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Revision A

UC-630

**State of Washington  
Department of Health  
Radioactive Air Emissions  
Notice of Construction Phase I  
for Spent Nuclear Fuel Project--  
Cold Vacuum Drying Facility,  
Project W-441**

Date Published  
July 1996



**United States  
Department of Energy**

P.O. Box 550  
Richland, Washington 99352

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## LIST OF TERMS

CSB	Canister Storage Building
CVD	Cold Vacuum Drying
CVDF	Cold Vacuum Drying Facility
HCS	Hot conditioning system
HCSA	Hot Conditioning System Annex
HEPA	High-efficiency particulate air
HVAC	heating, ventilation, and air conditioning
MCO	Multi-canister overpacks
NOC	Notice of construction
PUREX	Plutonium-Uranium Extraction
SNF	Spent nuclear fuel
VPS	Vacuum pumping system
WAC	Washington Administrative Code

**STATE OF WASHINGTON DEPARTMENT OF HEALTH  
RADIOACTIVE AIR EMISSIONS  
NOTICE OF CONSTRUCTION PHASE II FOR  
SPENT NUCLEAR FUEL PROJECT--COLD VACUUM DRYING FACILITY,  
PROJECT W-441**

## 1.0 INTRODUCTION

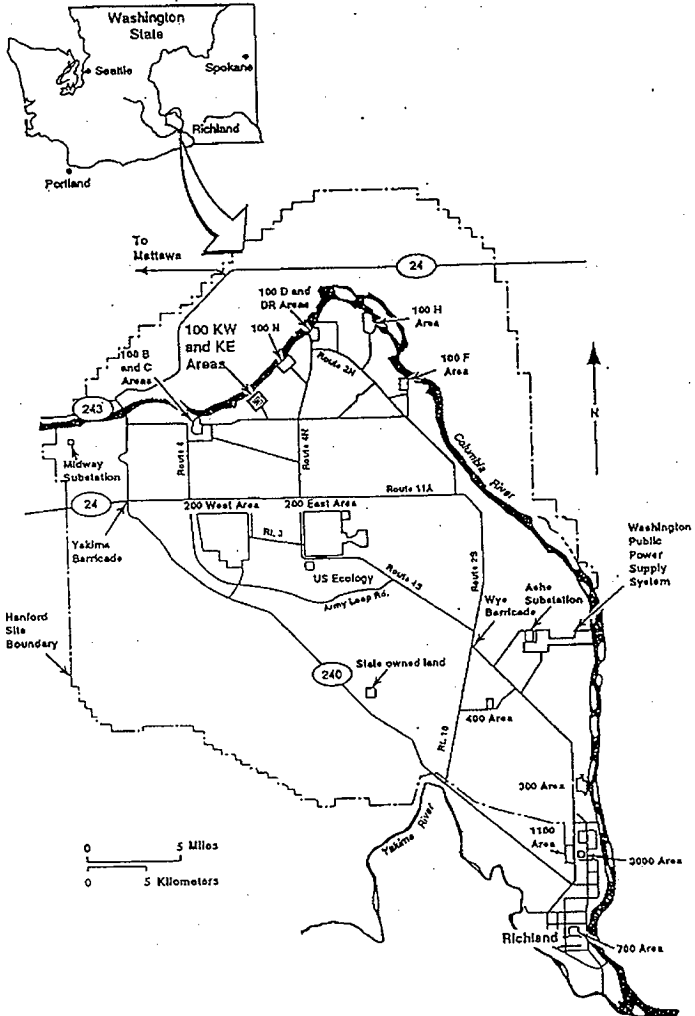
This notice of construction (NOC) provides information regarding the source and the estimated annual possession quantity resulting from operation of the Cold Vacuum Drying Facility (CVDF). Additional details on emissions generated by the operation of the CVDF will be discussed again in the Phase II NOC. This document serves as a NOC pursuant to the requirements of WAC 246-247-060 for the completion of Phase I NOC, defined as the pouring of concrete for the foundation flooring, construction of external walls, and construction of the building excluding the installation of CVDF process equipment. A Phase II NOC will be submitted for approval prior to installing and is defined as the completion of the CVDF, which consisted installation of process equipment, air emissions control, and emission monitoring equipment.

About 80 percent of the U.S. Department of Energy's spent nuclear fuel (SNF) inventory is stored under water in the Hanford Site K Basins. Spent nuclear fuel in the K West Basin is contained in closed canisters while the SNF in the K East Basin is in open canisters, which allow free release of corrosion products to the K East Basin water. Storage in the K Basins was originally intended to be on an as-needed basis to sustain operation of the N Reactor while the Plutonium-Uranium Extraction (PUREX) Plant was refurbished and restarted. The decision in December 1992 to deactivate the PUREX Plant left approximately 2,300 MT (2,530 tons) of N Reactor SNF in the K Basins with no means for near-term removal and processing.

The CVDF will be constructed in the 100 Area northwest of the 190 K West building, which is in close proximity to the K East and K West Basins (Figures 1 and 2). The CVDF will consist of six process bays in which SNF transport trailers can be housed while water is drained and a vacuum/gas purge process dries the SNF. The CVDF will have a support area consisting of a control room, change rooms, and other functions required to support operations.

"Response to Requirement" subtitle under each of the following sections identifies the corresponding Appendix A NOC requirement listed under Washington Administrative Code (WAC) 246-247-110.

Figure 1. Hanford Site and Vicinity Maps.



T950629



## 1.1 PROJECT DESCRIPTION

The SNF presently stored in the K Basins will be retrieved and placed in containers, processed to remove water, and stored dry in accordance with the *Hanford Federal Facility Agreement and Consent Order* (referred to as the Tri-Party Agreement) (Ecology et al. 1994). Processing of the SNF will take place at the Cold Vacuum Drying Facility (CVDF) and HCSA while storage of the SNF will take place at the CSB. Construction of the three facilities has or will begin in 1996.

The SNF will be removed from the K Basins as part of the SNF retrieval process. The first step in chemical processing will begin at the CVDF, where free water (bulk water [water that surrounds the SNF in each vessel containing the SNF] and absorbed water [water that adheres to the SNF after removal of bulk water]) will be removed from the vessel containing SNF. Potential radiological air pollutant emissions generated at the CVDF will be discussed in a separate NOC (Phase II) which will be submitted to the State of Washington Department of Health in accordance with WAC 246-247. Construction of the CVDF is scheduled to begin in November 1996.

After the SNF is dried at the CVDF, it will be moved to the CSB for staging. Once the SNF reaches the CSB, SNF that requires additional drying will be sent to the HCSA for conditioning. A brief process description of the HCSA and the CSB will be presented in this application for information purposes. The CSB construction began in April 1996.

The SNF will be moved from the staging area of the CSB to the HCSA and conditioned for interim storage. After the SNF is conditioned at the HCSA, the SNF will be returned to the CSB and placed into interim storage for up to 40 years. During the interim storage period, the SNF will be stored in sealed containers and little or no emissions will be generated.

## 1.2 NOTIFICATION REQUIREMENT AND GUIDANCE

This document serves as a NOC pursuant to the requirements of WAC 246-247-060 for the completion of Phase I, defined for the purpose of this NOC, as the pouring of concrete for the foundation flooring, construction of external walls, and construction of the building excluding the installation of CVDF process equipment. A Phase II NOC, defined for the purpose of this NOC and Phase II NOC, as the completion of the CVDF, consisting of installation of process equipment, air emissions control, and monitoring equipment will be submitted for approval prior to installation.

