July 1996

Conceptual Design Report for the ICPP Spent Nuclear Fuel Dry Storage Project

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**Conceptual Design Report for the
ICPP Spent Nuclear Fuel
Dry Storage Project**

Published July 1996

**Idaho National Engineering Laboratory
INEL Spent Nuclear Fuel Program
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Idaho Falls, Idaho 83415**

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ABSTRACT

The conceptual design is presented for a facility to transfer spent nuclear fuel from shipping casks to dry storage containers, and to safely store those containers at the Idaho Chemical Processing Plant at the Idaho National Engineering Laboratory. The spent fuels to be handled at the new facility are identified and the overall design and operating criteria are established. The physical configuration of the facility and the systems used to handle the SNF are described. A detailed cost estimate for the design and construction of the facility is presented.

EXECUTIVE SUMMARY

This report presents the technical approach, schedule, and estimated cost for designing and constructing a facility at the Idaho Chemical Processing Plant (ICPP) that will transfer spent nuclear fuel (SNF) from shipping casks into dry storage containers and provide interim dry storage of the SNF.

The Department of Energy entered into an agreement with the State of Idaho to place SNF into dry storage at the Idaho National Engineering Laboratory (INEL). The facility, as described in this report, is an essential means of implementing that agreement by providing the capability to receive, transfer, and store selected SNF. The concepts presented in this report will support the initial movement of SNF into dry storage by the commitment date of July 1, 2003. The design life of the facility is several decades, which also supports the agreements related to completion of SNF transfer activities.

Significant design requirements and assumptions are as follows:

- The facility is to be designed in accordance with 10 CFR 72 and the implementing standard ANSI/ANS 57.9
- The facility is to be designed to handle a wide variety of fuel configurations received in an undefined sequence
- The facility is to be used only for handling intact or canned fuel, i.e., all fuel received at the facility will be contained within an intact confinement boundary.

Several alternatives were considered and screened in order to settle on the selected concept. Design options included (1) upgrading and using the Test Area North (TAN) Hot Shop; (2) designing, constructing, and using a new, stand-alone shielded facility; (3) designing, constructing, and using a new, stand-alone, bermed, remote facility; (4) using the FAST pools for wet loading; and (5) using some existing cask handling capability at the FAST facility and performing packaging operations in a new facility added to FAST. On the basis of life cycle cost, compatibility with planned operations at the ICPP, and a conservative approach to initial project planning, a new, stand-alone, shielded facility was selected as the concept to be developed during this design stage.

The concept for the SNF Dry Storage Facility (DSF) includes two structures: a Dry Transfer Cell (DTC) for receiving, transferring, and packaging the SNF; and a Dry Storage System (DSS) for storing the SNF. The DSS includes SNF storage packages, transfer equipment, aboveground storage pad, and shielded storage modules. These are described below.

The DTC contains an Administrative Area, Utility Support Area, Cask Handling Bay, Cask Preparation Area, and Hot Cell.

The Administrative Area contains typical office and support functions.

The Cask Handling Bay includes the equipment and space in which shipping casks are received, unloaded from their transport vehicle, and placed vertically on an electrically driven trolley for transfer

into the rest of the facility. All subsequent cask operations are performed while the cask remains on the trolley. The Cask Handling Bay is also used for loading filled transfer casks onto the onsite transfer trailer.

A shipping cask is moved into the Cask Preparation Area on the trolley, the outer lids are removed, gas samples are taken from the cask cavity, and preparation is made to move the cask into the Hot Cell for fuel unloading and transfer. The Cask Preparation Area is used to prepare the shipping cask for return to the shipping facility. These operations include inspection and cleaning, replacement of cask lids, and leak testing before shipping. The Cask Preparation Area is also used for welding the lids on the SNF storage canisters after they are loaded in the Hot Cell.

The final part of the DTC is the Hot Cell, a heavily shielded cell into which the shipping cask, still on the trolley, is moved for unloading and transfer. Personnel entry into the Hot Cell is made for final cask preparation, placement of contamination barriers, and equipment maintenance. The fuel is transferred from the shipping cask using a remotely operated crane with a suite of end effectors that can manipulate a wide variety of SNF configurations. The fuel is transferred to one of four lag storage vaults for temporary storage until an appropriate inventory of SNF is accumulated to fill a Dual-Purpose Canister (DPC).

When sufficient fuel is accumulated, a DPC is brought through the Cask Preparation Area (on a trolley and in a vertically oriented transfer cask) and into the Hot Cell. Fuel is transferred from the lag storage vaults into the DPC, while the DPC remains in the transfer cask. When the DPC is full, its shield plug is inserted. The DPC is then moved back through the Cask Preparation Area where the DPC internal cavity is purged and backfilled with inert gas. Two lids are welded in place using an automatic welding machine. The transfer cask with sealed DPC is then moved into the Cask Handling Area.

In the Cask Handling Area, the transfer cask is loaded onto the on-Site transfer trailer, rotated into a horizontal orientation, and towed to the storage area.

In addition to the transfer equipment, the DSS includes a concrete basemat, asphalt driveways, and shielded storage modules. Based on an assessment of a previous study of a preferred storage configuration, the NUHOMS® horizontal dry storage system will be utilized. In this concept, the dry storage canister in the transfer cask is moved into alignment with a storage module that contains a cavity into which the DPC is pushed using a hydraulic ram mounted on the transfer vehicle. A shield door is lowered over the cavity opening and the DPC is in interim storage.

A study was performed to determine the best location for siting the DTC and DSS based on design requirements, land use/zoning/site development, environmental impact, available space, and utilities. The proposed site is southeast of CPP-666 (FAST) and is within the current ICPP plant perimeter fencing.

The Total Estimated Cost (TEC) is approximately \$41M for the DTC and \$59M for the DSS. The \$59M for the DSS includes the cost of DPCs and storage modules for about half of the SNF that is described in this report. Additional SNF could be accommodated with the procurement of additional

DPCs and storage modules and the expansion of the storage area. The capability for such expansion is included in the design.

The schedule for this project assumes that it will be a FY 1998 Line Item. Title Design will take approximately 20 months beginning in January 1998, and construction will be performed from January 2000 to January 2002. Facility operation will start at the end of FY-2002.

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ACRONYMS

A-E	Architect-Engineer
CAM	Constant Air Monitors
CCTV	Closed Circuit Television
CMAA	Crane Manufacturers Association of America
CMU	concrete masonry units
DHB	Dry Handling Bucket
DOE	Department of Energy
DPC	Dual-Purpose Canister
DSC	Dry Shielded Canisters
DSF	Dry Storage Facility
DSS	Dry Storage System
DTC	Dry Transfer Cell
ED&I	engineering, design, and inspection
EPA	Environmental Protection Agency
FAST	Fluorinel Dissolution Process and Fuel Storage
FDP	Fluorinel Dissolution Process
FSR	Feasibility Study Reports
FSVR	Fort St. Vrain Reactor
GFE	government-furnished equipment
GMAW	gas-metal-arc-welding
HSM	horizontal storage module
ICPP	Idaho Chemical Processing Plant

INEL	Idaho National Engineering Laboratory
IPDT	Integrated Product Development Team
ISFSI	Independent Spent Fuel Storage Installation
LAN	Local Area Network
LWBR	light water breeder reactor
MCC	Motor Control Center
OBE	Operating Basis Earthquake
OCRWM	Office of Civilian Radioactive Waste Management
OPC	other project cost
PDC	Project Design Criteria
PEP	Project Execution Plan
PEW	process equipment waste
RAM	Radiation Area Monitors
RCRA	Resource Conservation and Recovery Act
SCADA	Supervisory Control and Data Acquisition
SNF	spent nuclear fuel
SSE	Safe Shutdown Earthquake
TAN	Test Area North
TEC	Total Estimated Cost
TMI	Three Mile Island
TPC	Total Project Costs
UPS	uninterruptable power supply

Conceptual Design Report for the ICPP Spent Nuclear Fuel Dry Storage Project

1. INTRODUCTION

This Conceptual Design Report presents the conceptual design of a facility to transfer spent nuclear fuel (SNF) from U.S. Department of Energy (DOE) shipping casks into dual-purpose canisters (DPCs) and to place those canisters into dry storage at the Idaho Chemical Processing Plant (ICPP) at the Idaho National Engineering Laboratory (INEL). The facility is referred to as the Dry Storage Facility (DSF) and includes one building, referred to as the Dry Transfer Cell (DTC), in which the SNF is received and transferred into the DPCs and a storage area (the Dry Storage System) for storing the loaded DPCs.

The Department of Energy and the State of Idaho entered into an agreement (see Reference 1 for applicable details) to place INEL SNF into dry storage by 2023. Dry storage of SNF is operationally simpler and less costly than storage in water-filled pools. Also, dry storage facilities can be readily designed for safe storage durations of several decades. This is sufficient time for implementing decisions on final disposition of SNF and is a substantially longer period of time than is practical in many of the storage pools in which SNF is currently stored. The fuel is to be stored in a configuration suitable for off-site shipment as part of an NRC-licensed shipping package, and also suitable for long-term storage in a repository or monitored retrievable storage facility. According to the agreement, placement of selected SNF into dry storage is to start by July 2003. The facility described in this report will be used to package and store some of the DOE spent nuclear fuel that is currently residing in aging or filled storage facilities located at the INEL, other DOE laboratories, universities, and foreign research reactor facilities. The facility concept supports initial operation by 2003.

The fuel that will be packaged in the DTC and stored in the DSS was selected out of a comprehensive inventory of DOE SNF. A significant criterion for the selection of the fuel was that it be contained in a relatively sound first boundary of stainless steel or zirconium, (either fuel cladding or a "can") that separates the actual fuel material from the handling environment. The selection process was essentially one of elimination with the following SNF eliminated from the full list:

- Naval fuel—it will be managed by other efforts.
- SNF located at the INEL Test Area North (TAN)—this fuel will be packaged using existing equipment in the TAN Hot Shop and is expected to be in dry storage before the new facility is in operation.
- Sodium-bonded fuel—this requires additional treatment before it can be put into interim storage.
- SNF whose primary containment (cladding or can) are significantly degraded—this fuel will require handling in a suitable facility to package it in a sound first containment.

The resulting SNF to be handled in the Dry Storage Facility is identified and briefly described in Table 1-1. As may be noted by the absence of entries for some of the fuels, additional information will be required to support the identification of the final inventory to be handled. The preliminary schedule for receiving and placing that fuel into storage is presented in Table 1-2. As shown in Table 1-2, the SNF is currently located at the INEL and at facilities throughout the world. It is not expected that the SNF Dry Storage Project will have significant influence on the schedule of shipments from most off-Site locations. However, it is assumed that the shipment of on-Site SNF will be controlled by this project and that campaigns of fuel shipments from ICPP facilities will be scheduled to support efficient operations in the DTC. Appendix A documents a study performed to determine what equipment and processes will be needed to support efficient transfer of fuel from the FAST Facility to the DTC.

A storage concept that is considered highly reliable and cost effective is the placing of the SNF in sealed, shielded containers that are stored on a concrete basemat aboveground. This is an approach being adopted by the commercial nuclear power industry as reactor facility operators consume available space in their water-filled storage pools. In the selected concept, SNF is contained within two independent barriers to prevent the release of any radioactive materials during the life of the storage operation. The SNF, either contained in its intact cladding or in sealed cans is placed in steel DPCs (roughly 5 ft in diameter and 16 ft long). After the SNF is loaded, the canisters are sealed and placed in concrete vaults on a storage basemat. The vaults provide the radiological shielding required to reduce radiation fields to levels that ensure worker safety. The concrete also serves as a barrier to natural phenomena such as tornados and earthquakes. Cooling to dissipate decay heat from the SNF is achieved with natural convection cooling through air flow paths in the shielding vaults.

The arrangement of fuel within the DPCs was analyzed to ensure criticality safety, adequate heat removal capability, and adequate radiation shielding to provide storage through the year 2035 with assurance that the public, storage facility operations personnel, and the environment will all be protected from potential radiological hazards. Figure 1-1 illustrates a workable DPC loading of the specific SNF to be stored. This figure shows the distribution of SNF in the DPCs assuming that different types of fuel are generally not stored in the same DPC. More efficient use of the storage volume could be achieved if fuel types were mixed in some of the DPCs. Additional studies will be performed during later design stages to optimize DPC loading.

The specific configuration of the storage system was selected during the feasibility study documented in Reference 2. While other configurations could be used, the selected NUHOMS® horizontal storage method is considered the most cost effective at this time.

It is intended that the DSF will be licensed by the U.S. Nuclear Regulatory Commission. To this end, the facility will be designed in accordance with the guidance in ANSI/ANS 57.9, *Design Criteria for an Independent Spent Fuel Storage Installation (Dry Type)*, which implements Title 10, "Energy," Code of Federal Regulations, Part 72, "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High Level Radioactive Waste" (10 CFR 72). In general, the requirements of these documents have taken precedence over other requirements that have historically been imposed on INEL projects. Additionally, the DPC and its internal packaging must be designed and ultimately licensed for transport and final storage.

This report comprises ten sections (with the introduction) and several appendices.

Section 2 summarizes the most important design criteria and assumptions used to guide the facility design. No detailed requirements are contained in an appendix.

Section 3 starts with a description of the flow of SNF from receipt to placement into storage. It provides a broad overview of the facility features and capabilities. The remaining parts of Section 3 contain descriptions of the major systems that are contained in the facility. The specific operational requirements, functions, and physical descriptions are discussed.

Section 4 identifies the primary Codes and Standards that are applicable to the various facility systems. As the design becomes more detailed, additional codes and standards will be identified.

Section 5 describes the preliminary acquisition strategy, or the approach to be followed in developing the Title design and proceeding into construction.

Section 6 describes the alternative technical approaches that were considered in selecting the one to be developed in the conceptual design effort. A structured process was used to identify potential alternatives and to evaluate those alternatives against specified criteria to determine which concept was most appropriate for development.

Section 7 identifies a number of uncertainties that were identified during the conceptual design. In general, these uncertainties impart a level of risk to the validity of the design and the accuracy of the cost estimate. Those risks, and a description of actions that could be undertaken to address them are included in this section.

Section 8 is the summary level schedule for the project. It illustrates the sequence and timing of events that will occur to ensure the milestones agreed to by DOE and the State of Idaho will be met.

Section 9 summarizes the cost estimate and describes the key considerations made in developing the estimate. Details are included in an appendix.

Section 10 lists the primary references used in support of the design and the design criteria.

Several appendices include more detailed design criteria, studies and analyses performed to develop and confirm the design, and preliminary drawings of the facility and major equipment.

Table 1-1. SNF to be handled and canned in the DTC.

SNF Name	FHU* 2035	Height (in.)	Width (in.)	Length (in.)	DHB ^b Length	DHB Cells	Layers/ DHB	FHU/ DHB	DHBs	FHU per DPC	NUHOMS* DPC & Loading	No. of DPCs
ACRR ELEMENTS	256	TBD	TBD	TBD				0	TBD			1.00
ACRR EXPERIMENTS	1	TBD	TBD	TBD				0	TBD			*
ARKANSAS	3	TBD	TBD	TBD				0	TBD			*
CANDU *	3		5.00	168.0	1	NA	1	NA	NA	52	BWR DPC, 1 layer	0.00
CANDU *	3	TBD	3.50	12.0	4	7	3	21	1.00	1176	14-Tube, 12 layers	0.00
CP-5 CONVERTER CYLINDER	2	TBD	TBD	TBD				0	TBD			*
DRESDEN *	23	4.40	4.40	135.0	1	2	1	2	12.00	28	14-Tube, 1 layer	0.00
DRESDEN *	1	4.40	4.40	135.0	1	2	1	2	1.00	28	14-Tube, 1 layer	0.00
DRESDEN *	4	4.40	4.40	135.0	1	2	1	2	2.00	28	14-Tube, 1 layer	0.00
DRESDEN I REACTOR FUEL	2	TBD	TBD	TBD				0	TBD			*
FRR/TRIGA ***	4940	0.00	1.48	30.00	4	24	1	24	206.00	1344	14-Tube, 5 layers	3.00
FSVR	744	16.32	14.17	31.22	NA	NA	NA	NA	NA	35	FSV Basket/special 103" lg fuel bucket.	21.26
PATHFINDER	7	9.62	9.62	84.00	1.62	1	1	1	7.00	7	FSV Basket	0.62
PBF DRIVER CORE	60		8.63	60.00	1.25	1	2	2	30.00	28	14-Tube DPC, 3 layers	1.71
PULSTAR - BUFFALO	24	3.00	3.00	28.00	5	5	1	5	5.00	350	14-Tube DPC, 4 layers	0.07
PULSTAR-N.C. STATE UNIV.	34	2.74	3.15	37.98	1.25	5	3	15	3.00	263	14-Tube, 4 layers	0.13
PULSTAR-SUNY-BUFFALO	43	2.74	3.15	38.00	1.25	5	3	15	3.00	263	14-Tube, 4 layers	0.16
SHIPPINGPORT LWBR	48	TBD	25.50	158.0	NA	NA	1	NA	NA	3	Three, 25.57 in. dia cans per special DPC basket	16.00
SHIPPINGPORT PWR-C1-S4	1	5.5**	5.5**	104.5	1.25	1	1	1	1.00	14	14-Tube, 1 layer	0.06
SHIPPINGPORT PWR-C2-S1	19	7.38	7.38	104.5	1.25	1	1	1	19.00	14	14-Tube, 1 layer	1.09
SHIPPINGPORT PWR-C2-S2	20	7.38	7.38	104.5	1.25	1	1	1	20.00	14	14-Tube, 1 layer	1.14
TREAT	390	3.96	3.96	96.00	1.25	4	1	4	98.00	56	14-Tube, 1 layer	5.57
TRIGA BER-II (GERMANY)	21	3.15	2.99	36.80	4	5	1	5	4.20	280	14-Tube, 4 layers	0.08
TRIGA CONV. PENN STATE	241	TBD	1.48	28.31	5	24	1	24	10.04	1680	14-Tube, 5 layers	0.14
TRIGA CONV./ARRR	91	TBD	1.38	28.37	5	24	1	24	3.79	1680	14-Tube, 5 layers	0.05
TRIGA FLIP *	2	TBD	3.80	30.00	4	4	1	4	0.50	224	14-Tube DPC, 5 layers	0.01
TRIGA FLIP/OSU	91	TBD	1.48	28.58	5	24	1	24	3.79	1680	14-Tube, 5 layers	0.05
TRIGA FLIP/TEXAS A & M	101	TBD	1.48	30.00	4	24	1	24	4.21	1344	14-Tube, 5 layers	0.08
TRIGA FLIP/U.OF WI	101	TBD	1.48	30.00	4	24	1	24	4.21	1344	14-Tube, 5 layers	0.08
TRIGA FLIP/WASH.STATE UNI	78	TBD	1.48	30.00	4	24	1	24	3.25	1344	14-Tube, 5 layers	0.06
TRIGA SST	296	TBD	1.48	28.31	5	24	1	24	12.33	1680	14-Tube, 5 layers	0.18
TRIGA UNIV. OF ILLINOIS	305	TBD	1.48	28.31	5	24	1	24	12.71	1680	14-Tube, 5 layers	0.18

Table 1-1. (Continued).

SNF Name	FHU ^a 2035	Height (in.)	Width (in.)	Length (in.)	DHB ^b Length	DHB Cells	Layers/ DHB	FHU/ DHB	DHBs	FHU per DPC	NUHOMS [®] DPC & Loading	No. of DPCs
TRIGA-CORNELL	165	TBD	1.48	28.31	5	24	1	24	6.88	1680	14-Tube, 5 layers	0.10
TRIGA-FLIP	61	TBD	1.48	30.00	4	24	1	24	2.54	1344	14-Tube, 5 layers	0.05
TRIGA-FLIP/GA	117	TBD	1.48	30.00	4	24	1	24	4.88	1344	14-Tube, 5 layers	0.09
TRIGA/AFRRI	95	TBD	1.48	28.31	5	24	1	24	3.96	1680	14-Tube, 5 layers	0.06
TRIGA/DOW	78	TBD	1.48	28.31	5	24	1	24	3.25	1680	14-Tube, 5 layers	0.05
TRIGA/GA	155	TBD	1.48	28.31	5	24	1	24	6.46	1680	14-Tube, 5 layers	0.09
TRIGA/KANSAS STATE UNIV.	191	TBD	1.48	28.31	5	24	1	24	7.96	1680	14-Tube, 5 layers	0.11
TRIGA/MCCLELLAN AFB	90	TBD	1.48	28.31	5	24	1	24	3.75	1680	14-Tube, 5 layers	0.05
TRIGA/OSU	99	TBD	1.48	28.31	5	24	1	24	4.13	1680	14-Tube, 5 layers	0.06
TRIGA/REED COLLEGE	67	TBD	1.48	28.31	5	24	1	24	2.79	1680	14-Tube, 5 layers	0.04
TRIGA/TEXAS A & M	85	TBD	1.48	28.31	5	24	1	24	3.54	1680	14-Tube, 5 layers	0.05
TRIGA/TEXAS A & M	28	TBD	0.00	0.00	5	24	1	24	1.17	1680	14-Tube, 5 layers	*
TRIGA/UNIV. OF ARIZONA	98	TBD	1.47	28.47	5	24	1	24	4.08	1680	14-Tube, 5 layers	0.06
TRIGA/UNIV. OF MARYLAND	186	TBD	1.48	28.31	5	24	1	24	7.75	1680	14-Tube, 5 layers	0.11
TRIGA/UNIV. OF UTAH	225	TBD	1.48	28.31	5	24	1	24	9.38	1680	14-Tube, 5 layers	0.13
TRIGA/UNIV. OF WISCONSIN	127	TBD	1.48	28.31	5	24	1	24	5.29	1680	14-Tube, 5 layers	0.08
TRIGA/UNIV. OF WISCONSIN	28	TBD	TBD	TBD	5	24	1	24	1.17	1680	14-Tube, 5 layers	*
TRIGA/UNIV. OF CAL.-IRVINE	113	TBD	1.48	28.00	5	24	1	24	4.71	1680	14-Tube, 5 layers	0.07
TRIGA/UNIV. OF TEXAS@AUST.	158	TBD	1.48	28.31	5	24	1	24	6.58	1680	14-Tube, 5 layers	0.09
TRIGA/USGS	200	TBD	1.48	28.31	5	24	1	24	8.33	1680	14-Tube, 5 layers	0.12
TRIGA/VA	56	TBD	1.48	28.31	5	24	1	24	2.33	1680	14-Tube, 5 layers	0.03
TRIGA/WASH. STATE UNIV.	327	TBD	1.48	28.31	5	24	1	24	13.63	1680	14-Tube, 5 layers	0.19
PEACH BOTTOM CORE 1	18	TBD	3.5	144	1	4	1	4	5.00	56	14-Tube, 1 layers	0.32
PEACH BOTTOM CORE 1	796	TBD	3.5	144	1	4	1	4	199.00	56	14-Tube, 1 layers	14.21
PEACH BOTTOM CORE 2	786	TBD	3.5	126	1	7	1	7	113.00	98	14-Tube, 1 layers	8.00
									899	TOTAL		78.00

a. FHU: Fuel Handling Unit

b. DHB: Dry Handling Bucket

* Final data is required, but impact on total DPC count is expected to be minimal.

Table 1-2. SNF Dry Storage Project fuel receiving schedule.

SNF Name	Site	Facility	Location	Number of		Start Date	Finish Date
				FHU	Casks		
FSVR	INEL LITCO	ICPP-603 IFSF	ICPP	744	149	1/1/03	7/22/03
PATHFINDER	INEL LITCO	ICPP-603	UNDERWATER	7	2	7/22/03	11/15/03
SHIPPINGPORT PWR-C1-S4	INEL LITCO	ICPP-666	ICPP FAST/4	1	1	11/15/03	11/20/03
SHIPPINGPORT LWBR	INEL LITCO	ICPP-749 SECOND GEN.	ICPP-749	48	10	11/18/03	11/29/03
TREAT	INEL ANL-W	TREAT	ANL-W	390	78	12/16/03	1/1/04
SHIPPINGPORT PWR-C2-S1	INEL LITCO	ICPP-666	ICPP FAST/4	19	4	12/2/03	12/6/03
SHIPPINGPORT PWR-C2-S2	INEL LITCO	ICPP-666	ICPP FAST/4	20	4	12/9/03	12/16/03
TRIGA BER-II (GERMANY)	INEL LITCO	ICPP-603 IFSF	ICPP-603 IFSF	21	5	9/2/04	9/10/04
TRIGA FLIP	INEL LITCO	ICPP-603	UNDERWATER	2	1	9/10/04	9/12/04
TRIGA SST	INEL LITCO	ICPP-603	UNDERWATER	296	60	9/13/04	12/3/05
PEACH BOTTOM CORE 1	INEL LITCO	ICPP-603 IFSF	ICPP	18	4	12/17/04	1/23/05
TRIGA/AFRRI	NON DOE DOM.	ARMED FORCES RADIOBIO.FAC	ARMED FORCES RADIOBIO.FAC	95	19	3/11/06	4/7/06
FRR EAST/TRIGA	FRR	FOREIGN RESEARCH REACTOR	FOREIGN RESEARCH REACTOR	4,940	988	4/5/06	8/1/06
PBF DRIVER CORE	INEL LITCO	PER-620	REACTOR	60	12	12/2/06	1/23/08
PEACH BOTTOM CORE 1	INEL LITCO	ICPP-749 FIRST GENERATION	ICPP-749	796	160	12/3/08	8/10/09
PEACH BOTTOM CORE 2	INEL LITCO	ICPP-603 IFSF	ICPP	786	158	9/1/09	8/10/10
PULSTAR - BUFFALO	INEL LITCO	ICPP-603	UNDERWATER	24	5	9/9/09	9/17/09
TRIGA/REED COLLEGE	UNIVERSITY	REED REACTOR FACILITY	REED COLLEGE	67	14	2/22/12	4/12/12
PULSTAR-SUNY-BUFFALO	UNIVERSITY	STATE UNIV. OF NY-BUFFALO	STATE UNIV. OF NY-BUFFALO	43	9	4/12/12	6/17/12
TRIGA FLIP/TEXAS A & M	UNIVERSITY	TEXAS A & M	TEXAS A & M	101	21	6/20/12	8/18/12
TRIGA/TEXAS A & M	UNIVERSITY	TEXAS A & M	TEXAS A & M	85	17	8/18/12	9/16/12
TRIGA-CORNELL	UNIVERSITY	CORNELL UNIVERSITY	CORNELL	165	33	2/22/13	6/1/13
TRIGA/TEXAS A & M	UNIVERSITY	TEXAS A & M	TEXAS A & M	28	6	6/1/13	8/1/13
TRIGA/UNIV.OF CAL.-IRVINE	UNIVERSITY	UNIV. OF CALIF.-IRVINE	UNIV. OF CALIF.-IRVINE	113	23	2/22/14	4/15/14
TRIGA/UNIV.OF TEXAS@AUST.	UNIVERSITY	UNIV. OF TEXAS-AUSTIN	UNIV. OF TEXAS-AUSTIN	158	32	4/15/14	2/21/15
TRIGA/KANSAS STATE UNIV.	UNIVERSITY	KANSAS STATE UNIVERSITY	KANSAS STATE UNIVERSITY	191	39	7/1/15	8/22/15
TRIGA/UNIV. OF ARIZONA	UNIVERSITY	UNIVERSITY OF ARIZONA	UNIVERSITY OF	98	20	8/25/15	10/17/15
PULSTAR-N.C. STATE UNIV.	UNIVERSITY	N. CAROLINA STATE UNIV.	N. CAROLINA STATE UNIV.	34	7	10/20/15	11/21/15
TRIGA/UNIV. OF MARYLAND	UNIVERSITY	UNIVERSITY OF MARYLAND	UNIVERSITY OF MARYLAND	186	38	1/26/16	3/31/16
TRIGA CONV. PENN STATE	UNIVERSITY	PENNSYLVANIA STATE UNIV.	PENNSYLVANIA STATE UNIV.	241	49	2/2/16	3/27/16
TRIGA FLIP/OSU	UNIVERSITY	OREGON STATE UNIVERSITY	OREGON STATE UNIVERSITY	91	19	4/27/16	6/16/16
TRIGA UNIV. OF ILLINOIS	UNIVERSITY	UNIVERSITY OF ILLINOIS	UNIVERSITY OF	305	61	2/5/15	8/7/16
TRIGA/OSU	UNIVERSITY	OREGON STATE UNIVERSITY	OREGON STATE UNIVERSITY	99	20	10/7/16	11/2/16
TRIGA/UNIV. OF UTAH	UNIVERSITY	UNIVERSITY OF UTAH	UNIVERSITY OF	225	45	1/19/17	2/24/17
TRIGA/UNIV. OF WISCONSIN	UNIVERSITY	UNIVERSITY OF WISCONSIN	UNIVERSITY OF WISCONSIN	127	26	2/1/17	3/25/17

Table 1-2. (Continued).

SNF Name	Site	Facility	Location	Number of		Start Date	Finish Date
				FHU	Casks		
TRIGA FLIP/WASH.STATE UNIV.	UNIVERSITY	WASHINGTON STATE UNIV.	WASHINGTON STATE UNIV.	78	16	3/14/17	4/15/17
CANDU	SRS	RBOF	SAVANNAH RIVER	3	1	7/21/17	9/9/17
DRESDEN I REACTOR FUEL	ORNL	BLDG. 7920	STORAGE AREAS	2	1	2/27/18	3/1/18
TRIGA/UNIV. OF WISCONSIN	UNIVERSITY	UNIVERSITY OF WISCONSIN	UNIVERSITY OF WISCONSIN	28	6	7/27/18	9/22/18
TRIGA/WASH.STATE UNIV.	UNIVERSITY	WASHINGTON STATE UNIV.	WASHINGTON STATE UNIV.	327	66	3/29/17	10/23/18
TRIGA FLIP/U.OF WI	UNIVERSITY	UNIVERSITY OF WISCONSIN	UNIVERSITY OF WISCONSIN	101	21	9/25/18	10/23/18
TRIGA/DOW	NON DOE DOM.	DOW TRIGA REACTOR	DOW TRIGA REACTOR	78	16	3/1/18	5/1/19
TRIGA-FLIP/GA	NON DOE DOM.	GA TRIGA REACTOR FACILITY	TRIGA REACTOR	117	24	5/7/19	6/12/19
TRIGA/GA	NON DOE DOM.	GA TRIGA REACTOR FACILITY	TRIGA REACTOR	155	31	5/24/19	1/22/20
TRIGA/VA	NON DOE DOM.	OMAHA VA MEDICAL CENTER	OMAHA VA	56	12	2/14/20	3/14/20
TRIGA/USGS	NON DOE DOM.	USGS FAC. OF DENVER, CO	DENVER FEDERAL CENTER	200	40	3/11/20	3/19/20
TRIGA/MCCLELLAN AFB	NON DOE DOM.	SNRS	SNRS	90	18	2/20/20	3/28/20
TOTALS				11,859	2,391		

THE FOLLOWING UNDETERMINED FUELS HAVE NOT BEEN INCLUDED IN THE SCHEDULE

ACRR ELEMENTS	SANDIA NAT LAB	ANNULAR CORE RES REACTOR	DRY WELLS	256	52
ACRR EXPERIMENTS	SANDIA NAT LAB	ANNULAR CORE RES REACTOR	DRY WELLS	1	1
ARKANSAS	NON DOE DOM.	LYNCHBURG TECH. CTR.	B&W NESI	3	1
CP-5 CONVERTER	ANL-E	CHICAGO PILE 5	CASK / ROD STORAGE	2	1
DRESDEN	SRS	RBOF	SAVANNAH RIVER SITE (SRS)	23	5
DRESDEN	SRS	RBOF	SAVANNAH RIVER SITE (SRS)	1	1
DRESDEN	SRS	RBOF	SAVANNAH RIVER SITE (SRS)	4	1
TRIGA CONV./ARRR	NON DOE DOM.	ARRR	ARRR	91	19
TRIGA-FLIP	INEL ANL-W	N-RAD	N-RAD	61	13

NOTE: 1. A conservative estimate of (5) FHUs per cask was used.

2. The number of casks was rounded up to the nearest cask in each case.

Figure 1-1. DPC fuel loading schematic.

[illegible]

24	TRIGA
24	TRIGA
24	TRIGA
24	TRIGA
24	TRIGA
24	TRIGA
24	TRIGA
24	TRIGA
19	TRIGA

PARTIAL 14-TUBE BASKET
235 LAB DIA X 28.3"
UNIV. TRIGA FHUS

[illegible]

5	PULSTAR	BU
5	PULSTAR	BU
5	PULSTAR	BU
5	PULSTAR	BU
4	PULSTAR	BU

PARTIAL 14-TUBE BASKET
257 L46- DIA X 28.9" LONG
ACRR FIUS

[illegible][illegible]

30 L48 DIA X 30" FRP TRIGA FHUS	24 TRIGA
	6 TRIGA

[illegible]

Figure 1-1. (continued).

6 PARTIAL 14-TUBE BASKETS 336 TREAT FHUS	4 TREAT	
	4 TREAT	
	4 TREAT	
	4 TREAT	
	4 TREAT	
	4 TREAT	
	4 TREAT	
	4 TREAT	
	4 TREAT	
	4 TREAT	
	4 TREAT	
	4 TREAT	
	4 TREAT	
	4 TREAT	
PARTIAL 14-TUBE BASKET 54 TREAT FHUS	4 TREAT	
	4 TREAT	
	4 TREAT	
	4 TREAT	
	4 TREAT	
	4 TREAT	
	4 TREAT	
	4 TREAT	
	4 TREAT	
	4 TREAT	
	4 TREAT	
	4 TREAT	
	4 TREAT	
	2 TREAT	
PARTIAL 14-TUBE BASKET 77 PULSTAR NC ST U/SUNY BUFFALO FHUS	15 PULSTAR NC/SUNY BUFFALO 3-HIGH	
	15 PULSTAR NC/SUNY BUFFALO 3-HIGH	
	15 PULSTAR NC/SUNY BUFFALO 3-HIGH	
	15 PULSTAR NC/SUNY BUFFALO 3-HIGH	
	15 PULSTAR NC/SUNY BUFFALO 3-HIGH	
	2 PULSTAR NC/SUNY BUFFALO	
PARTIAL 14-TUBE BASKET 21 TRIGA BER-II GERMAN FHUS	5 TRIGA BER-II	
	5 TRIGA BER-II	
	5 TRIGA BER-II	
	5 TRIGA BER-II	
	1 TRIGA BER-II	
PARTIAL 14-TUBE BASKET IN SPECIAL PBF-34 CRICIFORM 3 CANDU 168" LONG USCS VECTRA PVR FC-DSC	1 CANDU (168" LONG)	
	1 CANDU (168" LONG)	
	1 CANDU (168" LONG)	

14 14-TUBE BASKETS 784 PEACH BOTTOM CORE 1 FHUS	4 PEACH BOTTOM CORE 1	
	4 PEACH BOTTOM CORE 1	
	4 PEACH BOTTOM CORE 1	
	4 PEACH BOTTOM CORE 1	
	4 PEACH BOTTOM CORE 1	
	4 PEACH BOTTOM CORE 1	
	4 PEACH BOTTOM CORE 1	
	4 PEACH BOTTOM CORE 1	
	4 PEACH BOTTOM CORE 1	
	4 PEACH BOTTOM CORE 1	
	4 PEACH BOTTOM CORE 1	
	4 PEACH BOTTOM CORE 1	
	4 PEACH BOTTOM CORE 1	
	4 PEACH BOTTOM CORE 1	
PARTIAL 14-TUBE BASKET 30 PEACH BOTTOM CORE 1 FHUS	4 PEACH BOTTOM CORE 1	
	4 PEACH BOTTOM CORE 1	
	4 PEACH BOTTOM CORE 1	
	4 PEACH BOTTOM CORE 1	
	4 PEACH BOTTOM CORE 1	
	4 PEACH BOTTOM CORE 1	
	4 PEACH BOTTOM CORE 1	
	4 PEACH BOTTOM CORE 1	
	2 PEACH BOTTOM CORE 1	
8 14-TUBE BASKETS 784 PEACH BOTTOM CORE 2 FHUS	7 PEACH BOTTOM CORE 2	
	7 PEACH BOTTOM CORE 2	
	7 PEACH BOTTOM CORE 2	
	7 PEACH BOTTOM CORE 2	
	7 PEACH BOTTOM CORE 2	
	7 PEACH BOTTOM CORE 2	
	7 PEACH BOTTOM CORE 2	
	7 PEACH BOTTOM CORE 2	
	7 PEACH BOTTOM CORE 2	
	7 PEACH BOTTOM CORE 2	
	7 PEACH BOTTOM CORE 2	
	7 PEACH BOTTOM CORE 2	
	7 PEACH BOTTOM CORE 2	
	7 PEACH BOTTOM CORE 2	
PARTIAL 14-TUBE BASKET 2 PEACH BOTTOM CORE 2 FHUS	2 PEACH BOTTOM CORE 2	

Figure 1-1. (continued).

2. DESIGN CRITERIA AND KEY ASSUMPTIONS

The Conceptual Design was developed on the basis of the Conceptual Design Criteria (Appendix B) and on a number of Key Assumptions identified during the design effort. The most significant of the Conceptual Design Criteria are summarized in Sections 2.1 through 2.4. The Key Assumptions are included as Section 2.5.

Appendix C contains the Project Design Criteria which were developed during the Conceptual Design effort. The Project Design Criteria (PDC) provide more detailed requirements than the Conceptual Design Criteria and are based on specific features established during the conceptual design. The PDC are to be used as the design requirements baseline during Title Design.

2.1 General and Performance Requirements

The Dry Storage Facility shall consist of a Dry Transfer Cell (DTC) in which SNF is transferred from shipping casks to Dual-Purpose Canisters (DPCs), and a Dry Storage System (DSS) to handle and store DPCs containing SNF.

- A DTC shall transfer SNF from shipping casks to dry storage canisters. The dry storage canisters shall be commercial DPCs, and shall be sealed and inerted for storage.
- A Dry Storage System comprising an outdoor aboveground concrete storage basemat, and suitable shielded, monitored, storage modules shall be provided. Loaded DPCs from the DTC shall be transported and placed into the storage modules on the storage basemat.
- The DTC shall be sized to transfer fuel from a maximum of 12 incoming SNF shipping casks per month, and to fill a maximum of two DPCs per month. The facility shall be designed to operate on a schedule of two 12-hour shifts per day.
- The DTC shall have the capability to perform minor canning processes. These include the packaging of peach bottom fuel elements, either already canned or in bare assemblies, in cans that are sealed to constitute the first of two confinement boundaries required by 10 CFR 72.
- The conceptual design shall include the Vectra NUHOMS® system for horizontal storage of the DPCs.
- The storage area shall be designed to allow ready expansion throughout its life up to a maximum capacity of 240 DPCs.
- A data management system shall be provided to record the receipt, inventory, transfer, and disposal of all SNF in storage. The records shall include, as a minimum, the name of the fuel shipper, the estimated quantity of radioactive material per item (including special nuclear material in spent fuel), item identification and serial number, storage location, onsite

movements and locations of each fuel assembly or DPC, and final shipment to an offsite location.

- Design life of the SNF Dry Transfer Cell and equipment shall be 30 years and have maintainable or replaceable life of 60 years.
- Design life of the Dry Storage System shall be 60 years
- The design life of the DPCs shall be 100 years.

2.2 Safety Requirements

- Facility design features and physical controls shall ensure occupational exposure is maintained ALARA during normal and off-normal operations.
- Spent fuel handling, packaging, transfer, and storage systems shall be designed to be maintained subcritical under the worst case moderated and reflected conditions, and to ensure that before a nuclear criticality accident is possible, at least two unlikely, independent, and concurrent or sequential changes must occur in the conditions essential to nuclear criticality safety.
- The DPC and its internal basket shall be designed to maintain the fuel cladding below the maximum allowable temperatures. Maximum allowable temperatures (380°C for 5-year-cooled fuel, 340°C for 10-year-cooled fuel must not be exceeded in the Hot Cell lag storage, the MP-187 transfer cask, and in the storage modules at all conditions to which the fuel may be exposed.
- The spent fuel storage package shall be designed to provide adequate heat removal capacity without active cooling systems.
- The fuel handling equipment shall be designed against single failure resulting in dropping the fuel. Designs shall include appropriate redundancy and consider diversity to reduce the possibility of concurrent common-mode failures of redundant items.
- The SNF Dry Storage Facility shall be designed to be able to recover from accidents involving dropping of casks, SNF, SNF baskets/buckets/cans, and DPCs.

2.3 Environmental Requirements

- The SNF Dry Storage Facility shall be designed for construction and operation in accordance with the environmental limitations described in DOE/EIS-0203-F, *Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement*.

2.4 Regulatory Requirements

- The facility shall be licensed by the NRC and shall be designed in accordance with 10 CFR 72 and 10 CFR 73.
- The facility shall be designed in accordance with ANSI/ANS 57.9, Design Criteria for an Independent Spent Fuel Storage Installation (Dry Type).
- The DPC and internal packaging shall be licensed for off-Site shipment in accordance with 10 CFR 71, and long term storage in accordance with 10 CFR 60.

2.5 Key Assumptions

The assumptions made during the development of the conceptual design are included below. These assumptions require verification during follow-on design efforts. In some cases, the assumptions may have a strong bearing on the direction of the design; in other cases, the assumptions simply identify important issues that need to be addressed as the design progresses.

- SNF is dry and located in a DOE- or NRC-approved shipping cask when it arrives at the Dry Transfer Cell. Some SNF may require final drying after being placed in the DPC, but there will be no appreciable free water that could be available to spread contamination during handling.
- Approximately two-thirds of the SNF to be handled has intact cladding or is in intact cans, i.e., the SNF cladding or the cans provide the first confinement barrier as defined by NRC 10 CFR 72.122. For this fuel, no additional conditioning, testing, treatment, decanning, or canning is required within the DTC.
- Peach Bottom (PB) SNF that will be placed in approximately 25 DPCs will require minor canning. This will be limited to overpacking the SNF, vacuum drying, purging, inerting and sealing the PB SNF inside a new can. It is assumed that no raw fuel will be exposed to the Hot Cell environment while transferring the PB fuel from the shipping cask to the DPC, lag storage, or canning station.
- The spent nuclear fuel has sufficient identification and records of previous characterization that only in-cell identification of SNF permanent marking is required to comply with DOT and NRC identification requirements for shipment and storage. Such characterization will meet the DOE requirements for "road ready" when properly sealed in DPCs.
- A DPC having an external shell of a standard commercial or DOE canister (e.g., a Vectra NUHOMS® or DOE OCRWM MPC) shall be specified. The internal basket features may be modified to meet the requirements of DOE SNF.

- No engineered features are required to open the DPCs for the purposes of adding more SNF, performing additional fuel characterization, or verifying the inventory of SNF once the DPC is closed (welded). Any verification actions, and any actions taken to verify that the SNF has not been disturbed, will be part of facility administrative processes.
- The commercially available automatic welding machine for whichever DPC is selected will be used in the DTC.
- Physical security requirements can be met with typical access controls (e.g., card readers and alarmed doors) to the facility. Specific security system capabilities to prevent removal of small quantities of SNF are not required.

Note: The requirements applicable to security systems are continuing to evolve. This is primarily a result of interpretations of existing regulations (10 CFR 73) and an understanding of proposed NRC rules. Where questions concerning the interpretation of 10 CFR 73 arise, guidance has been sought from NUREG-1497.

- Schedules for transferring SNF currently located onsite may be established and adjusted as necessary to support an uninterrupted sequence of filling a DPC by direct transfer from the onsite shipping cask(s). This will eliminate a potential need to temporarily store that fuel in the Hot Cell.

3. DESIGN DESCRIPTION

3.1 Facility and Operational Overview

This section describes the functions of the Dry Storage Facility (DSF) and the flow of materials [shipping casks, fuel, Dual-Purpose Canisters (DPCs), transfer casks] through the facility. It also briefly discusses the configurations and capabilities of the various facility systems. Details of the system configurations and capabilities are provided in Sections 3.2 through 3.10.

The DSF includes the necessary equipment to receive, handle, and store spent nuclear fuel. There are two primary parts to the facility: the Dry Transfer Cell (DTC) and the Dry Storage System (DSS). The facility will be located at the ICPP, where the fuel will be stored until moved for final disposition. The DSF is designed to provide versatile fuel-handling capabilities and minimize obsolescence.

3.1.1 Dry Transfer Cell

As illustrated in Figure 3-1, the main process areas in the DTC are the Cask Handling Bay, the Cask Preparation Area, the Hot Cell, the Buffer Area, the Utility Support Area and the Administrative Area. The general capabilities and operations that occur in these areas are described below. Figure 3-2 is a block diagram that illustrates the flow of equipment and material through the facility.

3.1.1.1 Fuel Receipt and Preparation. Fuel elements are received at the facility in a variety of shipping casks that are transported by truck/trailer. The casks, some of which are protected by covered shipping skids, are moved into the drive-through truck bay. If necessary, road grime is washed from the shipping packages. The shipping cover and tie-down rigging are removed, and handling trunnions installed if needed. Using a 150-ton overhead crane, personnel upright the cask, lift it from the skid, and place it vertically on an electrically driven trolley. The trolley is used to move the cask from the Cask Handling Bay into the Cask Preparation Area. In the Cask Preparation Area, a gas sample from the cask internal cavity is taken to ensure no abnormal radiological conditions exist that might require special cask/fuel handling operations. The outer lid (if the specific cask has that configuration) is removed with the crane in the Cask Preparation Area and temporarily stored. The inner cask lid bolts are also removed in the Cask Preparation Area to limit the amount of time required for lid removal once the cask is placed in the Hot Cell. The cask is then moved, on the trolley, through shielding doors and into the Hot Cell.

3.1.1.2 Hot Cell Operations. The Hot Cell has an overhead bridge system that includes two fuel-handling manipulators and hoist/hook assemblies that are mounted on separate trolleys but on the same bridge. The Hot Cell also contains four lag storage vaults for temporary storage of SNF. The vaults are used to accommodate the different capacities of the shipping casks and storage canisters.

The cask is moved into position in the Hot Cell and a combination of permanent and disposable contamination barriers are installed. The Hot Cell is then vacated for remote lid removal and fuel transfer.

LEGEND

1.	CASK HANDLING BAY	4.	BUFFER AREA
	a. TRUCK BAY	5.	HOT CELL
	b. LAYDOWN AREA		a. CANNING AREA
	c. CASK STAGING AREA		b. LAG STORAGE AREA
2.	ADMINISTRATIVE AREA		c. FUEL TRANSFER AREA
3.	UTILITY SUPPORT AREA	6.	CASK PREPARATION AREA

Figure 3-1. DTC main floor plan.

NOTE: Shipping cask trolley and transfer cask trolley travel on the same tracks.

SNF DRY STORAGE FACILITY
PROCESS FLOW DIAGRAM
FIGURE 1 OF 3

Figure 3-2. Block diagram of the flow of equipment and materials through the DSF.

HOT CELL PROCESS FLOW

FOR OFF-SITE FUEL

FOR ON-SITE FUEL

R = REMOTE OPERATION

SNF DRY STORAGE FACILITY
PROCESS FLOW DIAGRAM
FIGURE 2 OF 3

Figure 3-2. (continued).

TRANSFER CASK PROCESS FLOW

NOTE: Shipping cask trolley and transfer cask trolley travel on the same tracks.

SNF DRY STORAGE FACILITY
PROCESS FLOW DIAGRAM
FIGURE 3 OF 3

Figure 3-2. (continued).

Once personnel are out of the Hot Cell, the crane is used to remove the cask lid and place it in a temporary laydown area within the Hot Cell. The lid from a selected lag storage vault is opened, and the fuel transfer crane is used to remove the fuel from the cask.

The fuel may be placed in a lag storage vault, or in a Dry Handling Bucket (DHB) for consolidation with other elements before placement in the vault. The latter sequence is used when handling small fuel cans or single elements that are appropriate for consolidating to minimize the handling efforts required later in the storage sequence. The typical sequence will be to place the fuel cans or rods in a DHB.

As the fuel is removed from the shipping cask, it is visually identified with use of an in-cell camera. This identification is recorded, as is the specific location of that element or can in the DHB.

DHBs are placed in lag storage when they are full or after the last of the fuel is removed from the cask. As in the case of individual elements and cans, the location of the DHB and the identification of its contents are recorded.

When feasible from a fuel shipping schedule standpoint, the DHBs may be placed in the DPC without being first placed in lag storage. This variation on the handling sequence is primarily limited to campaigns of fuel transfers that involve relatively few shipments to fill a DPC and where those shipments originate on-Site.

Once the shipping cask is empty, the lag storage vault and shipping cask lids are replaced. If transfers have been made to a DPC, then its shield plug is put into place. Personnel reenter the hot cell, package any contaminated temporary barrier materials for disposal, survey the cask and trolley to ensure they are clean, decontaminate if necessary, and then move the shipping cask on the trolley back into the Cask Preparation Area.

3.1.1.3 Shipping Cask Return Operations. The empty shipping cask is surveyed and decontaminated if necessary, the lid(s) is rebolted and the seal leak checked. Maintenance on the cask can be performed in the Cask Preparation Area if the trolley is not needed to maintain schedule, or the cask can be moved to the Cask Handling Bay and placed aside for more time-consuming maintenance. After completion of any required maintenance, the shipping cask is placed back on its shipping trailer and returned to the appropriate shipper for the next load. The shipping cask can be temporarily stored on the loading dock if required by shipping logistics.

3.1.1.4 DPC Loading. When sufficient fuel is accumulated in the lag storage vaults to fill a DPC, the receipt and handling of shipping casks is interrupted to load a DPC with the SNF from the lag storage vault(s). The onsite transfer cask is brought into the Truck Bay on its transporter. The cask is upended, removed from the transporter, loaded with a DPC and the canister basket (with loose shield plug set in place), placed on a transfer trolley, and moved into the Hot Cell.

Contamination barriers are placed in position, and the DPC shield plug is set aside.

The Hot Cell is vacated and the lid from the appropriate lag storage vault(s) is opened. The fuel transfer crane is used to move SNF from the lag storage vault to the DPC. As is required for all SNF movements, the location of each element, can, or DHB is tracked and recorded.

Once the DPC is full, the lag storage vault lid is closed and the DPC shield plug is placed back on the DPC. The Hot Cell is then reentered and the transfer cask is surveyed, decontaminated if necessary, and prepared for moving to the Cask Preparation Area. Occupancy in the Hot Cell is minimized during these operations.

The transfer cask is moved into the Cask Preparation Area and the inner DPC lid is welded, inspected, and repaired if necessary. The DPC is leak checked, weld repaired if necessary, and filled with inert gas. The second DPC lid is put into place, welded, inspected, and repaired if needed. The transfer cask lid is secured to the transfer cask.

The transfer cask is then subjected to a final radiological survey and moved back to the Cask Handling Bay.

3.1.2 DPC Transport

Transport of the DPC, in the transfer cask, is performed with a custom trailer and tow vehicle. The transfer cask is moved with the crane from the trolley to the transfer cask trailer, and rotated to the horizontal position. From here the tow vehicle is used to haul the trailer and cask to the outside DSS (NUHOMS® System).

3.1.3 Dry Storage System

The DSS consists of a concrete basemat and a number of concrete vaults or modules. The modules are designed for shielding and passive cooling of the DPC, and each module holds a single, horizontally oriented DPC. The loaded, sealed DPC is pushed out of the transfer cask and into its assigned storage module with a hydraulic ram that is part of the transfer trailer. The storage module door is closed and welded. No further handling operations with the fuel and canister are required until the canister is retrieved for final disposition. Monitoring is performed for potential radiological releases, and periodic inspections are made to ensure security regulations are adhered to and that any off-normal conditions (such as obstructed storage module cooling vents) are identified and resolved.

3.2 Civil

3.2.1 General

The DTC will be located southwest of CPP-666 and the proposed location of the ICPP Interim Storage System project. This location, shown in Drawings T-1 and C-1, provides a convenient site for centralizing fuel transfer operations. This location was selected on the basis of a siting study included as Appendix D.

3.2.2 Surface Drainage

Surface drainage for this location is coordinated with the site drainage plan. Site run-off from the facility and DSS is diverted to ditches consistent with current ICPP controls.

3.2.3 Rock Excavation

A soils investigation will be conducted during title design to determine soil properties for design. To the extent practical, the results of prior investigations will also be used. No rock excavation is anticipated at the proposed location.

3.2.4 Soil Excavation and Shoring

Initial earthwork consists of clearing and grubbing the site of any vegetation (minimal) and grading areas for the building, parking, access roads, and DSS. Excavation is required for utilities, spread footings and mat foundations.

3.2.5 Finish Grading

The finished floor of the facility is at an elevation of 4,918 ft, 3.5 ft above the truck bay. The floor of the truck bay is approximately 1 ft above the existing grade and the entire area surrounding the building is sloped away to provide adequate drainage from the building to specified drainage paths. The DSS basemat (shown in Drawing C-5) will be constructed by excavating the area down a minimum of 1 ft and then raising the area back up to 3 ft above the existing grade to a finish elevation of 4,916 ft. This allows positioning of the storage module inlet vents above the 100-yr flood elevation of 4,917 ft.

3.2.6 Paving

Asphalt and concrete paving is provided around the building and the access roads. The DSS paving consists of 3-ft-thick concrete basemats supporting the storage modules and 2-ft-thick concrete approach slabs. Asphalt roadways, parking, and turn-arounds are designed and constructed for a minimum vehicle load for an American Association of State Highway and Transportation Officials HS-20 loading. As a minimum, this consists of 4 in. of asphalt on a 6-in.-thick crushed gravel base. A minimum of 12 in. of pit run gravel underlays the crushed roadbase. Roadways are a minimum of 20 ft wide and provided with compacted gravel shoulders. The basemat, approach slab, and roadways are also designed to include all loads associated with the transfer operations of the NUHOMS® storage modules. Each horizontal storage module (HSM) is approximately 20-ft long × 9-ft, 8-in. wide with a loaded weight of 300,000 lb. The NUHOMS® transport trailer has a gross vehicle weight of 258,000 lb and is moved using a conventional road tractor. The trailer weight is uniformly distributed to 16 independently steered, dual-tire axles for a maximum wheel loading of 15,500 lb/axle.

The prime mover axle loads are typically 15,000 lb front; 22,000 lb each on dual rear axles. During the canister transfer operation, the trailer is backed across the reinforced concrete approach slab and raised on four jacks that have a contact area of 1 ft². The loading on the jacks is uniformly distributed during the initial setting. As the canister is transferred to the HSM, the jack feet adjacent to the modules are loaded to a maximum value of 120,000 lb.

3.2.7 Slabs, Sidewalks, and Stoops

Reinforced concrete sidewalks, door stoops, and approaches are provided to facilitate personnel and vehicle access to the facility. No provisions for the physically handicapped are provided. Building utility and equipment pads are also reinforced concrete and sized to accommodate appropriate loadings. A bollard is provided at each vehicle entrance to the building.

3.2.8 Fencing

Perimeter fencing surrounding the DSS consists of galvanized, pipe supported, 11-gauge steel fabric with 2-in. mesh openings. A 20 ft clear zone will be maintained on each side of the fence. Fencing will be topped by three strands of barbed wire on a single 45-degree arm angled outward. Top rails are continuous along the top edge of the fence fabric. All installed fence hardware is peened or spot welded. The overall fence height, excluding barbed wire, is 8 ft. Fencing is grounded.

3.2.9 Underground Utilities

Utilities are provided by trenching to the existing location of utility services at ICPP. Pipe routing and connection points with existing ICPP utilities are identified in Drawing C-2. The sanitary sewer connection is located east of ICPP-665, which is approximately 400 ft from the construction site. All other utilities are located in the utility tunnel which is located approximately 100 ft from the construction site. All lines are cathodic protected and the steam line is also insulated. A sanitary sewer is provided by installation of a 8-in. ABS pipe line that will tie into the existing 8-in. sanitary sewer line. Steam will be provided by installation of a 4-in. carbon steel pipeline that will tie into the existing 12-in. high-pressure steam line located in the utility tunnel. Compressed air will be provided by installation of a 2-in. carbon steel pipeline that will tie into the existing 3-in. high-pressure air line located in the utility tunnel. Compressed gas will be provided by bottled gas located in the facility. Potable water will be provided by installation of a 2-in. carbon steel pipe line that will tie into the existing 4-in. potable water line located in the utility tunnel. Service waste will be provided by installation of a 2-in. carbon steel pipe line that will tie into the 4-in. service waste line located in the utility tunnel. During conceptual design, all associated utilities were analyzed for capacity utilization. All existing utilities have excess capacity and will provide the service needed.

3.2.10 Site Demolition

Site demolition includes the removal or destruction of several small buildings at the proposed DSS site. The buildings, shown in Drawing C-4, include two pre-engineered, steel-framed structures 25 ft × 30 ft and 40 ft × 50 ft, a wood-framed structure 110 ft × 30 ft, and a 25-ft × 50-ft trailer. The latter two are currently scheduled for removal by other projects. All of these structures are single story. In addition, 1,200 linear ft of 8-ft mesh fencing and removable concrete barriers will be removed.

3.3 Architectural

3.3.1 General

The new Dry Transfer Cell is a four-story structure consisting of approximately 26,000 ft². The building is a rough L-Shaped configuration with dimensions of 155 ft × 135 ft and an overall height of 64 ft. Building plans, elevations, and sections are shown in Drawings A-1 through A-12.

The various areas within the building are in a controlled environment provided by the HVAC and filtering systems. Different pressures are maintained from area to area by containment barriers and sealable entries. Exposed surfaces of contaminated work areas are decontaminable. The door types and air lock arrangements maintain the pressures for these areas.

Materials selected for the walls provide durability, low maintenance, shielding, insulation, and decontamination, with appropriate emphasis in these areas depending upon exact location and function within the facility.

The facility design is based upon a UBC occupancy classification for each area. The Administrative Area is Class B, the Cask Handling Bay Class is S-2, and the Hot Cell, Cask Preparation Area, Buffer Area, Operating Galleries, and Utility Support Areas are Class H-7. The UBC construction Type of II-N is used for the Facility.

3.3.1.1 Cask Handling Bay. Approximately 6,400 ft² is provided for washdown, loading, and unloading operations in the Truck Bay, Laydown Area, and Cask Staging Area, as shown on Drawings A-1 through A-4. This portion of the facility provides receiving and shipping services for the shipping and transfer casks and the DPCs. In addition to this principal function, this area supports minor decontamination and maintenance of transportation packages and provides temporary storage and support for internal handling equipment. A 150-ton cask handling crane with an auxiliary 15-ton hoist is supported over this area to handle the cask transportation package operations. The ground floor of the entire facility is elevated to match the height of the transport vehicle as it is positioned in the Truck Bay.

Truck Bay: This area is long enough for the longest transport package and supports washdown, maintenance, and inspection of the transport vehicle and shipping covers. A system is provided for the washdown of dirt and road grime from the transportation package carrier. An in-line holding tank system has provisions to collect, monitor, and dispose of washdown effluent.

Laydown Area: Space is provided for storing portable personnel barriers, overpacks, impact limiters, and shipping covers. Storage space is provided for special tools, unique to each cask, including lifting yokes and slings and devices necessary for the removal of shipping casks from the transportation vehicle. Storage space is also provided for cask appurtenances that must be removed while the shipping cask is in the loading and unloading cycle. Access is provided to all packages, vehicles, and installed components for purposes of testing, inspection, and maintenance.

Cask Staging Area: Trolley rails begin in this area of the Cask Handling Bay to enable the trolleys to travel into the Cask Preparation Area and the Hot Cell. Space for two trolleys is provided. Demountable work platforms above the trolley system are provided to access the top of the casks as they are inspected, maintained, and moved in and out of the Cask Preparation Area.

3.3.1.2 Cask Preparation Area. Approximately 1,000 ft² is provided for lid removal and installation, welding, gas sampling, and surveying activities of the casks entering and exiting the Hot Cell. In addition to providing space for the casks and working platforms, this area accommodates cask lids, DPC lids, automatic welding equipment, weld inspection equipment, lifting hardware and rigging, and an overhead crane.

Preparation: The preparation area includes a work location of sufficient space to accommodate the largest casks to be processed. The location includes a working area around the various casks at each required work elevation, a laydown area to accommodate cask secondary lids, special tools, and equipment, means for sampling and purging, and access to pressurized air, water, vacuum, and off-gas systems. Storage space is provided for contamination or shielding barriers.

Maintenance: The maintenance system includes the equipment and areas required to ensure the continuing in-service status of each cask, including such operations as replacement of valves and seals, examination, and exchange of shipping cask internals.

Decontamination: The decontamination wipedown process includes the space and equipment needed for removing minor radioactive contamination from the exterior of the casks, whether loaded or empty.

3.3.1.3 Hot Cell. Approximately 4,500 ft² is provided for the Hot Cell, which includes the Transfer Area, a Lag Storage Area, and a limited Canning Area. The Hot Cell is for movement of dry SNF from the shipping casks to the DPC, Lag Storage, or Canning Area. It includes shielded and decontaminable walls, floors, and ceilings, and remote handling devices, viewing windows, and closed circuit television monitoring to support removal and insertion of SNF out of shipping casks and into lag storage or DPCs. Interior surfaces of the shielded cell are coated to accommodate decontamination. A Buffer Area is provided next to the Hot Cell for a shielding labyrinth, leading to areas where anti-c clothing can be changed and personnel monitoring devices are located. The hot cell walls are made of 5-ft-thick reinforced concrete.

Canning Area: Canning operations are performed in the area next to the Lag Storage Area. The back side of this area, which has no wall, has a curb to contain expected small amounts of contaminated material that fall from the SNF assemblies as they are handled. An enclosure is also provided over the walkway to the Hot Cell exit passageway. The remote canning operations will be conducted with observation through shielded view windows on the next two floors from the Operating Corridors opposite the Hot Cell wall. The canning equipment anticipated for this area are listed below. For more detailed information, see Section 3.6 and Drawings A-1 through A-3, A-10 and A-11.

- Can Welder and Stand
- Weld Inspection/Test Equipment
- Can Piercing Tool
- Can Drying System
- Gas Sampling/Inerting/Purging Equipment.

Lag Storage Area: Lag storage vaults are provided to hold SNF between shipments when necessary to optimize DPC loading. Concrete shielding is provided around the four lag storage vaults to protect personnel entering the Hot Cell between shipments, the operators outside the cell, and the Cask Preparation Area. The Lag Storage Area consists of four concrete-shielded lag storage vaults with removable (for decon and maintenance) stainless steel sleeves and 14-tube DPC baskets. Cooling for the SNF in the Lag Storage Area is incorporated into the design. The top surface of the Lag Storage Area has storage space for the stepped concrete shield plugs that are removed from the vaults during SNF transfer. The equipment and space anticipated for this area are listed below. For more detailed information see Section 3.7.1.

- Four lag storage vaults with stepped concrete shield plugs

- Dry Handling Buckets
- Passive cooling for SNF stored in lag storage vaults
- Effluent drain to the floor drain/sump system of the Hot Cell.

Transfer Area: The Transfer Area provides for remote removal of SNF from shipping casks, transfer to and from canning and lag storage, and placement in DPCs. The loading and unloading equipment and features located in this area are listed below. For more detailed information see Section 3.5 of this CDR.

- Fuel handling crane
- Two trolleys
- Lifting fixtures (rigging and handling gear, grapples, slings)
- Rolling Stairway
- Dry Handling Buckets (DHB) and racks/can storage racks
- Laydown area for cask lids.

3.3.1.4 Buffer Area. Approximately 500 ft² is provided for a shielding labyrinth leading from the Hot Cell to the Buffer Area and then to the Anti-C Change Room. Door assemblies are provided separating these areas from each other and maintaining the pressure barriers and shielding requirements necessary to provide clean and safe work conditions.

The Buffer Area provides space for discarded protective clothing used in the Hot Cell and a stepoff pad where contamination can be detected by a personnel contamination monitor. All surfaces in the Buffer Area are decontaminable. The Anti-C Room provides storage of clean Anti-C clothing and space for changing into the clothing.

3.3.1.5 Operating Galleries. Approximately 2,500 ft² is provided for control and monitoring of remote handling and canning activities. The Operating Galleries are corridors a minimum of 10 ft deep and run the entire length of the Hot Cell on multiple levels as required by viewing angles through the shielding windows and separated from the Hot Cell by a concrete shielded wall. See Drawings A-1 through A-3.

The Operating Galleries provide shielding windows, utilities, and space for crane consoles that will allow remote operations for the cranes inside the Hot Cell. The Operating Galleries have four shielding windows, tool drops, concrete shielded walls, pressure barriers, and future utility rough-ins.

3.3.1.6 Utility Support Areas. Approximately 7,000 ft² is provided for HEPA Filter, Mechanical, Air Handler, Electrical Panels, uninterruptible power supply (UPS), Communication, Welding, Inert Gases, and Welding Observation Rooms.

Approximately 1,000 ft² of the Utility Support Areas is provided for the Welding Equipment, Inert Gas storage and control systems, and Welding Observation Rooms located in various rooms and elevations to support facility operations. Equipment space is also provided next to the Cask Preparation Area for welding equipment and gas systems.

3.3.1.7 Crane Maintenance Areas. Approximately 1,100 ft² is provided for the Crane Maintenance Areas. The two Crane Maintenance Areas are located in the south end of the Cask Handling Bay and the west end of the Hot Cell at an approximate elevation of 145 ft and are accessed by a common stair on the west end of the facility. The Crane Maintenance Areas are similar to catwalks in construction with grated floors suspended parallel to the bridge beams. See Drawings A-4, A-10, and A-12.

3.3.1.8 Administrative Areas. Approximately 1,600 ft² is provided for office and support areas for facility personnel. Office space for one supervisor is provided. This office will be provided with lighting, electrical receptacles, local area network, phone, glazed curtain wall for general observation and security, floor and wall coverings and other required furnishings as specified for administrative areas.

Approximately 350 ft² of the administrative area is provided for a Radiation Control and inspection office equipped with cabinetry, inspection and sniffing equipment, electrical receptacles, lighting, and decontaminable wall and floor coverings.

Approximately 400 ft² of the administrative area is provided for a Ready Room with conference furnishings for 8 to 10 people. Space and utilities for a vending machine will be accommodated just outside the Ready Room in the Corridor.

This area also provides space for men's and women's lavatories, showers, lockers, and change facilities, storage, and a janitor's room.

Approximately 3,500 ft² or 13% of the facility is assigned to stairs and circulation above and beyond the Operating Galleries.

3.3.2 Building Features

Building Construction: The floor areas within the facility are concrete slab-on-grade with a perimeter-insulated concrete foundation wall. The suspended floors and lower roof areas are supported by concrete with metal deck over steel bar joist. The suspended roofs over the Cask Handling Bay and the Hot Cell are supported by precast concrete beams, concrete core deck, with a concrete topping as shown on the drawings. Structural steel columns, beams, and joists are used in areas excluding the Hot Cell and the Cask Handling Bay. The latter two areas are constructed of reinforced concrete columns and beams.

Exterior Walls: The outer skin of the exterior walls of the Dry Transfer Cell, shown in Drawings A-6 through A-9, are of metal wall panel (similar to MBCI 26-gauge "A" Panel) over batt insulation, over rigid insulation, meeting the recommended R value of the INEL A/E Standards. The inner substrate wall is made of reinforced concrete, concrete masonry units (CMU), or metal stud with gypsum board. The overall thickness of the exterior walls varies as dictated by the structural, shielding and containment requirements. Glazing occurs in designated areas of the Administrative Area, the clerestory of the Cask Handling Bay, and specified areas of the Operating Galleries for natural daylighting. All glazing for

these areas are of highly insulated multiple panes integrated at the factory of "Low E" or "High Efficiency" type glazing.

Interior Walls: The interior walls of the Hot Cell are sealed with a decontaminable coating. The CMU walls are painted or sealed with a decontaminable coating where potential contamination areas are to be located. Such potential areas are in the Cask Preparation Area, the Buffer Area, the HEPA Filter Room, and limited Mechanical Areas. The finished gypsum board walls over metal studs, used only in the Administrative Area, receive vinyl wall coverings to lower maintenance and increase life cycle savings.

The floors consist of reinforced concrete slabs on grade. Where washdown or decon activities are to be located, the floors will be sloped to drains, accommodate catch basins, in-line holding tanks, inserts, embedments, isolation/expansion joints, and recesses where required. Recessed floors in the restroom, shower, and locker areas will accommodate grout and tile. Mechanical, Electrical, UPS, Communication, Cask Handling Bay, Equipment, Fan, Stairways, Janitor Room, and Air Handling Rooms have sealed concrete floors. The floors for the Hot Cell, the Cask Preparation Area, the Buffer Area, the Operating Galleries, the HEPA Filter Room, and other supporting areas in the secondary confinement area with potential radiation contamination have a decontaminable floor covering. Other floors will have a seamless vinyl floor surface. Recessed floor grating systems are provided at the main entry and vestibule.

The ceilings for the Ready Room, Supervisor Office, Rad Con Office, Lobby, and adjacent corridor are 2 ft x 2 ft suspended lay-in acoustical tile and T-grid system. Lobby tiles have hold-down clips to prevent displacement when both pairs of entry doors are open and differential pressure occurs. Painted water-resistant gypsum board with vapor barrier ceilings are used in areas of high moisture such as showers, lockers and restrooms. Painted gypsum board are used for vestibule, janitor, observation rooms, and electrical rooms. The remaining areas of the facility are exposed to painted structure as described above.

The roof for the Dry Transfer Cell, shown in Drawing A-5 is a built-up 5-ply roof with the best warranty and life cycle features. This roofing system will be further evaluated in Title Design to ensure original cost and projected maintenance are considered in life cycle costs. The lower roofs are accessed through doors shown on the drawings and the high roof is accessed through a roof hatch from the west stair at the Crane Maintenance Area at 145 ft elevation.

Doors, Windows, and Glazing: Passage doors are flush hollow metal construction with hollow metal frames. Exterior passage and vertical lift doors are insulated and weather sealed. Fire-rated doors have solid mineral cores with appropriate fire-rated labels, and non-rated fire doors have a rigid honeycomb construction core. All locks and cylinders are by the same manufacturer, and all exterior passage doors are secured by card readers. Interior locks are cipher locks with key override for fire protection purposes. All air locks and vestibule doors have glazing (tempered) provided where appropriate. The doors used as pressure/containment barriers receive perimeter seals and automatic door bottoms. All exterior glazing (which is minimal) are insulated with thermally broken frames.

Four Radiation Shielding Windows are installed (as shown on Drawings A-2, A-3, and A-10) at multiple levels, maximizing view angles for observing and controlling remote operations within the Hot Cell.

Vertical lift doors and bi-parting shield doors are required as noted on the drawings to address various design functions such as insulation, weatherization, containment, pressurization, and radiation shielding. Doors for all H-7 occupancies meet the requirements for areas having area openings to maintain pressure, shielding, and containment barrier separation.^a Special mechanical operator devices and inflatable seals are required in these areas. Door opening space accommodates floor space functions and head room requirements. Standard insulated vertical lift doors with weather seals at the perimeter are used for the entrances to the Truck Bay.

Specialties and Accessories: The facility is equipped with both cabinet and bracket-mounted fire extinguishers throughout. The type of extinguisher, size, and method of mounting are determined by the requirements for the location. Except for the clerestory windows, the exterior windows are equipped with horizontal slat venetian blinds. The Ready Room and Supervisors Office are equipped with dry marker boards. A ceiling mounted, pull-down projection screen is located in the Ready Room. Toilet accessories including dispensers, mirrors, toilet partitions, lockers, benches, cubical and shower curtains and mop racks are included.

Furniture and Equipment: The Ready Room will be provided with wall-mounted cabinetry and cupboards (see Ready Room section for appliances to be installed). A conference table with seating for a minimum of eight people is provided. The Supervisors Office and Rad Con office has the standard GSA furniture complement.

Signage: A complete signage package is provided for this facility addressing loads, restrictions, gender, Codes, confined spaces, operations, etc.

3.4 Structural

3.4.1 General

The building is a concrete and steel-framed structure with an interior reinforced concrete hot cell area.

3.4.2 Classification and Design Loads

Subpart F, "General Design Criteria," of 10 CFR 72, presents the general design criteria that are applicable to an ISFSI. USNRC Reg Guide 3.6 identifies ANSI/ANS-57-9-1984 as a recommended guideline for the design of an ISFSI which complies with 10 CFR 72.

All permanent and transient loads that could exist or be developed during normal operation of the facility shall be considered. The following loads are considered:

- **Dead Load**—Dead load of the structure and attachments including permanent equipment and piping.

a. Areas having quantities of materials in excess of those listed in Table 3-E, UBC that are health hazards as listed in Section 307.1.1, UBC.

- **Live Load**—Live loads include snow and rain, operating loads including impact, and vibratory and design transient loads due to operating equipment. Live loads will be determined as required by ANSI/ASCE 7-95, "Minimum Design Loads for Buildings and Other Structures."
- **Thermal Loads**—Thermal loads occur during operations due to restraint conditions and reaction of the structure from equipment, piping, etc. Thermal loads may be neglected when it is shown that their resultant stresses are secondary and self-limiting in nature and the response of the structure is ductile.
- **Lateral Soil Loads**—lateral soil pressures and groundwater effects are considered to the extent applicable.
- **Snow Load**—A ground snow load of at least 35 lb/ft² will be used in ANSI/ASCE 7-95 calculations. A minimum roof snow load of 30 lb/ft² is required in all INEL designs.
- **Natural Phenomena Loads:**
 - **Seismic:** 10 CFR 72 requires that the design earthquake to be considered for the facility are the SSE for a nuclear power plant with a minimum peak horizontal ground motion of 0.10 g with the appropriate response spectrum as referenced in 10 CFR 100, Appendix A. The SSE is to be defined by response spectra corresponding to the maximum vibratory accelerations at the elevation of the foundation of the structure. The response spectra are developed from a series of response spectra related to the vibratory motions caused by more than one earthquake. U.S. NRC Reg Guide 1.6 is an acceptable procedure for defining the design response spectra, unless site-specific response spectra data is available. The engineering method used to ensure that the required safety functions are maintained during and after the SSE include the use of a suitable dynamic analysis. 10 CFR 100 requires that the structure to be designed so that if the SSE occurs, specific structures, systems, and components will remain functional. These components are those necessary to ensure; (1) the integrity of the pressure boundary, (2) the capability to shut down the facility and maintain it in a safe condition, and (3) The capability to prevent or mitigate the consequences of accidents that could result in potential offsite exposures.
 - **Wind Loads:** Loads generated by the design basis wind at the 100-yr reoccurrence level per the requirements of ANSI/ASCE 7-95. This requirement is consistent with DOE-1020 standards which are applicable to other INEL structures. Tornado loads shall consider as a minimum ANSI/ANS-2.3.
 - **Flood:** The design flood elevation for the 100-yr flood is 4,917 ft for this area of the ICPP.
- **Off-Normal Operating and Accident Loads**—Loads due to a temperature rise resulting from loss of cooling air for an extended period of time or loads resulting from the maximum anticipated heat load are considered, as well as loads due to a drop of a heavy load as

described in Structural Analysis and Design of Nuclear Plant Facilities, ASCE Manual No. 58.

- Load Combinations—Structures are designed using applicable load combinations and stress limits stipulated in ASCE 7-95, American Institute of Steel Construction, AISC N690, American Concrete Institute, ACI-349.

3.4.3 Footings and Foundations

The building foundation is reinforced concrete consisting of individual spread footings for the steel-framed portion of the building. The hot cell and cask handling areas use continuous wall footings, reinforced grade beams and slab-on-grade construction. Footings are extended beyond the recorded frost depth to a minimum depth of 5 ft below grade. The administrative area slab is limited to office area type loads and is constructed of 5-in.-thick reinforced concrete.

