**U.S. Environmental Protection
Agency Clean Air Act
Notice of Construction for the
Spent Nuclear Fuel Project--
Cold Vacuum Drying Facility,
Project W-441**

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LIST OF TERMS

AED	Aerodynamic equivalent diameter
AHU	Air handling unit
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
CAM	Continuous air monitoring
CAEM	Continuous air emission monitoring
CFR	Code of Federal Regulations
CSB	Canister Storage Building
CVD	Cold Vacuum Drying
DOP	Diocetyl phthalate
HCS	Hot Conditioning System
HCSA	Hot Conditioning System Annex
HEPA	High-efficiency particulate air
HVAC	Heating, ventilation, and air conditioning
MCO	Multi-canister overpack
MEI	Maximally exposed individual
NOC	Notice of Construction
PUREX	Plutonium-Uranium Extraction
SNF	Spent nuclear fuel
TEDE	Total effective dose equivalent
UL	Underwriters Laboratories
VPS	Vacuum pumping system

**U.S. ENVIRONMENTAL PROTECTION AGENCY
CLEAN AIR ACT NOTICE OF CONSTRUCTION FOR THE
SPENT NUCLEAR FUEL PROJECT--COLD VACUUM DRYING FACILITY,
PROJECT W-441**

1.0 INTRODUCTION

This document provides information regarding the source and the estimated quantity of potential airborne radionuclide emissions resulting from the operation of the Cold Vacuum Drying (CVD) Facility. The construction of the CVD Facility is scheduled to commence on or about December 1996, and will be completed when the process begins operation. This document serves as a Notice of Construction (NOC) pursuant to the requirements of 40 Code of Federal Regulations (CFR) 61 for the CVD Facility.

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 release of corrosion products to the K East Basin water. Storage of the current inventory 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 2,100 MT (2,300 tons) of uranium as part of the N Reactor SNF in the K Basins with no means for near-term removal and processing.

The CVD Facility 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 CVD Facility will consist of five processing bays, with four of the bays fully equipped with processing equipment and the fifth bay configured as an open spare bay. The CVD Facility will have a support area consisting of a control room, change rooms, and other functions required to support operations.

1.1 APPLICANT

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Figure 1. Hanford Site and Vicinity Map

Figure 2. Site Location Plot Plan

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K BASIN O & H FACILITIES DESCRIPTION	
105 KE	WATER TUNNELS BASIN, OFFICE & FUEL TRANSFER AREA
119 KE	EXHAUST AIR SAMPLE BUILDING
161 KE	DIVISIONAL CONTROL ROOM
165 KE	POWER CONTROL BUILDING
165 KE	CHLORINE VAULT
1713 KE	WAREHOUSE/SHOP
1714 KE	WATER PUMP HOUSE
181 KE	CHLORINE VAULT
182 KE	CHLORINE VAULT
190 KE	WATER PUMP HOUSE
1705 KE	EFFLUENT WATER TREATMENT
1713 KE	SHOP BUILDING
1716 KE	CL & PAINT SHOP
1717 KE	MAINTENANCE SHOP
1717 KE	FAN HOUSE
1908 KE	OUTFALL INSTRUMENTATION BUILDING
1908 K	OUTFALL STRUCTURE

1701K	WO 214	BUILDING
1709K	WO 102	BUILDING
1711K	WO 101	BUILDING
1718K	WO 101	BUILDING
1719K	WO 102	BUILDING
1721K	WO 282	BUILDING
1723K	WO 907	BUILDING
1723K	WO 926	BUILDING
1723K	WO 923	BUILDING

CF	CONTAINED SPACE
PERMETER FENCES	PERMETER FENCES
SECURITY WARNING FENCES	SECURITY WARNING FENCES
RAILROADS	RAILROADS
ROADS	ROADS
UNIMPROVED ROADS	UNIMPROVED ROADS
GATE	GATE
BUILDINGS	BUILDINGS
O & D AREA OR MAINTENANCE SERVICES	O & D AREA OR MAINTENANCE SERVICES
CONCRETE PADS	CONCRETE PADS

1.2 PURPOSE OF NOTICE OF CONSTRUCTION

This document serves as a NOC pursuant to the requirements of 40 CFR 61 for the CVD Facility.

1.3 FACILITY LOCATION

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

1.4 FACILITY DESCRIPTION

As discussed in the *Conceptual Design Report for the Cold Vacuum Drying System* (WHC 1996a), the CVD Facility will be the first operational step in ensuring proper storage of the SNF. The main process descriptions and potential emission points of the CVD Facility are presented in this NOC.

The CVD Facility will consist of five process bays, four fully equipped with processing equipment, while the fifth is configured as an open spare bay, 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 CVD Facility will have a building footprint of approximately 1,325 m² (14,400 ft²) for the process bay areas and 276 m² (3,000 ft²) for administrative and change room functions.

The process bay building will have a bay width of approximately 9 m (30 ft) and a nominal building width of approximately 18 m (60 ft). The height of the process bays will be approximately 10 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 CVD Facility.

Figures 3, 4, and 5 show the layout of the CVD Facility, which includes four 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.

Cold Vacuum Drying Facility.

re 4. Cold Vacuum Drying Facility
Architectural First Floor Plan.

Figure 5. Cold Vacuum Drying Facility
Architectural Second Floor Plan

The SNF from the K Basins will be retrieved and placed into containers 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 CVD Facility. Each process bay of the CVD Facility 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 CVD Facility. Process bay construction shall be designed to provide radiological separation and confinement 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 CVD Facility exhaust stack which 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, inert gasses, and potable water. Radioactive water will be collected in a tank at the CVD Facility 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 collection system will contain vented tanks, which will be connected to the process vent and CVD Facility exhaust stack. The connection for pick up by tanker truck will be located in the spare process bay, and the vented emissions from the tanker truck will be collected by the process bay general ventilation system and exhausted to the CVD Facility stack. The radioactive water will be: (1) processed and disposed of or stored at an existing, licensed/permitted facility located on the Hanford Site; or (2) processed and returned to the basins for makeup water.

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

LEGEND

<u>XXX</u>	ROOM NUMBER
<u>-X.XX</u>	ROOM DESIGN SPACE PRESSURE
RELATIVE TO ATMOSPHERE
<u>XXX-XXX-XX</u>	EQUIPMENT TAG NUMBER

AIR FLOW DIAGRAM -- MECHANICAL ROOM

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

AIR FLOW DIAGRAM -- TRANSFER CORRIDOR

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

AIR FLOW DIAGRAM --- ADMINISTRATION AREA

2.0 BACKGROUND AND NATURE OF THE SOURCE

To provide the reader with sufficient background and nature of the source information on the CVD Facility an overall SNF Project description is required. However, to focus on the CVD processes, equipment and emission points requiring approval under this NOC Appendix A is provided for the reader. Appendix A provides the reader the background and brief descriptions of other facilities, processes, and activities associated with the overall SNF Project.

As required by 40 CFR 61, the following sections will focus on the CVD Facility processes, equipment and emission points, and when necessary provide reference to Appendix A for additional information as it relates to the entire SNF Project and proper handling and storage of the K Basins SNF.

Section 2.1 will describe the CVD Facility process equipment and process that will potentially release radionuclide to the CVD Facility emission control equipment and eventually release to the public and the environment.

Section 3.0 through 3.5 will describe and list the potential emissions and dose, ventilation system, and monitoring system for the CVD Facility. Supporting references and calculation information will be listed in Section 4.0 and the Appendices.

2.1 COLD VACUUM DRYING PROCESS DESCRIPTION OVERVIEW

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

The CVD process will remove as much free water (bulk water [water that surrounds the SNF in each MCO] and absorbed and adsorbed water [water that adheres to the SNF after removal of bulk water]) as possible from the MCOs before they are transported to the Canister Storage Building (CSB). The water will be removed by pumping and heating to 50°C (122°F) in a vacuum for a period of approximately 24 hours.

The CVD process will mitigate 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). Therefore, limited quantities of chemically bound water may remain in each MCO after the drying process.

