DOE/RL-96-76
Revision 0

U.S. Environmental Protection Agency Clean Air Act Notice of Construction for Spent Nuclear Fuel Project--Hot Conditioning System Annex, Project W-484

United States
Department of Energy
Richland, Washington

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U.S. Environmental Protection Agency Clean Air Act Notice of Construction for Spent Nuclear Fuel Project--Hot Conditioning System Annex, Project W-484

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AED	Aerodynamic equivalent diameter
CAM	Continuous air monitoring
CAEM	Continuous air emission monitoring
CFR	Code of Federal Regulations
CSB	Canister Storage Building
CVD	Cold Vacuum Drying
HCS	Hot Conditioning System
HCSE	Hot Conditioning System Equipment
HEPA	High-efficiency particulate air
HWVP	Hanford Waste Vitrification Plant
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

U.S. ENVIRONMENTAL PROTECTION AGENCY CLEAN AIR ACT NOTICE OF CONSTRUCTION FOR THE SPENT NUCLEAR FUEL PROJECT HOT CONDITIONING SYSTEM ANNEX, PROJECT W-484

1.0 INTRODUCTION

This notice of construction (NOC) provides information regarding the source and the estimated quantity of potential airborne radionuclide emissions resulting from the operation of the Hot Conditioning System (HCS) Annex. The construction of the HCS Annex is scheduled to commence on or about December 1996, and will be completed when the process equipment begins operations. This document serves as a NOC pursuant to the requirements of 40 Code of Federal Regulations (CFR) 61 for the HCS Annex.

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 contained in open canisters, which allows 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 N Reactor SNF in the K Basins with no means for near-term removal and processing.

The HCS Annex will be constructed as an annex to the Canister Storage Building (CSB) and will contain the hot conditioning equipment. The hot conditioning system (HCS) will release chemically-bound water and will condition (process of using a controlled amount of oxygen to destroy uranium hydride) the exposed uranium surfaces associated with the SNF through oxidation. The HCS Annex will house seven hot conditioning process stations, six operational and one auxiliary, which could be used as a welding area for final closure of the vessel containing the SNF. The auxiliary pit is being evaluated at this time for its usefulness to support other operations that may be needed to ensure proper conditioning of the SNF and proper storage of the vessel containing the SNF. Figures 1 and 2 contain map locations of the Hanford Site and the HCS Annex.

Figure 1. Hanford Site Map.

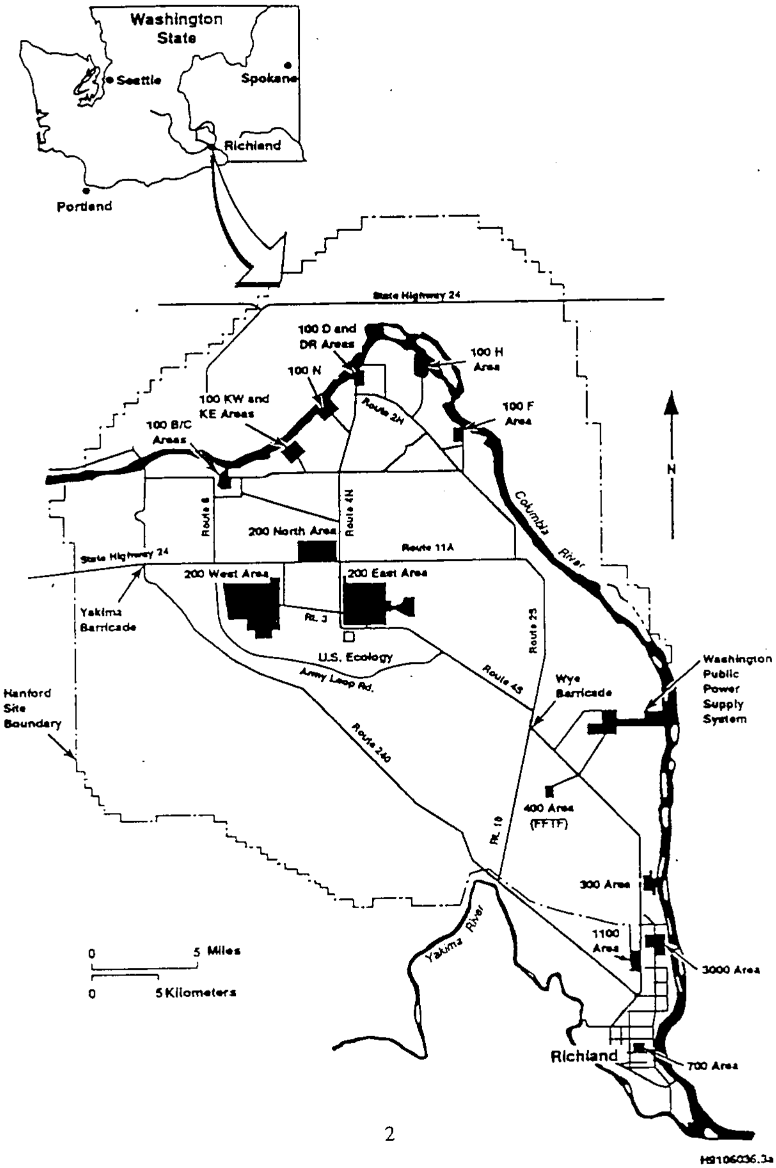
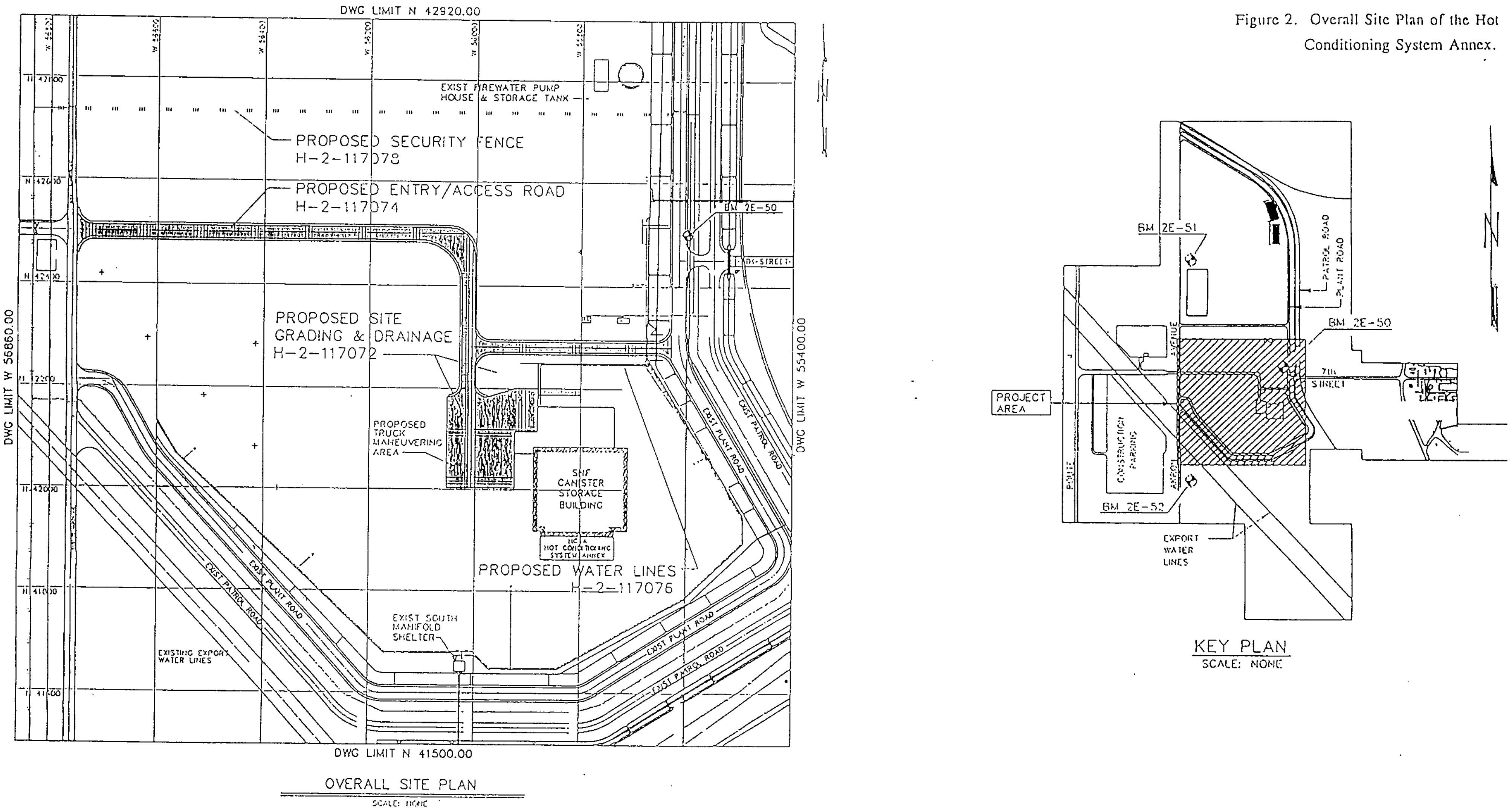


Figure 2. Overall Site Plan of the Hot Conditioning System Annex.