3.4.4 Structural Framing Systems

Hot Cell—The hot cell area is constructed of 5-ft-thick reinforced concrete walls which extend approximately 64-ft in height. Walls are supported by continuous footings and grade beams. The roof of the hot cell is constructed of prestressed concrete girders with precast hollow core panels spanning between girders. An 8-inch cast-in-place concrete topping complete the roof framing construction.

Cask Handling Bay—The walls of the cask handling bay are 2-ft-thick reinforced concrete with 8-ft $\times$ 4-ft pilasters spaced at 30-ft intervals. The wall system is supported by continuous spread footings and tied together with 6-ft $\times$ 4-ft grade beams. The roof is designed with 6-ft deep prestressed concrete girders with precast hollow-core panels spanning between girders. An 8-in., cast-in-place concrete topping completes the roof framing construction.

Administrative Areas—The Administrative area and upper floors of the facility are constructed of braced structural steel framing, steel joists, and concrete decking.

3.4.5 Special Structural Features

Crane Support Systems—The 150-ton cask handling crane is supported by the 2-ft thick concrete wall and pilasters. The concrete walls provide shear resistance in the north-south direction and resistance in the east-west direction is provided by tying the pilasters together with the opposing pilasters and hot cell wall with 6-ft $\times$ 4-ft grade beams and 6-ft deep prestressed concrete girders. The roofs of the hot cell and cask handling bay is designed to transfer the diaphragm forces generated. The crane in the hot cell is supported directly by the 5-ft thick concrete walls.

3.5 Handling Systems

The DTC Handling Systems comprise those systems that are responsible for the physical movement of the fuel from receipt to storage. The primary operating functions of the Handling Systems are:

- Transportation package receiving, unloading and handling

- Fuel transfer from shipping cask to DPC
- Cask transfer and DPC emplacement into storage
- DPC retrieval and loading into the transportation package.

The handling systems are also required to support other tasks such as cask preparation, fuel canning, decontamination, inspection and characterization, and welding. The primary handling systems or interfaces to the handling system are:

- Cranes
 - Cask Handling Crane
 - Cask Preparation Area Crane
 - Fuel Handling Crane
- Cask Transfer System (Trolleys)
- Multipurpose Transfer Cask and Transporter
- Lifting Fixtures
- Cask Work Platforms

Details of each of these systems are provided in the following sections.

3.5.1 Cranes

The design and performance requirements for the cranes in the DTC are provided in ANSI/ANS 57.9. Those requirements are specified by the function of the crane, its location in the process facility, and the importance (from a safety, criticality, and radiological release standpoint) of the lift. Some interpretation of the requirements is necessary to accommodate differences between the facility design and operations assumed in ANSI 57.9 and the design of the DTC as described in this document. The derived requirements specified in the description of the cranes are intended to meet the intent of ANSI 57.9 and the NOG-1 specification which implements most of those requirements.

Because the cost and complexity of single-failure proof cranes are significant factors in the overall design of the DTC, the circumstances that influenced the crane specifications will be discussed here. First, a number of key definitions provide a basis for discussion on how the crane specifications were derived.

The following definitions are from ANSI/ANS 57.9 and ANSI/ASME NOG-1.

Design Events (From ANSI/ANS-57.9)

Design Event I. Design Event I consists of that set of events that are expected to occur regularly or frequently in the course of normal operation of the DTC facility. Examples are the following:

- Transportation package receipt, inspection, unloading, maintenance, and loading
- Preparation of fuel units
- Transfer of spent fuel assembly from DTC to DSS
- Handling of radioactive waste generated during operations
- Insertion of fuel units into or retrieval from storage modules.

Design Event II. Design Event II consists of that set of events that, although not occurring regularly, can be expected to occur with moderate frequency or on the order of one during a calendar year of DTC operation. Examples are the following:

- A loss of external power supply for a limited duration
- A single operator error followed by proper corrective action
- Minor mechanical failure of spent fuel transfer machine during operation
- Failure of any single active component to perform its intended function upon demand
- Spurious operation of certain active components.

Design Event III. Design Event III consists of that set of infrequent events that could reasonably be expected to occur during the lifetime of the DTC. Examples are the following:

- A loss of external power supply for an extended interval
- Major mechanical malfunction involving the spent fuel transfer machine during operation (no loss of shielding but retrieval of fuel required)
- Dropping a fuel unit in a hot-cell area
- Loss of shielding optical oils in a hot-cell viewing window.

Design Event IV. Design Event IV consists of events that are postulated because their consequences may result in the maximum potential impact on the immediate environs. Their consideration establishes a conservative design basis for certain systems that are important to confinement. Typically, this set of events consists of plant-specific design events.

Crane Types and Other Definitions (From ANSI/ASME NOG-1)

Type I Crane—A crane that is used to handle a critical load. It shall be designed and constructed so that it will remain in place and support the critical load during and after a seismic event, but does not have to be operational after this event. Single-failure-proof features shall be included so that any credible failure of a single component will not result in the loss of capability to stop and hold the critical load.

Type II Crane—A crane that is not used to handle a critical load. It shall be designed and constructed so that it will remain in place with or without a load during a seismic event; however, the crane need not support the load nor be operational during and after such an event. Single-failure-proof features are not required.

Type III Crane—A crane that is not used to handle a critical load; no seismic considerations are necessary, and no single-failure-proof features are required.

Critical Load—Any lifted load whose uncontrolled movement or release could adversely affect any safety related system when such a system is required for unit safety or could result in potential offsite exposure in excess of the limit determined by the purchaser.

Credible Critical Load—Combinations of lifted loads and plant seismic events which have a probabilities of occurrence equal to or more than 10^{-7} times per calendar year at the plant of the crane installation. The critical loads handled by the crane, and their duration of lifts, shall be used in the calculations to determine the credible critical load to be considered for the crane in the crane design load combinations which include seismic loadings. The credible critical load shall be specified by the purchaser.

Single-Failure-Proof Features—Those features which are included in the crane design such that any credible failure of a single component will not result in the loss of capability to stop and hold the critical load within facility acceptable excursion limits.

With these definitions, some key assumptions can be made regarding general and specific design requirements for each of the DTC crane systems.

Assumptions:

- Since structural and mechanical design criteria are largely driven by earthquake loads, it is necessary to define what earthquakes fall under which Design Events. The Operating Basis Earthquake (OBE) is assumed to be a Design Event III. The Safe Shutdown Earthquake (SSE) is assumed to be a Design Event IV.
- Any cask loaded with SNF shall be considered a critical load. Many of the casks that are to be processed through the DTC are not licensed for over-the-road transport (onsite only). These casks are not rated for a drop. Even those casks that are licensed are drop-rated only with the impact limiters in place. Although it is unlikely that in any drop scenario that an offsite release could occur, a drop could compromise the confinement barriers of the SNF and significantly impact the health and safety of workers in the occupied areas of the DTC.

- SNF elements handled during remote operations in the hot cell shall not be considered a critical load. The basis for this assumption is twofold: First, the hot cell is designed for remote operations and the consequences of a fuel element drop should not compromise any safety systems, the health and safety of the workers, or result in an offsite release. Second, the fuel handling crane will be designed with sufficient single-failure proof features and system redundancy to recover from equipment failures, off-normal events, and accidents (such as dropping a fuel element).
- Other cranes (regardless of location in the DTC facility) not handling critical loads are not required to be single-failure proof (Type I) cranes. This may appear obvious, but there is some ambiguity between the ANSI/ANS 57.9 and the ANSI/ASME NOG-1 specifications in this regard.

3.5.1.1 Cask Handling Crane. The Cask Handling Crane is a 150/15-ton, top-running, double-girder overhead bridge crane located in the Truck Bay (see Figure 3-3). It is a NOG-1, Type I crane, specified to provide single-failure proof features per the requirements of ANSI/ANS 57.9.

The performance requirements derived from ANSI/ANS 57.9 for the Cask Handling Crane are:

- Provide equipment for off-loading and loading the transportation package for Design Event I
- Provide the capability to load into or remove DPCs from the transfer machine of the DSS for Design Event I

The functional design requirements derived from ANSI/ANS 57.9 for the Cask Handling Crane are:

- The Cask Handling Crane should be designed to accept all of the transportation packages expected to be handled at the DTC.
- The Cask Handling Crane and its support systems shall be designed to withstand all design loadings, including the design phenomena, while remaining in place. The crane may lose its function, but this loss of function shall not result in a loss-of-load incident.

This crane is the major lifting device for handling spent nuclear fuel casks and other heavy equipment in the facility. It is used in conjunction with rigging equipment to load and unload shipping casks and transfer casks from transporters. The 150-ton crane may also be used to load DPCs into the Transfer Casks before fuel transfer. The 15-ton auxiliary hoist is used for lighter-duty work such as removing impact limiters and other rigging equipment. It can also be used for handling smaller casks.

The crane bridge runs on north/south running rails mounted on reinforced concrete walls (see Drawings A-4, A-10, and M-3). The crane rails are approximately 45 ft high and are 90 ft long. The maximum lift of the crane will be approximately 40 ft. The crane ratings are based on the expected loads presented in Table 3-1. The crane is conservatively designed to accommodate future growth and to ensure all possible configurations of casks and rigging do not exceed the rated capacity of the crane.

Figure 3-3. The Cask Handling Crane is a top-running, double-girder overhead bridge crane similar to that shown above.

The Cask Handling Crane is not in a radiation area. The operating environment is typical of a continuously occupied modern indoor nuclear facility. The crane is designed to withstand the SSE, while remaining in place. It may lose its function, but this loss of function will not result in a loss-of-load incident.

Single-failure proof features for a Type I crane are included for both the primary (150-ton) and the auxiliary (15-ton) hoist. Electrically controlled dynamic braking is used.

The crane/bridge trolley drive type shall be an A1 or A-A1, the preferred bridge drive type shall be an A4, and the drive axles will be rotating type. No open gearing shall be permitted.

The crane is controlled via a radio link. A backup pendant control is provided. The crane is to be controlled from the main floor and from the crane maintenance mezzanine.

Table 3-1. Cask Handling Crane load drivers.

Capacity	Drivers ^a
150/15 ton	125 tons—Fully Loaded NUHOMS® MP-187 Cask (approximate) 100 tons—Fully Loaded NUHOMS® MP-197 Cask (approximate) 8 tons—Impact Limiters (each) (TN-REG and TN-BRP Casks and Impact Limiters fall within the NUHOMS® envelope)

a. Does not include the weight of the rigging. All values are rounded up to the nearest ton.

Load weighing devices are provided. Hoist speeds are approximately 5 ft/min for the 150-ton hoist and 25 ft/min for the 15-ton hoist. The maximum trolley and bridge speed is approximately 50 ft/min.

The avoidance of two-blocking is accomplished by the use of single-failure-proof features that do not rely on any action by the operator. The normal hoist limit switch is supplemented by an independent final hoist limit switch operated by the load block to remove power from the hoist motor and brakes.

Equipment is provided to de-energize the crane power supply in a seismic event. The hoist brakes are capable of holding the credible load during a seismic event.

The crane bridge passes directly over the ceiling of the Cask Preparation Area. A restricted handling path will be implemented so that crane loads and rigging equipment do not interfere with the Cask Preparation Area. The handling path is shown on Drawing A-1.

Light fixtures are provided on the crane bridge to illuminate the area below as the crane moves. A signal system is provided to indicate crane operating status. A flashing warning light is provided on the bridge to indicate that the crane is energized, and an annunciator indicates when the crane is in motion.

3.5.1.2 Cask Preparation Area Crane. The Cask Preparation Area Crane is a 7.5-ton overhead crane illustrated in Figure 3-4. It is a pendant-controlled NOG-1, Type II underhung monorail bridge crane except as noted herein. Technically, the NOG-1 specification covers only top running bridge, multiple girder, overhead and gantry cranes. However, NOG-1 specifies the earthquake structural requirements for the crane as well as the desired quality and inspection criteria. For Type II cranes, the Crane Manufacturers Association of America (CMAA) specifications cover all the other design criteria. For this configuration, CMAA-74 "Specification for Top Running and Under Running Single Girder Electric Traveling Cranes Utilizing Under Running Trolley Hoist" shall apply.

The Cask Preparation Area Crane is used for handling cask outer lids, tools, and other heavy equipment such as the DPC welding machine. The crane ratings are based on the expected loads shown in Table 3-2.

Figure 3-4. The Cask Preparation Area Crane will be a NOG-1, Type II underhung monorail with top running bridge crane. It will utilize a 7.5-ton low headroom hoist with motor geared trolley and bridge.

Table 3-2. Loads used for sizing the Cask Preparation Area crane.

Capacity	Drivers ^a
7.5 ton	4 ton—Cask Outer Lid (MP-187 Top Closure) 3 ton—Cask Outer Lid (MP-197 Top Closure) 1 ton—DPC Inner Lid 1 ton—DPC Outer Lid 2 ton—Welding Machine (Includes Neutron Shield and DSC Inner Lid Assembly) (TN-REG/TN-BRP do not have inner lids or shield plugs)

a. Does not include the weight of the rigging. All values are rounded up to the nearest ton.

The crane bridge runs on north/south running rails mounted on reinforced concrete walls (see Drawings A-12, M-3, and M-5). The crane rails are 28 ft high and 30 ft long. The maximum lift of the crane will be approximately 26 ft. The crane is designed with excess capacity to accommodate future growth and to insure all possible configurations of tools and rigging do not exceed its rated capacity.

The Cask Preparation Area Crane is not in a radiation area. The operating environment is typical of a continuously occupied modern indoor nuclear facility. The crane is designed to withstand a seismic event, while remaining in place, although it is not required to retain the load during the seismic event.

3.5.1.3 Fuel Unit Handling Crane. The Fuel Unit Handling Crane subsystem consists of a single overhead running double-girder bridge crane (see Drawings A-11 and M-4) upon which are mounted two trolleys. Each trolley contains a 2.5-ton capacity telescoping z-mast (so called because the mast only travels in the vertical or 'z' direction) with a teleoperated manipulator system mounted on the end of

each mast. Each trolley also incorporates a 15-ton hoist. The fuel handling crane is radio-controlled and designed in accordance with NOG-1 as a Type I crane except as noted herein. This ensures that no single-failure of the handling system will preclude returning the fuel assemblies to their storage locations in the transfer or shipping cask or to lag storage. The crane is designed for both normal operating loads and seismic loads where possible. The electrical system is designed so that the operator can stop and hold a load regardless of the failure of any single component used in normal operations.

The performance requirements derived from ANSI/ANS 57.9 for the Fuel Unit Handling Crane are as follows:

- Provide remote handling of fuel units for Design Event I and after Design Events II, III, and IV
- Provide the capability for special tooling to handle structurally damaged fuel units subsequent to Design Events II, III, and IV.

The most significant functional design requirements derived from ANSI/ANS 57.9 for the Fuel Unit Handling Crane are as follows:

- When provision for remote maintenance is not made, handling equipment for fuel units and transportation package closure lid(s) shall have sufficient redundancy so that no single-failure in the handling system will preclude returning unshielded fuel units to shielded storage locations or returning the closure lid(s) to the transportation package.
- Grapples, lifting attachments, and handling equipment for fuel units and transportation package closure lid(s) shall be designed for remote operations, and active lifting components shall be designed to retain their load and fail in a same manner (i.e., in the "latched" state) in the event of loss of actuating power. An independent, remote means shall be provided to disengage any grapple in the cell in the event an active grapple component fails to operate. Grapple operating envelopes shall be designed to be compatible with all interfacing storage and transportation systems.
- Grapples and lifting fixtures for handling fuel units or transportation package closure lid(s) shall be designed to provide positive engagement during a lift, and the grapples and associated controls shall be designed to minimize the potential for inadvertent disengagement. A means shall be provided to indicate that positive engagement has been achieved and to indicate the disengaged position.
- The cranes shall employ redundant limit switches and interlocks to prevent excessive horizontal movement that could affect operation or cause damage to the units being handled, as well as to prevent excessive vertical movement including two blocking. Redundant means of disconnecting power to the cranes shall be available to the operator. The means shall be independent of, and physically separated from, the normal controls, but conveniently located within the planned work area. Redundant means of braking vertical travel shall be provided. Braking of horizontal motion should be provided as necessary to facilitate the required positioning precision.

- If the possibility exists for fuel units to catch on lips or protrusions during lifting or lowering, the lifting equipment shall have interlocks to sense an unacceptable change (either an increase or a decrease) in hoisting force and automatically stop further travel.
- Remote handling equipment shall be incorporated into the design of the area to permit performance of normal process operations. Particular attention shall be given in the design to methods and equipment required to recover from equipment failures, off-normal events, and accidents.
- Special procedures for handling damaged fuel or damaged fuel units should be anticipated and provisions made in the design.

In addition to the requirements specified in ANSI/ANS 57.9, some of the facility-specific Fuel Unit Handling Crane requirements that must be addressed are the following:

- The Fuel Unit Handling Crane shall be of a flexible design to handle multiple (and often poorly documented) fuel configurations, weights, and attachment (grapple) points. A variety of grapples and other tools for fuel movement shall be provided.
- The system shall accommodate a wide variety of shipping (source) casks.
- The Fuel Unit Handling Crane shall support canning operations.

The design of the Fuel Unit Handling Crane is largely based on the highly successful and proven design used for dry fuel transfer at the INEL Test Area North Hot Shop. Improvements necessary to meet single-failure proof requirements and to provide redundant systems for off-normal events and accident recovery have been added, as well as many basic improvements resulting from the evolution of the hardware.

The following is a general description of the system:

The Fuel Unit Handling Crane uses teleoperated manipulators, a suite of remotely attached tools suspended from the shoulder hook on the z-masts, and/or the 15-ton hoist to grapple fuel assemblies in shipping casks, lift them vertically, and move them to a dry handling bucket. When full, the dry handling bucket is moved with either the z-mast or hoist to either a lag storage location or the DPC. Since the system has a full range of motion in the X, Y, and Z directions, it is adaptable to all of the anticipated cask designs. Furthermore, the z-masts and manipulators are sized to provide manipulator access to most of the Hot Cell below their bridge mount. This full range of motion along with the high degree of dexterity inherent in the design of the manipulators reduces the need for additional in-cell manipulators to perform other tasks. Locating the two manipulators with z-masts on separate trolleys on the same bridge allows for both independent and cooperative manipulator operations for maximum system flexibility. The ratings for the lifting components of the Fuel Unit Handling Crane are based on the expected loads listed in Table 3-3.

Redundant mechanical systems and the single-failure proof features of a NOG-1, Type I crane (e.g., extra-limit switches, dual-reeved hoists, redundant brakes) ensure that no single-failure in the handling system preclude returning unshielded fuel units to shielded storage locations or returning the

Table 3-3. Load drivers for sizing the Fuel Unit Handling Crane z-mast, manipulators, and hoist.

Capacity	Drivers ^a
Hoists—15 ton	15 ton—Lag Storage Plugs 9 ton—BWR/PWR Basket (Qualified for Over-The-Road Transport) 5 ton—DPC Shield Plug (FO or FC) 6 ton—TN-REG/TN-BRP Cask Lid 4 ton—Heavy Fuel Element (Shippingport LWBR)
Z-masts—2.5 ton	1 ton—Nominally Heavy Element 100 lb or less—Light Fuel Element
Manip 1—250 lb	
Manip 2—250 lb	

a. Does not include the weight of the rigging. Values are rounded up to the nearest ton.

closure lid(s) to the casks. This includes the use of two trolleys on the bridge. Each trolley is identical and contains a z-mast with manipulator, and hoist. Each trolley is independently capable of performing all of the duties required to perform a fuel transfer or to recover from the failure of the other trolley. The trolleys are designed to engage and push/pull each other in the event of the failure of a trolley drive unit. The bridge has a dual drive system, either of which is capable of moving the bridge in the event of a failure of one of the drive systems.

The z-masts and the manipulators do not meet all requirements of a NOG-1, Type I crane for two reasons. First, it is not practical from a structural standpoint to design the z-masts to withstand seismic loads with the mast in the extended position. However, the z-masts will withstand the seismic loads while in the stowed (fully retracted) position. During any fuel movement, one of the z-masts will be fully retracted so it will survive a seismic event and be available to recover from the potential failure of the other one. All other aspects of the z-mast's design meet NOG-1, Type I requirements for single-failure proof design. Second, the manipulators are not designed to be single-failure proof. However, they are designed so that the motors will not move under load with the power off. Interlocks on the manipulator prevent inadvertent release of the fuel by locking out the normal release signal when there is a load on the manipulator or grapple. An override capability is provided to allow release when specifically needed. Much of the fuel handling will be performed with grapples meeting the requirements of ANSI/ANS 57.9 suspended from the shoulder hook of the manipulator or from the hoist. The manipulators will primarily be used for rigging, tool handling, removing and installing lid bolts, and other high dexterity tasks. The manipulators will be used for direct fuel handling only when no other means is readily available.

Figure 3-5. An anthropomorphic teleoperated manipulator will be located at the end of each z-mast.

The manipulators are Par 6350 telerobotic manipulators or equivalent (see Figure 3.5-3). The manipulator's configuration is a six-degree-of-freedom anthropomorphic arm that is electrically actuated by the remote master controller. Overall reach of the manipulators is approximately 90 in. Load rating

at any hand orientation is a minimum of 250 lb. The manipulators are electrically-driven and mounted on the end of the telescoping z-mast. Interchangeable end effectors are provided for each of the two manipulators for maximum operational flexibility. A parallel jaw hand, single hook, dual hook, and a wide variety of tools and accessories can be used with the manipulators. A coupling on the wrist assembly allows these tools to be easily interchanged remotely. Coupling or uncoupling of a hand or accessory is accomplished by straight-line motion of a spring-loaded collar on the wrist. Change fixtures for remote operations will be provided. A tool power receptacle located at the wrist permits use of tools equipped with 115 volt ac/dc universal motors up to $\frac{1}{2}$ horsepower.

All wiring is internal and the manipulators are sealed to allow decontamination washdown. Internal motors drive the shoulder pivot, elbow pivot, wrist pivot, and hand. A hook is attached below the shoulder of the manipulator for use with the z-mast to hoist up to 5,000-lb loads. Vertical mast travel is provided using either ballscrew or dual reeved hoists. Vertical mast travel will provide positive drive for mast extension or retraction. If maintenance is required on the manipulators, z-masts, or trolleys, the

bridge will be moved to a crane maintenance area. Panels on the manipulators are designed to be easily removed to allow access for repairs.

The crane control system includes robotic control of the bridge, trolley, and three mast axes with the six manipulator axes. A portable controller suitable for operation from multiple viewing windows will provide the operation interaction with the control system. Bridge, trolley, and mast controls are conventional.

The accumulated radiation exposure expected to be seen at the crane bridge is estimated to be approximately 1×10^5 Rad over the 30-year life of the facility. The accumulated radiation exposure expected to be seen at the electro-mechanical manipulator is estimated to be approximately 1×10^7 Rad over the 30-year life of the facility. Note that the facility life is 30 years with an extension of 30 years possible. If a service life extension is required, equipment will be analyzed for replacement based on actual total exposure. Radiation-hardened optics and electronics for high radiation fields will be utilized. The motor control center for the crane will be located outside the hotcell for ease of maintenance and radiation protection.

Other features and specifications for the Fuel Handling Crane include:

- Single-failure proof features for a Type I crane shall be included for the z-mast and the 15-ton hoist. Electrically controlled dynamic braking shall be used.
- The trolley drive type shall be an A1 or A-A1, the preferred bridge drive type will be an A4, and the drive axles will be rotating type. No open gearing shall be permitted.
- The crane shall be controlled via a radio link. A backup pendant control shall be provided.
- Load weighing devices shall be provided. Hoist speeds will be approximately 25 ft/min for the z-mast and 25 ft/min for the 15-ton hoist. Trolley and bridge speed will be approximately 50 ft/min.
- The avoidance of two-blocking shall be accomplished by the use of single-failure-proof features and do not rely on any action by the operator. The normal hoist limit switch shall be supplemented by an independent final hoist limit switch operated by the load block to remove power from the hoist motor and brakes.
- Equipment shall be provided to de-energize the crane power supply in a seismic event. The hoist brakes will be capable of holding the credible load during a seismic event.
- Light fixtures shall be provided on the crane bridge to illuminate the area below as the crane moves. A signal system shall be provided to indicate crane operating status. A flashing warning light shall be provided on the bridge to indicate that the crane is energized, and an annunciator shall indicate when the crane is in motion.

Pan and tilt camera units with zoom lenses shall be mounted on each of the trolleys to provide wide-area closed-circuit TV monitoring capability for remote operations. Additional cameras shall be placed on the manipulators to provide close views of fuel handling operations. Some cameras may also

be included on fuel handling grapples to aid the operator in picking the fuel elements and to confirm grapple engagement. Cameras shall supplement direct viewing of operations via the operating gallery window control stations. An audio channel shall be provided from the hot cell to the operating gallery. Microphones in the hot cell shall be connected to adjustable volume speakers in the operating gallery to provide operators with audio feedback during operations. This has been proven to be an effective means of increasing an operator's awareness of the situation in the remote operating area.

3.5.2 Trolleys (Cask Transfer System)

The Cask Transfer System includes the trolleys, the rails on which they are mounted, adapters for accommodating different casks, and the attendant control system. The design of the cask transfer system is based on a design prepared by Trans Nuclear Inc., for the DOE Office of Civilian Radioactive Waste Management (OCRWM) for a similar facility.

The trolleys are approximately 11 ft × 9.8 ft × 3.4 ft and have capacities of 125 tons. They run on rails 9 ft apart that are at or slightly below the floor surface level. The main components of the trolleys are made of painted carbon steel. See Drawing M-14.

The cask adapters include tapered centering guides, bolted to the top plate of the trolley, to guide the cask in place during lowering. These centering guides will resist horizontal loading during a seismic event.

The cask is supported on the trolley by means of trunnion cradles and other fixtures with bolted tiedowns. The trunnion cradles are bolted to the top plate of the trolley. The trunnion cradles and tiedowns and other fixtures are designed to prevent the cask from becoming disengaged during a seismic event. The trolley and cask configurations are shown in Drawings M-12 and M-13.

The trolley is driven through one wheel on each side by a synchronous motor. The variable speed motor provides a trolley speed between 0.7 ft/min and 10 ft/min. The trolley moves at its selected fast speed for gross positioning and at the slow speed for fine positioning. Limit switches mounted on the rail stop the trolley and ensure that it is positioned properly in the Cask Staging Area, Cask Preparation Area, and the Hot Cell.

The trolley has two braking mechanisms: a service brake and an emergency brake. The service brake is located on the motor drive shaft. The emergency brake is located on the output shaft. Both brakes engage upon loss of electrical power. The emergency brake is automatically engaged as a parking brake when the trolley is not in motion.

Each trolley is locked in place by a locking pin that engages a corresponding hole in the concrete floor in the Cask Staging Area, Cask Preparation Area, and the Hot Cell. This prevents the trolley from sliding along its rails while work is being performed on the cask. The locks prevent damage to equipment or injury to personnel in the event of inadvertent activation of the trolley. The pins are designed to handle the forces resulting from the combined seismic loading and normal operation loads on the locking pin.

Trolley guidance is provided by two sets of lateral rollers on one of the two runway rails. Lateral rollers are used instead of flanged wheels to ensure accurate positioning of the trolleys on its rails.

Because of the heavy weight of the transfer cask and trolleys, and the need to prevent them from tipping over, a special rail was designed as shown in Drawing M-14.

A plate mounted beneath each trolley, which runs below the runway rail at each wheel location, prevents the trolleys from tipping over in a seismic event.

Bumper guards are located at the end of each runway rail to prevent damage to the trolleys. A tow ring for attaching a pulling device in the event of a motor failure is mounted on one end of the trolley.

The electrical cables for the motor and sensors on the trolley are run under the floor. The slack in the electrical cables is taken by a winder mounted on the base of the trolley.

Sensors are used to ensure that the Cask Transfer System operates properly. Examples of these sensors are:

- Limit switches on the trolleys (one on the front and one on the back), which stop motion in the event of a collision with the bumper guards. These prevent damage to the equipment.
- Limit switches mounted on the rails, which stop the trolleys at predesignated locations in the Cask Staging Area, Cask Preparation Area, and Hot Cell.
- Switches located in the locking pin housings in the concrete floor, which indicate that the locking pins are fully engaged. These are interlocked with the trolley controls to prevent powering the drive motors when the locking pin is engaged.

All maintenance and repair operations are performed manually. To keep personnel radiation exposures as low as reasonably achievable, trolley repairs and maintenance will normally be performed only when the casks are removed. As a minimum, the casks will be closed before any maintenance or repair is done on the trolleys. A tractor or winch can be used to pull the trolleys if the motors fail.

3.5.3 Lifting Fixtures

Lifting yokes are used to remove casks from transporters. The three lifting yokes depicted in Drawings M-10 and M-11 handle all shipping and transfer casks currently identified for use inside the DTC. Each yoke is designed for upending and lifting the variety of shipping and transfer casks. Two of the yokes are open hook designs with parallel lifting arms. The other yoke has closed-hooks, high strength wire rope, and a spreader beam. They are fabricated from high strength carbon steel plate material and are coated with a decontaminable coating. The lifting yokes connect to the hook on the 150-ton overhead crane in the Cask Handling Bay. The yokes are staged on racks for the convenience of attaching the cask handling crane hook. The racks are located on the north wall of the Cask Preparation Area.

Standard lifting and rigging gear are also be used in the facility. Nylon slings, wire rope, eyebolts, and shackles are used in conjunction with the overhead crane to lift the cask transport covers from the transporters and to remove impact limiters. These covers and impact limiters are staged in the Cask Handling Bay for inspection, maintenance, and repairs. Additional standard lifting and handling equipment are staged in the Cask Preparation Area and Hot Cell for lifting and moving cask lids, shield plugs, welding machine, etc.

The lifting yokes are designed and fabricated in accordance with the ASME B&PV Code rules for Class 2 component supports (Section III, D Subsection NF, excluding Subsection NCA), NUREG-612 and ANSI-N14.6 requirements for special lifting devices. Utilization of these criteria meets or exceeds the requirements of 10 CFR 72 and ANSI/ANS-57.9 as well as 10 CFR 50. These codes and standards require that the lifting yokes be conservatively designed and need not be specified as single-failure-proof. These yokes will be designed with factors of safety of 6 on material yield strength or 10 on material ultimate strength.

3.5.4 Multipurpose Transfer Cask and Transporter

The Multipurpose Transfer Cask used in the dry storage system provides shielding and protection from potential hazards during the fuel handling and transfer operations. The transfer cask has a 92.5 in. outside diameter and is 201.5 in. high with a 68-in. inside diameter by 187-in.-high inner cavity and a maximum payload capacity of 200,000 lb. The transfer cask is designed to meet the requirements of 10 CFR 71 and 10 CFR 72 as a multipurpose cask. As shown in Figure 3-6, the transfer cask is a nonpressure-retaining cylindrical vessel constructed of two concentric cylindrical steel shells, a bolted top cover plate, and a welded bottom end assembly. The annulus formed by the two shells is filled with cast lead for gamma shielding. The transfer cask also includes an outer steel jacket which is filled with hydrogen-rich grout for neutron shielding. The top and bottom assemblies also incorporate neutron shield grout. The transfer cask is designed to provide sufficient shielding to ensure that dose rates are less than 200 mR/hr at contact for a DPC filled with 24 PWR or 52 BWR commercial fuel assemblies.

The transfer cask is designed to be loaded with SNF in the vertical position and transported (via custom trailer) in the horizontal position. Two lifting trunnions are provided for handling the cask using a lifting yoke and overhead crane. Lower support trunnions are provided on the cask for pivoting the transfer cask from/to the vertical and horizontal positions on the transport trailer.

The tow vehicle, transfer-cask transport trailer, and cask, are shown in Figure 3-7. The transfer cask transport trailer is a dedicated, 8-axle, 32-wheel vehicle used to transport the horizontal cask and DPC over a road leading from the DTC Truck Bay to the basemat. The trailer has a 125-ton payload, is 21 ft long $\times$ 12 ft wide, and with the heavy haul road tractor, has a turning radius of 8.5 ft. Hydraulic jacks at all four corners raise and align the cask with the Horizontal Storage Module (HSM) before the DPC is inserted. The trailer is equipped with a hydraulic ram for pushing the DPC out of the cask and into the HSM. When the DPC is eventually removed from storage, the ram pulls it out of the HSM and back into the transfer cask.

The steps required to place the DPC in the HSM are as follows: The cask with DPC will have been placed on the trailer, lowered to the horizontal position, and the trunnion tie downs will have been installed as part of the DTC cask handling operations. The tow vehicle will be coupled to the trailer and the entire assembly hauled to an empty HSM. The tow vehicle, with the aid of the individual trailer axle steering system, will align the cask with the HSM. This configuration is shown in Figure 3-8. An optical alignment system is used to adjust the trailer corner jacks to align the DPC with the rails in the HSM. The top lid (back end) of the cask is removed, the HSM shield door is opened, and the ram penetration cover plate is removed from the bottom (front end) of the cask. The ram is then extended through the cask penetration port, coupled to the ram grapple ring on the bottom to the DPC, and actuated to push the DPC into the HSM on the guide rails. When the DPC is fully inserted, the ram is withdrawn and the HSM shield door is closed. The cask top cover plate and ram penetration cover plate are replaced, the corner jacks withdrawn, and the trailer and empty cask are towed from the basemat.

Figure 3-6. DPC transfer cask.

Figure 3-7. The onsite DPC transfer cask is mounted on a dedicated transport trailer with tow vehicle.

Figure 3-8. The onsite DPC transfer cask is designed to interface with the horizontal storage module.

3.5.5 Shipping Cask Handling

SNF shipments will arrive at the DTC in shipping casks transported on tractor-trailers. Drawings M-12 and M-13 show the envelopes and configurations of the 14 casks (mounted on cask transfer trolleys) expected to be used in shipping SNF to the facility. Table 3-4 summarizes the various shipping cask features.

3.5.6 Cask Work Platforms and Bucket Racks

The DTC facility is equipped with two fixed overhead work platforms; one is located in the Cask Handling Bay and the other is in the Cask Preparation Area (see Drawing M-8). These work platforms provide a safe and convenient elevated work area for personnel working around the tops of various casks. The platforms are required for regular maintenance and operations. Both work platforms are similar in design and incorporate steel grating with adapter grating sections for different diameter casks. Access to these elevated work areas is by a rolling stairway. This allows for the stairway to be moved out of the way when not in use to free-up valuable floor space for other operations. The work platforms are designed per OSHA and ANSI standards and are fabricated from carbon steel materials covered with a decontaminable coatings. The rolling stairways are commercially available and come in a variety of sizes and configurations to meet the needs of the DTC facility.

The work platform located in the Cask Handling Bay is fabricated with two structural beams as the base structure. The grating is fastened to the beams. This assembly is in two separate sections for ease of handling. The beams locate in different column pockets fabricated in the wall structure of the facility. The pockets are positioned vertically and correlate with various height casks. Three different pocket heights are necessary to access the tops of all the casks entering the facility. The cask handling crane is used to lift each beam and attached grating separately from one pocket to another depending on the height of the cask. The beams and attached grating are also removable and can be placed on a trailer bed and moved out of the facility when not in use. The grating is sized for the largest diameter cask with adapter sections easily positioned with the crane for smaller casks. Handrails and kick plates are features necessary for safety. Some sections of handrail are removable for operations requiring such. The rolling stairway, mentioned above, is used to provide access to the highest elevated position of the work

Table 3-4. Fourteen configurations of shipping casks have been identified that may be received and processed by the facility.

Shipping cask	Shipping mode	Outside dimension	Inside dimension	Weight (without impact)
High Load	Truck	35-in. sq × 69-in. high	13.5-in. sq × 51.5-in. high	27,250 lb (empty)
ATR	Truck	35-in. dia × 74-in. high	12.8-in. dia × 52.5-in. high	29,000 lb (empty)
Ft St Vrain	Truck	28-in. dia × 208-in. high	17.7-in. dia × 187.6-in. high	47,600 lb (empty)
Peach Bottom	Truck	42.62-in. dia × 173.12-in. high	26-in. dia × 159-in. high	62,000 lb (empty)
TN-BRP	Transporter	83.24-in. dia × 190.5-in. high	64-in. dia × 171-in. high	197,340 lb (max)
TN-REG	Transporter	90.25-in. dia × 180-in. high	71.75-in. dia × 163.25-in.	209,100 lb (max)
NAC-LWT	Truck	44.2-in. dia × 199.8-in. high	13.38-in. dia × 180.90-in.	51,200 lb (max)
NLI-1/2	Truck	47.13-in. dia × 195.25-in. high	13.38-in. dia × 178-in. high	46,200 lb (max)
GE-2000	Truck	38.5-in. dia × 71-in. high	26.5-in. dia × 54-in. high	33,550 lb (max)
IU-04	Truck	35.45-in. dia × 96.50-in. high	31.30-in. dia × 37.80-in.	45,000 lb (empty)
HFEF-6	Truck	32.75-in. dia × 92-in. high	6-in. dia × 67.38-in. high	29,900 lb (empty)
NFS 100	Truck	70.25-in. dia × 128.31-in. high	40-in dia × 103-in. high	TBD
GA-4	Truck	TBD	TBD	TBD
NRF-Large Cell*	Truck	81.50-in. dia × 165.50-in. high	55.50-in. dia × 139-in. high	220,000 lb (max)

platform. A fixed ladder attached to one beam and grating section is used to access the two lower positions.

The rolling stairway is used throughout the Cask Handling Bay for other operations requiring elevated, but limited, access. These operations include rigging and removal of the cask shipping cover and impact limiters, cask removal from the transporter, cask and DPC maintenance and inspection, and cask positioning on the trolley.

The work platform located in the Cask Preparation Area serves as an elevated work area for numerous required operations. Some of these operations are preparing the cask lid for removal, gas sampling, cask exterior decontamination, welding of DPC lids, weld NDE operations, vacuum drying, and cask cavity inerting. The design of this work platform is similar to the one described above with the exception that this one has folddown grating. This feature is necessary due to limited space available in the Cask Preparation Area. The grating folds up and out of the way to allow for positioning of the cask and trolley. Positioning is accomplished using a locator pin on the trolley base and a corresponding

sleeved hole in the concrete floor. As the cask is moved on the trolley into the Cask Preparation Area, the trolley is stopped at the proper location and the locating pin is inserted in the hole to ensure exact positioning. The folding grating, sized for the largest diameter cask, is lowered into position around the cask. The handrail is inserted around the outside of the grating, and adapter plates are installed as needed depending on the cask diameter. This platform is accessed using the same rolling stairway described above.

The Hot Cell has no fixed work platform. Most operations in the Hot Cell will be accomplished remotely. Only minor operations require personnel access to the tops of the casks in this area. Therefore, two rolling stairways of different heights are used to access various parts of the casks. These stairways remain in the Hot Cell and will be moved out of the general work area when not in use.

The Hot Cell is equipped with a set of racks for staging Dry Handling Buckets (DHB) for dry fuel transfer operations, and empty fuel cans for canning (see Drawing M-7). The racks are mounted on the east-west running wall of the Lag Storage Area and will be capable of holding up to 21 DHBs or cans. The racks are adjustable to accommodate varying lengths of DHBs and cans. Empty DHBs and cans are staged in the rack prior to fuel transfer operations in the numbers and sizes required for each campaign. The racks will be fabricated from stainless steel or carbon steel covered with a decontaminable coating.

3.6 SNF Packaging Systems

3.6.1 Canning System

This section describes the processes and equipment required for minor canning of SNF. The term "minor canning" refers to the packaging of relatively intact SNF into sealed cans to provide its first high integrity containment boundary. Only the Peach Bottom fuel (Cores 1 and 2) are considered suitable for the minor canning operations described below. Physical descriptions of the Peach Bottom fuel are provided in Table 3-5.

Table 3-5. Peach Bottom fuel data.

Fuel name	Unit form	Weight (lb)	Unit diameter (in.)	Unit length (in.)
Peach Bottom Core 1	Can	150	4.73	158
Peach Bottom Core 2	Element	90	3.50	126

The Peach Bottom fuel is stable but requires canning as a result of degradation of the cans that currently contain some of the fuel, cracked fuel spheres, or other degradation that raises questions concerning the long-term integrity of the containment boundary.

The concept developed for the minor canning operation is based on the assumption that the fuel, in either bare fuel or already-canned configurations, will be placed into new cans without decanning or other significant preparation.

3.6.1.1 Canning System Overview. As shown in Drawings M-1 and M-6, the canning station area is separated from the rest of the hot cell by a 4-in. high curb and the lag storage vault structure. It is located in the DTC Hot Cell next to the lag storage vaults. This location provides acceptable direct viewing through shielding windows, and leaves the Hot Cell main floor clear for normal fuel transfer and handling operations. All racks and stands are constructed of stainless steel, and the walls and floor in the canning station area are coated to facilitate decontamination. The average canning throughput capacity is two finished cans per day.

The overall sequence of operations is illustrated in Figure 3-9.

3.6.1.2 Can Description. The cans are made of 12-in. diameter, Schedule-10, stainless steel pipe. They have an internal cavity length of 161.50 in. and are similar to the dry handling buckets (DHB) discussed in Section 3.7.2. The can lids, which are ultimately welded to the cans, have a vacuum/pressurization port and are designed so purging, evacuating, leak testing, and back-filling with an inert gas can all be accomplished remotely.

The cans have an internal design pressure of 15 psig and a design temperature of 380°C.

Support spiders or cruciforms are used to restrain the fuel inside the can. Two such configurations are used: a spider structural support configuration (capable of holding up to seven elements) is used for

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Figure 3-9. SNF Packaging System flow diagram.

bare fuel elements and a cruciform (four quadrants) structural support configuration is used for previously canned fuels.

3.6.1.3 Canning Station Operations. After the SNF is moved into the Hot Cell and removed from the shipping cask, it is visually checked through the shielded viewing window(s) and by closed circuit television. Visual checks and inspection information will include determining the identity of the fuel unit, whether the fuel unit is intact or broken, whether any corrosion is present, the general condition of the fuel unit, and if the fuel unit requires any special handling.

If the incoming fuel unit is already canned, and if there are no obvious holes in the can wall, it is sent to the can piercing machine. If the fuel unit consists of a bare element, or if the can wall is obviously breached, it is then sent to the can loading station.

The following sequence is typical for Peach Bottom SNF canning operations:

Can Piercing: If the fuel is contained in an old but apparently intact can, it is moved to the can piercing machine. Can piercing is performed to ensure the contents can be dried during vacuum drying operations. The can piercing equipment is pneumatic and is designed to avoid penetrating the fuel inside the can.

The can piercing equipment holds the can in a vertical position without crushing the can. Once the can is secured, the piercing unit produces an opening into the can from the side at the top. As the piercing device is brought into contact with the side of the can, a seal on the end of the collar mates with the can side. A spring behind the collar provides the force to maintain the seal as the penetrating device produces an opening and is backed out. This method does not produce any chips or additional waste requiring disposal and produces a quick and clean penetration into the can.

As the penetration is made, the released gas is captured within the piercing head assembly and piped to a sampling system as shown in Figure 3-10. If the analyzer indicates that the can contains hydrogen, the can is purged with helium until the hydrogen level is low enough to allow safe handling. The gas is released to the DTC ventilation system and exhaust stack following the analysis. See Drawing M-9 for the canning equipment layout and the can piercing machine details.

The stand for the can piercing operation is fastened to the floor at the base and is capable of supporting the hardware with a loaded can in the event of an earthquake.

Can Loading: The can loading station consists of a support stand and a clamping mechanism. The new, empty can is placed on the base and the clamping mechanism is actuated to hold the can in the proper location. Bare fuel elements and pierced or breached cans are moved with the fuel handling crane to the can loading station and lowered into a new can. A lid is retrieved from the can/lid storage rack and placed on the can. The lid is then ready to be welded to the new can.

Like the piercing stand, the stand for the can loading operation is fastened to the floor at the base and is capable of supporting the hardware with a loaded can in the event of an earthquake. See Drawing M-9 for system hardware details and Drawings M-1 and M-6 for equipment layout within the Canning Area.

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Figure 3-10. Can piercing system and operational sequence.

Can Lid Welding: Once the cans are loaded, they are closed by welding on a lid. A gas-metal-arc-welding (GMAW) process is used, which is a common automatic welding application. The can welding station consists of the support stand (the same stand as used during can loading), a remotely operated welding arm with associated welding machine, gas supply, and a wire wheel. The welding power supply will be a shared unit with the DPC lid welding operations (see Section 3.6.2.1, DPC Automatic Welding System). See Drawing M-9 for the can welding system hardware, and Drawings M-1, M-5, and M-6 for equipment layout within the canning area.

Fuel Drying: The fuel drying operation (vacuum drying) is performed to remove water that may be present on the fuel or in the old cans. If sealed in the new can, water could support corrosion or potential pressurization resulting from radiolysis. The drying operation is performed in the same stand as the loading and welding. The lid of the can contains a port for attaching to the drying system and to gas supply used for purging, inerting, and pressurizing. The vacuum system is remotely connected to that port and the system is started. The vacuum exhaust is filtered prior to release into the ventilation system and exhaust stack. Depending on the fuel configuration and condition and on the amount of water present, the drying process may be relatively short (several minutes), or it may take several hours.

To test for dryness, the can is evacuated below the saturation pressure of water and isolated. If the pressure remains constant, the can and its internal contents are dry. If the pressure rises and stabilizes, water is present, in which case the vacuum drying continues. If the pressure continues to rise above the saturation pressure an air leak into the can is present and weld repair is required.

Can Seal/Purge/Inert/Leak Check: After the fuel has been dried, the can is pressurized with helium and checked for leaks. A sniffer probe attached to the electromechanical manipulator is maneuvered around the can and "sniffs" for helium around the lid weld area. If the can leaks, the weld is repaired and the leak test repeated. During the entire process, the can/lid assembly remains in the same support stand.

Once the integrity of the can weld/seal has been verified, the can is purged and filled with helium at nominally ambient pressure. The can vent/purge port is sealed by remotely welding and the can is ready to be introduced back into the normal process flow. The cans will be moved remotely using the fuel handling crane.

3.6.1.4 Canning System Equipment.

Closed Circuit Television (CCTV): An arrangement of lights and three cameras, specifically dedicated for canning, provide visual access to the canning area and the inside of the can. The cameras are located to allow for viewing of general operations and the specific tasks involved in canning. The cameras have zoom capability and are mounted on pan-and-tilt mechanisms. The CCTVs will aid the operators in can loading and setup processes as well as the various welding, leak checking, and other operational steps that may be in a blind area of the viewing windows. In addition, the system permits close-up viewing of key components, assesses equipment operation, and aids in component failure analysis.

Can/Lid Storage Rack: A stainless steel can/lid storage rack is used to temporarily store the empty cans/lids. The capacity of the rack is five cans and lids.

Fuel and Can Handling Tools: Specialized fuel and can handling tools have been identified for operations within the fuel canning process. These tools are described below:

- **Can/Lid Grapple:** This grapple is a new tool that will be used to remotely handle the new fuel cans and lids.
- **Peach Bottom Can Handling Tool:** The Peach Bottom can handling tool is an existing tool used to remotely handle the Peach Bottom Core 1 fuel (fuel in existing cans). Refer to existing LITCO Drawing Number 097984 for details. This tool may need slight modifications to accommodate the proposed canning process.
- **Peach Bottom Fuel Handling Tool:** The Peach Bottom fuel handling tool is an existing tool used to remotely handle the Peach Bottom Core 2 fuel (bare fuel element). Refer to existing General Atomics Drawing Number 800-156-15005 for details. This tool may need slight modifications to accommodate the proposed canning process.
- **Peach Bottom Fuel Handling Tool Grapple:** This is a new tool used with the Peach Bottom fuel handling tool to pull the fuel element out of the can.

3.6.2 DPC Welding, Drying, Purging, Inerting, and Sealing

After a DPC has been loaded with fuel in the Hot Cell the shield plug is installed, the DPC is surveyed and decontaminated as required, and it is moved on the trolley to the Cask Preparation Area for

final preparation for storage. The hinged deck plates of the Cask Preparation Area work platform are lowered into place around the cask and the handrails installed.

The operations performed to prepare the DPCs, and the equipment used in those operations are discussed in the following subsections.

3.6.2.1 DPC Automatic Welding System. The canister automatic welding system consists of two major components: the welding machine, shown in Figure 3-11, and the control console and power supply shown in Figure 3-12. The control console and power supply are located in a Weld Observation Area on the second level of the facility next to the Cask Preparation Area as shown on Drawings M-2 and M-5. The welding power supply will be shared with the welding machine for the canning operations as described in Section 3.6.1.

The Weld Observation Area is provided with a viewing window into the Cask Preparation Area where the weld machine resides and welding of DPC lids takes place. The weld machine is connected to the console and power supply with electrical cables and gas and coolant tubing. The welding system is designed to be controlled by a single weld operator from the control console, who views the welding operations through the viewing window and the CCTV system. Another operator is needed to enter the

Cask Preparation Area to observe and perform weld machine setup and removal operations. An intercom system is provided for their communication. Maximum radiation fields at the top of the DPC are expected to be on the order of 300 mR/hr and the use of the automatic welder is essential for ALARA operations.

The Cask Preparation Area crane lifts the automatic welder, which has been previously attached to the DPC inner lid, to the top of the cask and positions it on the DPC. The lid is then automatically welded in place. The weld is a multiple-pass weld and when completed forms the inner pressure boundary of the DPC that confines any radioactive particles in the DPC cavity. The weld is inspected and repaired if necessary. Upon successful completion of the inspection, the DPC is ready for the vacuum drying process (see the following subsection). At the completion of the drying process, the inner lid weld is helium leak tested. If leaks are not detected, then purging and inerting operations are performed, the inner lid ports are sealed, and the outer DPC lid is welded, using the automatic welder, in much the same way as the inner lid. The outer lid weld also receives an inspection to ensure its integrity.

3.6.2.2 DPC Vacuum Drying/Purging and Inerting. With the inner lid welded to the DPC, the canister is ready for vacuum drying, purging, inerting, and helium leak testing. The vacuum drying process evacuates the DPC cavity and lowers the moisture content to an acceptable level. The vacuum drying system is located inside the Cask Preparation Area. The system includes an air cooled heat exchanger and fan to supplement the vacuum pump's internal oil cooler during helium pump down. The system occupies a 3 ft by 4 ft space on the Cask Preparation Area floor. All controls and instrumentation for the system are mounted in a control console. Operator access is required only at the beginning and end of the evacuation and backfill operations.

The suction line of the vacuum drying system is connected to the DPC vent and siphon ports. A hose is connected from the discharge outlet of the vacuum drying system to the Hot Cell radioactive liquid waste system. A particle filter is located on the suction side of the vacuum drying system. The filter is used to capture any radioactive particles that may be entrained within the gas thereby preventing contamination of the vacuum drying system. A trap and drain in the vacuum discharge line allows any

Figure 3-11. Automatic Welding System.

Figure 3-12. Control Console and Power Supply.

liquid water remaining in the DPC cavity to be routed directly to the waste system. The vacuum drying system is completely closed so that all radioactive material is confined within a controlled system.

Helium is used to purge and inert the cavity of the DPC. Purging and inerting of the cavity atmosphere prepares the fuel for storage. At the completion of the vacuum drying process, the DPC cavity is filled with helium and a leak test is performed to assure that the canister is leaktight. The DPC is pressurized with helium to 22 psia and tested using a helium leak detector. If leak testing fails, repairs are made to the weld and the canister is tested again. The leak detector is mounted on a cart and is located inside the Cask Preparation Area. The cart is approximately 2 ft wide by 3 ft long.

Once the DPC lid welds pass the leak test, the DPC cavity is purged with helium to inert the atmosphere and pressurized to 17 psia. The vent and siphon ports are then welded closed and a final leak check performed. The purge and inert gas supply is located on the main level of the DTC in the Cask Staging Area. With the DPC cavity inerted, the outer DPC lid is welded in place following the procedure used for the inner lid.

3.7 SNF Storage

3.7.1 Lag Storage Area

Four lag storage vaults, shown in Drawings A-1 and A-10, are embedded in an elevated floor of the Hot Cell. A lag storage port is formed by a shielded concrete cavity within the hot cell. The cavity is 72-in. in diameter by 210-in. deep with a minimum of 3 ft of concrete shielding surrounding it. A 3-ft-thick, stepped concrete shield plug provides top shielding and access to the port. A 67.25-in. outside diameter by 167-in. high by 5/8-in. thick removable stainless steel sleeve is inserted within each port. The sleeve has a large drain port at its bottom plate for draining to a collection tank any water that might enter. The sleeve can be removed for decontamination or maintenance. The 2.38-in. radial annulus between the lag storage concrete cavity walls and the outside sleeve is used for natural convection cooling of the SNF that will be contained in a 14-tube DPC basket located within the sleeve. A 14-tube DPC basket can be removed from the sleeve for decontamination or placement in a DPC. The standard DPC basket is used in the lag storage port because it affords SNF handling operations identical to those used in loading the DPCs. The lag storage basket accepts various buckets containing fuel that will subsequently be placed in identical baskets within the DPCs.

The concrete shielding will protect personnel in the Cask Preparation Area, Hot Cell, and operating gallery from gamma and neutron radiation. The dose rate at the exterior of the Hot Cell wall in the operating gallery will always be below 0.125 mrem/hr. Calculations also show that the dose rate inside the Hot Cell at the outside of the three-ft thick lag storage walls will also be less than 0.125 mrem/hr when the lag storage ports are full of fuel.

The lag storage vault stainless steel liners are removable for ease of decontamination. During removal and decontamination, no trolleys or casks would be inside the hot cell. A drain in the bottom of the port prevents inadvertent buildup of decontamination water from moderating fuel within the lag storage vaults (although the fuel in the vaults will be critically safe in the full moderated and reflected condition). Effluent will drain into the hot cell floor drain system and be routed to a collection tank.

Lag-storage vault lid lifting eyes allow lid removal using the hot cell crane. Normally, only one lag storage port at a time will be open. When removed, the lid of the open port will be placed on or close to the closed lid of another port. Administrative controls will ensure that individuals never enter the hot cell unless all lag storage ports that contain fuel have their lids installed.

The allowable cladding temperatures for stainless- and Zircaloy-clad commercial fuel are 380°C and 340°C for 5- and 10-year cooled fuel, respectively. It will be assumed that all of the DOE SNF in the DTC will be subject to the 340°C cladding temperature. The lag storage vaults incorporate bottom and top air passages for convection cooling of the outside of the lag storage liner wall. The top passage connects to the Hot Cell exhaust air plenum just south of the lag storage ports. This results in forced cooling of the lag storage ports when the Hot Cell exhaust fans are operating and the exhaust ductwork is not valved out. If the Hot Cell exhaust shuts down the lag storage port cooling will revert to natural convection circulation through the top and bottom cooling passages. The lag storage ports will only be used to temporarily store offsite fuel that arrives in small quantities and cannot be transferred into a DPC without excessive dead time between the next shipment to be placed in that DPC. The large volume fuels in this category are Dresden, offsite TRIGA, Pulstar-Suny-Buffalo, and Pulstar-N.C. State Univ. Only one port is required for all the Dresden fuel and a separate port will be used for the TRIGA. The Pulstar-Suny-Buffalo and Pulstar-N.C. State University fuels can all be placed in four of 14 tubes of the third lag storage 14-tube basket. The fourth lag storage port is a spare.

3.7.2 Dry Storage System (DSS)

The DSS consists of an outdoor concrete basemat equipped with lighting and remote area monitors (RAMs), concrete HSMs located on the basemat, and the loaded, sealed, inerted DPCs (including their internal baskets, buckets, cans, and SNF loads). The transfer cask and its transporter and tow vehicle used to deliver and install the DPCs into the HSMs are described in Section 3.5.4. A description of the cask and transporter operations necessary to load the DPC into the HSM is also given in that section. Appendix E contains criticality safety analyses for six candidate fuels that make up approximately 90% of the total SNF to be loaded in the Dry Transfer Cell. Appendix E describes the configurations of the DPCs loaded into the MP-187 cask, as well as loaded into the HSMs. The results indicate that all K_{eff} values for the proposed loadings are less than 0.95. Initial shielding calculations indicate that the maximum dose rates at the outside of the MP-187 cask and the HSM, for worse-case fuel (FSVR), will be 26.5 ± 4.8 mrem/hr and the 0.55 ± 0.23 mrem/hr respectively.

3.7.2.1 Basemat. As indicated in Drawing C-1, the basemat is located south of ICPP 665. It is a 3-ft-thick reinforced concrete basemat that is 675 ft long and 276 ft wide. Further structural details of the details of the basemat can be found in Section 3.2.6. It is sized for a maximum of 240 HSMs, including 30 for the TMI debris cans, 100 for DTC fuel, and 110 for other TAN fuel and DOE SNF that will be processed in the future canning facility to be built next to the DTC.

3.7.2.2 Horizontal Storage Modules. The modules and basemat are located as shown on Drawings T-1, C-3, and C-5. A typical HSM is shown in Figure 3-13.

The module is a rectangular, thick-walled, precast, reinforced-concrete vault designed to provide 10 mrem/hr at contact on all accessible vertical walls when loaded with a single DPC containing 52 BWR or 24 PWR commercial fuel elements. Each module is 20-ft long $\times$ 15-ft high $\times$ 9-ft, 8-1/2 in. wide. The wall thicknesses are as follows: roof, 3 ft; front wall, 2.5 ft; side walls, 1.6 ft; and back wall,

Figure 3-13. NUHOMS® horizontal storage module.

1 ft; floor slab, 1 ft. Each module contains a DPC support structure with steel rails to receive and store one DPC in the horizontal position. Each module has a front-shielded door and opening for insertion of the DPC. After the DPC is inserted, the door is closed and welded for physical security purposes. The weight of an HSM with a loaded DPC inside is approximately 300,000 lb.

The HSMs are generally placed in double rows on the basemat (see Drawing C-3). The HSMs are placed back-to-back and side-by-side in the rows to reduce the size of the basemat and to reduce the HSM back and side wall thickness since they will face each other and create an exclusion zone between them. The distance between each double row of HSMs is 50 ft. This distance is required to maneuver the tow vehicle and transporter with the transfer cask for unloading of DPCs into the HSMs. Each DPC inside an HSM is cooled by a passive, natural-draft convection system in the HSMs. This consists of air inlets and outlets cast into the bottom and top, respectively, of the HSM side walls. A 6-in. gap is maintained between the sides of adjacent modules in the row to allow air to circulate through these vents.

Bird screen mesh is placed over this gap to prevent intrusion. Each module is designed to maintain the fuel cladding of 52 BWR or 24 PWR commercial fuel elements, within a DPC, below the allowable cladding temperature at fuel heat-generation rates of up to 24 kW per DPC. The modules are designed to withstand seismic accelerations, ambient temperatures, tornados, and floods within ranges that could be incurred at the INEL. The modules at the end of each row require an additional 2-ft of concrete shielding to achieve a maximum of 10 mrem/hr all around the double row. The radiation field between adjacent

modules and above them may be considerably higher than this; however, these are exclusion areas and will not be occupied.

3.7.2.3 Dual-Purpose Canisters. Dual-Purpose Canisters (suitable for storage and shipping) are used for storing the SNF. Each DPC consists of a shell assembly, a removable fuel basket, a top shield plug, and two top cover plates. The DPC shell that will be used for all of the DTC fuel is the NUHOMS® PWR FO-DSC. This DPC was chosen because it can be handled by the NUHOMS® MP-187 cask, transporter, and tow vehicle that will already have been purchased by the Three Mile Island (TMI) Core Debris Canisters Storage Program. This DPC is 186.2 in. long $\times$ 67.25 in. outside diameter with a 0.625-in.-thick wall and an internal cavity length of 167 in. The DPC shell has a permanent bottom shield plug and end plate, a removable top shield plug, and two steel top plates that, when welded to the top of the shell, form a secondary confinement barrier (the primary confinement barrier is formed by the fuel cladding or can for all fuel that will be handled in the DTC). The DPC shell also has integral internal lifting eyes and purge and vent ports. Drawing M-18 shows views of the PWR-FO-DSC with the three baskets that will be used to store all fuel handled in the DTC.

3.7.2.4 DPC Baskets. Each DPC will hold one of three special designs of DPC baskets that in turn hold buckets or cans of SNF. The three special baskets are the Fluor Daniel design (Reference 2) of the 14-Tube basket, the Shippingport LWBR 3-Tube basket, and the Fort St. Vrain (FSVR) 7-tube basket. These three baskets are shown in Drawings M-15 and M-16. The baskets are not permanently attached to the shell, and may be lifted in and out by an overhead crane. Neither the standard NUHOMS® BWR nor PWR baskets will be used for any of the DTC fuel.

3.7.2.4.1 14-Tube Basket—The 14-Tube basket, shown in Drawing M-17, consists of 22 transverse carbon steel spacer plates evenly spaced along the 167-in. cavity length of the DPC shell. They are held in position by four large tie rods that span the full internal cavity length. A pattern of 14, 13-in. diameter holes machined in each spacer plate forms 14 "tubes" that span the full basket length. This basket design is similar to that recommended by Fluor Daniel in Reference 3. This basket contains no neutron-absorbing poison material, and is designed to receive 12-in. Schedule-10 pipe buckets and cans described below. These baskets will be used to store all DTC fuel except Shippingport light water boiling water reactor (LWBR), FSVR, and Pathfinder. Approximately 40, 14-Tube baskets will be required for all DTC fuel.

3.7.2.4.2 Shippingport LWBR 3-Tube Basket—The LWBR 3-Tube basket, shown in Drawing M-17, is a special design that will hold only one type of fuel. That fuel consists of the 40 Shippingport LWBR elements currently stored in ICPP 749. Each of these elements is stored in a 25.57-in. outside diameter $\times$ 158-in.-long canister. It was decided not to remove the LWBR elements from these cans because the elements have complex shapes that would require many special DPC basket designs. In addition, the LWBR cans contain shock-absorbing material that prevents the element from crushing (if dropped from a height up to 8 in.) into a shape that could produce a criticality excursion if it was subsequently exposed to moderating water. Only three of the 25.57-in. LWBR cans will fit in a standard 67.25 in. diameter DPC and therefore the basket has three corresponding "tubes." The basket construction is similar to the 14-Tube style described above, and consists of 22 transverse carbon steel spacer plates evenly spaced along the 167-in. cavity length of the DPC shell. They are held in position by four tie rods that span the full internal cavity length. A pattern of three, evenly spaced 26-in. diameter holes machined in each spacer plate forms the three tubes that span the full basket length. These baskets

contain no neutron absorbing poison material. Twenty-two 3-Tube baskets will be required for all Shippingport LWBR fuel.

3.7.2.4.3 FSVR 7-Tube Basket—The FSVR 7-Tube basket, shown on Drawing M-17, is a special basket designed to hold 35 bare FSVR hexagonal fuel elements stacked five high in each of seven hexagonal full length tubes. Each hexagonal basket tube is a 3/4-in.-thick SST hexagonal tube with an inside opening that is 16.65-in. across the corners. One tube is located in the center of the basket, with six more close-packed around it for a total of seven tubes. Besides holding FSVR fuel, each of these baskets, with the use of the Pathfinder bucket described below, will be used to store seven Pathfinder fuel elements currently in ICPP 666. These baskets contain no neutron-absorbing poison material. Approximately 16, 7-Tube baskets will be required for all FSVR and Pathfinder fuel.

3.7.2.5 Dry Handling Buckets. Drawings M-15 and M-16 show some details of the buckets. All fuel, except that from FSVR and Shippingport LWBRs and Peach Bottom, will first be placed in buckets within the DTC, before being placed in a DPC basket. All fuel that will be placed in 12-in. Schedule-10 buckets will be, in turn, placed in a 14-Tube basket. As explained above, the Pathfinder fuel will be placed in a 14-in. Schedule-10 bucket that will in turn be placed in an FSVR basket.

3.7.2.5.1 12-in. Schedule-10 SST Buckets—The 12-in. Schedule-10 SST bucket designs are shown on Drawings M-15 and M-16. The buckets allow a small and manageable number of DPC Baskets and SNF items to be handled, while providing efficient SNF fuel packing within the DPCs. The bucket designs do not include poison, but the option to use poison has been maintained. As indicated in the bucket drawing, the 12-in. Schedule-10 buckets consist of one of four lengths of 12-in. Schedule-10 pipe, one of nine styles of cruciforms, and one style of lid. The cruciforms hold and separate the individual fuel elements. Each bucket has a lid that attaches with two 1/2-13 UNC captive screws after the fuel is loaded inside it. Each lid has a lifting-eye for transferring the bucket into the lag storage or into a 14-Tube DPC basket. The buckets are designed in four lengths as shown in the drawing. Eleven different 12-in. Schedule-10 bucket designs are required for all fuel to be handled in the DTC. A Table on Drawing M-16 shows each fuel, along with details of the bucket design and required bucket quantities. Five hundred eighty six 12-in. buckets are required.

3.7.2.5.2 14-in. SST Buckets—All of the Pathfinder fuel rods are stored in seven cans, each of which is too large to be placed in a 12-in. Schedule-10 pipe bucket. Therefore, a special 14-in. Schedule-10 pipe bucket was designed for Pathfinder cans. The Pathfinder bucket is also shown on the bucket drawing. They are 103-in. long including the bolted lid, with a cruciform made of four plates that form a single cell large enough for a single Pathfinder element. This bucket and its lid are similar to the others except that they have a larger diameter that will fit inside a tube of an FSVR 7-Tube basket. As the Table on Drawing M-16 shows, a total of seven 14-in. buckets is required. The 103-in. length of this bucket will allow 14 FSVR elements (two stacked above each bucket in each of the seven FSVR basket tubes) to be stored in the same DPC. Note that all seven Pathfinder fuel cans can be placed in one DPC along with 14 FSVR elements. The single Pathfinder DPC will require a special license that must also include a dual fuel provision if the 14 FSVR elements are loaded in the same DPC with Pathfinder.

3.7.2.6 Dry Storage Cans. The two designs of 12-in. Schedule-10 Cans are also shown on the bucket drawing (M-16). These cans are designed for the Peach Bottom Core 1 and Core 2 fuel that is the only fuel that needs to be canned in the DTC. The cans are 166-in. long and are made of 12-in. Schedule 10 SST pipe similar to the buckets described above. There are two styles of can cruciforms:

one holds four pre-canned Peach Bottom Core 1 fuel elements from ICPP 749, and the other holds seven bare Peach Bottom Core 2 elements from the ICPP 603 GSA. The cans have a special lid designed to be seal welded to the body to form the primary boundary of the fuel. Each lid is equipped with a quick-disconnect fitting (located in a recess) for venting and purging the can after the fuel is loaded and the lid welded. A small cover is seal-welded over the recess after the can is filled with helium to prevent the quick disconnect fitting from leaking helium through its mechanical seal. The table on the drawing shows a total of 317 cans is required for all Peach Bottom fuel.

3.7.2.7 Dry Handling Bucket and Can Fuel Loading. The various bucket and can fuel loadings are indicated on the bucket drawing (M-16). The cross sections show the various fuel unit cross sections within the bucket cruciforms. The drawing table shows the number of units that are stacked in each cruciform cell, and the total number of fuel units in each bucket or can. A total of 12,000 fuel units will be stored in the buckets and cans.

3.7.2.8 Basket Loading. The basket drawing (M-17) shows the three types of baskets described above. The FSVR basket is used for the FSVR and Pathfinder fuel. The 3-Tube basket is designed for the existing Shippingport LWBR 25.57-in. diameter $\times$ 158-in.-long cans. The 14-tube baskets are designed to hold combinations of the four different lengths of 12-in. Schedule-10 buckets and cans discussed above. These combinations are shown in Drawing M-18 as either a stack of five 33.2-in.-long buckets, a stack of four 41.5-in.-long buckets, a stack consisting of one 132.8-in.-long and one 33.2-in.-long bucket, or a single 166-in.-long bucket. Other combinations are possible, but will not completely fill a basket tube, e.g., a stack of three 41.5-in.-long buckets and one 33.2-in.-long bucket. With these combinations of bucket and can loading, efficient loading of different kinds of fuel is possible within the same 14-tube bucket. Appendix F analyzed the requirements for placing various fuels efficiently in canisters.

No structural analysis was performed as a part of the conceptual design. It is assumed that the 22 spacer-plate baskets will be sufficient to withstand all handling, storage, and shipping loadings, because similar designs have been developed for meeting 10 CFR 71 transportation requirements and 10 CFR 72 storage requirements. It is also assumed that suitable bucket cruciform thicknesses (for the cruciform designs shown on Drawing M-16) can be established in follow-on design stages, that will adequately support the fuel under loads required to be imposed by 10 CFR 71 and 10 CFR 72 storage requirements.

3.8 HVAC Systems

3.8.1 General Description

The facility HVAC systems provide temperature conditioning and filtration of supply air and provide pressure control within selected areas of the DTC. The systems also collect exhaust air from contamination control areas, i.e., the Hot Cell, Cask Preparation Area, and Utility Support Rooms, and pass the air through HEPA filters before discharge to the atmosphere. Exhaust systems will maintain the required flowrate of air through the facility, and supply systems will control the flow of air from clean areas to areas of higher potential for contamination.

Heating of supply air will be provided by steam heating equipment. Cooling will be provided by either evaporative cooling or refrigeration equipment. Evaporative cooling was selected for areas where

ventilation flowrate requiring once-through air dominated over cooling load. Evaporative cooling can provide air at a minimum 65°F at the design summer temperature. This applies mainly to the Hot Cell. In other areas, refrigerated cooling equipment was selected due to the dominance of cooling load over ventilation rates and the need to minimize exhaust air and the size of the final HEPA filtration system. Refrigerated systems were assumed to provide cooled air at 55°F. This allows lower air flowrates than evaporative cooling.

ANSI/ANS 57.9-1992 was used as the primary design document for configuring the HVAC systems and identifying contamination control zones. The HVAC system requirements in ANSI 57.9 are not as stringent as the DOE-ID Architect-Engineer (A-E) Standards, thus resulting in a lower capital and operational cost for the systems than is typical for comparable INEL facilities. The A-E standards were used for guidance when specific direction was not provided in ANSI/ANS 57.9.

3.8.1.1 Contamination Control Concept. Contamination control zones, as defined in ANSI 57.9, were identified as (1) personnel building areas with no potential for airborne radioactivity, (2) main building areas with low potential for airborne radioactive contamination, and (3) process areas with high potential for radioactive contamination. Personnel building areas are identical to Zone IV areas as identified in the DOE-ID A-E Standards. Likewise, main building areas represent Zone I and process areas represent Zone III areas. The area static pressures have been set to ensure that air within the facility flows from areas of low or no contamination potential toward areas of higher contamination potential. Table 3-6 and Drawing HV-1 show the contamination control scheme proposed for the facility.

Table 3-6. Contamination Control Areas.

ANSI 57.9 Contamination Control Areas (DOE-ID A-E Std Zones)	Facility Contamination Control Zones
Personnel Building Area (Zone IV)	Ready Room, Rad Con Office, Restrooms, Electrical Room, UPS Room, Janitorial Room, Supervisor Office, and Communications Room, Supply Air Mechanical Equipment Rooms, Operating Corridors
Main Building Area (Zone I)	Cask Preparation Area, Exhaust Fan Room, HEPA Filter Room, Buffer Room
Process Area (Zone III)	Hot Cell

Since the Hot Cell has the highest potential for contamination, it will have the lowest static pressure and was assigned as a process area. Infiltration into the Hot Cell will flow mainly from the Cask Preparation Area and the Buffer area located between the Hot Cell and the Anti-C change room. All air exhausted from the Hot Cell is HEPA filtered before discharge to the atmosphere. Main building areas for contamination control were assumed to be areas where contamination is not normally present but could be based on the type of operations performed in these areas, such as HEPA filter changeout, outer cask lid removal, cask lid welding, etc.

3.8.1.2 Facility HVAC System Design Parameters. Design temperatures were selected from the DOE-ID A-E standards and were used as the basis for determining the size of ventilation equipment. The design values are shown in the Table 3-7.

The roof of the facility will have minimum a U-value of 0.045 BTU/hr-ft²-F and the minimum U-value of the exterior walls will be 0.064 BTU/hr-ft²-F.

Table 3-7. Indoor and outdoor design temperatures.

	Winter (°F)	Summer (°F)
Outdoor	-14	93 DB 61 WB
Administrative areas	65	72
Hot Cell	65	76
Cask Preparation	65	76
Cask Handling Bay	65	76
All other areas	65	76

3.8.2 Description of HVAC Systems

The facility is divided into four main HVAC systems. These are as follows:

1. Cask Handling Bay HVAC System
2. Administrative Area HVAC System
3. Hot Cell and Cask Preparation Area HVAC System
4. Utility Support Area HVAC System.

These four systems were selected mainly on the definition of the contamination control zones and the physical separation of spaces within the facility. Drawings HV-2 through HV-3 show the schematics for each system. Drawings HV-4 through HV-6 show the location of major equipment.

3.8.2.1 Cask Handling Bay HVAC System. For ventilation purposes, the Cask Handling Bay area includes the Truck Bay, Laydown Area, Cask Staging Area, Weld Observation Room, Fan and Air Handler Rooms, and Operating galleries. This area is a main personnel building area for contamination control and is at atmospheric pressure. Heating is provided by AHU-1, which is sized to maintain this area at 65°F in the winter and 76°F in the summer. Outside air is provided to offset exfiltration losses due to truck exhaust and leakage to the Cask Preparation Area. Truck exhaust snorkels are provided for placement over the truck engine exhaust stacks to eliminate engine exhaust fumes from the area.

The Cask Handling Bay supply air system is operated as a fixed-volume system with one area operating as a variable air volume system. Conditioned and filtered air is supplied to this area by AHU-1. AHU-1 includes an outside air isolation damper, outside air/return air mixing section, 60% filter section, steam heating coil section, glycol cooling coil section, and fan section. The approximate fan capacity is 16,000 cfm at 5 in. total pressure. At this capacity, the fan needs a 480-V, 3-phase, 20-Hp electric motor. The fan capacity is controlled by automatically operated variable position inlet vanes or a variable speed drive to maintain a set pressure in the AHU-1 discharge duct. Supply air ducting provides the means for air distribution throughout the area. Return air ducting is minimum since this AHU is located within the Cask Handling Bay.

The temperature within the Cask Handling Bay spaces is monitored by electronic thermostats located throughout the work area and the data transmitted to the HVAC control system. The control system will then respond with appropriate signals to make adjustments in the area temperature using AHU-1, if required. To prevent overheating or overcooling of the Weld Observation room, this room is provided with a variable air volume box to adjust airflow based on the room temperature.

The heating load was estimated at 260,000 BTU/hr at the minimum winter design temperature. Heat gains from equipment operating in this area were not factored into the heat load to provide adequate heating when equipment is not operating. In the heating mode, the AHU discharge air temperature will be controlled to approximately 85°F.

The cooling load was estimated at 290,000 BTU/hr and included estimates for equipment operation to avoid undersizing of the cooling equipment. The cooling load was the driver for determining air flow requirements. Thus, refrigerated air at 55°F was used to reduce the amount of air flow required and the size of air handling equipment. Using evaporative cooled air at 65°F would have essentially doubled the amount of air flow required and significantly increased the size of the air handling equipment and ducting. In the cooling mode, the AHU discharge air temperature will be controlled to approximately 55°F.

Chiller WC-1 uses a 50/50 glycol/water mixture in a closed loop routed to the cooling coil for AHU-1 to provide cool supply air. WC-1 is a 40-ton capacity, water chilling unit with separate air cooled condenser. The condenser/compressor unit is located outdoors. Electrical power required for this unit is estimated at 480-V, 3-phase, 100 amps. This type of system was selected to provide a ground mounted unit accessible by operations and maintenance personnel. As an option, a roof-mounted, direct expansion compressor/air-cooled condenser unit could also be used to provide cooling to AHU-1.

Inlet filter changeout is performed by shutdown of the AHU, since this AHU provides only tempered and conditioned air and does not perform area pressure control functions.