### 1.3 FACILITY IDENTIFICATION *(Response to Requirement 2)*

Owner:

U.S. Department of Energy, Richland Operations Office  
P.O. Box 550  
Richland, Washington 99352

Responsible Manager:

Ms. E. D. Seilers, Director, Spent Nuclear Fuels Project Division  
U.S. Department of Energy, Richland Operations Office  
P.O. Box 550  
Richland, Washington 99352

#### 1.3.1 Facility Description

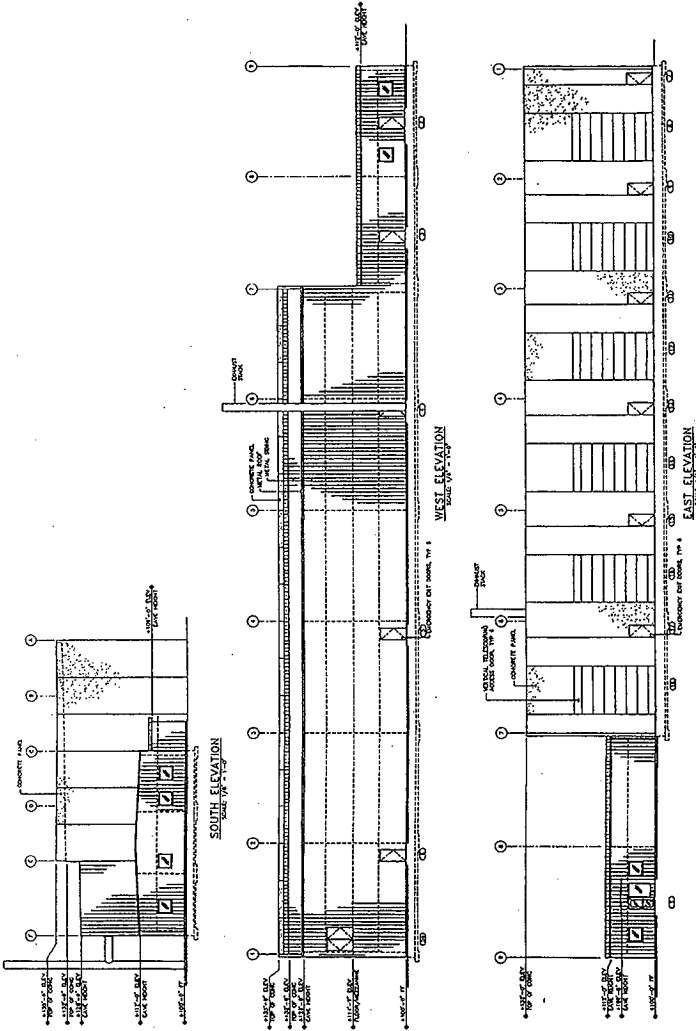
As discussed in the *Conceptual Design Report of the Cold Vacuum Drying System* (WHC 1996a), the CVDF will be the first SNF processing step in ensuring proper storage of the SNF. The main processes and potential emission points of the CVDF are presented in this NOC. The following description of the CVDF is submitted for approval under this NOC.

The CVDF will consist of six process bays within a steel frame pre-engineered metal building containing a second level mezzanine. Attached to the process bays will be a single-story pre-engineered metal building that will enclose administrative and change room functions. The building's exterior will be constructed of pre-cast concrete panels and insulated metal panels. The CVDF will have a building footprint of approximately 1,324.80 m<sup>2</sup> (14,400 ft<sup>2</sup>) for the process bay areas and 276 m<sup>2</sup> (3,000 ft<sup>2</sup>) for administrative and change room functions.

The process bay building will have a process bay width of approximately 9.14 m (30 ft) and a nominal building width of approximately 18.29 m (60 ft). The height of the process bays will be nominally 9.75 m (32 ft), which will be dictated by the manned access working level of the SNF shipping cask, the crane access to remove the cask lid, and the physical/functional requirements for all of the operations necessary in the CVDF.

Figures 3, 4, and 5 show the layout of the CVDF which includes the six independent process bays where SNF transport trailers will be parked and processed. These process bays will be connected by a corridor that will run along the west side of the building. Access to the process building will be accomplished with a corridor that will be adjacent to the main change room for radiological control of access/egress from the process area. Individual process bay access/egress control will be through a change room. Truck access to each process bay will be through overhead garage doors along the east side of the building. The corridor will allow personnel access through step off pads, as well as acting as a chase for service header piping and conduits.

Figure 3. Architectural Building Sections  
Cold Vacuum Drying Facility.







The SNF from the K Basins will be retrieved and placed into vessels called multi-canister overpacks (MCO). The MCOs will be shipped in a SNF shipping cask on a SNF transport trailer and moved by truck to the CVDF. Each process bay of the CVDF will be designed to enclose a SNF shipping cask and SNF transport trailer, without the truck attached, and will provide the operational space necessary to meet the function of the CVDF. Process bay construction shall be designed to provide radiological separation and containment within each process bay.

Personnel will enter the building through the support area at the south end, where there will be facilities for changing, bathrooms, lunch, and control of the building activities. Each process bay will be an independent nuclear material secondary confinement structure that will block release to the outside environment should an accident or natural phenomena event cause a release from the drying process.

Each process bay will be served by its own dedicated ventilation system. Each ventilation system, equipped with a high-efficiency particulate air (HEPA) filter, will circulate room air, as well as control process exhaust, vent streams, and emissions collected from a hood at the top of the MCO where process connections will be made and broken. These exhausts will be collected in the CVDF exhaust stack that will be monitored to detect radioactive emissions. The ventilation system diagrams are shown on Figures 6, 7, 8, and 9.

Other mechanical systems that will be connected to each process bay will include provisions for tempered water, compressed inert gas, fire suppression water, radioactive water collection, gases, and potable water. Radioactive water will be collected in a tank at the CVDF located in an isolated room with controlled access, located next to a process bay to allow a tanker truck to enter the process bay and receive the water from the storage tank. The radioactive water will be processed and disposed of or stored at an appropriate facility located on the Hanford Site.

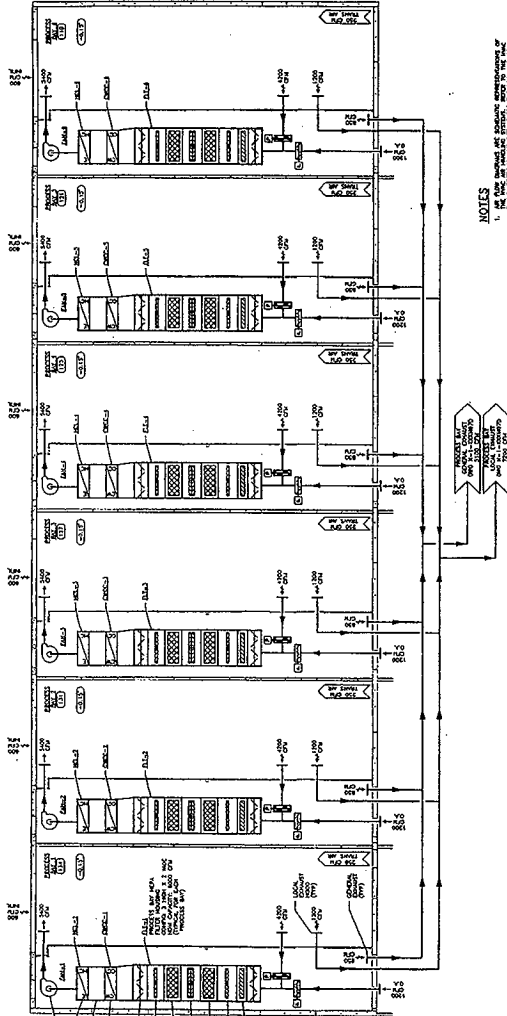
### 1.3.2 Location of Facility (*Response to Requirement 1*)

The CVDF will be a facility constructed at the K Basin Site in close proximity to the basins. The site selected for the CVDF is to the southwest of Building 165KW, Power Control Building, and 105KW Reactor Building. The CVDF Hanford Site coordinates are N4000, E7500. The CVDF location in the 100 Area as shown on Figure 2.

