs prior to storage with air as the heat transfer fluid. The following two alternatives were considered:

Alternative 2A Storage of 1200 MCOs in water filled tubes in vaults 1, 2 and 3, with forced refrigerated air cooling of the tubes during staging. MCOs are

removed and returned to the tubes after stabilization. After all fuel is stabilized, natural circulation passive cooling is established.

Alternative 2B Storage of 1200 MCOs in perforated tubes in vaults 1, 2 and 3, with forced refrigerated air cooling of the MCOs during staging. Unperforated confinement barrier sleeves are installed in the tubes while the MCOs are removed for stabilization, after which the stabilized MCOs are reinstalled in the tubes. After all fuel is stabilized, natural circulation passive air cooling is established.

Alternative 2A is based on utilization of water filled tubes since it was determined that a 50 F MCO temperature could not be achieved with air inside the tubes and refrigerated air temperatures in excess of 32 F. (Calculations indicated that 19 F air at 200,000 CFM was required to achieve a 50 F MCO temperature.) Refrigerated air temperatures in excess of 32 F are needed to preclude the possibility of freezing water and rupturing MCOs having very low heat generation. The use of water inside the tubes requires that the tube material be changed from corten to stainless steel for the same reasons discussed above under Alternative 1D. Other heat transfer fluids such as oils or other organics were considered, but they would represent a fire hazard and would be subject to degradation due to the ionizing radiation present.

Alternative 2B was conceived as a way to achieve the 50 F MCO temperature with refrigerated air temperatures in excess of 32 F without having to put water or some other heat transfer fluid inside the storage tubes. Other variations of this alternative such as piping refrigerated air connections to each of the storage tubes were rejected as being more costly and difficult to construct.

2.2.2 Evaluation and Selection of Alternatives

Table 2-2 shows the results of the evaluation of the above Concept 2 alternatives with respect to the same four evaluation criteria used for Concept 1. As before, all costs are preliminary rough order of magnitude estimates expressed in millions of dollars.

Alternatives 2A and 2B were found to be similar with respect to the identified cost differentiators, with a \$6 million cost advantage being indicated for Alternative 2A.

The schedule for the start of operations under Alternatives 2A and 2B would be the same.

From a technical feasibility standpoint, Alternative 2A is subject to the same MIC concerns discussed above for Alternative 1D.

TABLE 2-2 - EVALUATION OF ALTERNATIVES
CONCEPT 2 - REFRIGERATED AIR/PASSIVE DRY STORAGE

	ALT A		ALT B	
COST	▲ HVAC FOR LOWER AIR TEMPERATURE	NEG	TUBE LINER	+9.9
	SS TUBE ▲	+21.1	TUBE LINER INSTALLATION AND HARDWARE	+3.0
	TUBE H ₂ O MAINTENANCE OP COST	TBD	INCREASE BUILDING HT 20'	+3.2
			SHIELDING FOR LINER INSTALLATION	+0.1
			VAULT & HVAC SECOND CONFINEMENT	+10.0
			REENGINEERING	+1.0
			ADDITIONAL RADIATION MONITORING EQUIPMENT	+0.5
	TOTAL	+21.1+TBD	TOTAL	+27.7
SCHEDULE	SAME		SAME	
TECHNICAL FEASIBILITY	SS CORROSION IN STAGNANT H ₂ O		<ul style="list-style-type: none"> - Vault & HVAC system must provide second confinement during staging. - MCO failure during staging would spread contamination, (decon difficult), and risk of pyrophoric incident with unstabilized fuel exposed to air 	
OTHER	Requires provisions to preclude explosive hydrogen concentrations inside tube		Details of sleeve installation, MCO support in sleeve, etc. not defined and difficult.	

Alternative 2B requires that the vault and HVAC system provide a second confinement barrier prior to stabilization since the perforated tubes would not satisfy the requirement for a second barrier. Furthermore, failure of an MCO during this phase would spread contamination throughout the vault and HVAC system, making decontamination very difficult. In addition, failure of an MCO during this phase could result in water draining from the MCO and exposure of the unstabilized fuel to air, possibly initiating a pyrophoric reaction.

The Other factors noted indicate that both alternatives have additional negative features to be considered.

Review of the information contained in Table 2-2 led to the selection of Alternative 2A for further evaluation. The indicated concerns regarding the potential consequences of an MCO failure prior to stabilization under Alternative 2B was the principal reason for this selection.

3.0 EVALUATION OF SHIELDED CANISTER TRANSPORTER VS OVERHEAD CASK/CRANE

3.1 INTRODUCTION

Two systems for loading MCOs into the storage tubes in the SSF dry storage vaults after stabilization were evaluated. They are 1) A Shielded Canister Transporter (SCT) and 2) An overhead crane with associated casks and fixtures. The SCT is a mobile cask and hoisting system that was first designed and built for the Defense Waste Processing Facility at Savannah River. A similar system was designed for use in the HWVP/CSB. The overhead crane system is similar to methods used in Europe and at the Fort St. Vrain Fuel Storage Facility. Other methods for loading the storage tubes are possible but were deemed less attractive for this application.

The size and weight of the MCO will have an affect on the handling equipment and overall capital and operating cost of the system adopted. Two different size MCOs were considered in this evaluation:

- 1) A 6 canister MCO, 128 inches long, weighing 8,000 lbs.
- 2) A 10 canister MCO, 180 inches long, weighing 12,300 lbs.

The equipment required for the transfer systems associated with each of the above MCOs is described in Tables 3-1 and 3-2. Figures 3-1 and 3-2 describe the operation of this equipment. Cask weights were estimated based on the anticipated shielding requirements. Crane capacities were estimated based on the heaviest loads to be lifted and the safety margins required for critical lifts at Hanford. The SCT weight was estimated by adjusting the weight of the HWVP SCT design to compensate for the difference in the length of the MCO. The MCO shield cask weight is based on 12 inches of steel shielding. The SSF crane capacity was based on a safety margin of 125% of the heaviest lift anticipated.

The MCO shield cask is a bottom loading cask that incorporates an MCO grapple and hoist assembly. It would be positioned above a shield valve located above a selected SSF storage tube. The storage tube shield plug is handled (removed and installed) using a handling flask. This system is similar to that employed at the Fort St. Vrain fuel storage facility and at several locations in Europe. A tunnel cask transfer station within the SSF would be the point of entry for the MCO for the overhead crane/cask method. This station would require a floor plug shield valve.

For the SCT method, the MCO is picked up at the Stabilization Facility and delivered to the SSF as shown in Figure 3-1.

TABLE 3-1, 6 CANISTER MCO TRANSFER SYSTEMS
MCO SIZE AND WEIGHT
128 IN. LONG
8,000#

	Stabilization Facility	Transfer to SSF Dry Storage Vaults	SSF Dry Storage
SHIELDED CANISTER TRANSPORTER (SCT) SEE FIGURE 3-1	<ul style="list-style-type: none"> ○ SCT (self powered) (325,000 lbs) ○ Bottom loading port into SCT at ground level 	<ul style="list-style-type: none"> ○ Paved road (~1/2 mile max.) 	<ul style="list-style-type: none"> ○ Deck mounted shielded plug access to storage tubes
OVERHEAD CASK/CRANE SYSTEM SEE FIGURE 3-2	<ul style="list-style-type: none"> ○ Shielded MCO loading station • Powered transporter 	<ul style="list-style-type: none"> ○ Shielded transfer tunnel 	<ul style="list-style-type: none"> ○ Deck mounted shielded plug/valve access to transfer tunnel • Overhead crane (60T) ○ Floor plug shield valve ○ MCO shield cask (bottom loading) (46T) ○ Floor plug handling flask ○ Deck mounted shielded plug access to storage tubes

TABLE 3-2, 10 CANISTER MCO TRANSFER SYSTEMS
MCO SIZE AND WEIGHT
180 IN. LONG
12,300#

	Stabilization Facility	Transfer to SSP Dry Storage Vaults	SSF Dry Storage
SHIELDED CANISTER TRANSPORTER (SCT) SEE FIGURE 3-1	<ul style="list-style-type: none"> • SCT (self powered) (358,200 lbs) • Bottom loading port, into SCT at ground level. 	<ul style="list-style-type: none"> • Paved road (~ 1/2 mile max.) 	<ul style="list-style-type: none"> • Deck mounted shielded plug access to storage tubes
OVERHEAD CASK/Crane SYSTEM SEE FIGURE 3-2	<ul style="list-style-type: none"> • Shielded MCO loading station • Powered transporter 	<ul style="list-style-type: none"> • Shielded transfer tunnel 	<ul style="list-style-type: none"> • Deck mounted shielded plug/ valve access to transfer tunnel • Overhead crane (70T) • Floor plug shield valve • MCO shield cask (bottom loading) (56T) • Floor plug handling flask • Deck mounted shielded plug access to storage tubes

FIGURE 3-1
 SHIELDED CANISTER TRANSPORTER PICKUP AND DELIVERY

FIGURE 3-2

OVERHEAD CRANE PICKUP AND DELIVERY

3.2 SHIELDED CANISTER TRANSPORTER DESCRIPTION

The SCT is a self contained unit capable of transport of the MCO between the SSF and the Stabilization Facility. It includes all the equipment required to remove and replace the MCO in an SSF vault storage tube. In performing this operation the SCT also handles the storage tube shield plug, maintains a confined atmosphere within the storage tube and provides cooling to the MCO while it resides in the SCT cask.

Figure 3-3 shows the general configuration of the SCT. The gross weight of the unit will vary between 300,000 and 360,000 lbs depending on the weight of the MCO. The CSB operating floor as currently designed will support this weight.

The SCT consists of a steel frame vehicle that is driven by dual internal combustion engines. The engines are equipped to use propane fuel. Four wheel drive with dual tires on each wheel are employed. The speed of the unit is controllable from 0 to 3 mph at road grades of 0 to 3%.

The cask assembly, consisting of the canister cask, floor plug cask and cask shield valve are mounted to a trolley/rail system that is used to position the cask over the desired SSF storage tube.

The canister cask is constructed of mild and stainless steel, 5% borated polyethylene and tungsten. The tungsten results in a lighter weight assembly.

The cask assembly and floor plug cask contain integral hoist and grapple equipment. The canister hoist includes redundant motor drives to assure that the canister transfer operation can be complete after failure of the drive motor. The floor plug grapple has a manual override.

A ventilation plenum, with a filtering system, blowers and monitoring system is attached to the shield valve. During MCO transfer operations, storage tube air inlet and exhaust is controlled by this system. During transport from the Stabilization Facility to the SSF, this system is used to cool the MCO.

Control of the SCT takes place from the shielded operator cab. The cab includes a steering wheel, throttle, brakes, CCTV and two control consoles. One console is for vehicle operation and the other is for canister and plug handling operations. In a typical loading operation, the SCT is driven into the SSF and roughly located over the desired storage tube. Operation begins by location of the plug cask over the storage tube and subsequent removal of the plug. The cask assembly is then located over the open storage tube and the MCO lowered into the tube. The plug cask with plug is repositioned and the plug replaced. This entire operation takes place while maintaining atmosphere control of the

FIGURE 3-3
SHIELDED CANISTER TRANSPORTER

storage tube/cask cavity and providing shielding during the transfer.

3.3 OVERHEAD CASK/CRANE DESCRIPTION

The overhead cask/crane method is currently being employed as a canister loading method by the British at Sellafield, the French at Marcoule and at the Fort St. Vrain dry fuel storage facility in Colorado.

Unlike the SCT, the overhead cask/crane method will require a means to transport the MCO to the SSF. If the stabilization plant is close coupled to the dry storage facility an unshielded transfer cart operating in a below grade tunnel can be used to make the transfer as described in Figure 3-2. If the stabilization plant is at a distant location, a top-loading shipping cask can be used.

The overhead cask/crane method will require four basic components to load the canisters into the SSF storage tubes.

- 1) The bottom loading MCO shield cask
- 2) The floor plug shield valve
- 3) The floor plug handling flask
- 4) The overhead bridge crane

The bottom loading MCO shield cask has many of the same features as the SCT except that it is transferred and located by the overhead bridge crane. The cask will contain an integral hoist and grapple system to handle the MCO. It will incorporate a shield valve at the bottom and a ventilation system to control the atmosphere within the storage tube during MCO transfer.

The floor plug shield valve is used to seal and shield the storage tube when the tube's shield plug is removed. The valve is located over the desired storage tube using the overhead bridge crane. The floor plug handling flask is then mated with the top of the shield valve. A grapple within the flask is used to lift the plug thru the open shield valve. The valve is then closed and the flask containing the plug removed. The storage tube is now ready for installation of the MCO.

The MCO contained within the MCO cask is next positioned on top of the shield valve using the overhead bridge crane. The floor valve and the MCO cask bottom valve are next opened and the MCO lowered into the storage tube. Upon reaching bottom, the MCO cask grapple is disengaged and raised back into the MCO cask. The valves are closed and the MCO cask removed from the storage tube. Finally, the storage tube floor plug is re-installed, and the floor valve removed and installed over the next storage tube to be loaded.

3.4 COST COMPARISON

Table 3-3 contains the results of comparisons of the costs of the above two transfer systems for the two MCO sizes considered based on the assumption that the Stabilization Facility and the SSF are "close coupled". For non-close coupled arrangements, both systems would require additional cask receiving and unloading facilities of approximately equal cost and the costs of the shielded transfer tunnel and cart would not be applicable.

The cost estimates for the SCT were taken from a 1993 conceptual design estimate developed by Fluor Daniel for the HWVP SCT. The operating cost estimate was established from time and motion studies developed during conceptual design of the SCT, and estimates of the time required to perform the overhead crane/cask operations. The estimate factors in the crew size and total number of MCO transfers required to transfer all canisters. Other estimates were based on similar equipment recently designed by Fluor Daniel.

3.5 OTHER FACTORS

Other factors that differentiate the SCT from the overhead crane/cask method are described below.

3.5.1 Reliability/Maintainability

The SCT, as compared to the overhead crane/cask system, is a relatively complex system that does not have a proven operational record. Although an SCT has been in existence at DWPF for over 10 years, it has not been used because the plant is not yet operating and producing canisters. In contrast, the overhead crane/cask systems have been extensively used both in Europe and at Fort St. Vrain. The components are quite simple and control is basically manual, using the crane operator to locate the various components over the storage location. Although the SCT is designed using modular components, reliability/maintainability may be somewhat of a problem during initial use while the operators are learning to use the system. The SCT's more sophisticated control system is designed to both operate the vehicle and load and unload the canisters and plugs using a single operator. The overhead crane/cask method uses several operators and very little automation.

3.5.2 Operator Radiation Exposure

Operator exposure during routine canister and plug handling operations would not be different for the SCT and overhead crane/cask handling methods. However, in an off normal situation, the overhead crane/cask handling method would probably accrue a

TABLE 3-3
SCT-CASK/CRANE COST COMPARISON

All costs are in \$ millions

	SCT	MCO CASK	OVERHEAD CRANE	FLOOR SHIELD VALVES	FLOOR PLUG FLASK	SHIELDED TRANSFER TUNNEL & CART	STRUCTURAL COST DIFFERENCE	OPERATING COST	TOTALS
Overhead Cask/Crane Method (6 canister MCO)	-	2.23	1.40	0.40	0.1	1.40	0.14	1.92	7.59
Shielded Canister Transporter (6 canister MCO)	7.10	-	-	-	-	-	1.70	1.01	9.81
Overhead Cask/Crane Method (10 canister MCO)	-	2.45	1.60	0.40	0.1	1.50	0.16	1.15	7.36
Shielded Canister Transporter (10 canister MCO)	7.95	-	-	-	-	-	1.72	.606	10.28

high person-rem exposure because several operators would be involved. The SCT requires only one operator who resides in the shield cab during the entire operation.

3.5.3 Safety

The potential for an injury accident is greater for the overhead crane/cask handling method because of the labor intensive nature of the operations involved. The operations require crane transfer of many heavy components, in an area that will include several operating personnel. In contrast, the SCT involves only one operator who resides in the relatively safe environment of the SCT cab.

3.5.4 Dry Storage Capacity

Use of the overhead crane/cask concept results in a greater storage capacity for a given area of dry storage facility. This difference is attributed to the unusable area adjacent to the wall on the operating floor above the SSF dry storage vaults. In the case of the SCT, a 15 foot periphery is required. For the overhead/cask system a 6 foot periphery is required. This difference results in a differential of 138 storage tube locations for Alternative 1B. If the SCT was used with Alternative 1B, the total number of storage tube locations would be 374. Assuming that a 10 canister MCO was adopted, a minimum of 375 locations (2 MCOs per storage tube) would be required for fuel alone. This does not include the potential requirement for overpack MCOs or MCOs required for storage of stabilized sludge.

3.6 CONCLUSIONS

Based on the cost comparisons developed in Section 3.4 and the other factors considered in Section 3.5, it is concluded that the cask/crane system is preferred for the SSF. It is a proven, reliable, system and provides the a lower total cost than the SCT. In addition to the cost advantage, the cask/crane method provides the capability for maximizing the storage capacity of the dry storage vaults, enabling two storage vaults to be used to provide the required capacity after stabilization with 10 canisters per RMCO.

4.0 CONCEPT 1 TECHNICAL DESCRIPTION

4.1 FACILITY DESCRIPTION

4.1.1 Plot Plans

Figure 4-1 shows the outline of the Concept 1 SSF and an assumed adjacent Stabilization Facility superimposed on a modified Master Site Plan for what was previously the HWVP site within the 200 East Area. The SSF is shown on the location of the existing CSB foundation. Other existing buildings, roads, rail lines and underground utilities in the area are shown in their current locations. New facilities which have been proposed for construction in the area as shown in the Master Site Plan currently being prepared by Fluor Daniel for the Tank Waste Remediation System (TWRS) Site Integration Task Force have been rearranged slightly to be compatible with the Concept 1 layout and location. The Figure shows that location of the SSF on the existing CSB foundation is feasible and provides good access to all required utilities, roads and rail lines. It also shows that location of the SSF in this area is compatible with current plans for other facilities which have been proposed for construction in the area.

More detailed plot plans for Alternatives 1B and 1C are shown in Figures 4-2 and 4-3. The facilities shown within solid lines would be constructed during the initial phase of SSF construction and include all those facilities needed to receive and store the MCOs prior to stabilization. Completion of construction of the future vaults for passive dry storage would be deferred to coincide with completion of the Stabilization Facility. The Stabilization Facility outlines shown in Figures 4-2 and 4-3 show one possible location for the Stabilization Facility relative to the SSF and are not intended to portray an accurate representation of its size or geometry.

4.1.2 Rail Tunnel/Cask Unloading Area

4.1.2.1 General Description

The Rail Tunnel/Cask Unloading Area is a new addition of approximately 10,000 square feet to the original CSB design. It is located on the west side of the SSF and interfaces with the west end of the MCO Storage Pool as shown in Figure 4-4.

The main functions of this area are to safely receive, handle and prepare the incoming MCOs for placement in the Pool Storage racks prior to the MCO stabilization process. The MCOs are delivered inside a shipping cask, via rail car, one at a time. Before being returned to the K-Basins, the shipping casks are prepared for handling and loaded with an empty MCO.

WESTINGHOUSE HANFORD CO.
P.O. TVW-SW-520252

FLUOR DANIEL INC.
GOVERNMENT SERVICES OPERATING COMPANY

STAGING & STORAGE FACILITY
PLOT PLAN
CONCEPT 1 ALT B

FIGURE 4-2

CADFILE C1A

RAC 2/10/85

WESTINGHOUSE HANFORD CO.
P.O. TVW-SW-520252

FLUOR DANIEL INC.
GOVERNMENT SERVICES OPERATING COMPANY

STAGING & STORAGE FACILITY
PLOT PLAN
CONCEPT 1 ALT C

FIGURE 4-3

CADFILE C1B

RAC 2/10/88

WESTINGHOUSE HANFORD CO.
P.O. TVW-SW-520252

FLUOR DANIEL INC.
GOVERNMENT SERVICES OPERATING COMPANY

STAGING & STORAGE FACILITY
RAIL TUNNEL/CASK UNLOADING AREA
CONCEPT 1 ALT B & C

FIGURE 4-4

CADFILE FB1

RAC 2/13/95

The Rail Tunnel/Cask Unloading area capacity is as follows:

- (2) rail cars outside the facility
- (2) rail cars in the facility
- (4) shipping casks: (2) clean, ready for use, (1) contaminated, waiting for decontamination and (1) in the decontamination pit
- (28) empty new MCOs
- (1) empty new MCO overpack

The Rail Tunnel/Cask Unloading Area includes the Wash Area, the Cask Unloading and Storage Area, the Cask Preparation Pit, the Cask Unloading Pool and the Cask Loading Pit.

4.1.2.2 Wash Area

The Wash Area is a air lock confinement area where the incoming railroad cars and delivery truck/trailer are washed prior entering the Cask Unloading and Storage Area. Two railroad cars, and the donkey engine, and a truck trailer parked in parallel can be accommodated inside. A permanent ceiling installed liquid spray arrangement allows wash/decon of the shipping cask upper section. Hand held wash/decon lances are available for the lower areas.

4.1.2.3 Cask Unloading and Storage Area

The Cask Unloading and Storage Area is designed for unloading and loading shipping casks and for handling and storage of empty MCOs. Two railroad cars, one truck trailer, twenty eight MCOs, one MCO overpack and two clean ready to use shipping casks can be accommodated in this area. A 60 ton overhead crane, with a 10 ton auxiliary crane, running in the west/east direction services this area. A fifteen foot tall wall partially isolates this area from the Cask Preparation Pit, the Cask Unloading Pool and the Cask Loading Pit, but allows the passage of the overhead crane above it.

4.1.2.4 Cask Preparation Pit

The Cask Preparation Pit located between the isolation wall and the Storage Pool west end is dedicated to the preparation of shipping casks for unloading, which consists primarily of unbolting the cask cover. A sleeve, anchored to the bottom of the pit, receives and restrains the cask. Access working platforms are affixed to the upper interior walls of the pit. The 60 ton overhead crane is used to handle the cask. The Cask Preparation Pit could also be used for additional cask decontamination or other pre-unloading services if necessary.

4.1.2.5 Cask Unloading Pool

The Cask Unloading Pool, adjacent to the Cask Preparation Pit south end and Storage Pool west end, is dedicated to unloading MCOs from

their casks, MCO servicing and placing defective MCOs in an overpack. Underwater fixtures are provided to support the cask cover and two MCOs during servicing. Required MCO servicing is performed underwater at this location, using specially designed tools as described in Section 4.1.3. An opening through the common wall separating the Unloading Pool with the Storage Pool allows underwater transfer of MCO from one pool to the other. To minimize cross contamination to the Storage Pool, the pool water return flow is directed toward the Unloading Pool. In case contamination is detected in the Unloading Pool a portable gate can be placed in the wall opening to isolate the two pools. When retrieving an empty cask from the pool, the water in the cask is drained above the Unloading Pool using special tools. The 60 ton overhead crane is used to handle the cask and the portable gate. The 10 ton auxiliary crane is used to handle the cask cover, MCO and overpack.

The underwater transfer of the MCO from the Unloading Pool to the Storage Pool racks is accomplished using the Storage Pool Crane.

4.1.2.6 Cask Loading Pit

The Cask Loading Pit, similar in construction to the Cask Preparation Pit, is located south of the Cask Unloading Pool and is dedicated to cask preparation for return to the K-basins. With the cover removed, the cask is decontaminated, and an empty MCO is loaded inside the cask. The gap between cask cavity and MCO is filled with deionized water. Finally the cask cover is bolted on and decontaminated if necessary. The now ready to use cask is transferred to a storage position or to an empty railroad car located in the Cask Loading and Storage area.

4.1.3 MCO Servicing

4.1.3.1 Functional Description

After each MCO is received into the SSF for staging, the MCO will be purged with nitrogen, then deionized water will be added if needed to reach the desired level in the MCO. The servicing will be done with the MCO submerged in the Cask Unloading Pool, which is an extension of the storage pool. The pool water treatment system will maintain pool temperature, clarity, and radioactive contamination at acceptable levels.

4.1.3.2 System Design Requirements

The system must be capable of servicing 4 MCOs per day while MCOs are being received. Once all MCOs have been received, there may be need for servicing 2 MCOs per week. The pool water will provide sufficient shielding for operators above the pool to assist in making the necessary piping or hose connections to the MCO using specially designed tools. Water will flow into the servicing area

from the storage pool, then back to the pool treatment system. The containment and confinement requirements for this area are the same as for the pool. Because of the greater chance for contamination of the pool when MCO valves are opened, the water turnover time in the service area is 36 hr — half that of the pool, and there is a removable gate for isolating the Cask Unloading Pool from the storage pool in the event of high levels of contamination.

4.1.3.3 Design Assumptions

The MCO will be designed so that a grapple can be attached for transporting it underwater without the cask. The MCO will have at least three valved connections that can be remotely connected to piping or hoses, with each valve capable of remote operation (see Figure 4-5). One of the connections will have an interior dip tube which extends a known length below the desired water level (but above any sludge), and another connection will terminate at the top of the MCO, so that a differential pressure sensor in the service area can determine the MCO water level. One of the differential pressure legs will also be used for nitrogen purging, described below. The third valved connection will allow the MCO to be filled while the water level is monitored.

4.1.3.4 Mechanical Design and Operation

The servicing of 4 MCOs per day requires two service stations in the servicing area. Each station is equipped with a gas collection pot, filter, piping, and instruments that must be connected to the MCO for servicing. The station is attached by flexible hoses to fixed piping for nitrogen, water, and vent gas. The basic components of a station are shown on Figure 4-5. The system equipment list (Table 4-1) indicates the major items needed for the two stations as well as auxiliary equipment that supports the function of the stations.

The cask unloading crane brings the shielding cask with MCO into the Cask Unloading Pool. The cask provides operator shielding until the cask is covered by at least 7 ft of water. After the crane removes the cask lid and places the MCO on an underwater stand for servicing, the operator manually positions the servicing piping assembly onto the MCO, remotely couples the piping to the MCO connections and prepares to operate the MCO valves. The vent gas pressure and contamination level are monitored before the gas is released through a HEPA filter to the building stack. Upstream of the HEPA filter is a shielded gas collection pot which will serve as a radiation monitor source, catch any entrained liquid in the vent gas, and provide capability for gas sampling. After the pressure in the MCO is released, sufficient nitrogen is purged through the MCO to reduce the hydrogen concentration to 1% by

FIGURE 4-5

MCO SERVICE STATION
FOR CONCEPT 1 OR 2

RLD 2/9/95

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TABLE 4-1

EQUIPMENT LIST
STAGING AND STORAGE FACILITY
SSF
(CONCEPT 1)

EQUIPMENT DESCRIPTION	EQUIPMENT ID	CAPACITY/FLOW RATE	PHYSICAL SIZE (DIA X H)	MATERIAL	POWER	HEAT LOAD	COMMENT
<u>MCO SERVICING SYSTEM</u>							
NITROGEN CYLINDER RACK	R-1	40 SCF/DAY	FOUR 9" OD X 5' H CYLINDERS	STEEL			
DECON SOLUTION TANKS	V-1A/B/C/D	ATMOS. PRESS.	FOR 3' OD X 4' H	SS			
DECON PUMPS	P-1A/B	0.1 GPM, 150 PSIG	1' OD X 1'4"	SS	1.00	HP	
DECON SPRAY WATER HEATERS	H-1A/B	0.1 GPM	1' OD X 1'4"	STEEL	0.20	kW	
DIONIZED WATER TANK	V-2	ATMOS. PRESS.	3' OD X 8' H	SS			
MCO FILL PUMPS	P-2A/B	1 GPM, 10 PSIG	1' OD X 1'4"	SS	1.00	HP	
MCO PURGE COLLECTION POTS	V-3A/B	150 PSIG	12" OD X 1'4"	SS			
BETA/GAMMA PROCESS MONITORS	CAM-1A/B						
MCO VENT HEPA FILTERS	F-1A/B	10 CFM, 1M	3" OD X 3'4"	SS BODY			NUCLEAR GRADE CARTRIDGE FILTER

volume or less. After purging, the nitrogen flow is reduced in order to measure the level of water in the MCO. Nitrogen is stored in cylinders delivered by truck to a rack outside the building. If needed, deionized water is added by a metering pump through the collection pot in order to flush any contamination back into the MCO. The valves on the MCO are closed after servicing, the service station is disconnected, and the MCO is transported underwater by the pool transfer crane into the pool.