3.8.2.1.2 Cask Handling Bay HVAC System Supply Air Equipment Energy

Conservation Features—AHU-1 uses approximately 90% return air during the maximum winter heating season and the maximum summer cooling season. Return air is obtained from the Cask Handling Bay. Return air is mixed with outside air in the AHU mixing section and then passed through the AHU-1 inlet air filters. The mixed air temperature is controlled to approximately 55°F. Larger proportions of outside air may be used at various times during the year depending on the outside air temperature and the ability to maintain the mixed air at the mixed air temperature setpoint.

3.8.2.1.3 Cask Handling Bay HVAC System Supply Air Equipment Safety Features—

The temperature of the inlet air is monitored to prevent admittance of low temperature air which could frost the inlet filters or freeze an inactive steam coil. Upon detection of low inlet temperature (below 35°F), the return air damper opens to 100% and the outside air damper closes. Alarms on the facility HVAC control system notify the facility personnel that a low-temperature condition exists.

3.8.2.2 Administrative Area HVAC System. The Administrative Area HVAC System serves the ready room, Rad Con office, restrooms, custodial room, UPS and electrical rooms, communications room, and the supervisor's office. The restrooms receive transfer air from the corridor and are exhausted by toilet exhaust fans. These areas have been assigned as personnel building areas with no potential for contamination. This area is next to the Cask Handling Bay, which is also a personnel building area for contamination control. These areas have been provided with 1.5 cfm/ft².

The Administration Area HVAC supply air system operates as a variable air volume system. Conditioned and filtered air is supplied to this area by AHU-5. AHU-5 includes an outside air isolation damper, outside air/return air mixing section, 60% filter section, steam heating coil section, direct expansion cooling coil (7-1/2-ton capacity), and fan section. The approximate fan capacity is 3,000 cfm at 5 in. total pressure. At this capacity, the fan requires a 480-V, 3-phase, 15-Hp electric motor. The fan capacity is controlled by automatically operated variable position inlet vanes or a variable speed drive to maintain a set pressure in the AHU-5 discharge duct.

The temperature within the Administrative Area spaces is monitored by electronic thermostats located throughout the area and the data transmitted to the HVAC control system. The control system then responds with appropriate signals to the variable air volume boxes to make adjustments in the area temperature. Supply air ducting provides the means for air distribution throughout the area. Return air ducting is routed from the central corridor in the administrative area. The heating load was estimated at 66,000 BTU/hr at the minimum winter design temperature. Heat gains from equipment operating in this area were not factored into the heat load to provide adequate heating when equipment is not operating. In the heating mode, the AHU discharge air temperature will be controlled to approximately 100°F.

The cooling load was estimated at 50,000 BTU/hr, and included estimates for equipment operation to avoid undersizing the cooling equipment. The cooling load was the driver for determining air flow requirements. Thus, refrigerated air at 55°F was used to reduce the amount of air flow required and the size of air handling equipment. In the cooling mode, the AHU discharge air temperature will be controlled to approximately 55°F.

AC-2, the compressor/air-cooled condenser unit for AHU-5, requires 7-1/2-ton cooling capacity. Refrigerant piping is routed from AC-2 to the direct expansion coil in AHU-5. Electrical power required for this unit is estimated at 480 V, 3-phase, 22 amp. The condenser/compressor unit is located outdoors on the roof directly above the administrative area.

Inlet filter changeout is performed by shutdown of the AHU, since this AHU provides only tempered and conditioned air and does not perform area pressure control functions.

3.8.2.2.1 Administrative Area HVAC System Supply Air Equipment Energy Conservation Features—AHU-5 uses approximately 35% return air during the maximum winter heating season and the maximum summer cooling season. The remainder of the air is exhausted from

the restrooms and UPS room. Return air is obtained from the central corridor located in the Administrative area. Return air is mixed with outside air in the AHU mixing section and then passes through the AHU-5 inlet air filters. The mixed air temperature or filter inlet air temperature is controlled to approximately 55°F using a preheat coil if necessary. Larger proportions of outside air may be used at various times during the year depending on the outside air temperature and the ability to maintain the mixed air at the mixed air temperature setpoint.

3.8.2.2.2 Administrative Area HVAC System Supply Air Equipment Safety

Features—The temperature of the inlet air is monitored to prevent admittance of low-temperature air which could frost the inlet filters or freeze an inactive steam coil. Upon detection of low inlet temperature (below 35°F), the return air damper will open to 100% and the outside air damper will close. Alarms on the facility HVAC control system notify the facility personnel that a low-temperature condition exists.

3.8.2.3 Hot Cell and Cask Preparation Area HVAC System. The Hot Cell and Cask Preparation Area HVAC System controls the ventilation and air conditioning in the Cask Preparation Area, Buffer Area, and the Hot Cell. Two separate exhaust systems are included within this HVAC system. One exhaust system exhausts air from the Cask Preparation and Buffer Areas, and one exhausts from the Hot Cell.

3.8.2.3.1 Cask Preparation Area and Buffer Area—The Cask Preparation Area was designated as a Main Building area (or Zone I area) for contamination control purposes with its static pressure to be controlled at -0.1 in. W.G. below the Cask Handling Bay and the outside environment. The pressure is controlled by maintaining the exhaust air to a set flow and varying the supply air to obtain the desired negative pressure. Air is supplied to this area by AHU-2 and is exhausted through either the Cask Preparation Area Exhaust system or as infiltration air to the Hot Cell and through the Hot Cell exhaust system. AHU-2 is a once-through air system.

The Cask Preparation Area supply air system is operated as a variable volume system to control the air pressure within the area. Conditioned and filtered air is supplied to this area by AHU-2. Supply air ducting provides the means for air distribution throughout the area. Return air ducting is minimum since this AHU is located within this area. Pressure control within this area is performed using an automatically controlled supply air damper. The pressure is measured in this area and transmitted to the facility HVAC control system. Signals are sent from the control system to the automatic damper for pressure adjustment. See also the information with the Hot Cell Supply Air Equipment Description below.

The temperature within the Cask Preparation Area is monitored by electronic thermostats located and the data transmitted to the HVAC control system. Thermostats are located at work height in large open areas. The control system responds with appropriate signals to make adjustments in the area temperature using AHU-2 discharge temperature, if required. Since the Cask Preparation Area is an internal area with no outside exposure, the heating load is taken care of by the Cask Handling Bay system. In the heating mode, the AHU-2 discharge air temperature will be controlled to approximately 68°F.

In the cooling mode, the AHU discharge air temperature will be controlled to approximately 65°F. During the summer, AHU-2 will provide cooled air to maintain the Cask Preparation Area temperature at

76°F. Cooling will be provided by an evaporative cooling section within AHU-2. Outside air will be used without evaporative cooling when the outdoor temperature is below 65°F. Potable water will be used for the evaporative cooling section. Water treatment chemicals will be used in the evaporative cooling sump to control scale and algae buildup.

The Cask Preparation Area is exhausted by the Cask Preparation Area/Utility Support Area Exhaust equipment. This equipment consists of a single bank of final prefilters and HEPA filters, final exhaust fans (one primary and one in standby), and an exhaust stack with monitoring instrumentation. This exhaust equipment is located in the Utility Support Area HEPA Filter Room and Exhaust Fan Room. The exhaust air has a fixed air flowrate of approximately 2,630 cfm to ensure the direction of air flow is from the Cask Handling Bay toward the Hot Cell. See additional information below for the Utility Support Area Exhaust Air System.

3.8.2.3.2 Hot Cell—The Hot Cell Area is a process contamination area (Zone III area) when hot operations are in progress and is controlled to at least -0.6 in. W.G. below atmospheric pressure. Ventilation air is provided at a minimum rate of 6 air changes per hour or approximately 10% of the cell volume as required by ERDA 76-21. The pressure is controlled by maintaining a fixed exhaust flow and varying the supply flow to obtain the desired negative pressure. Exhaust air is routed to the Hot Cell exhaust system. The temperature and pressure of the hot cell are monitored and transmitted to the HVAC control system. Control signals are generated by the HVAC control system and sent to HVAC equipment when changes are required to operating parameters.

Supply air for the Hot Cell is provided by AHU-2. The supply air to the Hot Cell is controlled as a variable volume system controlled with the cell static pressure input to the control system. Conditioned and filtered air is supplied to this area by AHU-2. AHU-2 includes an inlet isolation damper, glycol heat recovery coil, 60% filter section, steam heating coil section, evaporative cooling unit section, and fan section. The approximate fan capacity is 22,830 cfm at 14 in. total pressure at 5,000 ft elevation (52 BHp). At this capacity, the fan requires a 480-V, 3-phase, 60-Hp electric motor. The fan capacity will be controlled by automatically operated variable position inlet vanes or a variable speed drive to maintain a set pressure in the AHU-2 discharge duct.

Supply air ducting carries the supply air into the Hot Cell. Ducting within the Hot Cell distributes the supply air along the upper portion of the cell, and the air flows downward in the cell from the upper levels to the lower portions where the exhaust ducts are located. An automatic isolation damper located at the cell boundary closes if necessary to prevent backflow of air from the Hot Cell. The Hot Cell envelop heat losses due to exterior walls and roof were estimated to be 64,000 BTU/hr at the minimum winter temperature. However, the heat losses were more than offset by the heat gain (estimated to be 130,000 BTU/hr) from lighting and equipment operation. Heat generated by the spent fuel was not factored into the heat gain since the heat from the fuel will generally be pulled directly into the exhaust system.

The total summer cooling load was estimated at 160,000 BTU/hr and included estimates for equipment operation to avoid undersizing of the cooling equipment. The ventilation rate exceeded that necessary for evaporative cooling at the estimated cooling load. In the cooling mode, the AHU-2 discharge air temperature will be controlled to 65°F.

Energy conservation features include a glycol heat recovery loop that extracts or rejects heat to the exhaust air from the Hot Cell. The heat recovery coil is sized to obtain a minimum of 32°F leaving air temperature during winter temperatures to ensure that the air filter does not get plugged with frost buildup. The heating coil is sized to provide the total amount of heat necessary should the heat recovery system fail to operate. Evaporative cooling was selected because of the significant amount of air required to achieve the air change rate and the normally dry ambient conditions that will allow efficient evaporative cooling. Evaporative cooling will be used whenever the outdoor temperature exceeds 60°F. At the maximum summer design temperatures, the supply air will be approximately 65°F, assuming an 85% efficient evaporation process. At the estimated cooling load for the Hot Cell, the 80% relative humidity of the supply air will drop to approximately 55% upon exiting the cell. When outdoor air is below 60°F, the air will be used directly without evaporative cooling.

AHU-2 is interlocked to prevent its operation when the hot cell exhaust fans are not in operation. After startup of the final exhaust fans, AHU-2 is allowed to start. The facility HVAC control system monitors the air temperature before the heating coil. When and if the temperature drops below 40°F, an alarm will be initiated at the HVAC control system supervisory monitor indicating a failure of the heat recovery system and the need for immediate attention to prevent possible heating coil freeze-up.

Air within the Hot Cell circulates to the exhaust grilles located next to the lag storage vaults. Ducting routes the exhaust air from the cell to the two exhaust air filter units. The final filters are located upstream of the exhaust fans in the HEPA filter room in the Utility Support Area. Each filter unit consists of a 4-filters-high by 3-filters-wide enclosure with an inlet low-leakage isolation damper for each filter, a 90% efficiency prefilter, a DOP inlet section, a HEPA filter, a DOP measuring section, and a final low-leakage damper for each filter. Each filter will be a 24-in. × 24-in. size rated for 1,000 cfm. Each filter unit requires 24 filters (12 prefilters and 12 HEPA filters).

Two exhaust fans (one in normal operation and one in standby) provide the required exhaust flow from the Hot Cell. Exhaust fans EF-1 and EF-2 are centrifugal fans each rated for high negative pressure capable of providing 20,000 cfm at 16 in. W. G. At this capacity and pressure, each fan requires a 480-V, 3-phase electric motor rated for at least 52 BHp. Each fan is constructed of the manufacturer's standard materials of construction and is sized to provide 100% of the exhaust air requirements. The additional fan will be in the standby mode. The fan air flow is controlled by a variable-speed drive or with variable-position inlet vanes. A stack located outside the building will discharge the exhaust air to the environment.

Glycol heat recovery coils located between the final filter unit and the exhaust fan provides for heat collection in the winter and heat rejection in the summer. Collected energy is transferred to the supply air system to offset ambient air heating or cooling needs using a glycol heat recovery system.

The Hot Cell exhaust fans operate continuously to maintain the flow of air into the Hot Cell and contain contamination within the Hot Cell. The Hot Cell exhaust fans are provided with standby power.

3.8.2.4 Utility Support Area HVAC System. The Utility Support Area HVAC System serves the Supply Air Mechanical Equipment Room, the HEPA Filter Room, and the Exhaust Fan Room.

The Supply Air Mechanical Equipment Room is a personnel building zone (Zone IV area) and contains AHU-2 and AHU-3. Supply air to this room is provided by AHU-3. Air flow to this room is

fixed volume, with some returning to the inlet of AHU-3. The instrument air equipment is also located in this room. This room will be controlled to 65°F in the winter and 76°F in the summer. Access is provided around each AHU for maintenance work for filter changeout and internal equipment inspection and repair.

Temperature instruments monitor the mixed air temperature to prevent steam coil freezeup. The quantity of outside air will vary depending on the outside air temperature and the cooling and heating requirements of the support area.

The HEPA Filter and Exhaust Fan Rooms are main building areas (Zone I areas) controlled to approximately -0.2 in. W.G. below atmospheric pressure. The supply air for these rooms is provided by AHU-3. The air flow through these rooms is controlled by maintaining a fixed exhaust air flow. The room pressures are controlled by modulating the supply air damper to obtain the desired pressure operating point. The exhaust from these rooms combines with the exhaust from the Cask Preparation Area. The HEPA Filter Room houses the final air filter units for the Hot Cell and for the Cask Preparation Area/Utility Support Area.

The Utility Support Area HVAC supply air system is operated as a fixed volume system for the Supply Air Mechanical Equipment Room and as a variable air volume system for the HEPA Filter and Exhaust Fan Rooms. The supply air fan is controlled to maintain the fan discharge pressure to a set value. Conditioned and filtered air is supplied to these areas by AHU-3. AHU-3 includes an outside air isolation damper, return air damper, inlet air mixing section, 60% filter section, steam heating coil section, evaporative cooling unit section, and fan section. The fan outputs 3,000 cfm at 5 in. total pressure and requires a 480-V, 3-phase, 15-Hp electric motor. The fan capacity is controlled by automatically operated variable position inlet vanes or a variable speed drive to maintain a set pressure in the AHU-3 discharge duct. Supply air ducting provides the means for air distribution throughout the area. Return air ducting is minimum since this AHU is located within this area.

The heating load was estimated at 61,000 BTU/hr at the minimum winter design temperature. Heat gains from equipment operating in this area were not factored into the heat load to provide adequate heating when equipment is not operating. In the heating mode, the AHU discharge air temperature will be controlled to approximately 90°F.

The cooling load was estimated at 162,000 BTU/hr and included estimates for equipment operation to avoid undersizing of the cooling equipment. The cooling load was the driver for determining air flow requirements. Thus refrigerated air at 55°F was used to reduce the amount of air flow required and the size of air handling equipment and the final HEPA filter unit. AHU-4 provides supplemental cooling to the HEPA Filter and Exhaust Fan rooms using a direct expansion packaged air handling unit rated at 15-ton cooling capacity. AHU-4 includes only a cooling coil. No heating coil is required. The fan for this unit outputs 5,000-7,000 cfm at 0.5 in. total pressure with a 480-V, 3-phase, 5-Hp electric motor.

AC-1 is the compressor unit/air cooled condenser for AHU-4. The compressor and air cooled condenser are located outdoors. This unit requires 480-V, 3-phase power and use approximately 41 amps.

AHU-3 uses return air from the Supply Air Mechanical Equipment Room. In addition, AHU-3 uses evaporative cooling during the peak summer cooling season. Direct outside air will be used at other times as long as the mixed air temperature can be maintained at 55°F.

AHU-3 is interlocked to prevent operation when the Utility Support Area/Cask Preparation Area exhaust fans are not in operation. After startup of the exhaust fans, AHU-3 is allowed to start. The facility HVAC control system monitors the air temperature before the heating coil. If the temperature drops below 40°F, an alarm is initiated at the HVAC control system supervisory monitor.

Air within the HEPA Filter and Exhaust Fan Rooms flows from supply ducts to exhaust ducts. The final filters are located upstream of the exhaust fans in the HEPA filter room in the Utility Support Area. Each filter unit consists of a 3-filters-high by 2-filters-wide enclosure with an inlet low-leakage isolation damper for each filter, a 90% efficiency prefilter, a DOP inlet section, a HEPA filter, a DOP measuring section, and a final low-leakage damper for each filter. Each filter is 24-in. × 24-in., rated for 1,000 cfm. The filter unit requires 12 filters (6 prefilters and 6 HEPA filters) and is oversized to allow changeout of one filter row containing two filters while the other two rows of filters remain on line.

A set of two exhaust fans (one in normal operation and one in standby) provides the required exhaust flow from the HEPA Filter and Exhaust Fan Rooms. Exhaust fans EF-3 and EF-4 are centrifugal fans each rated for high negative pressure capable of providing 4,800 cfm at 11 in. W. G. at 5,000 ft elevation. At this capacity and pressure, each fan requires a 480-V, 3-phase electric motor rated for at least 10 BHp. Each fan is constructed of the manufacturer's standard materials and is sized to provide 100% of the exhaust air requirements. The additional fan is in the standby mode. The fan air flow is controlled by a variable speed drive or with variable position inlet vanes. A stack located outside the building discharges the exhaust air to the environment.

3.9 Mechanical Utilities

Utilities that must be provided for the ICPP Spent Nuclear Fuel Dry Storage Facility include compressed air, compressed gas, potable water, fire water, high pressure steam, and waste systems. Existing ICPP plant utilities are located in the general area of the proposed facility, and pipe routing and connection points with the existing ICPP utilities are identified in drawing C-2. Waste systems include both service waste and sanitary waste systems. Compressed air, potable water, fire water, high pressure steam, and service waste lines are located in the utility tunnel which is approximately 100 ft from the facility. The tie-in for the sanitary sewer is located approximately 400 ft from the facility. Compressed gas will be provided using bottled gas located in the facility. The proposed utility usage has been analyzed and existing utility capacity is adequate for the proposed life of the facility.

3.9.1 Compressed Air

Compressed air is supplied to various locations in the facility from the ICPP underground utilities located in the utility tunnel. A 2-in. carbon steel pipeline will be routed to the new facility. The line enters the building in the mechanical room and is divided into plant air and instrument air in the mechanical room.

3.9.1.1 Plant Air. The plant air lines are copper with sweat fittings. The lines are anticipated to be 1-½ in. in diameter. The locations serviced with plant air include the Cask Handling Bay, Cask

Preparation Area, and the Hot Cell. Plant air is used to operate pneumatically operated tools associated with cask handling and preparation. All lines are terminated with quick disconnects for flexibility of use.

3.9.1.2 Instrument Air. Instrument air lines are copper with sweat fittings. These lines are also anticipated to be 1-1/2 in. in diameter. Instrument air is used for pneumatically operated HVAC system equipment, and for miscellaneous equipment requiring air for actuators. The air is filtered and dried to a dew point temperature of -40°F using a refrigerated dryer. Pressure regulators are provided at locations as required to reduce air pressure for use by the equipment.

3.9.2 Compressed Gas

Various compressed gases are required throughout the facility. Racks containing argon and helium gas cylinders are located in the can welding and inerting equipment room on the third level and in the Cask Staging Area. Argon gas is used for the welding processes and helium is used for pressure testing and inerting operations. Lines are routed from the manifolds to the Cask Handling Bay, Cask Preparation Area and the Canning Area in the Hot Cell.

3.9.3 Potable Water

Potable water is supplied from the ICPP underground utilities located in the utility tunnel through a 2-in. carbon steel line. The line enters the building in the mechanical room. The potable water line downstream of the backflow preventer is 2-in. diameter copper pipe with sweat fittings. The largest line in the facility is expected to be the 2-in. diameter, branch line with sizes to be finalized in Title Design.

Equipment and fixtures served include two water closets, one urinal, four sinks, two showers, shower/eyewash facilities, two evaporative coolant units, drinking fountains, and miscellaneous ports located in the Cask Handling Bay, Cask Preparation Area, and Hot Cell area.

A water heater is located in the janitor's closet next to the rest rooms. The unit provides 140°F water to the showers and sinks in the rest room and laboratory.

3.9.4 Waste Systems

Waste systems for the ICPP Spent Nuclear Fuel Dry Storage Facility include service waste, process equipment waste (PEW), and sanitary waste. Service waste and sanitary waste will be piped from the facility and tied into the existing ICPP utilities. PEW will be collected in a 1,000-gal tank, sampled, and transferred via tanker truck for treatment and storage. The decision to collect and transfer PEW in this manner is based on cost and experience. No PEW lines are located in the vicinity of the facility. From experience at the Site, it is expected that the amount of PEW collected will be minimal. The cost of routing a pipe to the nearest existing PEW line, located in ICPP 666, is expected to be greater than the cost of collection and transfer.

3.9.4.1 Service Waste. The service waste line is connected to the ICPP 4-in. service waste line located in the utility tunnel through a 2-in. carbon steel line that enters the building in the mechanical room. Service waste will be collected and tested before being pumped into the service waste line. Service waste capacity is provided in the Cask Handling Bay, and the Cask Preparation Area. Condensate from the HVAC equipment will also be disposed of using the service waste line.

3.9.4.2 Sanitary Systems. Sanitary sewer drains are provided at restroom fixtures and drinking fountains served by potable water. Vents are provided and terminate above the facility roof line. A sewer clean out is provided in the sewer main before it leaves the building and elsewhere as required to ensure that all sewer lines are cleanable. The sewer is connected to the existing ICPP system using an 8-in. ABS sewer line. The sewer tie-in connection is located east of ICPP-665. The total pipe length to reach the facility is estimated to be 400 ft. One manhole is required in the run for system cleanout capabilities.

3.9.5 Fire Protection

Automatic fire protection is provided throughout all areas of this facility with the exception of the Hot Cell. This protection consists of a wet pipe system installed in accordance with National Fire Protection Association codes and standards and Factory Mutual Data Sheets. In addition, fire hydrants are located around the building and inside the dry fuel storage yard in support of manual fire fighting efforts.

Although manual fire extinguishes will be available in the Hot Cell, automatic fire protection is not provided. While no potential criticality issues have yet been identified, automatic water systems present the potential for chemical reaction between water and the graphite fuels. Foam or gaseous systems would not be effective in the large Hot Cell with very high ceiling. When the Hot Cell is in fuel transfer operation, personnel are not present and the combustion loads are very small. No unacceptable consequences of a fire could be identified. When personnel are in the Hot Cell (and combustion loads are higher), the fire extinguishes provide adequate protection.

The automatic sprinkler system is designed based upon an ordinary hazard, group two occupancy as a minimum. Fire suppression, (water spray) is also provided for all HEPA filter systems which have a face area of 16 ft² or larger.

Fire alarms are installed and connected into the Site-wide fire alarm system. The alarms shall detect water flow, heat, and provide supervision for the fire alarm system.

Fire hydrants are arranged to allow access to all exterior areas of the building with a maximum of 300 ft of hose lay. Hydrants located in the storage yard are located at each end of the yard in a manner that allows access to the entire yard.

Some relocation of existing underground fire water mains will be required at the site for the storage basemat.

3.9.6 Steam

Steam is supplied to the facility from the ICPP underground utilities located in the utility tunnel through a 4-in. carbon steel line. The line is insulated and cathodic protection is provided. The steam system provides steam at a peak flow of 2,610 lb/hour at 135 psi. The steam line enters the building in the mechanical room and is routed from the mechanical room to the fan rooms as needed. Pipe sizes in the building will be identified during Title Design.

3.9.7 Tanks

3.9.7.1 Washdown Water Collection Tank. A storage tank is used to collect washdown water during operations in the Truck Bay. The tank has a capacity of 1,000 gallons. The water collected in the tank will be sampled prior to disposing through the service waste line, or transferring to the ICPP process equipment waste (PEW) system.

3.9.7.2 Process Equipment Waste (PEW) Collection Tank. A 1,000-gal PEW storage tank is located below grade for collection of decontamination water from the Hot Cell, water from the Vacuum Drying System located in the cask preparation area, and water from the fire protection system associated with the HEPA filter banks. The line from the vacuum drying system will include back flow prevention. The tank has sampling and pumping capabilities.

3.10 Electrical Systems

3.10.1 Power

The DTC facility receives 480-Vac, 800-A, 3-phase commercial power through feeders installed in an underground ductbank from Load Center 3. These terminate in the electrical equipment room at a service entrance-rated Motor Control Center (MCC). The electrical system includes standby power, emergency power, a 277/480-V distribution system, and a 120/208-V distribution system. These subsystems are shown in Drawing E-1 and are discussed below.

Standby power is provided to the DTC facility from the existing Standby Power System at ICPP. Standby power is provided only to the Hot Cell HVAC system exhaust fans and to the Uninterruptible Power Supply (UPS) and is made available through the normal power bus. Controls are provided by the ICPP Utility Control System.

Emergency power is provided by a 80-kVA UPS located in the electrical equipment room. The UPS is dedicated to the fire alarm system, voice paging system, evacuation alarm system, radiation monitoring and alarm system, and the security systems to include the spent fuel DSS perimeter lighting. The UPS has a battery backup sufficient to carry the rated load for 30 minutes.

The 277/480-V distribution system includes one MCC and five distribution panels. The MCC provides power to the HVAC system, cranes, distribution panels, and the spent fuel DSS. The MCC is rated at 277/480-V, 800-A, 3-phase, 4-wire with an 800-A main circuit breaker and ground fault protection. It is located in the electrical equipment room and is equipped with metering. All five distribution panels are 277/480-V, 3-phase, 4-wire panels. Each panel is equipped with a 225-A main breaker and has the capability to supply 42 branch circuits. The panels are located in the Truck Bay, the Cask Handling Bay, the third floor operating corridor, the UPS room, and the Can Welding and Inerting room.

The 120/208-V, 3-phase distribution system is included for receptacles and small power loads. Four panels are included: one panel is equipped with a 150-A main breaker and has the capability for 42 branch circuits. It is powered by a 45-kVA dry-type transformer. Both the transformer and the panel are located in the electrical equipment room. The panel provides power for office lighting and receptacles. Three panels are equipped with a 100-A main breaker and have the capability for 24 branch

circuits. Each panel is fed by a 25-kVA dry-type transformer. The transformers are located in the electrical equipment room, and of the four panels, one panel is located in the UPS room, two panels in the Electrical Equipment room, and one panel in the Can Welding and Inerting room.

3.10.2 Grounding

A perimeter ground loop consisting of #4/0 bare copper wire and ground rods is included around the facility. The facility steel, water piping, service equipment, distribution equipment, and motor frames are bonded to the ground loop. Equipment grounding is in accordance with the NEC Article 250. Equipment ground wires are included in all conduit runs.

An isolated grounding system is provided that consists of a series of isolated 1/4-in. copper bus bars radially connected via insulated #2/0 AWG ground conductors to a single point on the facility ground loop. All telecommunications equipment and any Supervisory Control and Data Acquisition (SCADA) systems use the insulated grounding conductors to connect to the isolated ground system.

3.10.3 Cathodic Protection

Utility piping is protected through connection to the existing ICCP cathodic protection system. Buried piping is electrically connected to the negative side of the existing rectifier with #2 AWG cable. Anodes are installed parallel and at the same elevation as the piping. A testing/bonding station is included to periodically monitor the cathodic protection system.

3.10.4 Lightning Protection

A lightning protection system meeting the requirements of NFPA 780 will be developed during later design stages. The cost estimate in Section 5 includes an allowance for this system and is based on the costs for comparable protection for other facilities.

3.10.5 Lighting

Lighting is designed in accordance with current Illuminating Engineering Society recommendations and uses power-conserving lamps and ballasts. Nonglare fluorescent fixtures are used throughout the facility. Lighting in individual rooms such as offices, breakrooms, and restrooms employs 120-V ballasts. Lighting controls in the offices use two toggle switches to provide three levels of illumination.

Lighting in open areas and equipment rooms uses 277-V ballasts. The 277-V lighting system is controlled by low-voltage switches at each point of entrance and egress of the area. These switches are connected to a programmable lighting control panel mounted in the electrical equipment room.

Emergency and exit lighting are provided at each means of egress. Emergency lighting is provided in all areas and is equipped with 277-V ballasts. This lighting is powered from internal Ni-Cad battery units. Exit lights consist of exit signs powered with Ni-Cad batteries. Three emergency lights will be provided in the Hot Cell.

High-pressure sodium fixtures are included in the Hot Cell. Twenty 1,000-watt ceiling-mounted fixtures and six 400-watt wall-mounted fixtures are included. Exterior building perimeter lighting are also high-pressure, wall-mounted sodium fixtures with photoelectric controls.

3.10.6 HVAC Controls

The HVAC system is controlled from an independent, microprocessor-based system. Temperature, pressure, and operating status information are collected by the system and the output signals generated for control of the HVAC equipment. Local interface units contain the input and output units connected to the central processor. A supervisory computer monitor is provided in the Shift Supervisor's office for reviewing the operating status of the system and making adjustments to control setpoints. A data highway connects the local interface units along with the supervisor's monitor.

3.10.7 Equipment Controls

Controls for the facility cranes are supplied by the crane vendor. The controls for cranes in the Hot Cell can be operated either in the cell or from outside any of the cell windows.

Remotely controlled, closed-circuit TV cameras are provided in the Hot Cell for general visual observation, fuel canning operations, fuel inspection, and documentation. Each window is also equipped with a visual inspection station that includes two high-resolution cameras, a monitor, camera controls for pan, tilt, and zoom functions, and recording capability for archival purposes.

A data entry station, used to record and monitor all fuel movements, is co-located with each visual inspection station. A data link permits communications between any of the stations. The data entered through these workstations in conjunction with the video record provide the required historical records for fuels accountability.

The Shift Supervisor's Office is provided with a microprocessor-based system for the collection of alarms from the HVAC system and any other required alarms.

3.10.8 Radiation Monitoring and Alarms

Radiation Area Monitors (RAMs) are located in the Truck Bay (1), Cask Preparation Area (1), Cask Staging Area (1), second floor operating corridor (1) third floor operating corridor (2), and the HEPA Filter room (1). All instruments alarm locally and remotely in the RadCon office. Monitor locations are shown on Drawings E-2 through E-4.

Beta/Gamma Constant Air Monitors (CAM) are located in the Truck Bay (1), Cask Preparation Area (1), Cask Staging Area (1), second floor operating corridor (1), third floor operating corridor (2), and the HEPA Filter room. An alpha CAM is located in the inlet duct to the Zone 1 HEPA filter of the HVAC system.

A criticality alarm system is provided in compliance with the criteria of ANSI/ANS 8.3-1986 and ANSI/ANS 57.9-1992. Neutron-sensitive detectors are provided as required by the above standards. These systems provide alarms throughout the facility with a two-tone warbler and flashing red lights.

Stack monitoring is provided for the detection of radioactive particulates in the air exhaust stream. These instruments comply with the requirements of ANSI-N42.17B-1989. Instruments provide remote readout/alarms in the RadCon Office. An evaluation per ANSI-N13.1-1969 will be performed during Title II design to determine if Iso-kinetic sampling will be required. The current cost estimate is based on providing iso-kinetic sampling for the Hot Cell stack.

Personnel Contamination Monitors are located by the doors between the Anti-C Change Area and the operating corridor and by the door between the Cask Handling Bay and the operating corridor.

Activity Monitors are provided in the washdown water collection tanks and in the PEW collection tank.

The Rad Con Office has a remote alarms monitor, four handheld survey instruments, and a FASTRAK II Dosimetry System (or equal).

Selected instruments (to be determined during Title Design) transmit data to a microprocessor-based system for display, recording, alarm, and trending in the Rad Con Office. The instruments will also be connected to the Radiation, Environmental, and Safety (RE&S) computer system for remote monitoring. The RE&S interface is in the utility tunnel.

3.10.9 Communications and Alarms

Voice and data telecommunications lines are included throughout the occupied areas of the facility. The new telecommunication service lines are routed in dedicated conduits.

The existing Broadband Local Area Network (LAN) will be made available in the facility. Access ports are provided in all normally occupied offices.

Fire alarm, emergency voice paging, and the evacuation alarm systems are compatible with existing systems at the ICPP. These systems have supervised controls and receive power from the UPS-backed panel. Power and signal wiring runs in separate dedicated raceways.

A device will be installed to record the response of the DTC structure in the event of an earthquake.

3.10.10 Data Acquisition and Recording

The data acquisition system is used for material controls and accountability at the DTC facility. The system includes individual PCs located at each window and the supervisor's office all networked to a local server. The system will maintain at least the following information on all fuels received: shipper's name, estimated quantity of radioactive material per item to include special nuclear material in the spent fuel, item identification and seal number, storage location, onsite movements of each fuel assembly, and ultimate storage location. A video record will also be made as each fuel is processed.

3.10.11 Security Systems

The DTC is provided with physical protection systems as required by the proposed 10 CFR 73.51. Access control to the facility (card readers) are installed on the exterior entrances. Passive Infrared Detectors are located in the Hot Cell. All exterior doors and all doors having direct access to the Hot Cell are alarmed. In addition to these, the doors into the UPS room, the HEPA Filter room, and the Hot Cell exhaust fans are alarmed. All systems interface with the existing Argus security systems. An Argus Field Panel is located in the UPS room, which provides the interface to the Argus host computer located in CPP-1674.

The perimeter of the DSS is illuminated with high-pressure sodium lights placed every 75 ft along the perimeter. The lights are provided UPS power from the DTC facility. The perimeter is also protected by an intrusion detection system which will be either a leaky coaxial cable type (Sentrax) buried underground or a fiber optic sensor mounted to the fence.

All alarms are monitored at the existing ICPP Central Alarm Station and the existing Secondary Alarm Station.

4. CODES AND STANDARDS APPLICABLE TO THE SNF DRY STORAGE PROJECT

Table 4-1 shows the codes and standards applicable to the design of the Dry Storage Facility. The codes and standards are listed as well as the titles and applicable areas. This list is not exhaustive, but covers the main codes and standards that apply. As title design commences and the designs become more detailed, additional codes and standards will be identified.

Table 4-1. Codes and Standards.

Code/standard	Title	Applies to
10 CFR 20	Standards for Protection Against Radiation	HVAC, Radiation Protection
10 CFR 50	Domestic Licensing of Production and Utilization Facilities	Handling
10 CFR 71	Packaging and Transportation of Radioactive Material	Casks and Transporter
10 CFR 72	Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste	
Subpart A	General Provisions	Project
Subpart B	License Application, Form, and Contents	Project
Subpart C	Issuance and Conditions of License	Project
Subpart D	Records, Reports, Inspections, and Enforcement	Safeguards/Security
Subpart E	Siting Evaluation Factors	Civil
Subpart F	General Design Criteria	All Systems
Subpart G	Quality Assurance	Quality
Subpart H	Physical Protection	Security
Subpart I	Training and Certification of Personnel	Operations, Safety
Subpart J	Provision of MRS Information to State Governments and Indian Tribes	Project
Subpart K	General License for Storage of Spent Fuel at Power Reactor Sites	Storage Area
Subpart L	Approval of Spent Fuel Storage Casks	Casks
10 CFR 73	Physical Protection of Plants and Materials	Handling/Rad protection and security
10 CFR 75	Safeguards on Nuclear Material - Implementation of US/IAEA Agreement	SNF Accountability
10 CFR 435	Energy Conservation Voluntary Performance Standards for New Buildings, Mandatory for Federal Buildings	Structural
10 CFR 830	Nuclear Safety Management	Safety
10 CFR 835	Occupational Radiation Protection	Radiation Protection
10 CFR 1021 (also in DOE Order 5440.1D, 40 CFR 1500-1508, and SEN 15-90)	NEPA implementing procedures	Project - EIS has been approved and ROD issued
10 CFR 1022	Compliance with Floodplain-Wetlands Environmental Review Requirements	Environmental

Table 4-1. (continued).

Code/standard	Title	Applies to
10 CFR 1046	Physical Protection of Security Interests	Security
29 CFR 1910	Occupational Safety and Health Standards for General Industry	
Subpart A	General	Project
Subpart B	Adoption and Extension of Established Federal Standards	Project
Subpart C	General Safety and Health Provisions	Safety
Subpart D	Walking - Working Surfaces	Stairs, platforms, ladders
Subpart E	Means of Egress	Architectural, fire protection
Subpart G	Occupational Health and Environmental Control	HVAC, noise
Subpart H	Hazardous Materials	Compressed gas
Subpart I	Personal Protective Equipment	Operations
Subpart J	General Environmental Controls	Sanitation, safety
Subpart K	Medical and First Aid	Safety
Subpart L	Fire Protection	Fire protection, safety
Subpart M	Compressed Gas and Compressed Air Equipment	Mechanical Utilities
Subpart N	Materials Handling and Storage	Cranes and rigging equip
Subpart O	Machinery and Machine Guarding	?? Canning??
Subpart Q	Welding, Cutting, and Brazing	Welding operations
Subpart S	Electrical	Electrical
Subpart Z	Toxic and Hazardous Substances	HVAC
29 CFR 1926	Occupational Safety and Health Regulations for Construction	All systems
40 CFR 50	National Primary and Secondary Ambient Air Quality Standards	HVAC/HEPA filtration
40 CFR 51	Requirements for Preparation, Adoption, and Submittal of Implementation Plans	HVAC/HEPA filtration
40 CFR 52	Approval and Promulgation of Implementation Plans	HVAC/HEPA filtration
40 CFR 53	Ambient Air Monitoring Reference and Equivalent Methods	Storage Area, HEPA
40 CFR 58	Ambient Air Quality Surveillance	Storage Area, HEPA.
40 CFR 260 et seq.	Hazardous Waste Management System: General	Resource Conservation and Recovery Act (RCRA)

Table 4-1. (continued).

Code/standard	Title	Applies to
40 CFR 261	Identification and Listing of Hazardous Waste	Sample and sample residue management
40 CFR 262	Standards Applicable to Generators of Hazardous Waste	Sample and sample residue management
40 CFR 268.50	Land Disposal Restrictions	Decontamination water
40 CFR 300 et seq.	National Oil and Hazardous Substances Pollution Contingency Plan	Operations - MSDS and chemical inventory
49 CFR 173 Subpart I	Shippers - General Requirements for Shipments and Packages Radioactive Materials	Decontamination of external surfaces of transport packages
American Institute of Steel Construction publication - 1989	Specification for Structural Steel Buildings, Allowable Stress Design and Plastic Design	Steel structures
ANSI/ACI 318-89	Building Code Requirements for Reinforced Concrete	Structural
ANSI/ACI 349-85	Code Requirements for Nuclear Safety Related Concrete Structures	Structural design for the facility, especially the confinement areas and storage vaults
ANSI/AISC N 690-1984	Specifications for the Design, Fabrication, and Erection of Steel Safety Related Structures for Nuclear Facilities	Structural design for the facility, especially the confinement areas and storage vaults
ANSI/ANS 2.3-1983	American National Standard for Estimating Tornado, and Extreme Wind Characteristics at Nuclear Power Sites	Structural
ANSI/ANS 2.19-1981 (R1990)	American National Standard Guidelines for Establishing Site-Related Parameters for Site Selection and Design of an Independent Spent Fuel Storage Installation (Water Pool Type)	Structural loads even though it is not a water pool type
ANSI/ANS 8.1-1983 (R1988)	American National Standard Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors	Criticality analysis/safety

Table 4-1. (continued).

Code/standard	Title	Applies to
ANSI/ANS 8.3-1986	American National Standard Criticality Accident Alarm System	Criticality analysis/safety
ANSI/ANS 8.17-1984 (R1989)	American National Standard Criticality Safety Criteria for Handling, Storage, and Transportation of LWR Fuel Outside Reactors	Criticality analysis/safety
ANSI/ANS 57.9	Design Criteria for an Independent Spent Fuel Storage Installation (Dry Type)	All systems
ANSI/ANS 57.10-1987	American National Standard Design Criteria for Consolidation of LWR Spent Fuel	Lag storage, HVAC, fire protection
ANSI/API 620-1986	Rules for Design and Construction of Large, Welded, Low Pressure Storage Tanks	Tanks
ANSI/API 650-1988	Welded Steel Tanks for Oil Storage (for tanks)	Tanks
ANSI/ASCE 7-95	Minimum Design Loads for Buildings and Other Structures	Structural
ANSI/ASCE 72-88	American National Standard Minimum Design Loads for Buildings and Other Structures	Structural
ANSI/ASME B&PV Code Section IX and Section III or Section VIII	Welding and Brazing Qualifications Nuclear Power Plant Components Pressure Vessels	Welding of sealed containers and for sealed container pressure boundaries
ANSI/ASME B31.3-1990	Chemical Plant and Petroleum Refinery Piping	Process piping
ANSI/ASME N509-1989	American National Standard for Nuclear Power Plant Air Cleaning Units and Components	HVAC
ANSI/ASME N510-1989	American National Standard for Testing of Nuclear Air-Cleaning Systems	HVAC
ANSI/ASME NOG-1-1989	American National Standard Rules for construction of Cranes, Overhead and Gantry (Top Running Bridge, Multiple Girder)	Cranes

Table 4-1. (continued).

Code/standard	Title	Applies to
ANSI/ASME NQA-1-1989	American National Standard Quality Assurance Program Requirements for Nuclear Power Plants	Quality, with special emphasis in unloading equipment, storage area structures, fuel handling/transfer, monitoring effluent and direct radiation, and HVAC in contaminated areas.
ANSI/AWS D1.1-1990	Structural Welding Code - Steel	Storage casks, vaults, cranes
ANSI B30.2-1990	Overhead and Gantry Cranes (Top Running Bridge, Multiple Girder)	Cranes
ANSI B30.11-1993	Monorails and Underhung Cranes	Cranes
ANSI/NFPA 10-1990	American National Standard for Portable Fire Extinguishers	Fire protection - extinguishers
ANSI/NFPA 12-1989	American National Standard for Carbon Dioxide Extinguishing Systems	Fire protection - extinguishers
ANSI/NFPA 12A-1989	American National Standard for Fire Extinguishing Systems - Halon 1301	Fire protection - extinguishers
ANSI/NFPA 12B-1990	American National Standard for Fire Extinguishing Systems - Halon 1211	Fire protection - extinguishers
ANSI/NFPA 13-1989	American National Standard for Sprinkler Systems	Fire protection - sprinkler systems
ANSI/NFPA 14-1990	American National Standard for Installation of Standpipe and Hose Systems	Fire protection - standpipe and hoses
ANSI/NFPA 72-1993	American National Standard National Fire Alarm Code	Fire protection - smoke detectors
ANSI/NFPA 801-1995	Facilities Handling Radioactive Materials	HVAC, fire protection, architectural
ANSI N13.1-1969	Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities	Electrical
ANSI N42.17B-1989	Performance Specifications for Health Physics Instrumentation Occupational Airborne Radioactivity Monitoring Instrumentation	Electrical
ANSI N14.6-1993	Special Lifting Devices for Shipping Containers weighing 10,000 Pounds (4500 kg) or More	Rigging

Table 4-1. (continued).

Code/standard	Title	Applies to
ASCE Manual No. 58	Structural Analysis and Design of Nuclear Power Plant Facilities	Structural
ASHRAE 90	American Society of Heating, Refrigerating, and Air-Conditioning, Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings	HVAC
CMAA 70	Crane Manufacturers Association of America, Inc., Specification for Electric Overhead Traveling Cranes	Cranes
CMAA 74-1987	Specifications for Top Running and Under Running Single Girder Electric Overhead Traveling Cranes Utilizing Under Running Trolley Hoist	Cranes
ASCE Manual No. 58	Structural Analysis and Design of Nuclear Power Plant Facilities	Structural
ASHRAE 90	American Society of Heating, Refrigerating, and Air-Conditioning, Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings	HVAC
CMAA 70	Crane Manufacturers Association of America, Inc., Specification for Electric	Cranes
CMAA 74-1987	Specifications for Top Running and Under Running Single Girder Electric Overhead Traveling Cranes Utilizing Under Running Trolley Hoist	Cranes
EPA/625/7-88/003, PL 101-508, USC§§6901, and DOE Orders	Hazardous and Solid Waste Amendment	Decontamination systems/ methods
ICBO/UBC	Uniform Building Code	Structural
Idaho Code 39-44-1 et seq.	Idaho Hazardous Waste Management Act	
IDAPA 16.01.01000-01999	Idaho Administrative Procedures Act - Clean Air Act	HVAC/HEPA filtration
INEL Transportation Manual	INEL Transportation Manual	Transport from facility to basemat
MIL-F-51068C	Filter: Particulate High Efficiency, Fire Resistant	HVAC, Fire protection
MIL-F-51079A	Filter Medium: Fire Resistant, High Efficiency	HVAC, Fire protection
NFPA 70	National Electric Code	Electrical
NFPA 101	Life Safety Code	Life safety, egress
NFPA 780		Electrical

Table 4-1. (continued).

Code/standard	Title	Applies to
NUREG-0612	Control of Heavy Loads and Nuclear Power Plants	Cranes and Rigging
UFC	Uniform Fire Code	Fire protection
USNRC Reg. Guide 1.6	Design Response Spectra for Seismic Design of Nuclear Power Plants	Structural

5. PRELIMINARY ACQUISITION STRATEGY FOR THE SNF DRY STORAGE PROJECT

5.1 General

This section describes the preliminary acquisition strategy for the SNF Dry Storage Project. The project has been separated into three major construction packages based on schedule requirements, degree of risk, and interfaces:

- Dry Transfer Cell (DTC) -- provides the capability to unload fuel from shipping/transfer casks and to place in dual-purpose canisters (DPCs) for transfer to the Dry Storage System basemat for interim storage in modular dry storage units; also includes work required to obtain an NRC license for the facility.
- Dry Storage System (DSS)-- includes the dry storage canisters, modular dry storage units, and basemat; procurement of the internal basket assemblies used to position fuel into the DPCs; and work required to obtain NRC licenses for each spent nuclear fuel type included in this project scope.
- Site Preparation and Utility Tie-Ins -- includes construction area clearing and grading, basemat area preparation (excavation and backfill with select material), construction fencing, and electrical and utility tie-ins to existing ICPP systems.

The final acquisition strategy for each construction package will be selected in mid FY 1997 and documented in the Project Execution Plan (PEP). Key criteria in this decision process include constructability; value; interface with existing facilities; technical, cost, and schedule risks; and project management control and coordination. Acquisition options have been identified for all three construction packages and are outlined in the following sections.

5.2 Dry Transfer Cell (DTC)

Several options have been considered for the DTC facility, including (1) a Design-Build contract, (2) AE design with LITCO serving as the construction manager (i.e., fixed price competitive bid construction), and (3) AE design with LITCO serving as the general contractor for construction. Prior to a final decision on these options, a preliminary design will be prepared by the LITCO Engineering Organization. If determined to be cost effective, an Integrated Product Development Team (IPDT) would then be formed. The IPDT would include several different vendors, engineering companies, and other experts that would work with LITCO and DOE-ID to evaluate the preliminary design of the facility and recommend the best approach for definitive design and construction. At the conclusion of the Preliminary Design or the IPDT effort, a decision on either a Design-Build contract or a Definitive Design AE contract will be made. If the Definitive Design option is chosen, a follow-on decision will be made at the completion of design to determine whether to proceed with the fixed price competitive bid or the LITCO general contractor option. Figure 5-1 shows the decision process for this facility. (Note: The

Definitive Design can either be done with the LITCO Engineering Organization or be released for competitive bid to the AE community. That decision will be made at a later date and documented in the PEP.)

Assumptions

- GFE Procurement will be required for some DTC equipment due to long-lead time.
- The Design-Build option would need to include contract clauses defining interfaces, time frame, and scope of the NRC licensing process.

5.3 Dry Storage System (DSS)

Two options have been identified for this construction package. The Design-Build contract with Newport News for the Long-Term Storage of TMI-2 Fuel Project contains a provision for additional purchase of horizontal storage. This contract could be extended to purchase internal basket assemblies, DPCs, modular storage vaults, and the basemat for this project. The second option would be to competitively bid a new Design-Build contract.

Assumptions

- A horizontal storage system will be used since this is the system that was selected for the Long-Term Storage of TMI-2 Project.
- Some of the equipment used for DPC loading on the TMI-2 Project could be reused on this project.
- One INEL dry storage system would be more cost effective and result in lower life cycle costs than maintaining two or more types of dry storage systems.

Issues

- Need to determine if a sole-source justification is required to specify a horizontal storage system. Currently, NUHOMS® is the only supplier of such a system.

5.4 Site Preparation and Utility Tie-Ins

Due to plant interface and potential unknown conditions (i.e., underground interferences, plant operations interface, schedule for utility outages to allow for tie-ins, etc.), all electrical and utility tie-ins, as well as site preparation, will be done as a separate construction package. Two acquisition options were identified -- use of LITCO construction forces or competitive fixed price bid. The final decision will be largely based on the complexity of the utility tie-ins and site preparation requirements and the degree of confidence in defining the existing conditions at the ICPP construction site.

Figure 5-1. Dry Storage Facility acquisition strategy options.

6. ALTERNATIVES

6.1 Introduction

The Dry Storage Facility includes the DTC and the DSS. The NUHOMS® horizontal storage system concept was established for the conceptual design of the DSS. The concept for the DTC, however, was essentially unrestrained at the beginning of the conceptual design effort. Several alternative approaches were identified and evaluated for that part of the facility. A structured Value Engineering assessment process was used to select the most appropriate concept for development in the conceptual design. The Value Engineering approach included the following sequence: defining the project objectives and essential requirements and criteria; brainstorming to identify potential approaches for meeting those objectives and requirements; assessing the requirements to determine which were essential "go/no-go" (musts) for meeting mission objectives and which could be compared on some scale that measured the degree to which they met objectives; and assigning an importance weighting to those latter criteria.

The alternatives were then evaluated against the weighted criteria. Relative scores were developed for each of the alternatives against each of the criteria, and total scores were developed that indicated the relative degree to which each alternative met the aggregate weighted criteria. The primary rating/selection criteria were: (1) minimize capital investment, (2) minimize life-cycle cost, (3) minimize impacts to existing operational schedules, (4) support ready NRC licensing, (5) minimize environmental issues, (6) minimize transportation complexity, (7) provide flexibility to meet evolving project missions, (8) minimize generation of D&D waste, and (9) simplify criticality control.

Seven alternatives were identified that appeared to meet the requirements specified for the project. These were: (1) use the Fluorinel Dissolution Process and Fuel Storage (FAST) Facility with support from a new addition and the Fluorinel Dissolution Process (FDP) facility as appropriate, (2) use the Test Area North (TAN) Hot Shop, (3) use a new, stand-alone shielded facility, (4) use a new, stand-alone facility that employs earthen berms and remote operation to provide protection from high radiation sources, (5) use underwater loading sequences to accomplish shielding, (6) use smaller DPCs that could be loaded at the shippers' facilities and be subsequently loaded directly into storage modules at INEL without further packaging, and (7) use modular DPCs that could be loaded into storage modules at INEL without further packaging.

The evaluations of the various alternatives are described below. Additional details concerning the evaluation are contained in Reference 4. The options for alternate configurations of DPCs (small or modular DPCs) were not evaluated against the criteria. These options may be appropriate for consideration as an alternate to a transfer facility, but were judged to be unresponsive to the overall project mission.

6.2 Identification and Assessment of Alternatives

The results of the assessment are summarized in Figure 6-1, with a conclusion that the options met the stated criteria in the following order (best match first): (1) TAN Hot Shop, (2) New, stand-alone shielded facility, (3) new bermed, remote facility, (4) Wet loading, (5) using the FAST and FDP facilities. The results are briefly discussed below, as is the rationale for ultimately choosing the new, shielded, stand-alone facility for development in the conceptual design.

6.2.1 TAN Hot Shop

The TAN Hot Shop has been used for years to perform the same operations required for the new mission. It will also be used to load the TMI-2 fuel debris canisters into Dry Shielded Canisters (DSCs), and load the DSCs into a transfer cask in preparation for shipment to ICPP for interim dry storage.

While significant upgrades to TAN infrastructure systems would be needed to support long-term operation, the cost of the facility upgrades were considered to be relatively low, and the overall cost of using the Hot Shop was considered to be the lowest of the identified options. The equipment and systems currently available in the Hot Shop would be adequate to perform the processes of placing the SNF in DPCs and shipping them to the ICPP for placement into dry storage. Remote handling equipment would require relatively little upgrading to be suitable for this activity, although if operation does not begin until 2003, additional upgrades would be anticipated as existing equipment reaches end-of-life.

The conceptual design was not based on the use of TAN because the evaluation team understood that TAN may not be retained as an operating facility through the anticipated life of the SNF Dry Storage Project.

6.2.2 New Stand-Alone, Shielded Facility

The description of the new stand-alone, shielded facility is contained in Section 3 of this report and is not repeated here. This facility concept was selected for development in the conceptual design because of its high relative ranking in the order of preference, and because it provides something of a conservative but cost-effective design for accomplishing the defined mission. It can be used as a baseline to compare to other options, particularly those options that require considerations beyond a simple capital cost comparison.

6.2.3 New Stand-Alone, Bermed, Remote Facility

This concept includes most of the equipment and features of the new, shielded facility but uses earthen berms for shielding around the fuel handling area, and relies solely on cameras rather than a combination of cameras and direct visual access to control the remote fuel-handling operations. This alternative is somewhat less expensive for the facility, but some utility costs would be higher as a result of placing the facility in a location further removed from existing operations. The primary reason this option was not selected for the conceptual design is that the lack of internal shielding walls would

Select Best SNF Dry Storage Facility Option

March 19-20, 1996

Decision Analysis Matrix

		Alternatives				
		A - FAST Facility	B - TAN Hot Shop	C - New Facility	D - Thin Wall Facility	E - Wet Loading
"Want" Criteria (10 = best to 1 = worst)	Weight					
Minimize Initial Investment	20	3.3 66	5 100	1.7 34	1.7 34	10 200
Minimize Life Cycle Cost	12	8 96	8 96	10 120	9 108	8 96
Minimize Schedule Impacts to Existing Operations	15	4 60	10 150	10 150	10 150	2 30
Ease of NRC Licenseability	10	7 70	8 80	10 100	8 80	7 70
Minimize Environmental Issues	5	10 50	7 35	10 50	9 45	9 45
Minimize Transportation Complexity	10	10 100	7 70	10 100	10 100	9 90
Flexibility	9	5 45	10 90	6 54	7 63	3 27
Minimize D&D Waste Generation	5	2 10	10 50	1 5	3 15	9 45
Simplify Criticality Control	7	10 70	9 63	10 70	10 70	6 42
Total Weighted Score		567	734	683	665	645

* - Ratings were based on the total estimated costs and then distributed across the scale of 10 (best) to 1 (worst).

Figure 6-1. Value Engineering Decision Analysis Matrix.

prevent concurrent operations at the facility while fuel was being transferred. This would probably limit throughput of the facility to a level that would not meet the projected need.

6.2.4 Wet Loading

This concept would use typical underwater handling processes to provide shielding during fuel transfers. The FAST pools would be used. This concept was projected to entail the lowest capital cost, but was not selected because of the probable conflicts with other FAST operations, and because submergence of the graphite fuels (which are chemically reactive with water) would probably require initial canning to prevent exposure to the pool water. This would substantially complicate the overall approach.

6.2.5 Use of the FAST Facility

A new hot cell would be added to the FAST facility, but the existing cask receiving area (and crane) would be used for offloading and initial handling of shipping and transfer casks. This would eliminate the need for a new cask handling crane and cask receiving area. While further study is appropriate for this option during later design stages, issues that reduce its attractiveness are the anticipated impacts on other activities scheduled in FAST and the need to keep the FAST facility operational for a longer period than currently planned. FAST is relatively expensive to operate, and it is expected that life-cycle costs would be higher for this option than for the new facility.

6.3 Conclusions From Study

As noted above, the alternative selected for development in the conceptual design is the new, stand-alone, shielded facility. At this stage of the project, this is the concept that is most responsive to the Conceptual Design Criteria (see Appendix A) and is technically most defensible. Further studies will be performed during later design activities to determine if the concept can be modified to reduce cost while still meeting the requirements established and documented in the Project Design Criteria (see Appendix B).

Basing the Conceptual Design on the selected alternative provides a conservative but realistic basis for project planning and future design activities.

7. UNCERTAINTIES AND RECOMMENDATIONS FOR FURTHER DESIGN DEVELOPMENT

A number of issues were identified during the conceptual design effort that require additional investigation before their impact on the facility design and cost can be fully understood. These uncertainties are typical for the initial design stages of a project of this nature. In general, the uncertainties have led to assumptions in the conceptual design that are reflected in the cost estimate.

Where conservative assumptions were made, opportunities exist to reduce the cost of the conceptual facility. Where non-conservative assumptions were made, there is risk that the current conceptual cost estimate understates the true cost of the facility.

The more significant uncertainties are described in Section 7.1. Section 7.2 identifies a number of areas where existing information is sufficient to support near-term additional studies. These are areas that if resolved, can reduce the level of uncertainty in the conceptual design and improve confidence in the correctness of the approach taken and in the corresponding cost estimates. These are recommended for near-term activity.

7.1 Project and Design Uncertainties

7.1.1 Facility Location and Configuration

As discussed in the previous section, the investigation of alternatives identified options to the location and configuration of the DTC. The conceptual design is based on a conservative approach, i.e., a stand-alone facility. The potential exists that one of the other options, particularly the integration with FAST, would be feasible and would have a lower capital and/or life cycle cost.

7.1.2 Cranes—Fuel Handling

The fuel handling crane may not meet the requirements of ANSI/ANS 57.9, simply because the fuel configurations to be handled in the DTC are different from those used as the basis for the commercial standard. Also, the definition of "critical loads" as applied to this facility needs to be accepted by the licensing authority before a defensible position can be established.

7.1.3 DPC Transfer System

The assumption has been included in the conceptual design that the transfer cask and transport equipment for moving the loaded DPC from the DTC to the Storage basemat will be provided by the TMI Dry Storage Project. Significant added costs would be incurred if the SNF Dry Storage Project were required to pick up that cost.

7.1.4 Licensing Issues

To minimize the number of DPCs required to package the fuels identified for this effort, some of the DPCs are projected to contain multiple fuel types. Licensing of these mixed-fuel packages by the NRC may be difficult since mixing has traditionally been avoided.

7.1.5 Security Requirements

Some uncertainty exists with regard to the physical security system needed. The requirements in 10 CFR 73 can be interpreted as significantly more rigorous than typical security provisions maintained at the INEL. On the other hand, informal discussions with NRC personnel concerning a draft modification to that CFR indicate that it is likely those requirements will be substantially reduced, probably to a level of rigor below that currently required by the DOE at the INEL. The conceptual design is based on using the lower level of rigor expected to be required by the NRC. There is some risk that the proposed modifications will not be codified, and there is also some risk that even if the NRC requirements are modified, DOE requirements may be imposed. Further discussions with DOE and NRC are required to reach a final decision on these requirements.

7.1.6 Cranes—Cask Handling

It is assumed for the conceptual design that a crane meeting NOG-1 Type-1 criteria will be required in the Cask Handling Bay. Cranes meeting these criteria are significantly more expensive than those procured to more typical commercial standards. If a justification can be found for a relaxation of the NOG-1 Type-1 requirement, then substantial savings (several hundred thousand dollars) may be achievable.

7.1.7 Minor Canning of SNF

The requirement that the capability for minor canning be included in the facility is based on the need to add flexibility, and therefore applicability, for the facility. However, a major assumption upon which the entire approach to DTC fuel transfer is based, is that the Hot Cell will be entered frequently by operations personnel. These entries are made to place and remove contamination control barriers, assemble tools, and to survey and decontaminate the equipment prior to removal from the Hot Cell, and to perform maintenance tasks. This manual approach allows the use of relatively simple remote tools and equipment, thus keeping capital costs lower. If the Hot Cell becomes contaminated as a result of handling degraded fuel, operating costs will increase and personnel exposures to radiation may increase. Additional tools and equipment would probably be needed and the throughput capability of the facility would be impacted, perhaps to the point where the facility becomes the bottleneck to the SNF Dry Storage Project.

7.1.8 DPC Loading Optimization

Thermal and shielding calculations are being performed on fuel loading configurations representing approximately 90% of the fuel to be handled in the SNF Dry Storage Project. The calculations are being made for DTC lag storage, for the DPCs loaded in the MP-187 cask, and for the DPCs loaded in the

NUHOMS® storage modules. Results of these analyses could require some reduced loading efficiencies in the DPCs, and increase the number of components and DPCs and concrete modules required. This would then be reflected as an increase in the facility cost.

7.1.9 SNF Structural Capability

It has been assumed in the conceptual design that the SNF can be handled, stored, and shipped in the horizontal position. There is an uncertainty regarding the capability of the fuel to withstand potential shipping and handling accelerations without damage to the cladding (first containment boundary). The degree to which this will meet applicable criteria is unknown. It is possible that specific support structures would be needed for some of the fuel types to ensure stresses on the fuel cladding remain within the limits of applicable criteria.

7.1.10 DPC Structural Capacity

The conceptual design of the DPC baskets is based on a Vectra "road ready" concept that has not yet been licensed. This design includes 22 lateral support plates in the DPC with cutouts forming channels that run the length of the DPC. Structural analyses have not been performed to validate the conceptual design addressed in this report.

While there is some risk that a major redesign might be required, it is anticipated that if changes are needed to meet the structural analyses, they will be minor (e.g., small increases in cruciform thickness) and will not affect the loading efficiency or the cost of the DPC, baskets and buckets.

7.1.11 Fire Protection

The Hot Cell does not have egress locations that fully comply with Life Safety regulations. The layout presented in the conceptual design is typical of hot cell designs and is considered fully adequate for the planned operations. This is based on the rationale that multiple exits are required to address the (radiation) hazard in the Hot Cell, and the hazard will be removed (material placed in secure shielded vaults or casks) whenever personnel are in the Hot Cell.

An additional fire safety issue is the lack of automatic fire protection for the Hot Cell. Foam and gaseous protection systems are considered to be ineffective in a room with such a high ceiling and large volume, and water could react chemically with some of the fuel that will be processed. Since the combustion load will be small, and since personnel entry will be administratively controlled, the absence of automatic fire protection systems is considered appropriate.

7.1.12 SNF Characterization

The fuel characterization information required by the NRC or DOE prior to licensing for storage or shipment to a repository is not well understood. 10 CFR 72 identifies rather general data needs that are considered achievable through a combination of shipping records (in accordance with 10 CFR 71) and fuel unit identification during fuel handling in the Hot Cell. The conceptual cost estimate is based on this approach. The DOE requirements contained in draft DOE Order 5820.2B are substantially more

detailed. Obtaining this information might require considerable process development and equipment to assay the fuels that are expected to be received with limited relevant data.

7.1.13 Ventilation System Requirements

Another area where DOE and NRC design requirements appear to differ is in the HVAC systems. The NRC requirements are interpreted as being less demanding than those of DOE. The conceptual design is based on the NRC requirements and if the applied interpretation is in error, or if it is determined that DOE requirements are to be applied, additional HEPA filtration will be required with a resultant increase in ventilation system complexity and cost.

7.2 Recommendations for Near-term Design Development

The following activities are recommended for near-term action. Completing these will provide the most significant reductions in the uncertainties identified above. These reductions in uncertainty will result in a corresponding increase in the confidence in the estimated facility cost.

- Complete a more detailed analysis of the impacts and cost reduction opportunities associated with interfacing the new facility with the existing FAST Facility. This will require an understanding of the operations that are scheduled at FAST through the period of interest and an assessment of the conflicts that would arise if the new facility were to share the cask handling crane. Requirements applicable to NRC licensing of all or parts of the facility would need to be defined.
- Complete the criticality, thermal, and shielding analyses of the DPC designs for the remainder of the major fuel types. This will provide the justification for the fuel loading planned and estimated in the conceptual design. The shielding calculations may also support reducing the cost of the shield wall surrounding the storage area.
- Perform the structural analyses required to confirm the DPC/basket/bucket designs for use with the six major fuel types identified for this project.
- Perform shielding and structural analyses to confirm the design approach and to identify cost reduction opportunities in the building structure. This would include additional crane and handling equipment definition to better establish the crane rail and building heights and to better define the minimum acceptable load ratings for the cranes.
- Continue the development of the design criteria and bases for the cask handling and fuel handling cranes. Part of this effort may depend on the consequences of a cask/fuel drop event, therefore limited investigation to determine those consequences would be included.
- Conduct a more detailed analysis to determine the applicable security requirements and the potential design and cost impacts of changes in those requirements. This may

require additional radiological information on the various fuels to be handled and a more in-depth understanding of the regulations (some of which are in draft form).

- Continue the criticality, thermal, shielding, and structural analyses on the remaining 10% of fuel included in this project. Specifically look at mixing the low volume fuels to improve storage efficiency.

8. SCHEDULE

The project schedule is summarized in Figure 8-1. The most important milestones shown in this figure are:

- Project Validation--June 18, 1996

The Settlement Agreement between the State of Idaho and the U.S. Department of Energy includes the submittal of a request for funding of this effort as a FY-98 line item. Project Validation is a necessary step in that formal request process.

- Start DPC Loading--July 1, 2003

This is the negotiated date for starting the movement of SNF from ICPP storage pools to dry storage.

The other milestones shown in the figure are intermediate objectives important to achieving the goal of starting the transfers by July, 2003 and placing the last of the pool-stored fuel into dry storage by the end of calendar year 2023.

The schedule for receiving various types of fuel during the period of 2003 to 2023 is shown, as is the schedule for procurement of DPCs and storage modules and the construction of the storage pads (basemats).

Figure 8-1. Project schedule.

OPEN PLAN (R)

REPORT: XNGBAR2

PROJECT: DPCCONST

LOCKHEED MARTIN IDAHO TECHNOLOGIES

DRY STORAGE PROJECT (DSP)

PAGE: 2

REPORT DATE: 30MAY96

Summary Activity Barchart in Calendar Years

TIME NOW: 18MAY96

Figure 8-1. (continued).

Figure 8-1. (continued).

9. COST ESTIMATE

The Total Estimated Cost (TEC) for the DTC is \$41M. The TEC for the Dry Storage System is \$59M. A breakdown of these costs is provided in Table 9-1 and details of the estimates are provided in Appendix G. It is important to note that the TEC of \$59M for the DSS does not include storage of all SNF described in this report. This estimate covers 50 DPCs (with baskets and DHBs) which is sufficient for storing SNF received through 2009. To store all of the SNF described in this report would require about 88 DPCs at a total DSS cost of \$134M, including escalation. These costs are in 1996 dollars that have been escalated to the approximate midpoints of each activity; i.e., design and construction.

Conceptual Estimates are required to obtain authorizing legislation and appropriations. The Conceptual Estimate is prepared to aid managers in establishing budgets. All costs relating to TEC for the project are included, including engineering, design, and inspection (ED&I), construction costs, government-furnished equipment (GFE), project management, construction management, management reserve, contingency, and escalation.

The Conceptual Estimate is based on all the detailed requirements in the CDR including, but not limited to, the design parameters, identified equipment (see Appendix H) applicable codes, specifications and standards, conceptual design criteria, quality assurance requirements, space requirements, definitions of scope, methods of performance, operations interfaces, and safety requirements.

Other project costs (OPCs) are all other costs related to a project that are not included in the TEC, such as supporting R&D, preauthorization costs prior to start of Title I design, plant support costs during construction, activation, and start-up. OPC will include, but not be limited to, R&D; NEPA documentation, project data sheet; CDR; short-form project data sheet; surveying for siting; conceptual design plan; and evaluation of Resource Conservation and Recovery Act (RCRA)/U.S. Environmental Protection Agency (EPA)/State of Idaho permit requirements. OPC has been estimated to be approximately \$5M.

Total Project Costs (TPCs) are all costs specific to a project incurred through the start-up of a facility but prior to the operation of a facility. It comprises TEC and OPC. TPC will include, but not be limited to, design and construction; contingency; economic escalation; Pre-Title I activities; Feasibility Study Reports (FSR); maintenance procedures (to support facility start-up); one-time start-up costs, initial operator training, and commissioning costs and operating procedures (to support facility start-up).

Construction labor rates are based on the prevailing wage rates as determined by the INEL Site Stabilization agreement. The labor values presented in the estimate are based on handbook values that have been adjusted to INEL practices and productivity factors. The labor costs are also based on an adequate supply of skilled workers in the area. Construction material costs are based on handbook values and recent vendor quotes.

It is assumed that the design will be prepared by the INEL A-E organization. This will eliminate additional costs to the design and project management organizations with regards to additional oversight and travel costs to an outside A-E, and decrease site and project familiarization time.

It is assumed that the Construction Management will be performed by the INEL Construction Management Organization, taking advantage of the knowledge of site-specific construction practices. The construction subcontractor will be responsible for the first-line inspection activities. The INEL Title III organization will be responsible for concrete and compaction testing, and the overall acceptance of the construction project.

Table 9-1. SNF Dry Storage Project cost summary.

	DTC	DSS	DSF
Engineering, design, Inspection	\$ 3,663,000	\$ 378,000	\$ 4,041,000
Management	5,820,000	6,880,000	12,700,000
Construction	11,995,000	2,682,000	14,677,000
Gov't furnished equipment	7,504,000	26,645,000	34,149,000
Procurement fees	292,000	400,000	732,000
G&A	1,220,000	1,900,000	3,120,000
Project contingency	6,424,000	7,466,000	13,890,000
Escalation	4,082,000	12,609,000	16,691,000
Total estimated cost	41,000,000	59,000,000	100,000,000

Escalation is defined as an estimate of the change in price levels over time. The rates used in the preparation of the estimate are based on the DOE-HQ *Departmental Price Change Index, FY 1998 Guidance, Anticipated Economic Escalation Rates for General Construction Projects*.

Contingency is defined as funds included within an estimate to cover materials, labor, conditions, and risk situations that are an intrinsic part of the intended scope of work, but are not specifically included elsewhere in the estimate due to an uncertainty, either as to the nature, existence, likelihood of occurrence, or magnitude of effect. Contingency funds are included in the project's TEC and shall be considered part of that cost and not extra.

A Contingency Analysis, included in Appendix "X", was prepared to determine the amount of contingency that will be required to complete the project as proposed. Contingency guidelines are established by DOE/FM-50, *Cost Estimating Guide, Vol. 6, Cost Guide* and are presented in the INEL *Cost Estimating Guide*.

The contingency is based on the identified assumptions noted during the preparation of the estimate. The incorporation of the assumptions into the estimate could have significant impact on the cost.

10. REFERENCES

1. INEL Spent Nuclear Fuel Program, *Mission Need Document for Spent Nuclear Fuel Dry Storage Project, proposed FY-98 Line Item Construction Project*, Lockheed Martin Idaho Technologies Company, March 1996.
2. Robert C. Hill et al., *Spent Nuclear Fuel Dry Storage Project Feasibility Study*, INEL-96/0061, February 1996.
3. Fluor Daniel, Inc., *Fuel Canning and Dry Modular Storage Feasibility Study Report*, Delivery Order 94-02A, Contract 4353A1, June 1994.
4. A. M. Conner, *Summary of the VE Session Held to Determine the Optimum SNF Dry Fuel Transfer Facility*, Letter Report AMC-09-96, April 1996.

Appendix A

CPP-666 FSA

Spent Nuclear Fuel (SNF) Transfers to the Dry Transfer Cell (DTC)

Appendix A

CPP-666 FSA Spent Nuclear Fuel (SNF) Transfers to the Dry Transfer Cell (DTC)

Conceptual Design

EXECUTIVE SUMMARY

The Conceptual Design for the transferring of SNF from CPP-666 FSA to the Dry Transfer Cell (DTC) investigates the loading of spent nuclear fuel (SNF) stored underwater at the Fuel Storage Area (FSA) pools in Building CPP-666 at the Idaho National Engineering Laboratory (INEL) into shipping casks and transferring the casks to the DTC. After receipt of the shipping casks at the DTC, the fuel is transferred into Dual Purpose Canisters (DPCs) in preparation for eventual dry storage.

The Feasibility Study by Fluor Daniel, Inc. evaluated the CPP-666 facility for modifications to allow loading of SNF underwater in the FSA pools into DPCs. The study considered both a base case (minor modifications) and a debottlenecking case (modifications to eliminate interference problems with ongoing operations). The study concluded that in both cases modifications are feasible and loading in DPCs is a viable option.

Since the subject Feasibility Study was completed, additional information about the amounts and types of fuel that must be handled in the FSA for dry storage at the INEL has been received. This information eliminated the need to consider Naval and aluminum fuels. It has now been determined that the Naval and aluminum fuels will be shipped to the Naval Reactors Facility and Savannah River Site, respectively, for preparation for storage. The Feasibility Study concluded that about 120 DPC underwater loadings would be needed to remove the SNF (including the Naval and aluminum fuels) from the FSA pools at CPP-666. With the exclusion of the Naval and Aluminum SNF from the FSA inventory, the remaining Department of Energy (DOE) pristine fuel types considered for loading into DPCs at the FSA number to six. These six fuel types can be loaded into 4 DPCs, which is considerably less than the 120 DPC loadings considered in the Fluor Daniel Feasibility Study. This latest information has directed a further evaluation of the need for modifications to CPP-666 as proposed in the Feasibility Study. This Conceptual Design Report (CDR) reevaluates the need for these modifications and investigates transferring SNF (no Naval or aluminum) in shipping casks to the DTC for further handling and loading into DPCs.

This Conceptual Design addresses:

- The types of SNF stored in the CPP-666 FSA pools that would be placed in dry storage under this CD.

- Loading pristine SNF stored in the CPP-666 FSA pools into shipping casks underwater, removing the loaded casks from the pool, and transferring the cask and fuel to the proposed Dry Fuel Transfer Facility (DTC) for loading into DPCs.
- The shipping casks and fuel loadings that will be required to make the SNF transfers from the CPP-666 FSA pools to the DTC.
- Adjusted cost comparison between concepts presented in the Fluor Daniel Feasibility Study (i.e., loading DPCs with SNF underwater in CPP-666 FSA pools) and item 1.

Considering that modifications to CPP-666 (primarily tooling and equipment for the Base Case) described in the Feasibility Study are same or similar to as those designed into the DTC (with the exception of the crush pads) and the small amount of SNF identified for loading into DPCs, it is proposed that the SNF stored in the FSA pools be loaded into shipping casks and transferred to the DTC for loading into DPCs. This effort will require no modifications to the CPP-666 facility. In addition, existing tooling and shipping casks will be utilized for the fuel loading and transfers.

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Appendix A

CPP-666 FSA

Spent Nuclear Fuel (SNF)

Transfers to the Dry Transfer Cell (DTC)

Conceptual Design

A-1. INTRODUCTION

The scope of work for this Conceptual Design Report for transferring SNF from CPP-666 FSA to the DTC for loading into DPCs requires the Architect-Engineer (A-E) to develop a conceptual design for the shipping cask that will load and transfer SNF stored at the FSA to the DTC. The SNF inventory considered in this report includes six different Department of Energy (DOE)^a pristine fuel types. These fuels are part of the Baseline SNF Inventory^{A-1} and must be prepared for dry storage and eventual off-site shipment.

The Feasibility Study by Fluor Daniel, Inc.^{A-2} has shown that it is feasible to load SNF stored underwater in the FSA into DPCs. This Study identified methods to accomplish this loading underwater, both for a base case and for a debottlenecking case. The base case investigated minor modifications and equipment to perform the work. The debottlenecking case looked at modifications to minimize interference problems with ongoing operations in the facility. Since the Feasibility Study was completed, additional information about the amounts and types of pristine fuel that must be handled in CPP-666 FSA for dry storage has been received. This information has reduced the amount of SNF to be handled significantly from that reported in the subject Feasibility Study by eliminating the Naval and aluminum fuels. The Naval SNF will be shipped to the Naval Reactors Facility, and the aluminum SNF will be shipped to the Savannah River Site for storage preparation. This CD assumes that no Naval or aluminum fuels will be loaded into DPC at CPP-666. With the elimination of these fuels, it has become necessary to re-evaluate the concepts considered in the subject feasibility study and investigate other options for handling and loading the SNF stored underwater in the FSA. This CD accomplishes these tasks.