### 1.4 TYPE OF PROPOSED ACTION (*Response to Requirement 3*)

The purpose of this NOC is to request approval for the completion of Phase I NOC, defined as the pouring of concrete for the foundation floor, construction of external walls, and construction of the building excluding the installation of CVDF process equipment. A Phase II NOC will be submitted for approval prior to installation and is defined as the completion of the CVDF, which consists of installation of process equipment, air emissions control equipment, and emission monitoring equipment. This NOC is being submitted for

Figure 6. Cold Vacuum Drying Facility  
Process Bays Air Flow Diagram.



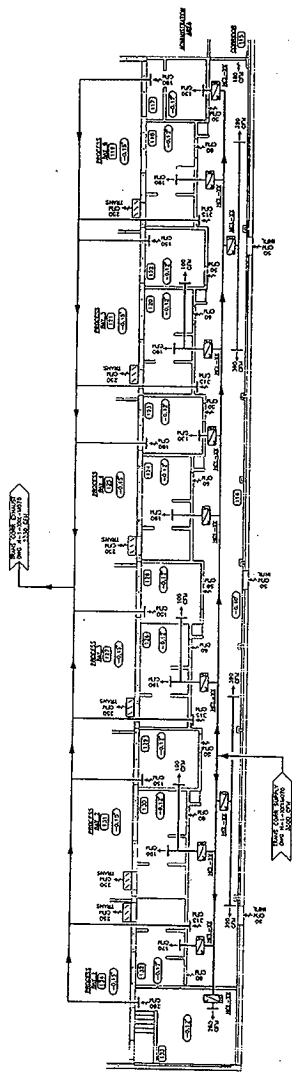
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- LEGEND**
- HEATERS
  - COOLERS
  - FAN COILS
  - RETURN AIR
  - SUPPLY AIR

PROCESS BAYS AIR FLOW DIAGRAM



Figure 8. Cold Vacuum Drying Facility  
Transfer Corridor Air Flow Diagram.



TRANSFER CORRIDOR AIR FLOW DIAGRAM

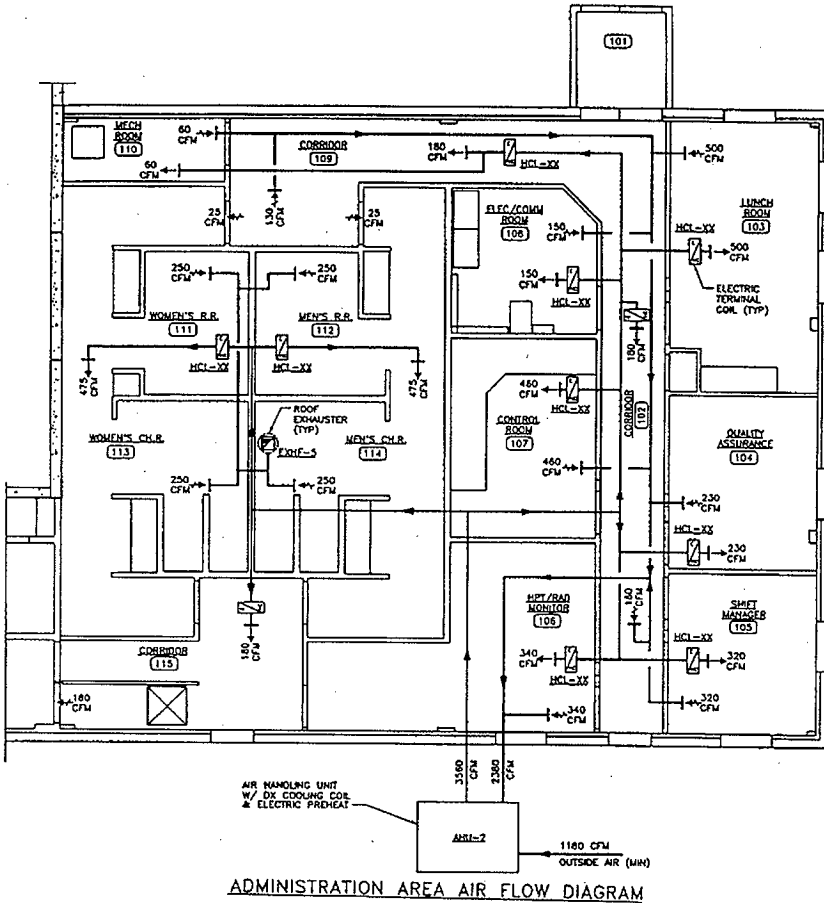
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2. AIR FLOW RATES ARE INDICATED FOR STORAGE AND AMMUNITION ROOMS.
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- (C) ROOM NUMBER
- (C) ROOM AREA
- (C) ROOM VOLUME
- (C) ROOM AIR FLOW RATE
- (C) ROOM AIR FLOW RATE
- (C) ROOM AIR FLOW RATE

Figure 9. Cold Vacuum Drying Facility Administration Area Air Flow Diagram.

**NOTES**

- AIR FLOW DIAGRAMS ARE SCHEMATIC REPRESENTATIONS OF THE HVAC AIR HANDLING SYSTEMS. REFER TO THE HVAC PLANS, SECTIONS, AND DETAILS FOR THE ACTUAL DUCT ROUTINGS, SIZES, AND LOCATIONS OF EQUIPMENT AND DUCT-INSULATED COMPONENTS.
- REFER TO DRAWING H-1-XXXXM07A FOR SYMBOLS, ABBREVIATIONS AND GENERAL NOTES.
- REFER TO DRAWINGS H-1-XXXXM07X THROUGH H-1-XXXXM07Z FOR THE ASSOCIATED HVAC CONTROL DRAWINGS.
- XXX

**LEGEND**

- XXX ROOM NUMBER
- X.XX ROOM DESIGN SPACE PRESSURE RELATIVE TO ATMOSPHERE
- XXX-XXX EQUIPMENT TAG NUMBER

the CVDF in accordance with WAC 246-247-060. Phase II NOC will be submitted before installation of the process equipment that generates the emissions at the CVDF. The project is under the management of the U.S. Department of Energy, Richland Operations Office and its contractors, working on the SNF Project at the Hanford Site. The CVDF is one of three facilities currently being designed and constructed to complete the retrieval, processing, and storage of SNF from the K East and K West Basins.

#### 1.5 STATE ENVIRONMENTAL POLICY ACT ENVIRONMENTAL CHECKLIST

*(Response to Requirement 4)*

The SNF CVDF is categorically exempted from the *State Environmental Policy Act of 1971* Process per WAC 197-11-845(1).

## 2.0 SOURCE INFORMATION

The following sections provide background information on the entire SNF project, process, and facilities. Section 2.1.2, CVDF, covers the functional and process operations requiring approval under this NOC. Section 3.0 lists the annual possession quantity, ventilation system, and monitoring system for the CVDF required approval under this NOC. Information presented in the other sections of this NOC is for background and will be further developed in the other facilities NOCs.