OVERALL SITE PLAN
SCALE: NONE

KEY PLAN
SCALE: NONE

1.1 APPLICANT

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

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

1.2 PURPOSE OF NOTICE OF CONSTRUCTION

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

1.3 FACILITY LOCATION

The HCS Annex will be an extension of the CSB. The HCS Annex will be located on the south end of the CSB. The HCS Annex will be located at Hanford Site coordinates N42000, W55800. The HCS Annex location in the 200 East Area is shown on Figure 2.

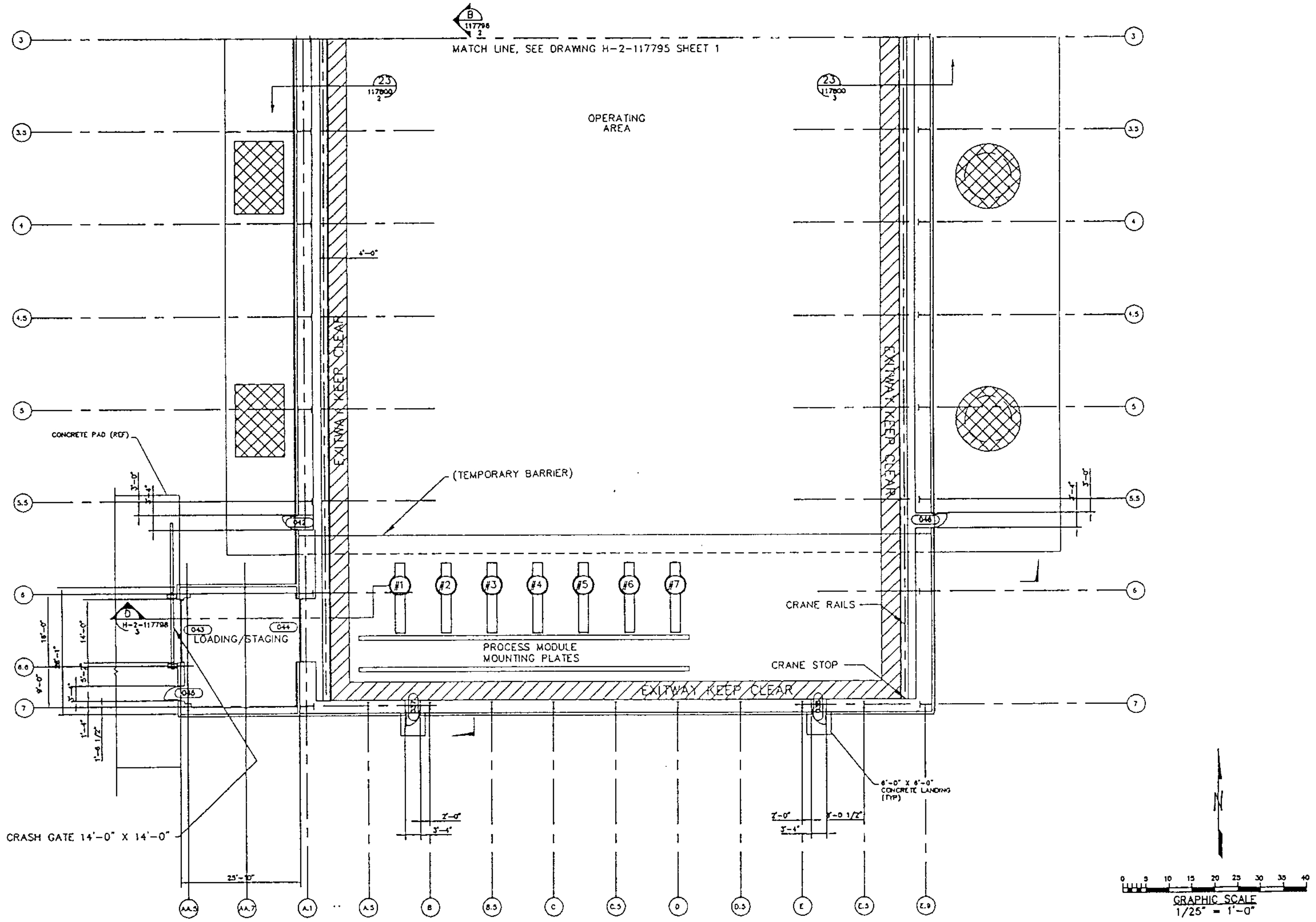
1.4 FACILITY DESCRIPTION

The HCS Annex will be approximately 9 m (30 ft) long by 41 m (136 ft) wide by 17 m (55 ft) high. Figure 3 shows the basic features of the HCS Annex. The HCS Annex will be an extension of the CSB and will house the HCS equipment (HCSE).

The following information is taken from the *Conceptual Design Report for the Hot Conditioning System Equipment* (WHC 1996a). The HCS will be the last SNF step before final interim storage. The main processes and potential emission points of the HCS Annex are presented in this NOC. The following description of the HCS Annex is submitted for approval under this NOC. The information is based on the latest conceptual design at the time of submittal of this NOC.

The HCS Annex will house seven hot conditioning process stations, six operational and one auxiliary, which could be used as a welding area for final closure of the vessel containing the SNF. The auxiliary pit is being evaluated at this time for its usefulness to support other operations that may be needed to ensure proper conditioning of the SNF and storage of the multi-canister overpacks (MCO). Each hot conditioning process station will be

Figure 3. Hot Conditioning System Annex Layout.



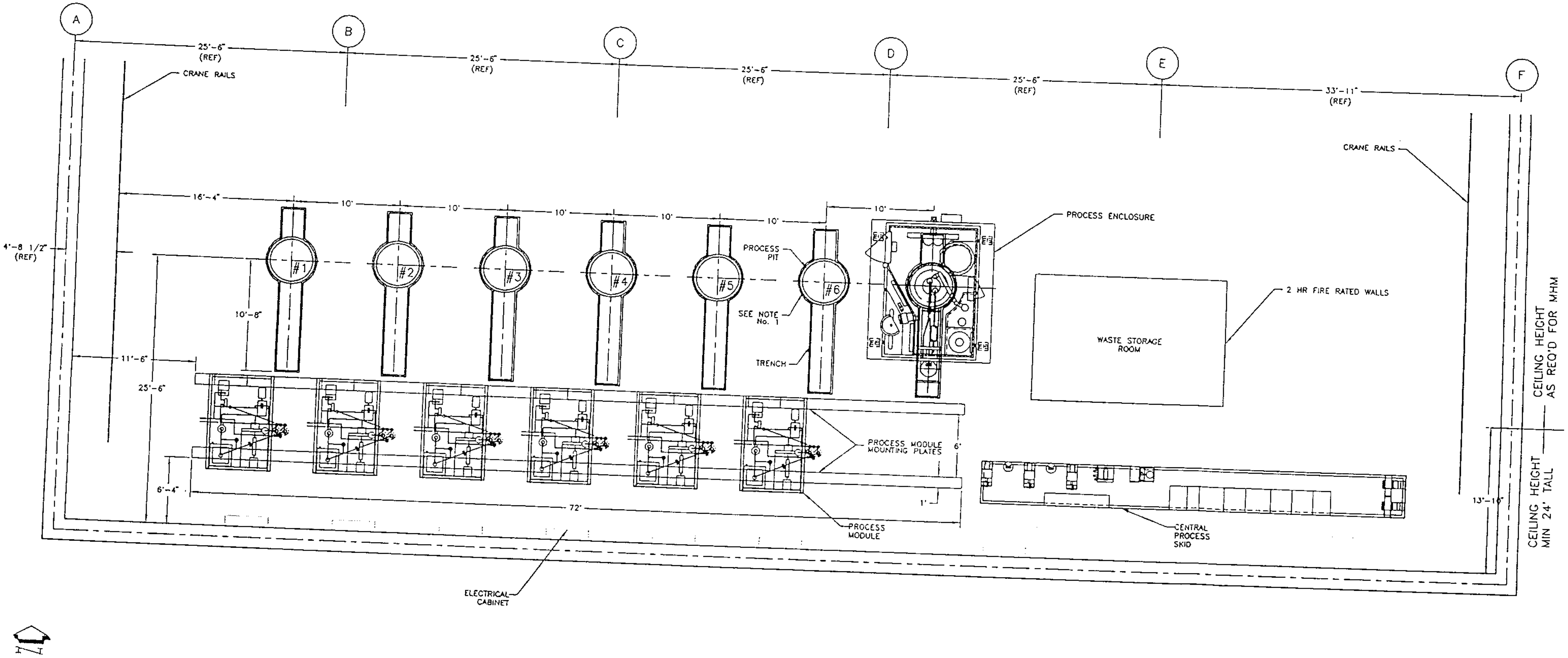
comprised of a process pit and a process module. Treatment will take place in ovens that are located in process pits, approximately 1 m (4 ft) in diameter and 6 m (20 ft) deep, which are below the HCS Annex floor. The process pit will hold the oven where the MCO will be heated and the SNF conditioned.