Other studies previously completed addressing SNF dry storage in relation to CPP-666 have been reviewed in sufficient detail to complete this Conceptual Design.^{A-3,A-4,A-5}

This Conceptual Design addresses the following items:

- The types of SNF stored in the CPP-666 FSA pools that would be placed in dry storage under this CD.

a. For the purpose of this report "pristine" fuel implies fuel where the cladding has not been breached nor has the can or bucket containing the fuel corroded through.

- Loading pristine SNF stored in the CPP-666 FSA pools into shipping casks underwater, removing the loaded casks from the pool, and transferring the cask and fuel to the proposed Dry Fuel Transfer Facility (DTC) for loading into DPC.
- The shipping casks and fuel loadings that will be required to make the SNF transfers from the CPP-666 FSA pools to the DTC.
- Adjusted cost comparison between concepts presented in the Fluor Daniel Feasibility Study (i.e., loading DPC with SNF underwater in CPP-666 FSA pools) and item 1.^b

The assumptions made in the development of this Conceptual Design are listed in Appendix A and relate to spent nuclear fuel inventory, shipping casks, cask inserts, and lifting and handling equipment.

A-2. DESCRIPTION OF CPP-666 FSA FACILITY

The FSA in building CPP-666 is used for receipt of SNF, preparation of fuel handling units (FHUs), and underwater storage of FHUs. Normal operations use cask handling crane (CRN-FR-903) and two fuel handling cranes (CRN-FS-901 and -902). A description of the four major areas utilized in this CDR is given below. The operating floor is reference (grade) elevation 0 foot 0 inch (see Figure A-1).

A-2.1 Truck Receiving Area

The Truck Receiving Area acts as an airlock between the FSA and the environment. There are two access routes into this area from the south end of building CPP-666. Both are serviced with large overhead roll-up doors. Additional roll-up doors between the Truck Receiving Area and the Cask Receiving Area form the airlock. This area has no permanently installed crane.

A-2.2 Cask Receiving Area

The Cask Receiving Area occupies the south end of the FSA, between the Truck Receiving Area and the unloading pools. The large overhead 130 ton crane services this area. Two decontamination rooms are located in this area. Decontamination Room No. 1 is 17 feet tall and used for shorter casks and Decontamination Room No. 2 is 22 feet tall and used for taller casks. Each room is equipped with front and roof doors for cask placement inside the room with the cask crane. There are walkways and platforms inside the decontamination rooms that allow for personnel access to all areas of the cask. The Decontamination Rooms are supplied with de-ionized water, filtered ventilation, and utility power.

The Cask Receiving Area has stainless steel collection trays on the floor for placement of lifting yokes, casks, and other equipment.

b. The cost estimate presented in the Fluor Daniel, Inc. Feasibility Study^{A-2} included cost for 120 DPC and associated IBA spacers. The adjusted cost reduces the number of DPC to 4 consistent with the amount of SNF to be handled in this CD. This reflects the decision to not handle the Naval and aluminum fuels.

A-2.3 Cask Unloading Area

The Cask Unloading Area is a pool area south of Pool No. 1 which is within reach of both the cask handling crane and the fuel handling cranes. It includes two fuel unloading pools where casks are placed for fuel loading/unloading: Unloading Pool No. 1 is 36 feet deep and Unloading Pool No. 2 is 44 feet deep. The bottom of each pool is protected with 1 inch thick steel plate. Lifting yoke storage racks are located on the south wall of the unloading pools. An isolation pool connects each unloading pool. Isolation Pool No. 1 is 31 feet deep and Isolation Pool No. 2 is 41 feet deep.

The Cask Unloading Area also includes the south end of the 31-foot deep transfer channel which connects both Unloading Pools to the storage pools (see Figure A-1).

A-2.4 Fuel Storage Area

The Fuel Storage Area consists of six pools aligned in the north-south direction and cross-connected by a transfer channel on the east. The SNF is stored in fuel racks in various locations within these six pools. This area is served by the two fuel handling cranes CRN-FS-901 and CRN-FS-902, each with a capacity of 10 tons.

A-3. FSA AND DTC CONFIGURATION AT TIME OF SNF SHIPMENT

It is assumed that all SNF described in Table A-1 will be temporarily stored at the CPP-666 FSA (in storage racks) by the time this design is implemented. CPP-666 operations of SNF movement, transfer, and shipping will be ongoing for other fuels not described in this report. Facility management and operations will allow and accommodate fuel transfers, loadings, and shipments, as described within this design. All necessary procedures and other documentation will be in place to allow loading and shipping of the SNF described herein. Facility cranes and lifting-and-handling equipment as well as tooling will be available and in usable condition. The DTC will be in operation and ready to receive SNF shipments.

A-4. CONCEPTUAL DESIGN

A-4.1 Overview

The purpose of this Conceptual Design is to define the concepts necessary to load SNF stored in the CPP-666 FSA pools into shipping casks and ship the casks to the DTC facility for SNF loading into DPC. This design does not address any part of the DTC facility in relation to loading the SNF identified in this report into DPC.

The SNF stored in the FSA that requires loading into DPC is listed in Table A-1. From the table it is evident that only a small amount of SNF is being considered per the requirements of this design. This CDR is based upon the SNF in Table A-1. As mentioned above, the Fluor Daniel, Inc. Feasibility Study proposed modifications in CPP-666 to handle a much larger amount of SNF than that listed in Table A-1.

Table A-1. ICPP-666 FSA SNF inventory (expected inventory to be moved from ICPP-666 FSA to the DTC in shipping casks).

Ref. No.	SNF name	FHUs	Estimated no. of DPCs	Site	Area	Facility ^a	Location	Geometry ^b	Unit	Height (in.)	Width (in.)	Length (in.)
1	Pathfinder	417	0.6	INEL LMITCO	ICPP	ICPP-603	Underwater Storage Middle	Cylinder	Rod	—	0.92	79.50
2	Pulstar- Buffalo	24	0.07	INEL LMITCO	ICPP	ICPP-603	Underwater Storage South	Square	Canister	3.00	3.00	35.00
3	Shippingport PWR-C1-S4	1	0.06	INEL LMITCO	ICPP	ICPP-666	ICPP FAST/4	Square	Cluster	5.50	5.50	104.50
4	Shippingport PWR-C2-S1	19	1.09	INEL LMITCO	ICPP	ICPP-666	ICPP FAST/4	Square	Cluster	7.38	7.38	104.50
5	Shippingport PWR-C2-S2	20	1.14	INEL LMITCO	ICPP	ICPP-666	ICPP FAST/4	Square	Cluster	7.38	7.38	104.50
6	TRIGA Flip	2	0.01	INEL LMITCO	ICPP	ICPP-603	Underwater Storage South	Cylinder	Canister	—	3.80	30.00
7	TRIGA SST	296	0.18	INEL LMITCO	ICPP	ICPP-603	Underwater Storage South	Cylinder	Element	—	1.48	28.31

a. Fuels that reside in ICPP-603 are to be relocated to ICPP-666 before the implementation of this design.

b. "Geometry" describes fuel only and does not necessarily describe the configuration of fuel storage.

Their proposal included much of the same equipment as that designed into the DTC. If the SNF listed in Table A-1 were to be transferred into the DTC for loading into DPC rather than loaded underwater in the FSA into DPC, this would eliminate the need for duplicate equipment in both CPP-666 and the DTC. In addition, heavy shipping casks were considered for the movement of the loaded DPC in the Feasibility Study which required crush pads located in strategic locations to protect the SNF and its packaging from possible drop accidents. If the SNF is loaded into existing shipping casks in CPP-666 and transferred to the DTC, crush pads are not required.

The proposed method (depicted in Figures A-2 and A-3) looks at loading the SNF at the FSA pools into existing shipping casks underwater; removing the casks from the pools, de-watering the casks, loading the shipping casks containing the SNF on a transporter, and transferring the fuel to the DTC facility. The DTC facility is designed to unload the SNF from the shipping casks, place the fuel into DPC, seal weld the DPC, vacuum dry the fuel, and inert the DPC. The DTC facility will contain all equipment for transferring and handling SNF from shipping casks to DPC.

Some of the fuels identified in Table A-1 are planned to be relocated from CPP-603 to CPP-666. These fuels are listed under the column heading "Facility" as ICPP-603. Some of the relocation activities and design work are currently ongoing and the remainder of the work is to be initiated in FY's '98 and '99. It is assumed that when these fuels are relocated, the cask and fuel handling equipment requiring modification and/or redesign, and the existing facility equipment used to relocate the fuel can and will be used to ship the SNF to the DTC. It is therefore further assumed that CPP-666 facility will have available for its operations, during the fuel shipments described in this CDR, all fuel handling tools and equipment that have been or will be used to originally place the SNF in the FSA either through the fuel relocation project or regular shipments.

All documentation and procedures used to place the SNF in the FSA will be used or modified as necessary to perform the work described within this report. It is the intent of this CD to utilize as much equipment and tooling as possible from the initial work to place the fuel in the FSA. This CD does not require any modification to the CPP-666 facility, nor does this CD identify any new tooling or equipment necessary to perform the required work. In addition, crush pads identified in the Fluor Daniel Report are not required under this design because smaller shipping casks are used to transfer the fuel.

All criticality, thermal, and structural calculations used to support the designs to relocate the CPP-603 fuels and other fuel from other facilities (i.e., Shippingport PWR from NRF) will be used to support this design. No additional calculations are foreseen at this time.

A-4.2 Specific Fuels Handling (Reference Table A-2)

A-4.2.1 Pathfinder

Pathfinder SNF is expected to be stored in stainless steel buckets in the storage pools of the FSA in CPP-666 per the CPP-603 Fuel Relocation Project.^{A-6} The bucket design is 9.36 inches square by 84 inches long and can accommodate 62 fuel handling units (FHUs). The referenced project will load the Pathfinder fuel in the buckets prior to shipment to the FSA. The cask used for making the shipments of this fuel from CPP-603 to CPP-666 is a modified HFEF-6 shipping cask (Naval Reactors Facility

Table A-2. SNF specific information.

CONCEPTUAL DESIGN
CPP-666 FSA SNF
TRANSFERS TO THE DTC

REF. NO.	SPENT NUCLEAR FUEL TYPE	(a) CASK REQUIRED FOR SHIPMENT	INSERT/ BASKET TYPE	FHU's	(b) FHU's/ CASK	(c) CURRENT FUEL PACKAGE	MOD. FUEL LGTH. (in.)	CASK INTERNAL HEIGHT (in.)	(d) CASK SHIPMENTS	LIFTING YOKE (J) SHORT	LIFTING YOKE (K) LONG
1	PATIFINDER	HIFEP-6 (MODIFIED)	NOT REQUIRED	417	62	BUCKET - 9 63" SQ. x 84" LG	79.50	Modified 84.00	7	CRNY-FR-911	CRNY-FR-907
2	PULSTAR-BUFFALO	HIGH LOAD CHARGER	3 x 3 ARRAY X 51" LG	24	9	SST CAN - 3" SQ. x 28" LG	28.00	51.50	3	CRNY-FR-911	CRNY-FR-907
3	SHIPPINGPORT PWR-C1-S1	NFS 100	(e) 10-1/2" SQ. X 100" LG	1	(f)	CRIT CAGE 10-1/2" SQ x 106" LG	100.00	103.00	(f) 0	CRNY-FR-950-3	CRNY-SF-807
4	SHIPPINGPORT PWR-C2-S1	NFS 100	(e) 10-1/2" SQ. X 100" LG	19	4	CRIT CAGE 10-1/2" SQ x 106" LG	100.00	103.00	5	CRNY-FR-950-3	CRNY-SF-807
5	SHIPPINGPORT PWR-C2-S2	NFS 100	(e) 10-1/2" SQ. X 100" LG	20	4	CRIT CAGE 10-1/2" SQ x 106" LG	100.00	103.00	5	CRNY-FR-950-3	CRNY-SF-807
(g) 6	TRIGA FLIP	N/A	N/A	2	N/A	(h) SCED 40 ALUM 5" OD x 36" LG	30.00	N/A	N/A	N/A	N/A
7	TRIGA SST	STR CHARGER	(i) 9-1/2" SQ. X 58" LG	296	20	(h) SST CAN 5" OD x 36" LG	28.37	59.00	15	CRNY-FR-911	CRNY-FR-907

NOTES:

- (a) The cask identified in this column will be used to transfer the SNF from the CPP-666 FSA pools to the Dry Transfer Cell Facility.
- (b) This is the total amount of FHU's the cask can accommodate per shipment.
- (c) Assumed package configuration in CPP-666 FSA pools
- (d) Number of cask shipments refers to the number of times the cask will be loaded and shipped in order to move all the identified fuel.
- (e) Insert #1 is a 10-1/2" square array with 4 compartments 100" long. Insert and cask were used to ship this fuel from NRF to CPP-666.
- (f) This fuel will be combined with 1 of fuel Ref. No. 4's shipments.
- (g) Fuel Ref. No. 6, Triga Flip, is currently in aluminum cans that may be corroded. It has yet to be determined if the DTC facility will handle this fuel.
- (h) Each can (aluminum or sst) contains approximately 5 FHU's
- (i) This Insert will be designed during the fuel relocation project.
- (j) Short lifting yokes are used for cask lifting outside the FSA pools.
- (k) Long lifting yokes are used for cask lifting into and out of the FSA pools.

owned/Figure A-4). Cask modifications are required to accommodate the bucket design. The modified cask cavity can accept 1 bucket per shipment and no basket arrangement or other insert is required. The HFEF-6 cask will be returned to NRF in the unmodified condition when the fuel relocation project is completed. It is assumed that the modified cask components will remain at CPP-666 for use by this project.

It is the intent of this CD to utilize the HFEF-6 cask for shipment of the Pathfinder fuel from CPP-666 to the DTC facility. It is assumed that the cask will be available and in operable condition for use when the shipments take place. The shipment of Pathfinder fuel from CPP-666 to the DTC facility will require that the HFEF-6 cask be again fitted with the modified components prior to fuel loading and shipping. The fuel will be shipped in the same configuration as determined in the Title II Design document for "CPP-603 Fuel Relocation Project."^{A-6} All calculations supporting criticality, thermal, and structural contained in the referenced Title II Design document will be utilized as required in shipping the fuel to the DTC.

The Baseline SNF Inventory^{A-1} indicates that there are 417 FHUs of Pathfinder fuel. With 62 FHUs per bucket and 1 bucket per HFEF-6 cask shipment, 7 shipment will be required to ship the Pathfinder fuel from the FSA to the DTC facility.

A-4.2.2 Pulstar-Buffalo

Currently, Pulstar-Buffalo SNF resides in stainless steel canisters in the CPP-603 South Basin and is planned to be relocated to CPP-666 FSA. The stainless steel storage canisters measure 3 inches square by 28 inches long and each accommodate 1 FHU. It is assumed that the fuel will remain in these stainless steel canisters during and after the relocation from CPP-603 to CPP-666 FSA.

The Pulstar-Buffalo fuel will be loaded into the high load charger cask prior to shipment from CPP-666 to the DTC. The cask will be fitted with an insert to provide spacing and accommodate multiple canisters per shipment. The insert is a 3 by 3 array measuring 51 inches long and is fabricated from borated stainless steel. The cask and insert are shown in Figure A-4. The cask fitted with the insert will accommodate 9 canisters of Pulstar-Buffalo SNF.

It is assumed that the high load charger cask and the insert will be available and in operable condition for use when the shipments to the DTC take place.

LITCO is preparing to relocate the Pulstar-Buffalo fuel from CPP-603 to CPP-666 prior to placing the fuel in dry storage. This CD assumes that this relocation will be completed before this design is implemented. The relocation effort will require that all criticality, thermal, and structural calculations be performed to show safe handling of the fuel is possible using the insert identified above and the high load charging cask. Upon completion of the relocation of the Pulstar-Buffalo fuel to CPP-666, the shipping of the fuel to the DTC facility will be initiated and completed. This shipment to the DTC will utilize all the same equipment, insert and cask used in the relocation effort. The fuel will be shipped in the same configuration as determined in the relocation effort. All calculations supporting criticality, thermal, and structural used in the relocation effort will be utilized as needed in shipping the fuel to the DTC.

The Baseline SNF Inventory^{A-1} indicates that there are 24 FHUs of Pulstar-Buffer fuel. With 9 FHUs per high load charger cask shipment, 3 shipments will be required to ship the Pulstar-Buffer fuel from the FSA to the DTC facility.

A-4.2.3 Shippingport PWR

The Shippingport SNF consists of three different types; Shippingport PWR-C1-S4, Shippingport PWR-C2-S1, and Shippingport PWR-C2-S2. This fuel is stored in the fuel storage racks in the FSA building CPP-666. The fuel was received from NRF packaged in a special PWR criticality control spacer arrangement. This fuel was shipped from the Expanded Core Facility at NRF in the NFS 100 cask. The details of the shipping are contained in the classified document "NFS-100 Cask SAR."^{A-7}

The special PWR criticality control spacer measures 10-1/2 inches square by about 100 inches long and fits directly inside the cavity of the NFS 100 cask containing insert no. 1. Insert no. 1 is a 4 compartment array measuring 100 inches long. This insert fits inside the NFS 100 cask and is designed for the special PWR criticality control spacer. The insert allows the cask to accommodate 4 FHUs of Shippingport PWR fuel.

The shipping of this PWR fuel from the FSA to the DTC will be accomplished using the special PWR criticality spacer and the NFS 100 cask. It is assumed that the cask will be available and in usable condition for this shipping effort. This CD will utilize the information contained in the NFS-100 Cask SAR to ship the Shippingport SNF from CPP-666 to the DTC. All the necessary calculations for criticality, thermal, and structural have been completed and approved in the referenced document. No additional tooling or other equipment will be necessary. All tooling and other equipment for this effort will reside at the CPP-666 facility.

The Baseline SNF Inventory^{A-1} indicates that there are 40 FHUs of Shippingport PWR fuel. With 4 FHUs per NFS 100 cask shipment, 10 shipment will be required to ship the fuel from the FSA to the DTC facility.

A-4.2.4 Triga Flip

The current configuration of the Triga Flip SNF is not known to any degree of certainty at the time of this CDR. Only 2 or 3 FHUs are stored in the underwater storage South Basin in CPP-603. The fuels may be in either aluminum or stainless steel open-top cans measuring 5 inch O.D. by 36 inch long. The integrity of the can structures and the fuel elements are not known. The DTC may not have the capability of handling this fuel. For these purposes, this fuel is not being considered for DPC loading in this CDR.

A-4.2.5 Triga SST

At present, the Triga SST SNF resides in stainless steel canisters in the CPP-603 South Basin. The canisters measure about 5 inches O.D. by 36 inches long and contain 5 FHU each. LITCO is preparing to relocate this fuel from CPP-603 to CPP-666 prior to placing it in dry storage.

The proposed configuration for the relocation of this fuel from CPP-603 to CPP-666 is to repackage the fuel into 9-1/2 inch square by 58 inch long stainless steel buckets and ship the buckets in the STR Charger cask. Approximately 20 FHUs will be loaded into each bucket. The cask cavity will only accept 1 bucket per shipment.

The relocation effort will require that all criticality, thermal, and structural calculations be performed to show safe handling of the fuel is possible using the bucket design and the cask. For the purpose of this CD it is assumed that the fuel will be repackaged as mentioned and the new package will be fully qualified.

Upon completion of the relocation of the Triga fuels to CPP-666, the shipping of the fuel to the DTC facility will be initiated and completed. This shipment to the DTC will utilize all the same equipment and cask used in the relocation project. The fuel will be shipped in the same configuration as determined adequate in the relocation effort. All calculations supporting criticality, thermal, and structural contained in the relocation effort will be utilized as required in shipping the fuel to the DTC.

This design will take the repackaged Triga fuels in the new buckets, load them back into the STR Charger cask underwater, remove the cask from the FSA pool, and ship the cask and fuel from CPP-666 to the DTC. It is assumed that the STR charger cask will be available and in operable condition for use when the shipments to the DTC take place.

The Baseline SNF Inventory^{A-1} indicates that there are 296 FHUs of Triga SST fuel. With 20 FHUs per bucket and 1 bucket per cask shipment, 15 shipments will be required to ship the fuel from the FSA to the DTC facility.

A-4.3 Cask and SNF In-Plant Movements (Reference Figures A-2 and A-3)

The cask will enter the truck receiving area through the east roll-up door on the transporter. Once inside the truck receiving area, the outside door is closed. The truck receiving area provides an airlock for the FSA facility. In the truck receiving area, road dirt is washed from the transporter and the cask if required. The transporter is then moved through the inner roll-up door into the Cask Receiving and Decontamination Area. The inner door is then closed.

With the cask transporter positioned in the Cask Receiving and Decontamination Area, the cask restraints are removed and the cask is prepared for movement using the cask crane. The cask crane (CRN-FR-903, capacity 130 tons) and short lifting yoke^c is attached to the cask and the cask is transported to Decontamination Room No. 1. The lifting yoke is removed from the cask trunnions and placed in the lay-down rack.

In the Decontamination Room the cask lid is made pool ready by loosening the lid bolts. The lid bolts are designed with bails for installation and removal underwater using pool reach tools. If the cask

c. Lifting yokes are designed for specific casks and are individually identified in Table A-2.

is a sealed design (i.e., HFEF-6 and NFS-100) the cavity is filled with water compatible with the FSA pool water. The cavity is filled prior to lowering the cask into the pool to prevent excess bubbling and contamination spray into the air that might occur by sinking the cask and flooding the cavity with pool water. The extra water from the cask added to the FSA pools is acceptable; the pools require about 8000 gallons of makeup water each month. Administrative controls will be utilized to factor the number of shipments and the total amount of water added to the pools in order to keep from adding too much water too quickly. The cask cavity is filled through the cask fill valve located near the top of the cask. The valve accepts a hose fitting and hose for filling. If the cask is not a sealed design (cavity will not hold water as in the STR Charger and High Load Charger) the cask is submerged into the Unloading Pool and it's cavity is naturally filled from the bottom up.

The cask crane and long lifting yoke are used to move the cask from the Decontamination Room onto the Unloading Pool no. 1 floor. With the cask positioned on the floor of the pool, existing "J" and "L" type pool tools are used to remove cask lid bolts and make lifting yoke connections with the cask lid. The lid is removed and staged out of the way. From here, the fuel handling crane is used to move fuel from the fuel storage racks to the cask. With the cask full, the shield lid is placed back on the cask using the cask crane and the long lifting yoke. The lid bolts are tightened using the pool reach tools and the cask is lifted from the pool.

The cask (i.e., STR Charger and High Load Charger) is allowed to drain and drip dry over the unloading pool and then is moved to Decontamination Room 1. If the cask is a sealed design (i.e., HFEF-6 and NFS-100) it's cavity is drained in Decontamination Room 1 rather than over the unloading pool. Draining is accomplished by accessing the drain valve located near the bottom of the cask. The blind flange is removed from the drain valve and a hose is connected to the valve. The valve is opened and the cavity drained. The drain water goes back into the pool. In addition, in the Decontamination Room, the cask exterior can be wiped down and decontaminated.

Next, the lid bolts are tightened in preparation for shipping and the cask is moved from the Decontamination Room to the transporter using the cask crane and the short lifting yoke. The cask is positioned on the transporter and secured in place. The lifting yoke is removed from the cask crane. The doors of the Cask Receiving and Decontamination Area are opened and the transporter is moved out of the Cask Receiving and Decontamination Area into the Truck Receiving Area. The doors of the Cask Receiving and Decontamination Area are then closed. The doors of the Truck Receiving Area are then opened and the transporter is moved out of the building.

A-4.4 Scheduling

The scheduling of the fuel shipments identified in this CD will need to be determined as more information is obtained and finalized on the shipment schedule of SNF to the INEL. It is believed that fuel shipments identified in this document can take place anytime an opening presents itself in the operations of CPP-666 and the DTC. The DTC preliminary schedule for operational start-up is September 2003.

It is recommended to schedule the shipping of all identical fuel during one time block in order to efficiently use the DTC. This would allow direct transfers from the shipping cask to the DPC and would eliminate the need for any lag storage use.

A-4.5 Time Estimates

Estimates for the "in process" hours for each fuel and associated shipping cask have been compiled in Table A-3. The estimates include all hours for receipt of the shipping cask, loading the fuel, and necessary preparations prior to shipment in CPP-666.

A-5. COST COMPARISON

A adjusted cost comparison has been completed and summarized in Table A-4. In developing the cost comparison it was necessary to revise costs estimated in the Fluor Daniel Feasibility Study^{A-2} to reflect the loading of 4 DPC rather than the 120 identified in the Study. From the summary it is evident that costs are much less to utilize the DTC and equipment contained therein to accomplish the packaging of the fuels into DPC. No major equipment is needed to transfer fuels from the FSA to the DTC. The only costs related to this CDR are those required to procure the 4 DPC.

A-6. CONCLUSIONS AND RECOMMENDATIONS

This CD has reviewed the option to ship the identified fuels from the FSA to the DTC in shipping casks for eventual loading into DPC. This document has also compared the costs associated with making modifications to the CPP-666 facility to load DPC directly underwater in the FSA to the cost of shipping the fuel to the DTC for loading into DPC. It is obvious, due to the small amount of pristine SNF to be handled, that modifications to CPP-666 should not be undertaken and that the identified fuels should be loaded into DPC in the DTC.

This design will utilize as much equipment and tooling as possible from the initial work to place the fuel in the FSA. No modifications to the CPP-666 facility are required, and no new tooling or equipment necessary to perform the required work has been identified.

The DTC will be operational and will be equipped with remote capabilities for dry handling of the SNF. This facility will be fully capable of performing the needed operations to meet the requirements for eventual above ground dry storage of SNF in DPC. Based on the current information, no further effort should be expended in addressing modifications to the CPP-666 facility.

Much of the relocation of SNF from CPP-603 to CPP-666 has yet to be completed. This CD is based upon this relocation work being completed prior to the implementation of this design. The actual package configuration of the relocation fuels (i.e., Pulstar-Buffalo and Triga) have yet to be finalized. This may have a minor affect on this CD as described above. Therefore, it is necessary to closely follow the fuel relocation work and make design adjustments as necessary as more information become available.

Table A-3. Time estimates to load shipping casks with SNF.

CONCEPTUAL DESIGN
 CPP-668 FSA SNF
 TRANSFERS TO THE DTC

	FUEL/CASK			
	PATHFINDER/ HFEF-6	PULSTAR-BUFFALO/ HIGH LOAD CHARGER	SHIPPINGPORT PWR/ NFS-100	TRIGA SST/ STR CHARGER
OPERATIONS				
RECEIVE CASK	1.5	1.5	1.5	1.5
CASK PREPARATIONS	1.5	1.0	2.0	1.0
OPEN CASK	1.0	1.5	2.0	1.5
TRANSFER FUEL*	1.5	7.5	3.5	1.5
CLOSE CASK	2.0	1.5	2.5	1.5
DECON CASK	2.0	2.0	3.0	2.0
LOAD ON TRUCK	1.5	1.0	1.5	1.0
**SUBTOTAL	11.0	16.0	16.0	10.0
NO. OF CASK SHIPMENTS	7	3	10	15
TOTAL IN FACILITY HRS	77.0	48.0	160.0	150.0

NOTES: RECEIVE CASK = TRANSPORTER BRINGS CASK INTO FACILITY, CASK IS REMOVED FROM TRAILER AND POSITIONED IN DECONTAMINATION ROOM

CASK PREPARATIONS = PREPARE CASK LID FOR REMOVAL UNDERWATER, FILL CAVITY WITH WATER, MOVE CASK TO POOL FLOOR

OPEN CASK = REMOVE LID BOLTS, LIFT LID FROM CASK, STOW LID

TRANSFER FUEL = TRANSFER FUEL FROM STORAGE RACK TO FILL CASK

CLOSE CASK = LIFT LID ONTO CASK AND SECURE, REMOVE CASK FROM POOL, DRAIN AND DRIP DRY OVER POOL

DECON CASK = POSITION CASK IN DECONTAMINATION ROOM, DECON EXTERIOR, TORQUE LID BOLTS

LOAD ON TRUCK = REMOVE CASK FROM DECON ROOM AND LOCATE ON TRANSPORTER, SECURE CASK

* HOURS TO TRANSFER FUEL TO FILL 1 CASK

** IN PROCESS HOURS FOR 1 CASK

Table A-4. Construction direct cost comparison.

Equipment Designation	CONSTRUCTION DIRECT COST COMPARISON									
	CPP-666 FSA Modifications To Enable DPC Loading Fluor Daniel Feasibility Study					CPP-666 FSA Spent Nuclear Fuel Transfers to the Dry Transfer Cell Conceptual Design				
	Qty	Material	Labor	Equipment	Total	Qty	Material	Labor	Equipment	Total
DPC - Dual Purpose Canister (Shell)	4	450,000	420,000		2,220,000	4	450,000	420,000		2,220,000
DPC Shield Plug	4	Inc	Inc	Inc		4	Inc	Inc	Inc	
IBA - Internal Basket Assembly	4	Inc	Inc	Inc		4	Inc	Inc	Inc	
DPC AutoWelder w/ Console and CCTV	1	650,000	1,779	150	651,929	1	Included in Dry Transfer Cell			
DPC Leak Test Mass Spectrometer	1	Inc	Inc	Inc		1	Included in Dry Transfer Cell			
DPC Vacuum Drying System	1	Inc	Inc	Inc		1	Included in Dry Transfer Cell			
DPC DI Water Supply/Drain Hose and Valve	1	1,500	-	-	1,500	NR				
DPC Equipment Preparation Station	1	2,500	10,671	900	14,071	NR				
DPC Fill Pump with Motor **	1	3,532	1,423	120	5,075	NR				
DPC Shield Plug Lifting Device	1	500	-	-	500	NR				
DPC Shield Plug Retainer	1	10,000	-	-	10,000	NR				
DPC Shield Plug Retainer Fastening Tool	1					NR				
Electrical Connecting Equipment **	1	8,265	5,461	498	14,224	NR				
IBA Spacer Installation Tool	1	1,750	-	-	1,750	1	Included in Dry Transfer Cell			
IBA Spacers, Port	62	400	-	-	24,800	AR	Included in Dry Transfer Cell			
IBA Spacers, Stacking	117	425	-	-	49,640	AR	Included in Dry Transfer Cell			
Large Cell Cask In-Pool Crush Pad	1	400,000	7,114	600	407,714	NR				
Lifting Yoke Storage Pan	1	11,435	889	75	12,399	NR				
OTC Crush Pad	1	400,000	7,114	600	407,714	NR				
OTC Crush Pad Lifting Device	1	750	-	-	750	NR				
Slings	1	750	-	-	750	1	Included in Dry Transfer Cell			
Total Cost					3,823,000					2,220,000

- Notes: (a) Labor on DPC is Engineering & Licensing
 (b) Current day costs - No Escalation
 (c) Direct Costs only - No Overhead and Profit
 (d) ** F-D costs that have been re-estimated
 (e) NR = Not Required / AR = As Required

A-7. REFERENCES

- A-1. A. P. Hoskins Letter to W. B. McNaught, APH-14-96, Dry Storage Facility—Dry Transfer Cell Baseline Spent Nuclear Fuel, Dated April 4, 1996
- A-2. CPP-666 FSA Modifications to Enable Dual Purpose Canister (DPC) Loading Feasibility Study, Dated April 1996, Prepared by Fluor Daniel, Inc. for DOE.
- A-3. Fuel Canning and Dry Modular Storage Feasibility Study (CADMOST Study), Dated June 1994, Prepared by Fluor Daniel, Inc. for DOE.
- A-4. Westinghouse Idaho Nuclear Co. (WINCO) ICPP-Process System Description, FAST Facility Fuel Storage Area, Volume XIII, Book 1, Dated August 1987.
- A-5. Spent Nuclear Fuel Dry Storage Project Feasibility Study, Dated February 1996, Prepared by Lockheed Idaho Technologies Co. for DOE.
- A-6. CPP-603 Fuel Relocation Project, "Pathfinder", Title II Design Package, Dated October 1995, Prepared by Fluor Daniel, Inc. for DOE.
- A-7. NFS-100 Cask Safety Analysis Report, ECF, Bettis, Westinghouse Electric Co., Naval Reactors Program, Document No. WAPD-REO "C"-267 "Classified."

Attachment A

Key Assumptions List

The following assumptions have been made in conjunction with this conceptual design.

The shipping casks identified in Table A-2 are available and in usable condition at the time of fuel transfer from CPP-666 to the Dry Transfer Cell Facility. In particular, the HFEF-6 cask and the NFS-100 cask are the property of the Naval Reactors Facility, these casks will be available for LITCO to use during this SNF campaign.

The shipping casks identified in Table A-2 are staged at the CPP site. This report does not address transporting shipping cask from another facility (i.e., NRF) to the CPP site.

Transporter/shipping truck and trailer are available and in good usable condition at the time of SNF shipment.

CPP-666 cranes, lifting and handling equipment and facilities identified in this report are available for use and in operable condition at time of SNF shipping.

All SNF identified in Table A-1 is in underwater storage at the CPP-666 FSA pools at the time it is required to be transferred to the DTC. This report does not address the relocation of SNF from CPP-603 or other facility to CPP-666.

Crush pads have not been used during past operations in CPP-666 facility for the casks identified in Table A-2 and will not be necessary for operations described in this Conceptual Design.

HFEF-6 cask modified components will be available and in usable condition at time of Pathfinder SNF shipping to the Dry Transfer Cell facility. Operations personnel will install the modified cask components prior to SNF loading.

All tooling and equipment existing or fabricated for SNF relocation from CPP-603 to CPP-666 will be available and in operable condition for use during this SNF campaign.

Calculations for criticality, thermal, and structural for specific SNF loading into a shipping cask (identified in Table A-2) have been or will be completed by others. These calculations can be used for the SNF shipping identified in this report.

Operations personnel, trained for SNF fuel transfer and shipping will be made available at CPP-666 to perform the work identified in this report.

The Dry Transfer Cell will be built at the CPP site and be in operation prior to shipping any SNF identified in Table A-1 from CPP-666 pools.

Fuel identified for relocation from CPP-603 to CPP-666 will be stored at the FSA in it's current proposed configuration, i.e., can, bucket, or cage.

The SNF will not be dried prior to receipt in the DTC. If drying of the SNF is required before loading into DPC, the drying process will take place in the DTC facility.

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Figure A-1. CPP-666 FSA partial floor plan.

- (X1) DELIVER EMPTY SHIPPING CASK TO FSA CASK RECEIVING AREA ON TRAILER.
- (X2) REMOVE CASK USING SHORT LIFTING YOKE FROM THE TRAILER.
- (X3) TRANSPORT SHIPPING CASK FROM THE TRAILER AND POSITION INSIDE DECON ROOM NO. 1.
- (X4) PREPARE CASK LID FOR REMOVAL UNDERWATER. FILL CASK (HFEF-6, NFS 100) CAVITY WITH WATER.
- (X5) TRANSFER CASK TO FUEL UNLOADING POOL NO. 1 USING THE LONG LIFTING YOKE.
- (X6) MOVE FHU FROM STORAGE RACK TO CASK.
- (X7) LOAD SNF IN CASK. INSTALL CASK LID.
- (X8) REMOVE LOADED CASK FROM POOL. RINSE, DRIP DRY, AND TRANSPORT CASK TO DECON ROOM 1.
- (X9) DECONTAMINATE CASK SIDE AND TOP. HEALTH PHYSICS TO RELEASE FOR FUTURE WORK.
- (X10) TRANSFER LOADED CASK FROM DECON ROOM NO. 1 TO TRAILER USING THE SHORT LIFTING YOKE.
- (X11) SHIP CASK LOADED WITH SNF TO DTC FACILITY.

GLOSSARY

FHU = FUEL HANDLING UNIT
 FSA = FUEL STORAGE AREA
 SNF = SPENT NUCLEAR FUEL
 DTC = DRY TRANSFER CELL

NOTES:

1. ROLL-UP DOORS ARE RECEIVING AREA ACTS
2. OVERHEAD CRANE "C" CASK HANDLING IN C.
3. CASKS USED ARE AS HIGH LOAD CHARG STR CHARGER HFEF-6 NFS-100

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Figure A-2. CPP-666 cask and SNF handling plan view.

MAX TRAVEL SOUTH FOR
CASK HANDLING CRANE HOOK
CRN-FR-903

INTERLOCKED SO THAT TRUCK
IS AN AIRLOCK.

CRN-FR-903" IS USED FOR
TRUCK RECEIVING AREA.

FOLLOWS:

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Figure A-3. CPP-666 cask and SNF handling section view.

NFS 100
SHIPPING CASK

NFS 100
BASKET

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HFEF-6 MODIFIED
CASK

HFEF-6
BASKET

(ALL D)

Figure A-4. Shipping casks and baskets.

STR
CHARGING CASK

HIGH LOAD
CHARGING CASK

STR
BASKET

HIGH LOAD
BASKET

ENSIONS ARE FOR REFERENCE ONLY)

Appendix B

Conceptual Design Criteria for the ICPP Spent Nuclear Fuel Dry Storage Project

Appendix B

Conceptual Design Criteria for the ICPP Spent Nuclear Fuel Dry Storage Project

B-1. INTRODUCTION

The INEL is committed to packaging existing and future spent nuclear fuel (SNF) and placing the packages in dry storage to comply with the Nuclear Regulatory Commission (NRC) requirements given in 10 CFR 72. The facility to package and store the SNF, an Independent Spent Fuel Storage Installation (ISFSI), is referred to herein as the SNF Dry Storage Facility. It comprises two principal parts: the Dry Transfer Cell, and the Dry Storage System (DSS). The Dry Storage Facility will be licensed by the NRC in accordance with 10 CFR 72. In addition, the fuel will be packaged such that it can be readily removed from storage and placed in a dedicated Type B shipping container. That package will be licensed in accordance with Department of Transportation (DOT) 49 CFR 173 and NRC 10 CFR 71.

This facility will receive DOE SNF that is contained in cladding or cans that are sufficiently sound to prevent direct exposure of the fuel material to the handling environment. The facility will be used to package the fuel for storage, place it in interim storage modules, and ultimately transfer the packages to offsite shipping casks. Key assumptions for the SNF Dry Storage Facility are listed in Attachment 1.

B-2. REQUIREMENTS

B-2.1 General Requirements

The SNF Dry Storage Facility shall comply with the requirements of ANSI/ANS 57.9.

B-2.2 Operational Requirements

1. The Dry Transfer Cell (DTC) shall transfer SNF from shipping casks to in-cell lag storage or dry storage canisters. The dry storage canisters shall be commercial dual-purpose canisters (DPCs), and shall be sealed and inerted for storage.
2. The DPCs shall provide one of two confinement barriers for the SNF as required during storage by 10 CFR 72.122.
3. The DPCs shall have corrosion resistance equal to or greater than that of 300 series stainless steel.
4. The DTC shall have the capability to perform minor canning processes. These include the packaging of fuel elements, either already canned or in intact assemblies, in cans that are sealed to constitute the first of two confinement boundaries required by 10 CFR 72.

5. The DTC shall be sized to transfer fuel from a maximum of 12 incoming SNF shipping casks per month (see Table 1 for shipping cask descriptions), and to fill a maximum of two DPCs per month. The facility shall operate on a schedule of two 12-hour shifts per day.
6. Equipment shall be provided for drying, inerting, sealing, and leak checking the DPCs.
7. Equipment shall be provided to sample the gases in the shipping cask internal cavity before opening the cask, and for verifying leak tight conditions before returning the empty cask to the shipper.
8. The equipment within the transfer cell shall have remotely changeable components to handle various types of SNF, SNF baskets, SNF buckets, SNF cans, cask and canister lids and shield plugs, hot-cell lag storage shield plugs, and to perform cell and equipment decontamination.
9. A DSS comprising an outdoor above-ground concrete storage basemat, and suitable shielded, monitored, storage modules shall be provided. Loaded DPCs from the DTC shall be transported and placed into the storage modules on the storage basemat.
10. The DSS shall be designed to allow ready expansion throughout its life up to a maximum capacity of 240 DPCs.
11. Equipment shall include a site transfer cask to transport DPCs from the DTC to the storage basemat and to safely transfer the DPC from the transfer cask to the storage module on the storage basemat.
12. Equipment shall be provided so that the DPCs can be safely retrieved from the storage modules and placed in dedicated offsite shipping casks.
13. Control room, office, change room, and shower facilities shall be minimized to the extent practical for efficient operation.
14. Facility control, process control, and data acquisition systems shall be provided.

B-2.3 Maintenance Requirements

1. The DTC shall include features to support local maintenance of contaminated equipment. The hot cell shall be designed to be used as a manual contaminated-equipment maintenance area. Normal operation may be suspended during manual maintenance operations. The hot cell shall be capable of being decontaminated.
2. Breathing air facilities within the DTC shall be provided as necessary.

B-2.4 Design Life Requirements

1. Design life of the SNF Dry Storage Facility and equipment shall be 30 years and have maintainable or replaceable life of 60 years.
2. The design life of the DPC shall be 100 years.
3. Design life of the Storage Facility shall be 60 years.

B-2.5 Structural Requirements

1. Structural design shall meet the requirements of ANSI/ANS 57.9.
2. Special features to provide handicapped access within the facility are not required.

B-2.6 Interface Requirements

1. The DTC shall receive SNF shipments by truck. Delivery by railcar shall not be precluded by the selected site.
2. The DTC shall include equipment to handle, unload, and interface with the MP-187 transfer cask and the shipping casks identified in Table 1. The design should be suitable for adaptation to other, yet-to-be-identified shipping casks whose size and weight are enveloped by those listed above.
3. The DTC handling equipment shall be able to interface and handle all SNF listed in Table 2.
4. The design of the DTC shall be such that ready access and space is assured for a future facility expansion to characterize and treat SNF (treatment may include SNF decanning, sizing, recanning, drying, and inerting).
5. The SNF Dry Storage Facility shall use existing ICPP utilities to the maximum extent supported by sound design and operating considerations.
6. DTC Siting shall be based on: access to existing utilities, use of existing roadways, access to existing security perimeters, and to a lesser extent, proximity to the storage basemat and access to a rail spur.
7. The Storage facility location shall be governed by available ground space at ICPP, integration with the TMI-2 fuel canister storage area, access to road, access to existing utilities, proximity to the DTC, and potential access to rail lines.

B-2.7 Specific Requirements

1. The conceptual design shall include the Vectra NUHOMS system for horizontal storage of the DPCs.

B-2.8 Safety Requirements

B-2.8.1 General

1. Facility design features and physical controls shall ensure occupational exposure is maintained ALARA during normal and off-normal operations.
2. Personnel radiation exposure levels throughout the SNF Dry Storage Facility shall not exceed 0.125 mr/hr for continuously-occupied areas.

B-2.8.2 Construction

1. The design of utility services and distribution systems that are important to safety shall include redundant systems to the extent necessary to maintain, with adequate capacity, the ability to perform safety functions assuming a single failure^a.
2. The Dry Storage Facility and its systems important to safety^b shall be designed to be evaluated by appropriate tests or by other means acceptable to the NRC to demonstrate that they will reasonably maintain confinement of radioactive material under normal, off-normal, and credible accident conditions.
3. Structures, systems, and components important to safety shall be designed and located so that they can continue to perform their safety functions effectively under credible fire and explosion exposure conditions.
4. The design of the Dry Storage Facility shall include provisions to protect against nuclear criticality that might otherwise result from the operation or the failure of fire suppression or decontamination systems.

a. A single failure is an occurrence that results in the loss of capability of a component to perform its intended safety function(s). A multiple failure, i.e., loss of capability of several components, resulting from a single occurrence, is considered to be a single failure. Systems are considered to be designed against an assumed single failure if neither (1) a single failure of any active component (assuming passive components function properly) nor, (2) a single failure of any passive component (assuming active components function properly) results in loss of the system's capability to perform its safety function(s).

b. Structures, systems, and components important to safety mean those features of the Storage Facility whose function is: (1) To maintain the conditions required to store spent fuel safely, (2) To prevent damage to the spent fuel waste container during handling and storage, or (3) To provide reasonable assurance that spent fuel can be received, handled, packaged, stored, and retrieved without undue risk to the health and safety of the public.

5. Spent fuel handling, packaging, transfer, and storage systems shall be designed to be maintained subcritical under the worst case moderated and reflected conditions, and to ensure that, before a nuclear criticality accident is possible, at least two unlikely, independent, and concurrent or sequential changes must occur in the conditions essential to nuclear criticality safety.
6. The DPC and its internal structures and containers shall be designed to maintain the fuel in a favorable geometry for nuclear criticality safety throughout the operations and life of the system.
7. Each entrance or access point into a high radiation area shall have either a control device that energizes a conspicuous visible or audible alarm signal so that the individual entering the high radiation area and the supervisor of the activity are made aware of the entry; or entryways that are locked, except during periods when access to the areas is required, with positive control over each individual entry.
8. The spent fuel storage package shall be designed to provide adequate heat removal capacity without active cooling systems.
9. The DPC and its internal basket shall be designed to maintain the fuel and fuel cladding below the maximum allowable temperatures. Allowable temperatures (380 C for 5-year old zirc or stainless clad fuel, 350 C for 10-year old zirc or stainless clad fuel, 180 C for aluminum clad/canned fuel) must be maintained in the Hot Cell lag storage, the MP-187 transfer cask, and in the storage modules at all ambient temperatures conditions to which the fuel may be exposed.
10. The radiation dose level at one meter from the exterior of the transfer cask (used to transport the loaded DPC to the DSS) shall be less than 200 mR/hr.
11. To limit the size of the radiation area surrounding the DSS, and to maintain reasonable radiation levels during fuel transfers into and out of the storage modules, the radiation dose level at the exterior of any storage module filled with a fuel-bearing DPC(s), shall be less than 200 mR/hr at contact and less than 10 mR/hr at 1 meter.
12. SNF that is reactive with water or other chemicals shall be protected from exposure to those materials.
13. The fuel handling equipment shall be designed against single failure* resulting in dropping the fuel. Designs shall include appropriate redundancy and consider diversity to reduce the possibility of concurrent common-mode failures of redundant items.
14. The SNF Dry Storage Facility shall be designed to prevent the dropping of casks, SNF, SNF baskets/buckets/cans, and DPCs under normal and off normal conditions including the design basis accidents (DBAs) that they shall withstand.

15. The SNF Dry Storage Facility shall be designed to be able to recover from accidents involving dropping of casks, SNF, SNF baskets/buckets/cans, and DPCs.
16. In-cell equipment shall be designed for recovery from all possible conditions to the extent that manned entry into the cell, for maintenance, can be accomplished.
17. If a fuel grapple is supporting the weight of the fuel, the grapple shall be interlocked so that it can not disengage from the crane (or overhead manipulator) or fuel to which it is connected even if the normal control command to do so is inadvertently given. A means of defeating this interlock shall be provided to ensure the grapple can be disengaged at any time even if the full weight of the fuel is on the grapple

B-2.8.3 Operation

1. Provisions shall be made to enable surveying the external surfaces of the shipping casks for radiation levels and radioactive contamination as soon as practical after receipt of the package, but not later than 3 hours after the package is received at the ICPP if it is received during normal working hours, or not later than 3 hours after the beginning of the next working day if it is received after working hours.
2. Nuclear criticality monitors, constant air monitors, remote area monitors, fire alarm, and emergency voice notification shall be connected with the existing ICPP alarm system.
3. Radiation protection for occupational workers shall be per 10 CFR 835 (Occupational Radiation Protection) and the INEL Radiation Control Manual.
4. Fire protection shall be in accordance with ANSI/ANS-57.9.

B-2.9 Environmental Requirements

1. Facility emission limits shall be consistent with the INEL Environmental Restoration and Waste Management Programs Final Environmental Impact Statement, DOE/EIS-0203-F.
2. Administrative controls and Best Available Control Technology shall be used to minimize the impacts of air emissions.
3. The facility processes and equipment shall be designed to limit solid waste generation to 115 m³ per year of LLW and 250 m³ per year of industrial (cold) waste.
4. Solid radioactive waste produced by SNF Dry Storage Facility operations shall be packaged in standard RWMC 4 x 4 x 8-ft plywood boxes for contact-handled (CH) LLW or INEL Mark III concrete containers for remote-handled (RH) LLW, and shipped to RWMC for disposal.

5. Means for measuring the amount and concentrations of radionuclides in effluents during normal operations, and under accident conditions, shall be provided for effluent control systems.
6. DTC warm liquid waste shall be controlled and verified to meet the criteria for existing ICPP handling systems, and shall be transferred to those systems.
7. If all or part of the facility is located outside of existing ICPP fences, the use of new land shall not exceed 551 acres when combined with other storage systems included in DOE/EIS-0203-F.

B-2.10 Safeguards and Security

1. A data management system shall be provided to keep records showing the receipt, inventory, transfer, and disposal of all SNF in storage. The records shall include, as a minimum, the name of the fuel shipper, the estimated quantity of radioactive material per item (including special nuclear material in spent fuel), item identification and serial number, storage location, on-site movements and locations of each fuel assembly or DPC, and final shipment to an off-site location.
2. Dual records shall be maintained to ensure an off-normal event cannot result in the loss of the sole records of SNF inventories. These records for spent fuel shall be retained for as long as the material is stored, and for a period of five years after the material is disposed of or transferred out of the Storage Facility.
3. Equipment shall be provided to conduct a physical inventory of all spent fuel and high-level radioactive waste in storage at intervals not to exceed 12 months unless otherwise directed by the Commission. A copy of the current inventory shall be retained as a record until the Commission terminates the license.

B-2.11 Quality Assurance Requirements

1. Quality assurance (QA) requirements for the SNF Dry Storage Facility are identified in ANSI/ANS 57.9, Section 6.15.

B-3 CODES AND STANDARDS

B-3.1 Code of Federal Regulations

10 CFR 71	Packaging and Transportation of Radioactive Material
10 CFR 72	Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste

49 CFR 173 Shippers-General Requirements for Shipments and Packagings

B-3.2 National Codes and Standards

ANSI/ANS-57.9 Design Criteria for an Independent Spent Fuel
Storage Installation (Dry Type)

B-4 REFERENCES

INEL Environmental Restoration and Waste Management Programs Final Environmental Impact Statement, DOE/EIS-0203-F.

Appendix C

**Project Design Criteria for the
Spent Nuclear Fuel Dry Storage Project**

ABSTRACT

This document gives the project design criteria for the spent nuclear fuel dry storage proposed design. The primary purpose of the document is to establish the technical baseline for title design. The specific criteria were developed from the conceptual design.

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ACRONYMS

CFR	Code of Federal Regulations
DOE	Department of Energy
DOT	Department of Transportation
DSF	Dry Storage Facility
DTC	Dry Transfer Cell
DPC	Dual Purpose Canister
HSM	Horizontal Storage Module
ICPP	Idaho Chemical Processing Plant
INEL	Idaho National Engineering Laboratory
ISFSI	Independent Spent Fuel Storage Installation
NRC	Nuclear Regulatory Commission
SNF	spent nuclear fuel
TMI	Three Mile Island
UBC	Uniform Building Code
UPS	Uninterruptable Power Supply

Appendix C

Project Design Criteria for the Spent Nuclear Fuel Dry Storage Project

C-1. INTRODUCTION

The Idaho National Engineering Laboratory (INEL) is committed to packaging existing and future spent nuclear fuel (SNF) and placing the packages in dry storage to comply with the Nuclear Regulatory Commission (NRC) requirements given in 10 Code of Federal Regulations (CFR) 72. The facility to package and store the SNF, an Independent Spent Fuel Storage Installation (ISFSI), is referred to herein as the SNF Dry Storage Facility (DSF). It comprises two principal parts: the Dry Transfer Cell (DTC), and the Storage Area. The DSF will be licensed by the NRC in accordance with 10 CFR 72. In addition, the fuel will be packaged such that it can be readily removed from storage and placed in a dedicated Type B shipping container. That package will be licensed in accordance with Department of Transportation (DOT) 49 CFR 173 and 10 CFR 71.

The DSF will receive Department of Energy (DOE) SNF that is contained in cladding or cans that are sufficiently sound to prevent direct exposure of the fuel material to the handling environment. The facility will be used to package the fuel for storage, place it in interim storage modules, and ultimately transfer the packages to offsite shipping casks.

C-2. REQUIREMENTS

C-2.1 Overview

The criteria contained in this document are based on the facility concept that is presented in the SNF Dry Storage Project Conceptual Design Report. As the design is developed further, some of the criteria may become nonapplicable, and others will be identified.

This overview of the concept is provided as an aid in understanding the context in which the criteria are imposed.

The facility will consist of two primary structures: The Dry Transfer Cell (DTC) and the Dry Storage System (DSS).

- The DTC contains four general areas: an Administrative Area, Cask Handling Bay, Cask Preparation Area, and Hot Cell.

The Administrative Area contains typical office and support functions.

The Cask Handling Bay will receive shipping casks, unload them from their transport vehicle, and place them vertically on an electrically driven trolley for transfer into the rest of the

facility. All cask operations will be performed while the cask remains on the trolley. The Handling Bay will also be used for loading filled transfer casks onto the onsite transfer trailer.

The Cask Preparation Area will receive a shipping cask from the trolley. In the Cask Preparation Area, the outer lids will be removed, gas samples taken from the cask cavity, and preparation made to move the cask into the Hot Cell for fuel unloading. The Cask Preparation Area will also be used to prepare the shipping cask for return to the shipping facility. These operations include inspection and cleaning, replacement of cask lids, and leak testing before shipping.

The Hot Cell is heavily shielded and will receive the shipping cask, still on the trolley, for unloading. Frequent personnel entry into the cell will be made for final cask preparation, placement of contamination barriers, and equipment maintenance. The fuel will be transferred using a remotely operated crane with a suite of end effectors used to grapple a wide variety of SNF configurations. The fuel will typically be transferred to one of four lag storage vaults for temporary storage until an appropriate inventory of SNF is accumulated to fill a Dual-Purpose Canister (DPC).

When sufficient fuel is accumulated, a DPC will be brought through the Preparation Area (on a trolley and in a vertically oriented transfer cask) and into the Hot Cell. Fuel will be transferred from the lag storage vaults into the DPC, while the DPC remains in the transfer cask. The fuel will be placed in the DPCs which, like the lag storage vaults, contain baskets to support the various SNF packages. When the DPC is full, a shield plug will be inserted and the DPC moved on the trolley back to the Cask Preparation Area. In the Cask Preparation Area, the first of two lids will be welded onto the DPC, the internal cavity will be purged and inerted with a gas, and a second lid will be welded in place. The sealed DPC will then be moved out to the Cask Handling Bay.

At the loading dock the DPC and transfer cask will be loaded, in a horizontal position, onto the onsite transfer trailer and towed to the Storage Facility.

- The DSS includes the transfer cask and trailer, a concrete basemat, asphalt driveways, and shielded storage modules. The DSS employs the NUHOMS® horizontal dry storage system. In this concept, the dry storage canister in the transfer cask will be moved into alignment with a storage module that contains a cavity into which the DPC is pushed using a hydraulic ram mounted on the transfer vehicle. A shield door will be lowered over the cavity opening and welded in place.

C-2.2 Civil Requirements

C-2.2.1 General

- A suitable site shall be located for the Dry Fuel Transfer Facility at the INEL in the vicinity of the Idaho Chemical Processing Plant (ICPP)

- Siting shall take into account the Three Mile Island-2 (TMI-2) storage project needs as well
- All civil designs shall be in accordance with 10 CFR 72, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, Subpart E (Siting Evaluation Factors) and Subpart F (General Design Criteria)
- All civil designs shall meet the requirements of ANSI/ANS 57.9-1992, Design Criteria for an Independent Spent Fuel Storage Installation (Dry Type).

C-2.2.2 Surface Drainage

- Surface drainage shall be taken into account when the siting location is chosen
- Surface drainage should be consistent with the site drainage plan and current ICPP controls.

C-2.2.3 Rock Excavation

- A soils investigation shall be conducted to determine soil properties for design.

C-2.2.4 Soil Excavation and Shoring

- Soil excavation and shoring shall be performed at the chosen site for clearing, grubbing, and grading the site.

C-2.2.5 Finish Grading

- Finish grading shall be performed and shall properly locate the storage module inlet vents above the 100 yr. flood elevation
- Finish grading shall be performed to allow proper drainage.

C-2.2.6 Paving

- Paving shall be provided for the storage area, around the building, for parking areas, and for the access roads
- Paving for vehicle traffic areas shall be designed and constructed for a minimum vehicle load for an AASHTO HS-20 loading
- Roadways shall be a minimum of 15 ft wide
- The basemat, approach slab, and roadways shall be designed to include all loads associated with the transfer operations of the storage modules.

C-2.2.7 Slabs, Sidewalks, and Stoops

- Sidewalks, door stoops, and approaches shall be provided as needed
- Guard posts shall be provided at all vehicle entrances to the facility.

C-2.2.8 Fencing

- Fencing shall be provided around the facility
- Fencing shall be grounded
- Fencing shall be a minimum height of 7 ft
- Fencing shall be topped with three strands of barbed wire.

C-2.2.9 Underground Utilities

- Existing underground ICPP utilities shall be extended as necessary to provide necessary services
- Siting shall take into account existing underground utilities.

C-2.2.10 Site Demolition

- Site demolition may be required, depending on the site location.

C-2.3 Architectural Requirements

C-2.3.1 General

- Architectural designs shall be in accordance with 10 CFR 72, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, Subpart F (General Design Criteria) and Subpart K (General License for Storage of Spent Fuel at Power Reactor Sites)
- Architectural designs shall meet the requirements of ANSI/ANS 57.9-1992, Design Criteria for an Independent Spent Fuel Storage Installation (Dry Type)
- Architectural designs shall be in accordance with 29 CFR 1910, Occupational Safety and Health Standards for General Industry, Subpart D (Walking-Working Surfaces) and Subpart E (Means of Egress).

C-2.3.1.1 Cask Handling Bay.

- The Cask Handling Bay shall provide for receipt and shipment of SNF and its transportation package as well as any associated decontamination, maintenance, and storage activities
- The Cask Handling Bay shall contain a truck bay, laydown area, and cask staging area and shall be sized in accordance with estimated equipment size and the cask shipping schedule
- Cask Handling Bay design shall be based upon a Uniform Building Code (UBC) occupancy classification of Class S-2.

Truck Bay

- The truck bay must interface with the transport trucks
- The truck bay shall support wash down activities of the transport vehicle and shipping covers.

Laydown Area

- Adequate space shall be provided for storing portable personnel barriers, over-packs, impact limiters shipping covers, shipment of low-level waste, lifting fixtures, special tools, and transportation package appurtenances

Cask Staging Area

- A means shall be provided for cask maintenance and moving transfer carts into and out of the Cask Preparation Area and Hot Cell.

C-2.3.1.2 Cask Preparation Area.

- Cask Preparation Area design shall be based upon a UBC occupancy classification of Class H-7
- Sufficient space shall be provided for preparation, welding, gas sampling, maintenance, and decontamination activities of the casks (all potential sizes) entering and exiting the Hot Cell. Sizing shall be based on equipment sizes and shipment schedule
- If contamination or shielding barriers are to be used, the Cask Preparation Area shall include storage space for these barriers.

C-2.3.1.3 Hot Cell.

- Hot Cell design shall be based upon a UBC occupancy classification of Class H-7.
- Sufficient space shall be provided for transfer of dry SNF from the shipping casks to the DPC casks or Lag Storage and a Canning Area.
- The Hot Cell shall include shielded and decontaminable walls, floors and ceilings as appropriate for remote handling devices, viewing windows, and closed circuit television monitoring to permit removal and insertion of fuel units into or out of transportation packages or transfer carts.
- A buffer area shall be required for personnel entering and exiting the cell.
- A work area shall be provided for welding and lid inspection of the transfer cask in the transfer cask bay.
- Sufficient space for a canning area shall be provided, including decontamination activities.
- Shielded view windows shall be provided for remote canning operations and SNF transfer.
- Sufficient space for a transfer system shall be provided.
- A Lag Storage Area shall be provided to hold SNF between shipments when necessary to optimize the final storage package.
- The ports shall provide sufficient shielding to protect personnel from gamma and neutron radiation. The dose rate at the exterior of the Hot Cell wall in the operating gallery shall be below 0.125 mrem/hr. The dose rate in the Hot Cell above the lag storage ports may be at a level of 5 mrem/hr.
- Cooling for the SNF in the Lag Storage Area shall be incorporated into the design. In order to reduce the cooling requirements for fuel within the lag storage ports, the two hottest fuels, Shippingport PWR and FSVR, shall not be placed in lag storage.
- Each Lag Storage port shall have a shield lid. The Lag storage area shall allow for storage space of the shield lids when they are removed.
- The ports shall provide unobstructed draining for any water that might enter the Hot Cell sump.
- The liners shall be decontaminatable.
- Each lag storage port shall have ventilation passages to maintain the fuel clad temperature below 340 °C.

C-2.3.1.4 Buffer Area.

- Buffer Area design shall be based upon a UBC occupancy classification of Class H-7
- Facilities for changing anti-c clothing and personnel monitoring (frisking) devices shall be provided adjacent to the cell
- A buffer area shall be provided for a shielding labyrinth leading from the Hot Cell to the Buffer Area and then to the Anti-C Change Room
- These areas shall be separated from each other and the pressure barriers maintained
- The Buffer Area shall provide space for discarded protective clothing used in the Hot Cell and a step off pad for frisking of contamination by PCM machine
- All surfaces in the Buffer Area shall be decontaminable as well as the floors and walls of the Anti-C room.

C-2.3.1.5 Operating Galleries.

- Operating Galleries design shall be based upon a UBC occupancy classification of Class H-7
- Operating galleries shall be provided as required by view angles
- Operating galleries shall be separated from the Hot Cell by a concrete shielded wall
- Space and utilities shall be provided to accommodate remote equipment operations.

C-2.3.1.6 Utility Support Areas.

- Utility Support Areas design shall be based upon a UBC occupancy classification of Class H-7
- Utility support areas shall be provided for the HEPA Filter, mechanical utilities, *electrical Panels, UPS, communication systems, and welding operations utilities - H-7 pending.*

C-2.3.1.7 Crane Maintenance Areas.

- Crane maintenance areas shall be provided to support maintenance of all three cranes.

C-2.3.1.8 Administrative Areas.

- Administrative Area design shall be based upon a UBC occupancy classification of Class B
- Office and support areas shall be provided for facility personnel, including a supervisor

- Office areas shall be provided with lighting, electrical receptacles, local area network, and phone
- A Ready Room shall be provided for conduct of meetings and work breaks.
- Men's and women's lavatories, showers, lockers, and change facilities shall be provided
- Storage and a janitor's room shall be provided.

C-2.3.2 Building Features

- All areas within the facility will be in a controlled environment provided by the HVAC and filtering systems (see HVAC requirements—Section 2.8)
- The entire surface area of the contaminated work areas shall be decontaminable
- Devices (such as door types or air lock arrangements) shall maintain pressure barriers for the areas
- Materials selected for the walls shall address durability, low maintenance, shielding, insulation and decontamination.
- The UBC construction Type of II-N shall be used for the Facility
- The walls of the DTC shall meet the recommended R value of the DOE-ID A/E Standards.
- Where wash down or decontamination activities are to be located, the floors shall be sloped to drains that lead to appropriate holding tanks.

C-2.4 Structural Requirements

C-2.4.1 General

- Structural designs shall be in accordance with 10 CFR 72, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, Subpart F (General Design Criteria)
- Structural designs shall meet the requirements of ANSI/ANS 57.9-1992, Design Criteria for an Independent Spent Fuel Storage Installation (Dry Type)
- Structural designs shall be in accordance with ICBO/UBC, the Uniform Building Code
- All designs using reinforced concrete shall meet the requirements of ANSI/ACI 318-89

- Structural designs shall promote energy conservation in accordance with 10 CFR 435, Energy Conservation Voluntary Performance Standards for New Buildings, Mandatory for Federal Buildings.

C-2.4.2 Classification and Design Loads

- All permanent and transient loads that could exist or be developed during normal operations of the facility shall be considered in the design of the facility. Loads to be considered shall include: dead, live, thermal, lateral soil, snow, natural phenomena, seismic, wind, flood, off-normal operating and accident loads, and load combinations.
- Design loads shall be determined in accordance with ANSI/ASCE 72-88.
- Live, snow, and wind loads and load combinations shall be determined in accordance with ANSI/ASCE 7-95.
- Seismic loads shall be determined in accordance with 10 CFR 72, 10 CFR 100, and USNRC Reg. Guide 1.6.
- Tornado loads shall be determined in accordance with ANSI/ANS-2.3.
- Off-normal operating and accident loads should be determined in accordance with ASCE Manual No. 58.
- Load combinations shall be designed using applicable load combinations and stress limits stipulated in ANSI/AISC N690 and ANSI/ACI-349.

C-2.4.3 Footings and Foundations

- Footings and foundations shall be provided as needed
- The Hot Cell and Cask Handling Bay shall be provided with continuous wall footings, reinforced grade beams, and slab on grade construction
- Footings shall be extended below the frost depth.

C-2.4.4 Structural Framing Systems

- The Hot Cell walls and roof shall be designed consistent with shielding and loading requirements
- The Cask Handling Bay walls and roof shall be designed consistent with shielding and loading requirements.

C-2.4.5 Special Structural Features

- The structural design must support the crane systems.

C-2.5 Handling Requirements

C-2.5.1 Shipping Casks

- Shipping casks shall be received in the truck bay. Therefore, any transporter shall interface with the truck bay
- Shipping casks must interface with the cask handling equipment (crane, lifting fixtures, etc.). Shippers shall provide any specialized handling equipment (trunnions, etc.) to off-load shipping casks.

C-2.5.2 Multipurpose Transfer Cask and Transporter

- A Multipurpose Transfer Cask shall be used to provide shielding and protection from potential hazards during the fuel handling and transfer operations.
- The Multipurpose Transfer Cask shall meet the requirements of 10 CFR 71 for onsite transfer and offsite transport and 10 CFR 72 for offsite transport.
- The Multipurpose Transfer Cask shall provide sufficient shielding to limit dose rates to less than 200 mR/hr at contact for a DPC filled with 24 PWR or 52 BWR commercial fuel assemblies. Actual shielding will be dependent on the actual fuel in the DPC and will be determined on a case-by-case basis.
- The Multipurpose Transfer Cask must interface with the cask handling equipment (crane, lifting fixtures, etc.).

C-2.5.3 Cask Handling Equipment

Lifting Fixtures

- Lifting fixtures shall be provided to remove casks from trailers and railcars.
- The lifting fixtures shall interface with the cranes, casks (shipping and transport), and associated equipment such as cask lids, shield plugs, welding machine, etc.
- The lifting fixtures shall be decontaminable, to the maximum extent possible.
- Standard lifting and rigging gear shall also be provided.

- The lifting yokes shall be designed and fabricated in accordance with the ASME B&PV Code rules for Class 2 component supports (Section III, D Subsection NF, excluding Subsection NCA), NUREG-0612 and ANSI-N14.6 requirements for special lifting devices. Utilization of these criteria meets or exceeds the requirements of 10 CFR 72 and ANSI/ANS-57.9 as well as 10 CFR 50.

Cask Transfer System

- A method for transferring casks from the Cask Handling Bay, through the Cask Preparation Area, and into the Hot Cell shall be provided
- The cask transfer system must interface with the various casks
- The cask transfer system must support the SNF shipment schedule
- The transfer system must be fail-safe
- ALARA shall be considered for maintenance of the cask transfer system.

C-2.5.4 Cranes

- All crane designs shall meet the intent of ANSI 57.9 and the NOG-1 specification which implements those requirements
- All crane designs shall meet the requirements of CMAA 70, Crane Manufacturers Association of America, Inc., Specification for Electric Overhead Traveling Cranes and CMAA 74-1987, Specifications for Top Running and Under Running Single Girder Electric Overhead Traveling Cranes Utilizing Under Running Trolley Hoist
- All cranes shall meet the requirement of NUREG-0612, Control of Heavy Loads and Nuclear Power Plants
- All crane designs shall be in accordance with ANSI B30.2-1990, Overhead and Gantry Cranes (Top Running Bridge, Multiple Girder) and ANSI B30.11-1993, Monorails and Underhung Cranes
- All cranes shall meet the requirements of 29 CFR 1910, Occupational Safety and Health Standards for General Industry, Subpart N, Materials Handling and Storage
- There shall be three cranes provided, including a Cask Handling Crane, a Cask Preparation Area Crane, and a Fuel Handling Crane.

Cask Handling Crane

- The Cask Handling Crane shall accept transportation packages expected to be handled at the DTC.
- The Cask Handling Crane and its support systems shall be designed to withstand all design loadings, including the design phenomena, while remaining in place. The crane may lose its function, but this loss of function shall not result in a loss-of-load incident.
- Equipment for off-loading and loading of the transportation package for Design Event I shall be provided.
- Lifting devices to handle package heads and package internals for Design Event I and to fail safe for Design Events II and III shall be provided.
- Devices for handling secondary heads, heavy impact tools, or stud tensioners, for Design Event I shall be provided.
- A system for transportation package placement and removal that does not require that the package pass over any other package and that minimizes the passing of one package close to another at the same level for Design Event I shall be provided.
- The capability to receive fuel units from or return fuel units to the fuel handling area for Design Event I shall be provided.

Cask Preparation Area Crane

- The Preparation Booth Crane should be designed to handle secondary heads, heavy impact tools, stud tensioners, DPC welding equipment, and other small loads expected to be handled in the DTC preparation area
- The Preparation Booth Crane shall provide devices for handling secondary heads, heavy impact tools, or stud tensioners, for Design Event I.

Fuel Handling Crane

- Remote handling of fuel units for Design Event I and subsequent to Design Events II, III, and IV shall be provided.
- The capability for special tooling to handle structurally damaged fuel units subsequent to Design Events II, III, and IV shall be provided.
- Materials shall withstand the cumulative effect of radiation exposures anticipated over their design life.

- Capability for emergency shutdown of the lifting and handling equipment power supply (i.e., manual disconnect) shall be incorporated into the equipment design, independent of and physically separated from the normal controls, but located within the planned work area and readily accessible.
- Handling and process equipment and other support equipment located within the shielded cell shall be designed to function in or be appropriately shielded from the high radiation field produced by unshielded fuel units.
- If provision for remote maintenance is not made, handling equipment for fuel units and transportation package closure lid(s) shall have sufficient redundancy so that no single failure in the handling system will preclude returning unshielded fuel units to shielded storage locations or returning the closure lid(s) to the transportation package.
- Grapples, lifting attachments, and handling equipment for fuel units and transportation package closure lid(s) shall be designed for remote operations, and active lifting components shall be designed to retain their load and fail in a same manner (i.e., in the "latched" state) in the event of loss of actuating power., An independent, remote means shall be provided for disengagement of any grapple in the cell in the event an active grapple component fails to operate. Grapple operating envelopes shall be designed to be compatible with all interfacing storage and transportation systems.
- Grapples and lifting fixtures for handling fuel units or transportation package closure lid(s) shall be designed to provide positive engagement during a lift, and the grapples and associated controls shall be designed to minimize the potential for inadvertent disengagement. A means shall be provided to indicate that positive engagement has been achieved and to indicate the disengaged position.
- Grapples and tools shall be designed to facilitate decontamination, nondestructive testing, maintenance, handling, and storage. Cracks or crevices likely to collect contamination should be avoided.
- Process cranes shall employ redundant limit switches and interlocks to prevent excessive horizontal movement that could affect operation or cause damage to the units being handled, as well as to prevent excessive vertical movement including double blocking. Redundant means of disconnecting power to the cranes shall be available to the operator. The means shall be independent of, and physically separated from, the normal controls, but conveniently located within the planned work area. Redundant means of braking vertical travel shall be provided. Braking of horizontal motion should be provided as necessary to facilitate the required positioning precision.
- If the possibility exists for fuel units to catch on lips or protrusions during lifting or lowering, the lifting equipment shall have interlocks to sense an unacceptable change (either an increase or a decrease) in hoisting force and automatically stop further travel.

- Remote handling equipment shall be incorporated into the design of the area to permit performance of normal process operations. Particular attention shall be given in the design to methods and equipment required to recover from equipment failures, off-normal events, and accidents.
- Design methods, loadings, and so forth shall be in accordance with section 6.17 of ANSI/ANS 57.9. The handling equipment may lose its function, but functional failure shall not result in a loss of load incident or inability to recover from the failure.
- The special procedures for handling damaged fuel or damaged fuel units should be anticipated and provisions made in the design.
- Safe access to perform necessary testing, inspection, and maintenance shall be provided (e.g., ladders, catwalks, and guard rails).
- Non remote transfer machines shall be automatically annunciated when in motion.
- The Fuel Unit Handling Crane shall be of a flexible design to handle multiple (and often poorly documented) fuel configurations, weights, and attachment (grapple) points. A variety of grapples and other tools for fuel movement shall be provided.
- The system shall accommodate a wide variety of shipping (source) casks.
- The Fuel Unit Handling Crane shall support canning operations

C-2.5.5 Cask Work Platforms

- The DTC facility shall be equipped with work platforms that shall provide a safe and convenient elevated work area for personnel working around the tops of various casks for regular maintenance and operations in the Cask Handling Bay and Cask Preparation Area
- Access shall be provided to these elevated work areas
- The work platforms shall be designed per OSHA and ANSI standards
- The work platforms shall be decontaminable
- The work platforms shall be designed to interface with all the casks that may be handled in the DTC
- Handrails and kick plates shall be provided
- Some sections of handrail shall be removable for operations requiring such.

C-2.6 SNF Packaging Systems Requirements

C-2.6.1 Canning System

- The canning design shall be in accordance with 10 CFR 72, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, Subpart F (General Design Criteria).
- The canning design shall meet the requirements of ANSI/ANS 57.9-1992, Design Criteria for an Independent Spent Fuel Storage Installation (Dry Type).
- Canning operations shall provide the Peach Bottom fuel the first or primary containment.
- Canning operations shall not be performed during fuel transfer operations.
- Canning activities shall all be remote operations. The DTC shall be evacuated with no manned entry during canning activities.
- The canning station shall be arranged in such a manner within the hot cell to allow for the full range of motion for the manipulators and other remote devices and still not interfere with other planned activities.
- Appropriate space shall be allocated for the specific canning activities planned. Special consideration shall be given to overhead crane envelopes, electro-mechanical manipulator envelopes, and locations of shielded viewing windows.
- The station throughput capacity shall be on average, two finished cans per day. The station capacity is based on the current operating capacity of the facility.
- Provision shall be made in the canning station area for easy decontamination.
- The walls of the hot cell located at the designated canning station area shall be provided with shielded viewing window(s).
- Quick disconnects for pneumatic, and electrical connections shall allow for remote handling.
- All racks and stands shall be constructed to aid in decontamination operations.
- All maintenance activities to canning hardware and equipment shall be performed manually.

Canning Station Operational Requirements

- Equipment shall be provided to visually verify the fuel and its condition. Precautions will need to be taken during this operation to minimize the spread of contamination. (Note, it is assumed that characterization equipment is already available in the hot cell.)

- The can piercing equipment shall pierce incoming fuel cans to ensure the contents can be dried during fuel drying operations. Precautions will need to be taken during this operation to minimize the spread of contamination. The can piercing equipment shall hold the can in a vertical position without crushing the can. The can piercing equipment shall cut through the wall of the can without damaging the fuel element inside the can.

To safely vent the pressure and prevent the formation of any explosive mixtures of hydrogen gas from occurring during the can piercing operation. A sampling, vent, and purge operation, in conjunction with the piercing operation, shall occur to sample the gas inside the can, vent any pressure, and purge the can if hydrogen is present.

The stand for the can piercing operation shall be fastened to the floor at the base. The stand for the can piercing operation shall be sufficient to support the hardware with a loaded can in the event of an earthquake.