4.1.4 Staging Pool and Pool Water Treatment System

4.1.4.1 Functional Description

After each MCO is received and serviced for staging, the MCO will be placed in a submerged rack located in the staging pool. The pool water provides shielding and cooling for 1200 MCOs. The pool water treatment system will maintain pool temperature, clarity, and radioactive contamination at acceptable levels. Although no leakage is expected from MCOs or system components, the pool and its water treatment system are designed to minimize radiation exposure in the event of leakage due to a credible accident.

4.1.4.2 System Design Requirements

The nominal value of heat generation per MCO is 600 Btu/hr and the upper limit is 1120 Btu/hr. The nominal gas generation per MCO is 1.2 L/day of hydrogen contaminated with 2.56 mCi/L of Kr-85. The upper limit MCO produces 14 L/day of hydrogen gas contaminated with 4.62 mCi/L of Kr-85. The nominal values apply to 80% of the MCOs, the upper limits apply to 5%, and 15% perform below the nominal values. There are no particulates or condensible vapors generated during non-accident conditions. The hydrogen generation rate approximately doubles for each 18 °F increase above 50 °F in the MCO. The total system cooling duty is based on the average MCO generating the nominal amount of heat.

The pool is lined with stainless steel to ensure water purity, to prevent water migration through the concrete pool structure, and to allow decontamination at the end of the facility life. As recommended by DOE Order 6430.1A, Section 1320, the liner has a leak detection system with a collection sump in the concrete structure.

The water treatment system returns water which has been purified and cooled to 44-45°F to the staging pool. This will maintain the water in all MCOs at 50°F or less under normal conditions. The system has sufficient redundancy (or else contingency back-up capability within the available response time) so that a single failure of any active component (such as a pump, filter, or control) will not cause loss of system function. The following requirements of ANSI/ANS 57.7 and NRC Reg Guide 3.49 are met: Clarity is sufficient to clearly see to the bottom of the pool. Contamination will be maintained at an annual average gross activity level of 5×10^{-4} mCi/L or less during normal operation.

The recirculation rate is sufficient to turnover the pool volume in less than 72 hours. The piping is designed so that water will not siphon out of the pool in the event of a piping leak. The rate of deionized water addition is sufficient to make up for evaporation.

The system will maintain a safe condition after loss of normal power, loss of cooling, and Design Basis Accidents such as earthquake; in these cases, credit will be taken for portable equipment that can be moved in during the period of time before temperatures, hydrogen concentration, or contamination levels exceed safe levels. The clean-up system will have the capacity for the worst-credible release of contamination into the pool, which is assumed to be all of the corrosion products and soluble constituents from two broken MCOs (resulting from a dropped MCO striking another MCO in the pool).

4.1.4.3 Design Assumptions

The MCO will be designed so that a grapple can be attached for transporting it underwater without the cask. The laboratory required for periodic analysis of pool water samples is not part of this facility. Fresh make-up to the deionizer will come from the site sanitary water, containing 95.1 ppm dissolved solids, less than 10 ppm suspended solids, pH 7.80, and CaCO_3 hardness of 73.46 ppm.

4.1.4.4 Mechanical Design and Operation

Figure 4-6 shows the arrangement of the storage pool and associated areas. The stainless steel storage racks in the pool are modular and installed during construction by a construction crane. The MCOs are stored vertically, submerged by about 24 ft of water. There are spaces for 1200 24" O.D. MCOs on a 28" center spacing, in a triangular array. In the event of a leaking MCO, the MCO can be placed in an overpack. There are 18 spaces for overpacked MCOs. MCOs are transported to and from the cask unloading pool by the pool storage crane. The depth of water above the storage rack allows the MCO being transported to be covered by 7 ft of water at all times. During transportation in the pool, the MCO is suspended above other MCOs in the racks. There are provisions for an underwater transfer channel from the pool, leading to the future Stabilization Facility, so that MCOs can be transferred underwater by cart.

Refer to Figure 4-7, the block diagram for pool water treatment and cooling. The pool water treatment system consists of pool skimmers and flow distribution piping, recirculation pumps, high-efficiency filters, filter backwash equipment, deionization units, deionization unit regeneration, waste slurry holding, waste water holding, chemical unloading, water chillers, and water sterilizers.

CSB MODIFICATIONS = VAULT # 3 TRANSFORMED TO A STORAGE POOL & ADDED STORAGE TUBES CAPACITY
POOLS (SNF & SLUDGE) LAYOUT @ (1) MCO LEVEL STORAGE = 1200 MCO & 18 OVERPACKS
AND (2) PASSIVELY COOLED STORAGE VAULTS W/ (2) SNF/MCO PER TUBE FOR A TOTAL OF (512) STORAGE TUBES & (11) OVERPACK

FIGURE 4-6

ALTERNATIVE "1B" POOL AND DRY STORAGE
PLAN VIEW

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FIGURE 4-7
PROCESS BLOCK FLOW DIAGRAM
POOL WATER TREATMENT

Table 4-2 lists the major equipment for the pool water treatment system. The skimmers remove floating debris from the storage pool and cask unloading pool. Inlet and outlet piping for the pool is designed to provide distribution of flow through the pool with minimum pressure loss. One operating pump and one spare provide a 72 hr turnover of the pool volume during normal operation. If contamination in the pool becomes abnormally high, both pumps can be operated to increase the recirculation rate. The filters are nuclear-grade filters with a particle capture size of one micron. Compressed air at 300 psig will be produced to improve backwashing and to supply the facility instrument air system. Stainless steel material was chosen for the compressed air to avoid getting pipe scale particles on the clean side of the filters during backwash. The deionization unit is a duplex package of two trains, so that one train can remain in operation while the other is regenerated. Each train removes both anions and cations (positively and negatively charged ions) from the water in resin beds. If contamination in the pool becomes abnormally high, both trains can be temporarily operated in parallel to increase the recirculation rate. The regeneration controls are automatic, to minimize operator exposure. The design of the filters and deionizers for accident conditions is discussed in section 4.2.3.3. Normally, regeneration is required less than once per year.

Nitric acid for cation bed regeneration is received by truck at 60% concentration by weight. Sodium hydroxide for anion bed regeneration is received by truck at 25% concentration by weight. The size of the storage tanks is just sufficient for regeneration, so that the inventory of hazardous chemicals is minimized. Pool water treatment system drainage and spent regeneration solutions will go to the waste water hold tank to be neutralized and monitored before being picked up by a truck with a pump. Pool water filtrate slurry and spent deionization resin will go to the contaminated waste slurry hold tank to be monitored before being pressurized into a shielded container on a truck, using compressed air. Fresh resin can be loaded into the deionization units by gravity, from above the shielded room containing the units. Separate curbed areas are provided for truck loading and unloading at the tanks for nitric acid, sodium hydroxide, waste water, and contaminated waste slurry.

Each chiller is sized for the nominal heat input from 1200 MCOs, heat gains from the surroundings, and the dissipated energy from the 125 hp recirculating pump. A 100% spare chiller and heat exchanger is provided, although interruptions in cooling can be tolerated. In the event of loss of cooling, the pool requires 165 hours to warm up 10 °F. However, recovery from an overheated

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Table 4-2

EQUIPMENT LIST
STAGING AND STORAGE FACILITY
SSF
(CONCEPT 1)

EQUIPMENT DESCRIPTION	EQUIPMENT ID	CAPACITY/FLOW RATE	PHYSICAL SIZE (DIA X H)	MATERIAL	POWER	HEAT LOAD	COMMENT
<u>POOL WATER TREATMENT SYSTEM</u>							
POOL SKIMMERS	F-1A/B/C/D		2" LINE SIZE	SS			BASKET STRAINERS
RECIRCULATION PUMPS	P-1A/B	550 GPM, 300 PSIG	8" SUCTION	SS	125.00 HP		ONE SPARE
PRIMARY POOL FILTERS	F-2A/B	550 GPM, 50 PSIG	6" CONNECTIONS	SS			
AIR COMPRESSOR	C-1A/B	100 SCFM, 350 PSIG		STEEL			ONE SPARE
COMPRESSED AIR RECEIVER	V-1	400 PSIG	4' OD X 8' H	SS			
DEIONIZATION UNIT	R-1	550 GPM, NET	FOUR TANKS 6' OD X 8' H	SS			ANION/CATION 2-TRAIN PACKAGE
25% CAUSTIC STORAGE	V-2	15 PSIG	6' OD X 8' H	SS			
25% CAUSTIC PUMP	P-2	5 GPM		SS	5.00 HP		
60% NITRIC ACID STORAGE	V-3	15 PSIG	4' OD X 8' H	SS			
60% NITRIC ACID PUMP	P-3	10 GPM		SS	5.00 HP		
WASTE SLURRY HOLD TANK	V-4	25 PSIG	8' OD X 16' L	SS			
WASTE WATER HOLD TANK	V-5	15 PSIG	8' OD X 12' L	SS			
POOL WATER CHILLERS	CH-1A/B	87 TONS, NET		STEEL	600.00 HP		ONE SPARE
POOL WATER EXCHANGERS	E-1A/B	1.0 MM BTU/HR		STEEL & SS			ONE SPARE
POOL WATER STERILIZERS	UV-1A/B	550 GPM		GLASS & SS			ONE SPARE
<u>INSTRUMENT AIR SYSTEM</u>							
INSTRUMENT AIR DRYER	DY-1	100 SCFM, NET					DUPLEX PACKAGE
INSTRUMENT AIR RECEIVER	V-1	150 PSIG	8' OD X 8' H	STEEL			

4-16

condition requires some spare cooling capacity. The pool water sterilizers, along with chemical addition, inhibit biological growth which would cloud the water. The glass in the ultraviolet sterilizers will require regular cleaning.

The equipment used to detect excessive contamination in the pool and locate a leaking MCO is discussed in section 4.2.3.3.

4.1.5 Natural Convection Cooling and HVAC

4.1.5.1 Natural Convection Cooling

After stabilization, MCOs will be returned from the Stabilization Facility to the SSF dry storage area in a shielded transfer tunnel as was shown in Figure 4-6. The MCO overhead cask/crane system which was described in Section 3.3 will retrieve the MCO from the transfer tunnel and install it in its assigned storage tube.

To accommodate the new layout of the vaults for Concept 1B the air intakes and the exhaust stack will be relocated as indicated on Figure 4-6. This concept has two vaults, Vault No. 1 has a total of 262 tubes and Vault No.2 has 250 tubes. There are provisions for 11 overpack tubes in this concept. The tube spacing and function of the passive ventilation system for this concept is identical to the CSB design.

The layout of the vault area for Concept 1C is identical to the CSB design. This concept has three vaults, each with 220 tubes. There are provisions for 17 overpack tubes in this concept. The tube spacing and function of the passive ventilation system for this concept is identical to the CSB design.

4.1.5.2 HVAC Systems for Normal Operation

HVAC/Office/Generator and Equipment Area. The HVAC system for this area will be the same as for the Canister Storage Building (CSB).

Operating Area HVAC System. The Operating Area HVAC System for the CSB design will be modified to accommodate the ventilation system for the pool, operating area above the dry storage vaults, MCO service area and the MCO/Cask unloading and storage area. The block flow diagram for this system is shown on Figure 4-8. The system is capable of diluting the hydrogen and krypton-85 to acceptable levels by introducing sufficient amounts of outside air. The Operating Area HVAC System for Concept 1C is larger than Concept 1B due to the addition of one vault.

Pool Water Treatment Area. This building consists of clean areas and potentially contaminated areas. The following brief description of the HVAC systems serving these two areas is applicable to both Concepts 1B and 1C.

The block flow diagram for the HVAC system serving the clean areas is shown on Figure 4-9. This system consists of an Air Handling Unit with evaporative cooler and heating coil.

FIGURE: 4 - 8

SSF FEASIBILITY STUDY
CONCEPT NUMBER: 1 AND 2
OPERATING AREA
HVAC SYSTEM

FIGURE: 4 - 9

SSF FEASIBILITY STUDY
CONCEPT NUMBER: 1
POOL WATER TREATMENT BUILDING
HVAC SYSTEM - CLEAN AREAS

The block flow diagram for the HVAC system serving the potentially contaminated areas is shown on Figure 4-10. Redundant Air Handling Units (AHU-1 and AHU-2) with evaporative cooler and heating coil supply air to these areas and the air is exhausted through redundant HEPA filter plenums (PF-1 and PF-2) and exhaust fans (EF-1 and EF-2).

4.1.5.3 HVAC Systems for Abnormal Operation

The block flow diagram for the HVAC system used for emergency ventilation of the Operating Area is shown in Figure 4-11, which is applicable to both Concepts 1B and 1C. This system is designed to be activated following an accident (potential drop of an MCO and release of contamination to the operating area) and is interlocked to stop the normally operating HVAC system. The HVAC system consists of two trains with HEPA filter plenums (PF-1 and PF-2) and exhaust fans (EF-1 and EF-2) sized to assure a negative pressure during the applicable design basis wind.

The passive ventilation system is designed to operate following all DBA's during the storage phase. No active HVAC systems are required during abnormal operation.

4.1.6 Structural

Vaults 1 and 2 are constructed essentially as originally designed for the CSB, except that due to the reduced heat loads insulating concrete will probably not be required. The operating floor deck will be constructed over Vaults 1 and 2 during the first phase of construction. The storage tubes for Vaults 1 and 2 can be installed at a later date. Vault 3 will be constructed as an underwater pool storage facility. New walls will be added along the north wall of Vault 3 to close off the passage to the intake and exhaust plenums. Location of the exhaust stack and the south intake structure will be slightly rearranged. The pool walls and floor will be lined with stainless steel plate installed using the wall paper method of installation. The liner plate will have leak detection chases. Crane rails will be added on top of the north and south pool walls for the top running double girder crane. This crane will be used to service the pool area.

A steel frame building approximately 180 ft long, 60 ft wide, and 17 ft high will enclose the water pool area. The operating floor shelter over Vaults 1 and 2 will be a steel frame building very similar to the originally designed CSB building except it will have crane rails and a girder for the overhead cask/crane system described in Section 3. This building will be approximately 122 ft long, 139 ft wide and 46 ft high. The shelter for Vaults 1 and 2 can be installed at a later date. On the west side of the pool there is a Cask/MCO Unloading and Storage Area Building 80 ft long, 90 ft wide, and 33 ft high. This building will also have an overhead crane for unloading and loading of casks and MCOs. The Wash Area Building, 65 ft long, 60 ft wide and 27 ft high, will be directly north of the Cask/MCO Unloading and Storage Area Building. These buildings will be steel frame buildings with metal siding and metal roof deck. On the south side of the pool there will be a

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FIGURE 4-10

SSF FEASIBILITY STUDY
CONCEPT NUMBER 1
POOL WATER TREATMENT BUILDING
HVAC SYSTEM - POTENTIALLY CONTAMINATED AREAS

FIGURE: 4 - 11

SSF FEASIBILITY STUDY
CONCEPT NUMBER: 1 AND 2
OPERATING AREA
HVAC EMERGENCY VENTILATION SYSTEM

Pool Water Treatment & Instrument Air Compressor Building. This is a concrete building 2 stories high approximately 123 ft long, 54 ft wide, and 20 ft high. On top of will be a steel frame building housing HVAC equipment. This steel building is 20 ft tall and occupies approximately 1/2 of the roof area. On the south east side of the plot is the HVAC/Office/Generator and Equipment Area Building. This is also a steel frame building and is identical to the CSB equipment/office area building.

4.1.7 Material Flow

4.1.7.1 General Description

The Material Flow includes two distinct phases: the Staging Material Flow and the Storage Material Flow which takes place only after startup of the Stabilization Facility.

4.1.7.2 Staging Material Flow

The Staging Material Flow involves tasks and sequences necessary to place packaged MCOs, received from the K-Basins, into racks located in the Staging Pool prior to stabilization.

The Staging Material Flow begins with a packaged MCO in a cask, on top of a rail car parked on a siding outside the Rail Tunnel/Cask Unloading Area. It terminates at the removal, from the facility, of a decontaminated cask loaded with a empty, ready to use MCO. Figures 4-12 and 4-13 depict the tasks, sequences, equipment and estimated time required to perform the tasks.

4.1.7.3 Storage Material Flow

The Storage Material Flow involves tasks and sequences for storing stabilized MCOs inside passively cooled storage tubes. This phase will occur only after the Stabilization Facility has been made operative.

The Storage Material Flow begins with the reception of a stabilized MCO, in a tunnel transfer cart, sent from the Stabilization Facility. It terminates with closure of the storage tube after loading of a MCO. If required, MCOs can be retrieved and sent back to the Stabilization Facility for overpacking by reversing the sequence. Figures 4-14 and 4-15 depict the tasks, sequences, equipment and estimated time required to perform the tasks.

It is assumed than placement of required impact absorbers inside the storage tubes is performed outside the MCO handling time frame. The bottom impact absorbers will be placed as the last step in storage tube installation. Upper impact absorbers will be installed in a campaign style manner, many in the same lapse of time, during a down time period.

FIGURE 4-12

CONCEPT "1", ALTERNATIVE "B"
STAGING MATERIAL FLOW DIAGRAM

CADFILE: FLOW1B

FIGURE 4-13

CONCEPT "1" , ALTERNATIVE "B"
STAGING MATERIAL TIME STUDY

FIGURE 4-14

CONCEPT "1", ALTERNATIVE "B"

STORAGE MATERIAL FLOW DIAGRAM: TO AND FROM FUTURE STABILIZATION FACILITY

CADFILE: FLOW1B

FIGURE 4-15

CONCEPT "1" , ALTERNATIVE "B"
STORAGE MATERIAL TIME STUDY

4.2 FEASIBILITY ISSUES

4.2.1 Structural

There are two primary structural feasibility questions to be addressed with respect to Concept 1. They are:

- 1) Changes in the seismic design criteria from the CSB design basis, and
- 2) Issues associated with adaptation of the design of Vault 3 to pool storage.

4.2.1.1 Changes in the Seismic Design Criteria

When the HWVP project was put on hold, the seismic design criteria was being revised. Specifically, UCRL-15910 was being revised and new site specific horizontal ground surface accelerations were being developed by Geomatrix. During that time Fluor Daniel was given direction to upgrade the design of the CSB based on a ground acceleration of 0.35g using the existing, at that time, SDC 4.1 Rev. 11, and UCRL 15910.

At the present time the latest design criteria documents are SDC 4.1 Rev. 12 and DOE-STD-1020-94, dated April 1994. (DOE-STD-1020-94 has replaced UCRL 15910.)

The significant changes are that the ground acceleration in DOE-STD-1020-94 for PC-4 (which is equivalent to Safety Class 1) in the Hanford 200 East Area is now 0.37g, and a 1.25 scale factor has been added. This means that the new seismic design load for PC-4 is $1.25 \times 0.37g = 0.4625g$ versus the 0.35g that the CSB design was upgraded to. This is 1.32 times greater than the seismic design criteria used for the CSB.

Therefore, it is important to note that, even if no changes were made to the original configuration, the design has to be re-evaluated for the increased seismic accelerations and there is a high probability that added reinforcement in the concrete and an increase in the steel member sizes for the operating shelter will be required. However, there is no reason to believe that this cannot be accomplished during the adaptation of the design of the CSB for the SSF.

4.2.1.2 Issues Associated With Adaptation of the Design of Vault 3 to Pool Storage

Any portion of the construction that has not been completed can be re-engineered and built to accommodate the new loads associated with a water filled pool. However some portions of the CSB concrete vault have been already built. When construction of the

CSB vault was halted the foundation mat and portions of the east exterior and north-east corner of the walls were constructed. Therefore the feasibility of conversion depends on whether the construction, as completed to date, can accommodate the new design loads without revision, and if not, the practicality of modifying it to do so.

Evaluation of the CSB design to accommodate the conversion to a design in which Vault 3 is built as a open water pool storage facility and Vaults 1 and 2 are built essentially as they were originally designed resulted in the conclusion that it is structurally feasible to do so. The following findings describe the results of the evaluation in greater detail:

1. The existing foundation slab thickness and rebar is acceptable as is.
2. In order to accommodate the new hydrostatic and seismic loads, the wall between Vaults 2 and 3 will be increased from 3'-0" to 3'-6". The 6 inch increase will be on the dry side, into the Vault 2. Additional vertical reinforcement will be added to this wall. This will be #11 rebar, at 9 inches on centers with each new layer located 6 inches northerly from existing #9 rebar dowels. This results in two layers of steel in each face of the wall, #11 and #9 spaced at 9 inches along the east-west direction. Additional rebar will be installed by drilling into the foundation mat and then grouting new rebar with non-shrink cementitious type grout. Placement of new rebar along the north-south direction in line with the existing #9 rebar will minimize congestion and the chances of damaging existing steel in the foundation mat.
3. The operating floor slab was designed as a continuous slab system. Pool storage will disrupt the structural system. No significant changes are expected to be required in the operating floor slab, since it is not planned to use the shielded cask transporter (SCT).
4. Exterior walls adjacent to the dry storage vaults should be acceptable as is.
5. The south, east, and west water pool walls will be exposed to hydrostatic and hydrodynamic loads from the interior side of the pool. The hydrostatic loads will be counteracted by soil pressure on the outside of the walls and therefore does not represent a very significant change. Of greater significance is the absence of the restraint that was previously provided by the operating floor slab. Because of this the design moments will increase. The wall thickness should remain the same, however additional layers of rebar

will be added. This additional rebar will be drilled and grouted into the foundation mat. It is expected to have two layers of rebar in each wall adjacent to the water pool areas. In addition, six pilaster type walls will be added on the south side of the Vault 3 on the exterior side, in line under the steel building columns. These walls will be ~3 ft thick, 6 ft wide and 42 ft tall, each.

6. New walls closing the intake and exhaust plenums along the north pool wall will be ~5 ft thick. Their rebar will be drilled and grouted into the foundation mat.
7. Stainless steel liner will be added to the pool area. It is assumed that a single plate liner with leak detection chases will suffice. The floor liner plate will be plug welded to the existing embedded carbon steel plates in the foundation mat. The liner plate along the walls can be installed by either the integral or the wallpaper method. For the wall paper method of installation it is estimated 1/4" thick liner plate on the floor and 3/16" thick liner plate on the walls. Embeds for the attachment of the liner plate are estimated to be L3x2x1/4 angles spaced ~3'-0" one way and ~5 ft the other way. Angles will have 5/8" diameter ~8" long studs at 6" centers.

If required, a double lined system can also be accommodated. For a double lined pool, with supports spaced at 18" on centers in addition to the above add 1/2" thick liner in the floor and 3/8" thick liner on the walls. Supports are estimated to be stainless steel C3x6.

8. MCO storage racks will be required in the pool. Details will be developed later, however it is estimated that each storage rack will store approximately 50 MCOs. These racks will have aspect ratios that will prevent them from being overturned during a Design Basis Earthquake. The pool floor will have shear guides/stops to position the racks and provide horizontal restraint against sliding during earthquake.
9. The CSB vault area north of the wall separating Vaults 3 (converted to pool storage) and Vault 2 will remain essentially the same. Very little design modifications or changes are expected in this area because little will be changed from the original design.
10. Steel frame buildings for the pool shelter, the operating shelter, and support buildings do not represent any feasibility issues.

11. For Alternative 1C, the issues are the same as for Alternative 1B except that provisions must be made for the future addition of Vault 4. This can be accomplished by building Vault 4 at the same time as Vaults 1 and 2 or deferring its construction until the second phase of SSF construction. In the latter case, this will require embedding rebar couplers into the operating floor slab and the east and west walls on the north side of the concrete vault during the first phase of construction. During the second phase, excavation and demolition of a portion of the operating floor, and openings for the intake and exhaust plenums in the north wall of Vault 1 will be required. The new rebar for the foundation mat for Vault 4 will be installed by drilling into the north side of the mat for Vault 1 and grouting rebar for the extension of the foundation. The foundation slab for the Vault 4 is poured, then the walls, then the operating floor slab. The remaining steps required to complete Vault 4 are then the same as for Vaults 1 and 2.

4.2.2 Thermal/HVAC

The cooling system for the storage pool is designed to maintain a 50 °F temperature in the water trapped in the upper-limit (hottest) MCO placed in the warmest part of the pool. The pool temperature outside the upper-limit MCO must be less than 47-48 °F. This requires a water temperature of 44-45 °F into the pool (from the chiller exchanger), based on designing for the minimum recirculation rate. These temperatures are within the typical range for industrial chilled-water systems.

ANSI/ANS-57.7 requires a pool turnover time of 72 hours or less; greater recirculation rates would reduce the temperature rise across the pool and increase the heat transfer coefficient, resulting in an increase in the allowable pool inlet temperature. In other words, there is no problem operating the pool at a 44-45 °F inlet temperature, and the pool cooling design could be adjusted to run even closer to 50 °F by increasing pump and piping sizes.

The heat transfer calculation to determine pool temperature is based on one-dimensional conduction through a 24" O.D. MCO with a 0.375" stainless steel wall. The heat transfer from the MCO outside surface to the pool water is calculated from the usual Nusselt number correlation for forced convection (Ref. Perry's Handbook, equation 10-44), after reducing the Reynolds number to account for the close spacing of the MCOs. The reduced Reynolds number indicates stable laminar flow, which is conservative because no credit was taken for vertical natural convection. No credit is taken for heat loss by infrared radiation, which is expected to be negligible. Although the heat transfer calculations assume an even distribution of flow across the tubes, no credit is taken for heat

transfer through the top or bottom, or portions of the MCO shell that do not have a canister at that level. Physical property data for the calculation is from Perry's Handbook.

Unequal distribution of pool flow can be partially corrected by placing baffles in the pool, or can be fully compensated by increasing the pool recirculation rate or placing the hottest MCOs in the greatest flow and coolest water. Baffles, elaborate flow distribution manifolding, or other modifications in pool cooling water flow distribution seem unnecessary, but could be utilized if they prove cost-effective.