Before transport each MCO will be heated to approximately 75°C (167°F) and held for six to ten hours to verify that the MCO will not overpressurize during transportation to the CSB. Following the post CVD monitoring, the temperature of each MCO will be

lowered to 25°C (77°F) and the MCO inerted with inert gas at approximately 155 mmHg (3 lbf/in²[g]) pressure. The MCOs will then be released from the CVD Facility and transported on the SNF transport trailer by truck to the CSB. Details on the CVD process equipment and operation process that will be accomplished are discussed in the following sections.

2.1.1 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 reactive gases (volumetric, off-gassing, residual free water, and in leakage) 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 CVD Facility ventilation exhaust system.

2.1.1.1 Vacuum Pumping System. The vacuum pumping system (VPS) for the CVD Facility drying module will consist of a single-stage vacuum pump, valves, traps, process filters (for the collection of micron sized particles), instrumentation, and process piping 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 gasses from reacting with the uranium metal of the SNF elements.

The VPS will remove reactive gases (volumetric, off-gassing, 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. Reactive 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, nitrogen, or helium) 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 process 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 within 24 hours.

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 inert gas leak checking of each MCO following installation of the top shield.

2.1.1.2 Multi-Canister Overpack/Cask and Temperature Control System. The MCO/cask and temperature control system for the CVD Facility will provide all necessary equipment and controls to allow the efficient and timely heating of each MCO/cask to approximately 75°C (167°F) for post vacuum drying monitoring. The MCO/cask will be cooled to approximately 10°C (50°F) for safe cold standby condition or 25°C (77°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.

The main components of the MCO/cask and temperature control system will be an electric water heater, a shell and tube type water cooler, and a centrifugal circulation pump. In addition, any contaminants entrained in the water stream during heating and cooling will be removed by continuously pumping a fraction of the water heater outlet stream through an ion exchange column.

2.1.1.3 Solids and Water Collection System. The solids and water collection system for the CVD Facility will consist of collection tanks, transfer pumps, piping, valves, and ion exchange column for treatment and disposal of water from the MCO. The solids and water collection system will provide for the disposal of HEPA filters and any contaminated equipment at the end of the project.

2.1.1.4 Cold Vacuum Drying Facility Structures and Auxiliary Systems. The CVD Facility 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 CVD Facility.

2.1.2 Process Steps

The sequence of actions expected to occur in the CVD Facility are shown on Figure 10. The MCO/cask SNF transport trailer will be aligned in the vacuum drying 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 health physics personnel and verified to be acceptable for manned access. The process bay doors will be closed, sealing the SNF transport trailer within a radiological confinement zone, prior to any operational processes beginning. As stated earlier, the process bays will be separate independent bays, and the doors will only be opened when all operational processes are complete or when the process bay is empty. The process bay doors will only be opened the amount of time required to back the SNF transport trailer into the bay and decouple and remove the truck. The same amount of time will be required when removing the SNF transport trailer after CVD.

Figure 10. Cold Vacuum Drying
Facility Process Flow Diagram.

The cask top cover will be removed and the ventilation hood installed over each MCO/cask top. The ventilation hood will be on a moveable boom, moved into close proximity to the work site, will have a face area that matches the dimensions of the work area, and be able to produce an adequate capture velocity at the extreme point source of potential contamination. Each MCO HEPA filter will be isolated (blank flange installed). The MCO shield plug will be checked to ensure proper closure/configuration prior to CVD. This will 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 and temperature control system will be connected to the cask and deliver water at various temperatures at a rate of approximately 94.75 L/min. (25 gal/min.) at approximately 1,034 mmHg (20 lbs/in.²) to heat and cool the MCO. During the drying process the MCO/cask and temperature control system will pump heated water into the inlet at a temperature of 60°C (140°F) through the MCO/cask annular space until the MCO has reached a temperature of approximately 50°C (122°F). This will achieve a hot standby condition for the SNF, which will allow a quicker drying cycle. A heatup rate of 20°C (35°F) per hour will be achieved by circulating heated water at a temperature of 60°C (140°F) at 94.75 L/min. (25 gal/min.) in the MCO/cask annulus.

The initial removal of the free water from each MCO will be by inert gas purging and suction pump (nominal removal rate shall be 38 L/min [10 gal/min]). The nominal amount of bulk water is 685 L (181 gal) for MKIA SNF and 572 L (151 gal) for MKIV SNF. The water will be drained and transferred to the drying station radioactive water storage tank, with vented emissions being exhausted to the process vent and CVD stack. Following bulk water draining, each MCO may be optionally purged with an inert gas at a rate of 0.1 to 0.2 m³/min. (3 to 5 std ft³/min.) for approximately 40 to 60 min. 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 and adsorbed water left on the internal surfaces of each MCO and surfaces of the SNF elements. Also, less than 296 ml (10 oz) of water will be left at the lower end of the axial dip tube. To reach the vapor pressure of water at the saturation temperature, 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) 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 (9.25E+01 TORR) at 50°C (122°F). As the absorbed and adsorbed water is depleted by evacuation, the MCO pressure will be reduced to less than 6.5E+01 Pa (5E-01 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 (5E+00 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 (3E+00 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 (3E+00 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 MCOs 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. Each MCO will be cooled by having the MCO/cask and temperature control system to shutdown the heater and replace the heated water with cooled water at a temperature of 10°C (50°F).

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 and pressure relief ports will be inert gas-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 mmHg (3 lbf/in²[g]) pressure.

3.0 SOURCES OF EMISSIONS

This section of the NOC describes the potential emissions and dose, ventilation system, and monitoring system of the CVD Facility. The CVD Facility inventory will only exist at the facility for the duration of operations, estimated to be two years. The facility may be left in an operational configuration for a period of time after operations. Although operations will have ceased, residual contamination of equipment and ventilation system of the facility will be a potential emission source until decontamination of the facility. Currently, long term plans for the facility have not been discussed; however, any residual contamination will be significantly less than the emissions presented in the tables found in this section.

Therefore, any decontamination or other activities that do not change the make up of isotopes presented in this NOC, and that do not exceed the levels listed in the tables, will be accomplished under this NOC. This will assume that any and all activities will take place with the ventilation control and emission monitoring systems in place, and operated under the same parameters listed in this section of the NOC. This section of the NOC is submitted for approval in accordance with regulations. The potential source for airborne radionuclide emissions will be the irradiated SNF stored in the MCOs. This 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 test results on samples of basin floor sludge from the K East Basin show that a relatively small portion of the uranium metal has corroded into uranium oxide and is dispersed as particulate matter in the basin floor 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. While the behavior of the aluminum clad and zirconium clad fuel is different the drying and conditioning system components, as well as the MCO are designed to serve the needs of both fuels. 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 11.

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 1996b), which corresponds to approximately 800 kg

Figure 11. 105-N Reactor Mark IV Spent Nuclear Fuel Element Assembly.

105-N REACTOR MARK IV FUEL ELEMENT ASSEMBLY
(DSU0015A)

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

Radionuclide	K Basins Radionuclide Inventory (Ci)
H-3	3.51E+04
C-14	6.62E+02
Co-60	4.00E+03
Kr-85	5.79E+05
Sr-90	9.79E+06
Y-90	9.79E+06
Sb-125	3.39E+04
Te-125m	8.26E+03
I-129	5.93E+00
Cs-134	1.69E+04
Cs-137	1.26E+07
Ba-137m	1.19E+07
Pm-147	4.91E+05
Sm-151	1.68E+05
Eu-154	1.01E+05
Eu-155	2.18E+04
U-234	8.78E+02
U-235	3.40E+01
U-236	1.27E+02
U-238	6.96E+02
Pu-238	1.22E+05
Pu-239	2.25E+05
Pu-240	1.30E+05
Pu-241	6.39E+06
Am-241	3.46E+05
Other	2.38E+04

Notes:

1. The inventory values (Willis 1995) are decayed to December 31, 1997, the scheduled start of spent nuclear fuel transfer to the Canister Storage Building.

Willis 1995, *105-K Basin Material Design Basin Feed Description for Spent Nuclear Fuel Project Facilities*, WHC-SD-SNF-TI-009, Vol. 1, Rev. A, Westinghouse Hanford Company, Richland, Washington.