- A new can/lid storage rack shall temporarily store the empty new cans/lids. Capacity of the rack shall be five cans and lids.
- The can loading equipment shall provide a means to hold a new can securely in place while fuel is loaded into the new can or load already canned fuel (over-packing) into the new cans. Precautions will need to be taken during this operation to minimize the spread of contamination. It is assumed that fuel handling equipment is available for canning operations within the hot cell.

The stand for the can loading operation shall be sufficient to support the hardware with a loaded can in the event of an earthquake.

- The can welding equipment shall weld the lids onto the new cans. Precautions will need to be taken during this operation to minimize the spread of contamination.

The stand for the can welding equipment shall be the same stand used for the can loading operations. The stand for the can welding equipment shall be sufficient to support the hardware with a loaded can in the event of an earthquake.

The fuel drying operation shall be performed to ensure that only dry fuel is sealed inside the can. The drying equipment shall provide a means to dry the fuel (probably using a vacuum type system/operation) inside the hot cell. The vacuum exhaust shall be filtered. (Note, it is assumed that once the fuel is canned, adequate drying, but not necessarily complete drying, will occur in a reasonable length of time.)

- The atmosphere within the cans shall be pressurized with inert gas to minimize corrosion due to oxygen and water vapor.
- Cans shall be helium leak tested in the hot cell to determine that they are properly sealed.

- Handling equipment such as cranes, electro-mechanical manipulators, grapples, tools, etc. shall be provided inside the cell, as required, to accomplish transfer of items and fuel from station to station and assist canning operations as necessary. (Note, it is assumed that the handling equipment is already available in the hot cell.)
- Fuel and can handling equipment (fuel specific tools, Peach Bottom can handling tool, new can/lid tools, miscellaneous tools, etc.) shall be provided inside the cell, as required, to accomplish transfer of items and fuel units from can to can and assist canning operations as necessary.
- The Closed Circuit Television (CCTV) system (including appropriate lighting), dedicated to the canning area, shall provide viewing capability for operation of the fuel canning equipment. All cameras in the canning area shall have zoom capability and be mounted on a pan-and-tilt mechanism. The system will supplement viewing through the shielded viewing windows.

C-2.7 Storage Area Requirements

- All storage systems shall be in accordance with 10 CFR 72, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, Subpart F (General Design Criteria), Subpart K (General License for Storage of Spent Fuel at Power Reactor Sites), and Subpart L (Approval of Spent Fuel Storage Casks)
- All storage systems shall meet the requirements of ANSI/ANS 57.9-1992, Design Criteria for an Independent Spent Fuel Storage Installation (Dry Type) and ANSI/ANS 57.10-1987, Design Criteria for Consolidation of LWR Spent Fuel.

C-2.7.1 Basemat and Horizontal Storage Modules

- A Storage Area comprising an outdoor above-ground concrete storage basemat and suitable shielded and monitored storage modules shall be provided. Loaded DPCs from the DTC shall be transported and placed into the storage modules on the storage basemat.
- The storage area shall be designed to allow ready expansion throughout its life up to a maximum capacity of 240 Horizontal Storage Modules. The total area shall be minimized, but still allow operations.
- Equipment shall be provided to open and close storage modules.
- The Horizontal Storage Modules shall provide sufficient shielding to limit radiation levels to 10 mR/hr at contact on all accessible vertical walls when loaded with a single DPC containing 52 BWR or 24 PWR commercial fuel elements.
- The Horizontal Storage Modules shall be of sufficient size to store one DPC (in the horizontal position).

- The Horizontal Storage Modules shall provide a method for passively cooling the DPCs.
- Each module shall be designed to maintain the fuel cladding below 340°C.
- The modules shall be designed to withstand seismic accelerations, ambient temperatures, tornadoes, and floods.
- The storage area shall allow for welding operations.

C-2.7.2 Dual Purpose Canisters

- Canisters shall be provided that are suitable for storing and shipping SNF. As such, the DPCs shall provide a secondary confinement barrier and have lifting eyes, purge ports, and vent ports.
- Only the shorter Vectra PWR-length DPC shall be used.
- The main fuel storage component shall be a DPC shell (Vectra FO-DSC for PWR fuel, Vectra Drawing NUH-05-4004NF, Revision 1). It is a 67.25 in. OD by 186.2 in. long canister with an internal cavity length of 167 in.

C-2.7.3 DPC Baskets

- Neutron absorbing materials shall be used as necessary
- Baskets that are placed within a DPC shall be one of three styles: the Fluor 14-Tube, the Shippingport LWBR 3-tube, or FSVR 7-tube.

14-Tube Basket Requirements

- This basket design shall be designed to receive 12 in. Schedule-10-pipe buckets with cruciforms that may have poison added if necessary.

Shippingport LWBR 3-tube Basket Requirements

- Shall be designed to hold three existing ICPP 749 cans that measure 25.57 in diameter by 158 in. long, and each of which hold a Shippingport LWBR fuel element.

FSVR 7-tube Basket Requirements

- Shall be designed to hold 35 bare FSVR hexagonal fuel elements stacked 5 high in each of seven hexagonal cells. Each hexagonal basket tube has an inside measurement of 16.65 inches across the corners and is made of 3/4-in. thick stainless steel.

C-2.7.4 Dry Storage Buckets

- Dry Storage Buckets must interface with DPC baskets
- There shall be two types of dry storage buckets: 12 inch and 14 inch stainless steel buckets
- Dry Storage Buckets shall have cruciforms to hold and separate individual fuel elements
- Dry Storage Buckets shall have lids
- A sufficient number and size of Dry Storage Buckets shall be provided to handle and anticipated fuels.

C-2.7.5 Dry Storage Cans

- Dry Storage Cans shall be provided for canning the Peach Bottom Core 1 and Core 2 fuel.
- Dry Storage Cans shall have cruciforms to hold and separate individual fuel elements.
- Lids for the Dry Storage Cans shall be provided and shall be welded to the can body.
- A method for venting and purging the Dry Storage Cans, once fuel is loaded and the lid welded, shall be provided.
- The cans shall be capable of sustaining loads during shipping and handling.
- The cans shall meet an internal design pressure of 15 psig. The can shall also meet a design temperature of 380°C.
- Cans shall allow for standard fabrication methods and procedures. Any handling features on the cans shall not interfere with the transport, loading, sealing, and testing processes.
- The can shall have a vacuum/pressurization port incorporated into its design. Cans shall be designed so that purging, evacuating, leak testing, and back-filling with an inert gas can all be accomplished remotely.

C-2.8 HVAC Requirements

- All HVAC systems shall be in accordance with 10 CFR 72, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, Subpart F (General Design Criteria) and 10 CFR 20, Standards for Protection Against Radiation.
- All HVAC systems shall meet the requirements of ANSI/ANS 57.9-1992, Design Criteria for an Independent Spent Fuel Storage Installation (Dry Type) and ANSI/ANS 57.10-1987, Design Criteria for Consolidation of LWR Spent Fuel.
- HVAC systems shall be in accordance with 29 CFR 1910, Occupational Safety and Health Standards for General Industry, Subpart G (Occupational Health and Environmental Control) and Subpart Z (Toxic and Hazardous Substances).
- The HVAC systems shall meet the air quality requirements addressed in 40 CFR 50-53, and 58.
- The HVAC systems shall be in accordance with ANSI/ASME N509-1989, Nuclear Power Plant Air Cleaning Units and Components and ANSI/ASME N510-1989, Testing of Nuclear Air-Cleaning Systems.
- The HVAC systems shall meet the requirements of Idaho Administrative Procedures Act (IDAPA) 16.01.01000-01999.
- The HVAC systems shall be in accordance with MIL-F-51068C (Filter: Particulate High Efficiency, Fire Resistant) and MIL-F-51079A (Filter Medium: Fire Resistant, High Efficiency).
- The Hot Cell atmospheric pressure shall be controlled during hot operations to -0.6 W. G. (or lower) below atmospheric pressure.
- Heating loads shall be based on a minimum winter outdoor design temperature of -14°F. Cooling loads shall be based on temperatures of 93°F dry bulb and 61°F wet bulb.
- The HVAC system should maintain a minimum temperature of 65°F in the winter and approximately 76°F in the summer in the Cask Handling Bay, Cast Preparation Area, and Hot Cell.
- The HVAC system must maintain a minimum temperature of 65 °F in the winter and approximately 72°F in the summer in the Administrative areas.
- Air shall flow from areas of least contamination potential to areas of highest contamination potential.
- The Cask Handling Bay shall normally be maintained at atmospheric pressure.

- A method for eliminating truck exhaust fumes from the Cask Handling Bay shall be provided.
- The Cask Preparation Area static pressure shall be controlled to a minimum of -0.1 in. W. G. below the Cask Handling Bay and the outside environment.
- The HVAC system shall collect exhaust air from contamination control areas and pass it through HEPA filters prior to discharge to the atmosphere.
- HVAC design for indoor temperature conditioning shall be based on ASHRAE 90.

C-2.9 Mechanical Utilities Requirements

- Mechanical utilities systems shall be in accordance with 10 CFR 72, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, Subpart F (General Design Criteria)
- Mechanical utilities systems shall meet the requirements of ANSI/ANS 57.9-1992, Design Criteria for an Independent Spent Fuel Storage Installation (Dry Type).

C-2.9.1 Compressed Air

- The system design for compressed air shall be in accordance with 29 CFR 1910, Occupational Safety and Health Standards for General Industry, Subpart M (Compressed Gas and Compressed Air Equipment)
- Compressed air shall be provided to the facility for plant air and instrument air
- The compressed air line shall be cathodic protected.
- Plant air shall be provided to operate pneumatically operated tools associated with cask handling and preparation in the Cask Handling Bay, Cask Preparation Area, and Hot Cell
- Instrument air shall be used for pneumatically operated HVAC system equipment and other pneumatic operations in the facility.

C-2.9.2 Compressed Gas

- The system design for compressed gas shall be in accordance with 29 CFR 1910, Occupational Safety and Health Standards for General Industry, Subpart H (Hazardous Materials) and Subpart M (Compressed Gas and Compressed Air Equipment)
- Compressed gas shall be provided to the facility
- Argon compressed gas shall be supplied for welding processes
- Helium compressed gas shall be supplied for pressure testing and inerting operations.

C-2.9.3 Potable Water

- Potable water shall be provided to the facility to service water closets, urinal(s), sinks, showers, shower/eyewash facilities, evaporative coolant units, drinking fountains, and miscellaneous ports
- The water line shall be cathodic protected
- A method for heating water to 140 °F for the showers and sinks shall be provided.

C-2.9.4 Waste Systems

Liquid Waste

- Liquid waste system(s) shall be provided for in the Cask Handling Bay, Cask Preparation Area, and Hot Cell. Condensate from HVAC equipment shall be disposed of using the liquid waste system
- The liquid system lines shall be cathodic protected
- Liquid waste shall be collected and tested prior to being pumped into the waste line

Sanitary Systems

- The sanitation system design shall be in accordance with 29 CFR 1910, Occupational Safety and Health Standards for General Industry, Subpart J (General Environmental Controls)
- Sanitary sewer drains shall be provided as needed
- Vents shall be provided as needed
- Sewer lines shall be cleanable.

C-2.9.5 Fire Protection

- Fire water shall be provided
- The fire water line shall be cathodic protected
- Fire protection shall be in accordance with ANSI/ANS-57.9.
- Fire protection systems shall ensure nuclear criticality and suppressant-SNF chemical reactions cannot occur.

C-2.9.6 Steam

- Steam shall be provided and routed to the HVAC system as required
- The steam lines shall be cathodic protected
- The steam lines shall be insulated.

C-2.10 Electrical Requirements

- All electrical systems shall be in accordance with 10 CFR 72, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, Subpart F
- All electrical systems shall meet the requirements of ANSI/ANS 57.9-1992, Design Criteria for an Independent Spent Fuel Storage Installation (Dry Type)
- Electrical systems shall be in accordance with 29 CFR 1910, Occupational Safety and Health Standards for General Industry, Subpart S (Electrical)

C-2.10.1 Power

- The electric power system shall be designed to provide emergency electrical supply to essential instrumentation, emergency lighting, emergency communications, and physical security systems.
- Standby power shall be supplied for the Hot Cell HVAC system exhaust fan.
- An Uninterruptable Power Supply (UPS) shall provide emergency power.
- The UPS shall support the Fire Alarm, Voice Paging, HVAC, Radiation Monitoring and Alarm, and security systems. There shall sufficient battery capacity to carry the rated load for a minimum of 30 minutes.

C-2.10.2 Grounding

- A perimeter ground loop of #4/0 bare copper and ground rods shall be included around the facility
- The following equipment shall be bonded to the ground loop: facility steel, water piping, service equipment, distribution equipment and motor frames
- Equipment grounding shall be in accordance with NEC Article 250
- An isolated grounding system shall be provided.

C-2.10.3 Cathodic Protection

- Utility piping shall be protected through connection to the existing ICCP cathodic protection system
- A testing/bonding station shall be included to periodically monitor the cathodic protection system.

C-2.10.4 Lighting

- Lighting shall be designed and included in accordance with current Illuminating Engineering Society (IES) recommendations
- Emergency and exit lighting shall be provided at each means of egress
- Hot Cell lighting shall be provided by high-pressure sodium fixtures
- Exterior lighting shall be provided.

C-2.10.5 Lightning Protection

- A lightning protection system shall be included and shall be designed in accordance with NFPA 780.

C-2.10.6 HVAC Controls

- A HVAC control system shall be provided. It shall be a smart system that can automatically generate control signals to change HVAC equipment operating parameters based on signal received from various monitors. A computer monitor shall be provided in the Shift Supervisor's office for reviewing the operating status of the system and making adjustments to control setpoints.
- Instrumentation shall be provided to detect and alarm both high and low differential pressure across filters in the HVAC system.
- Instrumentation shall be provided to initiate isolation of the HVAC system filters in the event of fire detection.

C-2.10.7 Equipment Controls

- Facility control, process control, and data acquisition systems shall be provided.
- Remotely controlled CCTV cameras shall be provided in the Hot Cell for general visual observation, fuel canning operations, fuel inspection, and documentation.

- Each Hot Cell window shall be equipped with a visual inspection station which shall include two high resolution cameras; a monitor; camera controls for pan, tilt, and zoom functions; and recording capability for archival purposes.
- Instrumentation shall be provided to measure and record the DTC structural response to an earthquake.
- A system shall be provided for the collection of alarms from the HVAC system and other alarms. This shall be located in the Shift Supervisor's office.

C-2.10.8 Radiation Monitoring and Alarms

- Radiation detection instrumentation shall be provided to warn operating personnel of radiation and airborne radioactivity levels above set limits.
- The RAMs shall alarm locally and remotely in the RadCon office.
- An alpha CAM shall be located in the inlet duct to the Zone 1 HEPA filter for the HVAC system.
- A Criticality Alarm System shall be provided in accordance with ANSI/ANS 8.3-1986.
- Stack monitoring shall be provided for the detection of radioactive particulates in the air exhaust stream. These instruments shall comply with ANSI-N42.17B-1989.
- Provision shall be made in the design for monitoring groundwater in the vicinity of the storage area for radioactive contamination.
- Activity monitors shall be provided in the wash water collected from the Hot Cell.
- Selected instruments (TBD) shall transmit data to a micro-processor based system for display, recording, alarm, and trending in the RadCon Control Office.

C-2.10.9 Communications and Alarms

- Voice and data telecommunications lines shall be provided throughout the occupied areas of the facility.
- The existing Broadband Local Area Network (LAN) shall be made available in the facility. Access ports shall be provided in all normally occupied offices.
- Fire alarm, emergency voice paging, and evacuation alarm systems shall be compatible with existing systems at ICPP.

C-2.10.10 Data Acquisition and Recording

- A data entry station shall be provided to record and monitor all fuel movements. The stations shall be linked for data communications.

C-2.10.11 Security Systems

- Physical protection of the facility and pad as well as the materials shall be in accordance with 10 CFR 73 and 10 CFR 72, Subpart H.
- At least one physical barrier shall be provided between areas accessible to the public and storage. This barrier shall be of sufficient height and strength to hinder unauthorized access. It shall have a 20-ft clear zone on either side and shall be provided with means for the detection of attempts to breach the barrier (intrusion alarm).
- The physical barrier and clear spaces shall be provided with suitable lighting installation as required to provide an illumination of no less than 0.2 fc, measured horizontally at ground level.

C-2.11 Design Life Requirements

- Design life of the SNF Dry Storage Facility and equipment shall be 30 years and have maintainable or replaceable life of 60 years
- The design life of the DPC shall be 100 years
- Design life of the Storage Facility shall be 60 years

C-2.12 Safety Requirements

C-2.12.1 Safety Classification

- A safety classification has been determined in accordance with 10 CFR 830 to be a Hazard Class 2.

C-2.12.2 Construction

- The design of utility services and distribution systems that are important to safety shall include redundant systems to the extent necessary to maintain, with adequate capacity, the ability to perform safety functions assuming a single failure.^a

a. A single failure is an occurrence that results in the loss of capability of a component to perform its intended safety function(s). A multiple failure, i.e., loss of capability of several components, resulting from a single occurrence, is considered to be a single failure. Systems are considered to be designed against an assumed single failure if neither (1) a

- The Dry Storage Facility and its systems important to safety^b shall be designed to be evaluated by appropriate tests or by other means acceptable to the NRC to demonstrate that they will reasonably maintain confinement of radioactive material under normal, off-normal, and credible accident conditions.
- Structures, systems, and components important to safety shall be designed and located so that they can continue to perform their safety functions effectively under credible fire and explosion exposure conditions.
- The design of the Dry Storage Facility shall include provisions to protect against nuclear criticality that might otherwise result from the operation or the failure of fire suppression or decontamination systems.
- Spent fuel handling, packaging, transfer, and storage systems shall be designed to be maintained subcritical under the worst case moderated and reflected conditions, and to ensure that, before a nuclear criticality accident is possible, at least two unlikely, independent, and concurrent or sequential changes must occur in the conditions essential to nuclear criticality safety.
- The DPC and its internal structures and containers shall be designed to maintain the fuel in a favorable geometry for nuclear criticality safety throughout the operations and life of the system.
- Each entrance or access point into a high radiation area shall have either a control device that energizes a conspicuous visible or audible alarm signal so that the individual entering the high radiation area and the supervisor of the activity are made aware of the entry; or entryways that are locked, except during periods when access to the areas is required, with positive control over each individual entry.
- SNF that is reactive with water or other chemicals shall be protected from exposure to those materials.
- The SNF Dry Storage Facility shall be designed to prevent the dropping of casks, SNF, SNF baskets/ buckets/cans, and DPCs under normal and off normal conditions including the design basis accidents (DBAs) that they shall withstand.

single failure of any active component (assuming passive components function properly) nor, (2) a single failure of any passive component (assuming active components function properly) results in loss of the system's capability to perform its safety function(s).

b. Structures, systems, and components important to safety mean those features of the Storage Facility whose function is: (1) To maintain the conditions required to store spent fuel safely, (2) To prevent damage to the spent fuel waste container during handling and storage, or (3) To provide reasonable assurance that spent fuel can be received, handled, packaged, stored, and retrieved without undue risk to the health and safety of the public.

- The SNF Dry Storage Facility shall be designed to be able to recover from accidents involving dropping of casks, SNF, SNF baskets/buckets/cans, and DPCs.
- In-cell equipment shall be designed for recovery from all possible conditions to the extent that manned entry into the cell, for maintenance, can be accomplished.
- If a fuel grapple is supporting the weight of the fuel, the grapple shall be interlocked so that it can not disengage from the crane (or overhead manipulator) or fuel to which it is connected even if the normal control command to do so is inadvertently given. A means of defeating this interlock shall be provided to ensure the grapple can be disengaged at any time even if the full weight of the fuel is on the grapple.
- Fire doors shall be provided as required by DOE-ID-12044, UBC, NFPA-80, and NFPA-101. In addition, all fire doors and frames shall meet all requirements of the Underwriters Laboratories and shall bear the UL or FM label. Fire doors and frames shall be constructed from metal. Structural members, such as steel channels embedded in wall openings, shall not substitute as door frames. All fire doors shall be provided with fitted frames which are anchored to, but separate from, the building structural members. The fire doors shall contain window fitted with UL approved safety glass which is not removable from the outside of the door. Their installation shall meet all of the requirements of NFPA-80 and NFPA-101.
- The facility design shall mitigate natural phenomena hazards. The design shall address common cause effects and interactions for: earthquakes, volcanic events, tornadoes, hurricanes, high winds, floods, excessive rains, excessive snow, ice cover, lightning, and fires. The secondary natural phenomena include drought, fog, frost, high temperatures, low temperatures, landslides, subsidence, surface collapse, uplift, storm surges, and waterspouts. Damage and failure will be considered for systems, structures, and components. In addition, the facility shall have instrumentation or other means to detect and record the occurrence and severity of seismic events.

C-2.12.3 Operation

- Provisions shall be made to enable surveying the external surfaces of the shipping casks for radiation levels and radioactive contamination as soon as practical after receipt of the package, but not later than 3 hours after the package is received at the ICPP if it is received during normal working hours, or not later than 3 hours after the beginning of the next working day if it is received after working hours
- Radiation protection for occupational workers shall be per 10 CFR 835 (Occupational Radiation Protection) and the INEL Radiation Control Manual
- Fire protection shall be in accordance with ANSI/ANS-57.9
- Facility design features and physical controls shall ensure occupational exposure is maintained ALARA during normal and off-normal operations

- Personnel radiation exposure levels throughout the SNF Dry Storage Facility shall not exceed 0.125 mr/hr for continuously-occupied areas.
- The following radiation zones (as described in the DOE-ID AE Standards) shall apply during operations:

Cask Handling Bay—Zone IV

Cask Preparation Area—Zone I

Hot Cell—Zone III

- Safe access will be provided to all packages, vehicles, and installed components for purposes of testing, inspection, and maintenance.

C-2.13 Environmental Requirements

- Facility emission limits shall be consistent with the INEL Environmental Restoration and Waste Management Programs Final Environmental Impact Statement, DOE/EIS-0203-F
- Administrative controls and Best Available Control Technology shall be used to minimize the impacts of air emissions
- The facility processes and equipment shall be designed to limit solid waste generation to 115 m³ per year of LLW and 250 m³ per year of industrial (cold) waste
- Solid radioactive waste produced by SNF Dry Storage Facility operations shall be packaged in standard RWMC 4 × 4 × 8-ft plywood boxes for contact-handled (CH) LLW or INEL Mark III concrete containers for remote-handled (RH) LLW, and shipped to RWMC for disposal
- Means for measuring the amount and concentrations of radionuclides in effluents during normal operations, and under accident conditions, shall be provided for effluent control systems
- DTC warm liquid waste shall be controlled and verified to meet the criteria for existing ICPP handling systems, and shall be transferred to those systems
- If all or part of the facility is located outside of existing ICPP fences, the use of new land shall not exceed 551 acres when combined with other storage systems included in DOE/EIS-0203-F.

C-2.14 Safeguards and Security

- A data management system shall be provided to keep records showing the receipt, inventory, transfer, and disposal of all SNF in storage. The records shall include, as a minimum, the

name of the fuel shipper, the estimated quantity of radioactive material per item (including special nuclear material in spent fuel), item identification and serial number, storage location, onsite movements and locations of each fuel assembly or DPC, and final shipment to an offsite location. The data management system shall meet the requirements of 10 CFR 72, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste, Subpart D (Records, Reports, Inspections, and Enforcement).

- Dual records shall be maintained to ensure an off-normal event cannot result in the loss of the sole records of SNF inventories. These records for spent fuel shall be retained for as long as the material is stored, and for a period of five years after the material is disposed of or transferred out of the Storage Facility.
- Equipment shall be provided to conduct a physical inventory of all spent fuel in storage at intervals not to exceed 12 months unless otherwise directed by the Commission. A copy of the current inventory shall be retained as a record until the Commission terminates the license.
- Physical protection of the facility and pad as well as the materials shall be in accordance with 10 CFR 72, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste, Subpart H (Physical Protection); 10 CFR 73, Physical Protection of Plants and Materials; and 10 CFR 1046, Physical Protection of Security Interests.

C-2.15 Quality Assurance Requirements

- Quality assurance (QA) requirements for the SNF Dry Storage Facility are identified in ANSI/ANS 57.9, Design Criteria for an Independent Spent Fuel Storage Installation (Dry Type), Section 6.15 and 10 CFR 72, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, Subpart G (Quality Assurance).
- All purchased items will be restricted to those not suspect/counterfeit, misrepresented, used, or other than represented/advertised in accordance with INEL-95/227, "Guidelines for Identifying Suspect/Counterfeit Material."
- Records, reports, and inspections shall be done in accordance with 10 CFR 72, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, Subpart D (Records, Reports, Inspections, and Enforcement).
- Training of personnel shall be performed in accordance with 10 CFR 72, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, Subpart I (Training and Certification of Personnel).

C-3. CODES AND STANDARDS

C-3.1 General

- 10 CFR 72, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel
- 29 CFR 1910, Occupational Safety and Health Standards for General Industry
- 29 CFR 1926, Occupational Safety and Health Regulations for Construction
- 40 CFR 260 et seq, Hazardous Waste Management System: General
- 40 CFR 261, Identification and Listing of Hazardous Waste
- 40 CFR 262, Standards Applicable to Generators of Hazardous Waste
- 40 CFR 268.50, Land Disposal Restrictions
- 40 CFR 300 et seq., National Oil and Hazardous Substances Pollution Contingency Plan
- ANSI/ANS 57.9, Design Criteria for an Independent Spent Fuel Storage Installation (Dry Type)

C-3.2 Civil

- 10 CFR 72, Subpart E, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, Siting Evaluation Factors
- 10 CFR 72, Subpart F, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, General Design Criteria

C-3.3 Architectural

- 10 CFR 72, Subpart F, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, General Design Criteria
- 10 CFR 72, Subpart K, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, General License for Storage of Spent Fuel at Power Reactor Sites
- 29 CFR 1910, Subpart D, Occupational Safety and Health Standards for General Industry, Walking - Working Surfaces
- 29 CFR 1910, Subpart E, Occupational Safety and Health Standards for General Industry, Means of Egress

- ICBO/UBC, Uniform Building Code

C-3.4 Structural

- 10 CFR 72, Subpart F, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, General Design Criteria
- 10 CFR 100, Reactor Site Criteria
- 10 CFR 435, Energy Conservation Voluntary Performance Standards for New Buildings, Mandatory for Federal Buildings
- ANSI/ACI 318-89, Building Code Requirements for Reinforced Concrete
- ANSI/ACI 349-85, Code Requirements for Nuclear Safety Related Concrete Structures
- ANSI/AISC N 690-1984, Specifications for the Design, Fabrication, and Erection of Steel Safety Related Structures for Nuclear Facilities
- ANSI/ANS 2.3-1983, American National Standard for Estimating Tornado, and Extreme Wind Characteristics at Nuclear Power Sites
- ANSI/ANS 2.19-1981 (R1990), American National Standard Guidelines for Establishing Site-Related Parameters for Site Selection and Design of an Independent Spent Fuel Storage Installation (Water Pool Type)
- ANSI/ANS 57.9-1992, Design Criteria for an Independent Spent Fuel Storage Installation (Dry Type)
- ANSI/ASCE 7-95, Minimum Design Loads for Buildings and Other Structures
- ANSI/ASCE 72-88, American National Standard Minimum Design Loads for Buildings and Other Structures
- ASCE Manual No. 58, Structural Analysis and Design of Nuclear Power Plant Facilities
- ICBO/UBC, Uniform Building Code
- USNRC Reg. Guide 1.6, Design Response Spectra for Seismic Design of Nuclear Power Plants

C-3.5 Handling

- 10 CFR 50, Domestic Licensing of Production and Utilization Facilities

- 10 CFR 71, Packaging and Transportation of Radioactive Material
- 10 CFR 72, Subpart F, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, General Design Criteria
- 29 CFR 1910, Subpart D, Occupational Safety and Health Standards for General Industry, Walking - Working Surfaces
- 29 CFR 1910, Subpart N, Occupational Safety and Health Standards for General Industry, Materials Handling and Storage
- ANSI/ANS 57.9-1992, Design Criteria for an Independent Spent Fuel Storage Installation (Dry Type)
- ANSI/ASME NOG-1-1989, American National Standard Rules for Construction of Cranes, Overhead and Gantry (Top Running Bridge, Multiple Girder)
- ANSI/AWS D1.1-1990, Structural Welding Code - Steel
- ANSI B30.2-1990, Overhead and Gantry Cranes (Top Running Bridge, Multiple Girder)
- ANSI B30.11-1993, Monorails and Underhung Cranes
- ANSI N14.6-1993, Special Lifting Devices for Shipping Containers Weighing 10,000 Pounds (4500 kg) or More
- CMAA 70, Crane Manufacturers Association of American, Inc. Specification for Electric Overhead Traveling Cranes
- CMAA 74-1987, Specifications for Top Running and Under Running Single Girder Electric Overhead Traveling Cranes Utilizing Under Running Trolley Hoist
- INEL Transportation Manual
- NUREG-0612, Control of Heavy Loads and Nuclear Power Plants

C-3.6 SNF Packaging Systems

- 10 CFR 72, Subpart F, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, General Design Criteria
- ANSI/ANS 57.9-1992, Design Criteria for an Independent Spent Fuel Storage Installation (Dry Type)

C-3.7 Storage

- 10 CFR 71, Packaging and Transportation of Radioactive Material
- 10 CFR 72, Subpart F, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, General Design Criteria
- 10 CFR 72, Subpart K, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, General License for Storage of Spent Fuel at Power Reactor Sites
- 10 CFR 72, Subpart L, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, Approval of Spent Fuel Storage Casks
- 40 CFR 53, Ambient Air Monitoring Reference and Equivalent Methods
- 40 CFR 58, Ambient Air Quality Surveillance
- ANSI/ANS 57.9-1992, Design Criteria for an Independent Spent Fuel Storage Installation (Dry Type)
- ANSI/ANS 57.10-1987, American National Standard Design Criteria for Consolidation of LWR Spent Fuel
- ANSI/AWS D1.1-1990, Structural Welding Code—Steel

C-3.8 HVAC

- 10 CFR 20, Standards for Protection Against Radiation
- 10 CFR 72, Subpart F, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, General Design Criteria
- 29 CFR 1910, Subpart G, Occupational Safety and Health Standards for General Industry, Occupational Health and Environmental Control
- 29 CFR 1910, Subpart Z, Occupational Safety and Health Standards for General Industry, Toxic and Hazardous Substances
- 40 CFR 50, National Primary and Secondary Ambient Air Quality Standards
- 40 CFR 51, Requirements for Preparation, Adoption, and Submittal of Implementation Plans
- 40 CFR 52, Approval and Promulgation of Implementation Plans

- 40 CFR 53, Ambient Air Monitoring Reference and Equivalent Methods
- 40 CFR 58, Ambient Air Quality Surveillance
- ANSI/ANS 57.9-1992, Design Criteria for an Independent Spent Fuel Storage Installation (Dry Type)
- ANSI/ANS 57.10-1987, American National Standard Design Criteria for Consolidation of LWR Spent Fuel
- ANSI/ASME N509-1989, American National Standard for Nuclear Power Plant Air Cleaning Units and Components
- ANSI/ASME N510-1989, American National Standard for Testing of Nuclear Air-Cleaning Systems
- ASHRAE 90, American Society of Heating, Refrigerating, and Air-Conditioning, Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings.
- IDAPA 16.01.01000-01999, Idaho Administrative Procedures Act, Clean Air Act
- MIL-F-51068C, Filter: Particulate High Efficiency, Fire Resistant
- MIL-F-51079A, Filter Medium: Fire Resistant, High Efficiency

C-3.9 Mechanical Utilities

- 10 CFR 72, Subpart F, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, General Design Criteria
- 29 CFR 1910, Subpart H, Occupational Safety and Health Standards for General Industry, Hazardous Materials
- 29 CFR 1910, Subpart J, Occupational Safety and Health Standards for General Industry, General Environmental Controls
- 29 CFR 1910, Subpart M, Occupational Safety and Health Standards for General Industry, Compressed Gas and Compressed Air Equipment
- ANSI/ANS 57.9-1992, Design Criteria for an Independent Spent Fuel Storage Installation (Dry Type)
- ANSI/API 620-1986, Rules for Design and Construction of Large, Welded, Low Pressure Storage Tanks

- ANSI/API 650-1988, Welded Steel Tanks for Oil Storage (for tanks)
- ANSI/ASME B31.3-1990, Chemical Plant and Petroleum Refinery Piping.

C-3.10 Electrical

- 10 CFR 72, Subpart F, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, General Design Criteria
- 10 CFR 72, Subpart H, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, Physical Protection
- 10 CFR 73, Physical Protection of Plants and Materials
- 29 CFR 1910, Subpart S, Occupational Safety and Health Standards for General Industry, Electrical
- ANSI/ANS 8.3-1986, American National Standard Criticality Accident Alarm System
- ANSI/ANS 57.9-1992, Design Criteria for an Independent Spent Fuel Storage Installation (Dry Type)
- ANSI-N13.1-1969 (R 1983), Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities
- NEC Article 250, Grounding
- NFPA-70, National Electric Code, 1996
- NFPA 780, Lightning Protection Code, 1996
- ANSI-N42.17B-1989 (R 1994), Performance Specifications for Health Physics Instrumentation—Occupational Airborne Radioactivity Monitoring Instrumentation.

C-3.11 Safety

- 10 CFR 20, Standards for Protection Against Radiation
- 10 CFR 72, Subpart F, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, General Design Criteria
- 10 CFR 72, Subpart I, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, Training and Certification of Personnel
- 10 CFR 73, Physical Protection of Plants and Materials

- 10 CFR 830, Nuclear Safety Management
- 10 CFR 835, Occupational Radiation Protection
- 29 CFR 1910, Subpart C, Occupational Safety and Health Standards for General Industry, General Safety and Health Provisions
- 29 CFR 1910, Subpart E, Occupational Safety and Health Standards for General Industry, Means of Egress
- 29 CFR 1910, Subpart G, Occupational Safety and Health Standards for General Industry, Occupational Health and Environmental Control
- 29 CFR 1910, Subpart I, Occupational Safety and Health Standards for General Industry, Personal Protective Equipment
- 29 CFR 1910, Subpart J, Occupational Safety and Health Standards for General Industry, General Environmental Controls
- 29 CFR 1910, Subpart K, Occupational Safety and Health Standards for General Industry, Medical and First Aid
- 29 CFR 1910, Subpart L, Occupational Safety and Health Standards for General Industry, Fire Protection
- ANSI/ANS 8.1-1983, American National Standard Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors
- ANSI/ANS 8.3-1986, American National Standard Criticality Accident Alarm System
- ANSI/ANS 8.17-1984 (R1989), American National Standard Criticality Safety Criteria for Handling, Storage, and Transportation of LWR Fuel Outside Reactors.
- ANSI/ANS 57.9-1992, Design Criteria for an Independent Spent Fuel Storage Installation (Dry Type)
- ANSI/ANS 57.10-1987, American National Standard Design Criteria for Consolidation of LWR Spent Fuel
- MIL-F-51068C, Filter: Particulate High Efficiency, Fire Resistant
- MIL-F-51079A, Filter Medium: Fire Resistant, High Efficiency
- NFPA 101, Life Safety Code

- UFC, Uniform Fire Code

C-3.12 Environmental

- 10 CFR 1021, NEPA Implementing Procedures
- 10 CFR 1022, Compliance with Floodplain-Wetlands Environmental Review Requirements

C-3.13 Safeguards and Security

- 10 CFR 72, Subpart D, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel; Records, Reports, Inspections, and Enforcement
- 10 CFR 72, Subpart H, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, Physical Protection
- 10 CFR 73, Physical Protection of Plants and Materials
- 10 CFR 75, Safeguards on Nuclear Material - Implementation of US/IAEA Agreement
- 10 CFR 1046, Physical Protection of Security Interests
- ANSI/ANS 57.9-1992, Design Criteria for an Independent Spent Fuel Storage Installation (Dry Type)

C-3.14 Quality Assurance

- 10 CFR 72, Subpart D, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, Records, Reports, Inspections, and Enforcement
- 10 CFR 72, Subpart G, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, Quality Assurance
- 10 CFR 72, Subpart I, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, Training and Certification of Personnel
- ANSI/ANS 57.9-1992, Design Criteria for an Independent Spent Fuel Storage Installation (Dry Type)
- ANSI/ASME NQA-1-1989, American National Standard Quality Assurance Program Requirements for Nuclear Power Plants

Appendix D

ICPP Spent Nuclear Fuel Dry Storage Project Siting Study

Appendix D

ICPP Spent Nuclear Fuel Dry Storage Project

Siting Study

D-1. INTRODUCTION

A study was performed to determine the best available location for siting the new Spent Nuclear Fuel (SNF) Dry Storage Facility. This facility will package existing and future SNF in a dual-purpose canister (DPC) and store temporarily on-Site. The facility will comprise a fuel transfer building (the Dry Transfer Cell [DTC]) and an aboveground storage area for storing the DPCs in precast concrete storage modules (the Dry Storage System [DSS]). Section D-2 reports the investigation of potential sites for the DTC. Section D-3 reports the investigation of potential sites for the DSS.

D-2. DTC FACILITY SITING STUDY

The Idaho National Engineering Laboratory (INEL) is committed to packaging existing and future spent nuclear fuel and placing the packages in dry storage, complying with 10 CFR 72. The SNF Dry Storage Facility will be designed to meet the requirements of the U.S. Nuclear Regulatory Commission (NRC) and associated regulatory guides, codes, and standards applicable to SNF storage. This facility will receive DOE SNF in good condition with no fuel cladding breaches, transfer the fuel to dual-purpose canisters (DPCs), and transfer the DPCs to interim storage modules on-Site. Ultimately, the SNF will be transported for final disposition off-Site.

The DTC will support cask maintenance, inspection, and transfer operations 24 hours a day. The facility will be sized to process 12 incoming SNF shipping casks per month.

D-2.1 DTC Facility Objectives

The facility objectives identified for this project are as follows:

- Provide transportation package (shipping cask) receiving, inspection, handling, and unloading
- Be able to decontaminate, perform minor maintenance, and temporarily store the transportation package
- Provide fuel unit verification
- Be able to transfer fuel unit from shipping buckets to storage buckets, and transfer storage buckets to lag storage
- Be able to transfer fuel unit and storage buckets to DPCs
- Be able to prepare DPCs for transfer to interim storage modules.

D-2.2. DTC Siting Criteria

D-2.2.1 Basic Facility Criteria

The DTC will occupy approximately 10,700 ft² and be constructed of concrete and structural steel. Paved entrances and vehicle staging/parking areas shall be provided.

D-2.2.2 Primary Facility Criteria

D-2.2.2.1 Location. The DTC should be central to the areas it will support. Shipments to the facility will be made from off-Site and INEL facilities including Power Burst Facility (PBF), Test Area North (TAN), Argonne National Laboratory (ANL)-West, and from within the Idaho Chemical Processing Plant (ICPP) facility such as CPP-666, CPP-749, and the Independent Spent Fuel Storage Facility. Off-Site shipments will be received from locations throughout the country. Shipments will be made mostly by truck, but rail shipments could also be expected in the future. The recommended site location should be close to existing facilities that can provide support services such as bus transportation, cafeteria, crafts/maintenance, fuel supply, and emergency response. Roadways should be of suitable design and construction to accommodate heavy truck traffic throughout the year.

D-2.2.2.2 Land Use/Zoning/Site Development. The location of the DTC should not conflict with past or future land use activities. Candidate sites must be located in areas zoned, or consistent with the handling and storage of spent nuclear fuel. An ideal site would require little site demolition and be relatively free of underground utility interferences. The floor height of the facility will be approximately 4 ft above the surrounding grade, therefore the existing elevation of the proposed area should be at least 4,913 ft to provide a floor elevation above the 100-year flood height of 4,917 ft.

D-2.2.2.3 Environmental Impact. The DTC should be located in such a manner as to minimize negative environmental impacts. It is desirable to locate the facility within the ICPP plant boundaries to avoid undisturbed areas. Environmentally controlled or disturbed areas should be avoided.

D-2.2.2.4 Space. The DTC will occupy approximately 10,700 ft². Sufficient space for vehicle staging and parking should also be provided. Site selection should also consider space provisions for future expansion of this facility or an adjacent facility for repackaging and transferring damaged fuel units.

D-2.2.2.5 Utilities. The DTC should be located near existing facilities that can provide the following:

Water: (Both potable and fire) shall be, as a minimum, an 8-in. main, and provide 1,000 gpm. Potable water shall be supplied at 60 gpm minimum.

Sanitary Sewer: An 8-in. sewer main connection is required as a minimum.

Service Waste: A service waste line with capacity for a 2-in. line connection is required.

Steam: A 12 -in. steam main with sufficient pressure for a 4-in. line connection.

Electrical Power/Telephone/Communications:

D-2.3 Alternate Sites Selected for Study

The location of this facility at the INEL has been selected at the ICPP to consolidate fuel handling operations. The specific location at ICPP will be recommended by this study.

Preliminary screening of the available sites within the plant boundaries based solely on building size and transportation requirements for shipping and receiving limits the location to the southern end of the plant. Two sites in this vicinity have been selected for evaluation (see Figure D-1). The two sites are as follows:

- Site 1: Area south of the CPP-749 storage yard and east of CPP-603
- Site 2: Area Southeast of CPP-666.

D-2.3.1 Site #1 South of CPP-749

D-2.3.1.1 Location. This location provides direct access to the plant perimeter road (Willow/Evergreen) which allows access to the west vehicle gate through an area of the plant with very little traffic. An existing rail spur cuts through the site for fuel shipments to CPP-603, which could be utilized for shipments to the DTC. Support services required for the facility and personnel are available within the ICPP.

D-2.3.1.2 Land Use/Zoning/Site Development. This area is next to CPP-603 (pool Storage) and CPP-749 Dry Fuel Storage area (underground). The area is free of existing structures and utilities that might interfere with new construction. The existing ground elevation of the area is approximately 4,914 ft. The plant perimeter road that accesses this location will require significant upgrading to accommodate the heavy truck traffic.

D-2.3.1.3 Environmental Impact. Currently there are two Environmentally Controlled Areas (ECAs 17-A, 17-B) within the proposed site. Contaminated soil excavated near CPP-603 was stored temporarily in these locations. These areas are listed as "No Action" sites and construction within the areas is not anticipated to be restricted, however there are required permits and risks assumed when excavating in these zones and it is highly desired to avoid these areas. The area south of the railroad tracks contains an additional environmentally controlled area (ECA 3).

Figure D-1. DTC alternate site plan.

D-2.3.1.4 Space. This location has sufficient space for the DTC and a future expansion if required. Approximately 90,000 ft² is available between the CPP-749 storage yard and the existing railroad tracks.

D-2.3.1.5 Utilities. Utility connections are available from existing ICPP sources. The steam plant utility tunnel provides the majority of the utility connections, approximately 700 ft from the proposed site. This area of the plant has few existing utilities and it is expected that the costs of extending the plant systems to this site will be significant.

Water: A 12-in. firewater main is available in the utility tunnel located. Approximately 1,900 ft of 8-in. ductile iron pipe would be required for the connection and building loop. A 4-in. potable water line (carbon steel) and a 3-in. potable water line (concrete lined) are available in the utility tunnel. Approximately 700 ft of pipe would be required for the connection.

Sanitary Sewer: The nearest sewer main connection is located just east of CPP-665. Approximately 1300 ft of 8-in. pipe and 4 manholes would be required to tie into the existing 8-in. main. The installation of at least one lift station is expected.

Service Waste: A 4-in. carbon steel service waste line is available in the utility tunnel. Approximately 700 ft of carbon steel pipe is required.

Steam: A 12-in. high pressure steam line is located in the utility tunnel. Approximately 700 ft of 4-in. carbon steel pipe is required.

Electrical Power: Electrical power is available at load center #4 requiring approximately 500 ft of underground duct bank and conduit.

Telephone/Communications: Available nearby from an existing manhole. Approximately 500 ft of duct bank and conduit required.

D-2.3.2 Site #2 Southeast of CPP-666

D-2.3.2.1 Location. This location provides excellent access for shipments and personnel from CPP-666. Shipments from off-Site are assumed would use the same routes that currently are used for fuel shipments to CPP-666. This site is closer to the plant support facilities such as cafeteria, bus service, medical etc. Fuel handling personnel and equipment could be readily shared between CPP-666 and the new facility.

D-2.3.2.2 Land Use/Zoning/Site Development. This area is currently not in use and is separated from the remainder of the plant by the security perimeter established for the FPR construction project. This security fence is no longer in service and can be removed. Locating the facility in this area would be consistent with existing planning efforts to consolidate fuel handling operations. An access road would need to be constructed from CPP-666 and to the new facility. The location of the facility will need to consider avoiding underground utilities located in the vicinity.

D-2.3.2.3 Environmental Impact. There are no existing ECAs within this location. The use of this site would have little adverse effect on the local environment since the adjacent area is already used for a

similar function. The greatest impact would result from the increased traffic to the area due to the fuel shipments.

D-2.3.2.4 Space. This site has sufficient available space for the proposed facility as well as a future expansion or an additional adjacent facility. Expansion to the south would be limited by the existing utility tunnel.

D-2.3.2.5 Utilities. Utility connections are available from existing plant sources. The steam plant utility tunnel provides the majority of the utility connections.

Water: A 12-in. firewater main is available in the utility tunnel located approximately 100 ft from the proposed site. Approximately 800 ft of 8-in. pipe would be required for the connection and building loop. A 4-in. potable water line (carbon steel) and a 3-in. potable water line (concrete lined) is also available in the utility tunnel. Approximately 100 ft of pipe would be required for the connection.

Sanitary Sewer: The nearest sewer main connection is located just east of CPP-665. Approximately 350 ft of 8-in. pipe and 1 manhole would be required to tie into the existing 8-in. main.

Service Waste: A 4-in. carbon steel service waste line is available in the utility tunnel. Approximately 100 ft of carbon steel pipe is required.

Steam: A 12-in. high pressure steam line is located in the utility tunnel. Approximately 100 ft of carbon steel pipe is required.

Electrical Power: 150 Ft of duct bank is required to access a manhole near CPP-665. Existing conduits are available to connect to Power Control Center #3 (approximately 300 ft).

Telephone/Communications: Available nearby from an existing manhole. Approximately 300 ft of duct bank is required.

D-2.4 Preliminary Site Recommendation

D-2.4.1 General

Each alternate site was evaluated against the siting criteria in the previous section. The results of this evaluation are summarized in the following tables. Each table rates the alternate sites against a specific criterion and its overall importance to the facility function.

D-2.4.2 Rating Values

The scale used for evaluating the criteria were established as follows:

- Importance Factor: 1 Least Important, good idea but not driven by criteria.
- 5 Most Important, critical to mission or significant cost impact.
- Site Rating: 0 Fails Criteria Requirements
- 1 Poor, meets criteria, significant costs, risks or unknowns. Substantial site work, demolition required. Inconvenient or inconsistent usage of site.
- 2 Average, meets criteria, some risks or unknowns. Normal level of site work, demolition or prep work. Some minor inconvenience or inconsistencies.
- 3 Good, meets criteria, little cost or inconvenience risk involved.
- 4 Excellent, Exceeds criteria, provides substantial cost savings, convenience, or flexibility. Ideal usage.

D-2.4.3 Rating Tables

D-2.4.3.1 Location:

Criterion Description	Importance Factor	Site 1 South of CPP-749		Site 2 East of CPP-666	
		Rating	Score	Rating	Score
Vehicle Access	5	3	15	3	15
Rail Access	3	4	12	1	3
Support Services	3	3	9	3	9
Operations Support	3	3	9	4	12
Storage Access	4	4	16	4	16
Personnel Access	1	2	2	3	3
Total Rating			63		58

D-2.4.3.2 Current Land Use

Criterion Description	Importance Factor	Site 1 South of CPP-749		Site 2 East of CPP-666	
		Rating	Score	Rating	Score
Consistent with fuel handling operations	4	4	16	4	16
Required Site Development	3	1	3	2	6
Total Rating			19		22

D-2.4.3.3 Environmental Impact

Criterion Description	Importance Factor	Site 1 South of CPP-749		Site 2 East of CPP-666	
		Rating	Score	Rating	Score
No negative impacts	5	3	15	3	15
Environmentally controlled areas	4	1	4	4	16
Total Rating			19		31

D-2.4.3.4 Space Requirements

Criterion Description	Importance Factor	Site 1 South of CPP-749		Site 2 East of CPP-666	
		Rating	Score	Rating	Score
Available area	5	4	20	4	20
Future expansion area	4	4	16	4	16
Total Rating			36		36

D-2.4.3.5 Utilities (See attached cost comparison sheet)

Criterion Description	Site 1 South of CPP-749		Site 2 East of CPP-666	
	Material	Cost	Material	Cost
Water	1,900 ft 8-in. ductile iron pipe	\$58,140	800 ft 8-in. ductile iron pipe	\$40,650
	700 ft 2-in. carbon steel pipe	\$7,455	100 ft 2-in. carbon steel pipe	\$2,913
Sanitary Sewer	1,300 ft 4-in. conc. pipe 4 manholes, two lift stations	\$72,982	350 ft 4-in. conc. pipe 1 manhole	\$16,111
Power	850 ft duct bank/conduit	\$116,578	600 ft duct bank/conduit	\$80,826
Telephone Communications	850 ft duct bank/conduit	\$16,578	600 ft duct bank/conduit	\$37,652
Steam/ Condensate	700 ft 4-in. carbon steel pipe	—	100 ft 4-in. carbon steel pipe	—
	700 ft 2-in. carbon steel pipe	\$15,596	100 ft 2-in. carbon steel pipe	\$3,768
Service waste	700 ft 2-in. carbon steel pipe	\$7,245	100 ft 2-in. carbon steel pipe	\$2,883
High Pres. Air	700 ft 2-in.	\$7,245	100 ft 2-in.	\$727
Trenching/ Backfill	Excavation, sand bed, asphalt patching, backfill, cathodic protection	\$342,475	Excavation, sand bed, asphalt patching, backfill, cathodic protection	\$119,049
Total		\$644,293		\$304,578
Importance Factor (5) Rating 1		5	Rating 3	15

—Cost Comparison prepared by LITCO Cost Estimating

UTILITY COST COMPARISON SUMMARY

		CPP-749				CPP-666			
		QNTY	MT'L	LABOR	TOTAL	QNTY	MT'L	LABOR	TOTAL
Fire Water	8" Ductile Iron	1900 ft	30.6		58140	800 ft	50.8125		40650
Potable Water	2" Carbon Steel	700 ft	10.65		7455	100 ft	29.13		2913
Sewer	4" Concrete Pipe	1300 ft	56.14		72982	350 ft	46.03		16110.5
Power	Ductbank	850 ft	137.15		116577.5	600 ft	134.709		80825.4
Communications	Ductbank	850 ft	19.503		16577.55	600 ft	62.753		37651.8
Steam/Cond	4" & 2" Carbon Steel	1400 ft	11.14		15596	200 ft	18.84		3768
Service Waste	2" Carbon Steel	700 ft	10.35		7245	100 ft	28.83		2883
Air Pipe	2" Carbon Steel	700 ft	10.35		7245	100 ft	7.27		727
Trenching	Excavation	14080 cy	8		112640	3971 cy	8		31768
	Sand Bed	786 cy	20		15720	216 cy	20		4320
	Asphalt R&R	2550 sy	1.5		3825	3600 sy	1.5		5400
	Backfill	17530 cy	8		140240	4892 cy	8		39136
	Cathodic Protection	1 lot	70050		70050	1 lot	38425		38425
Trenching Total					342475				119049
TOTALS					644,293				304,578

NOTES

1. The costs shown are direct construction costs only. Indirects (30%), Procurement (1.5%) and G&A (30%) have not been included.
2. Contingency (20% overall) and Management Reserve (10% already included in Contingency) have not been included.
3. It is assumed that rock will not be encountered during excavation activities.
4. It is assumed that radiological contamination will not be encountered during excavation activities.
5. Allowances for hand excavation (around underground obstructions) have not been included.
6. It is assumed that the soil removed during excavation may be used for backfill, and additional/import backfill materials will not be required.
7. The cost shown for the air pipe is based on the placement in the water trench.
8. The cost for the water pipes is based on separate trenches, however, it may be determined that the pipes may be placed in the same trench.
9. The power and communication costs shown for CPP-749 are based on all cables being pulled through the same duct bank. Power and communication routes to CPP-666 require separate duct banks.
10. The costs shown for the sewer pipe and the service waste pipe are based on a placement distance of 10' from the water pipes. If it is necessary that the lines are placed closer together, or if the lines should cross, concrete encasement of the sewer and service waste lines will be required.
11. If plastic/PVC pipe could be used for any of the systems in lieu of carbon steel, cathodic protection would not be required.
12. Unit costs per lineal foot for piping are a function of the total footage of pipe and fittings; relatively small units of pipe may have a large number of fittings and a resulting high cost per foot as compared to larger runs of larger pipe.

Figure D-2. Utility cost comparison summary.

D-2.5 Site Selection

Based on Total Rating score

Criterion	Site 1 South of CPP-749	Site 2 East of CPP-666
Location	63	58
Land Use	19	22
Environmental	19	31
Space Requirements	36	36
Utilities	5	15
Total Rating	142	162

D-2.6 Recommendation

The recommended site for the DTC based on the criteria and evaluation results presented in this study is Site 2 east of CPP-666. This site provides very good access from CPP-666 and incoming shipments from exterior sources, with less required plant upgrades. This location centralizes fuel transfer/handling operations to two adjacent facilities. This site will provide convenient personnel access and is closer to the plant support facilities. A significant savings in utility installation costs can be made at this location. Approximately \$339,715 in direct costs can be saved by constructing at Site 2. The greatest disadvantage of Site 2 is no existing provisions for rail shipments, which if considered, will offset the savings in utility costs.

The primary disadvantages of Site 1 is the substantial utility and road upgrades required. This location would also require excavation into environmentally controlled areas (for both the site and duct bank run), which should be avoided if possible.

D-3. DRY STORAGE SYSTEM SITING STUDY

The DSS will receive and store dry storage canisters in aboveground concrete vaults. This study evaluated two potential locations for the DSS at the ICPP.

The DSS will consist of an outdoor, aboveground concrete pad with commercial vault-type concrete storage modules. Approximately 100 horizontal storage modules will be required for the DSS. The design of the storage area should also include provisions for other storage projects presently in the design or planning stage. Proper coordination of the design and location of the storage area will benefit all related projects by centralizing the storage area, loading and unloading equipment, and monitoring requirements. This study will assume that a centralized area will be used for the storage of approximately 240 storage modules to accommodate all projected storage requirements.

D-3.1 DSS Objectives

The objectives identified for the DSS are as follows:

- Provide vault-type storage system
- Monitor stored fuels and storage areas
- Confine the storage container
- Provide physical protection
- Be able to insert and retrieve canisters
- Be able to inspect storage vaults.

D-3.2 Facility Siting Criteria

D-3.2.1 Basic Facility Criteria

The DSS will provide a secured, monitored, aboveground storage area for interim storage of dry spent fuels prior to final off-Site disposal.

D-3.2.2 Primary Facility Criteria

D-3.2.2.1 Location. The location of the facility should allow convenient access by shipping vehicles without impacting the operation of the ICPP. Roadways should be of suitable design and construction to accommodate heavy truck traffic throughout the year. A road width of 32 ft consisting of 20-ft-wide asphalt with compacted gravel shoulders is a minimum recommendation. The maximum wheel loads from the transport trailer are 15.5 kips per axle (16 axles total) and for the tractor 15 kips (front axle) and 22 kips (rear dual axles). Shipments will be made to the storage area from the new DTC, CPP-666 (FAST) and potentially from TAN. Shipments from the storage area will all be made to an off-Site

location, therefore it is desirable to locate the site near an existing exterior gate to provide direct access. The proposed area should be somewhat isolated from normal plant vehicle and pedestrian traffic.

D-3.2.2.2 Land Use/Zoning/Site Development. The location of the DSS should not conflict with past or future land use activities. Candidate sites must be located in areas zoned, or consistent with the handling and storage of spent nuclear fuel. It is desirable to locate the storage area site to avoid flooding above the elevation of the module inlet vents (1 ft above basemat) for abnormal conditions and above the bottom of the canisters (+5 ft 8 in.) for extreme conditions. The elevation of the 100-year flood at the ICPP is 4,917 ft, which would be considered an extreme condition. Assuming a 3-ft-thick subbase and basemat as a minimum, the required site ground elevation should be at least 4,914 ft. An ideal site would require very little site demolition and be relatively free of underground utility interferences.

D-3.2.2.3 Environmental Impact. The DSS should be located in such a manner as to minimize negative environmental impacts. It is desirable to locate the facility within the ICPP plant boundaries to avoid undisturbed areas. Environmentally controlled or disturbed areas should be avoided.

D-3.2.2.4 Space. The site selected for the DSS should be sized not only for the units identified for the DSF project, but should also include all other projected storage units of this type. A total area of 176,500 ft² will be required for 240 storage units. The location should also allow sufficient area to allow a convenient organized storage layout. A rectangular or square configuration is the most desirable.

D-3.2.2.5 Utilities. The DSS shall be located near existing facilities that can provide the following utility demands:

Electrical Power

Telephone/Communications

Security Alarms

D-3.3 Alternate Sites Selected for Study

Preliminary screening of the available sites at the ICPP based on the area required and transportation requirements limits the location to the southern end of the plant. Two sites were selected within the plant boundaries, and for comparison, two locations outside of the existing fence (see Figure D-3). The sites selected for the study are as follows:

Site # 1 Area south of CPP-691 (FPR)

Site # 2 South of CPP-749

Site # 3 Outside of the plant boundary (two sites identified).

Figure D-3. DSS alternate site plan.

D-3.3.1 Site 1 South of CPP-691 (FPR)

D-3.3.1.1 Location. This site is within the current plant perimeter fencing and a portion of this fencing could be utilized for the new storage area secured perimeter. This location would provide good access from both the new DTC and CPP 666. The existing FPR gate could be used for shipping units off-Site directly out of the plant. This location is isolated from the populated areas of the plant and would provide an ideal secured area.

D-3.3.1.2 Land Use/Zoning/Site Development. The area currently is used for warehousing and storage for much of the FPR support facilities and materials. Use of this site would require the dismantling or demolition of several steel buildings currently unoccupied or used for storage and the removal of several trailers. The relocation of the trailers is currently underway. It might be possible to use one of the existing buildings for storage of the transport vehicle, or equipment. There currently is an existing underground firewater line through this area which might require relocating depending upon the final site layout. The existing ground elevation of the area is approximately 4,913 ft. Three ft of fill will be required to attain the base elevation required for the 100-year flood.

D-3.3.1.3 Environmental Impact. There are no environmentally controlled areas in this vicinity and no other limiting environmental restrictions.

D-3.3.1.4 Space. This site has sufficient area for locating the proposed 240 units and could support a much larger facility while maintaining adequate isolation space from nearby facilities.

D-3.3.1.5 Utilities. Electrical power is available nearby at a Load Center 3, approximately 300 ft from the proposed storage area.

D-3.3.2 Site 2 East and South of CPP-749

D-3.3.2.1 Location. This site is within the current plant security perimeter and would provide good access from the DTC and CPP-666. Off-Site shipments made from the storage area could not be made directly out of the plant unless a new gate is constructed. The alternative shipment routes would be via the plant perimeter road and out the east gate or FPR gate. This area is isolated from the populated areas of the plant.

D-3.3.2.2 Land Use/Zoning/Site Development. This area is next to CPP-603 (pool Storage) and CPP-749 Dry Fuel Storage area (underground). The FAST Facility (pool storage) is also nearby. The area is free of existing structures and utilities that might interfere with new construction. The plant perimeter road and tunnel crossings will need upgrading to accommodate the heavy truck traffic. The existing ground level of the area is approximately 4,914 ft. Two ft of fill will be required at this location to raise the modules above the 100-year flood elevation.

D-3.3.2.3 Environmental Impact. Currently there are two ECAs (17-A, 17-B) next to the proposed site. Contaminated soil excavated near CPP-603 was stored temporarily in these locations. These areas are listed as "No Action" sites and construction within the areas should not be restricted; however, there are required permits and risks assumed when excavating in these zones and it is highly desirable to avoid

these areas. The area south of the railroad tracks contains an additional ECA (ECA 3). These areas might be encountered during the installation of the site utilities and limit the usable area.

D-3.3.2.4 Space. This site has available area for locating the proposed 240 units but would require encroaching across Evergreen Avenue and into the current security perimeter. Approximately 90,000 ft² of area is available between the CPP-749 storage yard and the existing railroad tracks. The area south of the railroad tracks contains an additional ECA (ECA 3). Access to the CPP-749 could also be restricted depending upon the size of the storage area.

D-3.3.2.5 Utilities. Electrical power is available at load center #4. Approximately 500 ft of underground duct bank and conduit is required. Telephone and communications are available nearby from an existing manhole. Approximately 500 ft of duct bank and conduit are required.

D-3.3.3 Site 3 Outside of the plant boundaries

D-3.3.3.1 Location. There are several possible locations outside of the plant perimeter fence that could be used for the storage area. For evaluation purposes, assume the area east of the percolation ponds and an area west of CPP-603, outside of the West Perimeter Road. Each of these sites would provide an isolated area with good road access. Shipments from the storage area could be made without impacting plant operations.

D-3.3.3.2 Land Use/Zoning/Environmental Impact. These areas are currently undisturbed sagebrush. Siting the storage area outside of the plant would increase the occupied land area of the plant and INEL, which is desirable to avoid.

D-3.3.3.3 Space. The areas outside of the plant have the greatest available space and flexibility for expansion at the ICPP.

D-3.3.3.4 Utilities. Electrical power at either proposed location should be readily available from the new plant power upgrade currently in design.

D-3.4 Preliminary Site Recommendation

D-3.4.1 General

Each alternate site was evaluated against the siting criteria in the previous section. The results of this evaluation are summarized in the following tables. Each table rates the alternate sites against a specific criterion and its overall importance to the facility function.

D-3.4.2 Rating Values

The scale used for evaluating the criteria were established as follows:

Importance Factor:	1	Least Important, good idea, not driven by criteria
	5	Most Important, critical to mission or significant cost impact.
Site Rating:	0	Fails Criteria Requirements
	1	Poor, meets criteria, significant costs, risks or unknowns. Substantial site work, demolition required. Inconvenient or inconsistent usage of site.
	2	Average, meets criteria, some risks or unknowns. Normal level of site work, demolition or prep work. Some minor inconvenience or inconsistencies.
	3	Good, meets criteria, little cost, inconvenience, or risk involved.
	4	Excellent, Exceeds criteria, provides substantial cost savings, convenience, or flexibility. Ideal usage.

D-3.4.3 Rating Tables

D-3.4.3.1 Location:

Criterion Description	Importance Factor	Site 1 South of CPP-691 (FPR)		Site 2 East of CPP-749		Site 3 Outside Plant	
		Rating	Score	Rating	Score	Rating	Score
Vehicle access	4	3	12	2	8	2	8
Off-Site shipping access	4	4	16	2	8	4	16
Isolation from operations/personnel	3	3	9	3	9	4	12
Existing security provisions	2	3	6	2	4	0	0
Total rating			43		29		36

D-3.4.3.2 Current Land Use/Site Development

Criterion Description	Importance Factor	Site 1 South of CPP-691 (FPR)		Site 2 East of CPP-749		Site 3 Outside Plant	
		Rating	Score	Rating	Score	Rating	Score
Consistent with fuel storage operations	4	2	8	4	16	2	8
Required site development	3	2	6	3	9	3	9
Utilities interference	2	2	4	4	8	4	8
Within developed plant boundaries	3	3	9	3	9	0	0
Total rating			24		42		25

D-3.4.3.3 Environmental Impact

Criterion Description	Importance Factor	Site 1 South of CPP-691 (FPR)		Site 2 East of CPP-749		Site 3 Outside Plant	
		Rating	Score	Rating	Score	Rating	Score
No negative impacts	5	3	15	3	15	1	5
Environmentally controlled areas	4	3	11	1	4	3	12
Total rating			27		19		17

D-3.4.3.4 Space Requirements

Criterion Description	Importance Factor	Site 1 South of CPP-691 (FPR)		Site 2 East of CPP-749		Site 3 Outside Plant	
		Rating	Score	Rating	Score	Rating	Score
Available area	5	3	15	3	15	3	15
Additional area for expansion and design flexibility	1	3	3	2	2	4	4
Total rating			18		17		19

D-3.5 Site Selection

Based on Total Rating score

Criterion	Site 1 South of CPP-691 (FPR)	Site 2 East of CPP-749	Site 3 Outside of Plant
Location	43	29	36
Land Use	24	42	25
Environmental	27	19	17
Space requirements	18	17	19
Utilities			
Total rating	112	107	97

D-3.6 Recommendation

The recommended site for the storage facility based on the criteria and evaluation results of this study is Site 1 south of CPP-691 (FPR) over Site 2 by a very narrow margin. The two sites are within the current plant perimeter and very similar with respect to available area, environmental impacts, isolation, and security provisions. The main advantage of Site 1 is better vehicle/shipping access, less upgrades or modifications to the plant, and no risks encountered by encroaching into existing ECAs. The existing FPR gate and perimeter fencing can be utilized as much as possible and road upgrades can be kept to a minimum. Site #2 does not currently allow shipments directly out of the plant and would require a new gate and a complete upgrade of the perimeter road system.

Appendix E

Criticality Safety Scoping Calculations for Selected Fuels in NUHOMS® Equipment

Lockheed Idaho Technologies Company

INTERDEPARTMENTAL COMMUNICATION

Date: June 6, 1996

To: Leroy C. Lewis MS 3114 6-3295
Daryl A. Lopez MS 3765 6-9020

From: Valerie L. Putman *Valerie L. Putman* MS 3458 6-9529

Subject: CRITICALITY SAFETY SCOPING CALCULATIONS FOR SELECTED FUELS IN
NUHOMS® EQUIPMENT - VLP-06-96

INTRODUCTION

Strategies for Department of Energy (DOE) spent nuclear fuel interim storage include use of a road-ready package with containers suitable for interim storage, intra-site transfers, transport to a permanent storage location, and final storage. The Standardized Nuclear Horizontal Modular Storage (NUHOMS) System and its associated equipment are designed for just such a strategy with spent commercial nuclear fuel. However, much of DOE's spent nuclear fuel is more highly enriched and it is more doubtful that credit will be permitted for fuel burnup and/or fixed neutron absorbers with DOE fuels.

At your request, Idaho National Engineering Laboratory (INEL) Criticality Safety personnel completed criticality safety scoping calculations for the following DOE fuels in NUHOMS equipment to assist in determining the number of containers needed and identifying possible basket design constraints:

- Fort St. Vrain (FSV) elements in the proposed FSV Dual Purpose Canister (DPC),
- Pathfinder Superheater elements in bucket BU-FS-910 in the proposed FSV DPC,
- Power Burst Facility (PBF) Driver Core assemblies in the NUHOMS 24P Dry Shielded Canister (DSC), which is also a DPC, and proposed 14-Tube DPC,
- Shippingport Light Water Breeder Reactor (LWBR) Canisters in the proposed LWBR DPC,
- Shippingport Pressurized Water Reactor (PWR) Core 2 Seed 1 (C2-S1) and Core 2 Seed 2 (C2-S2) assemblies in the NUHOMS 24P DSC, poison-modified NUHOMS 24P DSC, and proposed 14-Tube DPC,
- TREAT fuel in the NUHOMS 52B DSC, which is also a DPC, and proposed 14-Tube DPC, and
- TRIGA fuel rods in the proposed 14-Tube DPC.

Conclusions, design constraints, and scoping calculation limitations are described in this cover letter. Equipment, fuel, and fuel specific calculations are described in the attachment.

SUMMARY

Scoping calculations indicate these fuels will be critically safe in DPCs if specified constraints are satisfied. To envelope many hypothesized storage, handling, and transport conditions, calculations address optimum water moderation within a DPC, three full reflection conditions for a single DPC (water, concrete for storage vaults and wells, and stainless steel for transfer and shipping casks), and interaction between identical DPCs. However, several items are not addressed in this study. For example, models assume fuel and DPC equipment remain intact. Unaddressed items are listed at the end of this summary.

General Constraints

- The DPC, including associated buckets, tubes, and guide sleeves, and contained fuel must maintain their structural integrity.
- NUHOMS 24P and 52B DSC guide sleeve location and maximum cross-sectional inner-area are within design tolerances indicated by vendor literature (references 1, 2, 3, and 4 of attachment).
- Assuming the pipes are sufficiently sturdy, the maximum inner diameter of tubes or buckets in the 14-Tube DPC is within design tolerances of nominal 12 in. schedule 10 pipe and the tube or bucket positions are near described locations in the DPC (Figure 4, page 7 of attachment).

Constraints for FSV Elements in FSV DPC

- FSV elements are limited to a maximum five elements stacked in each of seven FSV DPC guide sleeves, for 35 elements per DPC. This limit is the DPC physical capacity.
- Each FSV DPC guide sleeve wall must be made from at least $\frac{3}{4}$ in. thick stainless steel.
- Separation distances for FSV DPCs should be re-evaluated when lag storage designs and calculation method validations are available, if there are any further plans to place FSV elements in lag storage.

Constraints for Pathfinder Superheater Elements in FSV DPC

- Pathfinder Superheater elements in bucket BU-FS-910 are limited to a maximum 64 elements per bucket. This limit exceeds the planned loading of 62 elements per bucket.
- Pathfinder buckets, BU-FS-910, are limited to a maximum two buckets stacked in each of seven FSV DPC guide sleeves, for 14 buckets per DPC. This limit might exceed the DPC physical capacity and does exceed the anticipated total of seven buckets.

Constraints for PBF Assemblies or Loose Rods in 14-Tube DPC or 24P DSC

- PBF fuel is limited to a maximum 63 fuel rods per tier, with or without assembly canisters, and three tiers per 14-Tube DPC tube, for a total 2646 fuel rods per DPC. This limit exceeds the DPC physical capacity for fuel assemblies but not for loose rods.
- PBF fuel is limited to a maximum 63 fuel rods per tier, with or without assembly canisters, and three tiers per NUHOMS 24P DSC guide sleeve, for 4536 fuel rods per DSC. This limit exceeds the DSC physical capacity for fuel assemblies but not for loose rods.
- If loose rods are loaded or if assembly aluminum canisters could be compromised, physical barriers between tiers should be considered.

Constraints for Shippingport LWBR Containers in LWBR DPC

- Calculations for LWBR Canisters in the LWBR DPC are required before a loading limit can be determined. However, criticality safety calculations are on hold due to questions with ²³³U data in nuclide cross section libraries and with permission to take some credit for burnup.

Constraints for Shippingport PWR Core 2 Assemblies in 14-Tube DPC

- Shippingport PWR C2-S1 and -S2 assemblies are limited to one per tube or bucket in a 14-Tube DPC, for a total 14 assemblies per DPC. This limit is the DPC physical capacity.
- Shippingport PWR assemblies are relatively centered within the tubes or buckets.

Constraints for TREAT Fuel in 14-Tube DPC or 52B DSC

- TREAT fuel must not exceed the internal volume of buckets or tubes in the 14-Tube DPC. This limit exceeds the DPC physical capacity with the proposed four-compartment TREAT Bucket.
- TREAT fuel cans are limited to five cans stacked per guide sleeve in a 52B DSC, with or without fixed neutron absorber, for a total 260 cans per DSC. This limit exceeds the 52B DSC physical capacity.
- One fuel element is equivalent to one fuel can for criticality calculation purposes.

Constraints for Al- and SS-Clad TRIGA Elements in 14-Tube DPC

- Standard, pseudo-standard, ACPR, FLIP, and similar TRIGA elements are limited to a maximum one element per TRIGA Bucket compartment, 24 compartments per bucket, five buckets stacked per tube, in the proposed 14-Tube DPC, for a maximum 70 buckets or 1680 elements per DPC. This loading is the DPC physical capacity with this bucket design.

- Elements must be verified to conform to the following generic description: initially stainless steel, Incoloy, or aluminum clad, outer diameter between 1.3 and 1.8 in., nominal 15 in. maximum active fuel length, 165g ^{235}U per element maximum at beginning-of-life (BOL), U-Zr-hydride fuel matrix, and without exotic materials which are significantly better moderators than water or hydride. Verification is necessary because there are a wide variety of elements identified with the TRIGA name, some of which might not be enveloped by fuel models here.
- Instrumented elements and fuel follower control elements for these fuel types are acceptable.
- Declad elements are acceptable if they maintain clad fuel geometry.
- One rod of a TRIGA 4-rod cluster counts as one standard TRIGA element.
- These elements may be intermixed within DPCs, tubes, and buckets.
- TRIGA Bucket outer walls must be made from nominal 12 in. schedule 10 stainless steel pipe. Smaller diameters and/or thicker walls are acceptable.
- TRIGA Bucket compartment walls are made from nominal $\frac{1}{8}$ in. thick stainless steel. Thicker walls are acceptable.

Constraints for Small-Diameter TRIGA Elements in 14-Tube DPC

- Although not recommended because of its inefficiency, small-diameter TRIGA elements may be loaded in the same manner as pseudo-standard TRIGA elements (maximum one element per TRIGA Bucket compartment, 24 compartments per bucket, five buckets stacked per tube in the proposed 14-Tube DPC). If this strategy is selected each small diameter element counts as one pseudo-standard element.
- Otherwise, small-diameter TRIGA elements are limited to a maximum four elements per TRIGA Bucket compartment, 24 compartments per bucket, five buckets stacked per tube in the proposed 14-Tube DPC, for a maximum 6720 elements per DPC.
- Small-diameter TRIGA elements must be verified to conform to the following generic description: initially stainless steel, aluminum, or Incoloy clad, nominal 0.54 in. maximum outer diameter, nominal 22 in. maximum active fuel length, 55g ^{235}U maximum per element at beginning-of-life, U-Zr-hydride fuel matrix, and without exotic materials which are significantly better moderators than water or hydride. Verification is necessary because descriptions for some TRIGA fuels, such as high-powered TRIGA, had to be assumed and therefore might not be enveloped by fuel models here.
- Instrumented elements and fuel follower control elements for these fuel types are acceptable.

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- Declad elements are acceptable if they maintain clad fuel geometry.
- TRIGA Bucket outer walls must be made from nominal 12 in. schedule 10 stainless steel pipe. Smaller diameters and/or thicker walls are acceptable.
- TRIGA Bucket compartment walls must be made from nominal $\frac{1}{8}$ in. thick stainless steel. Thicker walls are acceptable.
- Intermixing small-diameter elements, at more than one element per compartment, with regular diameter elements in the same bucket or DPC should not be allowed without further evaluation. The intended loading is probably safe, but intermixing increases the probability that small and regular diameter elements would be put in the same compartment, an abnormal condition not addressed in this scoping study.

Items Not Addressed

Scoping calculations do not address several items which should eventually be addressed through criticality safety evaluations, safety analysis, and/or loading limits, including:

- Effects of uncertainties such as design tolerances in manufacturing DPCs and some fuels,
- Calculation method validation,
- Mixing fuel types within one DPC,
- Loss of fuel, tube, bucket, sleeve, and/or DPC structural integrity, especially hypothesized rubblized end-of-life conditions for the final storage facility,
- Use of carbon steel rather than stainless steel where credit for steel was needed to demonstrate criticality safety, although this substitution should not have a significant adverse effect, and
- BER-TRIGA fuel.