The process module will be a skid which contains the hot conditioning process equipment. The process module will measure approximately 2 m (6 ft) by 3 m (9 ft) and 2 m (8 ft) high. There will be one process module per process pit. The process modules will be arranged to allow an approximately 1 m (4 ft) wide aisle all around to provide access for maintenance, and will contain an electrically powered heater and fan that will supply hot (300°C [572°F]) air to the oven. The process module will contain the vacuum pump, heat exchanger, valving, instrumentation, and other hot conditioning process equipment that does not have to be located in the process pit or trench. The trench will be a rectangular cross-section approximately 61 cm (24 in.) wide by 114 cm (45 in.) deep, located below the HCS Annex floor level that will connect the process pit with the process module. The piping that connects the MCO and oven, with the process module will be located in the trench.

The HCSE will contain its own exhaust fans, ducts, and nuclear grade filtration systems. Intake air will be drawn from the HCS Annex volume, through high-efficiency particulate air (HEPA) filters into potentially contaminated pit space, through the potentially contaminated trench, through the HCSE HEPA filter and supply fan, and out the HCSE stack. The HCSE stack will be approximately 27.4 m (90 ft) tall with an approximately 40 cm (16 in.) diameter. Figure 4 shows an illustration of the six operational hot conditioning process stations.

All of the HCSE components that will be located outside of the HCS Annex are classified as auxiliary facilities. These include the ventilation stack, the refrigerant condenser for the chilled water system, the inert gas bottles, and the tube trailers. The auxiliary facilities will be located to the immediate west of the HCS Annex.

Figure 4. Hot Conditioning Process Stations.



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2.0 BACKGROUND AND NATURE OF THE SOURCE

To provide the reader with sufficient background and nature of the source information on the HCS Annex an overall SNF Project description is required. However, to focus on the HCS processes, equipment and emission points requiring approval under this NOC the SNF Project description is listed in Appendix A. 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 HCS Annex 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 HCSE and processes that will potentially release airborne radionuclides to the HCS Annex emission control equipment and eventually release to the public and the environment.

Section 3.0 through 3.6 will describe and list the potential emissions and dose, ventilation system, and monitoring system for the HCS Annex. Supporting references and calculation information will be listed in Section 4.0 and the Appendices.

2.1 HOT CONDITIONING SYSTEM ANNEX PROCESS DESCRIPTION OVERVIEW

The following is summarized from information presented in the *Conceptual Design Report for the Hot Conditioning System Equipment* (WHC 1996a), and presents a general description of the HCSE configuration. This section is submitted for approval under this NOC.

The mission of the HCS project is to degas and condition (process of using a controlled amount of oxygen to destroy uranium hydride) the SNF that has been dried in the Cold Vacuum Drying (CVD) Facility, and that has been temporarily stored in the CSB awaiting availability of a hot conditioning process station. The hot conditioning process is designed to minimize hydrogen production arising from uranium-water vapor reaction, radiolysis of water, and uranium hydride breakdown during storage so that the MCO design threshold is not exceeded. Hot conditioning will consist of heating the SNF to approximately 300°C (572°F) and evacuating the MCO. This will release 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, the MCO will be cooled to 150°C (302°F) and a controlled amount of a low concentration oxygen/inert gas blend will be added to the MCO to oxidize highly reactive surfaces.

2.1.1 Hot Conditioning System Process Equipment

Each hot conditioning process station will be comprised of a process pit and a process equipment module. A total of seven hot conditioning process stations, six operational and one auxiliary (which could be used as a welding area for final closure of the MCOs). The auxiliary pit is being evaluated at this time for its usefulness to support other operations that may be needed to ensure proper conditioning of the SNF and proper storage of the MCOs.

Treatment will take place in ovens that will be located in each process pit. A process pit will be approximately 1 m (4 ft) in diameter and 6 m (20 ft) deep below the facility floor. There will be a total of six operational ovens in the HCS Annex. The ovens will be where the MCO will be heated and the SNF conditioned. The oven will essentially be designed as a very large thermos bottle placed within the process pit. The MCO will be placed inside the oven. An annular cover ring will be placed so that the hot air blown through the annular space between the MCO and oven interior wall is not lost into the process pit. The annular cover will be placed over the MCO by the manipulator contained in a process enclosure. An insulation cover will be placed over the top of the MCO. Heating will be accomplished by blowing hot air through the oven (Figure 5).

There will be a skid-mounted process equipment module associated with each oven which measures approximately 2 m (6 ft) by 3 m (9 ft) long by 2 m (8 ft) high. The process modules will be arranged to allow a 1 m (4 ft) wide aisle all around to provide access for maintenance. The process modules are located as close to the process pits as allowed by the MCO handling machine to minimize the size of the HCS Annex. The process module will contain a vacuum pumping system and an inert gas purge system to handle gas within the MCO. The process piping that connects the MCO and oven with the process module will run below floor level in a trench. The trench will be a rectangular cross sectional space, approximately 61 cm (24 in.) wide by 130 cm (51 in.) deep. The length will be dictated by the MCO handling machine clearance requirements.

To protect workers and the working space environment of the HCS Annex, a portable process enclosure will be used while working in the open process pit. The process enclosure will be equipped with a manipulator, HEPA filtration, operator work station, personnel entry door, and other equipment used to support hot conditioning. The process enclosure will offer some shielding and is ventilated so that it provides secondary confinement while the MCO top is exposed and the MCO ports are manipulated. When needed, the portable process enclosure will be placed over the oven after the MCO is placed in the oven. The portable process enclosure will offer some shielding, and contain a hoist and tele-operated manipulators. The hoist will be used to handle the process pit cover and the manipulators will be used to make and break the MCO connections. In addition, the portable enclosure will be used to replace the cold trap contained in the process piping located in the trench. The cold trap will be an air cooled unit (using chilled air to cool the unit), which will be used to remove iodine gas and cesium particulate from the gas stream being removed from the MCO. The cold trap unit will contain copper gauze to react with iodine fission product, chilling to capture cesium fission product and activated carbon for both cesium and iodine