(1,764 lbs) of uranium oxide. The total mass of uranium oxide in the basins is, therefore estimated at 5,100 kg (11,243 lbs).

While it is difficult to precisely calculate the total amount of basin floor sludge and SNF uranium oxide remaining in the MCO after washing, the following calculations are based on the best engineering judgement and include conservative adjustments to account for any uncertainties. The 5,100 kg (11,243 lbs) of SNF uranium oxide, as calculated above, provides an individual MCO load of approximately 12.75 kg (28.95 lbs) of uranium oxide when divided by the 400 MCOs estimated to be necessary for holding all of the SNF. Conservative figures of 100 percent of all basin floor sludge and 50 percent of SNF uranium oxide will be removed by cleaning the SNF; bringing the estimate of uranium oxide in each MCO, following loading of the SNF, to 6.38 kg (14.1 lbs). To be conservative and consistent with previous engineering judgement and NOCs a value of 6.75 kg (14.88 lbs) per MCO of uranium oxide after MCO loading, was used for emission calculations.

Approximately 720 g (1.59 lbs) of fuel is expected to oxidize during CVD, and approximately 2 kg (4.4 lbs) 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 CVD and transportation processes.

In addition, under most conservative assumptions, approximately 0.72 kg (1.59 lbs) of uranium oxide is expected to be generated as a result of CVD Facility processing. The uranium oxide generated during CVD Facility processing is estimated by the current reaction rate, expected time of CVD Facility processing, and the temperature of the material during processing. Combining the 6.75 kg (14.88 lbs) of uranium oxide from the MCO loading and the 0.72 kg (1.59 lbs) of uranium oxide generated as a result of CVD Facility processing yields 7.47 kg (16.47 lbs) of uranium oxide. This 7.47 kg (16.47 lbs) of uranium oxide contains approximately 6.58 kg (13.77 lbs) of uranium (Appendix B). Comparing 6.58 kg (13.77 lbs) of uranium to the total uranium contained in each MCO (5,250 kg [11,574 lbs]) we derive the percentage of uranium oxide particulate generated during CVD processing. The percentage of uranium oxide as particulates is as follows:

$$\frac{6.58 \text{ kg (13.77 lbs) uranium}}{5,250 \text{ kg (11,574 lbs) uranium per MCO}} = 0.12 \text{ percent}$$

To determine the emissions for the CVD Facility a physical release factor of 10^{-3} for particulate matter was used in accordance with 40 CFR 61, Appendix D.

The rest of the un-corroded fuel (99.88 percent) is an intact metallic solid that will not release any contained radionuclide particulate unless further corroded by induced oxygen or by the release of bound water. To determine the emissions from the physical form of a solid for the CVD Facility a physical release factor of 10^{-6} was used for solids in accordance with 40 CFR 61, Appendix D.

Gasses matrixed in the SNF metallic solid will be released as gasses by oxidation of

the uranium fuel. Gaseous radionuclides will be generated due to the water-uranium oxidation on the surface of the SNF. The 0.72 kg (1.59 lbs) of uranium oxide formed in the CVD Facility is equivalent to approximately 0.63 kg (1.41 lbs) of uranium ($0.72 \times 238/270$). The 0.63 kg (1.41 lbs) of uranium is 0.01 percent of the total uranium contained in the MCO (0.63 kg [1.41 lbs]/5,250 kg [11,574 lbs] per MCO). This oxide that forms during the CVD Facility process will release all gas equivalent to 0.01 percent of the total source term. The sludge present prior to CVD Facility processing (6.75 kg [14.88 lbs] of oxide) will have already released any gases at the K Basins. Therefore, the emissions at the CVD Facility will consist of 0.01 percent gases in curies. The gas has a maximum physical release factor of one (40 CFR 61, Appendix D). Table 2 lists as sources, those radionuclides that are expected to be in a changed physical state that will cause potential emissions as a result of the CVD process.

3.1 DESCRIPTION OF PROPOSED EMISSION CONTROLS

The HVAC system for the CVD Facility will consist of one HVAC system for each process bay, one HVAC system for the west corridor area, one HVAC system for the mechanical room, and one HVAC system for the administration area (Figures 12 through 16). Each HVAC system operates independently but interfaces with the building control system. The process bay HVAC system will be a constant volume recirculating system with a two stage HEPA filtration in the return air system. Each bay will incorporate a local slot hood that will continuously withdraw a portion of the air from the bay area. Air withdrawn through the slot hoods in each bay will combine into a single system and will then be filtered through a two stage HEPA plenum. Partially redundant (inherent level of redundancy supplied by having the exhaust fans powered by separate power panels) exhaust fans, running in parallel, will direct the exhaust air in ducts to the stack. Each bay also will have a general exhaust system. This general exhaust will combine with the west corridor exhaust system (see Figure 6 and 7).

The west corridor area HVAC system will be a constant volume once-through system. Air will be ducted to the access corridor and support rooms. Air supplied to the access corridor will be transferred to the material storage room and change rooms. The change rooms will be maintained with a positive pressure with respect to the process bays. Air from the west corridor support rooms, the controlled rooms in the administration area, and general exhaust from the process bays will be exhausted to a separate two-stage HEPA plenum. A separate set of partially redundant (inherent level of redundancy supplied by having the exhaust fans powered by separate power panels) exhaust fans, running in parallel, will direct the exhaust air to the stack.

The administration area will be served by a packaged unit with chilled water cooling and electric heat. Air will be recirculated through the administration area and an economizer will be used to reduce energy costs. Air from the restrooms and shower areas will be exhausted to the outside. The Administration Area HVAC will maintain the operating pressure of the office areas positive with respect to change room areas and the West Corridor Area.

Air Conditioning Process Bay Partial.

Cold Vacuum Drying Facility Heating, Ventilation, and Air Conditioning Process Bay Partial.

NORTH

HVAC PARTIAL PLAN -- TRANSFER CORRIDOR

SCALE 1/4" = 1'-0"

HVAC PARTIAL PLAN -- TRANSFER CORRIDOR

SCALE 1/4" = 1'-0"

Figure 14. Cold Vacuum Drying Facility Heating, Ventilation, and Air Conditioning Transfer Corridor.

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Figure 16. Cold Vacuum Drying Facility Heating, Ventilation, and Air Conditioning Administration Area.

HVAC PLAN -- ADMINISTRATION AREA
1/4" = 1'-0"

Table 2. Potential Unabated Emissions from the Cold Vacuum Drying Facility.

Radionuclide	K Basins Inventory (Ci)	Physical Form(a)	Radionuclide Inventory at CVD Facility(b)			Unabated Emissions(c) (Ci/yr)
			Gases (Ci)	Solids (Ci)	Particulates (Ci)	
H-3	3.51E+04	G (generated)	3.51E+00	---	---	1.76E+00
H-3	---	S (matrixed in fuel)	---	3.51E+04	---	1.75E-02
C-14	6.62E+02	G (generated)	6.62E-02	---	---	3.31E-02
C-14	---	S (matrixed in fuel)	---	6.62E+02	---	3.31E-04
Co-60	4.00E+03	S/P	---	4.00E+03	4.80E+00	4.40E-03
Kr-85	5.79E+05	G (generated)	5.79E+01	---	---	2.90E+01
Kr-85	---	S (matrixed in fuel)	---	5.79E+05	---	2.89E-01
Sr-90	9.79E+06	S/P	---	9.78E+06	1.17E+04	1.08E+01
Y-90	9.79E+06	S/P	---	9.78E+06	1.17E+04	1.08E+01
Sb-125	3.39E+04	S/P	---	3.39E+04	4.07E+01	3.73E-02
Te-125m	8.26E+03	S/P	---	8.25E+03	9.91E+00	9.08E-03
I-129	5.93E+00	G (generated)	5.93E-04	---	---	2.97E-04
I-129	---	S (matrixed in fuel)	---	5.93E+00	---	2.96E-06
Cs-134	1.69E+04	S/P	---	1.69E+04	2.03E+01	1.86E-02
Cs-137	1.26E+07	S/P	---	1.26E+07	1.51E+04	1.39E+01
Ba-137m	1.19E+07	S/P	---	1.19E+07	1.43E+04	1.31E+01
Pm-147	4.91E+05	S/P	---	4.90E+05	5.89E+02	5.40E-01
Sm-151	1.68E+05	S/P	---	1.68E+05	2.02E+02	1.85E-01
Eu-154	1.01E+05	S/P	---	1.01E+05	1.21E+02	1.11E-01
Eu-155	2.18E+04	S/P	---	2.18E+04	2.62E+01	2.40E-02
U-234	8.78E+02	S/P	---	8.77E+02	1.05E+00	9.65E-04
U-235	3.40E+01	S/P	---	3.40E+01	4.08E-02	3.74E-05
U-236	1.27E+02	S/P	---	1.27E+02	1.52E-01	1.40E-04
U-238	6.96E+02	S/P	---	6.95E+02	8.35E-01	7.65E-04
Pu-238	1.22E+05	S/P	---	1.22E+05	1.46E+02	1.34E-01
Pu-239	2.25E+05	S/P	---	2.25E+05	2.70E+02	2.47E-01
Pu-240	1.30E+05	S/P	---	1.30E+05	1.56E+02	1.43E-01
Pu-241	6.39E+06	S/P	---	6.38E+06	7.67E+03	7.03E+00
Am-241	3.46E+05	S/P	---	3.46E+05	4.15E+02	3.80E-01
Other	2.38E+04	S/P	---	2.37E+04	2.85E+01	2.61E-02