The results of the thermal analyses during storage operation with the existing CSB design concept, assuming the same intake structure, vault size and exhaust stack (height and diameter) indicate that an MCO fuel centerline temperature of 230 °F can be maintained by a passive ventilation system. This is based on an inlet air temperature of 115 °F (same design basis as CSB) and a ventilation flow rate of 53,000 CFM. The vault air temperature distribution and velocity profile for a fully loaded vault during passive ventilation are shown in Figures 4-16 and 4-17.

4.2.3 Contamination Control

4.2.3.1 Introduction

The potential contamination hazards are from gas normally generated by the MCOs before stabilization and from the unlikely failure of an MCO to contain the spent fuel. The feasibility concern is whether the MCOs can be cooled and vented while maintaining acceptable confinement/containment.

The unstabilized MCOs normally generate a nominal 600 Btu/hr of decay heat, and at 50 °F generate 1.2 L/day of hydrogen gas. The gas is contaminated with 2.56 mCi/L of Kr-85, and the rate of gas generation roughly doubles for every 10 °C (18 °F). The gas must be released from the MCOs without creating a fire or explosion hazard and without exceeding acceptable levels of contamination in occupied areas. The MCOs must be cooled to reduce the rate of gas generation and to prevent the MCOs from drying out. If the water contained in the unstabilized MCOs evaporates and uranium metal or uranium hydride from the fuel is exposed to air, there is a hazard of pyrophoric reaction. This intense reaction could melt the MCO shell, causing the release of fine particles of oxidized fuel containing radionuclides.

The remainder of this section discusses confinement and containment issues during normal MCO venting or accident conditions during staging and storage.

FIGURE 4-16

PASSIVE COOLING VAULT TEMPERATURE
PROFILE CONCEPTS 1C AND 2A

FIGURE 4-17
PASSIVE COOLING VELOCITY PROFILE,
CONCEPTS 1C AND 2A

4.2.3.2 Normal Operation

MCO Servicing. The servicing function is the same for all of the pool designs considered: After each MCO is received into the Staging and Storage Facility, the MCO is purged with nitrogen and deionized water is added if needed to reach the desired level in the MCO. The services can be done with the MCO submerged in a small section of the main pool. The pool temperature, clarity, and radioactive contamination must be maintained at acceptable levels; also, the level of contamination above the pool must be acceptable for controlled occupancy. The issues concerning gas releases from the MCO while submerged are the same as when the MCO is in direct contact with the pool during storage, discussed below under "open pool storage".

When deionized water is added to an MCO, there is a possibility of overfilling the MCO and causing contaminated water to enter the vent piping above water. Several features were incorporated to avoid this scenario (see Figure 4-5). First, it is assumed that the MCOs will have two valved connections that can be used for level indication. One of the connections must have a dip tube inside the MCO which extends well below the desired water level, but above the maximum sludge level. The other connection must terminate well above the desired liquid level, so that a differential pressure sensor in the service area can determine the MCO water level. The second feature is a purge collection pot, mounted on the vent line from the MCO. Any liquid entrained with the vent gas will be collected in the pot. When deionized water is added to an MCO, it will be introduced through the pot, so that any contamination will be rinsed back into the MCO. As a third feature to prevent overfilling the MCO, a metering pump will be used for filling, to ensure that deionized water fills the MCO at a constant rate of about 0.5 inch per minute, allowing sufficient time for monitoring and response. The fourth feature is a beta/gamma process monitor on the collection pot.

Open Pool Staging. Gas vented from the MCOs rises through 9 ft or more of water to reach the pool operating area, which is normally ventilated with enough fresh air (over 10,000 cfm) to dilute the hydrogen and krypton-85 to acceptable levels. The normal ventilation maintains an acceptable airborne contamination level of less than 10^{-5} mCi/L from Kr-85, and maintains the hydrogen concentration several orders of magnitude below the flammable limit. The contamination limit for controlled-access areas, including the factor for Kr-85, is contained in the DOE Radiological Control Manual.

Passive Air-Cooled Storage. After stabilization, the MCOs do not normally vent gas. There are no contamination issues during normal operation.

4.2.3.3 Abnormal Operation

MCO Servicing. The abnormal conditions that concern this system are the same as discussed below.

Open Pool Staging. The pool could become contaminated in the event of the failure of an MCO. Until the accident is quantified, it is assumed that the unmitigated consequences are severe enough to require safety class 1 or 2 systems, as defined in WHC document MRP 5.46 and DOE Order 6430.1A (Section 1300-3). To prevent this potential contamination from reaching the soil, the pool must be lined with stainless steel and monitored for leakage. Anywhere pool water is contained, there must be a way to inspect or test for leaks; this includes any piping that penetrates through walls or the ground. The glycol coolant in the chillers must have monitors or test connections to detect any leaks across the glycol/pool water heat exchangers.

The operating area above the pool could become contaminated in the event of a crane accident during MCO handling. Should any abnormal contamination be detected above the pool, alarms warn the operators to leave the area and the Emergency Ventilation System is activated. This system ensures that there is no unfiltered release from the building and that the hydrogen concentration remains orders of magnitude below the flammable limit.

The dropping of an MCO onto one or more MCOs in the pool is not the worst MCO accident (compared to an accident above the pool), but this accident was used as a basis for designing the pool water treatment system. It is assumed that if an MCO hits more than one other MCO, the force of impact will be spread so that the impacted MCOs do not crack open. With this assumption, the worst credible accident of this type involves the contents of two MCOs. The pool water filters and deionizers are sized to contain the upper limit corrosion products from two MCOs. The soluble corrosion products (cesium hydroxide) do not pose a criticality threat in the deionizer. The critically-safe geometry for the filters has not been determined in this study, due to time limitations.

Although the MCOs are not expected to leak, the feasibility of leak detection has been proven in many operating fuel pools. Sensitive detectors in the water treatment system will alarm if any MCO begins to leak. At that time "sipping" devices can be used for locating the leaking MCO to be placed in an overpack. A recent advancement in sipping technology (which allows a typical pool of fuel assemblies to be checked in a few days) is described in the June 1994 Nuclear News article, "Entergy first in U.S. to use fuel 'sipping'".

Passive Air-Cooled Storage. If there is a failure of a stabilized MCO during storage in a tube, the HEPA filter in the sealed floor

plug will prevent airborne contamination from spreading out of the tube. The floor plugs have test fittings which allow for periodic gas sampling to detect MCO failure. The contamination is localized, but there is no built-in design feature for clean-up.

4.2.4 Criticality

4.2.4.1 Introduction

One of the principal feasibility issues identified at the start of this study was the minimum allowable spacing between MCO's, from a criticality standpoint, and the identification of a feasible storage configuration based on criticality considerations. Since criticality safety was identified as a potential design driver, an analysis effort was undertaken to identify and quantify restrictions on N-Reactor fuel storage configurations based on criticality. Although the Design Basis contained in Appendix 1, received after the start of this study, indicates that there are no restrictions on MCO spacing and stacking based on criticality, it was decided to continue the analysis to verify the Design Basis. This section, and Section 5.2.4 for Concept 2, presents the results of this analysis.

4.2.4.2 Summary of Results

Preliminary criticality calculations were performed with simplified geometries, taking no credit for structural material, such as canister and MCO walls, and all simplifying assumptions made were conservative. These calculations confirmed that the MCO's could be stacked, even when loaded with five layers of canisters, and can be placed side-by-side without additional space between MCO's. The worst-case k_{eff} calculated was less than 0.90, well within the 0.95 limit imposed by the Nuclear Criticality Safety Manual, Section 2.0, Paragraph 5.1.3, Allowed Maximum Calculated K-effective.

4.2.4.3 Criteria and Assumptions

The criteria and standards on which these criticality calculations are based, as well as the assumption used in formulating the computations, are given the following paragraphs.

Applicable Orders and Standards. The criticality calculations performed in support of this feasibility study conform with the following criteria and standards:

DOE Order 5480.24, "Nuclear Criticality Safety"

DOE-STD-3007-93, "Guidelines for Preparing Criticality Safety Evaluations at Department of Energy Non-reactor Nuclear Facilities"

WHC-CM-4-29, "Nuclear Criticality Safety Manual," issued September 15, 1988.

Choice of Computer Models. The principal tool selected for criticality calculations is the PC version of MCNP, Version 4A, developed and supported by the Los Alamos National Laboratory (LANL), Reference 2. This code was selected because of its great flexibility, high fidelity modeling (e.g., ENDF/B-V continuous cross sections), and the ability to perform both shielding and criticality calculations.

Another code available for criticality calculations is KENO, Version V.A (contained in the SCALE-PC, Version 4.1; Reference 3). This code was not used to perform criticality calculations directly for this study, but was used to compare results during the validation and verification process.

Code Verification & Validation. All codes used in shielding and criticality calculations at Fluor Daniel have been verified by running the test problems supplied with the code packages. The test problem results are shown to be in agreement either with the published documentation supplied as part of the code package, or with the sample problem output, if supplied. This information is documented, dated, and retained on file at Fluor Daniel. Any changes, such as upgrades, corrections, modifications, etc., are incorporated into the documentation following rerunning of the verification problems.

MCNP, Version 4A is the latest version, Reference 2, of a widely used and well accepted radiation transport code employed for a wide variety of radiation analyses including neutron, photon and electron transport, and criticality. LANL has performed extensive calculations with MCNP, duplicating a wide range of experimental results, to validate the models contained in this code. The results of these benchmark cases are documented in References 4 and 5. The version of MCNP4A used at Fluor Daniel was tested by exercising the twenty-five sample problems supplied by LANL, and the results were found to be in agreement within reasonable statistical limits. These sample problems are designed to exercise a broad range of the code's computational capabilities, including criticality calculations, which is addressed by five of the twenty-five sample problems.

Material Properties. The densities and composition of materials used in the criticality calculations are given in Tables 4-3 and 4-4.

Preliminary Calculations. Preliminary criticality calculations were performed to define the worst case spacing of fuel elements inside a canister, and/or each layer of a CSB storage tube. To this end, a computational model of seven storage tubes was formulated; with

TABLE 4-3
DENSITIES OF SOME MATERIALS

<u>Material</u>	<u>Density (g/cc)</u>	<u>Material</u>	<u>Density (g/cc)</u>
Air	0.00122	Uranium	18.7
Aluminum	2.70	Water	1.0
Iron (Steel)	7.83	Zirconium	6.4

The fractional densities for compound materials used in this study are listed in Table 4-4.

TABLE 4-4
COMPOSITION OF MATERIALS USED IN RADIATION
SHIELDING CALCULATIONS
(Given as Fractional Densities in g/cm³)

Atomic Number	Element	Air	Water	Stainless Steel 304L ASTM A240
1	H		0.11111	
5	B ¹⁰			
5	B ¹¹			
6	C	0.00000017		0.0023
7	N	0.00092132		
8	O	0.00028276	0.88889	
11	Na			
12	Mg			
13	Al			
14	Si			0.0587
15	P			0.0035
16	S			0.0023
18	Ar	0.00001575		
19	K			
20	Ca			
22	Ti			
24	Cr			1.5660
25	Mn			0.1566
26	Fe			5.1009
28	Ni			0.9396
Total		0.00122	1.00	7.8299

12 vertical layers, each layer consisting of 31 fuel elements in a triangular pitch array. The material composition of this array consisted of fuel elements only: concentric cylinders of 1.25% enriched uranium, with zirconium cladding. All voids and spaces within the fuel elements and storage tubes were filled with water, and water was medium surrounding these storage tubes on all sides. The k_{eff} of this configuration was calculated, varying the pitch of the triangular array. The results are shown in Figure 4-18. The important result of these calculations is that the worst case spacing between fuel elements is 3.2 inches.

The spacing between storage tubes, was 55 inches. These tubes were again arranged in a hexagonal pattern, in cross section, which approximated the storage tube configuration within the CSB vaults. Because of this spacing between tubes, and because the tubes were immersed in water, there was no appreciable interaction between the tubes, and the results show no sensitivity to variations in this spacing (except when the tubes were placed very close together, as discussed below).

Results For Concept 1. In the interest of addressing the key factors, with respect to criticality safety, in each storage configuration, a computational model was formulated which could address these factors for both storage concepts. All uncertainties were compensated for with conservative assumptions. In the event these assumptions led to an unacceptable risk of a criticality event, it was planned to perform sensitivity studies to identify safe limits.

In this computational model, fuel elements were arranged in columns, each containing 280 fuel elements. Each column contained fuel arranged in patterns representative of two MCO's, stacked one on top of the other. Each MCO was modeled with five vertical layers of canisters, two canisters of 28 fuel elements, per layer. The 28 fuel elements in each layer were arranged in a pattern similar to that found in the canisters, Figure 4-19, but the center-to-center separation between fuel elements was taken to be 3.2 inches, the worst-case spacing from Figure 4-18.

In a nominal CSB vault, 220 such columns would have been arranged in a hexagonal pattern. This pattern was modeled as a triangular pitch array, with a 55 inch center-to-center separation between columns, Figure 4-20. (Since interaction between columns is negligible, this will be shown in what follows, changing the size of this array was not required.) The closest spacing between columns, which could be achieved in a flooded pool, was assumed to be 26 inches, center-to-center. This assumes a bare MCO, no tube, and a minimal amount of structural material for keeping the 24 inch OD MCO in place. For this calculation, no credit was taken for either the MCO or the canister walls. In fact, the only materials included in this

FIGURE 4-18
SENSITIVITY TO SPACING, 31 FUEL ELEMENTS
(IN A TRIANGULAR ARRAY) PER LAYER, 12 LAYERS, 7 COLUMNS


```
I 01/19/95 15:36:49
NFD307, N fuel, 28
elements/layer, 220 columns 47
inch spacing
probid = I 01/19/95 15:11:34
basis:
( 1.000000, 0.000000, 0.000000)
( 0.000000, 1.000000, 0.000000)
origin:
( 0.00, 0.00, 142.80)
extent = ( 50.00, 50.00)

.psz=-142.80
```

FIGURE 4-19
FUEL ELEMENTS IN A SINGLE LAYER OF AN MCO MODEL

```
I 08/15/94 13:50:37
MFC23, N fuel, hex lattice, 3.2
in pitch, 31 elements per
layer, full inventory
probid = I 08/15/94 13:49:16
basis:
( 1.000000, 0.000000, 0.000000)
( 0.000000, 1.000000, 0.000000)
origin:
( 0.00, 0.00, 0.00)
extent = ( 1700.00, 1700.00)
possible causes of dotted lines:
errors in the geometry.
cookie-cutter cell in the source.
a problem plane coincident with
the plot plane.

.end
```

FIGURE 4-20
CSB VAULT MODEL SHOWING STORAGE TUBES IN A TRIANGULAR ARRAY

model are the fuel, cladding, and the surrounding water. The results for this configuration gave a k_{eff} of 0.81289 with a standard deviation of 0.00091 (calculation ID: NF032). Replacing the water outside the MCO boundaries with air, gave a k_{eff} of 0.87063, +/- 0.00073 (NF033). This increase is probably due to the increased interaction between columns for this close a spacing.

To evaluate the impact of some of the structural material, assumed to be stainless steel (SS 304), the case with air outside the MCO was repeated, but this time the canister walls were included in the model. This calculation gave a k_{eff} of 0.77375, with a standard deviation of 0.00065 (NF034). Including the MCO wall material, further reduced the k_{eff} to 0.74524 +/- 0.00069 (NF035). (To accommodate the 3.2 inch spacing between fuel elements, the canister outside diameter was taken to be 9.2 inches and its thickness 0.25 inches, Figure 4-21. This should be compared to a standard schedule 20, 8 inch pipe which has an outside diameter of 8.625 inches and the same thickness.)

Increasing the spacing between columns to 55 inches and including the tube material, reduced the k_{eff} to 0.7234 +/- 0.00061 (NF036). The relatively small decrease between this case and case NF035, indicates that the interaction between columns has already been significantly reduced by the addition of the MCO wall material.

Case NF036 is representative of both the Concept 1 dry vault storage and Concept 2 storage of MCO's in water filled tubes with forced refrigerated air cooling of the tubes. Eliminating water from the calculation will result in an under-moderated situation with an effective decrease in k_{eff} . Filling the vault with water would have only a minor effect on the vault k_{eff} , since there is only negligible interaction between tubes at this spacing and when taking credit for tube and MCO wall thicknesses. (The case of a water filled vault is a credible accident scenario and would have to be considered in a criticality safety evaluation. Partial filling of the vault with water may actually be a worst case situation, as was illustrated by comparing results for cases NF032 and NF033.)

4.2.5 Shielding

The shielding evaluations were performed with MicroShield 4 which is adequate for the bulk shielding studies performed. Penetrations, ducts, and cracks were not evaluated but are noted where additional work will be needed in the future. Some allowances were taken with the bulk shielding thicknesses in anticipation of the more complicated geometries.

4.2.5.1 Introduction

The shielding issues for Concept 1 involve health protection of the occupants of the SSF throughout its life. The selection of an appropriate source term is examined by looking at the defined

```
I 02/08/93 15:17:05
MF036, M fuel, MCO,can.&tube
walls, 220 columns 33 inch
spacing, air in vault
probid = I 02/08/93 15:09:47
basis:
( 1.000000, 0.000000, 0.000000)
( 0.000000, 1.000000, 0.000000)
origin:
( 0.00, 0.00, 142.00)
extent = ( 50.00, 50.00)
.end
```

FIGURE 4-21
CROSS SECTION OF STORAGE TUBE SHOWING MCO AND CANISTER WALLS

"limit" source and another "shield" source, as well as a combination of the two sources. There are several water conditions that must be met at all times to provide a maximum dose rate of 0.5 mrem/hr. These include the minimum pool water depth over the filled MCO racks and the minimum water level over an individual MCO. The interior and exterior wall thicknesses are important to provide health protection during possible construction activities. The operating floor thickness must protect workers during maintenance activities. The thickness of the transporter or shielded cask must provide adequate shielding during transport, insertion and removal of the shield plugs and MCO's. The shielding parameters are identical for Alternatives 1B and 1C.

4.2.5.2 Source Selection

Three possible sources were examined to determine the most appropriate for the shielding studies. The "limit" source is that found in Appendix 1, "MCO Proposed Description" Draft Rev. A, R. G. Cowan, January 12, 1995. The "shield" source is that found in Table 3.6 - Safety Basis Radionuclides - referenced as the shield source in paragraph 3.6 - Shielding Design Basis of the "Draft Design Basis Feed Development", A. L. Pajunen, December 22, 1994. Direction from Westinghouse indicated that the "limit" source should be used. Previous experience and the increased number of radionuclides in the "shield" source prompted examination of the two sources. The "shield" source is based on the most radioactive fuel elements currently in the K-Basins. Apparently, there is only 0.6 metric tons of this material, which is considerably less than one filled MCO. However, three cases were examined: 1) filled MCO with the "limit" source; 2) filled MCO with the "shield" source; and 3) combined MCO with 0.6 metric tons of the "shield" source and the balance of the fuel elements of the "limit" source. A simple geometry of an MCO immersed in water with a 2 foot concrete wall was used to evaluate the three sources. All other things being equal, except for the radionuclide composition, the resulting dose rates were: "limit" - 0.0112 mrem/hr; "shield" - 0.0122 mrem/hr; and "combined" - 0.0114 mrem/hr. The limit source was selected since all sources were very close to being equal.

4.2.5.3 Minimum Water Depth Over a Single MCO

The MCO is brought into the SSF in a shielded cask. The cask is immersed in water before withdrawing the MCO. Radiation shielding of the MCO is provided by the water surrounding the cask and the MCO. Whenever the MCO is not in the cask, it must be surrounded and covered by water. Personnel do not generally have access to the sides or bottom of the pool (Section 4.2.5.5) so only the top of the MCO must be shielded. This shielding is provided by establishing a minimum water depth above the MCO which must be maintained. This minimum water depth is 6 feet.

4.2.5.4 Minimum Water Depth Over MCO Rack

Radiation shielding of the MCO rack is provided by the water surrounding and covering the MCO's in the racks. The MCO's in the racks must always be covered with water to provide cooling as well as shielding. Personnel do not generally have access to the sides or bottom of the pool (Section 4.2.5.5) so that only the top of the MCO's in the pool must be shielded. The normal pool depth above the racks must be at least 21 feet which accounts for a 15 foot long MCO and 6 feet of water above the single MCO. However, under emergency conditions, the minimum water depth above the rack is of interest. This is assuming that all MCO's are in the rack and that none are being inserted into the rack. This minimum water depth is 8 feet.

4.2.5.5 Minimum Concrete Thickness of Interior and Exterior Walls

There are several construction sequence possibilities for the SSF. The thickness of the interior walls is not important from a health protection standpoint if all construction is performed initially. However, if the pool is constructed first and filled and the dry storage vaults are built at a later time, the construction workers will need to be shielded against radiation penetrating the interior wall between the pool and the adjacent vault. The minimum wall thickness required is 36 inches. Since a 42 inch wall thickness has been specified to structurally contain the pool, the wall thickness is more than adequate from a shielding perspective.

The second construction sequence involves the construction of the Stabilization Facility adjacent to the exhaust plenum. Excavation could remove all of the soil surrounding the exterior wall. Again, the minimum wall thickness is 36 inches, so that the 54 inch exterior wall is more than adequate.

4.2.5.6 Minimum Thickness of Operating Floor

Radiation protection of personnel from stabilized MCO's in dry storage is provided by the concrete operating floor. This floor, along with the individual shield plugs which provide access into each storage tube, must provide shielding sufficient to maintain a target dose rate of 0.5 mrem/hr. The minimum floor thickness must be 48 inches. This floor thickness allows for a solid floor. When the floor is cast with plug holes and the holes are fitted with plugs which do not completely fill the space, radiation streaming is possible. Plugs and holes with steps solve this problem. It is estimated that the current design thickness of the floor is 60 inches which will provide adequate shielding. The geometry with the holes and plugs will need to be examined thoroughly at a later date.

4.2.5.7 Minimum Transporter/Cask Thickness of Steel and Tungsten

There are two options for transporting the MCO's filled with stabilized fuel tubes. The first would involve a stand alone transporter which would be driven around on the operating floor. The second would involve a special remote controlled cask which would be moved with an overhead crane. In either case, personnel health protection and shielding weight are important. The target contact dose rate is 0.5 mrem/hr. The thickness of iron to achieve this dose rate is 13 inches. The thickness of tungsten to achieve this dose rate is 4.5 inches. The tungsten shield is more expensive, but considerably lighter which reduces the cost of the transporter or overhead crane. These thicknesses provide gamma shielding only. The shielding will need to be checked for neutron shielding adequacy (Section 4.2.5.8)

4.2.5.8 Special Shielding Issues (Neutrons, Betas)

A neutron source was not provided and neutrons have been ignored during this study. However, in future design efforts, neutron dose rates will need to be evaluated. The areas of particular concern are the incoming and outgoing casks and the transporter/cask. These shielding structures are designed to provide adequate gamma shielding. Neutron shielding may be needed. The neutron source will result from some n, α reactions and spontaneous fission of the transuranics.

The beta source does not appear to be significant in the MCO. The shielding concern is not to provide beta shielding which is provided by the shell of the MCO, but to provide adequate shielding of the Bremsstrahlung radiation resulting from the beta absorption in the gamma shield.

4.2.6 Conversion

Conversion of Alternative 1B from water cooled staging of unstabilized fuel to passive dry storage of stabilized fuel is accomplished by installing the storage tubes in the already constructed vaults, constructing the metal building over the vaults and installing the enclosed mechanical, piping, HVAC and electrical equipment. Conversion of Alternative 1C requires construction of the third vault, which is a substantial distance away from the pool, followed by the same steps as for Alternative 1B.

As discussed in the preceding section, the radiation levels in Vault 2 when the pool is filled with MCOs will not preclude personnel entry into Vault 2 to install the storage tubes. Precautions to preclude accidents during construction of the metal building above Vault 2 from causing foreign objects to fall into the adjacent pool will be necessary, but are expected to be practical. However, if necessary, any structures which might present an unacceptable hazard if constructed during conversion could be built during the first phase to a point sufficiently removed from the pool to eliminate the need for such precautions.

5.0 CONCEPT 2 TECHNICAL DESCRIPTION

5.1 FACILITY DESCRIPTION

5.1.1 Plot Plans

Figure 5-1 shows the outline of the Concept 2 SSF and an assumed adjacent Stabilization Facility superimposed on a modified Master Site Plan for what was previously the HWVP site within the 200 East Area. The SSF is shown on the location of the existing CSB foundation. Other existing buildings, roads, rail lines and underground utilities in the area are shown in their current locations. New facilities which have been proposed for construction in the area as shown in the Master Site Plan currently being prepared by Fluor Daniel for the Tank Waste Remediation System (TWRS) Site Integration Task Force have been rearranged to be compatible with the Concept 2 layout and location. The Figure shows that location of the SSF on the existing CSB foundation is feasible and provides good access to all required utilities, roads and rail lines. It also shows that location of the SSF in this area is compatible with plans for other facilities which have been proposed for construction in the area.

A more detailed plot plan for Alternative 2A is shown in Figure 5-2. The Stabilization Facility outline shown in Figure 5-2 shows one possible location for the Stabilization Facility relative to the SSF and is not intended to portray an accurate representation of its size or geometry.

5.1.2 Rail Tunnel/Cask Unloading Area

5.1.2.1 General Description

The Rail Tunnel/Cask Unloading area is a new addition of approximately 10,000 square feet to the original SSF design. It is located in the north west corner of the SSF and interfaces with the MCO Storage Tube Area via a covered water canal as shown in Figure 5-3.

The main functions of this area are to safely receive, handle and prepare the incoming packaged MCO for placement in the storage tubes prior to stabilization. The packaged MCOs are delivered inside a shipping cask, via rail car, one at a time. Before being returned to the K-Basins, the shipping casks are prepared for handling and loaded with a empty MCO.

Except for the use of an underwater transfer canal to transfer MCOs to a receiving station within the operating area of the storage facility where they can be retrieved by the bottom loading MCO shield cask for transfer to their storage tubes, the Rail

WESTINGHOUSE HANFORD CO.
P.O. TW-SV-520252
FLUOR DANIEL, INC.
GOVERNMENT SERVICES OPERATING COMPANY
STAGING & STORAGE FACILITY
MASTER SITE PLAN
CONCEPT 2 ALT A

FIGURE 5-1

CADFILE 7B4
RAC 2/10/95

WESTINGHOUSE HANFORD CO.
P.O. TVW-SW-520252

FLUOR DANIEL INC.
GOVERNMENT SERVICES OPERATING COMPANY

STAGING & STORAGE FACILITY
PLOT PLAN
CONCEPT 2 ALT A

FIGURE 5-2

CADFILE C2A

RAC 2/27/95

Tunnel/Cask Unloading Area for Concept 2 is the same as previously described for Concept 1. A remotely operated hot cell type facility was considered as an alternative to the Cask Preparation Pit/Cask Unloading Pool/MCO Transfer Canal/Cask Loading Pit, but was expected to be more costly than the facilities described for Concept 1 and was therefore not considered further.

5.1.3 MCO Servicing

MCO Servicing is performed in the same manner and using the same equipment previously described for Concept 1.