VLP

Attachment

cc: Soon Sam Kim MS 3458 6-7634
Mark N. Neeley MS 3458 6-7635
Charles E. Stuart MS 3458 6-9489
J. Todd Taylor MS 3458 6-9656

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EQUIPMENT DESCRIPTIONS

NUHOMS 52B DSC

For purposes of this study the NUHOMS 52B DSC includes canister shell, 52 guide sleeves, neutron poison plates between any two guide sleeves within the shell, and basket structure (spacer discs, etc.) for positioning sleeves and plates. The shell is nominally a $67\frac{1}{4}$ in. outer diameter, circular cylinder with a $\frac{5}{8}$ in. thick stainless steel wall. Guide sleeves are square cylinders with a nominal 6 in. interior width and an approximate 177 in. usable length. Between each guide sleeve pair there is a nominal 6.3 in. wide, 0.1345 in. thick neutron absorber sheet with 75 wt% boron. Figure 1 shows the 52B DSC model developed by Mark Neeley which assumes DSC metals are stainless steel, modelled as either moderator or SS304, and which neglects fixed neutron absorbers. The 52B DSC is described in more detail in vendor literature.^{1,2,3}

NUHOMS 24P DSC

For purposes of this study the NUHOMS 24P DSC includes canister shell, 24 guide sleeves, and basket structure for positioning sleeves. The DSC does not include fixed neutron poisons. The shell is nominally a $67\frac{1}{4}$ in. outer diameter, circular cylinder with a $\frac{5}{8}$ in. thick stainless steel wall. Guide sleeves are square cylinders in two sizes, both with slightly more than 9 in. outside width and with approximately 173 in. usable length. Figure 2 shows the 24P DSC model developed by Chuck Stuart, which assumes DSC metals are stainless steel, modelled as moderator or SS304. The DSC basket includes thick steel end pieces which were neglected for consistency between various canisters models. This should have negligible effect on conclusions because most fuels are essentially infinite length in a fully loaded DSC. Fuel-specific calculations with infinite (20 cm or more) steel reflectors envelope actual end-piece thicknesses. The 24P DSC is described in more detail in vendor literature.^{2,3,4}

Poison-Modified 24P DSC

One DSC design, similar to the 24P DSC, includes neutron poison (absorber) either in or between guide sleeves. Material, thickness, and location strategy for poison plates in the 52B DSC were used to model a poison-modified 24P DSC because we did not have sufficient design information. Figure 3 shows the poison-modified 24P DSC model developed by Chuck Stuart. This model is identical to the 24P DSC model (Figure 2, page 4) except for poison plates. Use of this poisoned DSC was investigated as requested but its use is not recommended because the Nuclear Regulatory Commission has not yet ruled on the issue of fixed poisons with highly enriched fuels.

Figure 1 NUHOMS 52B DSC Model

Figure 2 NUHOMS 24P DSC Model

Figure 3 Poison-Modified 24P DSC Model

Proposed 14-Tube DPC

For purposes of this study the proposed 14-Tube DPC includes canister shell (assumed to be the 24P DSC shell), 14 tubes or bucket-openings (analogous to guide sleeves in the 24P DSC), and basket structure for positioning tubes or buckets.⁵ The DPC does not include fixed neutron absorbers. Figure 4 shows the 14-Tube DPC model developed by Chuck Stuart. Buckets or bucket stacks are considered to be DPC tubes, assumed to be made from 12 in. schedule 10 pipe. Additional bucket structural material is described as necessary with fuel-specific calculations. All materials are assumed to be stainless steel, modelled as moderator or SS304.

Proposed FSV DPC

For purposes of this study the proposed FSV DPC includes canister shell (assumed to be the 24P DSC shell), seven hexagonal guide sleeves (analogous to guide sleeves in the 24P DSC), and basket structure for positioning sleeves.⁵ The DPC does not include fixed neutron absorbers. Figure 5 shows the FSV canister model developed by Soon Sam Kim. Materials are assumed to be stainless steel, modelled as moderator, SS316, or SS304. Guide sleeves are assumed to be butted against each other.

Proposed LWBR DPC

For purposes of this study the proposed LWBR DPC includes canister shell (assumed to be the 24P DSC shell), guide opening(s) for Shippingport LWBR Storage Canisters (analogous to guide sleeves in the 24P DSC), and basket structure for positioning LWBR Storage Canisters.⁵ The DPC does not include fixed neutron absorbers. Depending on criticality safety and thermal limitations, there will be one to three openings for LWBR Canisters. Figure 6 shows the three-opening LWBR DPC model developed by Valerie Putman. All materials are assumed to be stainless steel, modelled as moderator or SS304.

Dry Storage Vaults, Wells, and Arrays

Several dry storage designs exist. Most designs involve a thick concrete cuboid with interior steel structure to hold one DPC and with a thick steel or lead-and-steel door. Such vaults provide near neutronic-isolation between DPCs in adjacent vaults. For a single DPC, these designs are enveloped by modelling a tight-fitting, thick concrete reflector around all sides of a DPC, as shown in Figure 7, to envelope worst-case concrete reflection. For an array of DPCs, a square-pitch two-dimensional infinite array with varying concrete divider thicknesses are modelled, as shown in Figure 8, to identify minimum thicknesses needed to isolate DPCs. Figures are included with fuel-specific calculations which use other models.

all unlabeled dimensions in cm

Figure 4 Proposed 14-Tube DPC Model

Figure 5 Proposed FSV DPC Model

Figure 6 Proposed LWBR DPC Model

Figure 7 Single Concrete-Reflected DPC Model for Generic Vault Conditions

Shipping and Transfer Casks

Various NUHOMS casks are available for moving DPCs. Casks vary in length, wall thickness, and types of shielding. Models of thick, tight fitting steel reflectors should envelope or approximate reflector effects for most of these casks. Figures are included with fuel-specific calculations which use different cask reflector models. These other models are based on a combination of the NUHOMS's Multi-Purpose Cask (MP-187) and On-Site Transfer Cask.^{2,3}

Figure 9 Model of Single Steel-Reflected DPC for Generic Cask Conditions

FORT ST. VRAIN (FSV) FUEL, STORAGE, AND TRANSPORT

FSV fuel elements are graphite blocks containing a triangular-pitched array of cylindrical fuel rods, poison rods, and coolant channels. Each element measures approximately 31.22 in. (79.2 cm) axially and 14.09 in. (35.8 cm) across the flats of a hexagonal radial surface (8.23 in. or 20.9 cm side length for each side). Elements are described more completely in reactor characterization reports.⁶

FSV fuel elements will physically fit only in the proposed FSV and LWBR DPCs, but more efficient packing is expected in the FSV DPC. It should be possible to stack five FSV elements per guide sleeve for a total 35 elements per DPC. Higher stacks and side-by-side configurations will not fit within a guide sleeve. Twenty-one and one-quarter FSV DPCs would be needed for the 744 FSV elements at the INEL.

Soon Sam Kim performed FSV scoping calculations using the geometry of a fuel model developed by Brian Palmer, with nuclide densities developed by Ken Woods and MCNP software.^{7,8,9} In all cases listed here, scoping calculations model a stack of five elements centered in each guide sleeve, with no vertical spacing between elements. For these calculations spacing between guide sleeves was fixed at 0.00 cm. Spacing between elements within a tier was investigated by varying guide sleeve diameter. Figure 10 shows the basic model.

Preliminary calculations address positioning elements within guide sleeves, guide sleeve thickness, optimum moderation, and four reflector conditions (water, concrete, steel, and the On-Site Transfer Cask). Results indicate the system is most reactive when gaps between guide sleeve and fuel element are minimized. For a $\frac{3}{8}$ in. sleeve thickness, at least 2 cm between fuel and sleeve is required to ensure the system k_{eff} does not exceed 0.95. If this sleeve thickness were used, a minimum 5.9 cm spacing, including guide sleeve walls, is required between elements in a tier. Table 1 summarizes results for this design, with varying moderator and reflector conditions.

Table 2 summarizes additional calculations, performed with a $\frac{3}{4}$ in. sleeve thickness and no gap between fuel and sleeve. In this model there is approximately $15\frac{3}{4}$ in. (40 cm) between outer radial surface of fuel and DPC outer surface. To provide comparison information, Table 2 includes a case with the NUHOMS On-Site Transfer Cask, shown in Figure 11. This model should be similar to the road-ready NUHOMS MP-187 Cask for criticality safety purposes.

DSC shell: 67.25 in. (170.8 cm)
outer diameter; 0.625 in. (1.5875
cm) thick SS304; 141.72 in.
(360 cm) interior length

guide sleeve: cross-section size
varied, 15.67 in. (39.81 cm) across
flats corresponds to 0 cm spacing
between FSV fuel element and wall;
3/8 or 3/4 in. thick SS304;
141.72 in. (360 cm) interior length

FSV element: 31.22 in. (79.2 cm) axially and 14.09 in.
(35.8 cm) across the flats of the hexagonal radial
surface (8.23 in. or 20.9 cm side length for each of the
six sides) [5 element stack per sleeve]

Figure 10 Model of FSV Fuel in Proposed FSV DSC

Table 1 35 FSV Elements in Proposed FSV Canister with a $\frac{3}{8}$ in Sleeve Thickness and 2 cm Spacing Between Sleeve and Fuel				
Case	Moderator WVF	DPC Reflector	$k_{eff} \pm \sigma$	$k_{eff} + 2\sigma$
1-1	1.00	33 cm water	0.910 ± 0.005	0.920
1-2		63 cm ICPP concrete	0.909 ± 0.004	0.917
1-3		20 cm stainless steel	0.909 ± 0.003	0.915
1-4	0.50	63 cm ICPP concrete	0.838 ± 0.006	0.850
1-5	0.20		0.696 ± 0.005	0.706
1-6	0.10		0.610 ± 0.007	0.624

Table 2 35 FSV Elements in Proposed FSV Canister with a $\frac{3}{4}$ in Sleeve Thickness and 0 cm Spacing Between Sleeve and Fuel				
Case	Moderator	DPC Reflector	$k_{eff} \pm \sigma$	$k_{eff} + 2\sigma$
2-1	full density water	33 cm full density water	0.932 ± 0.005	0.942
2-2		63 cm ICPP concrete	0.926 ± 0.005	0.936
2-3		20 cm stainless steel	0.933 ± 0.003	0.939
2-3a		cask (Figure 11, page 15) surrounded by 33 cm full density water	0.930 ± 0.004	0.938
2-4	void	63 cm ICPP concrete	0.434 ± 0.007	0.448

Figure 11 Model of Cask-Reflected FSV Fuel in Proposed FSV DPC

Table 3 summarizes calculations to determine necessary concrete thicknesses to isolate DPCs in lag storage, using the model shown in Figure 12. Results indicate that, although there is an approximate 1% increase in k_{eff} for an array compared to a single concrete reflected DPC, concrete thickness between DPCs does not affect array k_{eff} s. The $15\frac{3}{4}$ in. (40 cm) between fuel and DPC wall is much more significant than distance between DPCs.

Table 3 Six FSV-Loaded FSV DPCs in Concrete Vault Array (DSC as in Table 2; 6x1 DPC array; full density water moderator; circular cells in ICPP concrete; 2 ft (60.96 cm) ICPP concrete reflector)			
Case	DPC Edge-to-Edge	$k_{eff} \pm \sigma$	$k_{eff} + 2\sigma$
3-1	30.48 cm (1.00 ft)	0.939 ± 0.004	0.947
3-2	0.00 cm (0.00 ft)	0.939 ± 0.004	0.947

Results indicate:

- Optimum moderation occurs with full density water, for this model. This conclusion is not affected by horizontal spacing between elements, probably because the primary moderator is graphite in the elements.
- The proposed DPC will be critically safe ($k_{eff} \leq 0.95$), in isolation, fully loaded with FSV elements if canister and elements maintain their structural integrity and guide sleeves satisfy the following requirement.
- Minimum guide sleeve wall thickness must be a nominal $\frac{3}{4}$ in.
- Concrete thickness between DPCs in lag storage will not significantly affect array k_{eff} s. However, array k_{eff} s are essentially 0.95 and, therefore, caution should be used in applying these results.

Figure 12 Model of FSV-Loaded FSV DSCs in Lag Storage

PATHFINDER SUPERHEATER FUEL, STORAGE, AND TRANSPORT

Pathfinder Superheater elements are a stainless steel clad annular fuel containing 93.5% enriched UO_2 measuring approximately 79.5 in. (202 cm) in length by 0.839 in. (2.131 cm) in outer diameter of fueled portion. There are 417 elements at the INEL, 6 unirradiated and 411 irradiated. Elements are to be packaged in BU-SF-910 buckets, which are 9.63 x 9.63 x 84 in. (24.46 x 24.46 x 213.4 cm), at a maximum 62 elements per bucket for a total seven buckets. Pathfinder Power Plant reports and INEL evaluations provide further descriptions.^{10,11,12,13}

Pathfinder buckets are too large to fit in any DPCs except the proposed FSV and LWBR DPCs. More efficient loadings should be possible in the FSV DPC (Figure 5, page 8). It should be physically possible to stack two buckets per guide sleeve but not possible to insert two buckets side-by-side in one sleeve.⁵ One-half DPC will be needed for elements currently at the INEL.

Mark Neeley performed Pathfinder Bucket scoping calculations using an element model developed by Deborah Henrikson and the KENO V.a criticality code of SCALE 4 software.^{13,14} Figure 13 shows the basic model. The model includes an 8x8 array of elements (64 total elements) in each bucket and stacks two buckets in each guide sleeve, with no vertical spacing between buckets. Guide sleeves were represented with square, rather than hexagonal, radial cross-sections, providing closer reflection of fuel in cases which include guide sleeve steel. Figure 14 shows the vault model used for concrete-reflected cases. The vault model is based on the NUHOMS Horizontal Storage Module with interior dimensions reduced to provide close reflection.

Table 4 summarizes calculations addressing optimum moderation, guide sleeve thickness and location, and three reflector conditions. Including BU-FS-910 steel would produce lower k_{eff} s than listed. Table 5 summarizes calculations to determine isolation criteria for arrays of Pathfinder-loaded DPCs.

Results indicate:

- Optimum moderation occurs with full density water for a fully loaded FSV DPC. This conclusion is not affected by spacing between buckets.
- The FSV DPC will be critically safe ($k_{\text{eff}} \leq 0.95$) fully loaded with Pathfinder buckets if the canister, buckets, and elements maintain their structural integrity.
- Pathfinder fuel in BU-FS-910 in on DPC is essentially isolated from fuel in an adjacent identical DPC if guide sleeves are butted against each other.

Figure 13 Model of Pathfinder Bucket in FSV DSC

Figure 14 Model of Concrete-Vault Reflected DSC of Pathfinder Fuel

Table 4 Fourteen Pathfinder Buckets in an FSV DPC

Case	DPC Reflector	Additional Description	Moderator WVF	$k_{eff} \pm \sigma$	$k_{eff} + 2\sigma$
path010	vault (Figure 14, page 20)	sleeve and bucket modelled as moderator, 8.08 in. edge-to-edge spacing between sleeves	1.00	0.896 ± 0.002	0.900
path013			0.90	0.861 ± 0.002	0.865
path014			0.75	0.818 ± 0.002	0.822
path15			0.50	0.743 ± 0.002	0.747
path16			0.25	0.736 ± 0.002	0.740
path17			0.10	0.618 ± 0.002	0.622
path18			0.00	0.207 ± 0.001	0.209
path011	as above	sleeve and bucket modelled as moderator, 0.00 in. edge-to-edge spacing between sleeves	1.00	0.941 ± 0.002	0.945
path019			0.90	0.935 ± 0.002	0.939
path020			0.75	0.928 ± 0.002	0.932
path021			0.50	0.939 ± 0.002	0.943
path022			0.25	0.887 ± 0.002	0.891
path023			0.10	0.604 ± 0.002	0.608
path034	as above	bucket modelled as moderator; sleeves modelled as SS304, 0.00 in. edge-to-edge spacing between sleeves	0.90	0.882 ± 0.002	0.886
path035	30 cm full density water			0.887 ± 0.002	0.891
path036	30 cm SS304			0.876 ± 0.002	0.880

Table 5 Two-Dimensional Arrays of Pathfinder-Loaded FSV DPCs
(full density water moderator, sleeve and bucket modelled as moderator, 0.00 in. edge-to-edge spacing between sleeves)

Case	DPC Reflector	Number of DPCs	$k_{eff} \pm \sigma$	$k_{eff} + 2\sigma$
path011	flooded, tight-fitting, regular concrete vault (Figure 14, page 20)	1	0.941 ± 0.002	0.945
path041	identical DPCs in a square pitch array, 0.00 in edge-to-edge spacing between DPCs, full density water between DPCs	infinite	0.938 ± 0.002	0.942

POWER BURST FACILITY (PBF) FUEL, STORAGE, AND TRANSPORT

PBF Driver Core assemblies are arrays of 18.5% enriched uranium-zirconium steel-clad fuel, aluminum, and/or stainless-steel rods in aluminum canisters with spacer blades, as described in Section 4.2 of the System Design Description.¹⁵ Of the 72 assemblies at PBF, 36 contain only fuel rods, 24 contain a mixture of fuel and non-fuel rods, and 12 contain only non-fuel rods. There are six assembly canister designs, for arrays ranging from 31 to 62 rods, with the 62-fuel-rod design as the largest and most reactive assembly. However, 49-fuel-rod assemblies are the most common. All assemblies are 60 in. long but width varies with canister design.

If the NUHOMS 24P DSC is used, it will be possible to stack PBF fuel assemblies two high in each guide sleeve. Although the sleeve internal width is barely larger than the largest unirradiated assembly, it might be possible to fit two of the smallest assemblies side-by-side in a sleeve.^{2,3,4} Assuming one assembly per tier and that large irradiated assemblies will fit, approximately $1\frac{1}{4}$ 24P DSCs will be needed for the 60 PBF Driver Core fuel assemblies.

Valerie Putman performed PBF scoping calculations using assembly models developed by Virginia Dean and using the KENO V.a criticality code of SCALE 4 software.^{16,14} All fuel assembly designs are enveloped by her 63-rod model: a 7x9 array of fuel rods in a rectangular aluminum canister, neglecting canister parts above and below the active fuel region. Calculations model a stack of three assemblies centered in each guide sleeve, exceeding the DPC design length, to envelope elongated DPC shell designs and hypothetical fuel handling errors. Figure 15 shows the basic model and Figure 16 shows the DSC in an On-Site Transfer Cask.

Table 6 summarizes results for intact, 63-rod fuel assemblies in the 24P DSC for a variety of water moderator densities and three reflector conditions. To provide comparative information regarding a more realistic loading of the DSC, a few calculations were also performed using Virginia Dean's 49-rod canister model.¹⁶ This model is similar to the 63-rod model except that fuel rods are arranged in a 7x7 array and canister volume is reduced accordingly. Table 7 compares 49- and 63-rod-assembly results.

Table 8 summarizes results for loose fuel rods, to envelope two small side-by-side assemblies, hypothetical cases of canister failure, and hypothetical designs which include repackaging fuel rods. The loose-rod model is the 63-rod assembly model with water moderator in place of the aluminum canister.

Table 9 summarizes calculations to determine design criteria for 24P DPC arrays. The calculations model 63 loose fuel rods per tier per guide sleeve.

Figure 15 Model of PBF Assemblies in 24P DSC

Figure 16 Model of Cask-Reflected 24P DSC of PBF Assemblies

Table 6 PBF Fuel Assemblies in 24P DSC
(Centered vertical stack of three 63-fuel-rod assemblies per DSC guide sleeve)

Case	DSC Reflector	Moderator WVF	$k_{eff} \pm 1\sigma$	$k_{eff} \pm 2\sigma$
63rod.24P.100H2O.H2O	31 cm full density water	1.00	0.665 ± 0.001	0.667
63rod.24P.075H2O.H2O		0.75	0.684 ± 0.001	0.686
63rod.24P.050H2O.H2O		0.50	0.745 ± 0.001	0.747
63rod.24P.025H2O.H2O		0.25	0.823 ± 0.001	0.825
63rod.24P.010H2O.H2O		0.10	0.701 ± 0.001	0.703
63rod.24P.005H2O.H2O		0.05	0.542 ± 0.001	0.544
63rod.24P.001H2O.H2O		0.01	0.357 ± 0.001	0.359
63rod.24P.000H2O.H2O		0.00	0.318 ± 0.001	0.320
63rod.24P.100H2O.concrete.1	31 cm ICPP concrete	1.00	0.666 ± 0.001	0.668
63rod.24P.100H2O.concrete	62 cm ICPP concrete	1.00	0.663 ± 0.001	0.665
63rod.24P.075H2O.concrete		0.75	0.684 ± 0.001	0.686
63rod.24P.050H2O.concrete		0.50	0.746 ± 0.001	0.748
63rod.24P.025H2O.concrete		0.25	0.832 ± 0.001	0.834
63rod.24P.010H2O.concrete		0.10	0.667 ± 0.001	0.669
63rod.24P.005H2O.concrete		0.05	0.613 ± 0.002	0.617
63rod.24P.001H2O.concrete		0.01	0.424 ± 0.003	0.430
63rod.24P.000H2O.concrete		0.00	0.365 ± 0.003	0.371
63rod.24P.025H2O.SS	31 cm SS304	0.25	0.843 ± 0.001	0.845
63rod.24P.100H2O.cask	cask (Figure 16, page 24)	1.00	0.665 ± 0.001	0.667
63rod.24P.075H2O.cask		0.75	0.683 ± 0.001	0.685
63rod.24P.050H2O.cask		0.50	0.749 ± 0.001	0.751
63rod.24P.025H2O.caks		0.25	0.836 ± 0.001	0.838
63rod.24P.001H2O.cask		0.01	0.281 ± 0.001	0.283

Table 7 49-Rod vs. 63-Rod PBF Assemblies in 24P DSC (Centered stack of 3 assemblies per DSC guide sleeve, full density water moderation)				
Case	DSC Reflector	Fuel Rods per Assembly	$k_{eff} \pm 1\sigma$	$k_{eff} + 2\sigma$
49rod.24P.100H2O.H2O	31 cm thick, full density water	49 (7x7)	0.579 ± 0.001	0.581
63rod.24P.100H2O.H2O		63 (7x9)	0.665 ± 0.001	0.667
49rod.24P.100H2O.concrete.1	31 cm thick ICPP concrete	49 (7x7)	0.583 ± 0.001	0.585
63rod.24P.100H2O.concrete.1		63 (7x9)	0.666 ± 0.001	0.668
49rod.24P.100H2O.concrete	62 cm thick concrete	49 (7x7)	0.580 ± 0.001	0.582
49rod.24P.100H2O.concrete		63 (7x9)	0.663 ± 0.001	0.665

Table 8 Loose PBF Fuel Rods in 24P DSC (Centered 7x9x3 array of fuel rods per DSC guide sleeve)				
Case	DSC Reflector	Moderator WVF	$k_{eff} \pm 1\sigma$	$k_{eff} + 2\sigma$
63rods.24P.100H2O.H2O	31 cm thick, full density water	1.00	0.659 ± 0.001	0.661
63rods.24P.075H2O.H2O		0.75	0.675 ± 0.001	0.677
63rods.24P.050H2O.H2O		0.50	0.735 ± 0.001	0.737
63rods.24P.025H2O.H2O		0.25	0.826 ± 0.001	0.828
63rods.24P.000H2O.H2O		0.00	0.314 ± 0.001	0.316
63rods.24P.100H2O.concrete	62 cm thick ICPP concrete	1.00	0.660 ± 0.001	0.662
63rods.24P.075H2O.concrete		0.75	0.674 ± 0.001	0.676
63rods.24P.050H2O.concrete		0.50	0.739 ± 0.001	0.741
63rods.24P.025H2O.concrete		0.25	0.836 ± 0.002	0.840
63rods.24P.000H2O.concrete		0.00	0.359 ± 0.003	0.365
63rods.24P.100H2O.cask	cask (Figure 16, page 24)	1.00	0.660 ± 0.001	0.662
63rods.24P.075H2O.cask		0.75	0.676 ± 0.001	0.678
63rods.24P.050H2O.cask		0.50	0.739 ± 0.001	0.741
63rods.24P.025H2O.cask		0.25	0.837 ± 0.001	0.839
63rods.24P.001H2O.cask		0.00	0.271 ± 0.001	0.273

Table 9 Infinite Two-Dimensional Arrays of PBF-Loaded 24P DSCs (Centered 7x9x3 array of fuel rods per DSC guide sleeve, 0.25 WVF water moderator in DSC)						
Case	DSC Shell Material	Material Between DSCs	DSC Edge-to-Edge		$k_{eff} \pm 1\sigma$	$k_{eff} + 2\sigma$
			(cm)	(in.)		
63rods.24P-.025H2O.inf.00conc	moderator	ICPP concrete	0.00	0	0.866 ± 0.001	0.868
63rods.24P.025H2O.inf.00conc	SS304	ICPP concrete	0.00	0	0.852 ± 0.001	0.854
63rods.24P.025H2O.inf.03conc			7.62	3	0.845 ± 0.001	0.847
63rods.24P.025H2O.inf.06conc			15.24	6	0.840 ± 0.001	0.842
63rods.24P.025H2O.inf.025H2O	SS304	0.25 WVF water	0.00	0	0.842 ± 0.001	0.844
63rods.24P.025H2O.inf.100H2O		full density water			0.835 ± 0.001	0.839

PBF assemblies will also fit, in two-assembly-height stacks, in the proposed 14-Tube and FSV DPCs.⁵ Loading is not as efficient as with the 24P DSC, requiring about $2\frac{1}{10}$ 14-Tube DPCs for the 60 assemblies which contain fuel rods. However, scoping calculations address the 14-Tube DPC because the 14-Tube DPC was recently selected for reasons other than criticality safety. Table 10 and Table 11 summarize 14-Tube DPC results for 63 rods per tier, per tube. Optimum moderation, three reflector conditions, effects of tube or bucket wall, and optimum DPC separation are addressed. Results are similar to results for the 24P DSC except that no credit is needed for tube or bucket wall material and that each case has a lower k_{eff} . This comparison is expected because the 14-Tube DPC contains significantly less fuel.

PBF fuel assemblies and loose fuel rods are critically safe ($k_{eff} \leq 0.95$) in the 24P DSC or in the 14-Tube DPC at optimum moderation with concrete, water, or steel reflection, for 63 fuel rods maximum per tier in a guide sleeve or tube and three tiers maximum per guide sleeve or tube, if fuel rod, DPC, and DPC basket structural integrity is maintained. Although DPCs interact, infinite arrays are critically safe, with or without concrete dividers.

Most calculated k_{eff} values are so low that they should be considered as indicative of low reactivity but not as absolute, or realistic values. Qualitative comparisons between listed values are valid for PBF fuel (for example, fuel assemblies are less reactive than optimized loose fuel rods) but PBF k_{eff} values are not directly comparable to k_{eff} s for other fuels.

Table 10 PBF Fuel in 14-Tube DPC (Centered 7x9x3 array of loose fuel rods per tube)					
Case	Tube Material	DPC Reflector	Moderator or WVF	$k_{eff} \pm 1\sigma$	$k_{eff} \pm 2\sigma$
63rods.14T-.050H2O.H2O	moderator	31 cm thick, full density water	0.50	0.605 ± 0.001	0.607
63rods.14T-.025H2O.H2O			0.25	0.768 ± 0.001	0.770
63rods.14T-.000H2O.H2O			0.00	0.261 ± 0.001	0.263
63rods.14T-.100H2O.concrete	moderator	62 cm thick ICPP concrete	1.00	0.593 ± 0.001	0.595
63rods.14T-.075H2O.concrete			0.75	0.568 ± 0.001	0.570
63rods.14T-.050H2O.concrete			0.50	0.604 ± 0.001	0.606
63rods.14T-.025H2O.concrete			0.25	0.775 ± 0.002	0.779
63rods.14T-.000H2O.concrete			0.00	0.304 ± 0.003	0.310
63rods.14T.100H2O.concrete	SS304	62 cm thick ICPP concrete	1.00	0.581 ± 0.001	0.583
63rods.14T.075H2O.concrete			0.75	0.532 ± 0.001	0.536
63rods.14T.050H2O.concrete			0.50	0.510 ± 0.001	0.512
63rods.14T.025H2O.concrete			0.25	0.556 ± 0.001	0.558
63rods.14T.000H2O.concrete			0.00	0.257 ± 0.002	0.261
63rods.14T-.050H2O.SS304	moderator	31 cm thick SS304	0.50	0.605 ± 0.001	0.607
63rods.14T-.025H2O.SS304			0.25	0.780 ± 0.001	0.782
63rods.14T-.000H2O.SS304			0.00	0.215 ± 0.001	0.217

Table 11 Infinite Two-Dimensional Arrays of PBF-Loaded 14-Tube DPCs (Centered 7x9x3 array of loose fuel rods per tube, neglect tube material, 0.25 WVF moderator)						
Case	DPC Shell Material	Material Between DPCs	DPC Edge-to-Edge		$k_{eff} \pm 1\sigma$	$k_{eff} \pm 2\sigma$
			(cm)	(in.)		
63rods.14T--.025H2O.inf.00conc	moderator	ICPP concrete	0.00	0	0.797 ± 0.001	0.799
63rods.14T-.025H2O.inf.00conc	SS304	ICPP concrete	0.00	0	0.788 ± 0.001	0.790
63rods.14T-.025H2O.inf.03conc			15.24	6	0.778 ± 0.001	0.780
63rods.14T-.025H2O.inf.06conc			30.48	12	0.779 ± 0.001	0.781
63rods.14T--.025H2O.inf.00water	moderator	full density water	0.00	0	0.781 ± 0.001	0.783
63rods.14T-.025H2O.inf.00water	SS304	full density water	0.00	0	0.774 ± 0.001	0.776

SHIPPINGPORT LWBR FUEL STORAGE AND TRANSPORT

Most Shippingport LWBR fuel at the INEL was partially disassembled and is stored in large canisters with restraining devices and crush pads to assist in maintaining fuel integrity. The need for restraining devices and crush pads indicate this fuel might not be sufficiently sturdy for transport without reinforcement. This indication is especially important because previous calculations indicate that one LWBR Canister could be critical if the undermoderated fuel material is dispersed more than intended and some water, not necessarily enough to fill the LWBR Canister, is added.¹⁷

Each canister contains one blanket module, seed module, or tightly packed loading of miscellaneous rods and pieces. Miscellaneous rods and pieces are doubly contained, in small-diameter containers in the LWBR canister. These rods and pieces are remains of fuel removed from blanket and seed modules for analysis. Current plans are to avoid repackaging fuel by loading existing LWBR Canisters into DPCs.

LWBR Canisters are too large to fit in any DPC except the LWBR DPC (Figure 6, page 9).⁵ Up to three LWBR Canisters will physically fit in a DPC shell but scoping calculations will define canister number and location. LWBR Canisters are too long to stack in a DPC with the lid closed but stacking hypothetically could occur during handling.

Valerie Putman started LWBR scoping calculations updating canister models developed at the INEL and using the KENO V.a criticality code of SCALE 4 software.^{17,18,14} Currently modelled, intact fuel includes an end-of-life (EOL) Blanket III Module, a beginning-of-life (BOL) Seed Module, and end-of-life 32 in. long loose rods and pieces in a standard LWBR canister, neglecting material above and below the fueled region.

We identified significant questions with fuel models and neutron cross-section libraries, which will delay calculation completion. Criticality safety evaluations to date use estimated end-of-life data. Estimated, rather than guaranteed, end-of-life values are not currently permitted at INEL for criticality safety calculations if beginning-of-life is more reactive. It is doubtful that end-of-life values will be permitted by the Nuclear Regulatory Commission when it is time to license the DPCs for transport. In addition, newer ²³³U data in cross section libraries significantly increase calculated k_{eff} s, although neither old nor newer data are well validated. The cumulative effect of updating seed module models produces unacceptably high k_{eff} s, known to be significantly higher than is possible. These higher values do not allow us to qualify one seed module per DPC. Work is proceeding to resolve the questions, which also affect current fuel storage. Once funding is identified, an estimated 20 weeks are needed.

SHIPPINGPORT PWR FUEL, STORAGE, AND TRANSPORT

Shippingport PWR assemblies are zircaloy clad, approximately 91% enriched uranium, plate fuel. Each assembly is 7.38 in. (18.7452 cm) square in cross section with an approximate 97 in. (246.38 cm) active fuel length. Figure 17 shows a simplified cross-section of a Core 2 Seed 2 assembly. Further descriptions are included in storage evaluations.¹⁹

Figure 17 Shippingport PWR Core 2 Seed 2 Subassembly Cross Section

Shippingport PWR assemblies will physically fit one per 24P DSC guide sleeve, one per 14-Tube DPC tube, possibly two per FSV DPC guide sleeve, and possibly three per LWBR DPC canister opening.⁵ It should not be possible to stack assemblies within a DPC although a stack of two assemblies, without DPC lid, can be hypothesized as a handling error.

Chuck Stuart performed Shippingport PWR scoping calculations using the Core 2 Seed 2 assembly model developed by Deborah Henrikson and the KENO V.a criticality code of SCALE 4 software.^{19,14} This very detailed, discrete fuel model envelopes Core 2 Seed 1 assemblies and most Core 1 assemblies for criticality safety purposes. Guaranteed end-of-life fuel data is used, unlike beginning-of-life-no-poison fuel models used for most fuels.

Table 12 summarizes results for assemblies centered in the DPC volume, taking no credit for basket designs. As expected, configurations of one assembly and one stack of assemblies are critically safe but configurations involving side-by-side assemblies are critical. We should avoid any basket design which physically permits side-by-side assemblies in an unpoisoned bucket, tube, or sleeve.

Table 12 Shippingport PWR C2-S2 Assemblies in DPC Internal Volume (No shell, basket or guide sleeve materials)						
Case	DPC Reflector	# of Tiers	# of Assemblies per Tier	Spacing within Tier (cm)	$k_{eff} \pm \sigma$	$k_{eff} + 2\sigma$
pwr01	water	1	1	---	0.889 ± 0.003	0.895
pwr02			2	0.0	1.064 ± 0.003	1.070
pwr05		2	1	---	0.888 ± 0.003	0.894
pwr06			2	0.0	1.065 ± 0.003	1.071
pwr03	concrete	1	1	---	0.887 ± 0.003	0.893
pwr04			2	0.0	1.060 ± 0.003	1.066
pwr07		2	1	---	0.890 ± 0.003	0.896
pwr08			2	0.0	1.064 ± 0.003	1.070

Table 13 summarizes calculations for fuel in the 24P DSC (Figure 2, page 4) and the poison-modified 24P DSC (Figure 3, page 5), addressing effects of various materials, loading configurations (Figure 18, page 32), and reflector conditions. With the exception of one 12-assembly configuration (Figure 18b, page 32), results are unacceptable.^a The 24P DSC was rejected because a safer, more efficient packing should be achievable with different designs. However, results for assembly stacking are applicable to other designs (specifically, for larger arrays, array k_{eff} increases about 1% if units are stacked assemblies rather than single assemblies).

a. The results are critically unsafe ($k_{eff} > 0.95$) or uncomfortably close to $k_{eff} = 0.95$ for unvalidated calculations with very detailed discrete fuel models.

Figure 18a

Figure 18b

Figure 18c

Figure 18d

Figure 18e

Figure 18 Loading Configurations Modelled for
Shippingport PWR Assemblies in 24P DSC

Table 13 Shippingport PWR C2-S2 Assemblies in NUHOMS 24P DSC (full density water moderation)						
Case	DPC Reflector	Number of Occupied Guide Sleeves	# of Tiers per Guide Sleeve	Additional Description	$k_{eff} \pm \sigma$	$k_{eff} + 2\sigma$
cask01	water	24	1	no DSC wall	1.045 ± 0.003	1.051
cask02				with DSC wall	1.042 ± 0.003	1.048
cask03	regular concrete	24	1	no DSC wall,	1.049 ± 0.003	1.055
cask04				with DSC wall	1.052 ± 0.003	1.058
cask05				no DSC wall, thicker guide sleeve wall	1.022 ± 0.003	1.028
cask06	regular concrete	12 (Figure 18a, page 32)	1	no DSC wall	1.021 ± 0.003	1.027
cask07		12 (Figure 18b, page 32)			0.917 ± 0.003	0.923
cask08		4 (Figure 18c, page 32)			0.972 ± 0.003	0.978
cask09		4 (Figure 18d, page 32)			0.945 ± 0.003	0.951
cask10	regular concrete	12 (Figure 18b, page 32)	2	no DSC wall	0.924 ± 0.003	0.930
cask11		4 (Figure 18d, page 32)			0.944 ± 0.003	0.950
cask12		24			1.044 ± 0.003	1.050
cask13	regular concrete	24	1	poison-modified DSC (Figure 3, page 5), no DSC wall	0.984 ± 0.003	0.990
cask14		20 (Figure 18e, page 32)	1		0.942 ± 0.003	0.948
cask15		20 (Figure 18e, page 32)	2		0.954 ± 0.003	0.960

Table 14 summarizes results for assemblies in the proposed 14-Tube DPC (Figure 4, page 7), addressing effects of DPC shell, DPC tube or bucket, optimum moderation, and three reflector conditions. Calculations model one assembly centered in each tube, for a total 14 assemblies per DPC, with nominal pipe diameters and wall thicknesses for each tube.

Results indicate that assemblies are essentially isolated from each other in this configuration. Assemblies are far enough from the DPC wall that there is no significant difference in effects of common, strong reflectors. Shippingport PWR Core 2 assemblies are critically safe ($k_{\text{eff}} \leq 0.95$) in the 14-Tube DPC for all conditions considered, if:

- Assemblies are centered or nearly centered within the tubes or buckets,
- Tubes or buckets are sized and positioned as planned, and
- Assemblies, DPC, and DPC baskets maintain their structural integrity.

Table 14 Shippingport PWR C2-S2 Assemblies in Proposed 14-Tube DPC (1 assembly per tube, 30.48 cm thick DPC reflector)					
Case	Moderator WVF	DPC Reflector	Additional Description	$k_{\text{eff}} \pm \sigma$	$k_{\text{eff}} + 2\sigma$
cask16	1.00	regular concrete	12 in. schedule 40 SS304 pipe tubes, no DPC shell wall	0.911 ± 0.003	0.917
cask16b	0.50			0.767 ± 0.003	0.773
cask16c	0.25			0.736 ± 0.003	0.742
cask17	1.00	regular concrete	12 in. schedule 10 SS304 pipe tubes, no DPC shell wall	0.913 ± 0.003	0.919
cask17e	0.90			0.885 ± 0.003	0.891
cask17a	0.75			0.833 ± 0.003	0.839
cask17f	0.60			0.807 ± 0.003	0.813
cask17b	0.50			0.798 ± 0.003	0.804
cask17g	0.40			0.793 ± 0.003	0.799
cask17h	0.30			0.802 ± 0.003	0.808
cask17c	0.25			0.813 ± 0.003	0.819
cask17i	0.20			0.812 ± 0.003	0.818
cask17j	0.15			0.802 ± 0.003	0.808
cask17d	0.00			0.619 ± 0.002	0.623
cask17-ss	1.00	SS304	12 in. schedule 10 SS304 pipe tubes, no DPC shell wall	0.912 ± 0.003	0.918
cask17-H2O		water		0.912 ± 0.003	0.918
cask18-H2O	1.00	water	12 in. schedule 10 SS304 pipe tubes, with DPC shell wall	0.913 ± 0.003	0.919

Table 15 summarizes additional results, originally requested to determine minimum acceptable separation between DPCs in lag storage. Results indicate fuel in one 14-Tube DPC is essentially isolated from fuel in an identical adjacent DPC. No additional design constraints are needed to ensure critically safe storage for arrays of these PWR-loaded DPCs.

Table 15 Two-Dimensional Infinite Arrays of PWR-Loaded 14-Tube DPCs (1 assembly per 12 in. schedule 10 SS304 tube, full density water moderation, regular concrete dividing walls, square-pitch arrays)						
Case	DPC Shell Material	DPC Cell Cross Section	DPC Edge-to-Edge		$k_{eff} \pm \sigma$	$k_{eff} + 2\sigma$
			(cm)	(in.)		
cask97-00wall	moderator	square	0.00	0	0.914 ± 0.003	0.920
cask99-00wall	SS304	square	0.00	0	0.913 ± 0.003	0.919
cask99-06wall			15.24	6	0.911 ± 0.003	0.917
cask99-12wall			30.48	12	0.906 ± 0.003	0.912
cask99-18wall			45.72	18	0.915 ± 0.003	0.921
cask98-06wall	SS304	circular	15.24	6	0.910 ± 0.003	0.916
cask98-12wall			30.48	12	0.906 ± 0.003	0.912
cask98-18wall			45.72	18	0.915 ± 0.003	0.921
cask98-24wall			60.96	24	0.912 ± 0.003	0.918

TREAT FUEL, STORAGE, AND TRANSPORT

The INEL TREAT reactor is in-service although not currently operating. Available data consists primarily of a summary reactor description obtained before the reactor achieved initial criticality.²⁰ Each element contains a nominal 38g uranium at beginning-of-life as 93.1% enriched in ^{235}U , 0.248 wt% U_3O_8 uniformly dispersed in graphite (calculated 3.42g U/l and 3.18g $^{235}\text{U}/\text{l}$). Fuel is made into nominal 3.8 x 3.8 x 8 in. blocks, stacked six high, and clad in nominal 0.025 in. thick zircaloy-3 for each element. The fuel element is a squarish right cylinder (Figure 19a, page 37), nominally 3.96 x 3.96 x 107.25 in., with aluminum-clad reflector regions and irregularly shaped end-pieces above and below active fuel. Descriptions indicate it might be relatively easy to disassemble elements into fuel cans, reflector cans, and end pieces. Figure 19b shows the fuel model developed by Mark Neeley. The element is modelled as beginning-of-life fuel over the fuel can, neglecting can ends.

Mark Neeley and Valerie Putman performed calculations using the above fuel model with the KENO V.a criticality code of SCALE 4 software.^{20,14} Calculations model five stacked fuel cans per guide sleeve or bucket compartment in case of element disassembly and to envelope handling errors. Fuel-can stacks envelope intact elements and do not adversely affect packing efficiency for intact elements.

TREAT fuel elements fit in the NUHOMS 52B DSC (Figure 1, page 3) which was initially considered. It should not be possible to insert more than one intact element or one stack of three cans per guide sleeve, for a total 52 elements or 156 fuel cans per 52B DSC. Table 16 and Table 17 respectively summarize results for TREAT fuel in the 52B DSC, neglecting neutron absorber plates and guide sleeve material.

However, TREAT fuel elements will physically fit in all DPCs and, therefore, a more efficient design proposal, with the 14-Tube DPC (Figure 4, page 7), is used for most calculations.⁵ With this design TREAT elements would be loaded one intact element per compartment, four compartments per TREAT Bucket, one bucket per tube in the 14-Tube DPC, for a total 56 elements per DPC. Alternatively, a stack of three TREAT fuel cans can be loaded into each compartment for a total 168 cans per DPC. These loadings are the physical capacity for this bucket design. Figure 20 shows the basic model. Table 18 and Table 19 respectively summarize results for TREAT fuel in one 14-Tube DPC and in a two-dimensional infinite array of 14-Tube DPCs.

Table 20 summarizes results of calculations which take little or no credit for DPC basket design or fuel can structure, performed because previous calculations produced such low k_{eff} s.

Figure 19a Actual

Figure 19b Model

Figure 19 TREAT Fuel Can

Figure 20 Model of TREAT-Loaded 14-Tube DPC

Table 16 TREAT-Loaded 52B DSC (Stack of 5 fuel cans in each guide sleeve, guide sleeve walls and fixed neutron absorber modelled as moderator)				
Case	DSC Reflector	Moderator WVF	$k_{eff} \pm \sigma$	$k_{eff} + 2\sigma$
TREAT014	62 cm thick ICPP concrete	1.00	0.145 ± 0.001	0.147
TREAT013		0.75	0.181 ± 0.001	0.183
TREAT012		0.50	0.244 ± 0.001	0.246
TREAT011		0.25	0.367 ± 0.001	0.369
TREAT010		0.15	0.425 ± 0.001	0.427
TREAT008		0.10	0.426 ± 0.001	0.428
TREAT009		0.05	0.356 ± 0.002	0.360
TREAT015		0.00	0.114 ± 0.001	0.116

Table 17 Two-Dimensional Infinite Array of TREAT-Loaded 52B DSCs (Stack of 5 fuel cans in each guide sleeve, 0.10 WVF moderator in DPCs, guide sleeve walls and fixed neutron absorber modelled as moderator)					
Case	DSC Shell Material	DSC edge-to-edge		$k_{eff} \pm \sigma$	$k_{eff} + 2\sigma$
		(cm)	(in.)		
TREAT016	SS304	0.00	0	0.458 ± 0.001	0.460
TREAT017		15.24	6	0.438 ± 0.001	0.440
TREAT018		30.48	12	0.428 ± 0.001	0.430

Table 18 TREAT-Loaded 14-Tube DPC (Stack of 5 fuel cans in each compartment of TREAT 4-compartment bucket, nominal 12 in. schedule 10 bucket wall, no dividers, 1 bucket per tube in 14-Tube DPC)					
Case	Bucket Wall Material	DPC Reflector	Moderator WVF	$k_{eff} \pm \sigma$	$k_{eff} + 2\sigma$
TREAT.14T-.100WVF.H2O	SS304	31 cm thick full density water	1.00	0.182 ± 0.001	0.184
TREAT.14T-.075WVF.H2O			0.75	0.180 ± 0.001	0.182
TREAT.14T-.050WVF.H2O			0.50	0.182 ± 0.001	0.184
TREAT.14T-.025WVF.H2O			0.25	0.192 ± 0.001	0.194
TREAT.14T-.010WVF.H2O			0.10	0.165 ± 0.001	0.167
TREAT.14T-.000WVF.H2O			0.00	0.069 ± 0.001	0.071
TREAT.14T-.100WVF.conc	SS304	62 cm thick ICPP concrete	1.00	0.182 ± 0.001	0.184
TREAT.14T-.075WVF.conc			0.75	0.178 ± 0.001	0.180
TREAT.14T-.050WVF.conc			0.50	0.181 ± 0.001	0.183
TREAT.14T-.025WVF.conc			0.25	0.193 ± 0.001	0.195
TREAT.14T-.015WVF.conc			0.15	0.185 ± 0.001	0.187
TREAT.14T-.010WVF.conc			0.10	0.176 ± 0.001	0.178
TREAT.14T-.005WVF.conc			0.05	0.147 ± 0.001	0.149
TREAT.14T-.000WVF.conc			0.00	0.084 ± 0.001	0.086
TREAT.14T--.050WVF.conc	moderator	62 cm thick ICPP concrete	0.50	0.275 ± 0.001	0.277
TREAT.14T--.025WVF.conc			0.25	0.399 ± 0.001	0.401
TREAT.14T--.015WVF.conc			0.15	0.456 ± 0.001	0.458
TREAT.14T--.010WVF.conc			0.10	0.457 ± 0.002	0.461
TREAT.14T--.005WVF.conc			0.05	0.379 ± 0.002	0.383
TREAT.14T-.100WVF.SS304	SS304	31 cm thick SS304	1.00	0.183 ± 0.001	0.185
TREAT.14T-.075WVF.SS304			0.75	0.179 ± 0.001	0.181
TREAT.14T-.050WVF.SS304			0.50	0.182 ± 0.001	0.183
TREAT.14T-.025WVF.SS304			0.25	0.193 ± 0.001	0.195
TREAT.14T-.010WVF.SS304			0.10	0.183 ± 0.001	0.185
TREAT.14T-.000WVF.SS304			0.00	0.096 ± 0.001	0.098

Table 19 Two-Dimensional Infinite Arrays of TREAT-Loaded 14-Tube DPCs
(Stack of 5 fuel cans in each compartment of TREAT 4-compartment bucket,
nominal 12 in. schedule 10 SS304 bucket wall, no dividers,
1 bucket per tube in 14-Tube DPC, 0.25 WVF moderator in DPCs)

Case	DPC Shell Material	DPC edge-to-edge		$k_{eff} \pm \sigma$	$k_{eff} + 2\sigma$
		(cm)	(in.)		
TREAT.14T-.025WVF.inf.00conc	SS304	0.00	0	0.195 ± 0.001	0.197
TREAT.14T-.025WVF.inf.06conc		15.24	6	0.192 ± 0.001	0.194
TREAT.14T-.025WVF.inf.12conc		30.48	12	0.192 ± 0.001	0.194
TREAT-.14T-.025WVF.inf.00conc	moderator	0.00	0	0.197 ± 0.001	0.199
TREAT-.14T-.025WVF.inf.06conc		15.24	6	0.194 ± 0.001	0.196
TREAT-.14T-.025WVF.inf.12conc		30.48	12	0.192 ± 0.001	0.194

Table 20 DPC of TREAT Fuel with Little or No Structure

Case	DPC Reflector	Moderator WVF	Additional Description	$k_{eff} \pm \sigma$	$k_{eff} + 2\sigma$
TREAT020	identical DPCs, no spacing between	not applicable	fuel matrix homogenized throughout DPC shell; DPC array like Case TREAT016 (Table 17, page 39)	1.226 ± 0.002	1.23
TREAT019	identical DPCs, no spacing between	0.10	188 elements per DPC practically filling DPC volume; DPC array like Case TREAT020 above	1.182 ± 0.003	1.19
TREAT021	concrete	0.10	188 elements in one DPC practically filling DPC volume	1.170 ± 0.002	1.17
TREAT+.14T-.050WVF.conc	62 cm thick ICPP concrete	0.50	fuel matrix homogenized throughout buckets; bucket walls modelled as moderator, no dividers (see cases beginning with TREAT.14T-- (Table 18, page 40))	0.637 ± 0.002	0.641
TREAT+.14T-.025WVF.conc		0.25		0.810 ± 0.002	0.814
TREAT+.14T-.010WVF.conc		0.15		0.860 ± 0.002	0.864
TREAT+.14T-.010WVF.conc		0.10		0.848 ± 0.003	0.854
TREAT+.14T-.005WVF.conc		0.05		0.760 ± 0.003	0.766

Calculated k_{eff} s are very low when some credit is taken for DPC basket structure, fuel size, and fuel clad. This result is expected for such low concentration fuel. However, calculated k_{eff} s are very high when no credit is taken for fuel structure or fuel can placement. Results indicate:

- TREAT fuel is critically safe ($k_{eff} \leq 0.95$) in the 52B DSC, one element or a stack of five fuel cans per guide sleeve, at optimum moderation for full water, concrete, or steel reflection.
- TREAT fuel is critically safe in the 14-Tube DPC, with the number of elements or fuel cans per tube maximized, at optimum moderation for full water, concrete, or steel reflection.
- Although TREAT-loaded DPCs interact slightly, infinite arrays are critically safe, with or without concrete dividers.

In cases which include DSC guide sleeves or DPC TREAT Buckets with fuel can structure, the calculated k_{eff} s are so low that they should be considered as indicative of low reactivity but not as absolute, or realistic values. Qualitative comparisons between listed values are valid for TREAT fuel but TREAT k_{eff} values are not directly comparable to k_{eff} s for other fuels.

TRIGA FUEL, STORAGE, AND TRANSPORT

Table 21 summarizes TRIGA fuels addressed in these scoping calculations, which include all but one fuel identified with the *TRIGA* acronym. In some cases, particularly high-powered (93% enriched) elements, much of the description is assumed based on other TRIGA fuels. The fuel not addressed is BER-TRIGA, which was not identified as a candidate for this study.

TRIGA fuel is a uranium-zirconium hydride of varying enrichments, uranium-to-zirconium ratios, and zirconium-to-hydrogen ratios, shaped as annular or cylindrical pellets stacked in rods.

(Available data conflict regarding fuel meat shape and possible presence of a central zirconium rod but manufacturer's descriptions indicate an annular shape is usually necessary to evenly distribute hydride.) Fuel elements have varying diameters and clad materials, with miscellaneous end pieces, including graphite, at one or both ends of the fueled region. In most cases nominal fuel parameter values are known but the manufacturer considers additional data proprietary, and has not yet shared that information with us. Table 21 summarizes available and assumed data for the active fuel regions. Where sources provide conflicting data, the more conservative values are listed.^{21,22} Although cladding is indicated, a few declad elements exist.

TRIGA fuel elements physically fit in all DPCs and, therefore, a more specific design proposal is used. With this design, most TRIGA fuel would be loaded into a 24 compartment bucket, sized to stack five buckets per tube position in the 14-Tube DPC. For fuel elements with at least a $1\frac{1}{4}$ in. diameter, it should not be possible to insert more than one element per compartment, limiting a DPC to 1680 elements. Figure 21 shows the basic model of a TRIGA Bucket with this loading. Although the small-diameter elements are longer, it is hypothetically possible to load five or six small-diameter (Incoloy-clad) elements per bucket compartment. Figure 22 illustrates a worst-case model of nine declad small-diameter elements per compartment, as an example of models used to determine a maximum safe loading with this bucket design.

Mark Neeley and Valerie Putman performed calculations using fuel models developed by Valerie Putman, with the KENO V.a criticality code of SCALE 4 software^{21,22,14} Clad material is neglected to envelope effects of manufacturing uncertainties (tolerances) and to envelope declad elements. Figure 23 and Table 22 summarize fuel models. Each model uses beginning-of-life fuel and neglects material outside the active fuel region (fuel cladding, end reflector and poison pieces, etc.). Beginning-of-life fuel should be more reactive than end-of-life fuel because TRIGA reactors are typically operated in burst or pulse mode, which means there should be little fuel burnup.

Table 21 TRIGA Active Fuel Region Descriptions ^{a,21,22}						
General TRIGA Fuel Type	BOL ²³⁵ U		BOL U in Fuel Matrix (wt%)	H to Zr Atom Ratio	Outer Diameter (in.)	Length (in.)
	Mass (g)	Enrichment (wt%)				
Aluminum Clad						
Standard (instrumented and normal) ^b	36	20.0	8	1.0	1.41	14 or 15
Stainless Steel Clad						
Standard before 1965 (plain & streamline, instrumented & normal)	39	20.0	8.0	1.0	1.435	15
Standard after 1964 (plain & streamline, instrumented & normal)	39	20.0	8.5 to 9.0	1.7	1.435	15
Standard Fuel Follower Control Elements	38	20.0	8.5	1.6	< 1.355	15
1 rod of 4-Rod Cluster (instrumented & normal)	[39]	[20.0]	[9.0]	[1.7]	1.37	15
Pseudo-Standard ^c	54	20.0	12	1.7	[1.435]	15
Annular Core Pulsed Reactor (ACPR) (instrumented & normal)	54	20.0	12	1.7	1.40	15
ACPR Fuel Follower Control Element	54	[20.0]	[12]	1.6	[1.40]	14.25
Fuel Life Improvement Program (FLIP)	137	70.0	8.5	1.6	[1.435]	[15]
FLIP-LEU-I	101	20.0	20.0	1.6	[1.435]	[15]
FLIP-LEU-II	165	20.0	30.0	1.6	[1.435]	[15]
FLIP-LEU Fuel Follower Control Elements	97	20.0	20.0	1.6	< 1.355	15
Incoloy 800 Clad						
Standard (instrumented & normal)	55	20	45	1.6	0.51	22.0
High-Powered ^d	41.36	93.15	[45]	[1.6]	[0.51]	[22.0]

- a Nominal values with brackets ([]) around assumed or deduced values. Unless otherwise noted, fuel pellets are annular with an 0.225 in. inner diameter, usually with a zirconium rod inside the annulus. Seven fuel types have instrumented element designs, all of which are enveloped by the non-instrumented design.
- b The fuel pellet is cylindrical rather than annular for aluminum clad elements with a 14-in. active fuel length.
- c Type name used at INEL. Pseudo-standard TRIGA is most probably ACPR TRIGA fuel.
- d Where data is not available, this fuel type is assumed to be similar to standard Incoloy clad fuel, which is used in the same country (Romania).

all unlabeled dimensions in cm

Figure 21 Proposed TRIGA Bucket with Regular-Diameter TRIGA Elements

Figure 22 Proposed TRIGA Bucket Loaded with Small-Diameter TRIGA Fuel

Figure 23 Model of TRIGA Fuel Element

Table 22 TRIGA Fuel Model Parameters								
Parameter	Model Identifier (TRIGA _x where x is indicated below) ^a							
	b	4 ^b	p ^{c,d}	A ^c	7 ^e	L ^f	16 ^g	H ^h
Outer Diameter (in.)	1.478	1.37	1.37	1.37	1.37	1.37	0.51	0.51
Fuel Annulus Inner Diameter (in.)	0.225	0.225	0.225	0.225	0.225	0.225	0.225	0.225
Length	15	15	15	15	15	15	22	22
Enrichment (wt%)	20	20	20	20	70	20	20	93.15
BOL ²³⁵ U (g)	39	39	54	54	137	165	55	41.36
BOL Uranium Content (wt%)	9	9	9	12	8.5	30	45	45
H:Zr atom ratio	1.7	1.7	1.7	1.7	1.6	1.6	1.6	1.6
Cladding	none	none	none	none	none	none	none	none

- a These models include a central Zr rod. Models with moderator in place of the Zr rod are distinguished by adding a hyphen (-) to the end of the identifier (for example, TRIGA-- and TRIGAA-).
- b Model to investigate effects of fuel annulus diameter (compare results of TRIGA- and TRIGA4).
- c Model to investigate effects of uranium wt% in fuel meat (compare results of TRIGAP and TRIGAA).
- d Calculation results indicate one element of this model envelopes one element of any of these clad and declad TRIGA fuel types except the FLIP types. This model is selected for all standard TRIGA.
- e Model of declad FLIP.
- f Model of declad FLIP-LEU-II, which envelopes FLIP-LEU-I. This model is selected for all TRIGA-FLIP.
- g Model of declad standard Incoloy-800 clad TRIGA, selected for all small-diameter TRIGA elements.
- h Model of assumed declad high-powered TRIGA.

Table 23 compares results for various fuel models. All loadings of one element per TRIGA bucket compartment, except FLIP fuels, are enveloped by the *TRIGAP*- model, selected as the basic fuel model for standard TRIGA calculations. With this model it is important to note that each rod of a four-rod cluster is considered to be a single element. *TRIGA7*- and *TRIGAI*-, respectively, are the models selected for FLIP and small-diameter elements. These models envelope declad elements of their respective element types if fuel meat is intact.

Table 24 and Table 25 summarize results for 14-Tube DPCs with TRIGA Buckets, loaded to capacity with *TRIGAP*- (worst case pseudo-standard) elements. Calculations address optimum moderation and three reflector conditions for single DPCs and DPC separation for two dimensional infinite arrays of identical DPCs. Results indicate that it is necessary to take credit for steel in bucket outer walls to ensure criticality safety for optimally moderated, full reflection conditions. Infinite two dimensional array calculations indicate that fuel in one 14-Tube DPC is essentially isolated from fuel in an adjacent 14-Tube DPC. At one element per compartment, these results envelope all subject TRIGA element types except FLIP (Table 21, page 44).

Table 26 and Table 27 summarize results for 14-Tube DPCs with TRIGA Buckets, loaded to capacity with *TRIGA7*- (worst-case FLIP) elements. Calculations address optimum moderation and three reflector conditions for single DPCs and DPC separation for two dimensional infinite arrays of identical DPCs. Results indicate that it is necessary to take credit for steel in bucket walls and dividers to ensure criticality safety for optimally moderated, full reflection conditions. Results for FLIP fuel with steel dividers show trends similar to standard fuel without steel dividers, except that FLIP fuel is more reactive. The highest k_{eff} , 0.945 for the optimum moderated steel reflected case, is acceptable for these unvalidated calculations because fuel models are very conservative and it is doubtful that FLIP fuel is declad. This case might deserve special attention when a final bucket design is approved.

Table 28 and Table 29 summarize results for 14-Tube DPC with TRIGA Buckets, loaded with identical arrays of *TRIGAI*- (worst case Incoloy clad, small diameter) elements centered in each compartment. Calculations address element array size, optimum moderation, and two reflector conditions for single DPCs; and DPC separation for two dimensional infinite arrays of identical DPCs. Calculations take credit for steel in bucket walls and dividers because the goal is to determine a maximum loading and because this steel is required for criticality safety with FLIP elements:

Calculation assumptions and results indicate:

- Optimum moderation occurs at about 0.10 WVF for one element centered per compartment and varies for arrays of small-diameter elements in each compartment.
- One rod of a TRIGA 4-rod cluster should be counted as one standard element.

Table 23. Calculations To Confirm Enveloping Model Identity (1 element centered in each TRIGA bucket compartment, 70 buckets with moderator as compartment dividers per 14-Tube DPC, full density water moderator, 62 cm ICPP concrete reflector)				
Element's Central Rod Material	Case	Fuel Model (Figure 23, page 47 & Table 22, page 47)	$k_{eff} \pm \sigma$	$k_{eff} + 2\sigma$
Zr	TRIGA-.100WVF.vault	TRIGA-	0.709 ± 0.002	0.713
	TRIGA4-.100WVF.vault	TRIGA4	0.715 ± 0.002	0.719
	TRIGAP-.100WVF.vault	TRIGAP	0.823 ± 0.002	0.827
	TRIGAA-.100WVF.vault	TRIGAA	0.798 ± 0.002	0.802
	TRIGA7-.100WVF.vault	TRIGA7	1.011 ± 0.003	1.017
	TRIGAL-.100WVF.vault	TRIGAL	1.005 ± 0.003	1.011
	TRIGAI-.100WVF.vault	TRIGAI	0.572 ± 0.002	0.576
	TRIGAH-.100WVF.vault	TRIGAH	0.514 ± 0.002	0.518
moderator	TRIGA--.100WVF.vault	TRIGA--	0.712 ± 0.002	0.716
	TRIGA4-.100WVF.vault	TRIGA4-	0.724 ± 0.003	0.730
	TRIGAP-.100WVF.vault	TRIGAP-	0.821 ± 0.002	0.825
	TRIGAA-.100WVF.vault	TRIGAA-	0.806 ± 0.002	0.810
	TRIGA7-.100WVF.vault	TRIGA7-	1.011 ± 0.003	1.017
	TRIGAL-.100WVF.vault	TRIGAL-	1.007 ± 0.003	1.013
	TRIGAI-.100WVF.vault	TRIGAI-	0.583 ± 0.002	0.587
	TRIGAH-.100WVF.vault	TRIGAH-	0.521 ± 0.002	0.525

Table 24 Most TRIGA Fuels in 14-Tube DPC (1 TRIGAP- element centered in each bucket compartment; moderator bucket dividers, 5 buckets stacked in each tube)					
Case	Bucket Wall Material	DPC Reflector	Moderator WVF	$k_{eff} \pm \sigma$	$k_{eff} + 2\sigma$
TRIGAP-.14T-.050WVF.water	SS304	31 cm thick full density water	0.50	0.862 ± 0.002	0.866
TRIGAP-.14T-.025WVF.water			0.25	0.901 ± 0.002	0.905
TRIGAP-.14T-.000WVF.water			0.00	0.736 ± 0.002	0.740
TRIGAP-.14T-.100WVF.vault	moderator	62 cm thick ICPP concrete	1.00	0.851 ± 0.002	0.855
TRIGAP-.14T-.075WVF.vault			0.75	0.892 ± 0.002	0.896
TRIGAP-.14T-.050WVF.vault			0.50	0.975 ± 0.002	0.979
TRIGAP-.14T-.025WVF.vault			0.25	1.105 ± 0.003	1.111
TRIGAP-.14T-.000WVF.vault			0.00	0.903 ± 0.005	0.913
TRIGAP-.14T-.100WVF.vault	SS304	62 cm thick ICPP concrete	1.00	0.821 ± 0.002	0.825
TRIGAP-.14T-.075WVF.vault			0.75	0.842 ± 0.002	0.846
TRIGAP-.14T-.050WVF.vault			0.50	0.863 ± 0.002	0.867
TRIGAP-.14T-.025WVF.vault			0.25	0.900 ± 0.003	0.906
TRIGAP-.14T-.010WVF.vault			0.10	0.900 ± 0.003	0.906
TRIGAP-.14T-.000WVF.vault			0.00	0.818 ± 0.004	0.826
TRIGAP-.14T-.050WVF.SS304	SS304	31 cm thick SS304	0.50	0.861 ± 0.003	0.867
TRIGAP-.14T-.025WVF.SS304			0.25	0.904 ± 0.002	0.908
TRIGAP-.14T-.015WVF.SS304			0.15	0.923 ± 0.003	0.929
TRIGAP-.14T-.010WVF.SS304			0.10	0.926 ± 0.002	0.930
TRIGAP-.14T-.005WVF.SS304			0.05	0.915 ± 0.003	0.921
TRIGAP-.14T-.000WVF.SS304			0.00	0.877 ± 0.004	0.885

Table 25 Two-Dimensional Infinite Arrays of TRIGA-Loaded 14-Tube DPCs
(1 TRIGAP- element centered in each bucket compartment, SS304 bucket walls,
5 buckets stacked in each tube, 0.25 WVF moderator)

Case	DPC Shell Material	Material Between DPCs	DPC Edge-to-Edge		$k_{eff} \pm 1\sigma$	$k_{eff} + 2\sigma$
			(cm)	(in.)		
TRIGAP-.14T-.025WVF.inf.06conc	moderator	ICPP concrete	15.24	6	0.911 ± 0.002	0.915
TRIGAP-.14T-.025WVF.inf.00conc	SS304	ICPP concrete	0.00	0	0.905 ± 0.002	0.909
TRIGAP-.14T-.025WVF.inf.06conc			15.24	6	0.907 ± 0.002	0.911
TRIGAP-.14T-.025WVF.inf.12conc			30.48	12	0.905 ± 0.002	0.909
TRIGAP-.14T-.025WVF.inf.06water	moderator	full density water	15.24	6	0.897 ± 0.002	0.901
TRIGAP-.14T-.025WVF.inf.00water	SS304	full density water	0.00	0	0.891 ± 0.003	0.897
TRIGAP-.14T-.025WVF.inf.06water			15.24	6	0.896 ± 0.002	0.900

Table 26 TRIGA-FLIP Fuels in Single 14-Tube DPC (1 TRIGA7- element centered in each bucket compartment, SS304 bucket walls, 5 buckets stacked in each tube)					
Case	Bucket Divider Material	DPC Reflector	Moderator WVF	$k_{eff} \pm \sigma$	$k_{eff} + 2\sigma$
TRIGA7-.14T.050WVF. water	SS304	31 cm thick full density water	0.50	0.836 ± 0.003	0.842
TRIGA7-.14T.025WVF. water			0.25	0.886 ± 0.002	0.890
TRIGA7-.14T.000WVF. water			0.00	0.726 ± 0.002	0.730
TRIGA7-.14T-.100WVF.vault	moderator	62 cm thick ICPP concrete	1.00	1.011 ± 0.003	1.017
TRIGA7-.14T.100WVF.vault	SS304	62 cm thick ICPP concrete	1.00	0.804 ± 0.003	0.810
TRIGA7-.14T.075WVF.vault			0.75	0.804 ± 0.003	0.810
TRIGA7-.14T.050WVF.vault			0.50	0.837 ± 0.003	0.843
TRIGA7-.14T.025WVF.vault			0.25	0.895 ± 0.003	0.901
TRIGA7-.14T.010WVF.vault			0.10	0.916 ± 0.004	0.924
TRIGA7-.14T.000WVF.vault			0.00	0.829 ± 0.004	0.837
TRIGA7-.14T.050WVF.SS304	SS304	31 cm thick SS304	0.50	0.835 ± 0.002	0.839
TRIGA7-.14T.025WVF.SS304			0.25	0.902 ± 0.002	0.906
TRIGA7-.14T.015WVF.SS304			0.15	0.930 ± 0.003	0.936
TRIGA7-.14T.010WVF.SS304			0.10	0.935 ± 0.005	0.945
TRIGA7-.14T.005WVF.SS304			0.05	0.935 ± 0.003	0.941
TRIGA7-.14T.000WVF.SS304			0.00	0.900 ± 0.004	0.908

**Table 27 Two-Dimensional Infinite Arrays of TRIGA-FLIP Loaded 14-Tube DPCs
(1 TRIGA7- element centered in each bucket compartment, SS304 bucket walls and dividers,
5 buckets stacked in the tube)**

Case	Moderator WVF	DPC Shell Wall Material	Material Between DPCs	DPC Edge-to-Edge		$k_{eff} \pm 1\sigma$	$k_{eff} + 2\sigma$
				(cm)	(in.)		
TRIGA7- 14T.025WVF.inf.00conc	0.25	moderator	ICPP concrete	0.00	0	0.900 ± 0.002	0.904
TRIGA7-14T.010WVF.inf.00conc	0.10	SS304	ICPP concrete	0.00	0	0.903 ± 0.002	0.907
TRIGA7-14T.010WVF.inf.06conc				15.24	6	0.918 ± 0.002	0.922
TRIGA7-14T.010WVF.inf.12conc				30.48	12	0.911 ± 0.002	0.915
TRIGA7-14T.025WVF.inf.00conc	0.25	SS304	ICPP concrete	0.00	0	0.897 ± 0.003	0.903
TRIGA7-14T.025WVF.inf.06conc				15.24	6	0.901 ± 0.002	0.905
TRIGA7-14T.025WVF.inf.12conc				30.48	12	0.896 ± 0.003	0.902
TRIGA7- 14T.025WVF.inf.00water	0.25	moderator	full density water	0.00	0	0.893 ± 0.003	0.899
TRIGA7- 14T.025WVF.inf.00water	0.25	SS304	full density water	0.00	0	0.889 ± 0.003	0.895

**Table 28 Small-Diameter TRIGA Fuel in Proposed 14-Tube DPC (Table Page 1 of 2)
(Identical arrays of TRIGA1- elements in each of 24 bucket compartments,
SS304 bucket wall and dividers, 5 buckets stacked in each tube)**

Case	DPC Reflector	Number of Elements per Compartment	Moderator WVF	$k_{eff} \pm \sigma$	$k_{eff} + 2\sigma$
TRIGA1-2.14T.100WVF.vault	62 cm thick ICPP concrete	2 (2x1)	1.00	0.593 ± 0.02	0.597
TRIGA1-2.14T.075WVF.vault			0.75	0.597 ± 0.002	0.601
TRIGA1-2.14T.050WVF.vault			0.50	0.613 ± 0.002	0.617
TRIGA1-2.14T.025WVF.vault			0.25	0.630 ± 0.003	0.636
TRIGA1-2.14T.015WVF.vault			0.15	0.611 ± 0.003	0.617
TRIGA1-2.14T.010WVF.vault			0.10	0.581 ± 0.002	0.585
TRIGA1-2.14T.005WVF.vault			0.05	0.500 ± 0.003	0.506
TRIGA1-2.14T.000WVF.vault			0.00	0.331 ± 0.003	0.337

Table 28 Small-Diameter TRIGA Fuel in Proposed 14-Tube DPC (Table Page 2 of 2) (Identical arrays of TRIGA elements in each of 24 bucket compartments, SS304 bucket wall and dividers, 5 buckets stacked in each tube)					
Case	DPC Reflector	Number of Elements per Compartment	Moderator WVF	$k_{eff} \pm \sigma$	$k_{eff} + 2\sigma$
TRIGAI-4.14T.100WVF.vault	62 cm thick ICPP concrete	4 (2x2)	1.00	0.793 ± 0.002	0.797
TRIGAI-4.14T.075WVF.vault			0.75	0.786 ± 0.002	0.790
TRIGAI-4.14T.050WVF.vault			0.50	0.801 ± 0.002	0.805
TRIGAI-4.14T.025WVF.vault			0.25	0.834 ± 0.002	0.838
TRIGAI-4.14T.015WVF.vault			0.15	0.822 ± 0.002	0.826
TRIGAI-4.14T.010WVF.vault			0.10	0.787 ± 0.002	0.791
TRIGAI-4.14T.005WVF.vault			0.05	0.721 ± 0.002	0.725
TRIGAI-4.14T.000WVF.vault			0.00	0.569 ± 0.002	0.573
TRIGAI-4.14T.025WVF.SS304	31 cm thick SS304	4 (2x2)	0.25	0.838 ± 0.002	0.842
TRIGAI-5.14T.100WVF.vault	62 cm thick ICPP concrete	5 (2-1-2)	1.00	0.959 ± 0.002	0.963
TRIGAI-5.14T.095WVF.vault			0.95	0.948 ± 0.003	0.954
TRIGAI-5.14T.085WVF.vault			0.85	0.941 ± 0.003	0.947
TRIGAI-5.14T.075WVF.vault			0.75	0.933 ± 0.002	0.937
TRIGAI-5.14T.050WVF.vault			0.50	0.932 ± 0.002	0.936
TRIGAI-5.14T.025WVF.vault			0.25	0.941 ± 0.002	0.945
TRIGAI-5.14T.015WVF.vault			0.15	0.917 ± 0.002	0.921
TRIGAI-5.14T.010WVF.vault			0.10	0.878 ± 0.002	0.882
TRIGAI-5.14T.005WVF.vault			0.05	0.802 ± 0.002	0.806
TRIGAI-5.14T.000WVF.vault			0.00	0.656 ± 0.002	0.660
TRIGAI-6.14T.100WVF.vault	62 cm thick ICPP concrete	6 (2x3)	1.00	0.906 ± 0.002	0.910
TRIGAI-6.14T.075WVF.vault			0.75	0.904 ± 0.002	0.908
TRIGAI-6.14T.050WVF.vault			0.50	0.917 ± 0.003	0.923
TRIGAI-6.14T.025WVF.vault			0.25	0.956 ± 0.003	0.962
TRIGAI-6.14T.015WVF.vault			0.15	0.946 ± 0.002	0.950
TRIGAI-6.14T.010WVF.vault			0.10	0.916 ± 0.002	0.920
TRIGAI-6.14T.005WVF.vault			0.05	0.857 ± 0.002	0.861
TRIGAI-6.14T.000WVF.vault			0.00	0.740 ± 0.002	0.744
TRIGAI-9.14T.100WVF.vault	62 cm thick ICPP concrete	9 (3x3)	1.00	1.008 ± 0.003	1.014

Table 29 Infinite Two-Dimensional Arrays of 14-Tube DPCs Loaded with Small-Diameter TRIGA Elements

(Identical 2x2 arrays of TRIGA elements in each of 24 bucket compartments, SS304 bucket wall and dividers, 5 buckets stacked in each tube, 0.25 WVF moderator)

Case	Material Between DPCs	DPC Edge-to-Edge		$k_{eff} \pm \sigma$	$k_{eff} + 2\sigma$
		(cm)	(in.)		
TRIGA1-4.14T.025WVF.inf.00conc	ICPP concrete	0.00	0	0.829 ± 0.002	0.833
TRIGA1-4.14T.025WVF.inf.06conc		15.24	6	0.828 ± 0.002	0.832
TRIGA1-4.14T.025WVF.inf.12conc		30.48	12	0.829 ± 0.003	0.834

- Intact TRIGA fuel will be critically-safe ($k_{eff} \leq 0.95$) at one element per TRIGA Bucket compartment for all addressed conditions, if the bucket is constructed as indicated below and if the elements satisfy one of the descriptions in Table 21.
- Intact, small-diameter TRIGA fuel will be critically-safe ($k_{eff} \leq 0.95$) at four elements per TRIGA Bucket compartment for all addressed conditions, if the bucket is constructed as indicated below and if the elements satisfy one of the last two descriptions in Table 21.
- TRIGA Bucket walls must be constructed from nominal 12 in. schedule 10 stainless steel pipe. Smaller diameters and/or thicker walls are acceptable.
- TRIGA Bucket dividers must be constructed from nominal $\frac{1}{8}$ in. thick stainless steel for a maximum 24 compartments per bucket. Thicker divider walls are acceptable.
- TRIGA fuel in one DPC is essentially isolated from TRIGA fuel in an adjacent identical DPC, with or without concrete dividers.
- BER-TRIGA fuel is not addressed.

MIXED DPC ARRAYS

Storage operations can be simplified when differently loaded DPCs can be mixed in an array. Although these calculations do not model such arrays, results for arrays of identical DPCs indicate, in most cases, fuel within one DPC is neutronically isolated, or nearly isolated, from fuel in an adjacent DPC. Where interaction appears to be more than 1σ , k_{eff} s are relatively low.