- (a) G (generated) = gas generated through oxidation of the SNF with the water and released during CVD; S = solid; P = particulate matter
- (b) Percent of total inventory per radionuclide: Gases - 0.01%; Solids - 99.88%; Particulates - 0.12%. Cold vacuum drying facility inventory = K Basin inventory multiplied by percentage.
- (c) Release fractions: Gases = 1, Particulates = 10^{-3} , and Solids = 10^{-6} ; 40 CFR 61, Appendix D.

CVD = Cold Vacuum Drying
CFR = Code of Federal Regulations

40 Code of Federal Regulation (CFR) 61, 1989, "Methods for Estimating Radionuclide Emissions", Appendix D, *Code of Federal Regulations*, December 15, 1989.

Notes to Table 2:

- These emissions will be the maximum potential during the cold vacuum drying operation which will take approximately two years. Emissions in follow on years will be from residual contamination found on equipment and building interior. Any activities taking place after CVD operations will ensure the potential emissions do not exceed those listed in this table.
- The potential emissions listed in this table presume that all of the spent nuclear fuel will go through cold vacuum drying as stated in Note 1 above.

3.2 VENTILATION AND STACK OVERVIEW

The HVAC system for a typical process bay will ventilate the bay air space, condition operating space air, and maintain required relative pressures in the operating spaces. The HVAC system will maintain the integrity of the air space confinement by maintaining a pressure differential between the process bay and any surrounding air space. This will ensure all airflow is from areas with least contamination towards areas of highest possible contamination. A portion of the air supplied to the process bay area will be recirculated to reduce energy costs in maintaining comfort air-conditioning. Recirculated air will be filtered through two stages of HEPA filters to ensure adequate air quality. A general exhaust system will be provided for each bay and will be utilized to maintain air space pressure differential. Local slot hoods will be provided for each process bay. Slot hoods will be located near work areas with potential for contamination releases. Intake air from slot hoods will be filtered through two stages of HEPA filters and routed to the exhaust stack.

The HVAC system for the west corridor area will ventilate the corridor air space, condition operating space air, and maintain required relative air space pressures. The HVAC system will maintain airborne confinement by maintaining a pressure differential between the west corridor area and the process bays. This will ensure all airflow is towards areas of higher possible contamination. Exhaust air from the support rooms along the east wall of the corridor area will be filtered through two stages of HEPA filters and routed to the exhaust stack.

The HVAC system for the administration area will ventilate the area, condition operating space air, and maintain required air space relative pressures.

The CVD Facility exhaust will have a discharge velocity of approximately 1,066 mpm (3,500 fpm). The CVD Facility exhaust stack will have a minimum height of 1.3 times the height of the facility, which is equal to approximately 13 m (48 ft). The diameter of the stack will be approximately 76 cm (30 in.) and have a flow rate of approximately 546 m³/m (19,490 cfm). The CVD Facility exhaust stack will service the process bays and west corridor area.

3.2.1 System Configuration

The Process Bay Zone III HVAC systems will include an outside air intake louver, supply air handling unit (AHU), isolation dampers, duct mounted airflow measuring stations, duct heating coils, return air and exhaust air two stage HEPA filter assemblies, local slot intake hoods, exhaust air fans, and an exhaust air stack. The supply AHU will be comprised of the following equipment: an outside air/return air mixing box with dampers; 30 percent and 85 percent rated American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) filters; a chilled water cooling coil; an access section; and a centrifugal supply air fan. Electric heating coils located in the supply air duct will provide heating.

A HVAC exhaust system will be provided for each process bay and will be used to maintain space pressure. This exhaust combines with the west corridor exhaust system. Two stage HEPA filtration and redundant fans will be provided for this system. Local slot hoods provided for each process bay will exhaust air from the space through two stages of HEPA filters to the CVD Facility exhaust stack.

The West Corridor Zone IV HVAC system will include an outside air intake louver, supply AHU, isolation dampers, duct mounted airflow measuring stations, duct heating coils, exhaust air two stage HEPA filter assemblies, exhaust air fans, and an exhaust air stack (the CVD Facility exhaust stack is common to process bay and west corridor area). The supply AHU will be comprised of the following equipment: an outside air/return air mixing box with dampers, 30 percent and 85 percent rated ASHRAE filters, a chilled water cooling coil, an access section, and a centrifugal supply air fan. Electric heating coils located in the supply air duct will provide heating.

The Administration Area Zone IV HVAC systems will include a packaged AHU and local exhaust fans. The supply AHU will be comprised of the following equipment: an outside air/return air mixing box with dampers, 30 percent rated ASHRAE filter, a chilled water cooling coil, an electric preheat coil, and a centrifugal supply air fan. Powered roof ventilators will exhaust air from the restrooms and shower areas.

3.2.2 Ventilation Process Description

A typical process bay HVAC system will ventilate, condition operating space air, and maintain the required pressure differentials between the process bay and surrounding zones. The HVAC system will recirculate a portion of the air in the process bay to reduce operating costs in providing comfort air conditioning and ventilation. Outside air will be drawn through an intake louver and mixed with return air. The mixed air will then be drawn through two stages of filtration (30 percent and 85 percent), cooled by a chilled water coil, and supplied by a backward-inclined supply fan. Electric heating coils located in the supply duct provide heating when required.

The air in the process bay area, which will not be recirculated, will be exhausted through a general exhaust system and a local slot hood. The general exhaust will combine with the west corridor exhaust system before entering a two stage HEPA filter and continuing to the CVD Facility exhaust stack. Air exhausted through the slot hoods will be combined into a common system and HEPA filtered and directed to the CVD Facility exhaust stack. Partially redundant exhaust fans serve each exhaust system. The fans, each sized at a minimum of 60 percent total exhaust air capacity, will be used to draw the exhaust air to the stack. If one fan in a parallel system goes down the other will ramp up to approximately 80 percent of design flow. The supply system will be interlocked to the exhaust system to maintain space pressure differentials.

The west corridor area HVAC system will ventilate, condition operating space air, and maintain the required pressure differentials between the corridor spaces and the process

bays. The HVAC system will be a once-through system. All exhaust air will be sent through a two stage HEPA filter before exhausting out the CVD Facility exhaust stack. This exhaust system will be separate from the truck bay exhaust system up to a converging point at the stack. Outside air will be drawn through two stages of filtration (30 percent and 85 percent), cooled by a chilled water coil, and supplied by a backward-inclined supply fan. Electric heating coils located in the supply duct will provide heating when required. Partially redundant exhaust fans of a minimum of 60 percent total exhaust air capacity will be used to draw the exhaust air to the stack.