5.1.4 Cask Unloading Pool Water Treatment System

The Cask Unloading Pool Water Treatment System performs the same functions for the Cask Unloading Pool and Transfer Canal as the Staging Pool Water Treatment System performs for the Staging Pool in Concept 1. Its design is similar to the Staging Pool Water Treatment System for Concept 1, except that it is much smaller, is designed for a 36 hour turnover of pool volume and the deionization units will not be regenerated. Because of the small size of the units, the resin beds are replaced when they become saturated.

Table 5-1 lists the major equipment for the Cask Unloading Pool Water Treatment System.

5.1.5 MCO Cooling and HVAC

5.1.5.1 HVAC Systems for Normal Operation

Vault Refrigerated Air System. The block flow diagram for the HVAC system serving the SSF Vaults during staging is shown on Figure 5-4. The HVAC system is a recirculating refrigerated air system consisting of five 50,000 CFM Air Handling Units (4-operating and 1-standby) which supply chilled air at 35°F to the vault. This supply air temperature to the vault will maintain the MCOs at 50 °F. Since the MCO's are stored in water filled tubes which serve as a secondary confinement barrier, the air inside the vault will not be contaminated.

Vault Passive Ventilation System. The passive ventilation system for the Vault during dry storage will be identical to the CSB design. This concept has three vaults, each with 220 tubes. There are provisions for 17 overpacks and the tube spacing for this concept will be identical to the CSB design.

Operating Area HVAC System. The Operating Area HVAC System for the CSB design will be modified to accommodate the ventilation system for the MCO service area and the MCO/Cask unloading and storage

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02/14/95

TABLE 5-1

EQUIPMENT LIST
STAGING AND STORAGE FACILITY
SSF
(CONCEPT 2)

EQUIPMENT DESCRIPTION	EQUIPMENT ID	CAPACITY/FLOW RATE	PHYSICAL SIZE (DIA X H)	MATERIAL	POWER	HEAT LOAD	COMMENT
<u>POOL WATER TREATMENT SYSTEM</u>							
RECIRCULATION PUMPS	P-3A/B/C	30 GPM, 300 PSIG	2" SUCTION	SS	10.00 HP		ONE SPARE
PRIMARY POOL FILTERS	F-2A/B	30 GPM, 50 PSIG		SS			
DETONIZATION UNIT	R-1A/B	30 GPM, NET	FOUR TANKS 18' OD X 6' H	SS			
WASTE SLURRY HOLD TANK	V-4	25 PSIG	3' OD X 6' H	SS			
WASTE WATER HOLD TANK	V-5	15 PSIG	3' OD X 6' H	SS			
POOL WATER CHILLERS	CH-1A/B	2,200 BTU/HR (0.18 TONS) NET		STEEL	60.00 HP		ONE SPARE
POOL WATER EXCHANGERS	E-1A/B	1,100 BTU/HR		STEEL & SS			
POOL WATER STERILIZERS	UV-1A/B	30 GPM		GLASS & SS			
<u>INSTRUMENT AIR SYSTEM</u>							
AIR COMPRESSOR	C-1A/B	100 SCFH, 100 PSIG		STEEL			ONE SPARE
INSTRUMENT AIR DRYER	DY-1	100 SCFH, NET					DUPLEX
INSTRUMENT AIR RECEIVER	V-1	150 PSIG	8' OD X 8' H	STEEL			

area. The system is capable of diluting the hydrogen and krypton-85 to acceptable levels by introducing sufficient amounts of outside air. The block flow diagram for this system is the same as for Concept 1 (see Figure 4-8).

Pool Water Treatment Building. This building consists of clean areas and potentially contaminated areas. This is a much smaller system than required for Concept 1. A single HVAC system will be used to serve these areas.

The block flow diagram for the HVAC system serving these areas is shown on Figure 5-5. Redundant 2,000 CFM Air Handling Units (AHU-1 and AHU-2) with evaporative cooler and heating coil supply air to these areas and the air is exhausted through redundant HEPA filter plenums (PF-1 and PF-2) and exhaust fans (EF-1 and EF-2).

5.1.5.2 HVAC Systems for Abnormal Operation

Vault Refrigerated Air System. It has been estimated that on failure of the vault refrigerated air system used during staging, the water temperature inside the MCO will increase by 10 °F in approximately 50 hours. This would allow sufficient time to provide other emergency means of cooling, such as flooding the vault with water, in the event refrigerated air cooling could not be reestablished before MCO temperatures became excessive. The vault refrigerated air system therefore does not include any special features for abnormal operation.

Vault Passive Ventilation System. The Vault passive ventilation system used during dry storage is designed to operate following all DBA's. No other HVAC systems are required for operation of the vaults during abnormal operation.

Operating Area. The block flow diagram for the HVAC system for emergency ventilation of the Operating Area is the same as for Concept 1 (see Figure 4-11). This system is designed to be activated following an accident (potential drop of an MCO and release of contamination to the operating area) and is interlocked to stop the normally operating HVAC system. The HVAC system consists of two trains with HEPA filter plenums (PF-1 and PF-2) and exhaust fans (EF-1 and EF-2).

5.1.6 Structural

There are very few structural modifications to the current CSB design required for the SSF under this concept. The operating floor shelter over Vaults 1, 2 and 3 will be a steel frame building very similar to the original CSB design except it will have crane rails and a girder for the overhead cask/crane system described in Section 3. This building will be approximately 46 ft high.

On the west side of the Storage Vault will be the Refrigerated Air Mechanical Building, a 120 ft long, 40 ft wide, and 20 ft high steel frame building. West of that will be five air cooled condensers, each supported on a 8 ft X 15 ft concrete pad. North of the Storage Vault will be four other support buildings: the Cask/MCO Unloading and Storage Building (170 ft long, 61 ft wide, 33 ft high); the Wash Area Building (64 ft long, 50 ft wide, 27 ft high); the Water Treatment & Instrument Air Compressor Building (35 ft long, 30 ft wide, 17 ft high); and the Equipment/Office Building (100 ft long, 33 ft wide, 17 ft high). All support buildings will be steel frame buildings with metal siding and metal roof deck.

An HVAC duct, ~10ft x ~5 ft in size will be added connecting the exhaust stack and the Refrigerated Air Mechanical Area. This duct will be supported by the operating shelter. Refrigerated air will be returned to the air inlet ducts via ducts from the Refrigerated Air Mechanical Area. Removable blinds in the air inlet ducts and exhaust stack will isolate the refrigerated air system from the environment. The inlet air temperature to the vault will be ~ 35 F during staging. Due to the reduced heat load, insulating concrete will probably not be required in the vaults during refrigerated air or natural circulation ambient air cooling.

The storage tubes will be very similar to those designed for the CSB except they will be made out of stainless steel since they will be filled with water during staging. A 1/8 inch increase in the wall thickness of the storage tubes will be required for stainless steel.

5.1.7 Material Flow

5.1.7.1 General Description

The Material Flow includes two distinct phases: the Staging Material Flow and the Storage Material Flow which takes place only after completion of the Stabilization Facility.

5.1.7.2 Staging Material Flow

The Staging Material Flow involves tasks and sequences necessary to place packaged MCOs, received from the K-Basins, into forced air cooled storage tubes, filled with deionized water, in the Storage Tube Area, prior to stabilization.

The Staging Material Flow begins with a packaged MCO in a cask, on top of a rail road car parked outside the Rail Tunnel/Cask Unloading Area. It terminates at the removal, from the facility, of a decontaminated cask loaded with an empty, ready to use, MCO. Figures 5-6 through 5-9 depict the tasks, sequences, equipment and estimated time required to perform the tasks.

SSF Feasibility Study
Westinghouse Hanford Company
WHC P.O. TVW-SVV-370252

Fluor Daniel, Inc.
Government Services
Contract 04436305

FIGURE 5-4

SSF FEASIBILITY STUDY
CONCEPT NUMBER 2
VAULT - HVAC SYSTEM

SSF Feasibility Study
Westinghouse Hanford Company
WHC P.O. TW-SVW-370252

Fluor Daniel, Inc.
Government Services
Contract 04436305

FIGURE 5-5

SSF FEASIBILITY STUDY
CONCEPT NUMBER 2
POOL WATER TREATMENT BUILDING
HVAC SYSTEM

FIGURE 5-6

CONCEPT "2", ALTERNATIVE "A"

STAGING MATERIAL FLOW DIAGRAM, IN RAIL TUNNEL/CASK UNLOADING AREA

CAPRIE FLOWZA

SSF Feasibility Study
Westinghouse Hanford Company
WHC P.O. TW-5V-370252

Fluor Daniel, Inc.
Government Services
Contract 04436305

FIGURE 5-7

CONCEPT "2" ALTERNATIVE "A"
STAGING MATERIAL TIME STUDY
IN CASK UNLOADING & STORAGE AREA

CADFILE:

It is assumed that placement of the bottom impact absorbers inside the storage tubes is performed during the completion of construction. The upper impact absorbers are assumed to be installed in a campaign style manner during a down time period. Storage tubes are filled with the required amount of deionized water before the loading of MCOs starts.

5.1.7.3 Storage Material Flow

The storage material flow involves tasks and sequences for storing stabilized MCOs inside dry, passively-cooled storage tubes. These tubes being the same used for the prior staging phase. This phase will occur only after the Stabilization Facility has been made operative.

The Storage Material Flow begins with the removal of a submerged MCO from a storage tube and its transfer to the Stabilization Facility. It terminates with closure of a dry storage tube after loading a stabilized MCO in it. If required, MCOs can be retrieved and sent to the Stabilization Facility for overpacking by reversing the sequences order. Figures 5-10 and 5-11 depict the tasks, sequences, equipment and estimated time required to perform the tasks.

It is assumed that removal and replacement of the upper impact absorbers inside the storage tubes is performed outside the MCO handling time frame. The bottom impact absorbers remain in place and do not require handling. The upper impact absorbers are assumed to be removed and reinstalled in a campaign style manner, during a down time period. Removal of deionized water from the storage tubes is accomplished thorough the floor plug access tubes. This action takes place during the stabilization process.

5.2 FEASIBILITY ISSUES

5.2.1 Structural

The same two structural feasibility questions discussed for Concept 1 apply to Concept 2. They are:

- 1) Changes in the seismic design criteria from the CSB design basis, and
- 2) Issues associated with design adaptation

5.2.1.1 Changes in the Seismic Design Criteria

As identified in section 4.2.1.1, the new seismic design load has increased 1.32 times from the "old" seismic design criteria that the CSB was designed for. Therefore, even if no changes are made to the original configuration of the facility, the design still has

STORAGE MATERIAL FLOW DIAGRAM: TO AND FROM FUTURE STABILIZATION

CONCEPT "2", ALTERNATIVE "A"

FIGURE 5-10

SSF Feasibility Study
Westinghouse Hanford Company
WHC P.O. TVW-SVV-370252

Fluor Daniel, Inc.
Government Services
Contract 04436305

FIGURE 5-11

CONCEPT "2", ALTERNATIVE "A"
STORAGE MATERIAL TIME STUDY
OUT & INTO STORAGE TUBES

○ SEQUENCE #s FROM STORING MATERIAL
FLOW DIAGRAM, FIG. 5-10

- ▨ VACUUM CLEANER
- 70T/10T CRANE
- ▩ STORAGE TUBE LOADING CASK
- ⋯ PORTABLE SHIELDING GATE
- ▦ PORTABLE FLOOR PLUG UNIT

CADFILE:

to be re-evaluated for the increased accelerations of the new criteria and there is a high probability that some of the original design may need upgrading in terms of added reinforcement in the concrete and increase in the steel member sizes for the operating shelter. However, there is no reason to believe that this cannot be accomplished during the adaptation of the design of the CSB for the SSF.

5.2.1.2 Issues Associated With Design Adaptation

Evaluation of the issues involved in adaptation of the CSB design to refrigerated air cooling initially followed by conversion to natural circulation cooling with ambient air resulted in the conclusion that it is structurally feasible to do so. The following findings describe the results of the evaluation in greater detail:

1. The concrete vault design is essentially unchanged. The air temperature inside the vault during operation with refrigerated air will be ~ 35°F. This is within the operating temperature range that the concrete vault was designed for. Insulating concrete will probably not be required.
2. The operating floor shelter over Vaults 1, 2 and 3 will be a steel frame building very similar to the originally designed building except it will have crane rails and girder for the overhead crane to service MCO and cask. This building will be approximately 46 ft high. An HVAC duct, ~10 ft x ~5 ft in size will be added connecting the exhaust stack to the Refrigerated Air Mechanical Area. This duct will be supported by the operating shelter. There are no feasibility issues related to this addition.
3. The storage tubes will be very similar to what was originally designed except they will be made out of stainless steel to protect them from corrosion. It is estimated that the thickness of the tubes will increase by 1/8 inch, from the original design. This is because stainless steel has a lower yield stress than carbon steel.

5.2.2 Thermal/HVAC

This section documents the results of a series of thermal analyses that were performed to assess the feasibility of meeting the Multi-Canister Overpack (MCO) temperature requirements during wet and dry storage with the Concept 2 Staging and Storage Facility (SSF). These analyses were performed for forced refrigerated air and passive ventilation systems.

The thermal feasibility analyses is based on storage of MCO's in water filled tubes in vaults 1,2 and 3 with a forced refrigeration air cooling of the tubes during staging. MCO's are removed and returned to the tubes after stabilization and water removal from the tubes. After all fuel is stabilized, the passive air ventilation system is made operational.

5.2.2.1 Design Basis Assumptions

The following design basis assumptions were used for the thermal analyses:

- The heat generation rate was based on a total 1200 MCO's. Five percent are assumed to be at the upper limit (1120 BTUH) and the remaining 95% are assumed to be at the nominal value (600 BTUH). Due to the preliminary nature of the heat transfer calculations a ten percent safety factor was used for the heat generation rate. Additional heat loads were added for building heat gains and fan heat.
- The heat generation for the limiting case (1120 BTUH) per MCO was used for the calculating the MCO's water temperature assuming that it is located at the end of the vault.
- The design basis required storage conditions are as follows:
 - Staging: Water inside the MCO at 50 °F.
 - Storage: Maximum fuel centerline temperature at 400 °F.
- During the staging operation the MCO provides primary confinement and the water filled storage tubes provide the secondary confinement. It is assumed that the interior of the storage tubes are isolated from the vault, which would prevent the vault from getting contaminated.
- The total flow is assumed to be evenly and uniformly distributed around each of the containment tubes. This is a critical assumption that must be assured by design and verified by additional analyses using Computational Fluid Dynamic (CFD) techniques.
- The heat transfer coefficients for air were calculated at the point of maximum vault air temperature.
- One dimensional (radial) heat transfer only. Two-dimensional (radial and axial) heat transfer was not modeled.
- Heat transfer by radiation between the tubes was not considered.

5.2.2.2 Summary of Results:

The results of the thermal analyses during staging are shown in Table 5-2 and involve various combinations of MCO's surrounded by water in tubes for different ventilation flow rates.

The results indicate that it is feasible to maintain the MCO water temperature at 50 °F with a refrigerated forced air ventilation system. This system would require 200,000 CFM at a supply air temperature of 35 °F based on the above heat generation rate. The temperature of 35 °F was selected to prevent freezing of MCO's having very low heat generation. The MCO water temperature is calculated on the basis that the MCO is located at the end of the vault with the limiting heat load.

The results of this thermal analysis during storage with natural circulation cooling were previously presented in Section 4.2.2. The data shown there indicates an MCO fuel centerline temperature of 230°F can be achieved by a passive ventilation system.

The above results demonstrate the feasibility of using the refrigerated air and passive ventilation systems to meet the design basis MCO temperature requirements during both staging and storage.

It must be emphasized that these are rough conservative feasibility analyses using limited design information and do not cover all limiting or upset conditions. More detailed analyses are required using CFD techniques to cover all limiting and upset conditions and to verify some basic assumptions. Also no analysis was performed for MCO's stored in an overpack.

5.2.3 Contamination Control

5.2.3.1 Introduction

The potential hazards are from gas normally generated by the MCOs before stabilization and from the unlikely failure of an MCO to contain the spent fuel. The feasibility concern is whether the MCOs can be cooled and vented while maintaining acceptable confinement/containment.

The characteristics of unstabilized MCOs are described in Section 4.2.3. The remainder of this section addresses confinement and containment during normal venting and accident conditions. The design of the air cooling system was described in the previous section.

TABLE - 5-2

ALTERNATIVE 2A

THERMAL ANALYSIS - SUMMARY

MCO WATER TEMP. (°F)	SUPPLY AIR QUANTITY (CFM)	SUPPLY AIR TEMPERATURE TO VAULT (°F)	REMARKS
59	75,000	35	
56	100,000	35	
52	150,000	35	
50	200,000	35	Design basis

5.2.3.2 Normal Operation

MCO Servicing. The MCOs require servicing after receipt from the K-Basins prior to staging: After each MCO is received into the SSF, the MCO is purged with nitrogen and deionized water is added if needed to reach the desired level in the MCO. The services can be done with the MCO submerged in the Cask Unloading Pool. The pool temperature, clarity, and radioactive contamination must be maintained at acceptable levels; also, the level of contamination above the pool must be acceptable for controlled occupancy. The issues concerning gas and liquid releases from the MCO while submerged are the same as for Concept 1, discussed in Section 4.2.3. The design includes the normal building ventilation system for dilution of hydrogen and krypton-85, and an MCO servicing system that vents MCO gas to a stack and prevents overfilling of MCOs.

Closed Tube Staging. Gas vented from the MCOs rises through 5 ft or more of water in the storage tube to reach the operating area, which is normally ventilated with enough fresh air (over 10,000 cfm) to dilute the hydrogen and krypton-85 to acceptable levels. The operating area ventilation requirements are the same as for open pool staging under Concept 1, described in Section 4.2.3. However, since the storage tube is an enclosed space in which hydrogen could accumulate, provisions must be made to ensure that explosive concentrations do not develop. The following paragraph describes one concept for achieving this objective.

Each storage tube has a sealed floor plug with an embedded vent line and two test lines. The test lines have normally-closed valves and the vent line contains a HEPA filter. The tubes as originally designed can contain a pressure of almost 5 psig before the plug lifts from its sealed seat; the tube wall and bellows were designed for higher pressures. It would be simple to add a relief device to each vent line so that the vent would only be used if the pressure in the tube were to rise to about 4 psig. With a local pressure indicator added to each tube plug, pressures could be monitored and a portable cart used to sample and purge each tube with nitrogen. The cart would consist of a nitrogen cylinder on wheels, a regulator, a vent HEPA filter (similar to the one in the tube plug), and half-inch hoses to connect to the test lines on the plug. As long as each tube is vented and purged with nitrogen before the pressure rises above 0.8 psig, the hydrogen concentration will not exceed 6% by volume. A 6% mixture of hydrogen in nitrogen is non-flammable when mixed with any proportion of air. At the nominal design hydrogen generation rate, a tube with one MCO takes 110 days to reach 0.8 psig after venting and purging. With 1200 MCOs staged in 600 tubes, an average of 14 tubes per day would have to be vented and purged to maintain non-hazardous mixtures of hydrogen in the tubes.

Passive Air-Cooled Storage. After stabilization, the MCOs do not normally vent gas. There are no contamination issues during normal operation.

5.2.3.3 Abnormal Operation

MCO Servicing. The Cask Unloading Pool could become contaminated in the event of the failure of an MCO during unloading or servicing. Until the accident is quantified, it is assumed that the unmitigated consequences are severe enough to require safety class 1 or 2 systems, as defined in WHC document MRP 5.46 and DOE Order 6430.1A. To prevent this potential contamination from reaching the soil, the pit must be lined with stainless steel and monitored for leakage. Any place where pit water is contained, there must be a way to inspect or test for leaks; this includes any piping that penetrates through walls or the ground. The glycol coolant in the chillers must have monitors or test connections to detect any leaks across the glycol/pit water heat exchangers.

The operating area above the pit could become contaminated in the event of a crane accident during cask or MCO handling. Should any abnormal contamination be detected above the pool, alarms warn the operators to leave the area and the Emergency Ventilation System is activated. This system ensures that there is no unfiltered release from the building and that the hydrogen concentration remains orders of magnitude below the flammable limit.

The dropping of an MCO in the pool is not the worst MCO accident (compared, for example, to an accident during MCO handling above the storage tube operating floor), but this accident is a basis for designing the pool water treatment system. The pool water filters and deionizers are sized to contain the upper limit corrosion products from an MCO. The soluble corrosion products (cesium hydroxide) do not pose a criticality threat in the deionizer. The critically-safe geometry for the filters has not been determined in this study, due to time limitations.

Closed Tube Staging. If there is a failure of an MCO during staging, the HEPA filter in the sealed tube plug will prevent airborne contamination from spreading out of the tube. The tube plugs have test fittings which allow for periodic water sampling to detect MCO failure. The contamination is localized, but there is no built-in design feature for clean-up.

Passive Air-Cooled Storage. If there is a failure of a stabilized MCO during storage in a tube, only one tube becomes contaminated. The floor plugs have HEPA filters and test fittings which allow for periodic gas sampling to detect MCO failure. The contamination is localized, but there is no built-in design feature for clean-up.

5.2.4 Criticality

All the criticality calculations performed in support of this study have been reported in Section 4.1.2.4. All assumptions, approximations and computational procedures are discussed in that Section. The calculation identified as NF036 applies to both concepts. This case addressed water filled MCO's, stored in water filled tubes in the SSF vaults, as currently configured for the CSB (i.e., with center-to-center tube spacing of 55 inches). The k_{eff} for this case was found to be 0.7234, with a standard deviation of 0.00061. Other calculations discussed in Section 4.1.2.4 indicate that any variations on this configuration (such as filling the vault with water) would not increase the reactivity of this configuration appreciably. Limiting the MCO configuration to 28 fuel elements per layer is the key to maintaining a critically safe configuration. (This can be verified by observing the considerably higher k_{eff} 's calculated for MCO's with 31 fuel elements per layer.)

When evaluating criticality safety of dry vault storage, credible accident scenarios would have to be considered. These would include various degrees of flooding of the storage vaults. The results discussed in Section 4.1.2.4 can be extrapolated to cover this situation.

5.2.5 Shielding

5.2.5.1 Introduction

The shielding issues for Concept 2 involve health protection of the occupants of the SSF throughout its life. The selection of an appropriate source term is discussed in Section 4.2.5.2. The interior and exterior wall thicknesses are important to worker health protection during possible construction activities. The operating floor thickness is examined in Section 4.2.5.6. The thickness of the transporter or shielded cask is examined in Section 4.2.5.7.

5.2.5.2 Minimum Concrete Thickness of Interior and Exterior Walls

There are several construction sequence possibilities for the SSF. The thickness of the interior walls is not important from a health protection standpoint if all construction is performed initially. However, if one vault is constructed first and filled and the other storage vaults are built at a later time, the construction workers will need to be shielded against radiation penetrating the interior wall between the filled vault and the adjacent vault. An additional need for personnel access to a vault could be for cleanup before conversion to natural convection cooling. If this cleanup is required, all MCO's in the vault to be cleaned will need to be removed. Radiation levels from adjacent filled vaults will need to be less than 0.5 mrem/hr to avoid partial emptying of the

adjacent vaults. The minimum wall thickness required is 42 inches of full density standard concrete. Since the interior walls are currently 36 inches of full density concrete, the wall thickness is less than adequate for maintenance activities near the wall. At one time, there was an additional layer of thermal concrete (low density) applied to the interior surfaces of the vaults. If this additional thermal layer is included in the SSF design, the shielding may be adequate. Also, since entry into the vault will only occur if cleanup is required, localized shielding might be a better solution than increasing the wall thickness.

The second construction sequence involves the construction of the Stabilization Facility adjacent to the exhaust plenum. Excavation could remove all of the soil surrounding the exterior wall. Again, the minimum wall thickness is 42 inches, so that the 54 inch exterior wall is more than adequate.

5.2.6 Conversion

Conversion of Alternative 2A from refrigerated air cooling of unstabilized fuel to passive dry storage will be accomplished after stabilization of all the MCOs is complete. Water will be removed from the interior of the storage tubes as the MCOs are removed for stabilization and the MCOs containing dry stabilized fuel will be installed in the dry tubes upon return from the Stabilization Facility. When all of the fuel has been stabilized and higher fuel and vault temperatures can be tolerated, blinds in the air intake plenums and stack would be removed, air refrigeration equipment would be shut down and isolated if necessary, allowing natural circulation cooling to be established.

There do not appear to be any feasibility issues associated with the conversion from refrigerated air cooling to passive dry storage for this concept.

6.0 SAFETY ANALYSIS

6.1 APPLICABLE REQUIREMENTS

The environmental, safety and health (ES&H) requirements applicable to the SSF are very similar to the requirements applied to the HWVP CSB, especially for the storage phase. Other than updated requirements for protection against natural phenomena (recently issued DOE-STD-1020), all such requirements applicable to the CSB will apply to the SSF.

The CSB design (the starting point for the SSF design) was completed using these ES&H requirements as part of the design basis. This CSB design has been reviewed and approved by the DOE, WHC and the State of Washington as meeting all these requirements. This successful track record should ease the regulatory process for the SSF.

On the other hand, the fact that spent nuclear fuel (SNF) is being stored instead of glass, and the necessity for wet storage of unstabilized fuel in the staging phase, will make several new additional requirements applicable to the SSF. For example, in addition to meeting the requirements applicable to the CSB, WHC has indicated that the SSF will be required to meet the intent of Nuclear Regulatory Commission requirements for SNF storage facilities.

6.1.1 DOE Orders

The following safety related DOE Orders are applicable to the SSF. The technical descriptions provided in this report are intended to meet these regulations. They are the core of the safety design basis for the facility:

6.1.1.1 DOE Order 6430.1A, General Design Criteria

This is the primary design requirements document which the SSF must meet. Key safety related sections influencing the SSF design include:

1. Section 0200-1.3 Radiological Siting Guidelines
 Section 1300-1.4 Guidelines on Limiting Exposure of
 the Public

Establish offsite exposure limits for normal operations, and the basic 25 rem offsite dose limit for Design Basis Accidents (DBAs).

2. Section 1300 Special Facilities (in general)
 Section 1300-3 Safety Class Criteria (in
 particular)

Identify the requirements for DOE Safety Class (SC) structures, systems and components (SSCs), including the Single Failure Criterion.

3. Section 1320 Irradiated Fissile Material Storage
 Facilities

Identifies special design requirements applicable to both water pool-type and dry-type spent nuclear fuel (SNF) storage facilities such as the SSF. It also requires the designer to consider the applicability of NRC SNF storage requirements, such as 10CFR72 and Regulatory Guides 3.49 and 3.60 to the design of DOE SNF facilities. It requires primary and secondary confinement systems.

6.1.1.2 DOE Order 5480.5, Safety of Nuclear Facilities

Identifies general safety requirements applicable to the SSF, including effluent release limits for normal operation.

6.1.1.3 DOE Order 5480.22, Technical Safety Requirements

This Order defines the requirements for the Technical Safety Requirements (TSR) document. The TSRs are an agreement between a facility's operating management and the DOE regarding the safe operation of the facility. They define the safe operating limits, surveillance requirements, and management controls under which the facility must operate to maintain its safety design basis.

The TSRs are based on the facility Safety Analysis Report (SAR). They are closely related to the assumptions made in the Design Basis Accident (DBA) analyses regarding the initial condition of the facility (e.g., operability of Safety Class systems) when each accident is initiated.