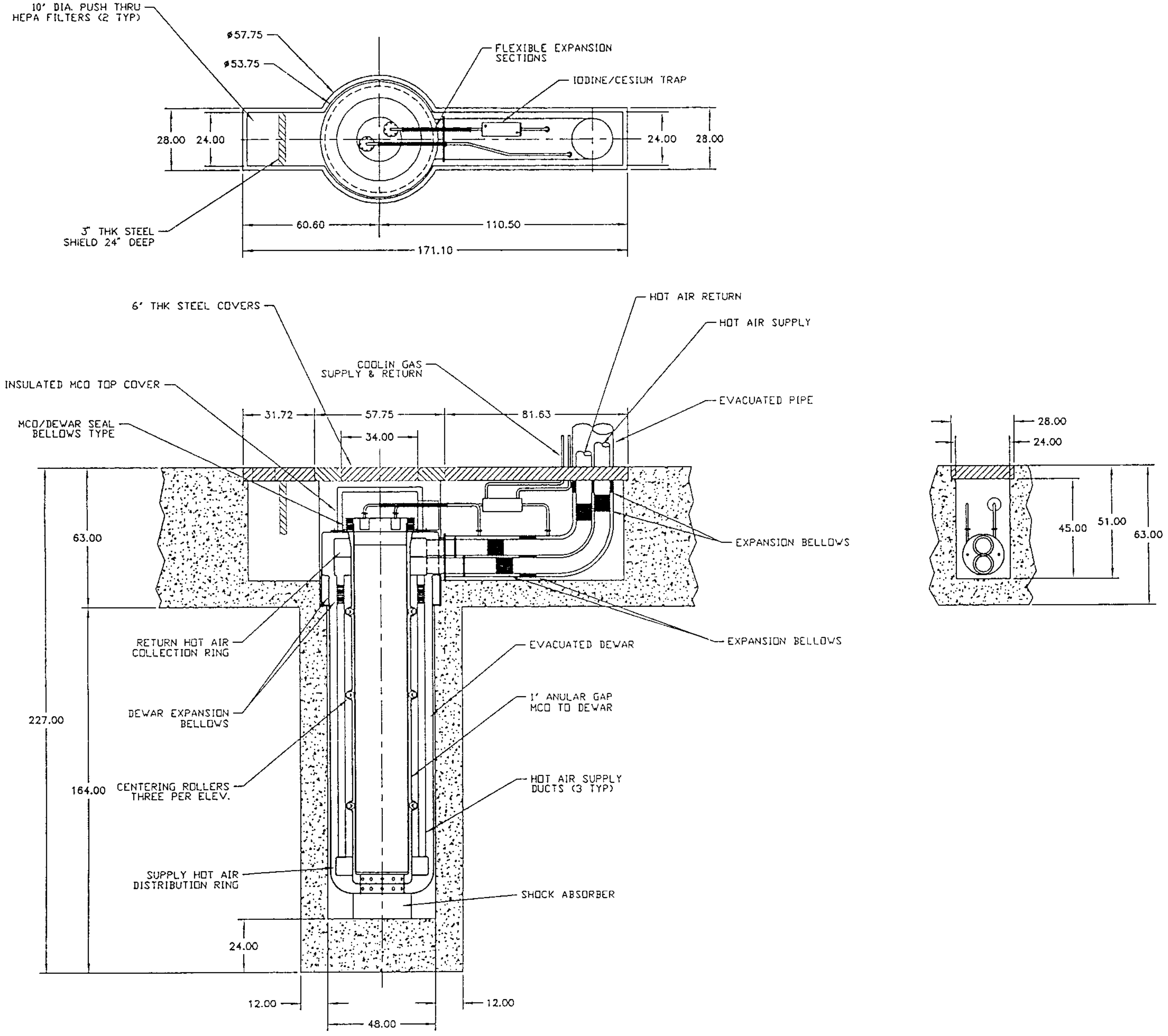


Figure 5. Multi-Canister Overpack Process Station.

secondary capture. If required, the final closure of the MCO will be made by welding a cover piece on the MCO while the MCO is in the oven after the hot conditioning has been completed. The portable enclosure will be fitted with a HEPA filter which allows HCS Annex air volume to flow through the oven and trench ventilation line to the HCSE stack (Figure 6).

The HCSE exhaust gas system will consist of a HEPA filter intake, and ducted manifold for up to six process stations, isolation nuclear grade dampers, two stage testable HEPA filter plenum with pre-filter, variable speed drive exhaust fan, static pressure sensors, and exhaust stack. Details on exhaust system can be found in Section 3.2.

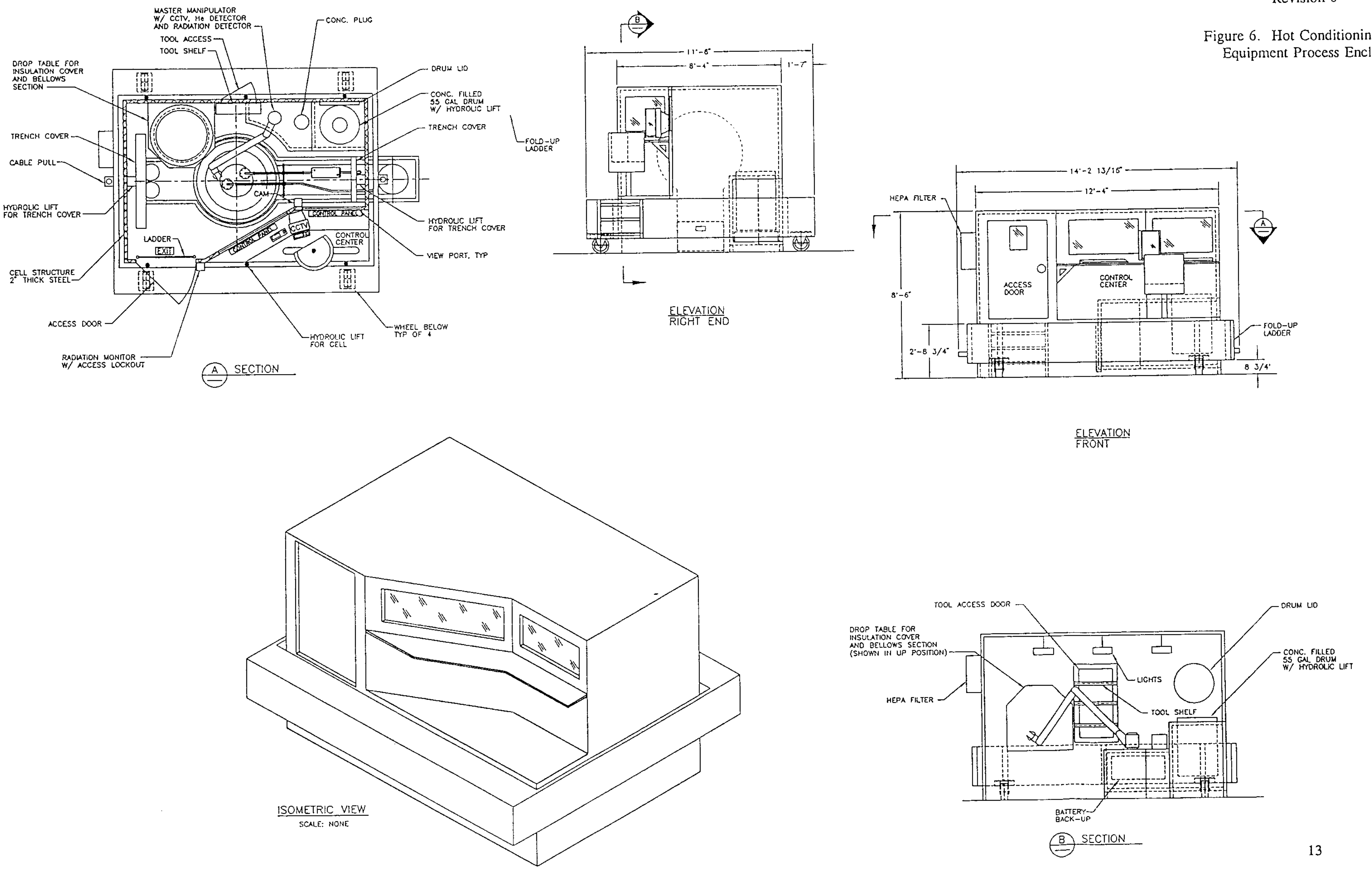
2.1.2 Process Steps

A MCO will be retrieved from a storage tube in the CSB by the MCO handling machine. The MCO handling machine will then move from the CSB into the HCS Annex. The MCO handling machine will then be aligned with an open process pit oven. The HCSE ventilation system will flow from the HCS Annex through the process station and trench. The MCO will then be placed into a process pit oven in the HCS Annex (see Figure 4). The portable enclosure will be placed over an oven. Then MCO connections will be made to the process module and HCSE exhaust. After all connections are made, the oven will be closed and the portable enclosure removed.

The vacuum system of the hot conditioning process module will be started to initiate flow through the MCO. Inert gas will be heated and bled into the MCO as the vacuum pump maintains the purge flow. The process gases will be circulated through the cold trap and maintained at a temperature that ensures proper heat transfer to the SNF for conditioning. Heating will be started in the process station and the core temperature of the MCO will be raised to approximately 300°C (572°F). The internal pressure of the MCO will be reduced to approximately 650 Pa (5 TORR), the MCO will be maintained at this temperature and pressure for approximately 48 hours. During this time the process gas, water, and hydrogen will be bled off and sent to the HCSE ventilation system. The process gases will pass through the cold trap where cesium particulate, found in the water vapor stream and iodine gases, will be collected. The remaining air pollutants pass through the process lines to the HEPA filters where particulate matter will be collected.

Heating will be stopped at approximately 48 hours, and cooling will begin by reducing the temperature of the air flowing through the oven annular space. The MCO temperature will be lowered to approximately 150°C (302°F) within an approximately 12 hour period, while not exceeding the 50-degree per hour specification. A controlled partial pressure of oxygen will be introduced into the MCO, along with an inert carrier gas, to condition (process of using a controlled amount of oxygen to destroy uranium hydride) remaining reactive surfaces. The MCO will remain at approximately 150°C (302°F) with oxygen present for passivation for approximately 12 hours.

Figure 6. Hot Conditioning System Equipment Process Enclosure.



The MCO will be slowly cooled to storage temperature and flushed with inert gas to remove oxygen. The portable enclosure will be moved back over the oven and the oven will be opened. The MCO will be isolated from the process and offgas systems, by closing the process valves, and then disconnected from those systems.