The administration area HVAC system will ventilate, condition operating space air, and maintain the required pressure differentials within the administration area. The HVAC system will recirculate a portion of the air in the administration areas to reduce operating costs in providing comfort air-conditioning and ventilation. A minimum amount of outside air will be drawn through an intake louver and mixed with return air. The mixed air will then be drawn through a filter, cooled by a chilled water coil or heated by an electric preheat coil and terminal heating coils, and supplied by a supply fan. Exhaust air in the controlled areas of the administration area will be directed to the west corridor area HEPA exhaust system.

3.2.3 Equipment Description

The following equipment will be used in the process bay HVAC:

- Supply Fan - backward-inclined, double-width, double-inlet, class III, centrifugal fan. Fans will be belt driven with high-efficiency motors.
- Exhaust Fans - backward-inclined, single-width, single-inlet, class III, centrifugal fans. Fans will be belt driven with high-efficiency motors and variable frequency drives.
- Cooling Coil - chilled water cooling coil.
- AHU Filters - 30 percent ASHRAE roughing filter and 85 percent ASHRAE final filter.
- Ductwork - galvanized supply ductwork and type 304 stainless steel exhaust and return ductwork.
- HEPA Filter Housing - 304 stainless steel, bag-out type, transitions on both ends, and assembled in the direction of air flow as follows: prefilter section, test section, first stage HEPA filter section, test section, second stage HEPA filter section, and final test section.
- HEPA Prefilter - 60.96 cm x 60.96 cm x 15.24 cm (24 in. x 24 in. x 6 in.) thick, Underwriters Laboratories (UL) Class 1, 65 percent efficiency per

ASHRAE standard 52 to 76.

- HEPA Filters - 60.96 cm x 60.96 cm x 29.21 cm (24 in. x 24 in. x 11 ½ in.) thick, UL Class 1, 99.97 percent efficiency per dioctyl phthalate (DOP) test, fire retardant plywood or stainless steel frame.
- Isolation Dampers - isolation dampers at HEPA filter plenums and exhaust fans will be American National Standards Institute Class 150 butterfly valves with motorized actuators and will meet the requirements of American Society of Mechanical Engineers (ASME) N 509-1989, Leakage Class I. Isolation dampers at outside air intakes will be industrial grade, galvanized opposed blade control dampers and will meet the requirements for ASME N 509-1989, Leakage Class II.

The following equipment will be used in the west corridor HVAC:

- Supply Fan - backward-inclined, double-width, double-inlet, class III, centrifugal fan. Fans will be belt driven with high-efficiency motors.
- Exhaust Fans - backward-inclined, single-width, single-inlet, class III, centrifugal fans. Fans will be belt driven with high-efficiency motors.
- Preheat Coil - electric.
- Cooling Coil - chilled water cooling coil.
- Heating Coil - electric reheat coils.
- AHU Filters - 30 percent ASHRAE roughing filter and 85 percent ASHRAE final filter.
- Ductwork - galvanized supply ductwork and type 304 stainless steel exhaust ductwork.
- HEPA Filter Housing - 304 stainless steel, bag-out type, transitions on both ends, and assembled in the direction of air flow as follows: prefilter section, test section, first stage HEPA filter section, test section, second stage HEPA filter section, and final test section.
- HEPA Prefilter - 60.96 cm x 60.96 cm x 15.24 cm (24 in. x 24 in. x 6 in.) thick, UL Class 1, 65 percent efficiency per ASHRAE standard 52 to 76.
- HEPA Filters - 60.96 cm x 60.96 cm x 29.21 cm (24 in. x 24 in. x 11 ½ in.) thick, UL Class 1, 99.97 percent efficiency per DOP test, fire retardant plywood of stainless steel frame.

- Isolation Dampers - isolation dampers at HEPA filter plenums and exhaust fans, will be American National Standards Institute Class 150 butterfly valves with motorized actuators and will meet the requirements of ASME N 509-1989, Leakage Class I. Isolation dampers at outside air intakes, will be industrial grade, galvanized opposed blade control dampers, and will meet the requirements for ASME N 509-1989, Leakage Class II.

The following equipment will be used in the administration area:

- Supply Fan - backward-inclined, double-width, double-inlet, class II, centrifugal fan. Fans will be belt driven with high-efficiency motors.
- Exhaust Fans - powered roof ventilators.
- Preheat Coil - electric.
- Cooling Coil - chilled water cooling coil.
- Terminal Heating Coils - electric.
- AHU Filters - 30 percent ASHRAE filter.
- Ductwork - galvanized and aluminum ductwork .

3.3 EFFLUENT MONITORING

The CVD Facility unabated dose will have a potential to discharge radionuclides into the air in quantities which could cause an effective dose equivalent in excess of one percent of the standard set forth in 40 CFR 61, Subpart H. All radionuclides which could contribute greater than 10 percent of the potential effective dose equivalent for this stack will be measured. In evaluating the potential of a release point to discharge radionuclides into the air for the purposes of this section, the estimated radionuclide release rates shall be based on the discharge of the effluent stream that would result if all pollution control equipment did not exist, but the facilities operations were otherwise normal. The following sections describe the equipment to be used to collect and monitor the CVD Facility stack emissions.

The CVD Facility will have exhaust stack sample monitoring in accordance with 40 CFR 61, Appendix B, Method 114. The airborne activity monitors for the SNF CVD Facility consist of the alpha sensitive continuous air monitoring (CAM) and a radioactive particulate sampler. Sample line design will minimize the possibility of line loss. It will utilize a 47 mm (2 in.) filter with 98 percent retention of 0.3 micron median diameter particles contained in a sealed, filter holder. The filter will be a Gelman Versapore 3000H, or equivalent.

3.3.1 Flow Measurement

The continuous air emission monitoring (CAEM) will contain flow instrumentation to monitor stack and individual sampler/monitor flow rates. The sample flow rate measurement will be accurate to approximately two percent. A differential pressure flow device will be used. The sample flow instrument will have an adjustable alarm set point for low flow. The stack and sampler flow instruments will also have the provision for totalizing the flow between filter changes. The stack flow instrument will be conducted in compliance with reference Method 2 or 2A of Appendix A to 40 CFR Part 60, per section 40 CFR 61.93(b)(1) of National Emission Standards for Hazardous Air Pollutants.

3.3.2 Sample Probe

The sample probes will be designed to the shrouded probe requirements. The probe inlet will have aspiration ratios in the range of 80 to 150 percent for 10 μm aerodynamic equivalent diameter (AED) particles. The sampler probe inlet will transport 80 to 130 percent of the 10 μm AED particles. It will also be configured for easy removal to allow washing the interior of the probe and capture of the washing liquid for analysis. A shrouded probe, as described in Section 2 of *Alternative Method Using Shrouded Probe* (EPA 1994), is the reference design.

3.3.3 Vacuum Pumps

A pump with backup, located in the CAEM System Cabinet, will be used to draw air through the filter at a constant flow rate of approximately 1 m^3/min (2.2 cfm) up to a maximum pressure drop of 150 mm (6 in.) of mercury. At this point the low flow alarm will be activated and the filter must be changed. Flow alarms are audibly and visually annunciated locally and repeated at the data control systems consoles and terminals. The flow control system consists of stainless steel piping, a stainless steel metal bellows pump, a controller, a motorized ball valve, and a mass flow meter with alarms. The motorized ball valve alters the velocity of the sample entering the CAM and thus, through the filter while maintaining a volumetric rate. The vacuum pump exhaust line will enter the exhaust ductwork downstream of the second set of shrouded probes.

3.3.4 Radioactive Particulate Sampling

The CAEMs will contain a record sampler. The remote sample head and the record sample filter will be as close as practical to the stack to minimize particulate line losses. The first set of shrouded probes in the exhaust stack will be used for particulate sampling. One probe will be located in the center of the stack and the second probe will be located half-way between the first probe and the wall of the exhaust stack. The flow from these probes will be combined outside the exhaust stack and will be piped to the CAEM Record Sampler located in the CAEM Cabinet. Placement of both the record sampler and the remote sample

head will insure ease of filter replacement.

The sample filters will be delivered to a laboratory for a complete alpha-beta analysis and gamma energy analyzed using equipment/procedures providing a lower detection limit of one picocurie per sample. The filters will then be composited for a quarterly gamma scan and an isotopic analysis for plutonium and americium-241.