6.1.1.4 DOE Order 5480.23, Nuclear Safety Analysis Reports

This Order defines the requirements for the preparation, review, and approval of DOE Safety Analysis Reports (SARs). It also describes acceptable SAR format, content, and level of detail. WHC has applied for an exemption from this Order and has indicated that the S&SF SAR will meet the intent of the format and content requirements in NRC Regulatory Guides 3.44 and 3.48.

6.1.1.5 DOE Order 5480.28, Natural Phenomena Hazards (NPH) Mitigation

This Order identifies the seismic and other NPH protection requirements applicable to the S&SF. To a large degree, this Order and its implementing Standards define the design of SSF structures.

6.1.2 DOE Standards

The following safety related DOE Standards are applicable to the S&SF. These standards generally provide guidance to the designer for meeting the intent of the above DOE Orders:

6.1.2.1 DOE Standard 1020, Natural Phenomena Hazards Design and Evaluation Criteria for DOE Facilities

This standard defines the detailed NPH design criteria applicable to each DOE site for structures to meet the intent of DOE Order 5480.28.

6.1.2.2 DOE Standard 1021, Natural Phenomena Hazards Performance Categorization Guidelines for Structures, Systems and Components

This standard defines DOE structural Performance Categories applicable the safety related structures in a facility as a function of the facility's Hazard Category. It also defines the structural requirements for each Performance Category to meet the intent of DOE Order 5480.28.

6.1.2.3 DOE Standard 1027, Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23

This Standard provides standard techniques for determining the hazard level of a facility, and for performing a Preliminary Hazards Analysis.

6.1.3 NRC Regulations

6.1.3.1 10CFR72, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste

Part 72 prescribes high level design and other licensing requirements for the independent storage of SNF. Its requirements in the design and safety analysis area are specified in more detail in Regulatory Guides 3.49 and 3.54.

6.1.3.2 Regulatory Guides

WHC has indicated that the SSF must meet the intent of the following NRC Regulatory Guides:

1. Regulatory Guide 1.25, Assumptions Used for Evaluating the Potential Radiological Consequences of a Fuel Handling Accident in the Fuel Handling and Storage Facility for Boiling Water and Pressurized Water Reactors

This Regulatory Guide identifies the assumptions required to be used in performing accident analysis for SNF storage facilities.

2. Regulatory Guide 3.44, Standard Format and Content for the Safety Analysis Report for an Independent Spent Fuel Storage Installation (Water Basin Type)

Regulatory Guide 3.48, Standard Format and Content for the Safety Analysis Report for an Independent Spent Fuel Storage Installation or Monitored Retrievable Storage Installation (Dry Storage)

WHC has indicated that the SSF SAR will meet the intent of the format and content requirements of these Regulatory Guides, rather than the requirements of DOE 5480.23, from which it has requested exemption.

3. Regulatory Guide 3.49, Design of an Independent Spent Fuel Storage Installation (Water Basin Type)

Generally, this Regulatory Guide merely finds acceptable the use of ANSI/ANS 57.7-1981 in the design of water basin type Independent Spent Fuel Storage Installations (ISFSIs).

4. Regulatory Guide 3.60, Design of an Independent Spent Fuel Storage Installation (Dry Type).2

Generally, this Regulatory Guide merely finds acceptable the use of ANSI/ANS 57.9-1992 in the design of dry type Independent Spent Fuel Storage Installations (ISFSIs).

6.1.4 Other Federal Regulations

6.1.4.1 National Environmental Policy Act

NEPA will require the preparation, review and approval of an Environmental Assessment for the SSF design.

6.1.4.2 Resource Conservation and Recovery Act (RCRA)

Enforcement of RCRA requirements generally is delegated to the individual States. For the State of Washington, RCRA requirements are implemented through WAC 173-303.

6.1.5 Washington State Regulations

Washington Administrative Code (WAC) 173-303

This (and several other statutes) implement the requirements of the Federal Resource Conservation and Recovery Act (RCRA) for the State of Washington. The primary objective of the 173-303 is to prevent the release of dangerous wastes into the ground water.

If the facility would contain dangerous wastes, it must apply to the Washington State Department of Ecology for a Dangerous Waste Permit. Key requirements of the RCRA that affect the design include a requirement for double containment of dangerous liquids and detection and collection of any leakage.

6.1.6 WHC Requirements

WHC-CM-4-46, Nonreactor Facility Safety Analysis

Provides requirements for the preparation, review and approval of safety analyses for facilities at the Hanford site. In particular, Section 9.0 (Draft Revision OB) of this manual defines a graded system for safety classification of systems, components, and structures (SSCs). It specifies design requirements applicable to the four WHC safety categories: Safety Class 1 (DOE Safety Class-offsite hazard), Safety Class 2 (onsite hazard only), Safety Class 3 (facility hazard only), and Non-Safety.

Section 9.0 (in Table 2 of Attachment 1) of WHC-CM-4-46 also specifies frequency-dependent Radiological Dose Limits for DBAs. These limits are discussed below in Section 6.2.

6.1.7 ANSI/ANS Standards

6.1.7.1 Standard 57.7, Design Criteria for an Independent Spent Fuel Storage Installation (Water-Pool Type)

Provides detailed design criteria for water-pool type ISFSIs such as the SSF in the staging phase. A basic requirement of this standard is a minimum of two barriers between the SNF and the outside environment. It also requires a pool liner and a positive means of detecting leakage from the pool.

6.1.7.2 Standard 57.9, Design Criteria for an Independent Spent Fuel Storage Installation (Dry Type)

Provides detailed design criteria for dry type ISFSIs such as the SSF in the storage phase. This standard also requires a minimum of two barriers between the SNF and the outside environment.

6.2 DESIGN BASIS ACCIDENTS/SAFETY CLASSIFICATIONS

This section documents the results of a first-cut Design Basis Accident (DBA) analysis for each SSF Option. It describes the pre-conceptual safety design basis of each SSF Feasibility Design Option, including the basis for determination of required Safety Class (SC) SSCs.

A spectrum of candidate accident scenarios is postulated. Included are scenarios required to be addressed by programmatic requirements and additional scenarios identified by the WHC Draft Preliminary Hazards Analysis (PHA). All postulated scenarios are addressed.

The radiological consequences for each DBA are calculated for each SSF Feasibility Design Option. The SSF is located on the site of the HWVP CSB (20,000 meter site boundary distance).

These consequences are compared with the onsite and offsite radiological dose limits of WHC-CM-4-46, Section 9.0 (Revision OB). Where unmitigated consequences exceed the dose limits, mitigating SSCs are designated as SC-2 or SC-1 as appropriate. Credit is taken for the operability of these SSCs to mitigate the consequences of the DBA to within the dose limit.

These frequency-dependent dose limits include the following:

A. Offsite:

1. Accident frequency of $>1E-2$ to $\geq 1E-1$ /year:	0.5 rem
2. Accident frequency of $>1E-4$ to $\leq 1E-2$ /year:	5 rem
3. Accident frequency of $>1E-6$ to $\leq 1E-4$ /year:	25 rem

B. Onsite:

1. Accident frequency of $>1E-2$ to $\geq 1E-1$ /year:	5 rem
2. Accident frequency of $>1E-4$ to $\leq 1E-2$ /year:	25 rem
3. Accident frequency of $>1E-6$ to $\leq 1E-4$ /year:	100 rem

6.2.1 DBA Methodology

6.2.1.1 Event Consequences

The methodology described in DOE-STD-1027-92 is used for this analysis. The following equation, from page A-6 of DOE-STD-1027-92, describes the basic method used to calculate the offsite dose for each DBA:

$$\text{MOI Dose} = (\text{MAR}) (\text{RF}) (\text{X/Q}) (\text{RR}) (\text{SA}) (\text{CEDE}) \quad (1)$$

$$\text{or:} \quad (\text{Source Activity}) (\text{CEDE}) (\text{RF}) (\text{X/Q}) (\text{RR}) \quad (1a)$$

where:

MOI Dose - Maximum Offsite Individual Dose [rem]

MAR - Material at Risk [grams]; RF - Release Fraction [Unitless]

RR - Respiration Rate [m3/sec]; SA - Specific Activity [ci/g]

X/Q - Atmospheric dispersion factor for the [sec/m3]
site boundary distance

CEDE - Committed Effective Dose Equivalent [rem/ci]
per curie inhaled

Source Activity = (MAR) (SA) [ci]

6.2.1.2 Initiating Event Frequencies

Formal quantitative calculation of event frequencies is not included in this assessment. The estimated frequencies listed in Results Table A are based on the frequency categories shown in the WHC Draft PHA.

As stated in the assumptions below, the frequencies of several scenarios are assumed to be below the threshold of credibility, based on the assumed outcomes of future, more detailed safety analyses. These assumptions should be verified or changed in later phases of the design of the SSF, based on the results of these analyses.

6.2.1.1 Scenario Development/Screening

The first step in the DBA analysis process is a screening process to justify eliminating from consideration all scenarios that are not DBAs. Remaining as DBAs are those scenarios that meet both of the following criteria:

- A. The scenario is "credible:" The frequency of occurrence of the initiating event is equal to or greater than 1E-6/year. Accidents with frequencies less than this threshold are considered to be "beyond the design basis," or "not credible." This credibility threshold is defined in Section 1300-1.4.2 (and the Glossary) of DOE Order 6430.1A. The basic credibility threshold of 1E-6/year is modified by DOE-STD-1021 for natural phenomena hazards (NPH) to 1E-5/year. Accidents beyond the design basis, or "residual risk," will be analyzed in later phases of the design as required by DOE Order 5480.23.
- B. The scenario is the limiting, or highest consequence, accident in its type: For example, the (credible) spill with the most severe consequence is the "design basis spill." If the plant is designed to mitigate the risk of the design basis spill to within the dose limits, then it also can mitigate adequately all spills of lesser consequence.

6.2.1.2 Material At Risk Estimates

All spent fuel received at the SSF will be contained in Safety Class Multi-Canister Overpacks (MCOs). For the purposes of this assessment, Material At Risk (MAR) is assumed to be the "maximum" inventory of radionuclides in each MCO, taken from the "MCO Description" contained in Appendix 1, times the number of MCOs at risk in each accident scenario. The one exception to this is the "uncontrolled gas discharge" DBA, where the MAR is assumed to be the Kr-85 inventory of one MCO.

Failure of a MCO containing the "maximum" radionuclide inventory would cause a release and a resultant dose that can be calculated. The theoretical inhalation dose that would result from uptake of the entire contents of a MCO (immersion dose for Kr-85) is calculated. This dose is the "peak inhalation Committed Effective Dose Equivalent (CEDE) at the source." The method of calculation of this dose source term is described below.

6.2.1.3 Source Terms

Equation (1a) shown in the Methodology section above can be restated as follows:

$$\begin{aligned} \text{MOI Dose} &= [(\text{Source Activity [in curies]}) (\text{CEDE})] \\ [(\text{RF})] & \quad [(\text{X/Q}) (\text{RR})] \\ \text{or} &= [\text{Inhalation CEDE at the source}] [K] \end{aligned}$$

where:

$$[\text{Inhalation CEDE} = (\text{Source Activity}) (\text{CEDE}) \quad (2) \\ \text{at the Source}]$$

$$\text{and} \quad K = (\text{RF}) (X/Q) (\text{RR})$$

The "K" part the dose calculation is independent of the nuclear characteristics of the source MAR (except for noble gases such as Kr-85, which have a RF of 1). Inhalation CEDE At the Source, on the other hand, is completely characteristic of the each nuclide making up the source term.

In fact, the RF (1E-3 for all isotopes except Kr-85) and RR (3.5E-4 m3/sec) and meteorology all are assumed to be fixed for the SSF by DOE-STD-1027-92. The CSB site boundary distance (20,000 meters) fixes X/Q for the SSF as well, as described below.

Equation 1 is intended to be used to calculate the dose caused by one source radionuclide at a time. The inventory of a MCO comprises several isotopes as listed given in the Appendix 1 "MCO Description".

The dose that would result from a failed MCO containing this mixture of isotopes actually would comprise the sum of the individual doses contributed by each isotope present in the mixture at the time of release:

$$(\text{Inhalation CEDE of the mixture}) = \sum_1 (\text{Source Activity})_1 (\text{CEDE})_1$$

The (Source Activity)₁ values used in this analysis are taken from the Appendix 1 "MCO Description". The CEDE₁ values are taken from DOE/EH--0070 and DOE/EH--0071.

6.2.1.4 Release Modeling

As stated above, the release model used for this analysis is taken from DOE-STD-1027-92. The Release Fraction (RF) used for each scenario is 1E-3. Respiration rate (RR) of the receptor used for each scenario is 3.5E-4 m³/sec. Both are bounding values taken from DOE-STD-1027-92, page A-7.

The offsite receptor distance for the HWVP CSB is 20,000 meters. The onsite receptor distance is 300 meters per DOE-STD-1027-92, page A-7.

Atmospheric dispersion factors (X/Q values) are derived for the offsite and onsite receptor distances using the meteorological assumptions recommended for Preliminary Hazard Analyses in Appendix A (p. A-7) of DOE-STD-1027-92:

D-stability weather classification

4.5 meters/second wind speed

These parameters are used with the appropriate distances as inputs to the GENII algorithm, documented in PNL-6584, to calculate the following X/Qs:

- A. Maximum Offsite Individual
(MOI) (20,000 meter Offsite Boundary): 3.206E-7
- B. Onsite receptor (300 meters): 2.200E-4

These values are significantly less conservative than the X/Qs used for the HWVP CSB accident analyses. At the high end of the range for X/Q is the conservative X/Q used for the HWVP CSB PSAR Addendum, the "0-8 hour release" site boundary X/Q, 8.67E-6. This is greater than the DOE-STD-1027 offsite X/Q by a factor of approximately twenty seven. This wide range of X/Qs that are potentially applicable to the SSF is used to calculate the "range" of doses reported in Results Table 6-1 below.

6.2.2 Assumptions

6.2.2.1 Initiating Event Frequency/Credibility

- A. Except for the "MCO failure" DBA, fire anywhere within the SSF is not a credible initiating event. Similarly, fire as a dependent event (e.g., caused by a DBE) is not a credible event. The basis for these assumptions is qualitative at this early phase of the design. The Fire Hazards Analysis (FHA) has not been performed. For several reasons, however, there is a level of confidence that the FHA will result in a detailed facility configuration that positively will prevent the introduction of significant combustibles into the facility and support this assumption.

Historically, SNF storage facilities such as the SSF have posed a substantially lower fire risk than other types of facilities such as reactors and radiochemical processing plants. Normal combustible loadings are at insignificant levels throughout most of the SSF. Review of chemical usage in the facility generally shows minimal use of combustible chemicals.

Process engineering has reviewed the rates and amounts of hydrogen releases from MCOs during normal operation. For Alternatives 1B and 1C, at the rate of once-through ventilation planned for the pool area, hydrogen concentrations will stay several orders of magnitude below flammable limits. Even after an extended loss of ventilation (not considered

credible) it would take several days for concentrations to reach flammable levels. This could be prevented merely by opening exterior doors to the wind.

For Alternative 2A, periodic purging of the tube annulus during normal operation will prevent the buildup of hydrogen to dangerous levels. Even if hydrogen levels did reach flammable levels in the annulus, there is no ignition source in the water filled tube.

There are, however, a few issues identified to date that could bear on the validity of this assumption and should be addressed in detail by the FHA:

- i. The capability should be provided for an adequate, timely response to a possible fire resulting from the failure of a MCO out of water, resulting from a handling drop or other leakage of water from a MCO and ignition of the uncovered fuel rods.
- ii. If diesel generators and/or batteries are used for backup electrical power, then the fire risk associated with this equipment should be addressed.
- iii. Although it is a relatively smaller risk, the fire risk associated with the use of ion exchange resins, filter media and regenerant chemicals should be addressed.
- iv. The FHA should consider the fire risks associated with any use of liquid nitrogen inside the SSF, such as the condensation and reevaporation of oxygen from the surrounding atmosphere.

This assumption is key to this assessment. If it were invalid (if a substantial release due to a fire (not related to a MCO failure) were credible inside the SSF, then SC mitigation may be required to meet the dose limits. Substantial additional SC SSCs could be required. This change could affect the estimated capital cost of the facility significantly.

- B. Explosion anywhere within the vicinity of the SSF structure (including the stacks) is not a credible initiating event. Similarly, explosion as a dependent event (e.g., caused by a DBE) is not a credible event. The basis for these assumptions also is qualitative at this early phase of the design, because the Fire Hazards Analysis (FHA) has not been performed. For reasons similar to those listed above for fire, however, there is a level of confidence that the FHA will result in a detailed plant configuration that positively will prevent the creation of a credible explosive hazard in the vicinity of the SSF and support this assumption.

There are, however, a few issues identified to date that could bear on the validity of this assumption and should be addressed in detail by the FHA:

- i. If hydrogen gas or other explosive gases or liquids would be used in the facility, the source containers preferably should be located outside the SSF, far enough away so that leakage and explosion involving all the stored gas would not be a credible threat to the SSF structures.
- ii. If any such gases are brought into the facility via permanently installed tubing, then the tubing from the storage bottle should be provided with Safety Class isolation valves. These valves must close automatically on high seismic acceleration.
- iii. If a bottles of such gases are transported into (the vicinity of) SSF structures, then the frequency and consequences of the resultant hazard should be limited:
 - a) The capacity of the bottles should be minimized, and
 - b) The amount of time the bottle is in the facility should be minimized.

The FHA should show that an explosion capable of failing Safety Class SSF structures is not a credible event.

This assumption also is key to this assessment. If it were invalid (if an explosion capable of threatening failure of SSF structures were credible), then SC mitigation and/or structural upgrades could be required to meet the dose limits. Substantial additional or upgraded SC SSCs could be required. This change could also affect the estimated capital cost significantly.

- C. Analysis of aircraft crash, both credibility (frequency) and consequences, is not included in this assessment (i.e., for purposes of this assessment, aircraft crash is assumed not credible). The extensive analysis already done for the HWVP PSAR proves that this is the case.
- D. This analysis assumes that a MCO will fail (release of its radioactive contents) if dropped from a significant height, both in and out of water, whether or not it is inside a MCO handling cask. In contrast, it is assumed that the transport cask (and the MCO inside it) will not fail if dropped from any height attainable in the facility, unless the lid is unbolted. If the lid is unbolted when the cask is dropped, then it is

assumed that the impact ejects the MCO from the transport cask and causes the MCO to fail.

Similarly, it is assumed that an uncontrolled discharge of gas from an MCO (due to a relief valve sticking open or a hydrogen burn inside the MCO) results in the release of the entire maximum inventory of Kr-85 from the MCO. This is considered to be a very conservative assumption that is a candidate for relaxation if necessary, by more detailed analysis in later phases of the design.

6.2.2.2 Event Consequences

- A. Loss of ventilation due to equipment failure or power failure is not considered to be a DBA initiating event because it causes no release by itself, and requires no mitigation by permanently installed SSCs. In later stages of the design, the effects of these and other equipment failures will be considered in the design of SC SSCs, when taken as single failures in addition to DBA initiating events, as required to meet the single failure criterion of DOE Order 6430.1A, WHC MRP 5.46 and IEEE 379.
- B. It is assumed that SSF SC SSCs will be designed to withstand the effects of the site-specific Design Basis Earthquake (DBE), Design Basis Wind (DBW), and Design Basis Ashfall and other natural phenomena hazards without causing an offsite dose exceeding the limit, as required by DOE-STD-1021-92, Reference L. This assumption is reflected in the capital cost estimates herein.
- C. It is assumed that only one MCO or cask will be moved at a time during any loading, unloading, servicing or inspection activity.
- D. It is assumed that adequate time is available after a loss of cooling or loss of power event to bring in mobile emergency cooling and/or makeup capability well before water levels or temperatures reach unacceptable levels. Preliminary process and HVAC calculations show that this assumption is valid for all three design Options. Specifically for Option 2.A, HVAC calculations show that approximately 50 hours after forced air cooling is lost, the temperature in the tubes has risen only ten degrees F. Based on this assumption, no permanently installed emergency cooling or makeup system is included in the SSF Feasibility Design, in accordance with Section 1320-4 of DOE Order 6430.1A.

6.2.3 Results

6.2.3.1 Scenario Screening Results

Table 6-1 shows the results of the scenario screening process used to determine which scenarios are considered DBAs applicable to each phase of SSF Concepts 1 and 2.

6.2.3.2 Material At Risk/Source Terms

Table 6-1 also shows the MAR quantities/source terms for each DBA.

6.2.3.3 Unmitigated Doses/Facility Hazard Category

Table 6-1 also shows the unmitigated offsite and onsite dose consequences for each DBA. Dose consequences are compared with the onsite and offsite dose limits of Section 6.2 above.

As Table 6-1 clearly shows, the total quantity of MAR present in the SSF makes the facility a candidate for DOE Hazard Category 1 (High Hazard), the same category as the K-Basins (and the HWVP CSB).

6.2.3.4 Safety Classifications

Where unmitigated offsite consequences exceed the applicable dose limit, credit must be taken for the operability of DOE Safety Class (WHC SC-1) SSCs to prevent or mitigate the consequences of the DBA to within the limit. When credit is taken for the SC-1 SCCs shown in Table 6-1, offsite consequences are less than the dose limits for all nine DBAs analyzed, given the Assumptions on which the analysis is based.

Similarly, onsite consequences are less than the onsite limits for most DBAs analyzed, again given the assumptions on which the analysis is based. The exceptions are DBA Nos. 2, 3 and 4, MCO failure scenarios. For these accidents, the particulate releases can be filtered by the emergency ventilation exhaust system to a small fraction of the threshold. Along with the particulate, however, the maximum MCO inventory of Kr-85, an unfilterable noble gas, is released.

Calculations show that release of the Kr-85 inventory only from a single MCO may exceed the onsite limits, depending on the X/Q used. If the X/Qs used for the HWVP PSAR are used (resulting in up to 720 rem), the limit would be exceeded. This issue probably can be resolved by more detailed analysis in later phases of the design.

Tables 6-1, 6-2 and 6-3 show the SC-2 and SC-1 SSCs required for the SSF design to meet the onsite and offsite dose limits.

TABLE 6-1
SAFETY ANALYSIS RESULTS SUMMARY

Applicable to Options	DBA No.	Initiating Event Scenario	Source Term	Unmitigated Offsite Dose/ Limit [rem]	Unmitigated Onsite Dose/ Limit [rem]	Estim. Freq. [Yr ⁻¹]	S.C. SSCs Required*
All (Staging Only)	1	Uncontrolled gaseous discharge from one MCO (relief sticks open, H ₂ burn inside MCO)	1 MCO Kr-85 Inventory	.029 - .76/ 0.5 - 5	19 - 720/ 5 - 25	1E-1 to 1E-3	MCO pressure boundary, Cask
All (Staging & Storage)	2	One MCO fails (Drop, damage, loss of MCO water inventory)	1 MCO Inventory	.14 - 3.7/ 5	94 - 3,500/ 25	1E-3	Emergency Ventilation Exhaust Filtration System (Minimum Filtration Efficiency of Approx. 99.9 percent), Tube Vent Capability
2.A Staging Only	3	2 MCOs fail (Loss of water in the tube annulus due to leakage)	2 MCOs Inventory	.27 - 7.4/ 5	188 - 7,000/ 25	1E-3	
Storage (All) & 2.A Staging	4	3 MCOs fail (Stacking too many MCOs in tube)	3 MCOs Inventory	.4 - 11.1/ 25	282 - 11,500/ 100	1E-4	
All (Staging Only)	5	Pool liner/tube failure: Leakage	Pool water	EHSC Calc. Req'd.	EHSC Calc. Req'd.	1E-3	Pool liner, leak detection
2.A Staging Only	6	Excessive cooling: Freezing & failure of multiple MCOs)	936 MCOs	164 - 4,400/ 25	1.1E5 - 3.1E6/ 100	1E-4	HVAC temperature controls, alarms
All	7	Design Basis Earthquake	936 MCOs	164 - 4,400/ 25	1.1E5 - 3.1E6/ 100	1E-5	Structures only
All	8	Design Basis Wind	936 MCOs	164 - 4,400/ 25	1.1E5 - 3.1E6/ 100	1E-5	Structures only
All	9	Design Basis Ashfall	936 MCOs	164 - 4,400/ 25	1.1E5 - 3.1E6/ 100	1E-5	Structures, ash handling equipment on air intakes

*WHC Safety Class 2 if the Onsite Limit applicable to the event frequency is exceeded, WHC Safety Class 1 (DOE Safety Class) if the Offsite Limit applicable to the event frequency is exceeded.

TABLE 6-2

DOE/WHC SAFETY CLASS STRUCTURES, SYSTEMS,
AND COMPONENTS ("STAGING PHASE")

SSC Type	Description ¹	Mitigates These DBAs	DOE S.C.? (WHC S.C.)/ Perf. Cat. ^{2,3}	S.F. Proof Design Req'd?	Q.L.	Operability Requirement
Structure	Vault (pool), including operating deck floor & tubes, if present	Natural phenomena hazards, including Design Basis:	Yes (1)/PC-4	No	1	Whenever MCOs are present
	Cask handling crane (structure only) & supports	Earthquake/Wind/Ashfall + Cask & MCO Drops	Yes (1*)/PC-4			
	MCO handling crane (structure only), overhead or deck-mounted, & supports					
	Above-grade walls and roof					
	Structures subject to compromise by "runaway rail transport"	Runaway rail transport			Whenever MCOs/Casks are moved	
	HVAC rooms	Cask & MCO Drops	No (2)/PC-3	No		
	Emergency generator & switchgear rooms	Cask & MCO Drops	No (2)/PC-3	No		
System	Emergency HVAC Exhaust [+ Pool Sweep for Concept 1 Only] (Fans, filters, ducting, sensing & actuation) + supports + electrical power (AC/DC)	Cask & MCO Drops	No (2)/PC-3	Yes	1	During cask & MCO handling
	MCO (incl. relief valve, fittings and other pressure boundary components) [NOT PART OF THE SSF SCOPE]	DBE, Uncontrolled gaseous discharge from MCO	Yes (1)/PC-4	Yes	1	Fuel present
	Transport cask [NOT PART OF THE SSF SCOPE]	Cask drops, collisions	No (2)/PC-3	No	1	MCO Present

1. Applicable to both Concepts 1 and 2, unless otherwise noted.
2. The SSF is a candidate for DOE Hazard Category 1 (High Hazard) per DOE-STD-1027. All DOE Safety Class (WHC SC-1, SC-1*) structures are Performance Category 4 and must withstand Natural Phenomena Hazards per DOE Order 5480.28 and DOE-STD-1021.
3. All DOE "Safety Significant" (WHC SC-2) structures are Performance Category 3 and must withstand Natural Phenomena Hazards per DOE Order 5480.28 and DOE-STD-1021.