Based on experience with different fuel arrays elsewhere, mixed DPC arrays should be critically safe because:

- If water reflected, optimally moderated DPC k_{eff} s are near but do not exceed 0.95, interaction between different DPCs should be no greater than interaction in an array of worst case, identical DPCs.
- If water reflected, optimally moderated DPC k_{eff} s are low (significantly less than 0.95), interaction between different DPCs is insufficient to raise the array k_{eff} above 0.95.

REFERENCES

- 1 "NUHOMS®-52B Dry Shielded Canister," *Vectra Technical Bulletin* (Seattle, Washington: Vectra Technologies, Inc., no date).
- 2 NUH-003 (Rev. 2), *Safety Analysis Report for the Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel*, Vol. I, Vectra Technologies, Inc., Seattle, Washington (November 1993).
- 3 NUH-05-151 (Rev. 1), *Safety Analysis Report for the NUHOMS®-MPI87 Multi-Purpose Cask*, Vectra Technologies, Inc., Seattle, Washington (February 1995).
- 4 "NUHOMS®-24P Dry Shielded Canister," *Vectra Technical Bulletin* (Seattle, Washington: Vectra Technologies, Inc., no date).
- 5 Project 020825 TBA (Draft), Daryl A. Lopez, "Criticality, Thermal, and Shielding Analysis of DTC Fuel," *MC&IE Department Task Baseline Agreement* (Idaho Falls, Idaho: Lockheed Idaho Technologies Company, April 9 and 30, 1996).
- 6 Gulf-GA-D12455, W. W. Hudritsch, W. J. Scheffel, and O. M. Stansfield, *Preirradiation Characterization of Material for the Fort St. Vrain HTGR Core Surveillance Program*, Gulf General Atomic (March 1973).
- 7 CSS-92-021, Brian [M.] Palmer, "Criticality Safety Issues Associated with the Burial of Highly Enriched Nuclear Fuel in a Geologic Repository" (Idaho Falls, Idaho: Westinghouse Idaho Nuclear Company, Inc., December 1992).
- 8 INEL-96/096, Kenneth B. Woods, "Criticality Safety Evaluation for Mixed Canisters of Fuels in the Irradiated Fuel Storage Facility" (Idaho Falls, Idaho: Lockheed Idaho Technologies Company, April 1996).
- 9 LA-12625-M, Judith F. Briesmeister (editor), *MCNP - A General Monte Carlo N-Particle Transport Code*, Los Alamos National Laboratory, Los Alamos, New Mexico (November 1993).
- 10 ACNP-63016, "Pathfinder Atomic Power Plant Technical Progress Report: January 1963 - March 1963" (Allis-Chalmers Manufacturing Company, June 1963).
- 11 ACNP-65599, P. S. Lacey, et. al., "Pathfinder Atomic Power Plant Boiler Core and Full Core Critical Experiments" (Allis-Chalmers Manufacturing Company, August 1966).
- 12 ACNP-65531, "Pathfinder Atomic Power Plant Technical Progress Report: April 1964 - June 1964" (Allis-Chalmers Manufacturing Company, April 1965).

- 13 INEL-95/228 (Rev. 1), D[eborah] J. Henrikson, "Criticality Safety Evaluation for Pathfinder in Divided Buckets, Revision 1" (Idaho Falls, Idaho: Lockheed Idaho Technologies Company, February 1996).
- 14 CCC-545 (version 4.0), *SCALE4, A Modular Code System for Performing Standardized Computer Analyses for Licensing Evaluation*, RSIC Computer Code Collection, Oak Ridge National Laboratory, Oak Ridge, Tennessee (1993).
- 15 SDD 4.2, M. J. Mortenson, "Reactor Core System," *PBF System Design Description* (Idaho Falls, Idaho: EG&G Idaho, Inc., approved March 1976).
- 16 NRRT-N-91-015, V[irginia] F. Dean, "Criticality Safety Analysis of the PBF Temporary Underwater Fuel Storage Racks with Reduced Cadmium" (Idaho Falls, Idaho: EG&G Idaho, Inc., April 1991).
- 17 Fast-7-84, E[dwin] Fast letter to R[obert] E. Wilson, "CSE for LWBR Vault Storage" (Idaho Falls, Idaho: Westinghouse Idaho Nuclear Company, Inc., March 6, 1984.)
- 18 Fast-30-86, E[dwin] Fast letter to G[erald] T. Paulson, "Vault Storage of LWBR Type Loose Rods and Cut Pieces" (Idaho Falls, Idaho: Westinghouse Idaho Nuclear Company, Inc., December 22, 1986).
- 19 DXH-02-94, D[eborah] J. Henrikson letter to B[rian] M. Palmer, "Shippingport PWR Geologic Disposal" (Idaho Falls, Idaho: Westinghouse Idaho Nuclear Company, Inc., April 5, 1994).
- 20 "Research, Test and Experimental Reactors," *Directory of Nuclear Reactors*, Vol. II, International Atomic Energy Agency, Vienna, Austria (1959): pp. 243-248.
- 21 GA-C18542, N. Tomsio, "Characterization of TRIGA Fuel" (San Diego, California: GA Technologies, Inc., October 1986).
- 22 WINCO-1215, B[rian] M. Palmer, "Unclassified Fuels in the CPP-603 Fuel Storage Basins" (Idaho Falls, Idaho: Westinghouse Idaho Nuclear Company, Inc., March 1994).

Appendix F

DPC Optimization and Loading Study

Appendix F

DPC Optimization and Loading Study

The fuel to be processed in the DTC is given in Table F-1. The following criteria were used to determine the design for DPC baskets and canisters to handle the fuel in Table 1:

- Use the Vectra PWR FO-DSC or FC-DSC style DPC (Vectra drawing NUH-05-4004NF) if possible so the MP-187 cask and its handling equipment (to be purchased for the TMI core debris canisters storage project) may also be used for the DTC system.
- If PWR FO-DSC or FC-DSC style DPCs can be used, avoid specifying standard NUHOMS 52-B DPCs (BWR DPC) and baskets because they cannot be placed in the MP-187 cask (the BWR DPC would require that a new OS-197 cask system be purchased).
- Store SNF in the smallest number of DPCs practical (because the per-canister cost for future transportation, handling, and ultimate disposal is expected to be very high).
- Avoid using borated neutron absorbing material in the storage baskets and buckets if possible, but use it if necessary to increase the loading efficiency and decrease the number of DPCs.
- Limit the number of different DPC basket designs to reduce design, fabrication, setup, and tooling/inspection charges.
- Limit the number of different bucket and welded-can designs to reduce design, fabrication, setup, and tooling/inspection charges.
- Place each level of FHU in a separate basket or bucket cell to avoid binding or "jackstrawing" FHUs with one another.

Based on these criteria, the following storage items were specified or designed for the DTC storage canister system :

1. DPC:
 - a. The Vectra PWR FO-DSC
2. Baskets:
 - a. A 14-Tube basket (14, 13-in. diameter round tubes) derived from previous concept work done by the Fluor Daniel Inc., for the INEL aluminum-clad fuel.
 - b. A 7-Tube basket (with hexagonal tubes) designed specifically for the 744 FSVR fuel blocks. This is also used for the Pathfinder FHUs in special 14-in. diameter buckets.

- c. A 3-Tube basket (three, 26-in. diameter round tubes) designed specifically for the 48, 25.5-in. diameter canisters currently stored in ICPP 749 that each contain a Shippingport LWBR FHU.
3. Buckets:
- a. 12-in. Schedule-10 SST buckets (for use in the 14-tube basket)
- Thirteen different buckets (comprising four different lengths and nine different cruciform designs) are used for all fuel in Table F-1 except Peach Bottom, Shippingport LWBR, FSVR, and Pathfinder.
- b. 14-in. Schedule-10 SST buckets (for use in the 7-tube FSVR basket)
- One bucket style is used for the Pathfinder FHUs. The bucket is 103 in. long and has a square, single-cell cruciform used to store Pathfinder FHUs in the 7-tube FSVR basket. Two FSVR fuel blocks can be stacked above each Pathfinder bucket in each basket cell.
4. 12-in. Schedule-10 SST Cans
- a. Two buckets styles (both 166-in. long and using two of the nine cruciform styles from 3-a above) are used for canning the Peach Bottom fuel in the DTC canning/welding station.

Results

The above criteria have been met. The NUHOMS PWR FO-DSC has been specified for all fuel because all three baskets will fit into it. Therefore, the OS-197 cask does not have to be purchased. The basket and bucket designs were held to a minimum while loading as efficiently as possible. The number of different baskets has been limited to three, the number of buckets to 14, and the number of cans to two. The bucket lengths have been designed to allow efficient stacking of different mixes of fuel in the same DPC (for small-volume fuel or partial loads left over after loading large-volume fuels in multi-DPCs). The total number of DPCs for all fuel in Table F-1 has been held to less than 80. Preliminary criticality analyses done on approximately 90% of the fuel in Table F-1 show that none of that fuel will require the addition of neutron-absorbing poison. With this design, each FHU is contained in its own cell so that no jackstrawing or binding can occur.

Thermal and shielding calculations are being run on fuel loading configurations representing approximately 90% of the fuel in Table F-1. The calculations are being run for DTC lag storage, for the DPCs loaded in the MP-187 cask, and for the DPCs loaded in the NUHOMS® precast concrete storage modules. Results of those analyses could require some reduced loading efficiency, and increase the number of components and DPCs required.

In addition, structural analyses have yet to be done on these configurations. It is anticipated that if changes are needed to meet the structural analyses, they will be minor (e.g., small increases in cruciform thickness) and will not affect the loading efficiency. Also, to achieve the number of DPCs postulated,

NRC licenses must be obtained for all DPC loadings, including those having mixes of different kinds of fuel in the same DPC.

Table F-1. Fuel to be processed in the DTC.

SNF_NAME	FHU 2035	HEIGHT (in)	WIDTH (in)	LEN. (in)	DHB LENGTH	DHB CELLS	LAYERS/ DHB	FHU/DHB	DHBs	FHU PER DPC	NUHOMS DPC & LOADING	NO. OF DPCs
ACRR ELEMENTS	256	0.00	0.00	0.00				NA	NA			1.00
ACRR EXPERIMENTS	1	0.00	0.00	0.00				NA	NA			*
ARKANSAS	3	0.00	0.00	0.00				NA	NA			*
CANDU *	3		5.00	168.0	1	NA	1	NA	NA	52	BWR DPC, 1 layer	0.06
CANDU *	3	0.00	3.50	12.0	4	7	3	21	1.00	1176	14-Tube, 12 layers	0.00
CP-5 CONVERTER CYLINDER	2	0.00	0.00	0.0				NA	NA			*
DRESDEN *	23	4.40	4.40	135.0	1	2	1	2	12.00	28	14-Tube, 1 layer	0.82
DRESDEN *	1	4.40	4.40	135.0	1	2	1	2	1.00	28	14-Tube, 1 layer	0.04
DRESDEN *	4	4.40	4.40	135.0	1	2	1	2	2.00	28	14-Tube, 1 layer	0.14
DRESDEN I REACTOR FUEL	2	0.00	0.00	0.00				NA	NA			*
FRR/TRIGA ***	4940	0.00	1.48	30.00	4	24	1	24	206.00	1344	14-Tube, 5 layers	3.68
FSVR	744	16.32	14.17	31.22	NA	NA	NA	NA	NA	35	FSV Basket/special	21.26
PATHFINDER	7	9.62	9.62	84.00	1.62	1	1	1	7.00	7	FSV Basket	0.62
PBF DRIVER CORE	60		8.63	60.00	1.25		2	2	30.00	28	14-Tube DPC, 3	1.71
PULSTAR - BUFFALO	24	3.00	3.00	28.00	5	5	1	5	5.00	350	14-Tube DPC, 4	0.07
PULSTAR-N.C. STATE UNIV.	34	2.74	3.15	37.98	1.25	5	3	15	3.00	263	14-Tube, 4 layers	0.13
PULSTAR-SUNY-BUFFALO	43	2.74	3.15	38.00	1.25	5	3	15	3.00	263	14-Tube, 4 layers	0.16
SHIPPINGPORT LWBR	48	0.00	25.50	158.0	NA	NA	1	NA	NA	3	Three, 25.57 in. dia	16.00
SHIPPINGPORT PWR-C1-S4	1	5.5**	5.5**	104.5	1.25	1	1	1	1.00	14	14-Tube, 1 layer	0.06
SHIPPINGPORT PWR-C2-S1	19	7.38	7.38	104.5	1.25	1	1	1	19.00	14	14-Tube, 1 layer	1.09
SHIPPINGPORT PWR-C2-S2	20	7.38	7.38	104.5	1.25	1	1	1	20.00	14	14-Tube, 1 layer	1.14
TREAT	390	3.96	3.96	96.00	1.25	4	1	4	98.00	56	14-Tube, 1 layer	5.57
TRIGA BER-II (GERMANY)	21	3.15	2.99	36.80	4	5	1	5	4.20	280	14-Tube, 4 layers	0.08
TRIGA CONV. PENN STATE	241	0.00	1.48	28.31	5	24	1	24	10.04	1680	14-Tube, 5 layers	0.14
TRIGA CONV./ARRR	91	0.00	1.38	28.37	5	24	1	24	3.79	1680	14-Tube, 5 layers	0.05
TRIGA FLIP *	2	0.00	3.80	30.00	4	4	1	4	0.50	224	14-Tube DPC, 5	0.01
TRIGA FLIP/OSU	91	0.00	1.48	28.58	5	24	1	24	3.79	1680	14-Tube, 5 layers	0.05
TRIGA FLIP/TEXAS A & M	101	0.00	1.48	30.00	4	24	1	24	4.21	1344	14-Tube, 5 layers	0.08
TRIGA FLIP/U.OF WI	101	0.00	1.48	30.00	4	24	1	24	4.21	1344	14-Tube, 5 layers	0.08
TRIGA FLIP/WASH.STATE UNI	78	0.00	1.48	30.00	4	24	1	24	3.25	1344	14-Tube, 5 layers	0.06
TRIGA SST	296	0.00	1.48	28.31	5	24	1	24	12.33	1680	14-Tube, 5 layers	0.18

Table F-1. (Continued).

SNF_NAME	FHU 2035	HEIGHT (in)	WIDTH (in)	LEN. (in)	DHB LENGTH	DHB CELLS	LAYERS/ DHB	FHU/DHB	DHBs	FHU PER DPC	NUHOMS DPC & LOADING	NO. OF DPCs
TRIGA UNIV. OF ILLINOIS	305	0.00	1.48	28.31	5	24	1	24	12.71	1680	14-Tube, 5 layers	0.18
TRIGA-CORNELL	165	0.00	1.48	28.31	5	24	1	24	6.88	1680	14-Tube, 5 layers	0.10
TRIGA-FLIP	61	0.00	1.48	30.00	4	24	1	24	2.54	1344	14-Tube, 5 layers	0.05
TRIGA-FLIP/GA	117	0.00	1.48	30.00	4	24	1	24	4.88	1344	14-Tube, 5 layers	0.09
TRIGA/AFRRI	95	0.00	1.48	28.31	5	24	1	24	3.96	1680	14-Tube, 5 layers	0.06
TRIGA/DOW	78	0.00	1.48	28.31	5	24	1	24	3.25	1680	14-Tube, 5 layers	0.05
TRIGA/GA	155	0.00	1.48	28.31	5	24	1	24	6.46	1680	14-Tube, 5 layers	0.09
TRIGA/KANSAS STATE UNIV.	191	0.00	1.48	28.31	5	24	1	24	7.96	1680	14-Tube, 5 layers	0.11
TRIGA/MCCLELLAN AFB	90	0.00	1.48	28.31	5	24	1	24	3.75	1680	14-Tube, 5 layers	0.05
TRIGA/OSU	99	0.00	1.48	28.31	5	24	1	24	4.13	1680	14-Tube, 5 layers	0.06
TRIGA/REED COLLEGE	67	0.00	1.48	28.31	5	24	1	24	2.79	1680	14-Tube, 5 layers	0.04
TRIGA/TEXAS A & M	85	0.00	1.48	28.31	5	24	1	24	3.54	1680	14-Tube, 5 layers	0.05
TRIGA/TEXAS A & M	28	0.00	0.00	0.00	5	24	1	24	1.17	1680	14-Tube, 5 layers	*
TRIGA/UNIV. OF ARIZONA	98	0.00	1.47	28.47	5	24	1	24	4.08	1680	14-Tube, 5 layers	0.06
TRIGA/UNIV. OF MARYLAND	186	0.00	1.48	28.31	5	24	1	24	7.75	1680	14-Tube, 5 layers	0.11
TRIGA/UNIV. OF UTAH	225	0.00	1.48	28.31	5	24	1	24	9.38	1680	14-Tube, 5 layers	0.13
TRIGA/UNIV. OF WISCONSIN	127	0.00	1.48	28.31	5	24	1	24	5.29	1680	14-Tube, 5 layers	0.08
TRIGA/UNIV. OF WISCONSIN	28	0.00		0.00	5	24	1	24	1.17	1680	14-Tube, 5 layers	*
TRIGA/UNIV. OF CAL-IRVINE	113	0.00	1.48	28.00	5	24	1	24	4.71	1680	14-Tube, 5 layers	0.07
TRIGA/UNIV. OF	158	0.00	1.48	28.31	5	24	1	24	6.58	1680	14-Tube, 5 layers	0.09
TRIGA/USGS	200	0.00	1.48	28.31	5	24	1	24	8.33	1680	14-Tube, 5 layers	0.12
TRIGA/VA	56	0.00	1.48	28.31	5	24	1	24	2.33	1680	14-Tube, 5 layers	0.03
TRIGA/WASH.STATE UNIV.	327	0.00	1.48	28.31	5	24	1	24	13.63	1680	14-Tube, 5 layers	0.19
PEACH BOTTOM CORE 1	18	0.00	3.5	144	1	4	1	4	5.00	56	14-Tube, 1 layers	0.32
PEACH BOTTOM CORE 1	796	0.00	3.5	144	1	4	1	4	199.00	56	14-Tube, 1 layers	14.21
PEACH BOTTOM CORE 2	786	0.00	3.5	126	1	7	1	7	113.00	98	14-Tube, 1 layers	8.02
									899		TOTAL	78.63

Appendix G
Cost Estimate Summary

COST ESTIMATE SUMMARY

Rev01-96

Project	<u>SNF DRY STORAGE PROJECT</u>	Type of Est	<u>Conceptual</u>	Date	<u>06/17/96</u>
		File No	<u>2314-B</u>	Chk'd By	<u></u>
Requester	<u>INEL / ICPP</u>	Prep'd By	<u>S.M. Bradford</u>	Appr'd By	<u></u>

	Unescalated	Escalation	Totals
ENGINEERING, DESIGN AND INSPECTION			
		10% of Construction Costs and GFE	
Title I and II Design	<u>3,357,000</u>	<u>276,000</u>	
Title III Inspection	<u>684,000</u>	<u>114,000</u>	
MANAGEMENT			<u>15,252,000</u>
Project Management	<u>11,211,000</u>	<u>2,331,000</u>	
Construction Management	<u>1,489,000</u>	<u>221,000</u>	
CONSTRUCTION			<u>17,061,000</u>
Div 1 General Requirements	<u>625,000</u>	<u>98,000</u>	
Div 2 Sitework	<u>1,582,000</u>	<u>260,000</u>	
Div 3 Concrete	<u>4,315,000</u>	<u>677,000</u>	
Div 4 Masonry	<u>426,000</u>	<u>66,000</u>	
Div 5 Metals	<u>891,000</u>	<u>133,000</u>	
Div 6 Wood and Plastics			
Div 7 Moisture Protection	<u>117,000</u>	<u>17,000</u>	
Div 8 Doors and Windows	<u>388,000</u>	<u>58,000</u>	
Div 9 Finishes	<u>310,000</u>	<u>46,000</u>	
Div 10 Specialties	<u>30,000</u>	<u>4,000</u>	
Div 11 Equipment	<u>1,486,000</u>	<u>222,000</u>	
Div 12 Furnishings	<u>11,000</u>	<u>2,000</u>	
Div 13 Special Construction			
Div 14 Conveying Systems	<u>622,000</u>	<u>93,000</u>	
Div 15 Mechanical	<u>2,009,000</u>	<u>300,000</u>	
Div 16 Electrical	<u>1,969,000</u>	<u>304,000</u>	
GOV'T FURNISHED EQUIPMENT	<u>34,149,000</u>	<u>9,338,000</u>	<u>43,487,000</u>
PROCUREMENT FEES	<u>734,000</u>	<u>180,000</u>	<u>914,000</u>
G&A	<u>3,120,000</u>	<u>691,000</u>	<u>3,811,000</u>
SUBTOTAL			<u>84,956,000</u>
PROJECT CONTINGENCY		18% of Subtotal	<u>15,044,000</u>
Management Reserve	<u>5,248,000</u>	<u>1,280,000</u>	
Contingency	<u>8,516,000</u>		
TOTAL ESCALATION		<u>16,711,000</u>	

TOTAL ESTIMATED COST:

\$100,000,000

COST ESTIMATE SUMMARY

Rev 01-96

Project	<u>SNF DRY STORAGE PROJECT</u>	Type of Est	<u>Conceptual</u>	Date	<u>06/17/96</u>
	<u>DRY TRANSFER CELL</u>	File No	<u>2314-B</u>	Chk'd By	<u></u>
Requester	<u>R. C. HILL</u>	Prep'd By	<u>S.M. Bradford</u>	Appr'd By	<u></u>

	Unescalated	Escalation	Totals
ENGINEERING, DESIGN AND INSPECTION		18% of Construction Costs and GFE	<u>3,985,000</u>
Title I and II Design	<u>3,153,000</u>	<u>246,000</u>	
Title III Inspection	<u>510,000</u>	<u>76,000</u>	
MANAGEMENT			<u>6,565,000</u>
Project Management	<u>4,481,000</u>	<u>545,000</u>	
Construction Management	<u>1,339,000</u>	<u>200,000</u>	
CONSTRUCTION			<u>13,787,000</u>
Div 1 General Requirements	<u>449,000</u>	<u>67,000</u>	
Div 2 Sitework	<u>674,000</u>	<u>101,000</u>	
Div 3 Concrete	<u>3,080,000</u>	<u>461,000</u>	
Div 4 Masonry	<u>322,000</u>	<u>48,000</u>	
Div 5 Metals	<u>891,000</u>	<u>133,000</u>	
Div 6 Wood and Plastics			
Div 7 Moisture Protection	<u>117,000</u>	<u>17,000</u>	
Div 8 Doors and Windows	<u>388,000</u>	<u>58,000</u>	
Div 9 Finishes	<u>310,000</u>	<u>46,000</u>	
Div 10 Specialties	<u>30,000</u>	<u>4,000</u>	
Div 11 Equipment	<u>1,486,000</u>	<u>222,000</u>	
Div 12 Furnishings	<u>11,000</u>	<u>2,000</u>	
Div 13 Special Construction			
Div 14 Conveying Systems	<u>622,000</u>	<u>93,000</u>	
Div 15 Mechanical	<u>2,009,000</u>	<u>300,000</u>	
Div 16 Electrical	<u>1,606,000</u>	<u>240,000</u>	
GOV'T FURNISHED EQUIPMENT	<u>7,504,000</u>	<u>748,000</u>	<u>8,252,000</u>
PROCUREMENT FEES	<u>292,000</u>	<u>44,000</u>	<u>336,000</u>
G&A	<u>1,220,000</u>	<u>122,000</u>	<u>1,342,000</u>
SUBTOTAL			<u>34,267,000</u>
PROJECT CONTINGENCY		20% of Subtotal	<u>6,733,000</u>
Management Reserve	<u>2,063,000</u>	<u>309,000</u>	
Contingency	<u>4,361,000</u>		
TOTAL ESCALATION		<u>4,082,000</u>	

TOTAL ESTIMATED COST:

\$41,000,000

DETAILED COST ESTIMATE SHEET

Rev 10-94

Project SNF DRY STORAGE PROJECT
DRY TRANSFER CELL
 Location INEL/ICPP
 Requester R. C. HILL

Type of Est. Conceptual
 Source (E) Eng. Est.
 (V) Vendor
 (P) Pur. Order
 (H) Handbook Ref.

File No. 2314-B Date 06/14/96
 Prep'd By S.M. Bradford

ACCT. NO.	DESCRIPTION	E.V, P,H	MAT'L UNIT	MAT'L UT. COST	UNIT LAB. HRS	TOTAL LAB. HRS.	LABOR RATE	LABOR COST	MAT'L COST	OH&P COST	TOTAL COST
DIV 1	GENERAL REQUIREMENTS										
	Supervision / Project Management - 1 FTE		27 mnths		173	4,671	40.00	186,840		56,052	242,892
	Safety Supervision - .25 FTE		27 mnths		43	1,168	40.00	46,710		14,013	60,723
	Training		30 ea		60	1,800	40.00	72,000		21,600	93,600
	Construction Fence		4,000 ft	10	complete				40,000	12,000	52,000
	TOTAL DIV 1 - GENERAL REQUIREMENTS					7,639		305,550	40,000	103,665	449,215
DIV 2	SITEWORK										
	Clear and Grub		105,500 sf	0.4	complete				42,200	12,660	54,860
	Build Up Area - Pit Run		4,000 cy	17	complete				68,000	20,400	88,400
	6" Crushed Gravel Subbase		870 cy	35	complete				30,450	9,135	39,585
	Asphalt - 4" - 24,000 SF		580 tons	60	complete				34,800	10,440	45,240
	Building Excavation / Backfill		4,200 cy	16	complete				67,200	20,160	87,360
	Trench Excavation and Backfill		6,500 cy	20.3	complete				131,950	39,585	171,535
	Fire Water Pipe -- Includes Hydrants, PIVs, etc		1,200 ft	40	complete				48,000	14,400	62,400
	Potable Water Pipe - 2" CS w/ Valving		100 ft	29.13	complete				2,913	874	3,787
	Sewer Pipe - 8" ABS w/ 1 Manhole		400 ft	46.03	complete				18,412	5,524	23,936
	Service Waste - 2" CS		100 ft	28.83	complete				2,883	865	3,748
	Steam Piping - 2" CS w/ Valving		100 ft	19.84	complete				1,984	595	2,579
	High Pressure Air Pipe - 2" CS		100 ft	7.27	complete				727	218	945
	Remove Existing Security Fence		1,200 ft	17	complete				20,400	6,120	26,520
	Mob and Demob		1 lot							61,089	61,089
	Storm Water Pollution Prevention Plan		1 lot	500	40	40	35.00	1,400	500	570	2,470
	TOTAL DIV 2 - SITEWORK							1,400	470,419	202,635	674,454

Type of Est. ConceptualFile No. 2314-BDate 06/14/96Project SNF DRY STORAGE PROJECT
DRY TRANSFER CELL

ACCT. NO.	DESCRIPTION	E,V, P,H	MAT'L UNIT	MAT'L UT. COST	UNIT LAB. HRS	TOTAL LAB. HRS.	LABOR RATE	LABOR COST	MAT'L COST	OH&P COST	TOTAL COST
DIV 3	CONCRETE										
	Footings / Foundation / Grade Beams		1,034 cy	65	0.4	414	32.67	13,512	67,210	24,217	104,939
	Reinforcing		96,295 lb	0.2	0.008	578	32.67	18,876	19,259	11,440	49,575
	Formwork		9,984 sf	0.45	0.05	499	32.67	16,309	4,493	6,240	27,042
	Slabs / Pads		739 cy	65	0.495	366	32.67	11,951	48,035	17,996	77,982
	Reinforcing		70,769 lb	0.2	0.008	425	32.67	13,872	14,154	8,408	36,434
	Mechanically Place		739 cy	25	complete				18,475	5,543	24,018
	Hot Cell		4,388 cy	65					285,220	85,566	370,786
	Snap Ties and Grout Holes		20,744 sf	1.5	complete				31,116	9,335	40,451
	Reinforcing		279,105 lb	0.2	0.008	2,233	32.67	72,947	55,821	38,630	167,398
	Formwork		41,488 sf	0.66	0.087	3,609	32.67	117,921	27,382	43,591	188,894
	Mechanically Place		4,388 cy	51	complete				223,788	67,136	290,924
	Roof Decks		273 cy	65	0.704	192	32.67	6,279	17,745	7,207	31,231
	Reinforcing		15,038 lb	0.2	0.008	120	32.67	3,930	3,008	2,081	9,019
	Formwork		11,034 sf	0.45	0.18	1,986	32.67	64,887	4,965	20,956	90,807
	Mechanically Place		273 cy	25	complete				6,825	2,048	8,873
	2nd, 3rd, 4th Floor Decks		96 cy	65	0.704	68	32.67	2,208	6,240	2,534	10,982
	Reinforcing		9,212 lb	0.2	0.007	64	32.67	2,107	1,842	1,185	5,134
	Mechanically Place		96 cy	25	complete				2,400	720	3,120
	Columns		64 cy	65	1.806	116	32.67	3,776	4,160	2,381	10,317
	Reinforcing		53,191 lb	0.2	0.008	426	32.67	13,902	10,638	7,362	31,902
	Formwork		7,128 sf	0.66	0.087	620	32.67	20,260	4,704	7,489	32,454
	Mechanically Place		64 cy	25	complete				1,600	480	2,080
	SUBTOTAL CONCRETE THIS PAGE					11,715		382,736	859,081	372,545	1,614,362

DETAILED COST ESTIMATE (CONT.SHEET)

Type of Est. ConceptualFile No. 2314-BDate 06/17/96

Project SNF DRY STORAGE PROJECT
DRY TRANSFER CELL

ACCT. NO.	DESCRIPTION	E,V, P,H	MAT'L UNIT	MAT'L UT. COST	UNIT LAB. HRS	TOTAL LAB. HRS.	LABOR RATE	LABOR COST	MAT'L COST	OH&P COST	TOTAL COST
	Walls in Cask Handling Area		851 cy	65					55,315	16,595	71,910
	Snap Ties and Grout Holes		21,364 sf	1.5	complete				32,046	9,614	41,660
	Reinforcing		90,773 lb	0.2	0.008	726	32.67	23,724	18,155	12,564	54,443
	Formwork		42,728 sf	0.66	0.087	3,717	32.67	121,445	28,200	44,894	194,540
	Mechanically Place		851 cy	51	complete				43,401	13,020	56,421
	Allowance for Block-Out		1 bt	100,000					100,000	30,000	130,000
	Finishing		23,525 sf	0.2	0.0165	388	32.67	12,681	4,705	5,216	22,602
	Concrete Dressing		5 bt		40	200	32.67	6,534		1,960	8,494
	Engineering - Shores / Forming		5 bt	1,500					7,500	2,250	9,750
	Weather Protection		5 bt	500	48	240	32.67	7,841	2,500	3,102	13,443
	Equipment - Manlifts - cost for 12 months		3 ea		12	36	5500.00	198,000		59,400	257,400
	Equipment - Cranes - cost for 6 months		2 ea		6	12	10000.00	120,000		36,000	156,000
	Equipment - Forklift - cost for 12 months		2 ea		12	24	6000.00	144,000		43,200	187,200
	8" Hollow Core Panels		9,984 sf	5	complete				49,920	14,976	64,896
	6' x 3' Prestressed Girder		420 ft	90	complete				37,800	11,340	49,140
	12" deep x 4' Double Tees		840 sf	5	complete				4,200	1,260	5,460
	Ductbarks w/ Manholes		600 ft	95	complete				57,000	17,100	74,100
	Pads		200 cy	150	complete				30,000	9,000	39,000
	Stairs, Stoops, etc		50 cy	450	complete				22,500	6,750	29,250
	SUBTOTAL CONCRETE THIS PAGE					5,344		634,226	493,242	338,240	1,465,708
	SUBTOTAL PREVIOUS PAGE					11,715		382,736	859,081	372,545	1,614,362
	TOTAL DIV 3 - CONCRETE					17,059		1,016,962	1,352,323	710,785	3,080,070
DIV 4	MASONRY										
	8" Block Wall		17,700 sf	14	complete				247,800	74,340	322,140
	TOTAL DIV 4 - MASONRY								247,800	74,340	322,140

Type of Est. ConceptualFile No. 2314-BDate 06/14/96Project SNF DRY STORAGE PROJECT
DRY TRANSFER CELL

ACCT. NO.	DESCRIPTION	E,V, P,H	MAT'L UNIT	MAT'L UT. COST	UNIT LAB. HRS	TOTAL LAB. HRS.	LABOR RATE	LABOR COST	MAT'L COST	OH&P COST	TOTAL COST
DIV 5	METALS										
	Stairways		1 lot	45,000		400	36.00	14,400	45,000	17,820	77,220
	Platform, Walkways, etc		1 lot	67,500		560	36.00	20,160	67,500	26,298	113,958
	Metal Building - Columns		21 bn	1,500	complete				31,500	9,450	40,950
	Beams		18 bn	2,500	complete				45,000	13,500	58,500
	Roof Trusses/Joints		6,430 ft	6	0.07	450	36.00	16,204	38,580	16,435	71,219
	Skin		35,496 sf	7	complete				248,472	74,542	323,014
	Standing Seam Metal Roof		480 sf	10	complete				4,800	1,440	6,240
	Floor Deck		6,760 sf	1	0.009	61	36.00	2,190	7,842	3,010	13,041
	Parapet / Fascia		600 ft	37	0.663	398	36.00	14,321	22,200	10,956	47,477
	Roof Hatch		1 ea	500	4	4	36.00	144	500	193	837
	Embedded Train and Trolley Rails		264 ft	100	complete				26,400	7,920	34,320
	Bridge Crane Rails		370 ft	27	complete				9,990	2,997	12,987
	Materials Handling		1 lot	27,500	complete				27,500	8,250	35,750
	Electrical Feed-Throughs at Windows		4 ea	10,000	complete				40,000	12,000	52,000
	Guard Posts		16 ea	165	complete				2,640	792	3,432
	TOTAL DIV 5 - METALS					1,873		67,419	617,924	205,603	890,945
DIV 7	THERMAL AND MOISTURE PROTECTION										
	Exterior Wall Insulation - 3" batt w/ 1" rigid		35,496 sf	1	0.015	532	32.67	17,395	35,496	15,867	68,758
	Foundation Insulation		3,000 sf	0.68	0.012	36	32.67	1,176	2,040	965	4,181
	Roof Insulation		16,500 sf	1.29	0.015	248	32.67	8,086	21,285	8,811	38,182
	Modified 5-ply Cold Tar		16,500 sf	0.0314	0.008	132	32.67	4,312	518	1,449	6,280
	TOTAL DIV 7 - THERMAL AND MOISTURE PROTECTION					948		30,969	59,339	27,092	117,401

DETAILED COST ESTIMATE (CONT.SHEET)

Type of Est. Conceptual

File No. 2314-B

Date 06/14/96

Project SNF DRY STORAGE PROJECT

DRY TRANSFER CELL

ACCT. NO.	DESCRIPTION	E.V.	MAT'L	UNIT	COST	MAT'L UT.	UNIT LAB.	HRS	TOTAL LAB. HRS.	LABOR RATE	LABOR COST	MAT'L COST	OH&P COST	TOTAL COST
DIV 8	DOORS AND WINDOWS													
	Truck Door - 16 x 16		2 ea		7,200	complete						14,400	4,320	18,720
	Roll-Up Door - 16 x 20		1 ea		7,200	complete						7,200	2,160	9,360
	Cell Door - 16 x 20 - Shielded		1 ea		100,000	complete						100,000	30,000	130,000
	Personnel - 3 X 7 Exterior		11 ea		750		55	32.67	1,797		8,250	3,014		13,061
	Personnel - 3 X 7 Interior		20 ea		550		100	32.67	3,267		11,000	4,280		18,547
	Personnel - 3 X 7 Cell - Shielded		4 ea		3,000		64	32.67	2,091		12,000	4,227		18,318
	Personnel - 6 X 7		8 ea		2,000		96	32.67	3,136		16,000	5,741		24,877
*	Hot Cell Viewing Window		4 ea		25,000		400	32.67	13,068		100,000	33,920		146,988
	Windows		24 ea		207		43	32.67	1,411		4,968	1,914		8,293
	TOTAL DIV 8 - DOORS AND WINDOWS						758		24,770		273,818	89,577		388,165
DIV 9	FINISHES													
	3 5/8" Metal Studs - Walls		2,300 sf		0.29	0.019	44	32.67	1,428		667			2,723
	3 5/8" Metal Studs - Ceiling		2,000 sf		0.29	0.024	48	32.67	1,568		580			2,793
	Gypsum Board - Walls		8,200 sf		0.24	0.017	139	32.67	4,554		1,957			8,479
	Gypsum Board - Ceiling		2,000 sf		0.24	0.021	42	32.67	1,372		480			2,408
	Paint - Enamel/Latex		50,000 sf		0.3	complete					15,000	4,500		19,500
	Paint - Epoxy		34,000 sf		5	complete					170,000	51,000		221,000
	Sealed Concrete		19,000 sf		1	complete					19,000	5,700		24,700
	Tile Flooring		2,650 sf		1.875	0.038	101	32.67	3,290		4,969	2,478		10,736
	Ceramic Wall Tile		700 sf		4	0.067	47	32.67	1,532		2,800	1,300		5,632
	Vinyl/Wall Covering		3,000 sf		0.75	0.017	51	32.67	1,666		2,250	1,175		5,091
	Acoustical Ceiling Tile		1,300 sf		1.24	0.023	30	32.67	977		1,612	777		3,365
	Seamless Vinyl Flooring		350 sf		1.875	0.038	13	32.67	435		656	327		1,418
	Carpet		60 sy		20	0.14	8	32.67	274		1,200	442		1,917
	TOTAL DIV 9 - FINISHES						523		17,096		221,182	71,483		309,762

* Denotes Government Furnished Equipment (GFE) - Material cost shown is Subcontractor handling fee.

Date 06/14/96

Project SNF DRY STORAGE PROJECT
DRY TRANSFER CELL

[illegible]

DETAILED COST ESTIMATE (CONT.SHEET)

Date 06/14/98

Project SNF DRY STORAGE PROJECT
DRY TRANSFER CELL

[illegible]

* Denotes Government Furnished Equipment (GFE) - Material cost shown is Subcontractor handling fee.

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Type of Est. ConceptualFile No. 2314-BDate 06/14/96Project SNF DRY STORAGE PROJECTPrep'd By T. E. SivillDRY TRANSFER CELL

ACCT. NO.	DESCRIPTION	E,V, P,H	MAT'L UNIT	MAT'L UT. COST	UNIT LAB. HRS	TOTAL LAB. HRS.	LABOR RATE	LABOR COST	MAT'L COST	OH&P COST	TOTAL COST
DIV 15	MECHANICAL										
	Fire Protection System - Wet Pipe										
	Facility Support/Admin Area - Single Story		13,700 sf	2.00	Included				27,400	8,220	35,620
	Facility Support - High Bay Areas		7,500 sf	4.00	Included				30,000	9,000	39,000
	Cell Area - Extra Hazard Areas		3,300 sf	NOT REQUIRED							N/A
	Hepa Filter Deluge Systems		4.00 ea	5,000	Included				20,000	6,000	26,000
	1000 Gal. Hepa Filter Water Collection System		1.00 lot	25,000	Included				25,000	7,500	32,500
	Plumbing Systems										
	Water Closet		2.00 ea	380.00	10.00	20	36.04	721	760	444	1,925
	Urinal		1.00 ea	390.00	7.00	7	36.04	252	390	193	835
	Lavatory		4.00 ea	402.00	8.00	32	36.04	1,153	1,608	828	3,590
	Shower		3.00 ea	590.00	12.00	36	36.04	1,297	1,770	920	3,988
	Mop/Service Sink		1.00 ea	650.00	13.00	13	36.04	469	650	336	1,454
	Kitchen Sink		1.00 ea	480.00	11.00	11	36.04	396	480	263	1,139
	Laboratory Bench Sink		1.00 ea	420.00	8.00	8	36.04	288	420	212	921
	Electric Water Coolers		1.00 ea	520.00	6.00	6	36.04	216	520	221	957
	Emergency Eyewash/Shower		2.00 ea	620.00	12.00	24	36.04	865	1,240	631	2,736
	Hot Water Heater		1.00 ea	8,611	24.00	24	36.04	865	8,611	2,843	12,319
	Hose Reels - Truck Washdown		2.00 ea	700.00	3.00	6	36.04	216	1,400	485	2,101
	Floor Drains		3.00 ea	302.00	12.00	36	36.04	1,297	906	661	2,864
	Sanitary Sewer and Vent Main System		24,500 sf	2.50	Included				61,250	18,375	79,625
	Roof Drainage System with Overflow Drains		24,500 sf	1.50	Included				36,750	11,025	47,775
	Service Waste System										
	1000 Gal. Holding Tank w/Instruments, Controls		1 ea	25,000	Included				25,000	7,500	32,500
	Trench Drains		60 lf	65.00	1.00	60	36.04	2,162	3,900	1,819	7,881
	Steam and Condensate System		24,500 sf	5.00	Included				122,500	36,750	159,250
	Plant and Instrument Air Piping System		24,500 sf	2.00	Included				49,000	14,700	63,700
	SUBTOTAL MECHANICAL THIS PAGE					283		10,199	419,555	128,928	558,681

DETAILED COST ESTIMATE (CONT.SHEET)

Type of Est. ConceptualFile No. 2314-BDate 06/14/96

Project SNF DRY STORAGE PROJECT
DRY TRANSFER CELL

ACCT. NO.	DESCRIPTION	E,V, P,H	MAT'L UNIT	MAT'L UT. COST	UNIT LAB. HRS	TOTAL LAB. HRS.	LABOR RATE	LABOR COST	MAT'L COST	OH&P COST	TOTAL COST
	EQUIPMENT										
	AIR HANDLING UNITS										
	AHU-1, Bay Area Loading/Unloading 16,000 cfm		1 ea	36,000	36	36	34.58	1,245	36,000	11,173	48,418
	AHU-2 Anti-C, Prep Booth, Hot Cell 22,830 cfm		1 ea	45,000	40	40	34.58	1,383	45,000	13,915	60,298
	AHU-3, Hepa Filter Room 3,000 cfm		1 ea	10,000	24	24	34.58	830	10,000	3,249	14,079
	AHU-4, Fan Room 7,000 cfm		1 ea	8,000	24	24	34.58	830	8,000	2,649	11,479
	AHU-5, Office, & Support Areas 2,515 cfm		1 ea	10,000	24	24	34.58	830	10,000	3,249	14,079
	EXHAUST FANS										
	Hot Cell Hepa Filter EF-1 & EF-2, 20,000 cfm		2 ea	16,000	16	32	34.58	1,107	32,000	9,932	43,039
	Mech. Rm Hepa Filter EF-3 & EF-4, 4,800 cfm		2 ea	4,500	16	32	34.58	1,107	9,000	3,032	13,139
	Toilet Rm's. and Jan. Closet, EF-6 & 7		2 ea	2,000	8	16	34.58	553	4,000	1,366	5,919
	HEPA FILTER										
**	Hepa Filters, F-1 & F-2		2 ea		16	32	125.00	4,000		1,200	5,200
**	Hepa Filters, F-3 & F-4		2 ea		16	32	125.00	4,000		1,200	5,200
	GLYCOL HEAT RECOVERY SYSTEM										
	(2) Coils, Pump, Expansion Tank, Piping, Valves, etc.		1 bt	75,000	320	320	34.58	11,066	75,000	25,820	111,885
	SUPPLEMENTAL COOLING SYSTEM										
	AC-1, -2 Air Cooled Cond. Unit, 15 ton, 7.5 ton		2 ea	4,500	16	32	34.58	1,107	9,000	3,032	13,139
	WC-1 Water Chiller/Condenser Unit, 40 ton		1 ea	30,300	88	88	34.58	3,043	30,300	10,003	43,346
	Crane To Set Equipment		1 bt		160	160	85.00	13,600		4,080	17,680
	SUBTOTAL MECHANICAL THIS PAGE					892		44,699	268,300	93,900	406,899

** HEPA Filter Housing will be purchased as GFE.

Type of Est. ConceptualFile No. 2314-BDate 06/14/96Project SNF DRY STORAGE PROJECTDRY TRANSFER CELL

ACCT. NO.	DESCRIPTION	E,V, P,H	MAT'L UNIT	MAT'L UT. COST	UNIT LAB. HRS	TOTAL LAB. HRS.	LABOR RATE	LABOR COST	MAT'L COST	OH&P COST	TOTAL COST
	AIR DISTRIBUTION SYSTEMS										
	TRUCK BAY - LOADING/UNLOADING										
	Exhaust Hose Reel Systems		2 ea	5,000	40	80	34.58	2,766	10,000	3,830	16,596
	Supply and Return Air Ductwork		2,600 sf	8	Included				20,800	6,240	27,040
	OA Intake Air Louver and Ductwork		1 ea	3,200	16	16	34.58	553	3,200	1,126	4,879
	OFFICE/SUPPORT AREAS/LABORATORY										
	OA Intake Air Louvers and Ductwork		30 sf	20	8	240	34.58	8,299	600	2,670	11,569
	Supply and Return Air Ductwork		12,900 sf	4	Included				51,600	15,480	67,080
	HOT CELL/TRANSFER CASK/HEPA FILTER AREAS										
	Supply Ductwork (Galv./SST)		9,000 sf	6	Included				54,000	16,200	70,200
	Supplemental Cooling Ductwork		2,000 lbs	0.6	0.12	240	34.58	8,299	1,200	2,850	12,349
	SST Exhaust Ductwork to Hepa Filters (12Ga.)		10,000 lbs	2	0.15	1,500	34.58	51,870	20,000	21,561	93,431
	SST Isolation Dampers		4 ea	4,500	4	16	34.58	553	18,000	5,566	24,119
	Galv. Exhaust Ductwork (10 Ga.) to Stack		5,000 lbs	0.6	0.12	600	34.58	20,748	3,000	7,124	30,872
	Isolation Dampers		10 ea	2500	6	60	34.58	2,075	25,000	8,122	35,197
	30" Dia. Stack		1 ea	32,000	Included				32,000	9,600	41,600
	18" Dia. Stack		1 ea	30,000	Included				30,000	9,000	39,000
	MISC. REFRIGERATION PIPING & INSULATION										
	Piping & Accessories to Air Cooled Condensers		1 lot	30,000	Included				30,000	9,000	39,000
	SUBTOTAL MECHANICAL THIS PAGE					2,752		95,164	299,400	118,369	512,933

Type of Est. ConceptualFile No. 2314-BDate 06/14/96
 Project SNF DRY STORAGE PROJECT
DRY TRANSFER CELL

ACCT. NO.	DESCRIPTION	E,V, P,H	MAT'L UNIT	MAT'L UT. COST	UNIT LAB. HRS	TOTAL LAB. HRS.	LABOR RATE	LABOR COST	MAT'L COST	OH&P COST	TOTAL COST
DIV 16	ELECTRICAL										
	Motor Control Center - 480V 800A		1 lot	125,000		200	31.60	6,320	125,000	39,396	170,716
	80 KVA UPS		1 lot	100,000	complete				100,000	30,000	130,000
	Distribution Panel - 480/277, 225A		5 ea	6,000	24	120	31.60	3,792	30,000	10,138	43,930
	Distribution Panel - 120/208, 100A		3 ea	2,000	20	60	31.60	1,896	6,000	2,369	10,265
	Distribution Panel - 120/208, 150A		1 ea	2,200	20	20	31.60	632	2,200	850	3,682
	45 KVA Dry Transformer - 480-208/120		1 ea	inc w/ mcc							
	25 KVA Dry Transformer - 480-208/120		3 ea	inc w/ mcc							
	Feeders to Motors		36 ea	550	28	1,008	31.60	31,853	19,800	15,496	67,149
	Feeders to Building		600 ft	29	0.778	467	31.60	14,751	17,400	9,645	41,796
	Standby Power		600 ft	13.5	0.364	218	31.60	6,901	8,100	4,500	19,502
	Feeders to Panels		9 ea	700	32	288	31.60	9,101	6,300	4,620	20,021
	Feeders for Misc Mechanical Equipment		15 ea	350	20	300	31.60	9,480	5,250	4,419	19,149
	Motor Starter - Size 1		6 ea	130	3	18	31.60	569	780	405	1,753
	Disconnect Switch - 250A		2 ea	708	6	12	31.60	379	1,416	539	2,334
	Disconnect Switch - 100A		1 ea	118	2	2	31.60	63	118	54	236
	System Testing and Checkout		1 lot	1,000		400	31.60	12,640	1,000	4,092	17,732
	Ground Loop		1 lot	5,000	complete				5,000	1,500	6,500
	Isolated Grounding System		1 lot	5,000	complete				5,000	1,500	6,500
	Cathodic Protection		1 lot	60,000	complete				60,000	18,000	78,000
	Lightning Protection		1 lot	22,500	complete				22,500	6,750	29,250
	SUBTOTAL ELECTRICAL THIS PAGE					3,113		98,377	415,864	154,272	668,513

Type of Est. ConceptualFile No. 2314-BDate 06/14/96Project SNF DRY STORAGE PROJECT
DRY TRANSFER CELL

ACCT. NO.	DESCRIPTION	E,V, P,H	MAT'L UNIT	MAT'L UT. COST	UNIT LAB. HRS	TOTAL LAB. HRS.	LABOR RATE	LABOR COST	MAT'L COST	OH&P COST	TOTAL COST
	Lighting - Includes Feeders										
	Admin Areas / Utility Support Rooms		13,500 sf	3	complete				40,500	12,150	52,650
	Programmable Lighting Controls		1 lot	20,000	complete				20,000	6,000	26,000
	Receptacles / Switches		20,000 sf	0.75	complete				15,000	4,500	19,500
	Welding Receptacle		1 ea	350	6	6	31.60	190	350	162	701
	High Bay Lighting - Includes Feeders		6,500 sf	6	complete				39,000	11,700	50,700
	Exit Lighting		8 ea	178	5	40	31.60	1,264	1,424	806	3,494
	Exterior Lighting		6 ea	725	10	60	31.60	1,896	4,350	1,874	8,120
	Hot Cell Lighting and Receptacles										
	Ceiling - 1000 W		20 ea	2,500	12	240	31.60	7,584	50,000	17,275	74,859
	Walls - 400 W		8 ea	1,075	10	80	31.60	2,528	8,600	3,338	14,466
	Emergency Lights		4 ea	750	4	16	31.60	506	3,000	1,052	4,557
	Gulton Receptacles		7 ea	12,000	4	28	31.60	885	84,000	25,465	110,350
	Feeders		39 ea	250	6	234	31.60	7,394	9,750	5,143	22,288
	CCTV - Cameras		11 ea	3,000	40	440	31.60	13,904	33,000	14,071	60,975
	CCTV - Monitors		4 ea	1,250	2	8	31.60	253	5,000	1,576	6,829
	CCTV - Recorders		2 ea	1,000	2	4	31.60	126	2,000	638	2,764
	CCTV - Quad Switches		3 ea	2,000	2	6	31.60	190	6,000	1,857	8,046
	CCTV - Camera Controls		3 ea	600	2	6	31.60	190	1,800	597	2,586
	CCTV - PTZ Controls		2 ea	900	2	4	31.60	126	1,800	578	2,504
	CCTV - 8 Channel Switch		2 ea	1,000	2	4	31.60	126	2,000	638	2,764
	CCTV - Cabling		5,400 ft	3.04	0.196	1,058	31.60	33,445	16,416	14,958	64,820
	Data Acquisition and Recording - See GFE										
	Cabling		4,200 ft	3.04	0.196	823	31.60	26,013	12,768	11,634	50,415
	Radiation Monitoring System - See GFE										
	Cabling		5,800 ft	1.52	0.098	568	31.60	17,961	8,816	8,033	34,811
	SUBTOTAL ELECTRICAL THIS PAGE					3,626		114,582	365,574	144,047	624,202

Type of Est. ConceptualFile No. 2314-BDate 06/14/96Project SNF DRY STORAGE PROJECT
DRY TRANSFERCELL

ACCT. NO.	DESCRIPTION	E,V, P,H	MAT'L UNIT	MAT'L UT. COST	UNIT LAB. HRS	TOTAL LAB. HRS.	LABOR RATE	LABOR COST	MAT'L COST	OH&P COST	TOTAL COST
	Seismic Detection System		1 lot	10,000	allowance				10,000	3,000	13,000
	Security System										
*	Argus Field Panel		1 ea	1,500	120	120	31.60	3,792	1,500	1,588	6,880
*	Remote Access Panel		12 ea	300	40	480	31.60	15,168	3,600	5,630	24,398
*	Remote Distribution Module		1 lot	7,500	complete				7,500	2,250	9,750
	Cabling		2,800 ft	3.04	0.098	274	31.60	8,671	8,512	5,155	22,338
	Interface to Host Computer -- CPP 1674		600 ft	12.8	complete				7,680	2,304	9,984
	Confined Space Entry at Man-holes		1 ea		4	4	31.60	126		38	164
	Fiber Optic / Telephone / Wire to Building		600 ft	11.5	0.214	128	31.60	4,057	6,900	3,287	14,245
	Confined Space Entry at Man-holes		8 ea		4	32	31.60	1,011		303	1,315
	Voice Paging, Fire Alarm and Evac System		1 lot	62,000	complete				62,000	18,600	80,600
	Voice / Data System		1 lot	6,000	complete				6,000	1,800	7,800
	LAN		1 lot	6,000	complete				6,000	1,800	7,800
	Intercom System		1 lot	15,000	complete				15,000	4,500	19,500
	Supervision		27 mnths		86.5	2,336	31.60	73,802		22,141	95,942
	SUBTOTAL ELECTRICAL THIS PAGE					3,374		106,628	134,692	72,396	313,716
	TOTAL DIV 16 -- ELECTRICAL					10,114		319,587	916,130	370,715	1,606,432

* Denotes Government Furnished Equipment (GFE) -- Material cost shown is Subcontractor handling fee.

Date 06/14/96

Project SNF DRY STORAGE PROJECT
DRY TRANSFER CELL

[illegible]

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Type of Est. Conceptual

File No. 2314-B

Date 06/14/96

Project

SNF DRY STORAGE PROJECT

DRY TRANSFER CELL

[illegible]

DETAILED COST ESTIMATE (CONT.SHEET)

Type of Est. ConceptualFile No. 2314-BDate 06/14/96Project SNF DRY STORAGE PROJECT
DRY TRANSFER CELL

ACCT. NO.	DESCRIPTION	E,V, P,H	MAT'L UNIT	MAT'L UT. COST	UNIT LAB. HRS	TOTAL LAB. HRS.	LABOR RATE	LABOR COST	MAT'L COST	OH&P COST	TOTAL COST
	ENGINEERING / DESIGN										
	Civil / Structural / Architectural		250 dwgs	5,000	complete			1,250,000			1,250,000
	Mechanical / Fire Protection		80 dwgs	5,000	complete			400,000			400,000
	Electrical / Life Safety		80 dwgs	5,000	complete			400,000			400,000
	Equipment		80 dwgs	5,000	complete			400,000			400,000
	Misc Studies		1 lot		7,500	7,500	74.00	555,000			555,000
	Design Reviews		2 ea		200	400	74.00	29,600			29,600
	Performance Specifications -- Equipment		8 ea		200	1,600	74.00	118,400			118,400
	INSPECTION										
	Title III Inspection		27 mnths		260	7,007	62.00	434,403			434,403
	Support -- Testing, Compaction		12 mnths		87	1,044	62.00	64,728			64,728
	Source Inspection		3 trips	2,000	24	72	62.00	4,464	6,000		10,464
	PROJECT MANAGEMENT										
	Project Management		57 mnths		375	21,375	74.00	1,581,750			1,581,750
	Project Suppt -- Cost Estimating, Quality, Safety, ESDC		57 mnths		225	12,825	74.00	949,050			949,050
	SAR		1 lot	600,000				600,000			600,000
	NRC Application		1 lot	500,000				500,000			500,000
	NRC Fee		1 lot	850,000					850,000		850,000
	CONSTRUCTION MANAGEMENT										
	Construction Coordination		27 mnth		75	2,025	61.00	123,525			123,525
	Field Engineer		27 mnth		375	10,125	56.00	567,000			567,000
	Construction Support		27 mnth		150	4,050	56.00	226,800			226,800
	CM Pool Account		1 lot			16,200	26.00	421,200			421,200

Rev 01-96

Project SNF DRY STORAGE PROJECT
DRY TRANSFER CELL
 Location INEL /ICPP
 Requestor R. C. HILL

Type of Est. Conceptual
 File No. 2314-B

Date 06/17/96
 Prep'd By S.M. Bradford

PROBABLE % VARIATION								PROJECT CONTINGENCY		SUMMARY
Cost Estimate Element	Unescalated Cost	% Total Cost	Prob % Var From Est		WT % of Prob		Contingency	%	Cost	Direct Cost with Contingency
			-	+	-	+				
Title I and II Design	3,153,000	9	5.00	15.00	0.46	1.38	1.20%	6.19%	417,000	3,570,000
Title III Inspection	510,000	1	5.00	15.00	0.07	0.22	0.19%	1.00%	67,000	577,000
Project Management	4,481,000	13	5.00	15.00	0.65	1.96	1.70%	8.80%	593,000	5,074,000
Construction Management	1,339,000	4	5.00	15.00	0.20	0.59	0.51%	2.63%	177,000	1,516,000
General Requirements	449,000	1	5.00	25.00	0.07	0.33	0.29%	1.49%	100,000	549,000
Sitework	674,000	2	5.00	30.00	0.10	0.59	0.52%	2.70%	182,000	856,000
Concrete	3,080,000	9	5.00	25.00	0.45	2.25	1.98%	10.24%	689,000	3,769,000
Masonry	322,000	1	5.00	25.00	0.05	0.23	0.21%	1.07%	72,000	394,000
Metals	891,000	3	5.00	25.00	0.13	0.65	0.57%	2.96%	199,000	1,090,000
Wood and Plastics										
Moisture Protection	117,000	0	5.00	25.00	0.02	0.09	0.08%	0.39%	26,000	143,000
Doors and Windows	388,000	1	5.00	25.00	0.06	0.28	0.25%	1.29%	87,000	475,000
Finishes	310,000	1	5.00	25.00	0.05	0.23	0.20%	1.03%	69,000	379,000
Specialties	30,000	0	5.00	25.00	0.00	0.02	0.02%	0.10%	7,000	37,000
Equipment	1,486,000	4	5.00	25.00	0.22	1.08	0.95%	4.94%	333,000	1,819,000
Furnishings	11,000	0	5.00	20.00	0.00	0.01	0.01%	0.03%	2,000	13,000
Special Construction										
Conveying Systems	622,000	2	5.00	20.00	0.09	0.36	0.32%	1.64%	111,000	733,000
Mechanical	2,009,000	6	5.00	25.00	0.29	1.47	1.29%	6.68%	450,000	2,459,000
Electrical*	1,606,000	5	5.00	25.00	0.23	1.17	1.03%	5.34%	359,000	1,965,000
GFE	7,504,000	22	5.00	25.00	1.09	5.47	4.82%	24.94%	1,679,000	9,183,000
Procurement Fees	292,000	1	5.00	20.00	0.04	0.17	0.15%	0.77%	52,000	344,000
G&A	1,220,000	4	5.00	20.00	0.18	0.71	0.62%	3.23%	217,000	1,437,000
Escalation	3,773,000	11	5.00	25.00	0.55	2.75	2.42%	12.54%	845,000	4,618,000
Subtotal	34,267,000	100			5	22				
Calculated Contingency	6,619,075						19.32%			
Resultant TEC	40,886,075									
Rounded TEC	41,000,000									
Project Contingency	6,733,000						19.65%			
Risk to Project							17.67%			
Management Reserve *	2,372,000						10.00%			
Contingency *	4,361,000									
Total	41,000,000							6,733,000	41,000,000	

CONFIDENCE LEVEL AND ASSUMED RISKS:

The Lockheed Idaho Technologies Co. Cost Estimate Contingency Analysis Model is based on the applied contingency and the assumptions upon which the estimate was predicated. The model is applied with a suggested risk level of 18% and a level of confidence of 90% the estimate will fall within the bid range. The Contingency Analysis is based on a weighted average to provide a 90% probability of underrun and 10% probability of overrun.

* The calculated Management Reserve and Contingency amounts include Escalation.

CONTINGENCY ANALYSIS GUIDE BY TYPE OF ESTIMATE:

Guidelines established by DOE/FM-50, Cost Estimating Guide, Vol. 6, Cost Guide, and as presented in the INEL Cost Estimating Guide.

PLANNING	20% - 30%
Experimental / Special Conditions	Up to 50%
CONCEPTUAL	15% - 25%
Experimental / Special Conditions	Up to 40%
TITLE I	10% - 20%
TITLE II	5% - 15%
TITLE II / AFC	Market Conditions

Project SNF DRY STORAGE PROJECT

DRY TRANSFER CELL

INEL / ICPP

Requester R. C. HILL

Type of Est. Conceptual

File No. 2314-B

Prepared By

Date

S.M. Bradford

06/14/96

G-22

Calendar Years		CY95	CY96	CY97	CY98	CY99	CY00	CY01	
Fiscal Years	FY96	ONDJFMAMJJAS	FY97	ONDJFMAMJJAS	FY98	ONDJFMAMJJAS	FY99	ONDJFMAMJJAS	FY01
	Escalation Period and Annual Escalation Rate		Months Rate	Months Rate	Months Rate	Months Rate	Months Rate	Months Rate	TOTAL COMPOUNDED RATE
Design Period					-----				
Title I, II		8	1.9	12	2.7	12	2.8	1	0.3
Construction Period							-----	*-----	
Title III		8	1.9	12	2.7	12	2.8	3.0	12
Labor		8	1.9	12	2.7	12	2.8	3.0	12
Mat'l & Subcontracts		8	1.9	12	2.7	12	2.8	3.0	12
Equipment or GFE		8	1.9	12	2.7	12	2.8	9	2.3
Indirects		8	1.9	12	2.7	12	2.8	3.0	12
CM		8	1.9	12	2.7	12	2.8	3.0	12
PM		8	1.9	12	2.7	12	2.8	3.0	12
		</							

Departmental Price Change Index - FY 1998 Guidance - Anticipated Economic Escalation Rates - Defense Programs & General Construction.

% Change/Composite Rate	2.8	2.7	2.8	3.0	3.0	3.0
-------------------------	-----	-----	-----	-----	-----	-----

Departmental Price Change Index - FY 1998 Guidance - Anticipated Economic Escalation Rates - Environmental Restoration.

% Change/Composite Rate	3.4	3.0	3.1	3.2	3.3	3.4
-------------------------	-----	-----	-----	-----	-----	-----

Departmental Price Change Index - FY 1998 Guidance - Anticipated Economic Escalation Rates - Waste Management.

% Change/Composite Rate	3.2	2.9	3.0	3.0	3.1	3.2
-------------------------	-----	-----	-----	-----	-----	-----

* It will be the responsibility of the estimator to determine the appropriate escalation rate to use, based on project funding and type.

COST ESTIMATE SUMMARY

Rev 01-96

Project	<u>SNF DRY STORAGE PROJECT</u>	Type of Est	<u>Conceptual</u>	Date	<u>06/14/96</u>
	<u>DRY STORAGE SYSTEM</u>	File No	<u>2314-B</u>	Chk'd By	<u></u>
Requester	<u>R. C. HILL</u>	Prep'd By	<u>S.M. Bradford</u>	Appr'd By	<u></u>

	Unescalated	Escalation	Totals
ENGINEERING, DESIGN AND INSPECTION		8% of Construction Costs and GFE	<u>240,000</u>
Title I and II Design	<u>100,000</u>	<u>8,000</u>	
Title III Inspection	<u>112,000</u>	<u>20,000</u>	
MANAGEMENT			<u>1,067,000</u>
Project Management	<u>799,000</u>	<u>97,000</u>	
Construction Management	<u>150,000</u>	<u>21,000</u>	
CONSTRUCTION			<u>3,152,000</u>
Div 1 General Requirements	<u>176,000</u>	<u>31,000</u>	
Div 2 Sitework	<u>908,000</u>	<u>159,000</u>	
Div 3 Concrete	<u>1,235,000</u>	<u>216,000</u>	
Div 4 Masonry	<u></u>	<u></u>	
Div 5 Metals	<u></u>	<u></u>	
Div 6 Wood and Plastics	<u></u>	<u></u>	
Div 7 Moisture Protection	<u></u>	<u></u>	
Div 8 Doors and Windows	<u></u>	<u></u>	
Div 9 Finishes	<u></u>	<u></u>	
Div 10 Specialties	<u></u>	<u></u>	
Div 11 Equipment	<u></u>	<u></u>	
Div 12 Furnishings	<u></u>	<u></u>	
Div 13 Special Construction	<u></u>	<u></u>	
Div 14 Conveying Systems	<u></u>	<u></u>	
Div 15 Mechanical	<u></u>	<u></u>	
Div 16 Electrical	<u>363,000</u>	<u>64,000</u>	
GOV'T FURNISHED EQUIPMENT	<u></u>	<u></u>	<u></u>
PROCUREMENT FEES	<u>40,000</u>	<u>7,000</u>	<u>47,000</u>
G&A	<u>300,000</u>	<u>53,000</u>	<u>353,000</u>
SUBTOTAL			<u>4,859,000</u>
PROJECT CONTINGENCY		17% of Subtotal	<u>841,000</u>
Management Reserve	<u>309,000</u>	<u>46,000</u>	
Contingency	<u>486,000</u>		
TOTAL ESCALATION		<u>722,000</u>	

TOTAL ESTIMATED COST:

\$5,700,000

DETAILED COST ESTIMATE SHEET

Rev 10-94

Project SNF DRY STORAGE PROJECT
DRY STORAGE SYSTEM
 Location INEL/ICPP
 Requester R. C. HILL

Type of Est. Conceptual
 Source (E) Eng. Est.
 (V) Vendor
 (P) Pur. Order
 (H) Handbook Ref.

File No. 2314-B Date 06/17/96
 Prep'd By S.M. Bradford

ACCT. NO.	DESCRIPTION	E,V, P,H	MAT'L UNIT	MAT'L UT. COST	UNIT LAB. HRS	TOTAL LAB. HRS.	LABOR RATE	LABOR COST	MAT'L COST	OH&P COST	TOTAL COST
DIV 1	GENERAL REQUIREMENTS										
	Supervision		12 mnths		173	2,076	40.00	83,040		24,912	107,952
	Training		10 ea		80	800	40.00	32,000		9,600	41,600
	Construction Fence		2,000 ft	10	complete				20,000	6,000	26,000
	TOTAL DIVISION 1 - GENERAL REQUIREMENTS							115,040	20,000	40,512	175,552
DIV 2	SITWORK										
	Surveying and Layout		1 lot	500	160	160	75.00	12,000	500	3,800	16,300
	Clear and Grub - Total Area		196,928 sf	0.08	complete				15,754	4,700	20,454
	Compacted Pit Run Base - Total Pad		29,443 cy	8	complete				235,544	70,700	306,244
	Excavation		3,958 cy	4	complete				15,832	4,700	20,532
	Compacted Gravel Base - Below Asphalt		724 cy	55	complete				39,820	11,900	51,720
	Asphalt		724 tons	60	complete				43,440	13,000	56,440
	Demolition / Removal of Existing Buildings		256,500 cf	0.45	complete				115,425	34,600	150,025
	Chain Link Fence - 8'		1,587 ft	20	complete				31,740	9,500	41,240
	Remove Existing Fence		752 ft	17	complete				12,784	3,800	16,584
	Existing FW Line - Abandon In Place		1 lot	2,600	complete				2,600	800	3,400
	Trench Excavation / Backfill		1,600 cy	18	complete				28,800	8,600	37,400
	Re-routed FW Line - 10" w/ Fittings, Hydrant		500 ft	38	complete				19,000	5,700	24,700
	Yard Fire Protection w/ Hydrants		600 ft	42	complete				25,200	7,600	32,800
	Trench Excavation / Backfill		1,950 cy	18	complete				35,100	10,500	45,600
	Mob and Demob		1 lot							82,344	82,344
	Storm Water Pollution Prevention Plan		1 lot	500	40	40	35.00	1,400	500	600	2,500
	TOTAL DIV 2 - SITWORK					200		13,400	622,039	272,844	908,283

Type of Est. ConceptualFile No. 2314-BDate 06/17/96Project SNF DRY STORAGE PROJECT
DRY STORAGE SYSTEM

ACCT. NO.	DESCRIPTION	E,V, P,H	MAT'L UNIT	MAT'L UT. COST	UNIT LAB. HRS	TOTAL LAB. HRS.	LABOR RATE	LABOR COST	MAT'L COST	OH & P COST	TOTAL COST
DIV 3	CONCRETE										
	Concrete Basemat and Approach Slabs		3,477 cy	65					226,005	67,802	293,807
	Reinforcing		335,000 lb	0.2	0.008	2,010	32.67	65,667	67,000	39,800	172,467
	Formwork		4,700 sf	0.45	0.08	376	32.67	12,284	2,115	4,320	18,719
	Mechanically Place		3,477 cy	51	complete				177,327	53,198	230,525
	Shield Walls		1,504 cy	65	0.505	760	32.67	24,814	97,760	36,772	159,346
	Snap Ties and Grout Holes		18,800 sf	1.5					28,200	8,460	36,660
	Reinforcing		169,000 lb	0.2	0.008	1,352	32.67	44,170	33,800	23,391	101,361
	Formwork		37,600 sf	0.66	0.087	3,271	32.67	106,870	24,816	39,506	171,192
	Mechanically Place		1,504 cy	25	complete				37,600	11,280	48,880
	Engineering - Forms / Shoring		1 bt	1,500					1,500	500	2,000
	TOTAL DIV 3 - CONCRETE					7,769		253,804	696,123	285,028	1,234,955
DIV 16	ELECTRICAL										
	Power to Perimeter Lighting - to DTC		500 ft	30	complete				15,000	4,500	19,500
	Perimeter Lighting		1,902 ft	100	complete				180,200	57,100	247,300
	Intrusion Detection System - Re-Us TMI - 2 Transceiver Modules / Enclosures										
	Cable Set and Accessories - 276 ft		2 ea	3,482					6,964	1,800	8,764
	Cable Set and Accessories - 675 ft		2 ea	6,964					13,928	3,700	17,628
	Control Module - Located in DTC		1 ea	29,420					29,420	7,800	37,220
	Interface Hardware, Misc. Installation of System		1 bt	11,808	64	64	31.60	2,022	11,808	3,700	17,530
	Tie-In to DTC		500 ft	24	complete				12,000	3,200	15,200
	TOTAL DIV 16 - ELECTRICAL					64			279,320	81,800	363,142

Type of Est. ConceptualFile No. 2314-BDate 06/17/96

Project SNF DRY STORAGE PROJECT
DRY STORAGE SYSTEM

ACCT. NO.	DESCRIPTION	E,V, P,H	MAT'L UNIT	MAT'L UT. COST	UNIT LAB. HRS	TOTAL LAB. HRS.	LABOR RATE	LABOR COST	MAT'L COST	OH & P COST	TOTAL COST
	ADMINISTRATIVE COSTS ASSOCIATED WITH STORAGE YARD - ONLY - DOES NOT INCLUDE HSMs OR DPCs										
	ENGINEERING / DESIGN										
	Civil / Structural		4 dwgs	3,500	complete			14,000			14,000
	Mechanical		3 dwgs	3,500	complete			10,500			10,500
	Electrical / Security		15 dwgs	5,000	complete			75,000			75,000
	INSPECTION										
	Title III Inspection - 1 FTE		12 mnths		113	1,350	62.00	83,700			83,700
	Compaction / Testing - .25 FTE		12 mnths		38	450	62.00	27,900			27,900
	PROJECT MANAGEMENT										
	Project Management		24 mnths		300	7,200	74.00	532,800			532,800
	Project Suppt - Cost Estimating, Quality, Safety, ESDC		24 mnths		150	3,600	74.00	266,400			266,400
	SAR - Covered under other portions of this U										
	NRC Application - Covered under other portions of this U										
	NRC Fee - Covered under other portions of this U										
	CONSTRUCTION MANAGEMENT										
	Construction Coordination		12 mnth		38	450	61.00	27,450			27,450
	Field Engineer		12 mnth		38	450	56.00	25,200			25,200
	Construction Support		12 mnth		75	900	56.00	50,400			50,400
	CM Pool Account		1 lot			1,800	26.00	46,800			46,800

Project SNF DRY STORAGE PROJECT
DRY STORAGE SYSTEM
 Location INEL / ICPP
 Requestor R. C. HILL

Type of Est. Conceptual
 File No. 2314-B

Date 06/14/86
 Prep'd By S.M. Bradford

PROBABLE % VARIATION								
Cost Estimate Element	Unescalated Cost	% Total Cost	Prob % Var From Est		WT % of Prob		Contingency	
			-	+	-	+		
Title I and II Design	100,000	2	5.00	10.00	0.10	0.21	0.17%	
Title III Inspection	112,000	2	5.00	10.00	0.12	0.23	0.20%	
Project Management	799,000	16	5.00	7.00	0.82	1.15	0.95%	
Construction Management	150,000	3	5.00	8.00	0.15	0.25	0.21%	
General Requirements	176,000	4	5.00	25.00	0.18	0.91	0.80%	
Sitework	908,000	19	5.00	30.00	0.93	5.61	4.95%	
Concrete	1,235,000	25	5.00	20.00	1.27	5.08	4.45%	
Masonry								
Metals								
Wood and Plastics								
Moisture Protection								
Doors and Windows								
Finishes								
Specialties								
Equipment								
Furnishings								
Special Construction								
Conveying Systems								
Mechanical								
Electrical	363,000	7	5.00	25.00	0.37	1.87	1.64%	
GFE								
Procurement Fees	40,000	1	5.00	20.00	0.04	0.16	0.14%	
G&A	300,000	6	5.00	20.00	0.31	1.23	1.08%	
Escalation	676,000	14	5.00	25.00	0.70	3.48	3.06%	
Subtotal	4,859,000	100			5	20		
Calculated Contingency	857,957						17.56%	
Resultant TEC	5,716,957							
Rounded TEC	5,700,000							
Project Contingency	841,000						17.31%	
Risk to Project							18.35%	
Management Reserve *	355,000						10.00%	
Contingency *	486,000							
Total	5,700,000							

PROJECT CONTINGENCY	
%	Cost
0.99%	8,000
1.11%	9,000
5.40%	45,000
1.17%	10,000
4.51%	38,000
28.05%	236,000
25.19%	212,000

CONFIDENCE LEVEL AND ASSUMED RISKS:

The Lockheed Idaho Technologies Co. Cost Estimate Contingency Analysis Model is based on the applied contingency and the assumptions upon which the estimate was predicated. The model is applied with a suggested risk level of 18% and a level of confidence of 80% the estimate will fall within the bid range. The Contingency Analysis is based on a weighted average to provide a 90% probability of underrun and 10% probability of overrun.

* The calculated Management Reserve and Contingency amounts include Escalation.

CONTINGENCY ANALYSIS GUIDE BY TYPE OF ESTIMATE:

Guidelines established by DOE/FM-50, Cost Estimating Guide, Vol. 6, Cost Guide, and as presented in the INEL Cost Estimating Guide.

