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DOE/RL-96-45
Rev. 0

Radioactive Air Emissions Notice of Construction for the 105-C Reactor Safe Storage Enclosure

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Richland, Washington

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Radioactive Air Emissions Notice of Construction for the 105-C Reactor Safe Storage Enclosure

Date Published
June 1996

United States
Department of Energy
P.O. Box 550
Richland, Washington 99352

EXECUTIVE SUMMARY

A Notice of Construction (NOC) is required by the Washington State Department of Health (DOH), pursuant to Washington Administrative Code (WAC) Chapter 246-247-060, for any proposed construction or modification of an existing emission unit that has the potential to emit airborne radionuclides. The following document is the NOC application to be submitted to the DOH for; 1) the decontamination and demolition of the 105-C Reactor's unnecessary structures and 2) the construction of the interim safe-storage enclosure for the 105-C Reactor block, located at the 100-B/C Area. This enclosure is to place the reactor into a safe-storage condition for up to 75 years. The decontamination and demolition process has the potential to generate radioactive air emissions. This document was prepared in accordance with the application information requirements specified in Appendix A of WAC 246-247-110.

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ACRONYMS

ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
BARCT	best available radionuclide control technology
BHI	Bechtel Hanford Inc.
CAP-88	Clean Air Assessment Package 1988
CFR	Code of Federal Regulations
D&D	decontamination and demolition
DOE	U. S. Department of Energy
DOH	Washington State Department of Health
ERC	Environmental Restoration Contractor
ERDA	U. S. Energy Research and Development Agency
ERDF	Environmental Restoration Disposal Facility
HEPA	High Efficiency Particulate Air
MEI	maximally exposed individual
NESHAP	National Emission Standards for Hazardous Air Pollutants
NOC	Notice of Construction
PNNL	Pacific Northwest National Laboratory
RL	Richland Operations Office
SEPA	State Environmental Policy Act
TEDE	total effective dose equivalent
UNC	UNC Nuclear Industries
WAC	Washington Administrative Code

1.0 INTRODUCTION

This Notice of Construction (NOC) presents the proposed plans for; 1) the decontamination and demolition (D&D)[1] of the 105-C Reactor's unnecessary structures and 2) the construction of the interim safe-storage enclosure for the 105-C Reactor block, located at the 100-B/C Area. This enclosure is to place the reactor into a safe-storage condition for up to 75 years.

Design and construction of the 105-C Reactor was undertaken in response to the international tension of the Cold War. Design started in March 1951 and construction began on June 6, 1951. Initial startup of the reactor was achieved on November 18, 1952. Final shutdown of 105-C Reactor was on April 25, 1969. The facility has been in a condition of minimum surveillance and maintenance since that time. Several areas of the facility are in an advanced state of deterioration, particularly the roof sections over the fan room and the work area. Access into the facility is restricted to maintenance and surveillance activities, with exceptions allowed for special circumstances.

Particulate radioactive air emissions may be generated during the D&D of the unnecessary structures. The NOC provides the description of the D&D process, the construction plans for the safe-storage enclosure, and the airborne contamination controls proposed for this project.

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

2.0 FACILITY LOCATION (Response to Requirement 1)

U.S. Department of Energy, Richland Operations Office
Hanford Site
100-B/C Area, 105-C Reactor
Latitude: W. 39200 Longitude: N. 96400 (Hanford Coordinates)
Richland, Washington 99352

The 100-B/C Area of the Hanford Site is located in the northern portion of the Hanford Site on the south bank of the Columbia River, approximately 35 miles northwest of the city of Richland, Washington (Figure 1). The 105-C Reactor is situated about 900 ft south of the 105-B reactor Building between two "high" water towers (Figure 2).

The 105-C Building is 105.5 m by 47.5 m by 36.6 m (346 ft by 150 ft by 120 ft). Except for the reinforced sections, the building can be classified as a light, non-airtight industrial structure. The lower levels of the building and the central area surrounding the reactor are reinforced concrete.