TABLE 6-3

DOE/WHC SAFETY CLASS STRUCTURES, SYSTEMS,
AND COMPONENTS "STORAGE PHASE"

SSC Type	Description ¹	Mitigates These DBAs	DOE S.C.? (WHC S.C.)/ Perf. Cat. ^{2,3}	S.F. Proof Design Req'd?	Q.L.	Operability Requirement
Structure	Vault, including tubes, operating deck floor, and passive natural circulation plenums and stacks	Natural phenomena hazards, including Design Basis:	Yes (1)/PC-4	No	1	At all times
	Cask handling crane (structure only) & supports (Applicable to SSF only, not present in HWVP CSB)	Earthquake/Wind/Ashfall	Yes (1*)/PC-4			
	MCO handling crane (structure only), & supports (Applicable to SSF only, not present in HWVP CSB)					
	Above-grade walls and roof					
System	Canister Transporter (Applicable for CSB, not present in SSF)	Canister drop or shear	No (2)/PC-3	Yes	1	Canister present
	MCO (incl. relief valve, fittings and other pressure boundary components) [NOT PART OF THE SSF SCOPE]	DBE,Uncontrolled gas discharge from MCO	Yes (1)/PC-4	Yes	1	Fuel present
	Transport cask [NOT PART OF THE SSF SCOPE]	Cask drops, collisions	No (2)/PC-3	No	1	MCO Present

1. Applicable to both Concepts 1 and 2, unless otherwise noted.
2. The SSF "storage phase" vaults are candidates for DOE Hazard Category 1 (High Hazard) per DOE-STD-1027. All DOE Safety Class (WHC SC-1, SC-1*) structures are Performance Category 4 and must withstand Natural Phenomena Hazards per DOE Order 5480.28 and DOE-STD-1021.
3. All DOE "Safety Significant" (WHC SC-2) structures are Performance Category 3 and must withstand Natural Phenomena Hazards per DOE Order 5480.28 and DOE-STD-1021.

Structures/Performance Categories. Because the SSF is a candidate for DOE Hazard Category 1, and because some of the structures listed in Table 6-2 and 6-3 provide DOE Safety Class (WHC SC-1) protection against natural phenomena hazards, these structures are candidates for designation as Performance Category 4-as defined in DOE Order 5480.28, and DOE-STD-1021.

Other structures listed in Tables 6-2 and 6-3 provide WHC SC-2 protection against natural phenomena hazards. These structures are candidates for Performance Category 3 as defined in DOE Order 5480.28, and DOE-STD-1021.

Systems. As Tables 6-2 and 6-3 show, there are no non-structure-related DOE Safety Class (WHC SC-1) systems required for the SSF (except the MCO pressure boundary itself, which is not part of the SSF scope). These tables also show the WHC SC-2 systems required for each SSF Alternative and Phase.

6.3 COMPARATIVE SAFETY EVALUATION

Only differences in the safety risks posed by the three Alternatives selected as described in Section 2 (i.e., safety discriminators) are evaluated in this section. Most of the safety risk associated with the SSF is the same for all three alternatives. For example, all three alternatives must include protection against NPH (DBA Nos. 7, 8 and 9). Also, failure of a single MCO out of water (DBA No. 2), uncontrolled gaseous discharge from an MCO (DBA No. 1) and pool liner/tube leakage (DBA No. 5) are applicable to all alternatives.

6.3.1 Concept 1 - Alternatives 1B and 1C

No significant safety discriminator has been identified between Alternatives 1B and 1C, which differ only in the number of vaults used during the storage phase. With regard to safety, they are essentially identical.

Both these alternatives have the following safety advantages over Alternative 2A:

6.3.1.1 Safety Discriminator No.1

A water-filled pool is inherently more forgiving than an air-cooled configuration for loss of cooling events (e.g., loss of power, pump/fan failures). This is true because of the large heat capacity of a pool and the much larger amount of heat energy required to evaporate and/or heat up the large mass of pool water than that required to heat up tubes. The practical benefit of this difference is a much longer minimum response time to restore cooling and/or makeup using portable equipment before loss of shielding or MCO uncovering.

However, this difference in heat capacity is not as important as it may initially seem. Calculations for Concept 2 show that approximately 50 hours after forced air cooling is lost, the temperature in the tubes has risen only ten degrees F. Concept 1 pool water temperature requires 165 hours to increase by the same amount. Because the rate of temperature increase is low for both concepts, allowing adequate time for restoration of normal cooling or other corrective action, permanently installed emergency cooling or makeup systems are not required for either Concept.

6.3.1.2 Safety Discriminator No. 2

Handling MCOs in a water filled pool is inherently less risky than handling an MCO (inside a cask) in air. In a pool the MCO is visible at all times, providing greater assurance that grapples and other handling tools are properly attached and functioning properly, and cooling is assured. Also, the consequences of a submerged MCO drop/failure are much less severe than a MCO/cask drop/failure in air (DBA No. 2), and cleanup is easier. Furthermore, the MCOs are stored in a single level in the pool, but are stacked two high in the storage tubes. MCO servicing after initial installation during staging will therefore require increased MCO handling for Alternative 2A, with a corresponding increase in the probability of an MCO drop.

6.3.1.3 Safety Discriminator No. 3

A leaking MCO is much less of a problem in a pool than in a storage tube, or during handling of a MCO/cask in air. In a pool, MCO leak detection is simpler and faster, resulting in less leakage prior to detection. Spread of contamination is limited by the pool cleanup system, overpacking is relatively easy, and a pyrophoric event is not likely.

Although the spread of contamination from a leaking MCO inside a storage tube is initially limited to the interior of the storage tube, moving a leaking MCO out of a tube to another location for overpacking could cause significant contamination problems inside the handling cask, on the operating deck, and at the overpacking location. If the leak was severe enough, it is possible that air could enter the MCO and contact the unstabilized, hydrided, fuel during movement to the overpack station or during overpacking, resulting in the risk of a pyrophoric event.

6.3.1.4 Safety Discriminator No. 4

Hydrogen generation is a much more significant problem for tube storage than for an open pool. Ventilation above the open pool easily maintains a negligible hydrogen concentration.

Extensive maintenance is required to keep prevent flammable hydrogen concentrations from developing in the enclosed space above the water surface in the tubes. Tube pressure surveillance/maintenance and reinerting of each tube will be required about every two weeks.

6.3.1.5 Safety Discriminator No. 5

Of lesser safety importance, a water-filled pool is not subject to an undetected overcooling event (DBA No.5) that could cause freezing (and possibly failure) of multiple tubes\MCOs cooled by air. The applicability of this DBA to Concept 2, and effective ways to prevent/detect it, should be analyzed in more detail in later phases of the design.

6.3.1.6 Safety Discriminator No. 6

A water-filled pool is slightly more forgiving than an air-cooled configuration for pool liner/tube leakage events, in terms of the threat to MCO cooling and integrity (DBA No. 3). This is true because of the enormous amount of water in an open pool compared to the inventory of a single tube.

In terms of accessibility for repair, both concepts present difficulty. Pool leaks are difficult to locate and repair underwater. Tube leaks are easy to identify, but difficult to repair because of the high radiation field.

6.3.1.7 Safety Discriminator No.7

Concept 1 has another, relatively minor safety advantage during the staging phase. Failure of from one to three MCOs out of water due operator error in stacking too many MCOs in a tube (DBA No. 4) is applicable to Concept 2 in the staging phase (and to both concepts in the storage phase). This event is, however, relatively unlikely.

6.3.2 Concept 2 - Alternative 2A

No safety advantages have been identified for Concept 2 over Concept 1.

7.0 COST ESTIMATES

7.1 ESTIMATE BASIS

The capital cost estimates of the three SSF alternative configurations were prepared as rough order of magnitude estimates, utilizing a combination of estimating methodologies. The excavation estimate for the vault/plenum area is shown at zero cost. The excavation was performed by the package 200-01 contractor, HWVP Project. The estimate for the existing slab constructed by David Mowat Company (Work Package 350-01, The HWVP Project), is shown at zero cost. Unit rates for the construction of the below grade portion of the SSF Facility, including the fabrication and installation of the storage tubes, were obtained from the HWVP CSB Package 350-01 fair cost estimate. Unit rates for the above grade portion of the facility were obtained from the Independent Cost Estimate (ICE) prepared by the architect engineer in October, 1992, as part of the HWVP review of Key Decision (K-D) 3B. Quantities of structural steel were developed by Engineering. The Mechanical and Process equipment requirements were obtained from the Equipment List. Equipment installation and associated bulk material costs were factored from the equipment, which was priced in-house.

Miscellaneous site support costs were derived from quantity take-off estimates. Estimates for engineering construction, and project management, are expressed as percentages of direct construction and GFE procurement costs.

7.1.1 Assumptions

- All direct costs are expressed in present day (1995) dollars.
- The estimate was based on a standard 40 hour work week.
- Sufficient skilled labor is available on site during the period of construction.
- No project mission changes or major rework will occur during the engineering and construction of the facility.
- No radioactive or otherwise contaminated soil, or underground obstructions, will be encountered during excavation for the facility.
- An estimated average craft wage rate of \$31.50/hour was applied to the estimated direct construction manhours. The average rate is based on the current Hanford Site stabilization agreement, and current Hanford Site prevailing wages. The estimated rate covers the craft's base wage, plus benefits and state legislated burdens.
- Engineering Costs:

25% of the direct construction cost estimates of the MCO Loading/Storage, Pool Water Treatment and Infrastructure Areas

(including the Refrigeration HVAC Bldg. in Option 2) was added to 12.5% of the Direct Construction Cost Estimate of the vaults and office areas to provide an estimate of the Conceptual/Advanced Conceptual and Detail Design costs. Conceptual/Advanced Conceptual Design was assumed to be 20% of the engineering cost estimate, and detail design was assumed to be 80%.

- The Title III engineering estimate was calculated at 4.0% of the direct construction cost estimate.
- The Title III inspection estimate was calculated at 4.0% of the Direct Construction Cost Estimate.
- Construction management costs were calculated at 8.0% of direct construction costs.
- Project management costs were calculated at 8.0% of direct construction costs.
- Field construction is fixed price. An allowance of 53% was applied to direct field labor dollars to provide for associated indirect field labor, temporary facilities, personnel protection, weather protection, area maintenance, small tools and consumables, field and home office staff, QA/AC staff, construction equipment usage, bond and insurance, and the Washington state business and occupation (B&O) tax.
- 5% was applied to direct field materials and equipment to provide for overhead and profit.
- 10% was applied to direct subcontract costs to provide for overhead and profit.
- Construction acceptance testing was calculated at 3% of direct field manhours.
- Mobilization and demobilization costs were calculated at 5% of direct field manhours.

7.1.2 Estimate Inclusions

The capital cost estimate includes all conceptual, detailed, and field engineering costs, direct and indirect field construction labor, material equipment, and subcontract costs, construction management, and project management costs, expended in the execution of the SSF project. The estimate was prepared in present day (1995) dollars and is escalated to the appropriate activity centroid dates dictated by the schedule (Section 8.0).

7.1.3 Estimate Exclusions

The following costs were excluded from the scope of the capital cost estimate:

- ~ All capital, start-up and operating spare parts.
- ~ Canister tube impact limiters.
- ~ Expense funded costs
- ~ Operating costs
- ~ Special work procedure (SWP) construction
- ~ Transfer tunnels and carts to and from the Stabilization Facility

7.1.4 Work Breakdown Structure (WBS)

The estimate was accrued to the following WBS:

WBS	ESTIMATE CODE ⁽¹⁾	DESCRIPTION	REMARKS
100	210/310	Rail Tunnel/Cask Unloading/Area	All Alts
200	220/320	Staging Pool	Alt 1B/1C only
300	230/330	Vaults & Inlet Exhaust Plenums	All Alts
400	240/340	Pool Water Treatment/Inst Air Compressor	All Alts
500	250/350	HVAC/Office/Generator Equipment	All Alts
600	260/360	Refrigerated Air Mechanical Area	Alt 2A Only
700	370	Site Support	All Alts
	100	Engineering	All Alts
	400	Construction Management	All Alts
	500	Project Management	All Alts

⁽¹⁾ Note the prefix code 2 indicates Procurement Costs, the prefix code 3, Construction Costs.

In addition, the estimate was encoded by DOE code as described in, and required by DOE Order RL5700.3.

The estimate was further accrued by CSI Code of Accounts.

7.1.5 Quantities

The following quantity abbreviations were used throughout the estimate for all capital cost estimate line items:

<u>Description</u>	<u>Unit Abbreviations</u>
Excavation and Backfill	M3 = Cubic Meters
Concrete	M3
Structural Steel	Tons
Liner Plate, Finishes/Coatings	M2 = Square Meters
Machinery & Equipment	EA = Each
Misc. Individual Items	EA
Allowances and Composites	Lot
Manhours	MH

7.1.6 References

The following documents were used as reference documents in the preparation of the capital cost estimate.

- Hanford Waste Vittrification Plant (HWVP) Baselined Preliminary Design Estimate, Rev. "F", dated July 1991.
- K-D 3B ice estimate of Package 350 [(HWVP) Canister Storage Building (CSB)] dated October, 1992.
- Fair cost estimate of Package 350-01 (below grade portion of the HWVP CSB) dated February, 1993.
- Drawings and Equipments Lists prepared in support of the SSF Report.

7.1.7 Escalation

The direct costs are expressed in current (1995 dollars). The estimate was evaluated in terms of the study schedule. The following direct costs were escalated to the centroid dates of their respective activities:

- Conceptual and Detailed Engineering - Design through initial construction
- Title III - Initial and deferred construction
- Procurement - Initial and deferred procurement
- Construction - Initial and deferred construction
- Construction Management - Initial and deferred construction

- Project Management - Initial project phase and deferred project phase

The escalation table used in the estimate preparation was provided by WHC through ICF Kaiser Hanford, Richland, WA.

7.1.8 Contingency

The estimated contingency was developed from an evaluation of the completeness of design information available to estimating, and the reliability of unit cost data obtained from prior estimates. The following contingencies were applied to the direct procurement, construction, and indirect cost centers of the estimate:

• Load In/Load Out & Pool Water Treatment -	30%
• Infrastructure -	15%
• Vaults -	15%
• Engineering -	15%
• Construction Management -	15%
• Project Management -	15%

The resulting composite contingency is 17%.

7.2 CONCEPT 1 CAPITAL COST

The following capital cost estimate alternatives are included in support of Concept 1:

Alternative 1B - Pool and 2 passive air cooled vaults

Alternative 1C - Pool and 3 passive air cooled vaults

7.2.1 Alternative 1B Cost Estimate

Tables 7-1 and 7-2 contain the estimated capital cost and cash flow requirements for Alternative 1B, respectively. Supporting detail is contained in Appendix 2.

7.2.2 Alternative 1C Cost Estimate

Tables 7-3 and 7-4 contain the estimated capital cost and cash flow requirements for Alternative 1B, respectively. Supporting detail is contained in Appendix 2.

7.2.3 RCRA Impact

The Concept 1, Alternatives B and C estimates reflect a single SS Pool Liner Design, 3/16" plate on the walls, 1/4" plate on the floor. The direct cost (1995 dollars), ex contingency, escalation, engineering, and management for the pool liner is 3.5 million dollars. If the pool were designed to meet RCRA requirements, the pool would require double lining, and the inner lining would require an increase in thickness. It is estimated that the RCRA impact for double lining, increased plate thickness, leak detection and steel channels could increase the installed cost by 2.5 to 3 times, or 5.25 to 7.0 million to a total of 8.75 to 10.5 million, installed direct costs.

7.3 CONCEPT 2 CAPITAL COST

The following capital cost alternative is included in support of Concept 2:

Alternative 2A - 3 vaults, processed material stored in water-filled SS tubes.

7.3.1 Alternative 2A Cost Estimate

Tables 7-5 and 7-6 contain the estimated capital cost and cash flow requirements for Alternative 1B, respectively. Supporting detail is contained in Appendix 2.

7.4 SIGNIFICANT OPERATING COST DIFFERENCES

Review of the operating costs associated with Concepts 1 and 2 revealed that Concept 2 will have higher operating costs than Concept 1. The following operating cost factors were considered in reaching this conclusion:

7.4.1 Operating Labor During Staging

The loading of MCOs into tubes is more labor-intensive than loading into a pool rack. The distances that the pool crane has to travel are shorter than for tube storage. Placing MCOs in tubes requires many more operating steps, because the floor plug, floor plug handling flask, bottom-loading cask, and impact absorbers have to be handled in addition to the MCO. A task analysis of tube loading shows that 4 operators would be required during the loading, while 2 operators would be required for loading the pool rack. At the design rate of 4 MCOs per day, the loading will require 300 days. Unloading at the end of staging will require another 300 days. At the current estimated wage plus burdens and overheads rate of \$34.50 per hour, plus 15% average shift differential, the Concept 2 labor cost is \$1,140,000 more (in present dollars) for loading and unloading.

In Concept 2 during staging, the tubes must be vented and purged at the rate of at least 14 per day to prevent hydrogen from building up in the tubes (see Section 5.2.3.2); Concept 1 does not require this activity. From an estimate of 2 operators working regular days, the Concept 2 labor cost is \$144,000 more per year of staging. Based on 7 years of staging, the Concept 2 labor cost is \$1,000,000 more (in present dollars) for venting and purging, with the cost increasing for each year of staging.

Combining the above labor costs without escalation, the Concept 2 labor cost differential (above Concept 1) will be \$2,150,000 plus \$144,000 per year for each year that staging extends beyond the assumed staging period of 7 years.

7.4.2 Fuel Cooling During Staging

In either concept, the heat load from the MCOs is the same. However, pool cooling is more efficient than air cooling, and the heat gain from surroundings is less for the pool. As a result, the horsepower ratings for the chillers and pool recirculation pumps in Concept 1 are about 500 kW less than for the chillers and air handling fans in Concept 2. At the Bonneville Power wholesale rate of 30 mills per kW-hr, Concept 2 costs about \$13,000 per year more for power.

7.4.3 Heating, Ventilation, and Lighting

Because the buildings have about the same size and requirements in either concept, there is no significant difference.

7.4.4 Crane Usage

In Concept 1, the pool crane is smaller than the storage crane in Concept 2. In addition, the storage crane has to travel farther with each MCO and perform more operations. The difference in power consumption averages about 50 kW, and is balanced by the difference below due to water sterilization. This difference is not significant.

7.4.5 Pool Water Sterilization

In Concept 1, the ultraviolet lamps for the sterilizers will consume less than 50 kW of power, which is not significant, and is balanced by the difference above due to cranes.

7.4.6 Chemical Consumption

The nitrogen consumption for MCO servicing and the decontamination chemical consumption are the same for either concept. Because the pool water deionizers will seldom require regeneration unless there is a leaky MCO, water treatment chemical usage is not significant.

SSF Feasibility Study
Westinghouse Hanford Company
WHC P.O. TW-370252

Fluor Daniel, Inc.
Government Services
Contract 04436305

TABLE 7-1

FLUOR DANIEL INC.
WESTINGHOUSE HANFORD COMPANY
JOB NO. 436305

** TEST - INTERACTIVE ESTIMATING **
STAGING AND STORAGE FACILITY
CONCEPT 1 ALTERNATE B
DOE_R01 - CAPITAL COST SUMMARY

PAGE 01 OF 01
DATE 03/09/95 12:00:00
BY JMF/RLJ/PCA/JFD

COST CODE =====	DESCRIPTION =====	1995 \$		ESCALATED TOTAL COST =====	CONTINGENCY		TOTAL DOLLARS =====
		TOTAL COST =====	%		%	TOTAL =====	
000	ENGINEERING	13,000,000	15	13,650,000	15	2,040,000	15,690,000
460	IMPROVEMENTS TO LAND	1,100,000	15	1,170,000	15	180,000	1,350,000
501	BUILDINGS	41,600,000	17	47,370,000	17	7,930,000	55,300,000
600	UTILITIES	1,000,000	15	1,060,000	15	160,000	1,220,000
700	SPECIAL EQUIP/PROCESS SYSTEMS	18,750,000	20	20,930,000	20	4,190,000	25,120,000
WWW	TITLE III INSPECTION	2,500,000	15	2,840,000	15	430,000	3,270,000
XXX	CONSTRUCTION MANAGEMENT	5,000,000	15	5,670,000	15	850,000	6,520,000
YYY	PROJECT MANAGEMENT	5,000,000	15	5,640,000	15	840,000	6,480,000
(ADJUSTED TO MEET DOE 5100.4)							

PROJECT TOTAL

87,950,000 98,330,000 17 16,620,000 114,950,000

REMARKS:

CONCEPT 1 ALTERNATE B

INITIAL CONSTRUCTION OF WET STORAGE POOL, TWO
PASSIVELY COOLED DRY STORAGE VAULTS AND SUPPORT
FACILITIES, WITH DEFERRED PROCUREMENT AND CON-
STRUCTION OF CORTEN VAULT STORAGE TUBES AND
SUPERSTRUCTURE.

(ROUNDED/ADJUSTED TO THE NEAREST " 10,000 / 100,000 " - PERCENTAGES NOT RECALCULATED TO REFLECT ROUNDING)

SSF Feasibility Study
Westinghouse Hanford Company
WHC P.O. TWV-SVV-370252

Fluor Daniel, Inc.
Government Services
Contract 04436305

TABLE 7-2
STAGING & STORAGE FACILITY
CONCEPT 1 ALTERNATIVE B
\$ EXPENDITURE - FY ESCALATED (\$ X 1000)

09-Mar-95

DESCRIPTION	TOTAL	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003
ENGINEERING/DESIGN	15,695	2,378	10,769	1,240				545	671	92
TITLE 3 INSP SERVICES	3,263		715	1,240				545	671	92
PROCUREMENT										
PROCURE PHASE 1	11,341		857	10,484				23,763	1,300	
PROCURE PHASE 2	25,063							23,763	1,300	
S/T PROCUREMENT	36,404		857	10,484						
CONSTRUCTION										
CONSTR PHASE 1	39,465		8,630	30,835				201	6,861	35
CONSTR PHASE 2	7,117							201	6,861	35
S/T CONSTRUCTION	46,582		8,630	30,835						
CONSTRUCTION MGMT										
CM PHASE 1	3,910		1,621	2,126	163				1,951	269
CM PHASE 2	2,616							396	1,951	269
S/T CM	6,526		1,621	2,126	163					
PROJECT MGMT										
PM PHASE 1	3,865	599	1,517	1,517	232				1,342	185
PM PHASE 2	2,617							1,090	1,342	185
S/T PM	6,482	599	1,517	1,517	232			1,090	1,342	185
TOTAL	114,952	2,977	24,109	47,442	395			26,540	12,816	673

SSF Feasibility Study
Westinghouse Hanford Company
WHC P.O. TVW-SVV-370252

Fluor Daniel, Inc.
Government Services
Contract 04436305

TABLE 7-3

FLUOR DANIEL INC.
WESTINGHOUSE HANFORD COMPANY
JOB NO. 436305

** TEST - INTERACTIVE ESTIMATING **
STAGING AND STORAGE FACILITY
CONCEPT 1 ALTERNATE C
DOE_R01 - PROJECT COST SUMMARY

PAGE 01 OF 01
DATE 03/09/95 12:00:00
BY JMF/RLJ/PCA/JFD

COST CODE	DESCRIPTION	1995 \$ TOTAL COST	ESCALATED TOTAL COST	CONTINGENCY %	CONTINGENCY TOTAL	TOTAL DOLLARS
=====	=====	=====	=====	=====	=====	=====
000	ENGINEERING	13,000,000	13,650,000	15	2,040,000	15,690,000
460	IMPROVEMENTS TO LAND	1,100,000	1,170,000	15	180,000	1,350,000
501	BUILDINGS	52,320,000	60,780,000	16	9,940,000	70,720,000
600	UTILITIES	1,000,000	1,060,000	15	160,000	1,220,000
700	SPECIAL EQUIP/PROCESS SYSTEMS	19,110,000	21,380,000	20	4,250,000	25,630,000
WWW	TITLE III INSPECTION	2,500,000	2,840,000	15	430,000	3,270,000
XXX	CONSTRUCTION MANAGEMENT	5,900,000	6,810,000	15	1,020,000	7,830,000
YYY	PROJECT MANAGEMENT	5,900,000	6,780,000	15	1,020,000	7,800,000
	(ADJUSTED TO MEET DOE 5100.4)					

PROJECT TOTAL 100,830,000 114,470,000 17 19,040,000 133,510,000

TYPE OF
ESTIMATE ROUGH ORDER OF MAGNITUDE (R O M)

ARCHITECT
ENGINEER FLUOR DANIEL

OPERATING
CONTRACTOR WESTINGHOUSE HANFORD COMPANY

REMARKS:

CONCEPT 1 ALTERNATE C

INITIAL CONSTRUCTION OF WET STORAGE POOL, TWO
PASSIVELY COOLED DRY STORAGE VAULTS AND SUPPORT
FACILITIES, WITH DEFERRED PROCUREMENT AND ERECTION
OF CORTEN STORAGE TUBES, PLUS THE DEFERRED CON-
STRUCTION OF A FOURTH PASSIVELY COOLED VAULT, AND
THE ERECTION OF THE ENTIRE VAULT SUPERSTRUCTURE.

(ROUNDED/ADJUSTED TO THE NEAREST " 10,000 / 100,000 " - PERCENTAGES NOT RECALCULATED TO REFLECT ROUNDING)

SSF Feasibility Study
Westinghouse Hanford Company
WHC P.O. TW-5W-370252

Fluor Daniel, Inc.
Government Services
Contract 04436305

TABLE 7-4
STAGING & STORAGE FACILITY
CONCEPT 1 ALTERNATIVE C
\$ EXPENDITURE - FY ESCALATED (\$ X 1000)

09-Mar-95

DESCRIPTION	TOTAL	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003
ENGINEERING/DESIGN	15,695	2,378	10,769	1,240			137	545	547	80
TITLE 3 INSP SERVICES	3,263		715	1,240			137	545	547	80
PROCUREMENT										
PROCURE PHASE 1	11,342		858	10,484						
PROCURE PHASE 2	30,532						2,216	28,316		
S/T PROCUREMENT	41,874		858	10,484			2,216	28,316		
CONSTRUCTION										
CONSTR PHASE 1	39,886		8,722	31,164				3,940	13,154	69
CONSTR PHASE 2	17,163							3,940	13,154	69
S/T CONSTRUCTION	57,049		8,722	31,164						
CONSTRUCTION MGMT										
CM PHASE 1	3,910		1,621	2,126	163			1,787	1,866	272
CM PHASE 2	3,925							1,787	1,866	272
S/T CM	7,835		1,621	2,126	163					
PROJECT MGMT										
PM PHASE 1	3,865	599	1,517	1,517	232					
PM PHASE 2	3,925						409	1,635	1,642	239
S/T PM	7,790	599	1,517	1,517	232		409	1,635	1,642	239
TOTAL	133,506	2,977	24,202	47,771	395		2,898	36,768	17,756	739

SSF Feasibility Study
Westinghouse Hanford Company
WHC P.O. TVW-SVV-370252

Fluor Daniel, Inc.
Government Services
Contract 04436305

TABLE 7-5

FLUOR DANIEL INC.
WESTINGHOUSE HANFORD COMPANY
JOB NO. 436305

** TEST - INTERACTIVE ESTIMATING **
STAGING AND STORAGE FACILITY
CONCEPT 2 ALTERNATE A
DOE_R01 - PROJECT COST SUMMARY

PAGE 01 OF 01
DATE 03/09/95 12:00:00
BY JMF/RLJ/PCA/JFD

COST CODE =====	DESCRIPTION =====	1995 \$ TOTAL COST =====	ESCALATED TOTAL COST =====	CONTINGENCY % =====	TOTAL DOLLARS =====
000	ENGINEERING	14,500,000	15,030,000	15	2,250,000
460	IMPROVEMENTS TO LAND	1,100,000	1,170,000	15	180,000
501	BUILDINGS	62,980,000	67,090,000	16	10,630,000
600	UTILITIES	1,000,000	1,060,000	15	160,000
700	SPECIAL EQUIP/PROCESS SYSTEMS	15,630,000	16,660,000	19	3,220,000
WWW	TITLE III INSPECTION	3,200,000	3,400,000	15	510,000
XXX	CONSTRUCTION MANAGEMENT	6,500,000	6,910,000	15	1,040,000
YYY	PROJECT MANAGEMENT	6,500,000	6,830,000	15	1,020,000
(ADJUSTED TO MEET DOE 5100.4)					

PROJECT TOTAL

111,410,000 118,150,000 16 19,010,000 137,160,000

TYPE OF
ESTIMATE ROUGH ORDER OF MAGNITUDE (R O M)

ARCHITECT

ENGINEER FLUOR DANIEL

OPERATING
CONTRACTOR

WESTINGHOUSE HANFORD COMPANY

REMARKS:

CONCEPT 2 ALTERNATE A

INITIAL CONSTRUCTION OF THREE STORAGE VAULTS,
MCO STORAGE IN WATER FILLED S.S. TUBES, NO
DEFERRED CONSTRUCTION.