### 2.1 PROCESS DESCRIPTION *(Response to Requirements 5 and 7)*

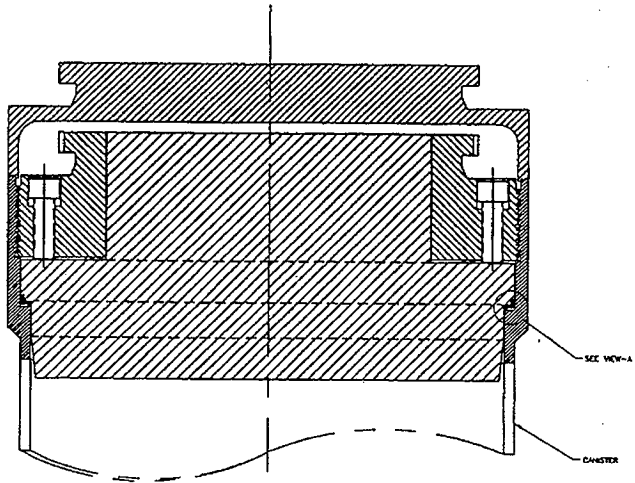
The Westinghouse Hanford Company SNF Project has been assigned the task to remove approximately 2,300 MT (2,530 tons) of SNF from the K East and K West Basins, condition it, and place it into dry storage. The process requires the design and construction of several new facilities, which will house the conditioning and storage of the SNF. The retrieval of the SNF will be accomplished in existing facilities at the K Basins. The objective of the project is to safely remove and condition the SNF for interim storage that can last up to 40 years and may be extended to a total of 75 years. Part of the retrieval process will be to load the SNF into new MCOs for conditioning and interim storage. The new MCOs will be a single use SNF vessel that will be capable of maintaining SNF containment and subcriticality after being closed and sealed. Each MCO will consist of a shell, a shield plug, several rerack baskets, and incidental equipment. Figure 10 illustrates a welded-type MCO assembly. This assembly will have to be sealed by welding. Figure 11 shows a mechanical closure be considered for sealing the MCOs. Either design will secure the MCO for processing and transport.

As discussed in the *Performance Specification for the Spent Nuclear Fuel Multi-Canister Overpack* (WHC 1996b), the MCO shell will be a cylindrical stainless-steel vessel that provides access to its cavity through its top end and receives a shield plug for its closing. The MCOs will be approximately 406.4 cm (160 in.) long with a 60.46 cm (24 in.) diameter. Each MCO will weigh approximately 1,812 kg (4,000 lbs) empty, and can hold approximately 7,248 kg (16,000 lbs) of SNF and water (for a full weight of approximately 9,060 kg [20,000 lbs] including rerack baskets, shell, shield plug, incidental equipment, and water and SNF from the basins).

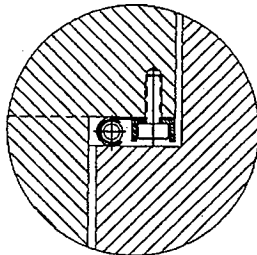
The MCOs will hold rerack baskets that will be loaded at the basins with SNF elements or SNF fragments. The rerack baskets will be cylindrical annular open-top containers that receive and hold the SNF elements or SNF fragments. Five types of rerack baskets are planned: two types to handle N Reactor SNF, which holds an average of 48 to 54 SNF elements; one type for Single Pass Reactor SNF, which holds 120 single pass SNF elements; and two types for SNF fragments, which holds 50 percent by weight of the rerack basket. All of the rerack baskets will be designed to maximize payload and minimize movement during shipping, while considering ease of loading into the MCOs and gas circulation for conditioning.



Figure 11. Multi-Canister Overpack Mechanical Closure.



ASSEMBLY  
NOT TO SCALE



VIEW-A

The shield plug provides penetrations, ports and connections, a rupture disk, and a internal and external HEPA filter. The rupture disk and a HEPA filter will be connected to the outside of the shield plug. Incidental equipment includes criticality control structures, a dip tube connecting to ports on the MCO shield plug, features and devices to seal the MCO, and interface features for component handling. The final interim storage of stabilized SNF in the CSB consists of the following steps that will be described in more detail:

- Retrieval of SNF from the K Basins
- Cold vacuum drying (CVD) of SNF in the MCOs at the CVDF
- Staging the MCOs in the CSB
- Hot conditioning system (HCS) of SNF in the MCOs at the HCSA
- Interim storage of the MCOs at the CSB.

The following descriptions of the SNF retrieval, staging, hot conditioning, and interim storage of MCOs are provided only as background information because they are incidental to the CVDF. The descriptions are general in nature because many of the details have not yet been defined and the processes are not part of this NOC. Approval will be obtained, before commencement of the described activities, as required by federal and state regulations. Separate NOCs will be submitted to all regulate agencies for the K Basin activities, the CVDF, CSB, and HCSA, as applicable.

Transport of all K Basin SNF to the CSB will require approximately two years and the hot conditioning will require approximately two and one-half years for all of the SNF to be processed (DOE 1994). Staging of the MCOs will occur simultaneously with the CVDF and HCSA processing.

### 2.1.1 Spent Nuclear Fuel Retrieval from the K Basins

The SNF in K East Basin is currently stored in open canisters, while SNF in K West Basin is stored in closed canisters. The process for retrieval and cleaning of the SNF is discussed in *Spent Nuclear Fuels, Fuel Retrieval Sub-Project Conceptual Design Report* (LATA/BNFL/Foster Wheeler 1996). The cleaning process will minimize the amount of basin floor sludge and SNF canister sludge that leaves the basins. The K Basin project is working on methods to treat and dispose of any waste products, such as old SNF canisters, floor, sludge, etc., while minimizing waste and ensuring a safe cleanup which protects the environment. A brief description of the SNF cleaning process, which takes place at both K East and K West Basins, is presented below. This description supports sound engineering judgement for the amount of SNF canister sludge that could be carried into each MCO.

All SNF canisters will be retrieved from the basins and sent to the primary clean station. The primary clean station will consist of a containment box with an internal perforated wash basket. The cleaning process will begin by loading a single SNF canister containing SNF assemblies into the wash basket and closing and locking the containment box lid. The wash basket will be rotated for one cycle as basin water is flushed through the wash basket and containment box to remove SNF canister sludge and basin floor sludge

(accumulated basin dirt and debris) from the SNF.

Upon completion of the initial cycle, rotation of the wash basket will be stopped with the SNF canister in an inverted position. The SNF canister will be removed from the containment box, allowing the SNF assemblies (see Figure 12) to discharge to the wash basket. The containment box lid will be closed and locked, and a second cleaning cycle will begin. During the second cleaning cycle, the SNF assemblies will be tumbled as basin water is flushed through the wash basket and containment box to remove SNF canister sludge and basin floor sludge from the individual SNF assemblies.

Some of the SNF assemblies will be moved for disassembling. The SNF assemblies requiring assembling, will be disassembled by removing the inner SNF element from the outer SNF element. A portion of the SNF elements will be visually inspected. If a SNF element fails the inspection, it will be subject to a secondary cleaning process. The secondary cleaning station will use a high pressure water jetting system on individual SNF elements. The SNF element will be placed into a SNF element cradle within a containment enclosure to remove adhering sludge. The SNF element cradle will align the SNF element axis with the jetting nozzle enabling the high pressure water jetting action to pass through the bore of the element. After cleaning, the SNF elements will be moved to the MCO loading area for placement into the MCO rerack baskets.