The top of the MCO will be surveyed and decontaminated as necessary to ensure safe handling. The cold trap will be replaced periodically depending on the amount of pollutants collected per MCO. This determination will be based on radiation readings to ensure that the cold trap can be safely handled and disposed of.

After all disconnections are completed, the portable enclosure will be moved away from the oven, and the MCO handling machine will be brought back to lift the MCO out of the oven and place it back into a CSB storage tube. As a result of hot conditioning the SNF will be stabilized for interim storage. The project goal is to store the SNF in closed vessels with no emissions being generated during interim storage.

2.1.3 Solid Waste/Process Exhaust Gases

The sources of solid waste generated at the HCS Annex will fall into two categories: (1) waste as a direct result of operating and conditioning equipment (i.e., HEPA filters, cold traps, and filters used by the monitoring equipment); and (2) general cleaning and inspection (i.e., welding rods, wipes, swipe test, etc.). The solid waste will be collected in drums and transported by hand carts to the HCS Annex solid waste staging area. From there the waste will be sent to the appropriate waste disposal or treatment facility.

3.0 SOURCES OF EMISSIONS

This section of the NOC describes the potential emissions and dose, ventilation system and monitoring system for the HCS Annex. This section is submitted for approval under this NOC. The HCS Annex inventory will only be present during approximately a two year period in which the MCOs will undergo treatment prior to entry into interim storage. 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 of the 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 provide significantly less potential or abated emissions than those 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. 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 (Figure 7).

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 supported the estimate of a maximum of 3,800 Ci of cesium-137

Figure 7. 105-N Reactor Mark IV Spent Nuclear Fuel Element Assembly.

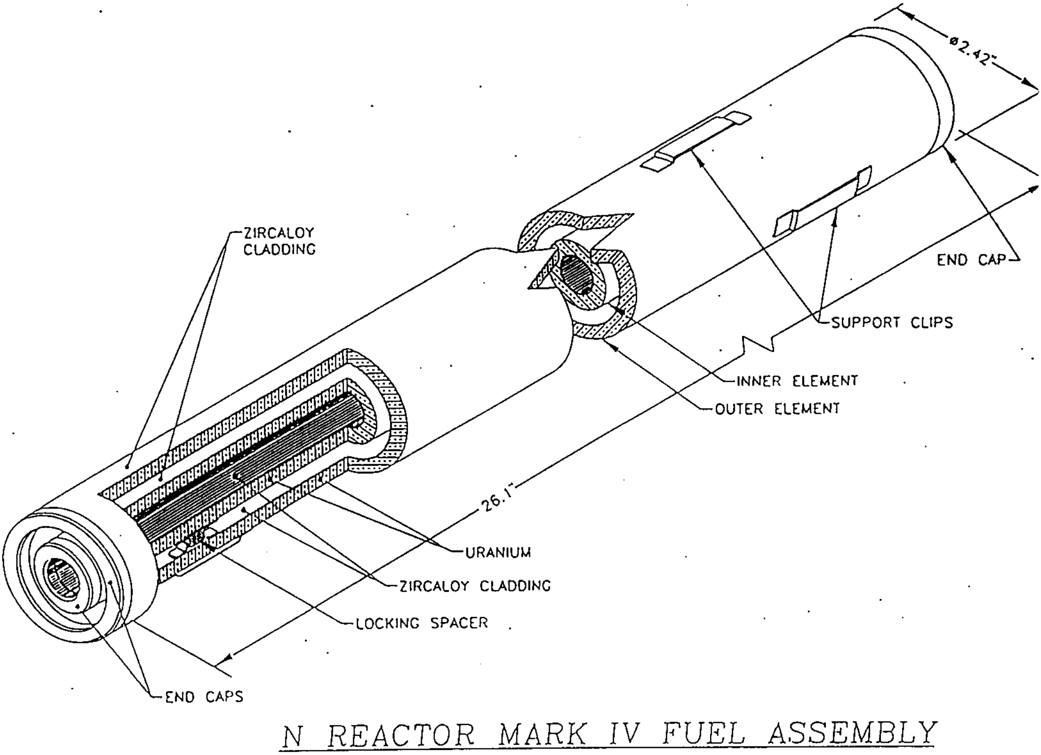


Table 1. Combined K Basins Radionuclide Inventory Decayed to December 31, 1997.

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 to Table 1:

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 Basis Feed Description for the Spent Nuclear Fuel Project Facilities*, WHC-SD-SNF-IT-009, Vol. 1 Rev. A, Westinghouse Hanford Company, Richland, Washington.

released from SNF in the K West Basin (WHC 1996b), which corresponds to approximately 800 kg (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, provide 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.

At the end of the hot conditioning process a total of one percent of the MCO fuel inventory is estimated to be particulate. Of the one percent total particulate estimate, 0.6 percent is generated in the hot conditioning process. The 0.6 percent estimate is based on the amount of oxygen which could produce a uniform oxide layer 1 to 2 mils (0.001 to 0.002 in.) thick on the exposed uranium surface. The other 0.4 percent was created during all the other process steps and transportation from the time the SNF left the K Basins to the start of hot conditioning.

In addition, under most conservative assumptions 52.5 kg (115.74 lbs) of uranium oxide may be generated as a result of the fuel processing steps from CVD through HCS. The uranium oxide generated during HCS processing is estimated by the current reaction rate, expected time of HCS 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 uranium oxide generated from CVD through the HCS processing yields 59.6 kg (131.39 lbs) of uranium oxide. This 59.6 kg (131.39 lbs) of uranium oxide contains approximately 52.5 kg (115.74 lbs) of uranium (Appendix B). Comparing 52.5 kg (115.74 lbs) of uranium compared to the total uranium contained in each MCO (5,250 kg [11574 lbs]) we derive the percentage of uranium oxide particulate generated during HCS processing. The percentage of uranium oxide as particulates is as follows:

$$\frac{52.5\ kg\ (115.74\ lbs)\ uranium}{5{,}250\ kg\ (11{,}574\ lbs)\ uranium\ per\ MCO} = 1\%$$

The estimation of potential emissions from this facility is based on the release fractions of 40 CFR 61, Appendix D, Section 2(b) with one exception. Appendix D prescribes "If any nuclide is heated to a temperature of 100°C (212°F) or more, boils at a temperature of 100°C (212°F) or less, or is intentionally dispersed into the environment, it must be considered to be a gas". The SNF will be heated to approximately 300°C (572°F) during hot vacuum conditioning in this facility but the SNF will not volatilize to the extent that it should be considered for emission estimation purposes to behave as a gas.

Most (99 percent) of the SNF to be processed in this facility is in the form of reactor-irradiated metallic uranium (melting point 1133°C [2071°F]). The vapor pressure of uranium is approximately 9E-37 mmHg (3.5E-38 inches Hg) at 327°C (621°F). The radionuclides that formed in the uranium as a result of irradiation exist essentially as a metallic solid solution and can thermodynamically be expected to exhibit vapor pressures one or more orders of magnitude lower than those of their pure elemental form because of their dilution. Similarly, the radionuclides (other than tritium, carbon-14, and iodine-129, which are expected to escape as a gas) that are released from metallic solid solution in that portion of the uranium that has oxidized or hydrated will exist in an oxide form with relatively low vapor pressures.

The oxides of the radionuclides have melting points ranging from approximately 400°C (752°F) for cesium oxide to 2750°C (4982°F) for uranium oxide. Radionuclides such as antimony and cesium that form lower-melting oxides can also be expected to be chemically incorporated into the uranium oxide formed during oxidation of the SNF and thus exhibit vapor pressures lower than those of their pure oxide form.

In summary, the physical facts of this SNF potential emission source do not support use of a release fraction of one, i.e., the source simply does not have the potential for volatilization as a gas. The 40 CFR 61, Appendix D release fractions of 10^{-6} for solids, 10^{-3} for particulates and one for gases adequately estimate the emission potential for this source.

To determine the emissions for oxides formed(1 percent) at the HCS Annex a physical release factor of 10^{-3} for particulate matter was used in accordance with 40 CFR 61, Appendix D. The rest of the uncorroded SNF (99 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. To determine the emissions for the HCS Annex a physical release factor of 10^{-6} was used 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 35.8 kg (78.9 lbs) of uranium oxide formed in the HCS Annex is equivalent to approximately 31.5 kg (69.4 lbs) of uranium (35.8 x 238/270). The 31.5 kg (69.4 lbs) of uranium is 0.6 percent of the total uranium contained in the MCO (31.5 kg [69.4 lbs]\5250 kg [11,574 lbs] per MCO). This oxide that forms during the HCS process will release all gas equivalent to 0.6 percent of the total source term. The gas generated during the other processing steps is lost prior to the HCS processing. Therefore, the emissions at the HCS Annex will consist of 0.6 percent gases in curies. The gas has a maximum physical release factor of one (40 CFR 61, Appendix D). Table 2 lists as source, those radionuclides that are expected to be in a changed physical state that will cause potential emissions as a result of the hot conditioning process.