(ROUNDED/ADJUSTED TO THE NEAREST " 10,000 / 100,000 " - PERCENTAGES NOT RECALCULATED TO REFLECT ROUNDING)

SSF Feasibility Study
Westinghouse Hanford Company
WHC P.O. TVW-SVV-370252

Fluor Daniel, Inc.
Government Services
Contract 04436305

TABLE 7-6
STAGING & STORAGE FACILITY
CONCEPT 2 ALTERNATIVE A
\$ EXPENDITURE - FY ESCALATED (\$ X 1000)

09-Mar-95

DESCRIPTION	TOTAL	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003
ENGINEERING/DESIGN	17,288	2,604	12,133	2,552						
TITLE 3 INSP SERVICES	3,910		1,359	2,552						
PROCUREMENT PROCUREMENT	65,857		4,976	60,881						
CONSTRUCTION CONSTRUCTION	34,308		6,561	27,747						
CONSTRUCTION MGMT CM	7,942		3,161	4,146	635					
PROJECT MGMT PM	7,850	1,180	2,991	2,991	688					
TOTAL	137,155	3,784	31,180	100,868	1,323					

8.0 SCHEDULES

8.1 SCHEDULE ASSUMPTIONS

8.1.1 General

These schedules are based on the use of the Canister Storage Building (CSB) design and partially completed construction from the Hanford Waste Vittrification Plant (HWVP) Project. Utility tie-ins are available from the completed construction of the HWVP project.

WHC provided the date for start of the engineering studies, the Key Decision 0 date of 10 March 1995, and the date of May 9, 1995 for approval by DOE of the Functions and Requirements for the project. May 10, 1995 is assumed to be the start of Conceptual Design and Capital funds are assumed to be available in October 1995. The Stabilization Facility is assumed to be operational in December 2002.

This schedule assumes that there will be no annual funding constraints for the duration of the project.

The cost estimates prepared for each alternative provide a basis for each schedule.

An important objective of these schedules was to have the SSF operational and ready to receive MCO's from the K-Basins as rapidly as possible. Aggressive, but achievable schedules were therefore developed for Phase 1 activities. Phase 2 activities for Alternatives 1B and 1C were scheduled based on the assumed date for operation of the Stabilization Facility and did not require an aggressive approach.

8.1.1.1 Engineering and Design

Maximum use of the existing engineering and design of the CSB and the results of this feasibility study allows the approximately three month duration for conceptual design. New requirements and additional facilities will have minimal impact to the existing facility design and drawings.

Client review changes will have no impact at the end of conceptual engineering and definitive design. Continuous reviews and alignments are required to minimize change.

8.1.1.2 Procurement and Construction:

The October 1992 statused Mowat schedule for the CSB was used as a basis for deriving activity durations for completion of the walls, the operating floor and storage tube installation.

The construction of the facility will be performed with specialty subcontractors.

There is no shortage of local craft labor or specialty contractors in the area.

Construction is based on a standard forty hour work week. Scheduled overtime is excluded from this schedule.

The concrete slab and walls that are currently in place will be used with minimal changes required to complete the concrete vault walls and operating floor.

The walls for the pool and for vaults one and two, will be formed and poured simultaneously.

Rebar for the walls and for the operating floors will be pre-assembled and set in place with cranes.

Structural steel buildings will be prefabricated in shops, and assembled in the field.

There is no shortage of material locally, including concrete batch plant requirements.

Long lead equipment items will be identified very early so as to not delay construction.

There are no shortages of construction equipment in the area.

Reviews by WHC will be concurrent with the design during all phases with a twenty day review continuing after the end of conceptual design.

DOE reviews will be for twenty days after the WHC review period.

Independent cost verifications will be for twenty days after the WHC review and concurrent with the DOE reviews.

ESAAB reviews will take place for twenty-five days subsequent to the DOE reviews and prior to Key decisions one through four.

Safety analysis reports will be generated on a one step SAR basis. Final review and approval extends for a nine month period

and approval is required prior to start-up. Construction will be allow to commence based on approval of a preliminary safety evaluation.

8.1.2 Alternative 1 B

The impact of providing a double pool liner to meet RCRA requirements is not included in this schedule. A six month extension to the initial construction phase should be anticipated if a double pool liner is required for the pool area.

Procurement and fabrication of the storage vault tubes is deferred to fiscal 2001.

Installation of the storage tubes, erection of the steel structure and equipment installation associated with the storage vaults is deferred to fiscal 2002. Storage tube installation is performed one vault at a time.

8.1.3 Alternative 1 C

The impact of providing a double pool liner to meet RCRA requirements is not included in this schedule. A six month extension to the initial construction phase should be anticipated if a double pool liner is required for the pool area.

The construction of Vault 4 is deferred to fiscal 2001. Construction will include excavation adjacent to the existing Vault 1, forming and pouring the concrete slab, walls and operating deck for Vault 4.

Procurement and fabrication of the storage vault tubes is deferred to fiscal 2000.

Installation of the storage tubes, erection of the steel structure and equipment installation associated with the storage vaults is deferred to fiscal 2002. Storage tube installation is performed one vault at a time.

8.1.4 Alternative 2 A

Construction of the operating decks will be concurrent in all three vaults.

Storage tube installation will be concurrent in all three vaults.

8.2 ALTERNATIVE 1B SCHEDULE

Figure 8-1 contains the schedule for Alternative 1B. It shows that, subject to the above assumptions, it is possible to achieve operation of the first phase of the SSF in November 1997.

Procurement and construction of the second phase of the SSF can be deferred until December 2000, in order to have the facility available for passive dry storage by December 2002.

8.3 ALTERNATIVE 1C SCHEDULE

Figure 8-2 contains the schedule for Alternative 1C. It shows that, subject to the above assumptions, it is possible to achieve operation of the first phase of the SSF in November 1997.

Procurement and construction of the second phase of the SSF can be deferred until July 2000, in order to have the facility available for passive dry storage by December 2002.

8.4 ALTERNATIVE 2A SCHEDULE

Figure 8-3 contains the schedule for Alternative 2A. It shows that, subject to the above assumptions, it is possible to achieve operation of the SSF in December 1997. The entire facility is constructed initially under this alternative so there is no second phase of procurement and construction.

FIGURE 8-2
STAGING & STORAGE FACILITY
ALT 1C - CSB ADAPTATION

WHC-SD-W379-ES-002 Rev. 0

Sheet 2 of 2

FLUOR DANIEL, INC.

Date	Revision	Checked	Approved

Project Start 01DEC94
Project Finish 19DEC92
Data Date 01DEC94
Plot Date 14FEB95

Legend:
Early Bar
Progress Bar
Critical Activity

CSB/C

Early	Finish	Out
10MAR95	01NOV95	0
28FEB96	31JUL96	0
24DEC97		0

KEY DECISIONS

Early	Finish	Out
09MAY95	01JUN95	0
04OCT95		0

KEY MILESTONES

Early	Finish	Out
06/JAN/95	24/FEB/95	36

CONCEPTUAL DESI

10MAY95	01AUG95	60
05JUL95	29AUG95	40
02AUG95	30OCT95	64
30AUG95	26SEP95	20
30AUG95	26SEP95	20
27SEP95	31OCT95	25

SSF DESIGN

01NOV95	28MAY96	150
01NOV95	02JAN96	45
01NOV95	26DEC95	40
27DEC95	23JAN96	20
27DEC95	23JAN96	20
24JAN96	27FEB96	25
29MAY96	25JUN96	20
29MAY96	25JUN96	20
26JUN96	30JUL96	25

PROCUREMENT

27DEC95	19MAR96	60
03JAN96	08APR97	330
31JUL96	22OCT96	60
23OCT96	20MAY97	150

CONSTRUCTION

28FEB96	27FEB96	0
28FEB96	27FEB96	0
20MAR96	30SEP97	400
20MAR96	28MAY96	50
29MAY96	06AUG96	50
29MAY96	01OCT96	90
29AUG96	29OCT96	60
07AUG96	26NOV96	80

1995 1996 1997 1998 1999

KEY DECISION #0

KEY DECISION #1 & #2

KEY DECISION #3A

KEY DECISION #3B

KEY DECISION #4

DOE APPROVAL OF F & R

DESIGN ONLY VALIDATION

CAPITAL DOLLARS AVAILABLE

ENGINEERING STUDIES

CONCEPTUAL DESIGN

WHC REVIEW/APPROVE CDR

ADVANCED CONCEPTUAL DESIGN

INDEPENDENT COST VERIFICATION

DOE DESIGN REVIEW

DOE DESIGN REVIEW (3A)

DOE DESIGN REVIEW (3B)

ESAB #3A

ESAB #3B

BID & AWARD VAULT CONSTRUCTION

BID & AWARD TUBE FABRICATION

SSF CONSTRUCTION PROCUREMENT

FAB & DELIVER TUBE ASSEMBLIES

ROADS (COMPLETE)

SITE CLEAR & GRUB (COMPLETE)

BLDG EXCAV & CONCR SLAB (COMPLETE)

ENG'R & INSPECTION SERVICES - TITLE III

F&P VAULTS (3A)

BACKFILL EXTERIOR WALLS (3A)

F&P OPERATING FLOOR (3A)

CONSTRUCT RAIL SPUR TO MCO UNLOADING AREA

F&P FDN & WALLS WTR TRTMT/INSTR AIR COMPR AREA

8-9

ALT 2A - CSB ADAPTATION

STAGING & STORAGE FACILITY

FIGURE 8-3

WHC-SD-W379-ES-002 REV. 0

PLUM DAMEL, INC.

Checked Approved

1995 1996 1997 1998 1999

FIGURE 8-3
STAGING & STORAGE FACILITY
ALT 2A - CSB ADAPTATION

WHC-SD-W379-ES-002 Rev. 0

8-10

Project Start 81DEC94
 Project Finish 23DEC97
 Data Date 81DEC94
 Plot Date 14FEB95

CSBA

Sheet 2 of 2

FLUOR DANIEL, INC.			
Date	Reviser	Checked	Approved

9.0 CONCLUSIONS AND RECOMMENDATIONS

9.1 FEASIBILITY OF CSB ADAPTATION

The results of this study demonstrate that it is feasible to adapt the design of the CSB to meet the F&Rs of the SSF. Construction of the SSF on the CSB site will enable the already completed CSB site clearing and grubbing, site preparation, excavation, base mat and walls to be utilized for the SSF, saving both time and money. Use of the CSB site for the SSF is also consistent with master plans currently being developed for the Hanford Site and the objective of moving the N-Reactor fuel away from the Columbia River.

9.2 CONCEPT 1 VS CONCEPT 2

Table 9-1 compares Concept 1, Alternatives 1B and 1C, against Concept 2, Alternative 2A, with respect to capital cost, operating cost, schedule, safety, technical feasibility, and other factors.

9.3 OTHER ALTERNATIVES

Relaxation of the 50°F maximum MCO temperature requirement prior to stabilization will allow other, less costly, alternatives to be considered. Appendix 3 contains a description of several of these alternatives and a comparison of their estimated costs against Alternatives 1B, 1C and 2A.

TABLE 9-1
EVALUATION OF CONCEPTS 1 AND 2

	ALTERNATIVE 1B		ALTERNATIVE 1C		ALTERNATIVE 2A	
CAPITAL COST (ESCALATED) \$ MILLIONS	PHASE 1 PHASE 2 TOTAL	74.9 40.0 114.9	PHASE 1 PHASE 2 TOTAL	76.1 57.4 133.5	PHASE 1 PHASE 2 TOTAL	137.2 -- 137.2
OPERATING COST DELTA \$ MILLIONS	BASE		BASE		+ 2.2	
SCHEDULED START OF OPERATIONS	NOVEMBER 1997		NOVEMBER 1997		DECEMBER 1997	
SAFETY	PREFERRED		PREFERRED		LESS DESIRABLE	
TECHNICAL FEASIBILITY	NO FEASIBILITY QUESTIONS		NO FEASIBILITY QUESTIONS		SS CORROSION WITH STAGNANT H ₂ O IN TUBES UNRESOLVED	
OTHER	-ALLOWS DEFERRAL OF PHASE 2 PROCUREMENT AND CONSTRUCTION COST UNTIL FY 2001 -PROVIDES 512 STORAGE TUBES. COULD ACCOMMODATE THE EQUIVALENT OF 1200 MCOs DURING STORAGE BY VOLUME REDUCTION -PROVIDES AVAILABLE POOL STORAGE SPACE FOR OTHER SITE USES AFTER STABILIZATION		-ALLOWS DEFERRAL OF PHASE 2 PROCUREMENT AND CONSTRUCTION COST UNTIL FY 2000 -PROVIDES 660 STORAGE TUBES -PROVIDES AVAILABLE POOL STORAGE SPACE FOR OTHER SITE USES AFTER STABILIZATION		-PROVIDES 660 STORAGE TUBES	

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APPENDIX 1 - DESIGN BASIS

The following functions and requirements data was furnished by WHC for use as a design basis for this study:

TRANSPORTATION INTERFACES RAIL CAR AND CASK

- SIZE AND WEIGHT OF RAIL CAR: Standard flat-bed rail car
- CASK DIMENSIONS, WEIGHTS, LIFTING POINTS (CASK AND LID): MCO transportation cask: 60,000 lbs, lifting trunions on side above center of gravity
- EXPECTED SURFACE CONT. LEVEL: Outside: DOT limits worst case; Inside: K-East Basin water; assume decon from top with cask upright. No tip/flip capability required.
- TIE DOWN POINTS: TBD
- MATERIALS/FINISHES (CASK): 304 SS
- CASK C-G's: Geometric center
- RAIL CAR TRANSPORTATION SAFE GUARD: Standard DOE requirements for SNF
- RAIL CAR POSITIONING TECHNIQUE IN SSF: Designer's choice
- RAIL CAR ATTACHMENT POINTS: TBD for loads; standard couplings front and back.
- STORAGE FACILITY/CASK HANDLING
 - STANDARD RIGGING: Pick cask with rigging fixture
 - SPECIAL TOOLS attached to the crane hook and
 - PICK HEIGHT lifting trunions. Maximum pick height at 2.5x height of cask from floor to bottom of cask.
- MONITORING REQUIREMENTS: Time from MCO closure and cask seal at K-Basins. Visual gauge monitoring of MCO - to - cask seal pressure and internal cask temperature.

- SERVICE REQUIREMENTS
 - AIR
 - WATER
 - POWERS
 - IMPACT RECORDING
- NUMBER OF RAIL CARS: 2 cars in the facility at once for cask unload/load cycle and MCO load/unload cycle
- LAG STORAGE REQUIREMENTS
 - RAIL CARS: 2 cars on rail siding outside
 - CASKS: 4 casks; 2 clean, ready for use; 1 contaminated, waiting for decontamination; 1 in the decontamination station.
 - MCO's: 1 week supply at facility: 4/day consumed.
 - RAIL CAR WEIGHT - FULL CASK LOAD: Standard flatbed rail car plus 60,000 lb cask
 - IDENTIFICATION OF ANY OTHER TRANSPORTER CONCEPTS: TBD, assume rail
 - SECURITY NEEDS (LIMITS, ETC.): DOE standards for SNF
 - TRANSPORTER CONVEYANCE
 - LOCOMOTIVES Designer choice inside facility.
 - TRACKMASTER: Locomotive delivery to facility and pick-up from facility.
 - TUGGERS
 - RAIL CAR MATERIALS AND SURFACE FINISH: Assume easily decontamination design to facilitate standard wash-down technologies.
 - CAR IDENTIFICATION AND TRACKING: Visual
 - BRAKE STATUS: Visual indication

MCO INTERFACES

- SIZE: See attached table
- SHAPE: See attached table
- WEIGHT/CG'S: EMPTY/LOADED: See attached table

- MATERIAL AND FINISH CONDITION: 304 SS
- LIFTING POINTS/GEOMETRY: Top of MCO; specifics TBD. Lifting fixtures compatible with normal crane hook.
- ATTACHMENTS FOR MONITORING: MCO lid
- ATTACHMENTS FOR SERVICES: MCO lid
- DEFINITIONS OF SERVICE REQUIREMENTS:
 - Vent and inert-gas purge MCO upon receipt;
 - Cycle for water addition at 2 MCOs/week after completion of MCO delivery to the SSF
- MONITORING REQUIREMENTS: Temperature of cooling media (must limit MCO temperatures as listed below)
- REQUIRED STORAGE CONDITIONS: Staging: water inside MCO at 50 F.
Storage: Fuel centerline temperature at 400 C.
- IDENTIFICATION REQUIREMENTS: Visual identification of MCO, or per DOE standard material accountability requirements for SNF
- TRACKING REQUIREMENTS: DOE standard material accountability requirements for SNF
- MINIMUM, MAXIMUM, AVERAGE RADIATION LEVELS: TBD, being calculated
- EXPECTED SURFACE CONDITIONS: Nominal conditions: clean
Upset conditions: K-Basin water contamination
- CRITICALLY CONTROL SPACING: MCO stacking acceptable, MCO placement side-by-side with no gap acceptable.
- INSPECTION REQUIREMENTS: Receipt inspection: MCO - to - cask seal verification - visual gauge observation. MCO seal verification - visual gauge observation. Surface contamination of MCO and cask. MCO weight. MCO H₂ levels during venting.
- ORIENTATION REQUIREMENTS: VERTICAL +- 10 degrees

- SEALING SURFACES LOCATION/CONFIGURATION/MATERIALS/ etc.: Top of MCO lid
- ACCELERATION LIMITS: Normal crane operating limits; or 2-g vertical lift, 1-g vertical lowering, 1-g horizontal, impact limiters for long vertical placements.
- SOURCE TERMS
 - RADIOLOGICAL See Cowan list. List must be updated to describe minimum MCO source term, % of MCOs at minimum, average, and maximum levels, sludge source term and # of sludge MCOs.
 - CHEMICAL
 - HAZARDOUS
 - LIQUID
 - GAS
 - THERMAL Assume sludge MCOs contain RCRA waste. Assume 100 m³ of sludge. SSF must meet RCRA waste storage requirements for sludge MCOs.
- STANDARD RIGGING HARDWARE: Deployed from crane hook. Designer's choice.
- SPECIAL TOOLS: Deployed from crane hook. Designer's choice.
- MAXIMUM ALLOWABLE OPERATION PRESSURE: 125 psig prior to venting. Gas volume 50 liters. Gas venting through breather filter (air cooling) or water trap (water pool cooling).
- RESPONSIBILITY FOR MCO OVERPACK DESIGN: SSF designer
- ALLOWABLE PICK ELEVATIONS: 2.5 x MCO height from floor to bottom of MCO.

MCO PROPOSED DESCRIPTION

DRAFT Rev. A R. G. Cowan January 12, 1995

ATTRIBUTE	NOMINAL VALUE-936 MCO's	LIMIT
Outside Diameter	24.0 inches	24.5 inches
Length	150 inches	180 inches (MPC limit)
Weight 8 canisters/MCO		
Uranium	4,964 lb	5,800 lb
Zr	350 lb	370 lb
Water	1,600 lb	1,550 lb
Stainless Steel	3,500 lb	4,500 lb
TOTAL	10,414 lb (4,725 kg)	12,220 lb (5,545 kg)
Radionuclides >100 Ci	Table 3.3 <u>W. L. Willis</u>	Mark IV 16% 240 @ 10 yr
Co-60 ²	158 ci	23 ci (622 Ci)
Kr-85	n/a	1,730 Ci
Sr-90	11,200 Ci	19,800 Ci
Y-90	11,200 Ci	19,800 Ci
Cs-137	14,400 Ci	26,400 Ci
Ba-137m	13,700 Ci	25,000 Ci
Pm-147	1,100 Ci	6,030 Ci
Sm-151	184 Ci	260 Ci
Eu-154	137 Ci	483 Ci <i>added</i>
Pu-238	134 Ci	300 Ci
Pu-239	240 Ci	365 Ci
Pu-240	138 Ci	263 Ci
Pu-241	7,880 Ci	22,000 Ci
Am-241	337 Ci	465 Ci
TOTAL (all)	61,200 Ci	125,000 Ci
Heat Generation	600 BTU/hr (176 W)	1120 BTU/hr (328 W)
% Fissile (U-235 + Pu-239)/U	0.925%	0.849 % ²
Hydrogen Gas Generation	1.2 L/day @ 0.1%/year U oxidation by water	14 L/day @ 1.0%/year U oxidation by water
Kr-85 in gas released	2.56 mCi/L	4.62 mCi/L

¹ The Co-60 concentration is uncertain because it is an activation product from impurities in the metal fuel. Tank samples indicate a higher than predicted concentration. An adjusted concentration based on tank samples was used by Willis and the same adjustment is shown () for the limit.

² The highest enrichment is 1.15% in unirradiated IA fuel but very little low exposure spike remains from shut down.

³ Assume 5% of MCO's at upper limit; 80% at nominal value; 15% below nominal value.

APPENDIX 2 - COST ESTIMATE DETAIL

The following tables contain WBS breakdowns of the cost estimates provided in Section 7. Figures A2-1 and A2-2 indicate the scope of the procurement and construction WBS accounts.

PREFIX 2 = PROCUREMENT
PREFIX 3 = CONSTRUCTION

STAGING & STORAGE FACILITY
PLOT PLAN
CONCEPT 1 ALT C

FIGURE A2-1
CONCEPT 1 WBS AREAS

A2-2

PREFIX 2 = PROCUREMENT
PREFIX 3 = CONSTRUCTION

STAGING & STORAGE FACILITY
PLOT PLAN
CONCEPT 2 ALT A

FIGURE A2-2
CONCEPT 2 WBS AREAS

A2-3

FLUOR DANIEL INC.
WESTINGHOUSE HANFORD COMPANY
JOB NO. 436305

** TEST - INTERACTIVE ESTIMATING **
STAGING AND STORAGE FACILITY
CONCEPT 1 ALTERNATE B
DOE_R02 - WORK BREAKDOWN STRUCTURE SUMMARY

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DATE 03/09/95 12:00:00
BY JMF/RLJ/PCA/JFD

TABLE A2-1

WBS	DESCRIPTION	ESTIMATE SUBTOTAL	ONSITE INDIRECTS	SUB TOTAL	ESCALATION %	SUB TOTAL	CONTINGENCY %	TOTAL DOLLARS
110	CONCEPTUAL/ADVANCED CONCEPTUAL DESM	2100000	0	2100000	1.59	33390	15	2453399
120	DETAILED DESIGN	8400000	0	8400000	3.29	276360	15	9977814
130	TITLE III ENGR - INITIAL PHASE	1600000	0	1600000	6.25	100000	15	1955000
131	TITLE III ENGR - DEFERRED PHASE	900000	0	900000	26.41	237690	15	1308344
132	TITLE III INSP - INITIAL PHASE	1600000	0	1600000	6.25	100000	15	1955000
133	TITLE III INSP - DEFERRED PHASE	900000	0	900000	26.41	237690	15	1308344
	SUBTOTAL 1 ENGINEERING	15500000	0	15500000	6.36	985130	15	18957901
210	RAIL TUNNEL/CASK UNLOAD/MCO SERVICE	2742594	0	2742594	6.67	182931	30	3803182
220	POOL	792330	0	792330	6.67	52848	15	971955
230	VAULTS AND INLET/EXHAUST PLENUMS	17539017	0	17539017	24.26	4254965	15	25063080
240	POOL WTR COOLING & INST AIR COMP	1549798	0	1549798	6.67	103372	30	2149121
250	HVAC/OFFICE/GENERATOR//EQUIP BLDG	3600574	0	3600574	6.67	240159	15	4416842
	SUBTOTAL 2 PROCUREMENT	26224313	0	26224313	18.43	4834275	17	36404180
310	RAIL TUNNEL/CASK UNLOAD/MCO SERVICE	2076552	0	2076552	6.25	129785	30	2868236
320	POOL	10448177	0	10448177	6.25	653011	15	12766367
330	VAULTS AND INLET/EXHAUST PLENUMS	15500082	0	15500082	12.62	1955658	15	2074098
340	POOL WTR COOLING & INST AIR COMP	5360649	0	5360649	6.25	335041	30	7404396
350	HVAC/OFFICE/GENERATOR//EQUIP BLDG	1421807	0	1421807	6.25	88864	15	1737271
370	SITE SUPPORT	1416945	0	1416945	6.25	88559	15	1731329
	SUBTOTAL 3 CONSTRUCTION	36224212	0	36224212	8.97	3250918	18	46581697
411	CONST MGT - INITIAL PHASE	3200000	0	3200000	6.25	200000	15	3910000
412	CONST MGT - DEFERRED PHASE	1800000	0	1800000	26.41	475380	15	2616687
	SUBTOTAL 4 CONSTRUCTION MANAGEMENT	5000000	0	5000000	13.51	675380	15	6526687
511	PROJ MGT - INITIAL PHASE	3200000	0	3200000	5.02	160640	15	3864736
512	PROJ MGT - DEFERRED PHASE	1800000	0	1800000	26.41	475380	15	2616687
	SUBTOTAL 5 PROJECT MANAGEMENT	5000000	0	5000000	12.72	636020	15	6481423
	PROJECT TOTAL	87,948,525	0	87,948,525	11.80	10,381,723	17	114,951,888