3.3.5 Alpha Monitoring

The CAEMs will also contain an alpha CAM. The second set of shrouded probes, located approximately 1 to 2 m (6 to 8 ft) downstream from the first set of probes, will provide the sample stream for the alpha CAM. One probe will be located in the center of the stack and the second probe will be located half-way between the first probe and the wall of the exhaust stack. The flow from these probes will be combined outside the exhaust stack and will be piped to the CAM located in the CAEM Cabinet.

The alpha CAM will collect a sample of particles/gas exiting the stack. The line loss and filter efficiency will be such that the collected particle sample will contain >50 percent of the 10 μ m and larger AED particles that are present in the free stream. This performance will be tested and documented by (in order of preference) a field acceptance test, laboratory wind tunnel testing, or the verified model.

The alpha portion of the alpha CAM will include a completely separate alpha sampler which contains a parallel 47 mm (2 in.) diameter 0.3 micron efficient filter, which is monitored by a lead shielded silicon surface barrier detector with an active area of 500 mm² (1 in.²). The alpha CAMs also include circuitry for background subtraction of radon-thoron activity. The alpha CAMs will be Nuclear Research Corporation model MS-2PFF, or equivalent.

3.3.6 Threshold of Detection

The sensitivity of the alpha CAM to plutonium-239 in a 2 mR/hr background of 0.662 MeV photons and in the presence of ambient radon-thoron with a counting time of 16 minutes and a sample collection period of 4 hours will be a minimum of 4×10^{-12} μ Ci/ml.

3.4 POTENTIAL RADIOACTIVE EMISSIONS FROM THE FACILITY

The inventory of radionuclides in the SNF (listed in Table 1) is divided into physical state categories of solids, particulates, and gasses that are appropriate to CVD. The potential abated emissions from this inventory during CVD were calculated and are summarized in Table 3.

Table 3. Abated Emissions from the Cold Vacuum Drying Facility.

Radionuclide	Physical Form	Unabated Emissions (Ci/yr)	Emission Reduction Factor	Abated Emissions (Ci/yr)
H-3	G (generated)	1.76E+00	1	1.76E+00
H-3	S (matrixed in fuel)	1.75E-02	3,000	5.85E-06
C-14	G (generated)	3.31E-02	1	3.31E-02
C-14	S (matrixed in fuel)	3.31E-04	3,000	1.10E-07
Co-60	S/P	4.40E-03	3,000	1.47E-06
Kr-85	G (generated)	2.90E+01	1	2.90E+01
Kr-85	S (matrixed in fuel)	2.89E-01	3,000	9.65E-05
Sr-90	S/P	1.08E+01	3,000	3.59E-03
Y-90	S/P	1.08E+01	3,000	3.59E-03
Sb-125	S/P	3.73E-02	3,000	1.24E-05
Te-125m	S/P	9.08E-03	3,000	3.03E-06
I-129	G (generated)	2.97E-04	1	2.97E-04
I-129	S (matrixed in fuel)	2.96E-06	3,000	9.88E-10
Cs-134	S/P	1.86E-02	3,000	6.19E-06
Cs-137	S/P	1.39E+01	3,000	4.62E-03
Ba-137m	S/P	1.31E+01	3,000	4.36E-03
Pm-147	S/P	5.40E-01	3,000	1.80E-04
Sm-151	S/P	1.85E-01	3,000	6.16E-05
Eu-154	S/P	1.11E-01	3,000	3.70E-05
Eu-155	S/P	2.40E-02	3,000	7.99E-06
U-234	S/P	9.65E-04	3,000	3.22E-07
U-235	S/P	3.74E-05	3,000	1.25E-08
U-236	S/P	1.40E-04	3,000	4.65E-08
U-238	S/P	7.65E-04	3,000	2.55E-07
Pu-238	S/P	1.34E-01	3,000	4.47E-05
Pu-239	S/P	2.47E-01	3,000	8.25E-05
Pu-240	S/P	1.43E-01	3,000	4.76E-05
Pu-241	S/P	7.03E+00	3,000	2.34E-03
Am-241	S/P	3.80E-01	3,000	1.27E-04
Other	S/P	2.61E-02	3,000	8.71E-06

G = gas

S = solid

P = particulate matter

3.5 MAXIMUM POTENTIAL OFFSITE DOSE

The total potential unabated emission for each radionuclide was multiplied by the appropriate dose equivalent factor for the site location to calculate the total unabated annual total effective dose equivalent (TEDE) to the hypothetical maximally exposed individual (MEI) at the site boundary. The isotope-specific unabated annual doses then were summed to obtain the total dose estimate shown in Table 4.

The potential unabated dose to a MEI has been calculated (Appendix B) using generalized location-specific criteria generated for that purpose (WHC 1991) to meet the requirements of 40 CFR 61, Subpart H and is shown in Table 4. This criteria places the MEI 9,900 m (32,472 ft) west of the 100 Area. The unabated dose is based on the discharge of the effluent stream that would result if all pollution control equipment did not exist, but the facilities operations were otherwise normal.

The abated emission is the unabated emission reduced by the HEPA filter reduction factor of 3,000 (WHC 1991) for the particulate radionuclides and with no reduction for the gaseous radionuclides, listed in Table 3. The potential abated dose to a MEI is shown in Table 5. The dose is based on abated air emissions from the CVD Facility exhaust stack. The dose is summarized in Table 6 and is the maximum annual dose to which the nearest offsite individual would receive due to abated emissions.

This dose combined with all other DOE Hanford emission impacts will not cause the Hanford Site to exceed the U.S. Environmental Protection Agency limit of ten mrem per year stated in 40 CFR 61.94. The actual abated TEDE is expected to be much lower than the conservative estimate provided in Table 6, for the following reasons:

- Internal process HEPA filters, such as the MCO HEPA filters and process equipment HEPA filters, are incorporated in the design but were not factored into the emission calculations.
- Any particulate emitted from the CVD Facility will have to pass through two HEPA filters in a series. Additional reductions gained by the second of these filters have not been factored into the abated dose.
- Cold vacuum drying will remove water to reduce the corrosion layer on the surface of the SNF. This layer represents the particulate most available to become airborne.
- Iodine and carbon are conservatively shown as gasses due to 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 non-volatile compounds with a very limited vapor pressure, such as CsI and BaCO₃.

Table 4. Unabated Dose from the Cold Vacuum Drying Facility.

Radionuclide	Physical Form	Unabated Emissions (Ci/yr)	Dose Equivalent(a) (mrem/Ci)	Unabated Total Dose (mrem/yr)	Percent
H-3	G (generated)	1.76E+00	3.36E-05	5.90E-05	0
H-3	S (matrixed in fuel)	1.75E-02	3.36E-05	5.90E-07	0
C-14	G (generated)	3.31E-02	4.02E-03*	1.33E-04	0
C-14	S (matrixed in fuel)	3.31E-04	4.02E-03*	1.33E-06	0
Co-60	S/P	4.40E-03	4.28E-02	1.88E-04	0
Kr-85	G (generated)	2.90E+01	7.49E-08	2.17E-06	0
Kr-85	S (matrixed in fuel)	2.89E-01	7.49E-08	2.17E-08	0
Sr-90	S/P	1.08E+01	6.45E-02	6.94E-01	4
Y-90	S/P	1.08E+01	4.50E-04	4.84E-03	0
Sb-125	S/P	3.73E-02	6.13E-03*	2.28E-04	0
Te-125m	S/P	9.08E-03	1.11E-03	1.01E-05	0
I-129	G (generated)	2.97E-04	3.19E-01*	9.46E-05	0
I-129	S (matrixed in fuel)	2.96E-06	3.19E-01*	9.46E-07	0
Cs-134	S/P	1.86E-02	4.62E-02	8.58E-04	0
Cs-137	S/P	1.39E+01	3.53E-02	4.89E-01	3
Ba-137m	S/P	1.31E+01	(b)	0.00E+00	0
Pm-147	S/P	5.40E-01	1.38E-03	7.45E-04	0
Sm-151	S/P	1.85E-01	9.67E-04	1.79E-04	0
Eu-154	S/P	1.11E-01	2.69E-02	2.99E-03	0
Eu-155	S/P	2.40E-02	2.73E-03	6.54E-05	0
U-234	S/P	9.65E-04	4.03E+00	3.89E-03	0
U-235	S/P	3.74E-05	3.85E+00	1.44E-04	0
U-236	S/P	1.40E-04	3.82E+00	5.33E-04	0
U-238	S/P	7.65E-04	3.59E+00	2.75E-03	0
Pu-238	S/P	1.34E-01	1.18E+01	1.58E+00	10
Pu-239	S/P	2.47E-01	1.28E+01	3.17E+00	19
Pu-240	S/P	1.43E-01	1.28E+01**	1.83E+00	11
Pu-241	S/P	7.03E+00	2.03E-01*	1.43E+00	9
Am-241	S/P	3.80E-01	1.94E+01*	7.38E+00	44
Other	S/P	2.61E-02	Unknown	0.00E+00	0
Totals				1.66E+01	100