Table 2. Potential Unabated Emissions from the Hot Conditioning System Annex.

Radionuclide	**K Basins Inventory (Ci)**	**Physical Form(a)**	**Radionuclide Inventory at HCS Annex(b)**			**Unabated Emissions(c) (Ci/yr)**
			Gases (Ci)	**Solids (Ci)**	**Particulate (Ci)**	
H-3	3.51E+04	G (generated)	2.11E+02	---	---	1.05E+02
H-3	---	S (matrixed in fuel)		3.49E+04	---	1.74E-02
C-14	6.62E+02	G (generated)	3.97E+00	---	---	1.99E+00
C-14	---	S (matrixed in fuel)	---	6.58E+02	---	3.29E-04
Co-60	4.00E+03	S/P	---	3.96E+03	4.00E+01	2.20E-02
Kr-85	5.79E+05	G (generated)	3.47E+03	---	---	1.74E+03
Kr-85	---	S (matrixed in fuel)	---	5.76E+05	---	2.88E-01
Sr-90	9.79E+06	S/P	---	9.69E+06	9.79E+04	5.38E+01
Y-90	9.79E+06	S/P	---	9.69E+06	9.79E+04	5.38E+01
Sb-125	3.39E+04	S/P	---	3.36E+04	3.39E+02	1.86E-01
Te-125m	8.26E+03	S/P	---	8.18E+03	8.26E+01	4.54E-02
I-129	5.93E+00	G (generated)	3.56E-02	---	---	1.78E-02
I-129	---	S (matrixed in fuel)	---	5.89E+00	---	2.95E-06
Cs-134	1.69E+04	S/P	---	1.67E+04	1.69E+02	9.29E-02
Cs-137	1.26E+07	S/P	---	1.25E+07	1.26E+05	6.92E+01
Ba-137m	1.19E+07	S/P	---	1.18E+07	1.19E+05	6.54E+01
Pm-147	4.91E+05	S/P	---	4.86E+05	4.91E+03	2.70E+00
Sm-151	1.68E+05	S/P	---	1.66E+05	1.68E+03	9.23E-01
Eu-154	1.01E+05	S/P	---	1.00E+05	1.01E+03	5.55E-01
Eu-155	2.18E+04	S/P	---	2.16E+04	2.18E+02	1.20E-01
U-234	8.78E+02	S/P	---	8.69E+02	8.78E+00	4.82E-03
U-235	3.40E+01	S/P	---	3.37E+01	3.40E-01	1.87E-04
U-236	1.27E+02	S/P	---	1.26E+02	1.27E+00	6.98E-04
U-238	6.96E+02	S/P	---	6.89E+02	6.69E+00	3.82E-03
Pu-238	1.22E+05	S/P	---	1.21E+05	1.22E+03	6.70E-01
Pu-239	2.25E+05	S/P	---	2.23E+05	2.25E+03	1.24E+00
Pu-240	1.30E+05	S/P	---	1.29E+05	1.30E+03	7.14E-01
Pu-241	6.39E+06	S/P	---	6.33E+06	6.39E+04	3.51E+01
Am-241	3.46E+05	S/P	---	3.43E+05	3.46E+03	1.90E+00
Other	2.38E+04	S/P	---	2.35E+04	2.38E+02	1.31E-01

(a) G (generated) = gas generated through oxidation of the spent nuclear fuel with the water and released during HCS; S = solid; P = particulate matter

(b) Percent of total inventory per radionuclide: Gases - 0.6%; Solids - 99%; Particulates - 1%. HCS Annex inventory = K Basin inventory multiplied by percentage.

(c) Release fractions: Gases = 1, Particulates = 10^{-3}, and Solids = 10^{-6}; 40 CFR 61, Appendix D.

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

HCS = hot conditioning system

Notes to Table 2:

1. These emissions will be the maximum potential during the hot conditioning system operation which will take approximately two years. Emissions in follow on years will be from residual contamination found on equipment and building interior. Potential emission from any activities taking place after HCS operations will be less than the emissions listed in this table.

2. The potential emissions listed in this table presume that all of the spent nuclear fuel will go through hot conditioning as stated in Note 1 above.

3.1 DESCRIPTION OF PROPOSED EMISSION CONTROLS

The potential emissions from the HCS Annex will be the radionuclide particulates. The HCSE exhaust system will have a two stage HEPA filter prior to the exhaust gas leaving the facility through a dedicated exhaust stack. The HEPA filters will be the bag in/out type located in a stainless-steel housing. The housing will ensure testability and contain a prefilter prior to the two stage HEPA filters. The HCSE exhaust system will have a redundant HEPA plenum.

3.2 VENTILATION AND STACK OVERVIEW

The conceptual design of the HCS Annex combined ventilation system for the HCSE exhaust gas system consists of a HEPA filter intake, ducted manifold for up to six process stations, isolation nuclear grade dampers, two stage testable HEPA filter plenum with pre-filter, variable speed drive exhaust fan, static pressure sensors, and exhaust stack.

The HCS Annex exhaust stack will be 1.5 times the HCS Annex building height, which is equal to approximately 27.4 m (90 ft) high with an internal diameter of approximately 40 cm (16 in.). The function of the stack will be to discharge the exhaust from the combined ventilation system to the atmosphere.

3.2.1 System Configuration

The HCSE will contain its own exhaust fans, ducts and nuclear grade filtration systems. Intake air will be drawn from the HCS Annex volume through HEPA filters (provided by the HCSE) into potentially contaminated process pit space through the potentially contaminated vault and process trench, through an HCSE provided HEPA filter, through an HCSE provided fan, and out a stack provided by the HCSE. This will assure a negative pressure in the potentially contaminated pit and process trench. The HCS Annex will have its own exhaust stack for the potentially contaminated exhaust generated by the HCS Annex process. Penetration in the pre-existing HCS Annex structure for the stack, stack pipe, stack foundation, and so forth will be part of the HCSE scope. The air volume drawn from the HCS Annex will range from 28 to 141 m^3/min (1,000 to 5,000 scfm).

3.2.2 Ventilation Process Description

The combined ventilation system is designed to exhaust six process pit/trench spaces and the process gas exhaust from six MCOs. Air will be drawn through a HEPA filter into the process pit space at a nominal rate of approximately 4.25 m^3/min (150 cfm) per process pit. The HEPA filter serves as an isolation, backdraft, prevention, and filtering device. The air will move through the process pit and trench space to the exhaust duct inlet manifold, through an isolation damper, pre-filter and two stages of HEPA filters with isolation dampers, exhaust fan, and finally exits the HCS Annex through a dedicated HCSE exhaust stack.

Approximately 0.56 m^3/min. (20 cfm) of process exhaust gas from each of the six MCOs may enter the process exhaust stream at any time. Variable speed drives on the exhaust fan motors will be modulated using pressure sensors to adjust air flow to keep exhaust flow in the stack constant. Motorized dampers on the exhaust from each process pit will be modulated using pressure sensors with integral controllers to maintain a nominal 4 m^3/min. (150 cfm) flow rate through the process pit/trench. The process vent system will collect gases vented from the pressure relief valves and discharged from the vacuum pumps located in the process modules. A collection manifold extends from the combined ventilation system on the service module to each of the process modules. All of the process gases pass through HEPA filters located in the process trench before they are vented to the final set of HEPA filters in the combined ventilation system.

The process lines will contain cold traps used to cool the gases to approximately 100°C (183.2°F) allowing capture of cesium and iodine gases. The cold trap contains copper gauze used to react with iodine fission products, chilling to capture cesium fission products, and activated carbon for both cesium fission product and iodine secondary capture before it enters back into the process or into the combined ventilation system. Additionally, the cold trap will contain a HEPA filter.

3.2.3 Equipment Description

The combined ventilation system will consist of the following equipment:

- Exhaust Fan - Backwardly inclined, class III centrifugal fan, standard application for hot gases to approximately 93.3°C (200°F), intrinsically safe construction, with belt drive, and variable frequency motor controllers.
- HEPA Filter Housing - Type 304 stainless-steel, bag in/out type, transition on both ends, 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 Filters - 61 cm by 61 cm by 29.2 cm (24 in by 24 in by 11.5 in thick) Underwriters Laboratories (UL) Class 1, 99.97 percent efficiency per dioctyl phthalate test, and stainless-steel frame.
- Prefilter - 61 cm by 61 cm by 0.5 cm (24 in by 24 in by 6 in thick), UL Class 1, 65 percent efficiency per American Society of Heating, Refrigerating and Air Conditioning Engineers standards 52-76.