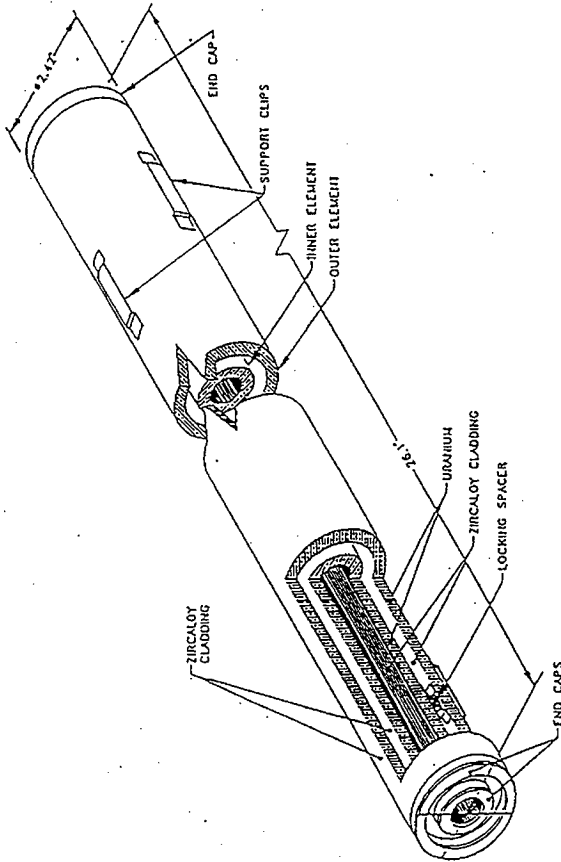
At the basin MCO loading area the SNF will be placed into the MCO rerack baskets and loaded under water into the MCOs. Each MCO will be filled and the payload maximized. Once a MCO is filled with SNF rerack baskets, it will be readied for transportation. At this time the MCO shield plug will be replaced and the MCO sealed by mechanical closure or welding before being removed from the load out pits. Each transport cask will be sealed, and checked for contamination on the external surfaces, after being removed for the basin load out pit. If necessary, the transport cask will be cleaned to remove any contamination. The level of cleanliness is governed by safe handling levels and worker protection.

Each MCO and cask will then be removed from the basin and placed on a SNF transport trailer and readied for transport by truck to the CVDF. The transport cask will provide secondary confinement to the SNF inside the MCO. Once the transport cask is loaded on the SNF transport trailer, it will remain there until it is removed at the CSB.

### 2.1.2 Cold Vacuum Drying

As discussed in the *Conceptual Design Report for the Cold Vacuum Drying System* (WHC 1996a), the CVD will be the first processing step in ensuring proper storage of the SNF. The following is a description of the process and the equipment used to remove the water from the MCO. As discussed in Section 2.0, this section of this NOC is submitted for approval.

Figure 12. 105-N Reactor Mark IV Spent Nuclear Fuel Element Assembly.



105-N REACTOR MARK IV FUEL ELEMENT ASSEMBLY

(OS00015A)

The CVD process will be used to remove as much free water as possible from the MCOs before they are transported to the CSB. Bulk water will be removed by pumping. Remaining absorbed water will be removed by heating to 50°C (122°F) in a vacuum for a period of approximately 24 hours.

The CVD process will arrest further SNF corrosion, reduce the potential for temperature driven excursions, and prevent excessive hydrogen build-up. Cold vacuum drying will not be expected to remove chemically-bound water (water chemically adhered to the SNF). It is estimated that approximately 2 kg (4.41 lbs) of chemically-bound water may not be removed by CVD; thereby, remaining in each MCO.

Following CVD, each MCO will be heated to 75°C (167°F) and held for six hours to verify that the MCO will not overpressurize during transportation to the CSB. Following the post CVDF monitoring, the temperature of each MCO will be lowered to 25°C (77°F) and the MCO inerted with helium at approximately 155.10 mmHG (3 lbf/in<sup>2</sup>g) pressure. The MCOs will then be released from the CVDF and transported on the SNF transport trailer by truck to the CSB.

**2.1.2.1 Cold Vacuum Drying Facility Process Equipment.** Each MCO will be emptied of bulk water and then evacuated by a vacuum system to remove residual free water and to prevent atmospheric and other gases from reacting with the uranium metal of the SNF elements. The vacuum system will extend from the MCO (after the first isolation valve) to the exhaust manifold that interfaces with the CVDF ventilation exhaust system.

**2.1.2.1.1 Vacuum Pumping System.** The vacuum pumping system (VPS) for the CVDF drying module will consist of a single-stage vacuum pump, valves, traps, filters, instrumentation, and ducting that shall achieve and maintain the required operating pressures in the MCO. The VPS will evacuate each MCO to remove residual free water and to prevent atmospheric and reactive gas species from reacting with the uranium metal of the SNF elements.

The VPS will remove gas species (volumetric, outgassing, residual free water, and in-leakage) from each MCO to the degree required for proper shipment of each MCO within a transport cask to the staging area of the CSB. Gases to be removed include the following:

- Residual free water (as vapor) following bulk water pumping of the MCO
- Air from the initial evacuation of the MCO
- Inert gas (argon, helium, or nitrogen) used to backfill the MCO
- Tritium and fission gases generated by the SNF elements
- Atmosphere in-leakage.

The VPS will consist of one active pump per drying module. The system will contain filters to prevent the contamination of the downstream equipment. The VPS will control the internal pressure inside each MCO during the initial pumpdown to prevent the water from freezing and to achieve a pressure of 1.3E+01 Pa (1E-01 TORR) for residual water vapor removal. The VPS will evacuate each MCO to an operating internal pressure in 24 hours

with the gas loads at the average decay heat power condition. This condition assumes that each MCO will be leak-tight to the MCO design operating pressure of  $7.7E+06$  mmHg cc/sec ( $1E-04$  atm. cc/sec).

The VPS will control the introduction of inert gas for backfilling each MCO (normal shutdown) and in off normal (non-emergency) shutdown conditions. It will prevent contaminants from backstreaming to each MCO through the use of the inert gas purge system. All valves will have electropneumatic operators. The VPS will be designed to assist in the helium leak checking of each MCO following installation of the top shield.

**2.1.2.1.2 Multi-Canister Overpack/Cask Temperature Control System.** The MCO/cask temperature control system for the CVDF will provide all necessary equipment and controls to allow the efficient and timely heatup and cooling of each MCO/cask to approximately  $75^{\circ}\text{C}$  ( $167^{\circ}\text{F}$ ) for post CVD monitoring. The MCO/cask will be cooled to approximately  $10^{\circ}\text{C}$  ( $50^{\circ}\text{F}$ ) for safe cold standby condition or  $25^{\circ}\text{C}$  ( $77^{\circ}\text{F}$ ) for nominal shipping condition. The heating system will also provide heating of the vacuum piping to prevent condensation of water in the piping prior to the system condenser and the residual gas analyzer.

**2.1.2.1.3 Solid and Water Collection System.** The solid and water collection system for the CVDF will consist of collection tanks, transfer pumps, piping and valves for disposal of water from the MCO. The solid and water collection system will provide for the disposal of HEPA filters, and any contaminated equipment at end of the project.

**2.1.2.1.4 Cold Vacuum Drying Facility Structures and Auxiliaries.** The CVDF structures and auxiliary systems will consist of concrete pads, confinement, shielding walls, cranes, handling equipment, fixtures, remote connection equipment, process heating, ventilation, and air conditioning (HVAC) systems, electric load centers, inert gas bottle racks, water supplies and drains, area public address/alarms, telephones, data acquisition and control centers, fire protection systems, area radiation detectors, and security detection interfaces for the CVDF.

**2.1.2.2 Process Steps.** The sequence of actions expected to occur in the CVDF is shown on Figure 13 and presented in the text below.

The MCO/cask SNF transport trailer will be aligned in the CVD process bay; the truck will be disconnected from the SNF transport trailer and driven out of the station. The cask external surface dose rate will be surveyed by CVD module instrumentation and verified to be acceptable for manned access. The SNF transport trailer will then be secured to the foundation due to seismic concerns. The process bay doors will be closed, sealing the SNF transport trailer within a radiological confinement zone.