- (a) Dose estimates are from WHC 1991 for the 100 Area, unless not available; dose factors marked with "**" is from CAP 88 modeling numbers from K Basin Files (Appendix B); **No approved dose factor available, used plutonium-239 dose factor since plutonium-239 and plutonium-240 reported in same lab analysis results.
- (b) The dose factor cesium-137 accounts for the dose from all daughter product decay reactions.

G - gas; S - solid P - particulate matter

Rhoads, K., 1988, *Dose and Risk Equivalent Summaries, Non-Radon Individual Assessment*, CAP88-PC Version 1.00, Clean Air Act Assessment Package, Calculations for 100 Area Unit Dose Factors, October 31, 1996, Richland, Washington.

WHC, 1991, *Unit Dose Calculation Methods and Summary of Facility Monitoring Plan Determinations*, WHC-EP-0498, November 1991, Westinghouse Hanford Company, Richland, Washington.

Table 5. Abated Dose from the Cold Vacuum Drying Facility.

Radionuclide	Physical Form	Abated Emissions (Ci/yr)	Dose Equivalent(a) (mrem/Ci)	Abated Total Dose (mrem/yr)	Percent
H-3	G (generated)	1.76E+00	3.36E-05	5.90E-05	1
H-3	S (matrixed in fuel)	5.85E-06	3.65E-05	1.97E-10	0
C-14	G (generated)	3.31E-02	4.02E-03*	1.33E-04	2
C-14	S (matrixed in fuel)	1.10E-07	4.02E-03*	4.43E-10	0
Co-60	S/P	1.47E-06	4.28E-02	6.27E-08	0
Kr-85	G (generated)	2.90E+01	7.49E-08	2.17E-06	0
Kr-85	S (matrixed in fuel)	9.65E-05	7.49E-08	7.23E-12	0
Sr-90	S/P	3.59E-03	6.45E-02	2.31E-04	4
Y-90	S/P	3.59E-03	4.05E-04	1.61E-06	0
Sb-125	S/P	1.24E-05	6.13E-03*	7.62E-08	0
Te-125m	S/P	3.03E-06	1.11E-03	3.36E-09	0
I-129	G (generated)	2.97E-04	3.19E-01*	9.46E-05	2
I-129	S (matrixed in fuel)	9.88E-10	3.19E-01*	3.15E-10	0
Cs-134	S/P	6.19E-06	4.62E-02	2.86E-07	0
Cs-137	S/P	4.62E-03	3.53E-02	1.63E-04	3
Ba-137m	S/P	4.36E-03	(b)	0.00E+00	0
Pm-147	S/P	1.80E-04	1.38E-03	2.48E-07	0
Sm-151	S/P	6.16E-05	9.67E-04	5.95E-08	0
Eu-154	S/P	3.70E-05	2.69E-02	9.96E-07	0
Eu-155	S/P	7.99E-06	2.73E-03	2.18E-08	0
U-234	S/P	3.22E-07	4.03E+00	1.30E-06	0
U-235	S/P	1.25E-08	3.85E+00	4.80E-08	0
U-236	S/P	4.65E-08	3.82E+00	1.78E-07	0
U-238	S/P	2.55E-07	3.59E+00	9.16E-07	0
Pu-238	S/P	4.47E-05	1.18E+01	5.28E-04	9
Pu-239	S/P	8.25E-05	1.28E+01	1.06E-03	18
Pu-240	S/P	4.76E-05	1.28E+01**	6.10E-04	10
Pu-241	S/P	2.34E-03	2.03E-01*	4.75E-04	8
Am-241	S/P	1.27E-04	1.94E+01*	2.46E-03	42
Other	S/P	8.71E-06	Unknown	0.00E+00	0
Totals				5.82E-03	99

- (a) Dose estimates are from WHC 1991 for the 100 Area unless not available; dose factors marked with "*" is from CAP 88 modeling numbers from K Basin files (Appendix B); **No approved dose factor available, used plutonium-239 dose factor since plutonium-239 and plutonium-240 reported in same lab analysis results.
- (b) The dose factor cesium-137 accounts for the dose from all daughter product decay reactions.

G - gas; S - solid; P - particulate matter

Rhoads, K., 1988, *Dose and Risk Equivalent Summaries, Non-Radon Individual Assessment*, CAP88-PC Version 1.00, Clean Air Act Assessment Package. Calculations for 100 Area Unit Dose Factors, October 31, 1996, Richland, Washington.

WHC, 1991, *Unit Dose Calculation Methods and Summary of Facility Monitoring Plan Determinations*, WHC-EP-0498, November 1991, Westinghouse Hanford Company, Richland, Washington.

Table 6. Summary of Abated Dose.

Emission Source	Emission Type	Total Unabated Dose (mrem/yr)	Total Abated Dose (mrem/yr)
Cold Vacuum Drying	Gaseous Solids/Particulate	2.89E-04 1.66E+01	2.89E-04 5.53E-03
Totals		1.66E+01	5.82E-03

4.0 REFERENCES

- 40 Code of Federal Regulation (CFR) 52, Appendix E, 1975, "Performance Specifications and Specification Test Procedures or Monitoring Systems for Effluent Stream Gas Volumetric Flow Rate," *Code of Federal Regulations*, as amended.
- 40 Code of Federal Regulation (CFR) 60, Appendix A, "Test Methods," *Code of Federal Regulations*.
- 40 Code of Federal Regulation (CFR) 61, 1991, "National Emissions Standards for Hazardous Air Pollutants (NESHAP)," *Code of Federal Regulations*, as amended.
- 40 Code of Federal Regulation (CFR) 61, 1991, "National Emissions Standards of Radionuclide Other than Radon from U.S. Department of Energy Facilities," Subpart H, *Code of Federal Regulations*, as amended.
- 40 Code of Federal Regulation (CFR) 61, 1989, "Methods for Estimating Radionuclide Emissions", Appendix D, *Code of Federal Regulations*, December 15, 1989.
- DOE, 1994, *Integrated Process Strategy for K Basins Spent Nuclear Fuel*, WHC-SD-SNF-SP-005, Volume 1, Rev. 0, July 1995.
- EPA, 1994, *Alternative Method Using Shrouded Probe*, D.H. Nichols, United States Environmental Protection Agency, letter to R.F. Pellitier, United States Department of Energy, November 21, 1994.
- LATA/BNFL/Foster Wheeler, 1996, *Spent Nuclear Fuels, Fuel Retrieval Sub-Project Conceptual Design Report*, Volume I and II, L/B-SD-SNF-Rpt-09, Revision 0, LATA/BNFL/Foster Wheeler for Westinghouse Hanford Company, Richland Washington
- Rhoads, K., 1988, *Dose and Risk Equivalent Summaries, Non-Radon Individual Assessment*, CAP88-PC Version 1.00, Clean Air Act Assessment Package, Calculations for 100 Area Unit Dose Factors, October 31, 1996, Richland, Washington.
- WHC, 1996a, *Conceptual Design Report for the Cold Vacuum Drying System*, WHC-SD-SNF-CDR-003, Revision 0, Merrick & Company for Westinghouse Hanford Company, Richland, Washington.
- WHC, 1996b, *Analysis of Sludge from Hanford K East Basin Floor and Weasel Pit*, WHC-SP-1182, Westinghouse Hanford Company, Richland, Washington.
- WHC, 1996c, *Performance Specification for the Spent Nuclear Fuel Multi-Canister Overpack*, WHC-S-0426, Revision 1, Westinghouse Hanford Company, Richland, Washington.