- Isolation Dampers - American National Standards Institute class 150 butterfly valves with motorized actuators which will meet the requirements of American Society of Mechanical Engineers N 509-1989, Leakage Class I.
- Centrifugal Pumps - Nominal 91 lpm (24 gpm) each.

3.3 EFFLUENT MONITORING

The HCS Annex 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 ten 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 HCS Annex stack emissions.

The HCS Annex will have exhaust stack sample monitoring in accordance with 40 CFR 61, Appendix B, Method 114. The airborne activity monitors for the SNF HCS Annex consist of the alpha sensitive continuous air monitoring (CAM), and radioactive particulate sampling. 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 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 filters and monitors 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 system 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 the volumetric rate. The vacuum pump exhaust line will be downstream of the second shrouded probe.

3.3.4 Radioactive Particulate Sampling

The CAEMs will contain a record sampler. The remote sample head and the record sampler filter holder will be as close as practical to the stack to minimize particulate line losses. The first shrouded probe in the exhaust stack will be used for particulate sampling. The probe will be located in the center of the stack. The flow from the probe 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. 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 shrouded probe, located approximately 1 to 2 m (6 to 8 ft) downstream from the first probe, will provide the sample stream for the alpha CAM. The probe will be located in the center of the stack. The flow from the probe 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 greater than

50 percent of the 10 μm 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 mm^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 4.0E-12 μCi/ml.

3.5 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, particulate, and gasses that are appropriate to hot conditioning. The potential abated emissions from this inventory during hot conditioning were calculated and are summarized in Table 3.

3.6 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 (see 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 maximum affected individual in the Ringold area, 16,000 m (17,440 ft) east of the 200 East 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 3. Abated Emissions from the Hot Conditioning System Annex.

Radionuclide	Physical Form	Unabated Emissions (Ci/yr)	Emission Reduction Factor	Abated Emissions (Ci/yr)
H-3	G (generated)	1.05E+02	1	1.05E+02
H-3	S (matrixed in fuel)	1.74E-02	3,000	5.81E-06
C-14	G (generated)	1.99E+00	1	1.99E+00
C-14	S (matrixed in fuel)	3.29E-04	3,000	1.10E-07
Co-60	S/P	2.20E-02	3,000	7.33E-06
Kr-85	G (generated)	1.74E+03	1	1.74E+03
Kr-85	S (matrixed in fuel)	2.88E-01	3,000	9.59E-05
Sr-90	S/P	5.38E+01	3,000	1.79E-02
Y-90	S/P	5.38E+01	3,000	1.79E-02
Sb-125	S/P	1.86E-01	3,000	6.21E-05
Te-125m	S/P	4.54E-02	3,000	1.51E-05
I-129	G (generated)	1.78E-02	1	1.78E-02
I-129	S (matrixed in fuel)	2.95E-06	3,000	9.82E-10
Cs-134	S/P	9.29E-02	3,000	3.10E-05
Cs-137	S/P	6.92E+01	3,000	2.31E-02
Ba-137m	S/P	6.54E+01	3,000	2.18E-02
Pm-147	S/P	2.70E+00	3,000	8.99E-04
Sm-151	S/P	9.23E-01	3,000	3.08E-04
Eu-154	S/P	5.55E-01	3,000	1.85E-04
Eu-155	S/P	1.20E-01	3,000	3.99E-05
U-234	S/P	4.82E-03	3,000	1.61E-06
U-235	S/P	1.87E-04	3,000	6.23E-08
U-236	S/P	6.98E-04	3,000	2.33E-07
U-238	S/P	3.82E-03	3,000	1.27E-06
Pu-238	S/P	6.70E-01	3,000	2.23E-04
Pu-239	S/P	1.24E+00	3,000	4.12E-04
Pu-240	S/P	7.14E-01	3,000	2.38E-04
Pu-241	S/P	3.51E+01	3,000	1.17E-02
Am-241	S/P	1.90E+00	3,000	6.34E-04
Other	S/P	1.31E-01	3,000	4.35E-05

G = gas
S = solid
P = particulate matter

Table 4. Unabated Dose from the Hot Conditioning System Annex.

Radionuclide	Physical Forms	Unabated Emissions (Ci/yr)	Dose Equivalent(a) (mrem/Ci)	Unabated Total Dose (mrem/yr)	Percent
H-3	G (generated)	1.05E+02	2.19E-05	2.31E-03	0
H-3	S (matrixed in fuel)	1.74E-02	2.19E-05	3.82E-07	0
C-14	G (generated)	1.99E+00	2.62E-03	5.20E-03	0
C-14	S (matrixed in fuel)	3.29E-04	2.62E-03	8.62E-07	0
Co-60	S/P	2.20E-02	2.90E-02	6.37E-04	0
Kr-85	G (generated)	1.74E+03	4.88E-08	8.48E-05	0
Kr-85	S (matrixed in fuel)	2.88E-01	4.88E-08	1.40E-08	0
Sr-90	S/P	5.38E+01	4.38E-02	2.36E+00	4
Y-90	S/P	5.38E+01	3.77E-04	2.03E-02	0
Sb-125	S/P	1.86E-01	4.15E-03	7.73E-04	0
Te-125m	S/P	4.54E-02	Unknown	0.00E+00	0
I-129	G (generated)	1.78E-02	2.91E-01	5.18E-03	0
I-129	S (matrixed in fuel)	2.95E-06	2.91E-01	8.58E-07	0
Cs-134	S/P	9.29E-02	3.13E-02	2.91E-03	0
Cs-137	S/P	6.92E+01	2.39E-02	1.65E+00	3
Ba-137m	S/P	6.54E+01	(b)	0.00E+00	0
Pm-147	S/P	2.70E+00	1.14E-03	3.08E-03	0
Sm-151	S/P	9.23E-01	7.59E-04	7.01E-04	0
Eu-154	S/P	5.55E-01	1.82E-02	1.01E-02	0
Eu-155	S/P	1.20E-01	4.26E-02	5.10E-03	0
U-234	S/P	4.82E-03	3.19E+00	1.54E-02	0
U-235	S/P	1.87E-04	2.96E+00	5.53E-04	0
U-236	S/P	6.98E-04	3.02E+00	2.11E-03	0
U-238	S/P	3.82E-03	2.84E+00	1.09E-02	0
Pu-238	S/P	6.70E-01	8.02E+00	5.38E+00	10
Pu-239	S/P	1.24E+00	8.67E+00	1.07E+01	19
Pu-240	S/P	7.14E-01	8.66E+00	6.19E+00	11
Pu-241	S/P	3.51E+01	1.38E-01	4.85E+00	9
Am-241	S/P	1.90E+00	1.31E+01	2.49E+01	44
Other	S/P	1.31E-01	Unknown	0.00E+00	0
Totals				**5.61E+01**	**100**

(a) Dose estimates are from WHC 1991 for the 200 East Area, unless not available.
(b) The dose factor cesium-137 accounts for the dose from all daughter product decay reactions.

G = gas
S = solid
P = particulate matter

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. The dose is based on abated air emissions from the HCS Annex 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, in contribution with all other U.S. Department of Energy Hanford Site offsite dose 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 be much lower than the conservative estimate provided in Table 6, for the following reasons:

- Internal process HEPA filters, such as the MCO HEPA filter and process equipment, cold trap and HEPA filters, are incorporated in the design, but were not factored into the emission calculations.
- Any particulate emitted from the HCS Annex will have to pass through two HEPA filters in a series. Additional reductions gained by the second of these filters has not been factored into the abated dose.
- 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 $BaCo_3$.

Table 5. Abated Dose from the Hot Conditioning System Annex.