PLANNING	20% - 30%
Experimental / Special Conditions	Up to 50%
CONCEPTUAL	15% - 25%
Experimental / Special Conditions	Up to 40%
TITLE I	10% - 20%
TITLE II	5% - 15%
TITLE II / AFC	Market Conditions

ESCALATION SHEET

Rev 01-96

Project SNF DRY STORAGE PROJECT
DRY STORAGE SYSTEM
 Location INEL / ICPP
 Requester R. C. HILL

Type of Est. Conceptual
 File No. 2314-B

Date 06/14/96
 Prepared By S.M. Bradford

Calendar Years	CY95		CY96		CY97		CY98		CY99		CY00		CY01		
Fiscal Years	FY96		FY97		FY98		FY99		FY00		FY01		FY01		TOTAL COMPOUNDED RATE
Escalation Period and Annual Escalation Rate	ONDJFMAMJJAS		ONDJFMAMJJAS		ONDJFMAMJJAS		ONDJFMAMJJAS		ONDJFMAMJJAS		ONDJFMAMJJAS		ONDJFMAMJJAS		
	Months	Rate	Months	Rate	Months	Rate	Months	Rate	Months	Rate	Months	Rate	Months	Rate	
Design Period							-----*-----								
Title I, II	8	1.9	12	2.7	12	2.8								7.55%	
Construction Period													-----*-----		
Title III	8	1.9	12	2.7	12	2.8	12	3.0	12	3.0	12	3.0	12	3.0	17.52%
Labor	8	1.9	12	2.7	12	2.8	12	3.0	12	3.0	12	3.0	12	3.0	17.52%
Matl & Subcontracts	8	1.9	12	2.7	12	2.8	12	3.0	12	3.0	12	3.0	12	3.0	17.52%
Equipment or GFE	8	1.9	12	2.7	12	2.8	12	3.0	12	3.0	12	3.0	12	3.0	17.52%
Indirects	8	1.9	12	2.7	12	2.8	12	3.0	12	3.0	12	3.0	12	3.0	17.52%
CM	8	1.9	12	2.7	12	2.8	12	3.0	12	3.0	12	3.0	12	3.0	17.52%
PM	8	1.9	12	2.7	12	2.8	12	3.0	12	3.0					14.10%

Departmental Price Change Index - FY 1998 Guidance - Anticipated Economic Escalation Rates - Defense Programs & General Construction.

% Change/Composite Rate	2.8	2.7	2.8	3.0	3.0	3.0	
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Departmental Price Change Index - FY 1998 Guidance - Anticipated Economic Escalation Rates - Environmental Restoration.

% Change/Composite Rate	3.4	3.0	3.1	3.2	3.3	3.4	
-------------------------	-----	-----	-----	-----	-----	-----	--

Departmental Price Change Index - FY 1998 Guidance - Anticipated Economic Escalation Rates - Waste Management.

% Change/Composite Rate	3.2	2.9	3.0	3.0	3.1	3.2	
-------------------------	-----	-----	-----	-----	-----	-----	--

* It will be the responsibility of the estimator to determine the appropriate escalation rate to use, based on project funding and type.

COST ESTIMATE SUMMARY

Rev 01-96

Project	<u>SNF DRY STORAGE PROJECT</u>	Type of Est	<u>Conceptual</u>	Date	<u>06/14/96</u>
	<u>DRY STORAGE SYSTEM</u>	File No	<u>2314-B</u>	Chk'd By	<u></u>
Requester	<u>INEL / ICPP</u>	Prep'd By	<u>S.M. Bradford</u>	Appr'd By	<u></u>

	<u>Unescalated</u>	<u>Escalation</u>	<u>Totals</u>
ENGINEERING, DESIGN AND INSPECTION		<u>1% of Construction Costs and GFE</u>	<u>206,000</u>
Title I and II Design	<u>104,000</u>	<u>22,000</u>	
Title III Inspection	<u>62,000</u>	<u>18,000</u>	
MANAGEMENT			<u>7,620,000</u>
Project Management	<u>5,931,000</u>	<u>1,689,000</u>	
Construction Management	<u></u>	<u></u>	
CONSTRUCTION			<u></u>
Div 1. General Requirements	<u></u>	<u></u>	
Div 2 Sitework	<u></u>	<u></u>	
Div 3 Concrete	<u></u>	<u></u>	
Div 4 Masonry	<u></u>	<u></u>	
Div 5 Metals	<u></u>	<u></u>	
Div 6 Wood and Plastics	<u></u>	<u></u>	
Div 7 Moisture Protection	<u></u>	<u></u>	
Div 8 Doors and Windows	<u></u>	<u></u>	
Div 9 Finishes	<u></u>	<u></u>	
Div 10 Specialties	<u></u>	<u></u>	
Div 11 Equipment	<u></u>	<u></u>	
Div 12 Furnishings	<u></u>	<u></u>	
Div 13 Special Construction	<u></u>	<u></u>	
Div 14 Conveying Systems	<u></u>	<u></u>	
Div 15 Mechanical	<u></u>	<u></u>	
Div 16 Electrical	<u></u>	<u></u>	
GOVT FURNISHED EQUIPMENT	<u>26,645,000</u>	<u>8,590,000</u>	<u>35,235,000</u>
PROCUREMENT FEES	<u>400,000</u>	<u>129,000</u>	<u>529,000</u>
G&A	<u>1,600,000</u>	<u>516,000</u>	<u>2,116,000</u>
SUBTOTAL			<u>45,706,000</u>
PROJECT CONTINGENCY		<u>17% of Subtotal</u>	<u>7,594,000</u>
Management Reserve	<u>2,865,000</u>	<u>923,000</u>	
Contingency	<u>3,806,000</u>		
TOTAL ESCALATION		<u>11,887,000</u>	

TOTAL ESTIMATED COST:

\$53,300,000

DETAILED COST ESTIMATE (CONT.SHEET)

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Type of Est. ConceptualFile No. 2314-BDate 06/17/96

Project SNF DRY STORAGE PROJECT
DRY STORAGE SYSTEM

ACCT. NO.	DESCRIPTION	E,V, P,H	MAT'L UNIT	MAT'L UT. COST	UNIT LAB. HRS	TOTAL LAB. HRS.	LABOR RATE	LABOR COST	MAT'L COST	OH & P COST	TOTAL COST
	ADMINISTRATIVE COSTS ASSOCIATED WITH HSMs or DPCs - ONLY - DOES NOT INCLUDE ANY YARD WORK										
	ENGINEERING / DESIGN										
	Performance Specification - Storage Modules		1 ea		200	200	74.00	14,800			14,800
	Performance Specification - Canister Assembly - by Fuel Type										
	Shipping Port PWR - C2		1 ea		200	200	74.00	14,800			14,800
	FSVR		1 ea		200	200	74.00	14,800			14,800
	Pathfinder		1 ea		200	200	74.00	14,800			14,800
	Shipping Port LWBR		1 ea		200	200	74.00	14,800			14,800
	PBF Driver - 51 / 62 Rod										
	PBF Driver - 34 / 46 / 49 Rod										
	PBF Driver - 28 Rod										
	Peachbottom - Core 1		1 ea		200	200	74.00	14,800			14,800
	Peachbottom - Core 2		1 ea		200	200	74.00	14,800			14,800
	Treat										
	Triga - BERII - Germany										
	Triga - Standard - 20% Enr.										
	Triga - 70% Enr.										
	Triga - Flip - 70% Enr.										
	FRR Triga - 93% Enr.										
	ACRR										
	Candu - 168" long										
	Dresden										
	Pulstar - Buffalo										
	Pulstar - N.C. State Univ										
	Pulstar - Suny - Buffalo										
	SUBTOTAL ENGINEERING / DESIGN										103,600

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Type of Est. Conceptual

Date 06/17/96

Project SNF DRY STORAGE PROJECT
DRY STORAGE SYSTEM

[illegible]

G-32

Date 06/17/96

Project SNF DRY STORAGE PROJECT
DRY STORAGE SYSTEM

ACCT. NO.	DESCRIPTION	E,V, P,H	MAT'L UNIT	MAT'L UT. COST	UNIT LAB. HRS	TOTAL LAB. HRS.	LABOR RATE	LABOR COST	MAT'L COST	OH & P COST	TOTAL COST
	NRC Application -- per Year										
	Shipping Port PWR -- C2		1 lot	200,000				200,000			200,000
	FSVR		1 lot	200,000				200,000			200,000
	Pathfinder		1 lot	included							
	Shipping Port LWBR		1 lot	200,000				200,000			200,000
	PBF Driver -- 51 / 62 Rod										
	PBF Driver -- 34 / 46 / 49 Rod										
	PBF Driver -- 28 Rod										
	Peachbottom -- Core 1		1 lot	200,000				200,000			200,000
	Peachbottom -- Core 2			included							
	Treat										
	Triga -- BERII -- Germany										
	Triga -- Standard -- 20% Enr.										
	Triga -- 70% Enr.										
	Triga -- Flip -- 70% Enr.										
	FRR Triga -- 93% Enr.										
	ACRR										
	Candu -- 168" long										
	Dresden										
	Pulstar -- Buffalo										
	Pulstar -- N.C. State Univ										
	Pulstar -- Suny -- Buffalo										
	SUBTOTAL PROJECT MANAGEMENT THIS PAGE							800,000			800,000

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DETAILED COST ESTIMATE (CONT.SHEET)

Type of Est. Conceptual

File No. 2314-B

Date 06/17/96

Project

SNF DRY STORAGE PROJECT
DRY STORAGE SYSTEM

[illegible]

DETAILED COST ESTIMATE (CONT.SHEET)

Project SNF DRY STORAGE PROJECT
DRY STORAGE SYSTEM

Type of Est. ConceptualFile No. 2314-BDate 06/17/96

ACCT. NO.	DESCRIPTION	E,V, P,H	MAT'L UNIT	MAT'L UT. COST	UNIT LAB. HRS	TOTAL LAB. HRS.	LABOR RATE	ENGR/LIC COST	MAT'L COST	OH & P COST	TOTAL COST
GFE	GOVERNMENT FURNISHED EQUIPMENT										
	NUHOMS Storage Modules		50 ea	150,000	complete				7,500,000		7,500,000
	Canister Assembly - Includes Canister w/ Plug, Basket, Bucket - by Fuel Type										
	Shipping Port PWR - C1/C2		3 ea	352,156	complete			590,000	1,056,468	264,100	1,910,568
	FSVR		22 ea	160,130	complete			590,000	3,522,860	880,700	4,993,560
	Pathfinder		1 ea	49,854	complete			590,000	49,854	12,500	652,354
	Shipping Port LWBR		16 ea	219,800	complete			590,000	3,516,800	879,200	4,986,000
	PBF Driver - 51 / 62 Rod										
	PBF Driver - 34 / 46 / 49 Rod										
	PBF Driver - 28 Rod										
	Peachbottom - Core 1		1 ea	347,556	complete			590,000	347,556	86,900	1,024,456
	Peachbottom - Core 2		8 ea	373,848	complete			590,000	2,990,784	747,700	4,328,484
	Treat										
	Triga - BERII - Germany										
	Triga - Standard - 20% Enr.										
	Triga - 70% Enr.										
	Triga - Flip - 70% Enr.										
	FRR Triga - 93% Enr.										
	ACRR										
	Candu - 168" long										
	Dresden										
	Pulstar - Buffalo										
	Pulstar - N.C. State Univ										
	Pulstar - Suny - Buffalo										
	100 Ton Crane		1 ea	1,000,000					1,000,000	250,000	1,250,000
	On-Site Transfer Cask, Cask Transport & Alignment System - Heavy Haul Industrial Trailer, Cask Support Skid, Skid Positioning System - USE TMI-2 EQUIPMENT										
	Hydraulic Ram System - Hydraulic Cylinder & Supports, Hydraulic Power Supply, Canister Grapple Assembly - USE TMI-2 EQUIPMENT										
	TOTAL GOVERNMENT FURNISHED EQUIPMENT							3,540,000	18,984,322	2,871,100	26,645,422

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DETAILED COST ESTIMATE (CONT.SHEET)

Rev 10-94

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Type of Est. ConceptualFile No. 2314-BDate 06/17/96

Project SNF DRY STORAGE PROJECT
DRY STORAGE SYSTEM

ACCT. NO.	DESCRIPTION	E,V, P,H	MAT'L UNIT	MAT'L UT. COST	UNIT LAB. HRS	TOTAL LAB. HRS.	LABOR RATE	ENGR/LIC COST	PROCURE FEE	G&A COST	TOTAL COST
	PROCUREMENT FEES AND G&A -- by Fuel Type										
	NUHOMS Storage Modules		1 bt	7,500,000					112,500	w/ canister	112,500
	Canister Assembly -- Includes Canister w/ Plug, Basket, Bucket -- by Fuel Type										
	Shipping Port PWR -- C2		1 bt	1,910,568					28,659	150,000	178,659
	FSVR		1 bt	4,993,560					74,903	450,000	524,903
	Pathfinder		1 bt	652,354					9,785	150,000	159,785
	Shipping Port LWBR		1 bt	4,986,000					74,790	150,000	224,790
	PBF Driver -- 51 / 62 Rod										
	PBF Driver -- 34 / 46 / 49 Rod										
	PBF Driver -- 28 Rod										
	Peachbottom -- Core 1		1 bt	1,024,456					15,367	Included	15,367
	Peachbottom -- Core 2		1 bt	4,328,484					64,927	150,000	214,927
	Treat										
	Triga -- BERII -- Germany										
	Triga -- Standard -- 20% Enr.										
	Triga -- 70% Enr.										
	Triga -- Flip -- 70% Enr.										
	FRR Triga -- 93% Enr.										
	ACRR										
	Candu -- 166" long										
	Dresden										
	Pulstar -- Buffalo										
	Pulstar -- N.C. State Univ										
	Pulstar -- Suny -- Buffalo										
	100 Ton Crane		1 ea	1,250,000					18,750	150,000	168,750
	TOTAL PROCUREMENT FEES AND G&A								399,681	1,200,000	1,599,681

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Rev 01-96

Project SNF DRY STORAGE PROJECT
DRY STORAGE SYSTEM
 Location INEL /ICPP
 Requestor R. C. HILL

Type of Est. Conceptual
 File No. 2314-B

Date 06/14/96
 Prep'd By S.M. Bradford

PROBABLE % VARIATION								PROJECT CONTINGENCY		SUMMARY
Cost Estimate Element	Unescalated Cost	% Total Cost	Prob % Var From Est		WT % of Prob		Contingency	%	Cost	Direct Cost with Contingency
			-	+	-	+				
Title I and II Design	104,000	0	5.00	15.00	0.01	0.03	0.03%	0.18%	14,000	118,000
Title III Inspection	62,000	0	5.00	15.00	0.01	0.02	0.02%	0.11%	8,000	70,000
Project Management	5,931,000	13	5.00	7.00	0.65	0.91	0.75%	4.71%	357,000	6,288,000
Construction Management										
General Requirements										
Sitework										
Concrete										
Masonry										
Metals										
Wood and Plastics										
Moisture Protection										
Doors and Windows										
Finishes										
Specialties										
Equipment										
Furnishings										
Special Construction										
Conveying Systems										
Mechanical										
Electrical										
GFE	26,645,000	58	5.00	18.00	2.91	10.49	9.15%	57.22%	4,345,000	30,990,000
Procurement Fees	400,000	1	5.00	20.00	0.04	0.18	0.15%	0.96%	73,000	473,000
G&A	1,600,000	4	5.00	20.00	0.18	0.70	0.81%	3.83%	291,000	1,891,000
Escalation	10,964,000	24	5.00	25.00	1.20	6.00	5.28%	32.99%	2,505,000	13,469,000
Subtotal	45,706,000	100			5	18				
Calculated Contingency	7,310,923						16.00%			
Resultant TEC	53,016,923									
Rounded TEC	53,300,000									
Project Contingency	7,594,000						16.81%			
Risk to Project							17.38%			
Management Reserve *	3,788,000						10.00%			
Contingency *	3,806,000									
Total	53,300,000							7,593,000		53,299,000

CONFIDENCE LEVEL AND ASSUMED RISKS:

The Lockheed Idaho Technologies Co. Cost Estimate Contingency Analysis Model is based on the applied contingency and the assumptions upon which the estimate was predicated. The model is applied with a suggested risk level of 18% and a level of confidence of 90% the estimate will fall within the bid range. The Contingency Analysis is based on a weighted average to provide a 90% probability of underrun and 10% probability of overrun.

* The calculated Management Reserve and Contingency amounts include Escalation.

CONTINGENCY ANALYSIS GUIDE BY TYPE OF ESTIMATE:

Guidelines established by DOE/FM-50, Cost Estimating Guide, Vol. 6, Cost Guide, and as presented in the INEL Cost Estimating Guide.

PLANNING	20% - 30%
Experimental / Special Conditions	Up to 50%
CONCEPTUAL	15% - 25%
Experimental / Special Conditions	Up to 40%
TITLE I	10% - 20%
TITLE II	5% - 15%
TITLE II / AFC	Market Conditions

ESCALATION SHEET

Rev 01-96

Project SNF DRY STORAGE PROJECT
DRY STORAGE SYSTEM
 Location INEL / ICPP
 Requester R. C. HILL

Type of Est. Conceptual
 File No. 2314-B

Date 06/14/96
 Prepared By S.M. Bradford

Calendar Years	CY95		CY96		CY97		CY98		CY99		CY00		CY01		
Fiscal Years	FY96		FY97		FY98		FY99		FY00		FY01				
Escalation Period and Annual Escalation Rate	ONDJFMAMJJAS		ONDJFMAMJJAS		ONDJFMAMJJAS		ONDJFMAMJJAS		ONDJFMAMJJAS		ONDJFMAMJJAS		TOTAL COMPOUNDED RATE		
	Months	Rate	Months	Rate	Months	Rate	Months	Rate	Months	Rate	Months	Rate			
<i>Design Period</i>					-----		-----		-----		-----		----->		
Title I, II	8	1.9	12	2.7	12	2.8	12	3.0	12	3.0	24	6.1	21.06%		
<i>Construction Period</i>					-----		-----		-----		-----		----->		
Title III	8	1.9	12	2.7	12	2.8	12	3.0	12	3.0	48	12.6	28.47%		
Labor	8	1.9	12	2.7	12	2.8	12	3.0	12	3.0	48	12.6	28.47%		
Mat'l & Subcontracts	8	1.9	12	2.7	12	2.8	12	3.0	12	3.0	48	12.6	28.47%		
Equipment or GFE	8	1.9	12	2.7	12	2.8	12	3.0	12	3.0	60	15.9	32.24%		
Indirects	8	1.9	12	2.7	12	2.8	12	3.0	12	3.0	48	12.6	28.47%		
CM	8	1.9	12	2.7	12	2.8	12	3.0	12	3.0	48	12.6	28.47%		
PM	8	1.9	12	2.7	12	2.8	12	3.0	12	3.0	48	12.6	28.47%		

Departmental Price Change Index - FY 1998 Guidance - Antidpated Economic Escalation Rates - Defense Programs & General Construction.

% Change/Composite Rate	2.8	2.7	2.8	3.0	3.0	3.0	
-------------------------	-----	-----	-----	-----	-----	-----	--

Departmental Price Change Index - FY 1998 Guidance - Antidpated Economic Escalation Rates - Environmental Restoration.

% Change/Composite Rate	3.4	3.0	3.1	3.2	3.3	3.4	
-------------------------	-----	-----	-----	-----	-----	-----	--

Departmental Price Change Index - FY 1998 Guidance - Antidpated Economic Escalation Rates - Waste Management.

% Change/Composite Rate	3.2	2.9	3.0	3.0	3.1	3.2	
-------------------------	-----	-----	-----	-----	-----	-----	--

* It will be the responsibility of the estimator to determine the appropriate escalation rate to use, based on project funding and type.

Appendix H

Equipment List

Spent Nuclear Fuel Dry Storage Project

Appendix H

Equipment List

Spent Nuclear Fuel Dry Storage Project

Mechanical Equipment

- Fire extinguisher cabinets
- Projection screen
- Dry marker board
- Furniture
- Cask transfer trolleys (2)
- Cask Handling Bay work platform
- Preparation Booth Area work platform
- Welding machines (2)
- Leak, purge, and gas sampling equipment (2)
- Pneumatic can piercing tool
- Can drying system
- Helium leak detector
- 14-in. Baskets (3)
- Storage stands (2)
- Lifting yokes (3)
- Misc. tooling (2)
- Fuel handling grapples (2)
- Can handling tool (for Peach Bottom fuel)
- Fuel handling tool (for Peach Bottom fuel)
- Fuel handling tool grapple (for Peach Bottom fuel)
- Cask access rollaway stairways (2)
- 150/15-ton bridge crane
- 7.5-ton bridge crane
- Fuel-handling crane with 3 trolleys, z-masts, manipulators, controls, etc.
- 500-gal HEPA filter water collection system
- HEPA filter deluge systems (4)
- Electric water cooler
- Emergency eyewash/shower (2)
- Hot water heater
- Hose reels (2)
- 5,000-gal holding tank with instruments and controls (2)
- Hot Cell, Anti-C Room, and Cask Preparation Area supply air unit
- Utility Support Area supply air unit
- Exhaust Fan Room cooling unit and air cooled condenser
- Administrative Area HVAC unit and air cooled condenser
- Hot Cell exhaust HEPA filters (2)
- Utility Support Area HEPA filters (2)
- Hot Cell exhaust fans (2)
- Utility Support Area exhaust fans (2)

- Glycol heat recovery system
- Lab fume hood exhaust fan
- Toilet rooms and janitor closet exhaust fans (2)
- Exhaust hose reel systems (2)
- SST isolation dampers (4)
- Isolation dampers (10)
- Probes, spool piece, and CAMS - isokinetic sampling (for 30-in. stack and for 18-in. stack)
- Air flow transfer and static pressure measuring station and associated instrumentation and controls

Electrical Equipment

- 80 kVA Uninterruptible Power Supply
- Distribution panels (5-480/277, 225A; 3-120/208, 100A; 1-120/208, 150A)
- Dry transformer - 480-208/120 (1-45 kVA, 3-25 kVA)
- Feeders
- Motor starter - Size 1(6)
- Disconnect switches (2-250A, 1-100A)
- Lighting (interior, exterior, and exit)
- Receptacles and switches
- Welding receptacle
- CCTV cameras (15)
- CCTV monitors (5)
- CCTV quadswitches (15)
- PCs (5)
- Network server
- VCRs (15)
- Microprocessor based alarm collection system
- Seismic detection device
- RAMs (6)
- CAMs - beta/gamma (6)
- CAM - alpha
- Hand and foot counters (3)
- Holding tank activity monitor
- Criticality indicator/detector (2)
- Alarms monitor
- Hand-held radiation monitoring frisker (4)
- FASTRAK II dosimetry system
- Beta/gamma spectrometer
- Alpha spectrometer
- Argus field panel
- Remote security access panel (12)
- Voice paging, fire alarm, and evacuation system
- Remote distribution module
- Voice/data system
- Local area network
- Intercom system

Appendix I

Drawings

D

C

B

A

CPP AREA MAP
SCALE: 1"=200.0'

D

N 634,390.00
E 296,128.15

C

B

A

SITE M

SCALE: 1" =

AP
10.0'

FOR DRAWING INDEX SEE DRAWING NO.		APPROVALS		DATE		U.S. DEPARTMENT OF ENERGY FOR IDAHO OPERATIONS OFFICE IDAHO FALLS, IDAHO A/E CONTRACT NO. 13323	
0 1" 2" SCALE: 1" = 1' IN 1/10"		PROJECT NO.S		CONST REV		CPP	
0 1" 2" SCALE: 1" = 1' IN 1/16"		DESIGN PHASE		DESIGN		SPENT NUCLEAR FUEL DRY TRANSFER FACILITY	
QUALITY LEVEL		CONCEPTUAL		CHECKED		SITE MAP	
		APPROVED		DATE		SIZE INDEX CODE NUMBER AREA TYPE G ORIG D 1530	
		SUBCONTRACT NO.		RELEASED		DRAWING NO. REV A/E DRG. NO. 3339-10 1 C-1	
						SCALE NOTED SPEC CODE 188CONST	

D
C
B
A
ADCS NO.

N 694,390.00
E 296,728.15

SEE TIE IN TABLE

UTILITY F

SCALE: 1" = 5'

TIE IN TABLE

TYPE	SIZE	UTILITY LINE IN TUNNEL
STEAM	4"	12" H8N-101671
HIGH PRESSURE	2"	3" HAN-101688
SERVICE WASTE	2"	4" S1N-109846
POTABLE WATER	2"	4" C1N-109851
FIRE WATER	8"	12" FAN-113300

PLAN
0.0'

FOR DRAWING INDEX SEE DRAWING NO.		APPROVALS		DATE				U.S. DEPARTMENT OF ENERGY FOR IDAHO OPERATIONS OFFICE IDAHO FALLS, IDAHO A/E CONTRACT NO. 13223	
0 1" 2" SCALE: 1" = 1" IN 1/10"		PROJECT NO. 5		CONST REV		CPP		SPENT NUCLEAR FUEL DRY TRANSFER FACILITY	
0 1" 2" SCALE: 1" = 1" IN 1/15"		DESIGN PHASE		DESIGN		INDEX CODE NUMBER AREA TYPE CL ORG		DRAWING NO. REV A/E DWG. NO.	
		CONCEPTUAL		CHECKED		DRAWN <i>Chris Feller</i> 5-29-96		UTILITY PLAN 1530	
		APPROVED		DATE		SUBCONTRACT NO.		SCALE NOTED SPEC 188CONST	
QUALITY LEVEL				RELEASED				3339-11 1 C-2	

D

C

B

A

ADOC NO.

D

C

B

A

FENCING TO
BE REMOVED

PARTIAL AREA PLAN

SCALE: 1" = 100.0'

D

C

B

A

FOR DRAWING INDEX SEE DRAWING NO.		APPROVALS		DATE			
<div style="display: flex; justify-content: space-between;"> <div> <p>SCALE: 1" = 1' IN 1/10"</p> </div> <div> <p>PROJECT NO. S</p> </div> </div>		CONST. REV		<div style="display: flex; justify-content: space-between;"> <div> <p>SCALE: 1" = 1' IN 1/16"</p> </div> <div> <p>DESIGN PHASE</p> </div> </div>			
		DESIGN				DESIGN	
		CHECKED				CHECKED	
		CONCEPTUAL				CONCEPTUAL	
APPROVED		DATE		SUBCONTRACT NO.			
QUALITY LEVEL		RELEASED		SUBCONTRACT NO.			

Lockheed
Idaho Technologies Company

U.S. DEPARTMENT OF ENERGY
FOR IDAHO OPERATIONS OFFICE
IDAHO FALLS, IDAHO
A/E CONTRACT NO. 13223

**SPENT NUCLEAR FUEL
DRY TRANSFER FACILITY**

STORAGE SECTION AND DETAILS

SIZE	INDEX CODE	NUMBER	ORIG	DRAWING NO.	REV	A/E DRG. NO.
D	AREA	TYPE	CL	530		

SCALE NOTED

33393-12

1

C-5

MAIN LEVEL FLOOR PL

SCALE: 3/32"=1'-0"

LEVEL TWO FLOOR PL

SCALE: 3/32"=1'-0"

LEVEL THREE FLOOR PLAN

SCALE: 3/32"=1'-0"

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED

FOR DRAWING INDEX SEE DRAWING NO.		APPROVALS		DATE				U.S. DEPARTMENT OF ENERGY FOR IDAHO OPERATIONS OFFICE IDAHO FALLS, IDAHO A/E CONTRACT NO. 13223	
0 1" 2" SCALE: 1" = 1" IN 1/10"		PROJECT NO.S		CONST REV		CPP		SPENT NUCLEAR FUEL DRY TRANSFER FACILITY	
0 1" 2" SCALE: 1" = 1" IN 1/15"		DESIGN PHASE		DESIGN		INDEX CODE NUMBER AREA TYPE C, 1 ORIG		DRAWING NO.	
QUALITY LEVEL		CONCEPTUAL		CHECKED		DRAWN <i>Chris Zeller</i> 6-17-96		REV	
APPROVED		DATE		SUBCONTRACT NO.		SCALE 200 100 530		A/E DWG. NO.	
				RELEASED		SPEC 188CONST		A-3	

PLAN

ADOCS NO. A

3333-03 1

LEVEL FOUR FLOOR PL

SCALE: 3/32"=1'-0"

FOR DRAWING INDEX SEE DRAWING NO.		APPROVALS		DATE				U.S. DEPARTMENT OF ENERGY FOR IDAHO OPERATIONS OFFICE IDAHO FALLS, IDAHO A/E CONTRACT NO. 13223	
0 1" 2" SCALE: 1" = 1" IN 1/10"		PROJECT NO.S		CONST REV		CPP		SPENT NUCLEAR FUEL DRY TRANSFER FACILITY	
0 1" 2" SCALE: 1" = 1" IN 1/15"		DESIGN PHASE		DESIGN		SIZE INDEX CODE NUMBER AREA TYPE CL ORIG		DRAWING NO.	
QUALITY LEVEL		CONCEPTUAL		CHECKED		D 200 100 530		REV	
APPROVED		DATE		DRAWN <i>Chris Z. Miller</i> 6-13-96		SCALE SPEC CODE 158CON8T		A/E DWG. NO.	
				SUBCONTRACT NO.				A-4	
				RELEASED					

N

ADDCS NO. A

3339-04

D

C

B

A

ROOF PLAN

SCALE: 3/32"=1'-0"

D

C

B

A

TOP OF PARAPET EL. 164'-0"

TOP OF PARAPET EL. 144'-0"

TOP OF PARAPET EL. 130'-0"

MAIN FLOOR EL. 100'-0"

EAST ELEVATION
SCALE: 3/32"=1'-0"

INSULATED (R-16 MIN) METAL WALL PANELS
OVER WALL SUPER STRUCTURE TYP -
SEE LEGEND ON FLOOR PLANS FOR SUPER
STRUCTURE MATERIALS

FINISH GRADE EL. 96'-6"

12'-0" X 20'-0" BLOCK OUT/COLD
JOINT IN CONCRETE WALL FOR
DOOR OPENING IN FUTURE EXPANSION

16'-0" X 16'-0"
VERTICAL LIFT DOOR

ION

FOR DRAWING INDEX SEE DRAWING NO.		APPROVALS		DATE		Lockheed Idaho Technologies Company		U.S. DEPARTMENT OF ENERGY FOR IDAHO OPERATIONS OFFICE IDAHO FALLS, IDAHO A/E CONTRACT NO. 13223	
0 1" 2" SCALE: 1" = 1" IN 1/10"		PROJECT NO.S	CONST REV			SPENT NUCLEAR FUEL DRY TRANSFER FACILITY EAST ELEVATION			
0 1" 2" SCALE: 1" = 1" IN 1/16"		DESIGN PHASE	P.N.						
		CONCEPTUAL	DESIGN						
		APPROVED	CHECKED						
		DATE	DRAWN	B. RHODES 6-12-96					
QUALITY LEVEL			SUBCONTRACT NO.						
			RELEASED						

SIZE	INDEX CODE	NUMBER	DRAWING NO.	REV	A/E DWG. NO.
D	AREA	TYPE	G	ORIG	
SCALE	NOTED	SPEC	CODE	189CONST	A-6

3339-151

D

C

B

A

FINISH GRADE EL. 96'-6"

WEST ELEVATION
SCALE: 3/32"=1'-0"

ON

FOR DRAWING INDEX SEE DRAWING NO.		APPROVALS		DATE	 U.S. DEPARTMENT OF ENERGY FOR IDAHO OPERATIONS OFFICE IDAHO FALLS, IDAHO A/E CONTRACT NO. 13223
 SCALE: 1" = 1" IN 1/10"	PROJECT NO.S	CONST. REV			
	DESIGN PHASE CONCEPTUAL	P.M.			
		DES. MGR			
		DESIGN CHECKED			
 SCALE: 1" = 1" IN 1/16"	DRAWN B. RHODES	6-12-96		WEST ELEVATION	
	SUBCONTRACT NO.			SIZE	INDEX CODE NUMBER
QUALITY LEVEL	APPROVED	DATE	RELEASED	SCALE	NOTED

AREA	TYPE	CL	ORIG	DRAWING NO.	REV	A/E DWG. NO.
D			530			A-7

D

C

B

A

NORTH ELEVATION
SCALE: 3/32"=1'-0"

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED

D

C

B

FOR DRAWING INDEX SEE DRAWING NO.		APPROVALS		DATE		U.S. DEPARTMENT OF ENERGY FOR IDAHO OPERATIONS OFFICE IDAHO FALLS, IDAHO A/E CONTRACT NO. 15223	
PROJECT NO. S		CONST. REV				SPENT NUCLEAR FUEL DRY TRANSFER FACILITY NORTH ELEVATION	
DESIGN PHASE		DES. MGR					
CONCEPTUAL		DESIGN					
CHECKED		DRAWN		B. RHODES 6-12-96			
APPROVED		DATE		SUBCONTRACT NO.			
QUALITY LEVEL		RELEASED				SIZE INDEX CODE NUMBER D AREA TYPE CL ORIG SCALE NOTED 530 SPEC CODE 189CONST.	
						DRAWING NO. 3339-17 REV A/E DWG. NO. A-8	

A
ADDCS NO.

D

C

B

A

TOP OF PARAPET EL. 130'-0"

FINISH GRADE EL. 96'-6"

SOUTH ELEVATION
SCALE: 3/32"=1'-0"

D

C

B

A

SECTION

SCALE: 3/32"=1'-0"

A
TYP

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED

TOP OF PARAPET
ELEV 164'-0"

BEARING
ELEV 154'-0"

N CRANE

FIN FL
ELEV 135'-0"

2'-0"

15'-0"

FOR DRAWING INDEX SEE DRAWING NO.		APPROVALS		DATE				U.S. DEPARTMENT OF ENERGY FOR IDAHO OPERATIONS OFFICE IDAHO FALLS, IDAHO A/E CONTRACT NO. 13223	
PROJECT NO. 5		CONST REV				CPP		DRY FUEL STORAGE FACILITY	
		P.M.							
DESIGN PHASE		DESIGN							
CONCEPTUAL		CHECKED							
APPROVED		DATE		DRAWN B. SEARLE 5/96		SUBCONTRACT NO.		SECTION	
QUALITY LEVEL				RELEASED				SIZE INDEX CODE NUMBER D 200 100 530 SCALE NOTED SPEC 188CON8T	
								DRAWING NO. REV A/E DWG. NO. 3339-08 1 A-10	

D

C

B

A

FINISH FLOOR EL. 128'-0"

FINISH FLOOR EL. 114'-0"

FINISH FLOOR EL. 100'-0"

MECH/HEPA

HEPA

OPERATING
GALLERY

OPERATING
GALLERY

CORRIDOR

HOT CELL

SECTION

SCALE: 3/32"=1'-0"

↓	4	3	2	1
---	---	---	---	---

REVISIONS		
REV	DESCRIPTION	DATE

FINISH GRADE EL. 96'-6"

B
TP

FOR DRAWING INDEX SEE DRAWING NO.		APPROVALS		DATE	
PROJECT NO. 2		CONST. REV.			
SCALE: 1" = 1' IN 1/10"		DES. MGR.			
DESIGN PHASE		DESIGN			
CONCEPTUAL		CHECKED			
APPROVED DATE		DRAWN BY RHODES 6-12-96			
		SUBCONTRACT NO.			
		RELEASED			
QUALITY LEVEL					

Lockheed Idaho Technologies Company U.S. DEPARTMENT OF ENERGY FOR IDAHO OPERATIONS OFFICE A/E CONTRACT NO. 18933	
SPENT NUCLEAR FUEL DRY TRANSFER FACILITY	
SECTION	
SIZE D INDEX CODE NUMBER 1550 AREA TYPE 1550	DRAWING NO. 18933
SCALE NOTED 18933	A/E DWG. NO. A-11

4	3	2	1
---	---	---	---

ADDCS NO.

D

C

B

A

TOP OF PARAPET
ELEV 164'-0"

TOP OF BEAM
ELEV 144'-2"

FIN FLR
ELEV 96'-6"

TRUCK
BAY

CASK
HANDLING BAY

CASK
PREPARATION AREA

SECTION

SCALE: 3/32"=1'-0"

C
TYP

FOR DRAWING INDEX SEE DRAWING NO.		APPROVALS		DATE		U.S. DEPARTMENT OF ENERGY FOR IDAHO OPERATIONS OFFICE IDAHO FALLS, IDAHO A/E CONTRACT NO. 13223	
0 1" 2" SCALE: 1" = 1" IN 1/10"		PROJECT NO.S		CONST REV		CPP	
0 1" 2" SCALE: 1" = 1" IN 1/16"		DESIGN PHASE		DESIGN		DRY FUEL STORAGE FACILITY	
		CONCEPTUAL		CHECKED		SECTION	
QUALITY LEVEL		APPROVED		DATE		SIZE INDEX CODE NUMBER AREA TYPE G. 1 ORIG D 200 00 530	
				RELEASED		DRAWN B. SEARLE 5/96 SUBCONTRACT NO.	
						SCALE NOTED 189CONST	
						REV A/E DWG. NO. A-12	

132'-0"
REF

D

C

→

B

A

150'-0"
REF

1

2

3

4

5

A

B

C

D

E

F

TRUCK BAY

CASK
PREPARATION
AREA

WELDING
EQUIP

GAS
SYSTEM

COMM

UP
LOBBY

RADCON

READY ROOM

SUPT.
OFF

JAN.

ELEC
ROOM

WOMEN

MEN

UPB

MECHANICAL
ROOM

CANNING

CONTAMINATION CONTROL PLAN

SCALE: 3/32"=1'-0"

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED

PROCESS AREA (ZONE III)

MAIN BUILDING AREA (ZONE I)

PERSONNEL BUILDING AREA (ZONE IV)

FOR DRAWING INDEX SEE DRAWING NO.		APPROVALS		DATE	
 SCALE: 1" = 1' IN 1/10"		PROJECT NO.S		CONST REV	
		DESIGN PHASE		P.M.	
		CONCEPTUAL		DES MGR	
		APPROVED		DATE	
QUALITY LEVEL		SUBCONTRACT NO.		RELEASED	
		DRAWN		5/96	
		CHECKED			
		DESIGNED			
		P.M.			
		DES MGR			
		CHECKED			
		DRAWN		5/96	
		SUBCONTRACT NO.			
		RELEASED			
		LOCKHEED		U.S. DEPARTMENT OF ENERGY	
		Idaho Technologies Company		FOR IDAHO OPERATIONS OFFICE	
				IDAHO FALLS, IDAHO	
				A/E CONTRACT NO. 13323	
		CPP		SPENT NUCLEAR FUEL	
				DRY STORAGE FACILITY	
				CONTAMINATION CONTROL PLAN	
		SIZE		INDEX CODE	
		D		1530	
		AREA		TYPE	
		SCALE		NONE	
		3338-HV6		188CONST	
		HY-1			

D
C
B
A
ADCS NO.

D

C

B

A

HOT CELL AND CASK PREPARATION AREA HVAC SYSTEM

UTILITY SUPPORT AREA HVAC SYSTEM

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED

NOTES

1. MINIMUM CELL EXHAUST AIR VELOCITY 2500-3000 FPM.
2. MINIMUM CELL AIR CHANGES PER HOUR: 6 PER ERDA 76.21.
3. DAMPER TO CLOSE ON LOSS OF INSTRUMENT AIR OR ELECTRICAL POWER, OR WHEN HOT CELL SHIELDING DOOR IS CLOSED AND CELL PRESSURE IS $> .25"$ W.G.
4. DAMPERS TO CLOSE AND FANS TO STOP IF FIRE IS DETECTED UPSTREAM OF FILTERS.
5. VENTILATION SYSTEM DESIGN PER ANSI/ANS5.3. DESIGN CRITERIA FOR AN INDEPENDENT SPENT FUEL STORAGE INSTALLATION. (DRY TYPE)
6. PROVIDE INSTRUMENTS TO MEASURE DIFFERENTIAL PRESSURE ACROSS ALL FILTERS.
7. MAXIMUM STEAM CAPACITY ASSUMES FAILURE OF HEAT RECOVERY SYSTEM.

FOR DRAWING INDEX SEE DRAWING NO.		APPROVALS		DATE		U.S. DEPARTMENT OF ENERGY FOR IDAHO OPERATIONS OFFICE IDAHO FALLS, IDAHO A/E CONTRACT NO. 13223
PROJECT NO.S	CONST REV			CPP	
DESIGN PHASE		P.W.	DES MGR			SPENT NUCLEAR FUEL DRY STORAGE FACILITY HVAC SCHEMATIC	
CONCEPTUAL		DESIGN	CHECKED				
APPROVED		DATE	DRAWN	BRONSON	5/96		
QUALITY LEVEL			SUBCONTRACT NO.			SIZE INDEX CODE NUMBER D AREA TYPE CL ORIG 200 201530	
			RELEASED			DRAWING NO. REV A/E DTC. NO. SCALE NONE 1SSCONST HV-2

D
C
B
A

ADOCS NO.

132'-0"
REF

D

1

2

3

4

5

A

LIMIT BOUNDARY
OF CRANE HOOK

TRUCK BAY

FIN. EL 96'-6"

FIN. EL 100'-0"

B

C

8'-0"
TYP

C

150'-0"
REF

CASK
PREPARATION
AREA
BELOW

D

WELDING
EQUIP

GAS
SYSTEM

ANTI-C
CHANGE

BUFFER AREA

CANNING

B

UP

COMM

UP

LOBBY

E

SUPT.
OFF.

JAN.

ELEC
ROOM

RADCON

READY ROOM

WOMEN

MEN

UPB

AHU-3

AHU-2

MECHANICAL
ROOM

ACU-1

A

HYAC SYSTEMS MAIN FLOOR

SCALE: 3/32"=1'-0"

NOTES

- DUCTING IS SHOWN FOR LAYOUT AND IS NOT TO SCALE.
- DUCTING FOR ADMINISTRATIVE AREA TO BE ROUTED FROM AHU-5 TO ALL AREAS AS SHOWN ON DRAWING HV-3.

FOR DRAWING INDEX SEE DRAWING NO.		APPROVALS		DATE				U.S. DEPARTMENT OF ENERGY FOR IDAHO OPERATIONS OFFICE IDAHO FALLS, IDAHO A/E CONTRACT NO. 13223	
 SCALE: 1" = 1' IN 1/10"		PROJECT NO.		CONST. REV.		CPP		SPENT NUCLEAR FUEL DRY STORAGE FACILITY	
 SCALE: 1" = 1' IN 1/16"		DESIGN PHASE		DESIGN		DES. MGR.		DRAWING NO.	
		CONCEPTUAL		CHECKED		DRAWN: BRONSON		5/96	
APPROVED		DATE		SUBCONTRACT NO.		INDEX CODE NUMBER		REV	
QUALITY LEVEL				RELEASED		AREA TYPE		A/E DWG. NO.	
						530		HV-4	
						SCALE NOTED		188CON8T

D

C

B

A

HYAC SYSTEM LEVEL TWO

SCALE: 3/32"=1'-0"

132'-0"

16'-0"

150'-0"

D

C

B

A

1

2

3

4

A

B

C

D

E

F

RECIRCULATED
AIR INTAKE

OUTSIDE AIR
INTAKE AT ROOF

AHU-1

AIR HANDLER ROOM

CASK
PREPARATION
AREA
BELOW

LOWER ROOF AREA

UP

CANN

HYAC SYSTEM LEVEL THREE

SCALE: 3/32"=1'-0"

FLOOR

FOR DRAWING INDEX SEE DRAWING NO.		APPROVALS		DATE				U.S. DEPARTMENT OF ENERGY FOR IDAHO OPERATIONS OFFICE IDAHO FALLS, IDAHO A/E CONTRACT NO. 13223	
PROJECT NO.S DESIGN PHASE CONCEPTUAL APPROVED DATE QUALITY LEVEL	0 1" 2" SCALE: 1" = 1' IN 1/10" 0 1" 2" SCALE: 1" = 1' IN 1/16"	CONST REV				CPP		SPENT NUCLEAR FUEL DRY STORAGE FACILITY	
		P.M.							
		DES MGR							
		DESIGN							
		CHECKED							
		DRAWN	BRONSON	5/96				HVAC SYSTEM-LEVEL THREE	
		SUBCONTRACT NO.							
		RELEASED							
		SIZE INDEX CODE NUMBER AREA TYPE T CA ORIG D 530		DRAWING NO.		REV		A/E DRG. NO.	
		SCALE		SPEC		189CONST		HY-6	

335B-HV5

ADOC NO. A

LOAD CENTER 3 480 VAC, 3 PH, COMM/STAND-BY

D

1000AF
800AT

800AT
GFI

C

250A

100A

200A

60A
MCP

10A
MCP

40A
MCP

15A
MCP

DSW

DSW

DSW

CONTROL
PANEL

CONTROL
PANEL

CONTROL
PANEL

CABLE
REEL

CABLE
REEL

CABLE
REEL

150 TON CRANE
15 TON AUXILIARY HOIST

7 1/2 TON CRANE

FUEL HANDLING CRANE

480/277V CASK DISTRIBUTION
CASK HANDLING

CASK HANDLING B.

B

A

ONE-LINE DIAGRAM

FOR DRAWING INDEX SEE DRAWING NO.

0 1" 2"
SCALE: 1" = 1' IN 1/10"

0 1" 2"
SCALE: 1" = 1' IN 1/16"

QUALITY LEVEL

APPROVALS

DATE

CONST REV

P.M.

DES MGR

DESIGN

CHECKED

DRAWN D BRONSON/96

SUBCONTRACT NO.

RELEASED

U.S. DEPARTMENT OF ENERGY
IDAHO OPERATIONS OFFICE
IDAHO FALLS, IDAHO
A/E CONTRACT NO. 13223

Lockheed
Idaho Technologies Company

CPP

**SPENT NUCLEAR FUEL
DRY STORAGE FACILITY**

ONE-LINE DIAGRAM

INDEX CODE NUMBER
AREA TYPE T.C. 1208

DRAWING NO. 101530

REV 1

A/E Dwg. NO. E-1

3338-EI

MAIN LEVEL FLOOR PLAN
SCALE: 3/32"=1'-0"

LEGEND

- CM CRITICALITY MONITOR
- FCM PERSONNEL CONTAMINATION MONITOR
- CAM BETA/GAMMA CONSTANT AIR MONITOR
- RAM RADIATION AIR MONITOR
- ACAM ALPHA CONSTANT AIR MONITOR
- △ PASSIVE INFRARED DETECTORS
- REMOTE ACCESS PANEL (CARD READER)
- DOOR ALARMS
- ARGUS FIELD PANEL

FOR DRAWING INDEX SEE DRAWING NO.		APPROVALS		DATE				U.S. DEPARTMENT OF ENERGY FOR IDAHO OPERATIONS OFFICE IDAHO FALLS, IDAHO A/E CONTRACT NO. 13223	
PROJECT NO.S		CONST REV						CPP	
DESIGN PHASE		DESIGN		DES MGR				SECURITY ALARMS & RADIATION INSTRUMENTATION	
CONCEPTUAL		CHECKED		DRAWN BRONSON		5/96		DRAWING NO.	
APPROVED		DATE		SUBCONTRACT NO.				REV	
QUALITY LEVEL				RELEASED				A/E Dwg. NO.	

SIZE	INDEX CODE	NUMBER	DRAWING NO.	REV	A/E Dwg. NO.
D	AREA TYPE	CL	ORIG		
SCALE	NOTED	SPEC	CODE	188CON8T	E-2

LEVEL TWO FLOOR PLAN

SCALE: 3/32"=1'-0"

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED

FOR DRAWING INDEX SEE DRAWING NO.		APPROVALS		DATE	
<p>SCALE 1" = 1' IN 1/10"</p> <p>SCALE 1" = 1' IN 1/16"</p>		PROJECT NOS. DESIGN PHASE CONCEPTUAL APPROVED		CONST. REV. P.L. DES. MGR. DESIGN CHECKED DRAWN SUBCONTRACT NO.	
QUALITY LEVEL RELEASED		DATE 5/96		U.S. DEPARTMENT OF ENERGY FOR DIVISION OF PLANT AND ENVIRONMENTAL SERVICES AT CONTRACT NO. 15220	
SECURITY ALARMS & RADIATION INSTRUMENTATION DRY STORAGE FACILITY CFP SIZE INDEX CODE NUMBER 1530		DRAWING NO. REV A/E DWE. NO.		3358-E3 186CON8T E-3	

ADDCS NO. A

132'-0"

16'-0"

D

C

B

A

150'-0"

(A)

(B)

(C)

(D)

(E)

(F)

(1)

(2)

(3)

(4)

DEMOUNTABLE
PLATFORM/GRATING

DEMOUNTABLE
BEAM

RAILING

FIN EL 120'-0"

CASK
PREPARATION
AREA
BELOW

AIR HANDLER ROOM

CAN WELDING
AND
INERTING EQUIP

RAM

CAN

CANNI

DN

UP

LOWER ROOF AREA

LEVEL THREE FLOOR F

SCALE: 3/32"=1'-0"

PLAN

FOR DRAWING INDEX SEE DRAWING NO.		APPROVALS		DATE		U.S. DEPARTMENT OF ENERGY FOR IDAHO OPERATIONS OFFICE IDAHO FALLS, IDAHO A/E CONTRACT NO. 13223	
0 1" 2" SCALE: 1" = 1" IN 1/10"		PROJECT NO.S		CONST REV		CPP	
0 1" 2" SCALE: 1" = 1" IN 1/16"		DESIGN PHASE		DES MGR		SPENT NUCLEAR FUEL DRY STORAGE FACILITY	
QUALITY LEVEL		CONCEPTUAL		CHECKED		SECURITY ALARMS & RADIATION INSTRUMENTATION	
APPROVED		DATE		DRAWN BRONSON 5/96		INDEX CODE NUMBER AREA TYPE CL DRG 1530	
				SUBCONTRACT NO.		DRAWING NO. REV A/E DWG. NO.	
				RELEASED		SCALE 188CONST	
						E-4	

3358-E4

ADOC NO.

D

C

B

A

PARTIAL MAIN FLOOR EQUIPMENT ARRANGEMENT

SCALE: 3/16"=1'-0"

4
3
2
1

FOR DRAWING INDEX SEE DRAWING NO.

0 1" 2"
SCALE: 1" = 1" IN 1/10"

0 1" 2"
SCALE: 1" = 1" IN 1/16"

QUALITY LEVEL

PROJECT NO.	
DESIGN PHASE	CONCEPTUAL
APPROVED	DATE

APPROVALS	DATE
CONST REV	
P.M.	
DES MGR	
CHECKED	
DRAWN HURLEY	5-22-96
SUBCONTRACT NO.	
RELEASED	

U.S. DEPARTMENT OF ENERGY
FOR IDAHO OPERATIONS OFFICE
IDAHO FALLS, IDAHO
A/E CONTRACT NO. 15223

CPP

**SPENT NUCLEAR FUEL
DRY TRANSFER FACILITY**

PARTIAL MAIN FLOOR EQUIPMENT ARRANGEMENT

SIZE	INDEX CODE	NUMBER	DRAWING NO.	REV	A/E DWG. NO.
D	AREA	TYPE	530		M-1
SCALE	NOTED				

4
3
2
1

3339-01A

1

NT

A
ADDCS NO.

D

2

3

4

C

C

CASK
PREPARATION
AREA
BELOW

7.5 TON
UNDER HUNG HOIST

→

D

B

WELDER
POWER
SUPPLY

GAS FOR
CANNING
SYSTEM
WELDING &
INNERTING

CANNING
WELD
CONSOLE

A

NOTE:
THE FOLLOWING HAVE BEEN REMOVED FOR CLAIRITY:
WASTE BOX
ROLLING STAIRWAY
CANNING EQUIPMENT
CAN/BUCKET RACKS

E

PARTIAL LEVEL THREE AND ABOVE EQUIP

SCALE: 3/16"=1'-0"

OPERATING LIMIT OF 15 TON HOIST

OPERATING LIMIT OF Z-MAST

FUEL
HANDLING
CRANE

40T CELL BELOW

OPERATING LIMIT OF Z-MAST

OPERATING LIMIT OF 15 TON HOIST

OPERATING GALLERY
FIN FL EL 128'-0"

ENT ARRANGEMENT

FOR DRAWING INDEX SEE DRAWING NO.		APPROVALS		DATE		U.S. DEPARTMENT OF ENERGY FOR DAAO OPERATIONS OFFICE 1400 FALLS CHURCH A/E CONTRACT NO. 13223
PROJECT NO.'S		CONST REV		CPP
DESIGN PHASE		DES MGR		SPENT NUCLEAR FUEL DRY TRANSFER FACILITY PARTIAL LEVEL THREE & ABOVE EQUIPMENT ARRANGEMENT	
CONCEPTUAL		DESIGN		CHECKED			
APPROVED		DATE		DRAWN HURLEY 5-22-96			
QUALITY LEVEL				SUBCONTRACT NO.		SIZE INDEX CODE NUMBER D AREA TYPE CL ORIG SCALE 5330	
				RELEASED		DRAWING NO. REV A/E DWG. NO. M-2	

D

C

B

A

ADDCS NO.

D

C

B

A

SECTION

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED

FORCING AND
DING STATION

A
M-1

FOR DRAWING INDEX SEE DRAWING NO.		APPROVALS		DATE		 <small>Lockheed Technologies Company</small>		<small>U.S. DEPARTMENT OF ENERGY</small> <small>FOR IDAHO OPERATIONS OFFICE</small> <small>IDAHO FALLS, IDAHO</small> <small>A/E CONTRACT NO. 13223</small>	
<div style="display: flex; align-items: center;"> <div style="flex: 1;"> <p style="font-size: 0.8em;">SCALE: 1" = 1' IN 1/10"</p> </div> <div style="flex: 1; border-left: 1px solid black; padding-left: 5px;"> <div style="display: flex; justify-content: space-between; font-size: 0.7em;"> PROJECT NO.S DESIGN PHASE </div> <div style="text-align: center; font-weight: bold; font-size: 0.8em;">CONCEPTUAL</div> <div style="display: flex; justify-content: space-between; font-size: 0.7em;"> APPROVED DATE </div> </div> </div>		<div style="display: flex; justify-content: space-between; font-size: 0.7em;"> CONST REV P.N. </div> <div style="display: flex; justify-content: space-between; font-size: 0.7em;"> DES MGR DESIGN </div> <div style="display: flex; justify-content: space-between; font-size: 0.7em;"> CHECKED DRAWN HENDRICKS/5/30/96 </div>		<div style="display: flex; justify-content: space-between; font-size: 0.7em;"> CPP SPENT NUCLEAR FUEL DRY TRANSFER FACILITY </div> <div style="display: flex; justify-content: space-between; font-size: 0.7em;"> PARTIAL ELEVATION EQUIPMENT ARRANGEMENT INDEX CODE NUMBER </div>		<div style="display: flex; justify-content: space-between; font-size: 0.7em;"> SIZE AREA </div> <div style="display: flex; justify-content: space-between; font-size: 0.7em;"> TYPE CL </div>		<div style="display: flex; justify-content: space-between; font-size: 0.7em;"> DRAWING NO. REV </div> <div style="display: flex; justify-content: space-between; font-size: 0.7em;"> A/E DRG. NO. M-3 </div>	
<div style="display: flex; align-items: center;"> <div style="flex: 1;"> <p style="font-size: 0.8em;">SCALE: 1" = 1' IN 1/16"</p> </div> <div style="flex: 1; border-left: 1px solid black; padding-left: 5px;"> <div style="display: flex; justify-content: space-between; font-size: 0.7em;"> QUALITY LEVEL RELEASED </div> </div> </div>		<div style="display: flex; justify-content: space-between; font-size: 0.7em;"> SUBCONTRACT NO. SCALE 3/16" = 1'-0" </div>		<div style="display: flex; justify-content: space-between; font-size: 0.7em;"> INDEX CODE NUMBER 530 </div>		<div style="display: flex; justify-content: space-between; font-size: 0.7em;"> AREA TYPE </div>		<div style="display: flex; justify-content: space-between; font-size: 0.7em;"> CL ORIG </div>	

ADDCS NO. A

D

C

B

A

OPERATING GALLERY

OPERATING GALLERY

CORRIDOR

15 TON
HOIST

Z-MAST
(2.5 TON CAPACITY)

ELECTROMECHANICAL
MANIPULATOR (2)
250 LB CAPACITY

FUEL HANDLING CRANE

PAN
C

HOT CELL

LAG STORAGE AREA

CANNING & DRY
HANDLING
BUCKET RACKS

TROLLEY &
TRANSFER CASK

SECTION

B
M-1

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED

TILT UNIT VIDEO
CAMERA W/ZOOM
LENS (TYP)

ROLLING
STAIRWAY

FOR DRAWING INDEX SEE DRAWING NO.		APPROVALS		DATE		U.S. DEPARTMENT OF ENERGY FOR IDAHO OPERATIONS OFFICE IDAHO FALLS, IDAHO A/E CONTRACT NO. 13223	
0 1" 2" SCALE: 1" = 1' IN 1/10"		PROJECT NO.S		CONST REV		CPP	
0 1" 2" SCALE: 1" = 1' IN 1/15"		DESIGN PHASE		P.M.		SPENT NUCLEAR FUEL DRY TRANSFER FACILITY	
CONCEPTUAL		DESIGN		DES MGR		PARTIAL ELEVATION EQUIPMENT ARRANGEMENT	
APPROVED		DATE		CHECKED		DRAWN HENDRICKS 5/23/96	
QUALITY LEVEL		SUBCONTRACT NO.		RELEASED		INDEX CODE NUMBER AREA TYPE CL ORIG D 530	
						DRAWING NO. REV A/E Dwg. No. M-4	

sectbb

ADCS NO.

D

C

B

A

CASK
HANDLING BAY

CASK PREPARATION
AREA CRANE

2.5 TON HOIST

CASK
PREPARATION AREA

OPERATING
GALLERY

CANNING WELD
CONSOLE

WELD
OBSERVATION AREA

DPC WELD
CONSOLE

WORK PLATFORM
SEE DWG M-8

HELIUM
LEAK TESTING

VACUUM DRYING
SYSTEM

BUFFER

SECTION

C
M-1

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED

CRANE
CONTROL ROOM

FUEL HANDLING CRANE
OPERATOR CONTROL CENTER

FIN FLR
ELEV 100'-0"

FOR DRAWING INDEX SEE DRAWING NO.		APPROVALS		DATE	
PROJECT NO.S		CONST REV			
		P.M.			
		DES MGR			
DESIGN PHASE		DESIGN			
CONCEPTUAL		CHECKED			
DRAWN HENDRICKS 5/23/96		SUBCONTRACT NO.			
APPROVED	DATE	RELEASED			
QUALITY LEVEL					

Lockheed <i>Idaho Technologies Company</i>		U.S. DEPARTMENT OF ENERGY FOR IDAHO OPERATIONS OFFICE IDAHO FALLS, IDAHO A/E CONTRACT NO. 13223	
CPP		SPENT NUCLEAR FUEL DRY TRANSFER FACILITY	
PARTIAL ELEVATION EQUIPMENT ARRANGEMENT			
SIZE D	INDEX CODE AREA TYPE	NUMBER 530	DRAWING NO.
SCALE 1/2"=1'-0"		SPEC CODE	REV
		A/E DWG. NO. M-5	

ADOS NO. 13223

D

C

B

A

ADJUSTABLE SHELF REF

ADJUSTABLE SHELF

CANNING AREA BUCKET RACK

HOT CELL BUCKET RACK

FOR DRAWING INDEX SEE DRAWING NO.		APPROVALS		DATE		 U.S. DEPARTMENT OF ENERGY FOR IDAHO OPERATIONS OFFICE IDAHO FALLS, IDAHO A/E CONTRACT NO. 13223	
0 1" 2" SCALE: 1" = 1" IN 1/10"		PROJECT NO.S		CONST REV		CPP	
0 1" 2" SCALE: 1" = 1" IN 1/16"		DESIGN PHASE		P.N.		SPENT NUCLEAR FUEL DRY TRANSFER FACILITY	
QUALITY LEVEL		CONCEPTUAL		DESIGN		CANNING AND DRY HANDLING BUCKET RACKS	
APPROVED		DATE		CHECKED		DRAWING NO.	
RELEASED		SUBCONTRACT NO.		DRAWN HENDRICKS 5/16/96		REV	
				SCALE 1/2" = 1'-0"		A/E DWG. NO.	
				SPEC CODE		M-7	

A
ADDCS NO.

consupp2

D

C

B

A

PLATFORM DECKING W/ADAPTER
SECTIONS FOR VARIOUS CASK
CONFIGURATIONS

WORK PLATFORM

FOR DRAWING INDEX SEE DRAWING NO.		APPROVALS		DATE		 SPENT NUCLEAR FUEL DRY TRANSFER FACILITY		
 SCALE: 1" = 1' IN 1/10"	PROJECT NO.S DESIGN PHASE CONCEPTUAL APPROVED DATE	CONST REV						U.S. DEPARTMENT OF ENERGY FOR IDAHO OPERATIONS OFFICE IDAHO FALLS, IDAHO A/E CONTRACT NO. 13222
		DESIGN						
		CHECKED						
 SCALE: 1" = 1' IN 1/16"	DRAWN HENDRICKS 5/28/96 SUBCONTRACT NO. RELEASED	 CPP		CASK PREPARATION AREA WORK PLATFORM & DETAILS		M-8		
		SIZE INDEX CODE NUMBER AREA TYPE GL ORIS		DRAWING NO.				
		SCALE 3/8"=1'-0"		PREPARED BY				

D

C

B

A

D
C
B
A
ADDCS NO.

FOR DRAWING INDEX SEE DRAWING NO.		APPROVALS		DATE	
0 1" 2" SCALE: 1" = 1' IN 1/10"		PROJECT NO.	CONST REV		
0 1" 2" SCALE: 1" = 1' IN 1/16"		DESIGN PHASE	P.N.		
		CONCEPTUAL	DES MGR		
		APPROVED	DESIGN		
		DATE	CHECKED		
			DRAWN		
			SUBCONTRACT NO.		
			RELEASED		
		U.S. DEPARTMENT OF ENERGY FOR IDAHO OPERATIONS OFFICE IDAHO FALLS, IDAHO A/E CONTRACT NO. 13223			
		Lockheed Idaho Technologies Company		CPP	
		SPENT NUCLEAR FUEL DRY TRANSFER FACILITY			
		CANNING PLATFORM AND EQUIPMENT ARRANGEMENT			
		SIZE	INDEX CODE	NUMBER	DRAWING NO.
		D	AREA	TYPE	CL
				530	
		SCALE	SPEC		REV
			CODE		A/E DWG. NO.
					M-9

FOR DRAWING INDEX SEE DRAWING NO.		APPROVALS		DATE	
<div style="display: flex; align-items: center;"> <div style="margin-right: 10px;"> <p>SCALE: 1" = 1" IN 1/16"</p> </div> <div> <p>PROJECT NO. S</p> <p>DESIGN PHASE</p> <p>CONCEPTUAL</p> <p>APPROVED</p> <p>DATE</p> <p>QUALITY LEVEL</p> </div> </div>		CONST REV		<div style="display: flex; align-items: center;"> <div style="margin-left: 10px; font-size: x-small;"> U.S. DEPARTMENT OF ENERGY FOR IDAHO OPERATIONS OFFICE IDAHO FALLS, IDAHO A/E CONTRACT NO. 13223 </div> </div>	
		P.N.			
		DES MGR			
		DESIGN			
CHECKED		DRAWN F HURLEY		5/14/96	
SUBCONTRACT NO.		RELEASED		<div style="display: flex; align-items: center;"> <div style="margin-right: 10px;"> <p>SIZE D</p> <p>SCALE 3/4"=1'-0"</p> </div> <div> <p>INDEX CODE NUMBER 530</p> <p>AREA TYPE 530</p> </div> </div>	
<div style="display: flex; align-items: center;"> <div style="margin-right: 10px;"> <p>CPP</p> <p>SPENT NUCLEAR FUEL DRY TRANSFER FACILITY</p> <p>CASK LIFTING YOKES AND CASKS</p> </div> <div> <p>DRAWING NO.</p> <p>REV</p> <p>A/E Dwg. NO. M-10</p> </div> </div>					
		Yokecast			

D

C

B

A

DETAIL (1) (4) (5)

DETAIL (2)

D

C

B

A

TRANSFER CASK FOR DPC

TN-BRP CASK

TN-

REG CASK

FORT ST VRAIN CASK

PEACH BOTTOM CASK

FOR DRAWING INDEX SEE DRAWING NO.		APPROVALS		DATE	
PROJECT NO.S		CONST REV			
DESIGN PHASE		P.M.			
CONCEPTUAL		DES MGR			
APPROVED		CHECKED			
DATE		DRAWN HENDRICKS		1/31/96	
QUALITY LEVEL		SUBCONTRACT NO.			
		RELEASED			

Lockheed

Idaho Technologies Company

U.S. DEPARTMENT OF ENERGY

FOR IDAHO OPERATIONS OFFICE

IDAHO FALLS, IDAHO

1/2 CONTRACT NO. 15253

CPP

SPENT NUCLEAR FUEL

DRY TRANSFER FACILITY

SHIPPING AND TRANSFER CASKS & TROLLEY ARRANGEMENTS

SIZE	INDEX CODE	NUMBER	DRAWING NO.	REV	A/E ORG. NO.
D	AREA	TYPE	CL	ORIG	
			530		
SCALE 1/2"=1'-0"			M-12		

D

C

B

A

NFS 100 CASK

HIGH LOAD CHARGER CASK

ATR SPENT FUEL
TRANSFER CASK

4

3

2

1

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED

HFEF-6 CASK

STR CHARGING CASK

FOR DRAWING INDEX SEE DRAWING NO.		APPROVALS		DATE	
 SCALE: 1" = 1' IN 1/10"		PROJECT NO. S DESIGN PHASE CONCEPTUAL APPROVED DATE		CONST REV P.N. DES MGR DESIGN CHECKED DRAWN: HENDRICKS 1/31/96 SUBCONTRACT NO. RELEASED	
 SCALE: 1" = 1' IN 1/15"		QUALITY LEVEL		LOCKHEED Idaho Technologies Company U.S. DEPARTMENT OF ENERGY FOR IDAHO OPERATIONS OFFICE IDAHO FALLS, IDAHO A/E CONTRACT NO. 13223	
SPENT NUCLEAR FUEL DRY TRANSFER FACILITY SHIPPING AND TRANSFER CASKS & TROLLEY ARRANGEMENTS				CPP INDEX CODE NUMBER AREA TYPE CG ORIG D 530 SCALE 1/2" = 1'-0" DRAWING NO. REV A/E Dwg. NO. M-13	

4

3

2

1

cask4a

ADDCS NO.

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED

FOR DRAWING INDEX SEE DRAWING NO.		APPROVALS		DATE		 <small>U.S. DEPARTMENT OF ENERGY FOR IDAHO OPERATIONS OFFICE IDAHO FALLS, IDAHO A/E CONTRACT NO. 1322</small>		
 SCALE: 1" = 1" IN 1/10"	PROJECT NO.S	CONST REV			CPP SPENT NUCLEAR FUEL DRY TRANSFER FACILITY CASK TRANSFER TROLLEY AND RAILS			
	DESIGN PHASE	P.N.						
	CONCEPTUAL	DES MGR						
 SCALE: 1" = 1" IN 1/15"	APPROVED	DATE	CHECKED			SIZE INDEX CODE NUMBER AREA TYPE 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 SCALE 3/4"=1'-0"		
	DESIGN	DRAWN HENDRICKS	1/31/96					
	SUBCONTRACT NO.							
QUALITY LEVEL			RELEASED			DRAWING NO. REV A/E DWG. NO. M-14		

D

C

B

A

SEE DETAIL FOR
PATH FINDER
BUCKET LID

SEE DETAIL FOR
SHIPPINGPORT
BUCKET LID

103.0

"X"
SEE TABLE ON
SHEET M-16 FOR DIM

PATHFINDER BUCKET

14" SCHEDULE 10
SSP PIPE

SHIPPINGPORT BUCKET
USED FOR:
SHIPPINGPORT
DRESDEN
TRIGA
PBF DRIVER CORE
TREAT
PULSTAR
CANDU

12" SCHEDULE 10S
SSP PIPE

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED

NOTE:

ALL MATERIAL IS 304 SST UNLESS OTHERWISE NOTED.

FOR DRAWING INDEX SEE DRAWING NO.		APPROVALS		DATE	
<div style="display: flex; align-items: center;"> <div style="width: 20px; height: 20px; border: 1px solid black; margin-right: 5px;"></div> <div> <p>1"</p> <p>SCALE: 1" = 1" IN 1/10"</p> </div> </div> <div style="display: flex; align-items: center; margin-top: 5px;"> <div style="width: 20px; height: 20px; border: 1px solid black; margin-right: 5px;"></div> <div> <p>1"</p> <p>SCALE: 1" = 1" IN 1/16"</p> </div> </div>	PROJECT NO.S	CONST REV			
	DESIGN PHASE	P.M.			
	CONCEPTUAL	DES MGR			
	APPROVED	DESIGN			
DATE	CHECKED				
	DRAWN HENDRICKS 5/28/96				
	SUBCONTRACT NO.				
	RELEASED				

U.S. DEPARTMENT OF ENERGY

FOR IDAHO OPERATIONS OFFICE

IDAHO FALLS, IDAHO

A/E CONTRACT NO. 13223

SPENT NUCLEAR FUEL DRY TRANSFER FACILITY

TUBE BASKET, BUCKETS AND CANS

SIZE	INDEX CODE NUMBER	DRAWING NO.	REV	A/E DWG. NO.
D	AREA 1 TYPE 1 G 1 ORG	530		M-15
SCALE	NONE	SHEET		

D

SECTION B
SCALE: 3"=1'-0"

DRESDEN
(4.4 X 4.4 X 135 LONG)

SECTION B
SCALE: 3"=1'-0"

CANDU
(3.5" DIA X 12" LONG)

SECTION B
SCALE: 3"=1'-0"

TREAT
(3.96" X 3.96" X 96" LONG)

SEC
SCALE:

SHIPP
(138" X 1.
SHIPPIN
(138" X 1.

C

SECTION B
SCALE: 3"=1'-0"

TRIGA
(1.48" DIA X 36.8" LONG)
ACRR ELEMENTS
(1.41" DIA X 28.8" LONG)
ACRR EXPERIMENTS
(1.41" DIA X 28.8" LONG)

SECTION B
SCALE: 3"=1'-0"

PULSTAR-BUFFALO
(3.0" 3.0" X 28" LONG)
PULSTAR-N.C. STATE UNIV.
(2.74" 3.15" X 31.98" LONG)
PULSTAR-SUNY-BUFFALO
(2.74" X 3.15" X 38" LONG)
TRIGA BER-II GERMANY
(3.15" 2.93" X 36.8" LONG)
TRIGA FLIP
(3.8" DIA X 30" LONG)

B

SECTION A
SCALE: 3"=1'-0"

PATHFINDER
(3.62 X 3.62 X 84 LONG)
FOR PLACEMENT IN FBVR BASKET
TUBE

SECTION C
SCALE: 3"=1'-0"

PEACH BOTTOM CORE 2
(3.5" DIA X 126" LONG)

SECTION C
SCALE: 3"=1'-0"

PEACH BOTTOM CORE 1
(4.75" DIA X 153" LONG)

A

NOTE
CROSSHATCHED AREAS REPRESENT
FUEL CROSS SECTIONS

FOR DRAWING INDEX SEE DRAWING NO.

PROJECT NOS.

DESIGN PHASE

CONCEPTUAL

APPROVED DATE

RELEASED

SUBCONTRACT NO.

DRAWN

CHECKED

DES. MGR.

P.L.

CONST. REV.

DATE

APPROVALS

DATE

DATE

DATE

DATE

DATE

DATE

DATE

DATE

U.S. DEPARTMENT OF ENERGY
FOR DAVID OPERATIONS OFFICE
AT CONTRACT NO. 12223
A/E DRL NO.

CPD
Lockheed
Lockheed Technologies Company
TUBE CONFIGURATION CROSS SECTIONS

SCALE NONE
D
AREA TYPE O
ORIG
5.30
M-16

ADDCS NO.

SNF NAME	BODY STYLE	LENGTH (X)	CRUCIFORM STYLE	LID STYLE	CELLS	LAYERS	FBU PER BUCKET	TOTAL FBU 2035
ACRR ELEMENTS	TRIQA	41.5	SHIPPINGPORT	24	1	24	11	256
ACRR EXPERIMENTS	TRIQA	41.5	SHIPPINGPORT	24	1	24	N/A	1
CANDU (12" LG)	CANDU	41.5	SHIPPINGPORT	1	3	21	1	3
CANDU (166" LG)	TBD	TBD	TBD	TBD	TBD	TBD	14	28
DRESDEN	DRESDEN	166.0	SHIPPINGPORT	2	1	2	14	28
PATHINDER	PATHINDER	103.0	PATHINDER	1	1	1	7	16
PBF DRIVER CORE (51/62 ROD)	PBF-51	166.0	SHIPPINGPORT	1	3	3	6	16
PBF DRIVER CORE (34/46/49 ROD)	PBF-34	166.0	SHIPPINGPORT	1	3	3	14	40
PBF DRIVER CORE (28-ROD)	PBF-28	166.0	SHIPPINGPORT	2	3	6	1	4
PEACH BOTTOM CORE 1	TREAT	166.0	PEACHBOTTOM	4	1	4	204	814
PEACH BOTTOM CORE 2	CANDU	166.0	PEACHBOTTOM	1	1	7	113	186
PULSTAR-BUFFALO	PULSTAR-BUFFALO	33.2	SHIPPINGPORT	5	1	5	5	24
PULSTAR-N.C. STATE UNIV.	PULSTAR-BUFFALO	132.8	SHIPPINGPORT	5	3	15	3	34
PULSTAR-BUNT-BUFFALO	PULSTAR-BUFFALO	132.8	SHIPPINGPORT	5	3	15	3	43
SHIPPINGPORT PWR-C1	PBF-34	132.8	SHIPPINGPORT	11	1	1	1	1
SHIPPINGPORT PWR-C2	SHIPPINGPORT PWR	132.8	SHIPPINGPORT	1	1	1	39	39
TREAT	TREAT	132.8	SHIPPINGPORT	4	1	4	98	390
TRIQA BER-II (GERMANY)	PULSTAR-BUFFALO	41.5	SHIPPINGPORT	5	1	5	5	21
TRIQA-STANDARD (20% ENR)	TRIQA	33.2	SHIPPINGPORT	24	1	24	327	1833
TRIQA (10% ENR)	SHIPPINGPORT	33.2	SHIPPINGPORT	24	1	24	10	228
TRIQA FLIP (10% ENR)	SHIPPINGPORT	41.5	PULSTAR-BUFFALO	24	1	24	23	551
FRR TRIQA (33% ENR)	SHIPPINGPORT	33.2	TRIQA	24	1	24	37	818

SECTION B
SCALE: 3'-1'-0"
(3' X 100' LONG)

SECTION B
SCALE: 3'-1'-0"
(6.13' X 5.83' X 50' LONG)

SECTION B
SCALE: 3'-1'-0"
(6.4' X 5.83' X 50' LONG)

SECTION B
SCALE: 3'-1'-0"
(3.49' X 5.83' X 50' LONG)

REVISIONS

REV. DATE APPROVED

D

27.68" DIA BC

C

→

B

A

14-TUBE BASKET

3-TUBE SHIPPINGPORT LWBR BASKET

D

SECTION E
14-TUBE BASKET IN PAR DPC

SECTION A
3-TUBE SHIPPINGPORT LINER BASKET IN PAR DPC

C

B

A

14-TUBE BUCKETS (DWG M-14)

SHIPPINGPORT LINER CANS

SECTION C
SHIPPINGPORT LINER DPC

SECTION B
14-TUBE DPC SHOWING BUCKET LOADING OPTION

DPC

FOR DRAWING INDEX SEE DRAWING NO.		APPROVALS		DATE		 Lockheed <i>Idaho Technologies Company</i> CPP		U.S. DEPARTMENT OF ENERGY FOR IDAHO OPERATIONS OFFICE IDAHO FALLS, IDAHO A/E CONTRACT NO. 13223			
0 1" 2" SCALE: 1" = 1" IN 1/10"	PROJECT NO.S DESIGN PHASE CONCEPTUAL APPROVED DATE QUALITY LEVEL	CONST REV		P.M.				SPENT NUCLEAR FUEL DRY TRANSFER FACILITY DTC DUAL PURPOSE CANISTER ASSEMBLIES		DRAWING NO. _____ REY _____ A/E DTC NO. M-18	
		DES MGR		DESIGN							
		CHECKED		DRAWN	HURLEY						
RELEASED		SCALE		INDEX CODE NUMBER		AREA TYPE CL ORIG		SPEC CODE			
				530							