- WHC, 1996d, *Conceptual Design Report for the Hot Conditioning System Equipment*, WHC-SD-SNF-CDR-007, Revision 0, Merrick Company for Westinghouse Hanford Company, Richland, Washington.
- WHC, 1995, *K Basin Corrosion Program Report*, WHC-EP-0877, dated September 1995, Westinghouse Hanford Company, Richland, Washington.
- WHC, 1991, *Unit Dose Calculation Methods and Summary of Facility Monitoring Plan Determinations*, WHC-EP-0498, November 1991, Westinghouse Hanford Company, Richland, Washington.
- Willis 1995, *105-K Basin Material Design Basin Feed Description for Spent Nuclear Fuel Project Facilities*, WHC-SD-SNF-TI-009, Vol. 1, Rev. A, Westinghouse Hanford Company, Richland, Washington.

APPENDIX A
SPENT NUCLEAR FUEL PROJECT BACKGROUND AND OVERVIEW

SPENT NUCLEAR FUEL OVERVIEW

The Hanford Site SNF Project Team has been assigned the task to remove approximately 2,100 MT (2,300 tons) of uranium as part of the 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 single use SNF vessels 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 A-1 illustrates a MCO assembly. Figure A-2 shows the mechanical closure being considered for the MCOs.

As discussed in the *Performance Specification for the Spent Nuclear Fuel Multi-Canister Overpack* (WHC 1996c), 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 cm (160 in.) long with a 60 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.

The shield plug provides penetrations, ports and connections, a rupture disk, and an internal HEPA filter. The rupture disk 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
- CVD of SNF in the MCOs at the CVD Facility

Figure A-1. Multi-Canister Overpack Assembly.

Figure A-2. Multi-Canister Overpack Mechanical Closure.

ASSEMBLY
NOT TO SCALE

VIEW-A

- Staging the MCOs in the CSB
- Hot conditioning system (HCS) of SNF in the MCOs at the Hot Conditioning System Annex (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 CVD Facility. 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. Separate approval will be obtained as necessary. It is expected separate NOCs will be submitted for the K Basin activities, the CVD Facility, CSB, and HCSA.

Transport of all K Basin SNF to the CSB will require approximately two years (DOE 1994). Staging of the MCOs is currently scheduled to occur simultaneously with the CVD Facility and HCSA processing.

SPENT NUCLEAR FUEL RETRIEVAL FROM THE K BASINS

The SNF in the K East Basin is currently stored in open canisters, while SNF in the 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 in the MCOs. 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 transported in 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, 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 washing of the canister and SNF, 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 (Figure 11 in Section 3.0 of the main document) 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. These will be disassembled by removing the inner SNF element from the outer SNF element. Both 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 mechanical brush system on individual SNF elements. 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 contamination. The level of cleanliness is governed by safe handling levels and worker and environmental 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 CVD Facility. 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.

The aggressive schedules of SNF 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 potential 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.

CANISTER STORAGE BUILDING (MULTI-CANISTER OVERPACK STAGING)

Once CVD 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.

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.

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. 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 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 process port 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. It is intended that the MCOs will be sealed with pressure relief protection during staging.

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 for up to 40 years.

HOT VACUUM CONDITIONING

The following information is taken from the *Conceptual Design Report for the Hot Conditioning System Equipment* (WHC 1996d). The following is a brief summary to provide an overview of the interaction between the CVD Facility and HCSA.

Hot conditioning of SNF contained in the MCOs will be performed in the HCSA. It will ensure that gases resulting from the radiolysis of water and other volitized material does not exceed the sealed MCO design 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 will 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 neutron interrogation of the MCO to determine residual water content.

Each hot conditioning process station is 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 conditioned. The process module will be a skid which contains 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.

CANISTER STORAGE BUILDING (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 MCO 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. Interim storage is presently scheduled for 40-years; however provisions can be made to extend this period to 75 years, if necessary. The project goal is to store the SNF in sealed vessels with no emission being generated during interim storage.

APPENDIX B
COLD VACUUM DRYING FACILITY POTENTIAL AIR EMISSION
CALCULATIONS AND SUPPORTING INFORMATION

INTENT:

To estimate unabated and abated emissions for radionuclides from the Spent Nuclear Fuels Project (SNFP).

BACKGROUND:

The SNFP will utilize three major processing facilities:

- 1) Multi-Canister Overpack (MCO) staging in the Canister Storage Building (CSB)
- 2) Cold Vacuum Drying (CVD) Facility
- 3) Hot Conditioning System Annex (HCSA)

Emissions from these three facilities are expected to be in the form of gases and particulates from the corrosion of the spent fuel rods in the K Basins. Emissions will occur when the MCOs are opened during staging and during processing in the CVD Facility and HCSA.

GIVEN/DATA:

- 1) A radionuclide inventory for the combined K-Basins as shown in Table 1 was obtained from Reference 1.
- 2) Release fractions for each physical form were obtained from Reference 2.
- 3) Dose equivalents were taken from Reference 3 and ccmail message on page B-5.
- 4) Project lifetime is two (2) years for the CVD Facility.

ASSUMPTIONS:

- 1) To be conservative, it was assumed that emissions from each facility would be estimated based on the total radionuclide inventory.
- 2) For radionuclides which are emitted as gases, 100 percent of the potential gas generated is assumed to be lost.
- 3) Estimates of percent of total inventory by physical form provided by WHC personnel.

Note: Data and assumptions specific to each process are listed as notes to each calculation table.

METHODOLOGY:Unabated Emissions

Unabated Emission Rate Per Radionuclide (Ci/year) = K Basins Inventory (Ci) x Emission Factor (gas, solid, or particulate)/project operating lifetime (years)

Unabated Dose per Radionuclide (mrem/yr) = Unabated Emission Rate (Ci/yr) x Dose Equivalent (mrem/Ci)

Unabated Total Dose = Sum of Individual Unabated Doses from each Radionuclide

Abated Emissions

Abated Emissions Rate (Ci/yr) = Unabated Emissions rate (Ci/yr)/Dose Reduction Factor

Abated Total Dose = Sum of Individual Abated Doses from each Radionuclide

Note: The system HEPA filters have a dose reduction factor of 3,000. Credit is only taken for one stage of HEPA filtration, although the system will utilize three HEPA filtration stages in series.

SUMMARY:

Results of the emission estimates are given in Tables 2 through 5 and are summarized in Table 6 of the main body of this report.

REFERENCES:

- 1) Willis 1995, *105-K Basin Material Design Basin Feed Description for Spent Nuclear Fuel Project Facilities*, WHC-SD-SNF-TI-009, Vol. 1, Rev. A, Westinghouse Hanford Company, Richland, Washington.
- 2) 40 Code of Federal Regulation (CFR) 61, 1989, "Methods for Estimating Radionuclide Emissions", Appendix D, *Code of Federal Regulations*, December 15, 1989.
- 3) WHC, 1991, *Unit Dose Calculation Methods and Summary of Facility Monitoring Plan Determinations*, WHC-EP-0498, November 1991, Westinghouse Hanford Company, Richland, Washington.

Table B-1. MCO Particulate Quantities as a function of Process Step

Process Step (end of step)	Nominal Quantity Particulate (UO ₂)	Basis
MCO Loading	6.75 kg (5.95 kg U)	1/2 of total uranium oxide inventory
Cold Vacuum Drying	7.47 kg (6.58 kg U) (0.72 kg UO ₂ generated)	Basin reaction rate adjusted for temp. ¹
Transportation to CSB	9.47 kg (8.34 kg U) (2 kg UO ₂ generated)	Basin reaction rate adjusted for time and temperature. ¹
Staging at CSB	23.8 kg (21 kg U) (14.3 kg UO ₂ generated) (0.4% of fuel)	All remaining Water reacts to form oxide particulate. ¹
Hot Conditioning	59.6 kg (52.5 kg U) (35.8 kg UO ₂ 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.

¹ Based on limiting quantities of particulate which could be generated.

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