Radionuclide	Physical Form	Abated Emissions (Ci/yr)	Dose Equivalent(a) (mrem/Ci)	Abated Total Dose (mrem/yr)	Percent
H-3	G (generated)	1.05E+02	2.19E-05	2.31E-03	7
H-3	S (matrixed in fuel)	5.81E-06	2.19E-05	1.27E-10	0
C-14	G (generated)	1.99E+00	2.62E-03	5.20E-03	17
C-14	S (matrixed in fuel)	1.10E-07	2.62E-03	2.87E-10	0
Co-60	S/P	7.33E-06	2.90E-02	2.12E-07	0
Kr-85	G (generated)	1.74E+03	4.88E-08	8.48E-05	0
Kr-85	S (matrixed in fuel)	9.59E-05	4.88E-08	4.68E-12	0
Sr-90	S/P	1.79E-02	4.38E-02	7.85E-04	2
Y-90	S/P	1.79E-02	3.77E-04	6.76E-06	0
Sb-125	S/P	6.21E-05	4.15E-03	2.58E-07	0
Te-125m	S/P	1.51E-05	Unknown	0.00E+00	0
I-129	G (generated)	1.78E-02	2.91E-01	5.18E-03	16
I-129	S (matrixed in fuel)	9.82E-10	2.91E-01	2.86E-10	0
Cs-134	S/P	3.10E-05	3.13E-02	9.69E-07	0
Cs-137	S/P	2.31E-02	2.39E-02	5.52E-04	2
Ba-137m	S/P	2.18E-02	(b)	0.00E+00	0
Pm-147	S/P	8.99E-04	1.14E-03	1.03E-06	0
Sm-151	S/P	3.08E-04	7.59E-04	2.34E-07	0
Eu-154	S/P	1.85E-04	1.82E-02	3.37E-06	0
Eu-155	S/P	3.99E-05	4.26E-02	1.70E-06	0
U-234	S/P	1.61E-06	3.19E+00	5.13E-06	0
U-235	S/P	6.23E-08	2.96E+00	1.84E-07	0
U-236	S/P	2.33E-07	3.02E+00	7.03E-07	0
U-238	S/P	1.27E-06	2.84E+00	3.62E-06	0
Pu-238	S/P	2.23E-04	8.02E+00	1.79E-03	6
Pu-239	S/P	4.12E-04	8.67E+00	3.57E-03	11
Pu-240	S/P	2.38E-04	8.66E+00	2.06E-03	7
Pu-241	S/P	1.17E-02	1.38E-01	1.62E-03	5
Am-241	S/P	6.34E-04	1.31E+01	8.30E-03	26
Other	S/P	4.35E-05	Unknown	0.00E+00	0
Totals				**3.15E-02**	**99**

(a) Dose estimates are from WHC 1991 for the 200 East Area, unless not available.

(b) The dose factor cesium-137 accounts for the dose from all daughter product decay reactions.

G = gas
S = solid
P = particulate matter

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 Emissions.

Emission Source	**Emission Type**	**Total Unabated Dose (mrem/yr)**	**Total Abated Dose (mrem/yr)**
Hot Conditioning	Gaseous Solids/Particulate	1.28E-02 5.61E+01	1.28E-02 1.87E-02
Totals		**5.61E+01**	**3.15E-02**

4.0 REFERENCES

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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.

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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 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 two 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. The project goal is to store the SNF in closed vessels with no emissions being generated during interim storage. 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. 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 a 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 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 close 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.

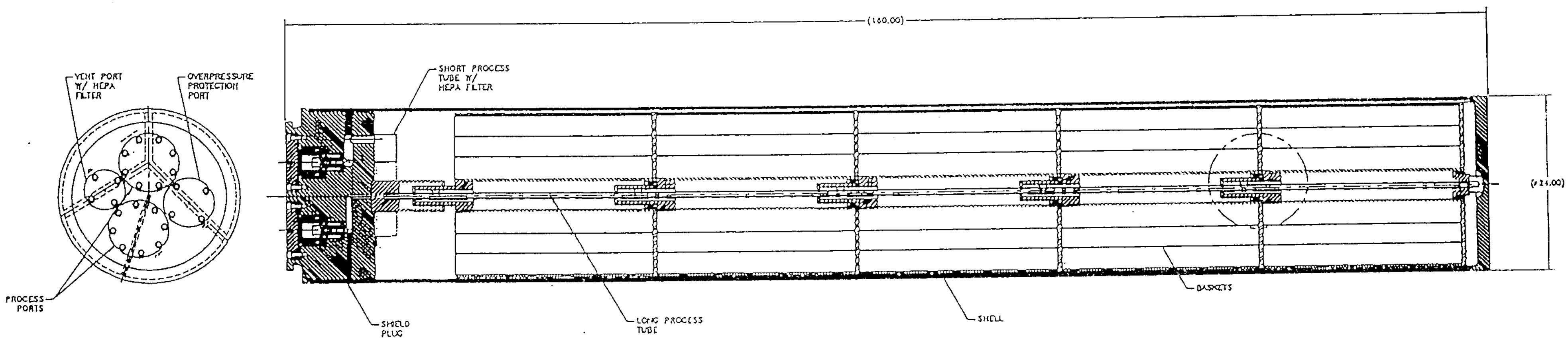
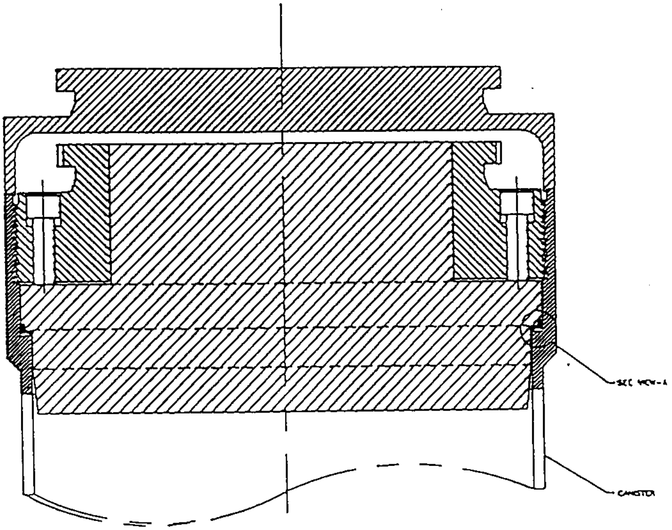


Figure A-2. Multi-Canister Overpack Mechanical Closure.



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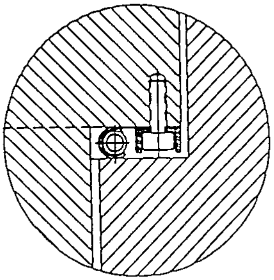
NOT TO SCALE



VIEW-A

- Staging the MCOs in the CSB
- Hot conditioning of SNF in the MCOs at the HCS Annex
- Interim storage of the MCOs at the CSB.

The following descriptions of the SNF retrieval, staging, and interim storage of MCOs are provided only as background information because they are incidental to the HCS Annex. 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 that NOCs will be submitted for the K Basin activities, the CVD Facility, CSB, and HCS Annex.

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 HCS Annex 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 basin 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 (see Figure 7 located in 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 a containment box will remove SNF canister sludge and basin floor sludge from the individual SNF assemblies.

Some of the SNF assemblies may 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 closed. Each transport cask will be closed, and checked for contamination on the external surfaces, after being removed from 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 environment protection.

Each MCO and cask will then be removed from the basin and placed on a SNF transport trailer and readied for transfer 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 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 form oxides in the basins or will react in either conditioning, transportation, staging, or storage. Because actual emission 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 in calculating potential emissions from the facility, when possible.

COLD VACUUM DRYING

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

The CVD process will be used to remove as much free water (bulk water [water that surrounds the SNF in each MCO] and adsorbed and absorbed water [water that adheres to the SNF after removal of bulk water]) as possible from the MCOs before being transported to the CSB. Bulk water will be removed by pumping. Remaining adsorbed and 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 lbs) of chemically-bound water may not be removed by CVD; thereby, remaining in each MCO.

Before transport, each MCO will be heated to approximately 75°C (167°F) and held for six hours to verify that the MCO will not over pressurize during transportation to the CSB. Following the post CVD Facility monitoring, the temperature of each MCO will be lowered to 25°C (77°F) and the MCO inerted with helium at approximately 155 mmHG (3 lbf/in^2[g]) pressure. The MCOs will then be released from the CVD Facility and transported on the SNF transport trailer by truck to the CSB.

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 any gas any 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 closed 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.

CANISTER STORAGE BUILDING (INTERIM STORAGE)

Upon completion of hot conditioning, or upon confirmation the MCO is ready, each MCO will be closed 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 closed MCOs are 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 remain 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 closed vessels with no emissions being generated during interim storage.

APPENDIX B
HOT CONDITIONING SYSTEM ANNEX POTENTIAL AIR EMISSION CALCULATIONS AND SUPPORTING INFORMATION

INTENT:
To estimate unabated and abated emissions for radionuclides from the SNF Project.

BACKGROUND:
The SNF Project will utilize three major facilities:

1) MCO staging in the CSB

2) CVD Facility

3) HCS Annex

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 may occur at the CSB and during processing in the CVD Facility and HCS Annex.

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.
4) Project lifetime is two (2) years for the HCS Annex.

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 Hanford Site contractor 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 two 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 text of this document.

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

Table B-1. Multi-Canister Overpack 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 condition fuel.
Interim Storage	59.6 kg	No additional oxide is generated during storage.

MCO = multi-canister overpack
CSB = Canister Storage Building
OU^2 = uranium oxide

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

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