FLUOR DANIEL INC.
WESTINGHOUSE HANFORD COMPANY
JOB NO. 436305

** TEST - INTERACTIVE ESTIMATING **
STAGING AND STORAGE FACILITY
CONCEPT 1 ALTERNATE B
S1 - ESTIMATE SUMMARY BY WBS

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TABLE A2-2

WBS	DESCRIPTION	MANHOURS	LABOR	EQUIP USAGE	MATERIAL	SUB- CONTRACT	EQUIPMENT	OVERHEAD & PROFIT	TOTAL DOLLARS
110	CONCEPTUAL/ADVANCED CONCEPTUAL DESN	0	0	0	0	2100000	0	0	2100000
120	DETAILED DESIGN	0	0	0	0	8400000	0	0	8400000
130	TITLE III ENGR - INITIAL PHASE	0	0	0	0	1600000	0	0	1600000
131	TITLE III ENGR - DEFERRED PHASE	0	0	0	0	900000	0	0	900000
132	TITLE III INSP - INITIAL PHASE	0	0	0	0	1600000	0	0	1600000
133	TITLE III INSP - DEFERRED PHASE	0	0	0	0	900000	0	0	900000
SUBTOTAL 1	ENGINEERING	0	0	0	0	15500000	0	0	15500000
210	RAIL TUNNEL/CASK UNLOAD/MCO SERVICE	0	0	0	0	0	2611994	130600	2742594
220	POOL	0	0	0	0	0	754600	37730	792330
230	VAULTS AND INLET/EXHAUST PLENUMS	0	0	0	0	0	16703826	835191	17539017
240	POOL WTR COOLING & INST AIR COMP	0	0	0	0	0	1475998	73800	1549798
250	HVAC/OFFICE/GENERATOR//EQUIP BLDG	0	0	0	0	0	3429118	171456	3600574
SUBTOTAL 2	PROCUREMENT	0	0	0	0	0	24975536	1248777	26224313
310	RAIL TUNNEL/CASK UNLOAD/MCO SERVICE	27750	874125	0	654346	47340	0	500741	2076552
320	POOL	104950	3305925	0	5133436	0	0	2008816	10448177
330	VAULTS AND INLET/EXHAUST PLENUMS	233883	7367315	0	4026749	0	0	4106018	15500082
340	POOL WTR COOLING & INST AIR COMP	82220	2589930	0	1331481	0	0	1439238	5360649
350	HVAC/OFFICE/GENERATOR//EQUIP BLDG	20600	648900	0	408562	0	0	364345	1421807
370	SITE SUPPORT	5615	176874	0	166399	883280	0	190392	1416945
SUBTOTAL 3	CONSTRUCTION	475018	14963069	0	11720973	930620	0	8609550	36224212
411	CONST MGT - INITIAL PHASE	0	0	0	0	3200000	0	0	3200000
412	CONST MGT - DEFERRED PHASE	0	0	0	0	1800000	0	0	1800000
SUBTOTAL 4	CONSTRUCTION MANAGEMENT	0	0	0	0	5000000	0	0	5000000
511	PROJ MGT - INITIAL PHASE	0	0	0	0	3200000	0	0	3200000
512	PROJ MGT - DEFERRED PHASE	0	0	0	0	1800000	0	0	1800000
SUBTOTAL 5	PROJECT MANAGEMENT	0	0	0	0	5000000	0	0	5000000

PROJECT TOTAL
475,018 14,963,069 0 11,720,973 26,430,620 9,858,327 87,948,525

TABLE A2-3

FLUOR DANIEL INC.
WESTINGHOUSE HANFORD COMPANY
JOB NO. 436305

** TEST - INTERACTIVE ESTIMATING **
STAGING AND STORAGE FACILITY
CONCEPT 1 ALTERNATE C
DOE_RO2 - WORK BREAKDOWN STRUCTURE SUMMARY

PAGE 01 OF 01
DATE 03/09/95 12:00:00
BY JMF/RLJ/PCA/JFD

WBS	DESCRIPTION	ESTIMATE SUBTOTAL	ONSITE INDIRECTS	SUB TOTAL	ESCALATION % TOTAL	SUB TOTAL	CONTINGENCY % TOTAL	TOTAL DOLLARS
=====	=====	=====	=====	=====	=====	=====	=====	=====
110	CONCEPTUAL/ADVANCED CONCEPTUAL DESN	2100000	0	2100000	1.59	33390	15	2453399
120	DETAILED DESIGN	8400000	0	8400000	3.29	276360	15	9977814
130	TITLE III ENGR - INITIAL PHASE	1600000	0	1600000	6.25	100000	15	1955000
131	TITLE III ENGR - DEFERRED PHASE	900000	0	900000	26.41	237690	15	1308344
132	TITLE III INSP - INITIAL PHASE	1600000	0	1600000	6.25	100000	15	1955000
133	TITLE III INSP - DEFERRED PHASE	900000	0	900000	26.41	237690	15	1308344
	SUBTOTAL 1 ENGINEERING	15500000	0	15500000	6.36	985130	15	18957901
210	RAIL TUNNEL/CASK UNLOAD/MCO SERVICE	2742594	0	2742594	6.67	182931	30	3803182
220	POOL	792330	0	792330	6.67	52848	15	971955
230	VAULTS AND INLET/EXHAUST PLENUMS	21366424	0	21366424	24.26	5183494	15	30532406
240	POOL WTR COOLING & INST AIR COMP	1549798	0	1549798	6.67	103372	30	2149121
250	HVAC/OFFICE/GENERATOR//EQUIP BLDG	3600574	0	3600574	6.67	240159	15	4416842
	SUBTOTAL 2 PROCUREMENT	30051720	0	30051720	19.18	5762804	17	41873506
310	RAIL TUNNEL/CASK UNLOAD/MCO SERVICE	2076552	0	2076552	6.25	129785	30	2868236
320	POOL	10448177	0	10448177	6.25	653011	15	12766367
330	VAULTS AND INLET/EXHAUST PLENUMS	22755756	0	22755756	16.71	3802415	15	30541897
340	POOL WTR COOLING & INST AIR COMP	5360649	0	5360649	6.25	335041	30	7404396
350	HVAC/OFFICE/GENERATOR//EQUIP BLDG	1421807	0	1421807	6.25	88864	15	1737271
370	SITE SUPPORT	1416945	0	1416945	6.25	88559	15	1731329
	SUBTOTAL 3 CONSTRUCTION	43479886	0	43479886	11.72	5097675	17	57049496
411	CONST MGT - INITIAL PHASE	3200000	0	3200000	6.25	200000	15	3910000
412	CONST MGT - DEFERRED PHASE	2700000	0	2700000	26.41	713070	15	3925031
	SUBTOTAL 4 CONSTRUCTION MANAGEMENT	5900000	0	5900000	15.48	913070	15	7835031
511	PROJ MGT - INITIAL PHASE	3200000	0	3200000	5.02	160640	15	3864736
512	PROJ MGT - DEFERRED PHASE	2700000	0	2700000	26.41	713070	15	3925031
	SUBTOTAL 5 PROJECT MANAGEMENT	5900000	0	5900000	14.81	873710	15	7789767
=====								
PROJECT TOTAL		100,831,606	0	100,831,606	13.52	13,632,389	17	133,505,701

TABLE A2-4

FLUOR DANIEL INC.
WESTINGHOUSE HANFORD COMPANY
JOB NO. 436305

** TEST - INTERACTIVE ESTIMATING **
STAGING AND STORAGE FACILITY
CONCEPT 1 ALTERNATE C
S1 - ESTIMATE SUMMARY BY WBS

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WBS	DESCRIPTION	MANHOURS	LABOR	EQUIP USAGE	MATERIAL	SUB- CONTRACT	EQUIPMENT	OVERHEAD & PROFIT	TOTAL DOLLARS
110	CONCEPTUAL/ADVANCED CONCEPTUAL DESN	0	0	0	0	2100000	0	0	2100000
120	DETAILED DESIGN	0	0	0	0	8400000	0	0	8400000
130	TITLE III ENGR - INITIAL PHASE	0	0	0	0	1600000	0	0	1600000
131	TITLE III ENGR - DEFERRED PHASE	0	0	0	0	900000	0	0	900000
132	TITLE III INSP - INITIAL PHASE	0	0	0	0	1600000	0	0	1600000
133	TITLE III INSP - DEFERRED PHASE	0	0	0	0	900000	0	0	900000
SUBTOTAL 1	ENGINEERING	0	0	0	0	15500000	0	0	15500000
210	RAIL TUNNEL/CASK UNLOAD/MCO SERVICE	0	0	0	0	0	2611994	130600	2742594
220	POOL	0	0	0	0	0	754600	37730	792330
230	VAULTS AND INLET/EXHAUST PLENUMS	0	0	0	0	0	20348975	1017449	21366424
240	POOL WTR COOLING & INST AIR COMP	0	0	0	0	0	1475998	73800	1549798
250	HVAC/OFFICE/GENERATOR//EQUIP BLDG	0	0	0	0	0	3429118	171456	3600574
SUBTOTAL 2	PROCUREMENT	0	0	0	0	0	28620685	1431035	30051720
310	RAIL TUNNEL/CASK UNLOAD/MCO SERVICE	27750	874125	0	654346	47340	0	500741	2076552
320	POOL	104950	3305925	0	5133436	0	0	2008816	10448177
330	VAULTS AND INLET/EXHAUST PLENUMS	336368	10595598	0	6232847	0	0	5927311	22755756
340	POOL WTR COOLING & INST AIR COMP	82220	2589930	0	1331481	0	0	1439238	5360649
350	HVAC/OFFICE/GENERATOR//EQUIP BLDG	20600	648900	0	408562	0	0	364345	1421807
370	SITE SUPPORT	5615	176874	0	166399	883280	0	190392	1416945
SUBTOTAL 3	CONSTRUCTION	577503	18191352	0	13927071	930620	0	10430843	43479886
411	CONST MGT - INITIAL PHASE	0	0	0	0	3200000	0	0	3200000
412	CONST MGT - DEFERRED PHASE	0	0	0	0	2700000	0	0	2700000
SUBTOTAL 4	CONSTRUCTION MANAGEMENT	0	0	0	0	5900000	0	0	5900000
511	PROJ MGT - INITIAL PHASE	0	0	0	0	3200000	0	0	3200000
512	PROJ MGT - DEFERRED PHASE	0	0	0	0	2700000	0	0	2700000
SUBTOTAL 5	PROJECT MANAGEMENT	0	0	0	0	5900000	0	0	5900000
PROJECT TOTAL		577,503	18,191,352	0	13,927,071	28,230,620	28,620,685	11,861,878	100,831,606

FLUOR DANIEL INC.
WESTINGHOUSE HANFORD COMPANY
JOB NO. 436305

** TEST - INTERACTIVE ESTIMATING **
STAGING AND STORAGE FACILITY
CONCEPT 2 ALTERNATE A
DOE_R02 - WORK BREAKDOWN STRUCTURE SUMMARY

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TABLE A2-5

WBS	DESCRIPTION	ESTIMATE	ONSITE INDIRECTS	SUB TOTAL	ESCALATION %	SUB TOTAL	CONTINGENCY %	TOTAL DOLLARS
110	CONCEPTUAL/ADVANCED CONCEPTUAL DESN	2300000	0	2300000	1.59	36570	15	2336570
120	DETAILED DESIGN	9000000	0	9000000	3.29	296100	15	9296100
130	TITLE III ENGR - INITIAL PHASE	3200000	0	3200000	6.25	200000	15	3400000
132	TITLE III INSP - INITIAL PHASE	3200000	0	3200000	6.25	200000	15	3400000
	SUBTOTAL 1 ENGINEERING	17700000	0	17700000	4.14	732670	15	18432670
210	RAIL TUNNEL/CASK UNLOAD/MCO SERVICE	3382118	0	3382118	6.67	225588	30	3607706
230	VAULTS AND INLET/EXHAUST PLENUMS	45985724	0	45985724	6.67	3067248	15	49052972
240	POOL WTR COOLING & INST AIR COMP	91911	0	91911	6.67	6131	30	98042
250	HVAC/OFFICE/GENERATOR//EQUIP BLDG	3600574	0	3600574	6.67	240159	15	3840733
260	HVAC MECHANICAL ROOM	152807	0	152807	6.67	10192	30	162999
	SUBTOTAL 2 PROCUREMENT	53213134	0	53213134	6.67	3549318	16	56762452
310	RAIL TUNNEL/CASK UNLOAD/MCO SERVICE	2445312	0	2445312	6.25	152832	30	2598144
330	VAULTS AND INLET/EXHAUST PLENUMS	20228401	0	20228401	6.25	1264274	15	21492675
340	POOL WTR COOLING & INST AIR COMP	684567	0	684567	6.25	42785	30	727352
350	HVAC/OFFICE/GENERATOR//EQUIP BLDG	1421807	0	1421807	6.25	88864	15	1510671
360	HVAC MECHANICAL ROOM	1302607	0	1302607	6.25	81413	30	1384020
370	SITE SUPPORT	1416945	0	1416945	6.25	88559	15	1505504
	SUBTOTAL 3 CONSTRUCTION	27499639	0	27499639	6.25	1718727	17	29218366
411	CONST MGT - INITIAL PHASE	6500000	0	6500000	6.25	406250	15	6906250
	SUBTOTAL 4 CONSTRUCTION MANAGEMENT	6500000	0	6500000	6.25	406250	15	6906250
511	PROJ MGT - INITIAL PHASE	6500000	0	6500000	5.02	326300	15	6826300
	SUBTOTAL 5 PROJECT MANAGEMENT	6500000	0	6500000	5.02	326300	15	6826300
	PROJECT TOTAL	111,412,773	0	111,412,773	6.04	6,733,265	16	118,146,038
								19,008,647
								137,154,682

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TABLE A2-6

FLUOR DANIEL INC.
WESTINGHOUSE HANFORD COMPANY
JOB NO. 436305

** TEST - INTERACTIVE ESTIMATING **
STAGING AND STORAGE FACILITY
CONCEPT 2 ALTERNATE A
S1 - ESTIMATE SUMMARY BY WBS

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WBS	DESCRIPTION	MANHOURS	LABOR	EQUIP USAGE	MATERIAL	SUB- CONTRACT	EQUIPMENT	OVERHEAD & PROFIT	TOTAL DOLLARS
=====	=====	=====	=====	=====	=====	=====	=====	=====	=====
110	CONCEPTUAL/ADVANCED CONCEPTUAL DESM	0	0	0	0	2300000	0	0	2300000
120	DETAILED DESIGN	0	0	0	0	9000000	0	0	9000000
130	TITLE III ENGR - INITIAL PHASE	0	0	0	0	3200000	0	0	3200000
132	TITLE III INSP - INITIAL PHASE	0	0	0	0	3200000	0	0	3200000
SUBTOTAL 1	ENGINEERING	0	0	0	0	17700000	0	0	17700000
210	RAIL TUNNEL/CASK UNLOAD/MCO SERVICE	0	0	0	0	0	3221064	161054	3382118
230	VAULTS AND INLET/EXHAUST PLENUMS	0	0	0	0	0	43795928	2189796	45985724
240	POOL WTR COOLING & INST AIR COMP	0	0	0	0	0	87534	4377	91911
250	HVAC/OFFICE/GENERATOR//EQUIP BLDG	0	0	0	0	0	3429118	171456	3600574
260	HVAC MECHANICAL ROOM	0	0	0	0	0	145530	7277	152807
SUBTOTAL 2	PROCUREMENT	0	0	0	0	0	50679174	2533960	53213134
310	RAIL TUNNEL/CASK UNLOAD/MCO SERVICE	33640	1059660	0	735196	47340	0	603116	2445312
330	VAULTS AND INLET/EXHAUST PLENUMS	305254	9615502	0	5253981	0	0	5358918	20228401
340	POOL WTR COOLING & INST AIR COMP	10700	337050	0	160838	0	0	186679	684567
350	HVAC/OFFICE/GENERATOR//EQUIP BLDG	20600	648900	0	408562	0	0	364345	1421807
360	HVAC MECHANICAL ROOM	17610	554715	0	432278	0	0	315614	1302607
370	SITE SUPPORT	5615	176874	0	166399	883280	0	190392	1416945
SUBTOTAL 3	CONSTRUCTION	393419	12392701	0	7157254	930620	0	7019064	27499639
411	CONST MGT - INITIAL PHASE	0	0	0	0	6500000	0	0	6500000
SUBTOTAL 4	CONSTRUCTION MANAGEMENT	0	0	0	0	6500000	0	0	6500000
511	PROJ MGT - INITIAL PHASE	0	0	0	0	6500000	0	0	6500000
SUBTOTAL 5	PROJECT MANAGEMENT	0	0	0	0	6500000	0	0	6500000
PROJECT TOTAL		393,419	12,392,701	0	7,157,254	31,630,620	50,679,174	9,553,024	111,412,773

APPENDIX 3

OTHER ALTERNATIVES

During review of the draft of this report, interest was expressed in other alternatives which were not constrained by the Design Basis given in Appendix 1. In particular, it was indicated that it was possible that the 50°F MCO temperature limit prior to stabilization could be relaxed. If this temperature were relaxed to about 100°F, it would be possible to store the MCOs in dry Corten storage tubes cooled by refrigerated air (Concept 2). If this temperature were relaxed to about 185-230°F, it would be possible to store the MCOs in dry Corten storage tubes cooled by natural circulation of ambient air (Concept 3). Relaxing the MCO temperature limit prior to stabilization would not have any significant affect on the design or cost of the water cooled alternatives (Concept 1).

In order to permit evaluation of these other alternatives against those previously studied, ROM cost estimates were developed for the following additional alternatives:

Alternative 2C. This alternative is the same as Alternative 2A (660 storage tubes) except that the storage tubes are not filled with water, allowing Corten to be used, which results in an MCO temperature of about 100°F when cooled with 35°F refrigerated air. Table A3-1 shows the relationship between MCO water temperature and refrigerated air flow rate for this alternative.

Alternative 2D. This Alternative is the same as Alternative 2C except that storage tubes are installed in only two of the three vaults, resulting in a total of 440 storage tubes. The number of storage tubes in two vaults could be increased to 512 using the same configuration as for Alternative 1B, but the cost of this was not evaluated. The MCO temperature would be about the same as for Alternative 2C (about 100°F).

Alternative 2E. This alternative is the same as Alternative 2A except that storage tubes are installed in only two of the three vaults, resulting in a total of 440 storage tubes. As above, the number of storage tubes in two vaults could be increased to 512. The MCO temperature would be about the same as for Alternative 2A (about 50°F).

Alternative 3A. This alternative is the same as Alternative 2C (660 storage tubes) except that cooling is by natural circulation of ambient air. This results in a fuel temperature of about 185°F if the MCO is filled with water or about 230°F if the MCO is not filled with water (damp) when the ambient air temperature is 115°F.

Alternative 3B. This alternative is the same as Alternative 3A except that storage tubes are installed in only two of the three vaults, resulting in a total of 440 storage tubes. As above, the number of storage tubes in two vaults could be increased to 512. The MCO temperature would be about the same as for Alternative 3A (about 185-230°F).

A comparison of the capital costs of the above alternatives against those previously presented is contained in Table A3-2. This table shows that relaxing the MCO temperature prior to stabilization to about 100°F, can enable the capital cost of the refrigerated air cooled alternatives to fall below that of the comparable water cooled alternatives. Further relaxation of the MCO temperature prior to stabilization to 185-230°F, allows the use of natural circulation cooling resulting in additional reductions in the capital cost of the facility.

Schedules for the above Concept 1 and 2 alternatives would be the same as those shown in Section 8. Figure A3-1 shows the schedule for Alternatives 3A and 3B and indicates that they could be operational by December 1997.

Cash flow requirements for the above alternatives are indicated in Tables A3-3 through A3-7. These cash flow requirements are compared with those for the previously defined alternatives in Figures A3-2 through A3-5.

The comparative safety evaluation of Concepts 1 and 2 contained in Section 6.3 generally applies to the new Concept 2 alternatives (2C, 2D and 2E) defined in this section. A comparative safety evaluation with Concept 3 has not been performed, but many of the comments made in comparing Concept 1 to Concept 2 would apply in comparing Concept 1 to Concept 3 as well. In addition, there are many unknowns regarding the behavior of metallic fuels in wet or damp storage at elevated temperature which have to be resolved for Concept 3.

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TABLE A3-1
ALTERNATIVE 2C MCO TEMPERATURES

MCO WATER TEMP. (°F)	SUPPLY AIR QUANTITY (CFM)	SUPPLY AIR TEMP. TO VAULT (°F)	REMARKS
100	75,000	35	AIR FILLED TUBES
97	100,000	35	AIR FILLED TUBES
94	150,000	35	AIR FILLED TUBES
92	200,000	35	AIR FILLED TUBES

NOTES:

1. Data Based on 1200 MCO's.

TABLE A3-2 SSF CAPITAL COST COMPARISON

	1B 1 Pool @ 50- 2 Vaults Corten Tubes	1C 1 Pool @ 50- 3 Vaults Corten Tubes	2A 50°F Refrig Air 3 Vaults SS Tubes	2C 100°F Refrig Air 3 Vaults Corten Tubes	2D 100°F Refrig Air 3 Vaults, 1 Empty Corten Tubes	2E 50°F Refrig Air 3 Vaults, 1 Empty SS Tubes	3A 185-230°F 3 Vaults Mat Circ Corten Tubes	3B 185-230°F 3 Vaults 1 Empty Mat Circ Corten Tubes
Load In / Load Out	4,819	4,819	6,604	6,604	6,604	6,604	6,604	6,604
Infrastructure	1,417	1,417	1,417	1,417	1,417	1,417	1,417	1,417
Vault	<u>56,213</u>	<u>67,296</u>	<u>72,692</u>	<u>47,886</u>	<u>41,246</u>	<u>57,823</u>	<u>46,431</u>	<u>39,793</u>
Total Direct Const \$ (1995)	62,449	73,532	80,713	55,907	49,267	65,844	54,452	47,814
Engineering	13,000	13,000	14,500	10,400	10,400	14,500	10,000	10,000
Title III Inspection	2,500	2,500	3,200	2,200	2,200	3,200	2,200	2,200
Construction Management	5,000	5,900	6,500	4,500	4,000	5,300	4,400	3,800
Project Management	<u>5,000</u>	<u>5,900</u>	<u>6,500</u>	<u>4,500</u>	<u>4,000</u>	<u>5,300</u>	<u>4,400</u>	<u>3,800</u>
Total, 1995 \$	87,949	100,832	111,413	77,507	69,867	94,144	75,452	67,614
Escalation	10,381	13,632	6,733	4,638	4,145	5,611	4,522	4,017
Contingency	<u>16,622</u>	<u>19,042</u>	<u>19,009</u>	<u>13,609</u>	<u>12,388</u>	<u>16,250</u>	<u>13,051</u>	<u>11,800</u>
Total Estimated Cost (TEC)	114,952	133,506	137,155	95,754	86,400	116,005	93,025	83,431

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TABLE A3-3
STAGING & STORAGE FACILITY
CONCEPT 2 ALTERNATIVE C
\$ EXPENDITURE - FY ESCALATED (\$ X 1000)

09-Mar-95

DESCRIPTION	TOTAL	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003
ENGINEERING/DESIGN	12398	1812	8832	1754						
TITLE 3 INSP SERVICES	2688		934	1754						
PROCUREMENT PROCUREMENT	35,481		2,681	32,800						
CONSTRUCTION CONSTRUCTION	34,255		6,551	27,704						
CONSTRUCTION MGMT CM	5,498		2,188	2,870	440					
PROJECT MGMT PM	5,434	817	2,071	2,071	475					
TOTAL	95,754	2,629	23,257	68,953	915					

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TABLE A3-4
STAGING & STORAGE FACILITY
CONCEPT 2 ALTERNATIVE D
\$ EXPENDITURE - FY ESCALATED (\$ X 1000)

09-Mar-95

DESCRIPTION	TOTAL	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003
ENGINEERING/DESIGN	12,398	1,812	8,832	1,754						
TITLE 3 INSP SERVICES	2,688		934	1,754						
PROCUREMENT PROCUREMENT	28,882		2,182	26,700						
CONSTRUCTION CONSTRUCTION	32,714		6,257	26,457						
CONSTRUCTION MGMT CM	4,887		1,945	2,551	391					
PROJECT MGMT PM	4,831	726	1,841	1,841	423					
TOTAL	86,400	2,538	21,991	61,057	814					

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TABLE A3-5
STAGING & STORAGE FACILITY
CONCEPT 2 ALTERNATIVE E
\$ EXPENDITURE - FY ESCALATED (\$ X 1000)

09-Mar-95

DESCRIPTION	TOTAL	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003
ENGINEERING/DESIGN	17,288	2,604	12,133	2,552						
TITLE 3 INSP SERVICES	3,910		1,359	2,552						
PROCUREMENT PROCUREMENT	49,165		3,715	45,450						
CONSTRUCTION CONSTRUCTION	32,767		6,267	26,500						
CONSTRUCTION MGMT CM	6,475		2,577	3,380	518					
PROJECT MGMT PM	6,400	962	2,439	2,439	560					
TOTAL	116,005	3,566	28,489	82,872	1,078					

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TABLE A3-6
STAGING & STORAGE FACILITY
CONCEPT 3 ALTERNATIVE A
\$ EXPENDITURE - FY ESCALATED (\$ X 1000)

09-Mar-95

DESCRIPTION	TOTAL	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003
ENGINEERING/DESIGN	11,922	1,812	8,380	1,730						
TITLE 3 INSP SERVICES	2,688		958	1,730						
PROCUREMENT PROCUREMENT	35,269		2,665	32,604						
CONSTRUCTION CONSTRUCTION	32,456		6,641	25,815						
CONSTRUCTION MGMT CM	5,376		2,183	2,864	329					
PROJECT MGMT PM	5,314	811	2,055	2,055	393					
TOTAL	93,025	2,623	22,882	66,798	722					

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TABLE A3-7
STAGING & STORAGE FACILITY
CONCEPT 3 ALTERNATIVE B
\$ EXPENDITURE - FY ESCALATED (\$ X 1000)

09-Mar-95

DESCRIPTION	TOTAL	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003
ENGINEERING/DESIGN	11,922	1,812	8,380	1,730						
TITLE 3 INSP SERVICES	2,688		958	1,730						
PROCUREMENT PROCUREMENT	28,671		2,166	26,505						
CONSTRUCTION CONSTRUCTION	30,917		6,326	24,591						
CONSTRUCTION MGMT CM	4,643		1,886	2,473	284					
PROJECT MGMT PM	4,590	700	1,775	1,775	340					
TOTAL	83,431	2,512	21,491	58,804	624					

FIGURE A3-2 CSB ADAPTATION COMPARISONS

2 VAULT OPTION HISTOGRAMS PROGRAM COSTS (\$ MILLIONS)

▨ CASE 1B POOL 50F

▤ CASE 2D REFRIG 100F

▩ CASE 2E REFRIG 50F

▣ CASE 3B NAT CIRC 200F+

FIGURE A3-3
CSB ADAPTATION COMPARISONS

**2 VAULT OPTION CASH FLOWS
PROGRAM COSTS (\$ MILLIONS)**

FIGURE A3-4 CSB ADAPTATION COMPARISONS

3 VAULT OPTION HISTOGRAMS PROGRAM COSTS (\$ MILLIONS)

▢ CASE 1C POOL 50F

▤ CASE 2A REFRIG 50F

▥ CASE 2C REFRIG 100F

▧ CASE 3A NAT CIRC 200F+

CSB ADAPTATION COMPARISONS

FIGURE A3-5

3 VAULT OPTION CASH FLOWS
 PROGRAM COSTS (\$ MILLIONS)