The cask top cover will be removed and the ventilation hood installed over each MCO/cask top. Each MCO HEPA filter will be isolated (blank flange installed). The MCO will be sealed by ensuring the mechanical closure is closed properly for CVD or the MCO



shield plug will be weld sealed prior to CVD. Either method is to ensure that when CVD begins the MCO will be able to be pressurized. The process bay drying system will be connected to each MCO, and the free water pumping process will begin.

The MCO/cask annulus water heating/cooling system will be connected and a water outlet temperature of 50°C (122°F) will be obtained. This will achieve a hot standby condition for the SNF, which will allow a quicker drying cycle. The heatup rate of 20°C (35°F) per hour will be achieved by circulating heated water at 94.75 L/min (25 gal/min) in the MCO/cask annulus. Each MCO could be cooled to 10°C (50°F) by the water heating/cooling system. This latter condition will be the safe cold standby condition for the SNF.

The initial removal of the free water from each MCO will be by inert gas purging and suction pump (nominal removal rate shall be 37.9 L/min [10 gal/min]). The nominal amount of bulk water is 685.16 L (181 gal) for MK1A SNF and 571.59 L (151 gal) for MK1V SNF. The water will be drained and transferred to the drying station radioactive water storage tank. Following bulk water draining, each MCO may be optionally purged with an inert gas at a rate of 0.09 to 0.15 m<sup>3</sup>/mi (3 to 5 std ft<sup>3</sup>/min) for an approximately 40 to 60 minute duration. This step will partially dry the SNF and sweep loose particulate into the internal MCO HEPA filter.

Following the pump and purge operation, there will be absorbed water left on the internal surfaces of each MCO and surfaces of the SNF elements. Also, less than 295.7 ml (10 ounces) of water, will be left at the lower end of the axial dip tube. Each MCO will be evacuated to an initial pressure in the range of 1.3E+03 Pa to 1.3E+04 Pa (10 to 100 TORR) (to the vapor pressure of water at the saturation temperature) by the VPS.

As each MCO is heated, the vapor pressure of the water in the MCO will increase to a minimum of 1.2E+04 Pa (92.5 TORR) at 50°C (122°F). As the absorbed water is depleted by evacuation, the MCO pressure will be reduced to less than 6.5E+01 Pa (0.5 TORR). During the evacuation period, a combination of an inert gas purge and a throttle valve adjustment will prevent the pressure from being lower than 6.5E+02 Pa (5 TORR) to mitigate water freezing in the MCO. The purge will be interrupted at the end of the drying phase to achieve a base pressure of 3.9E+02 Pa (3 TORR) or less. The purge will be stopped for no more than 60 minutes at a time (the vacuum pump will be isolated if purge cannot be re-established within the 60 minute period). To satisfy the initial drying criteria, a water vapor pressure of less than 3.9E+02 Pa (3 TORR) will be required during a one hour hold period with the VPS isolated. The residual free water removed by the VPS will be collected in a condenser and then drained to the CVD process bay radioactive water storage tank.

The VPS and inert gas purge systems will then be isolated, the MCO will be heated to 75°C (167°F) (in a six hour period) and the MCO total and partial pressures will be monitored for a six hour period. The partial pressure increase rates for argon, hydrogen, krypton, nitrogen, oxygen, and water will be measured. Upon verification that the monitored conditions are acceptable, the MCO will be lowered to a temperature of 25°C

(77°F) and readied for transfer to the CSB.

The MCO will then be backfilled with an inert gas and slightly pressurized. The process connections will be removed and blank flanges will be installed. The MCO process, vent, and pressure relief ports will be helium-leak checked to ensure that the MCO is sealed during transport to the CSB. The MCO/cask annulus will be drained of water, vacuum dried, and back filled with an inert gas to approximately 155.10 mmHG (3 lbf/in<sup>2</sup>[g]) pressure.

### 2.1.3 Multi-Canister Overpack Staging

Once the CVDF processing is complete, the MCOs will be transported to the CSB for staging. During transportation to the CSB, the temperature of the MCOs may rise slightly and some hydrogen may be generated from the reaction of residual water with the SNF. The hydrogen generation reaction rate doubles for each 8.33 to 11.11°C (15 to 20°F) temperature rise. The MCOs are expected to arrive at the CSB at a total internal pressure of approximately 1,034 to 1,551 mmHg (20 to 30 lbf/in<sup>2</sup>[g]).

Each MCO will be unloaded at the CSB from its SNF transport trailer using a crane to move the cask and MCO into the MCO receiving station. The MCO and cask will then be monitored and, if required, connected to a purge system at the receiving station. Monitoring will identify gas buildup due to oxidation.

Connected by a single pipe, the purge system consists of an inert gas cylinder and a vacuum pump, which exhausts to the CSB exhaust stack. By opening and closing a series of valves, the purge system can draw a vacuum on the MCO to remove gases and then change its operation to flow inert gas into the MCO to purge the MCO. When the purge system is coupled to each MCO quick-connect fitting, gas contained in each MCO will flow through a canister-type HEPA filter and the attached flexible connection to a pressure gage. After the pressure is recorded, a sample of the gas will be taken and the temperature of the gas will be recorded. After the sample is secured, the remaining gas in each MCO will be vented through a vent line equipped with testable HEPA filters, leading to the CSB exhaust stack.

Once each MCO is depressurized, a vacuum pump will be used to remove as much of the remaining gas as possible. Purging will then reduce any pressure buildup in each MCO, ensuring an inert internal environment, and will allow staging to begin with the lowest possible concentration of hydrogen. It is expected that the MCO internal pressure will depend on the initial pressure, the time elapsed since each MCO was closed, and the internal temperature during that period. The purge system vacuum pump will exhaust into the CSB exhaust which is connected to the CSB exhaust stack. To complete the purge, each MCO will be refilled with inert gas to reach a slight positive pressure. With purging complete, the quick-connect canister-type HEPA filter will be removed, the cover on the quick-disconnect will be replaced, and the covers on each MCO HEPA filter and rupture disc will be removed to activate them.

Following purging, each MCO will be transferred and loaded into storage tubes within the CSB by means of the MCO handling machine. The MCO handling machine will have a self-contained dual HEPA filtered ventilation system as shown in Figure 14. The MCO handling machine ventilation system will exhaust filtered air into the operating space of the CSB.

In the CSB the MCOs will be stored vertically in storage tubes with one or two MCOs in each storage tube. The storage tubes will be closed with a shield plug that incorporates a redundant seal, a HEPA filtered vent, and a quick disconnect fitting for depressurizing or purging the storage tube. The storage tube HEPA filter on the vent is not testable in service; however, it is pre-tested and has the same effectiveness as the main ventilation filters. All MCOs will be vented while being staged at the CSB before hot conditioning.

After the transfer cask is unloaded, a new, empty MCO will be loaded into the cask and sent to the K Basins. This cycle is expected to be repeated over a two year period to remove and stage all of the SNF from the basins. The MCOs will be staged until they are hot vacuum conditioned and placed into interim storage.

#### 2.1.4 Hot Conditioning System

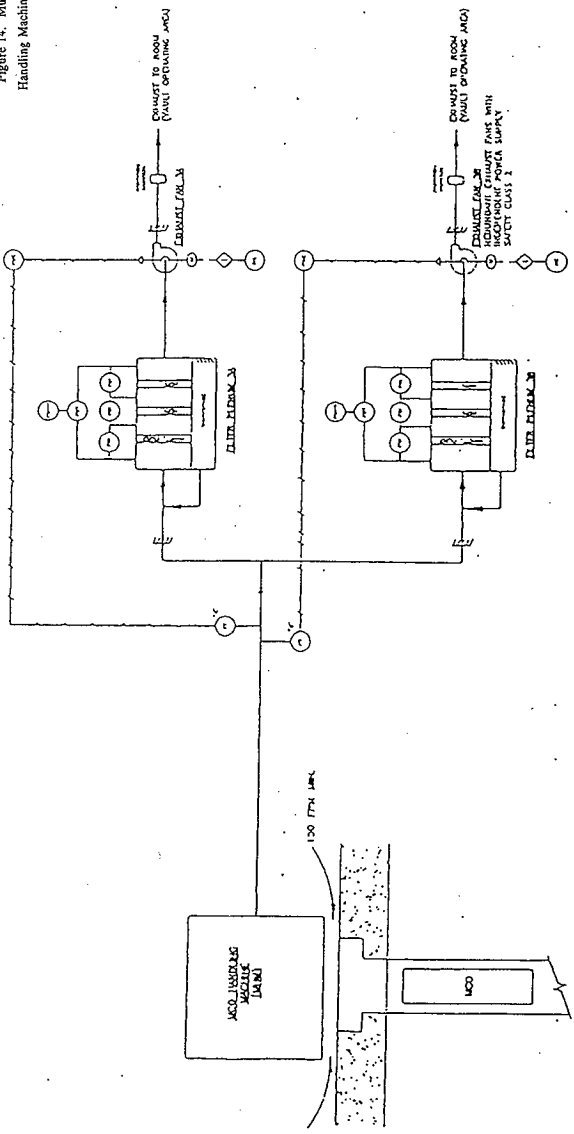
The following information was first presented in the *Hot Conditioning Trade Study* (Fluor Daniel, Inc. 1995). Since then, Westinghouse Hanford Company has contracted a design firm to complete the final design of the HCSA and conditioning equipment to be used to perform the final step prior to interim storage of the SNF. The following is a brief summary to provide an overview of the interaction between the CVDF and HCSA.

Hot conditioning of SNF contained in the MCOs will be performed in the HCSA subsequent to the initial CVD done at the CVDF. It will ensure that gas generated from the radiolysis of water and other volitized material does not exceed the sealed MCO design pressure limits. Hot conditioning will consist of heating the SNF to approximately 300 to 350°C (572 to 662°F) under a vacuum. This will remove the chemically bound water and cause a significant portion of the uranium hydride that may be present, to decompose and release hydrogen from the SNF. A passivation step will be completed to reduce the overall reactivity of the SNF. In the passivation step, each MCO would be cooled to 150°C (302°F) and a controlled amount of oxygen (in an inert gas diluent) will be added to each MCO to oxidize any highly reactive surfaces.

The process equipment required for HCS will consist of seven similar hot conditioning process stations, six operational and one auxiliary pit which could be used as a welding area for final sealing of the MCOs, or for neutron interrogation of the MCO to determine residual water content.

Each hot conditioning process station will be comprised of a process pit and a process module. The process pit will hold the oven where the MCO will be heated and the SNF

Figure 14. Multi-Canister Overpack  
Handling Machine Ventilation Diagram.



conditioned. The process module will be a skid which contain the hot conditioning process equipment. The process piping connecting the MCO and oven to the process module will be located in a trench below the HCSA floor.

### 2.1.5 Interim Storage

Upon completion of hot conditioning, or upon confirmation the MCO is ready, each MCO will be sealed and placed in interim storage. The SNF in each MCOs is expected to generate minimal gas and oxide particulates during interim storage. Interim storage will end when the sealed MCOs are either shipped to a repository for permanent disposal, or to a yet undefined processing plant. Because the exact outcome of the SNF is not yet defined, the MCOs may stay in interim storage for up to 40 years. In addition to the expected 40-year interim storage period, provisions can be made for extending storage to 75 years, if necessary. Sealed MCOs are not expected to be vented before removal and shipping; thus, no environmental releases are expected during interim storage.

### 3.0 FACILITY INVENTORY (Response to Requirements 8, 10, 11, and 12)

This section of the NOC describes the annual possession quantity of the CVDF. This section is submitted for approval under this NOC. The potential source for airborne radionuclide emissions will be the irradiated SNF stored in the MCOs. The SNF was irradiated 9 to 25 years ago and is decreasing in activity due to normal radioactive decay processes. The activity was calculated with radionuclide decay to December 31, 1997 (Table 1), the expected starting date for SNF retrieval from the basins.

Water in the MCO can be the cause of potential emissions by means of the following mechanisms:

- As the water evaporates, it can transport radionuclides from the SNF as it leaves the MCO.
- The water can react with uranium with the resultant release of krypton-85, hydrogen, and tritium gasses.

The results of tests on samples of basin floor sludge from the K East Basin show that a relatively small portion of the SNF has corroded and is dispersed as particulate matter in the sludge. Most of the SNF remains intact as a metallic solid in the form of high grade metallic elements clad with aluminum or zirconium alloy. Several variations in the design of the SNF element assemblies were used, but all were similar to the Mark IV SNF Element Assembly illustrated on Figure 12.

The *K Basin Corrosion Program Report* (WHC 1995) estimates the total SNF corrosion is at 4,300 kg (9,480 lbs) of uranium oxide in the K East Basin. The K West canister water sampling accounted for a maximum of 3,800 Ci of cesium-137 released from SNF in the K West Basin (WHC 1996c) which corresponds to approximately 800 kg (1,764 lbs) of uranium oxide. The total mass of SNF oxide in the basins is therefore estimated at 5,100 kg (11,243 lbs).

Assuming that the 5100 kg (11,243 lbs) of the uranium oxide generated in the basins will be divided by 400, equal to the approximate number of MCOs, then each MCO could contain approximately 12.75 kg (28.05 lbs) of uranium oxide. Then assume during the cleaning cycle half of the uranium oxides and all basin floor sludge is removed from the SNF by cleaning. The MCOs, thus could contain an average of approximately 6.38 kg (14.1 lbs) of uranium oxide immediately following the loading of the SNF. To be conservative, this value was increased to 6.75 kg (14.88 lbs) of uranium oxide contained per MCO. This increase was estimated based on the maximum quantity of water available to react and form uranium oxide.

In addition, approximately 0.720 kg (1.59 lbs) of uranium oxide is expected to be generated as a result of CVDF processing. The uranium oxide generated during CVDF processing is estimated by the current reaction rate, expected time of CVDF processing and

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Table 1. Combined K Basins Radionuclide Inventory Decayed to December 31, 1997.

Radionuclide	K Basins Inventory (Ci)	Physical Form(a)	Annual Possession Quantity at CVDF(b)		
			Gases (Ci)	Solids (Ci)	Particulate (Ci)
H-3	3.51E+04	G (generated)	1.76E+00	---	---
H-3	---	S (matrixed in fuel)	---	1.75E+04	---
C-14	6.62E+02	G (generated)	3.31E-02	---	---
C-14	---	S (matrixed in fuel)	---	3.31E+02	---
Co-60	4.00E+03	S/P	---	2.00E+03	2.40E+00
Kr-85	5.79E+05	G (generated)	2.90E+01	---	---
Kr-85	---	S (matrixed in fuel)	---	2.89E+05	---
Sr-90	9.79E+06	S/P	---	4.89E+06	5.87E+03
Y-90	9.79E+06	S/P	---	4.89E+06	5.87E+03
Sb-125	3.39E+04	S/P	---	1.69E+04	2.03E+01
Te-125m	8.26E+03	S/P	---	4.13E+03	4.96E+00
I-129	5.93E+00	G (generated)	2.97E-04	---	---
I-129	---	S (matrixed in fuel)	---	2.96E+00	---
Cs-134	1.69E+04	S/P	---	8.44E+03	1.01E+01
Cs-137	1.26E+07	S/P	---	6.29E+06	7.56E+03
Ba-137m	1.19E+07	S/P	---	5.94E+06	7.14E+03
Pm-147	4.91E+05	S/P	---	2.45E+05	2.95E+02
Sm-151	1.68E+05	S/P	---	8.39E+04	1.01E+02
Eu-154	1.01E+05	S/P	---	5.04E+04	6.06E+01
Eu-155	2.18E+04	S/P	---	1.09E+04	1.31E+01
U-234	8.78E+02	S/P	---	4.38E+02	5.27E-01
U-235	3.40E+01	S/P	---	1.70E+01	3.04E-02
U-236	1.27E+02	S/P	---	6.34E+01	7.62E-02
U-238	6.96E+02	S/P	---	3.48E+02	4.18E-01
Pu-238	1.22E+05	S/P	---	6.09E+04	7.32E+01
Pu-239	2.25E+05	S/P	---	1.12E+05	1.35E+02
Pu-240	1.30E+05	S/P	---	6.49E+04	7.80E+01
Pu-241	6.39E+06	S/P	---	3.19E+06	3.73E+03
Am-241	3.46E+05	S/P	---	1.73E+05	2.08E+02
Other	2.38E+04	S/P	---	1.19E+04	1.43E+01

(a) G - gas; S - solid; P - particulate matter

(b) percent of total inventory per radionuclide: G - 0.01%; S - 99.88%; P - 0.12% - Annual possession quantity = inventory multiplied by percentage. Annual possession quantity for gas radionuclides is determined as stated, however, the solid for that radionuclide is equal to the inventory minus the gas divided by two. Gas percentage is estimated based on some loss during loading.

Notes to Table 1:

1. The gases generated are assumed to be emitted 100 percent. They are a result of the cold vacuum drying facility (CVDF) process. The amounts noted have a potential to be emitted annually from the process stack over a period of two years while the CVDF is in operation.
2. The inventory values (Willis 1995) are decayed to December 31, 1997, the scheduled start of spent nuclear fuel (SNF) transfer to the Canister Storage Building.
3. Iodine and carbon are shown as gases due to the lack of data and uncertainty as to their form. It is more likely, given the strong reducing conditions of dry storage, that they will exist as refractory compounds with a very limited vapor pressure, such as CsI and BaCO<sub>3</sub>. In this case they would be retained in the multi-canister overpack with a release fraction the same as particulate metal oxides (2E-04).

Willis 1995, *Integrated Process Strategy for K Basins Spent Nuclear Fuel*, WHC-SD-SNF-SP-005, Vol. 1, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

the temperature of the material during processing. Combining the 6.75 kg (14.88 lbs) of uranium oxide from the MCO loading and the 0.720 kg (1.59 lbs) of uranium oxide generated as a result of CVDF processing yields 7.47 kg (16.47 lbs) of uranium oxide. This 7.47 kg (16.47 lbs) of uranium oxide contains approximately 6.26 kg (13.77 lbs) of uranium (Appendix A). Using 6.26 kg (13.77 lbs) of uranium compared to the total uranium contained in each MCO ( 5,250 kg [11574 lbs]). The percentage of particulates as uranium oxide is as follows:

6.26 kg (13.77 lbs) uranium/5,250 kg (11,574 lbs) uranium per MCO = 0.12 percent

The rest of the un-corroded SNF (99.88 percent) is an intact metallic solid that will not release any contained radionuclide unless further corroded by induced oxygen or by the release of bound water.

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**APPENDIX A**  
**SPENT NUCLEAR FUEL MEMORANDUM FROM W. WILLIS**

The aggressive schedules of Spent Nuclear Fuel Project activities and new facilities have not allowed for complete characterization of the fuel and other materials in the K Basins. Virtually all of the airborne releases expected from existing and planned spent fuel conditioning, transportation, staging and storage facilities will be dependant on the amount of fuel which has reacted to oxides in the basins or will react in either conditioning, transportation, staging, or storage. Because releases are tracked on an annual basis the average inventory of all the MCOs as opposed to the projected maximum inventory of any single MCO should be used when possible.

This Memo documents assumptions made and particulate information used for permitting activities only. These particulate quantities are not intended for use in safety documentation or for process control. Use of the particulate quantities in this memo for purposes other than permitting should be explicitly cleared through J. R. Frederickson.

The K Basin Corrosion Program Report, WHC-EP-0877 estimates the total fuel corrosion at 4,300 kg of uranium oxide ( $UO_2$ ) in the K East Basin. K West canister water sampling accounted for a maximum of 3,800 Ci of Cs-137 released from fuel in the K West Basin (Data Analysis, K West Basin Canister Liquid and Gas Samples, Gamma Energy Analysis and Mass Spectrometry Data, WHC-SD-SNF-ANAL-007). The 3,800 Ci Cs-137 corresponds to approximately 800 kg of  $UO_2$ . The total mass of fuel oxide in the basins is therefore estimated at 5,100 kg.

Assuming that all of the fuel oxide generated in either basin remains in the fuel storage canisters, and that half of the fuel oxides and all floor sludge is removed from the fuel in the fuel cleaning and sludge removal processes, the MCOs will contain an average of approximately 6.38 kg of sludge immediately following the loading of fuel. This number is based on 400 MCOs or on average 5250 kg uranium per MCO.

In the phase I NOC for the CSB, 6.75 kg sludge for an average MCO was assumed. Although 6.75 kg was based on early assumptions about the allowable water for sealed transportation, the references above suggest that 6.75 is a very reasonable estimate.

Approximately 720 g of fuel is expected to oxidize in the CVD process, and approximately 2 kg of fuel is expected to oxidize during transportation. Both estimates are bounding numbers based on the current reaction rate of the fuel in the K East Basin adjusted for expected times and temperatures of the cold vacuum drying and transportation processes.

At the end of the staging process, a total of 0.4% of the MCO fuel inventory is estimated to be particulate. The 0.4% estimate is based on the amount of water estimated to remain in the MCO following the cold vacuum drying process, and assuming that all the remaining water reacts to produce uranium oxide. At the end of the hot conditioning process, a total of 1% of the MCO fuel inventory is estimated to be particulate. Of the 1% total particulate estimate, 0.6% is generated in the hot conditioning process. The 0.6% estimate is based on the amount of oxygen which would produce a uniform oxide layer 1 - 2 mils thick on the exposed uranium surface in the MCO.

Although best engineering judgment indicates otherwise, previous documents have indicated toxic constituents such as PCBs may be released from the MCO. For conservatism, it is assumed that the toxic constituents found in the floor sludge but not expected in fuel oxides, are assumed to be released from the SNFP facilities. The concentration of these toxic materials is based on the highest concentration measured in floor sludge.

The particulate quantities listed above are summarized in the following table.

MCO Particulate Quantities as a function of Process Step		
Process Step (end of step)	Nominal Quantity Particulate (UO <sub>2</sub> )	Basis
MCO Loading	6.75 kg (5.95 kg U)	1/2 of total uranium oxide inventory
Cold Vacuum Drying	7.47 kg (6.26 kg U) (0.72 kg UO <sub>2</sub> generated)	Basin reaction rate adjusted for temp. <sup>1</sup>
Transportation to CSB	9.47 kg (8.02 kg U) (2 kg UO <sub>2</sub> generated)	Basin reaction rate adjusted for time and temperature. <sup>1</sup>
Staging at CSB	23.8 kg (21 kg U) (14.3 kg UO <sub>2</sub> generated) (0.4% of fuel)	All remaining Water reacts to form oxide particulate. <sup>1</sup>
Hot Conditioning	59.6 kg (52.5 kg U) (32.5 kg UO <sub>2</sub> generated) (1.0% of fuel)	Temperature increased and oxygen added to passivate fuel.
Interim Storage	59.6 kg	No additional oxide is generated during storage.

<sup>1</sup> Based on limiting quantities of particulate which could be generated.

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