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[1] For this document, D&D does not refer to decommissioning

Figure 1. Hanford Site Map.

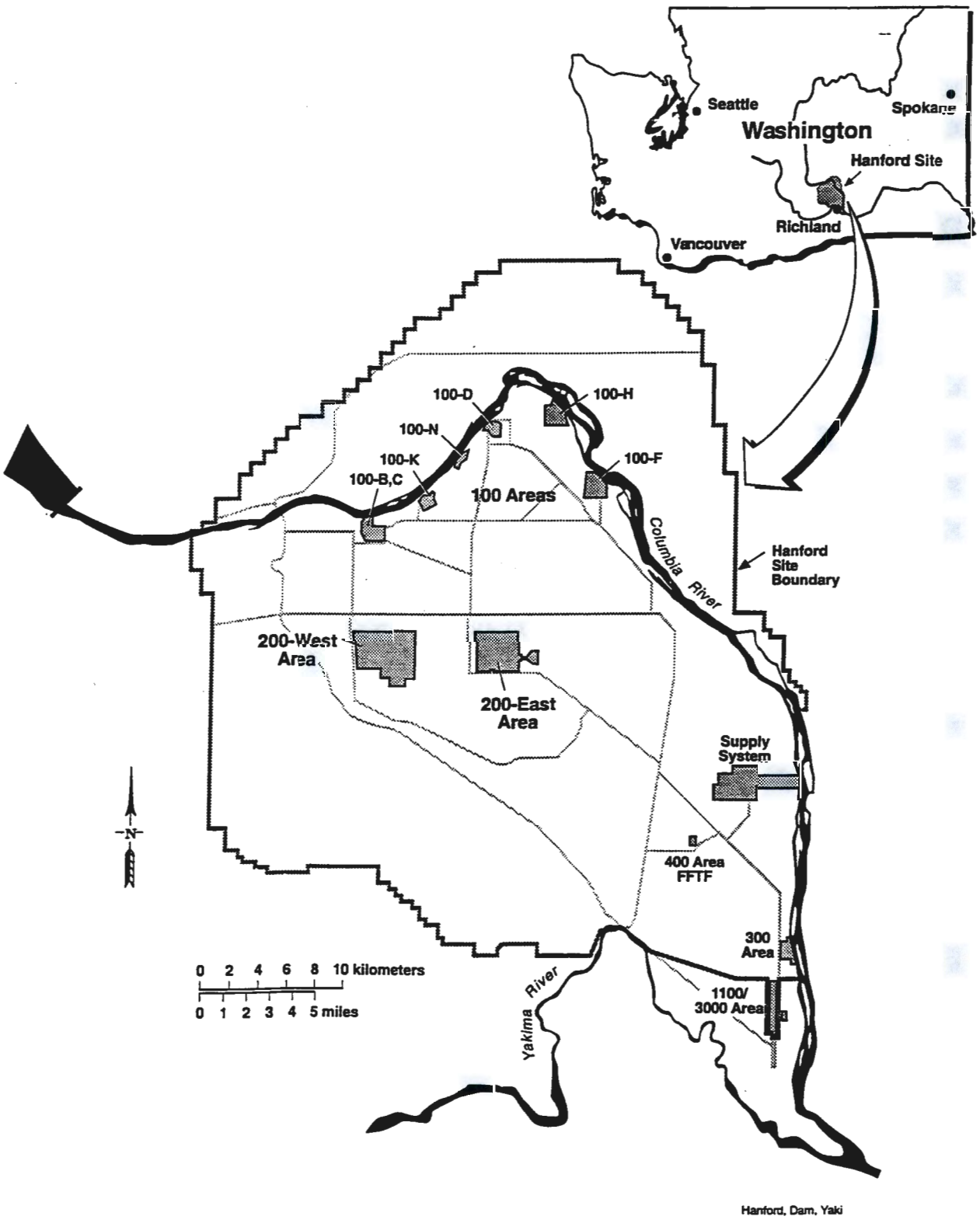
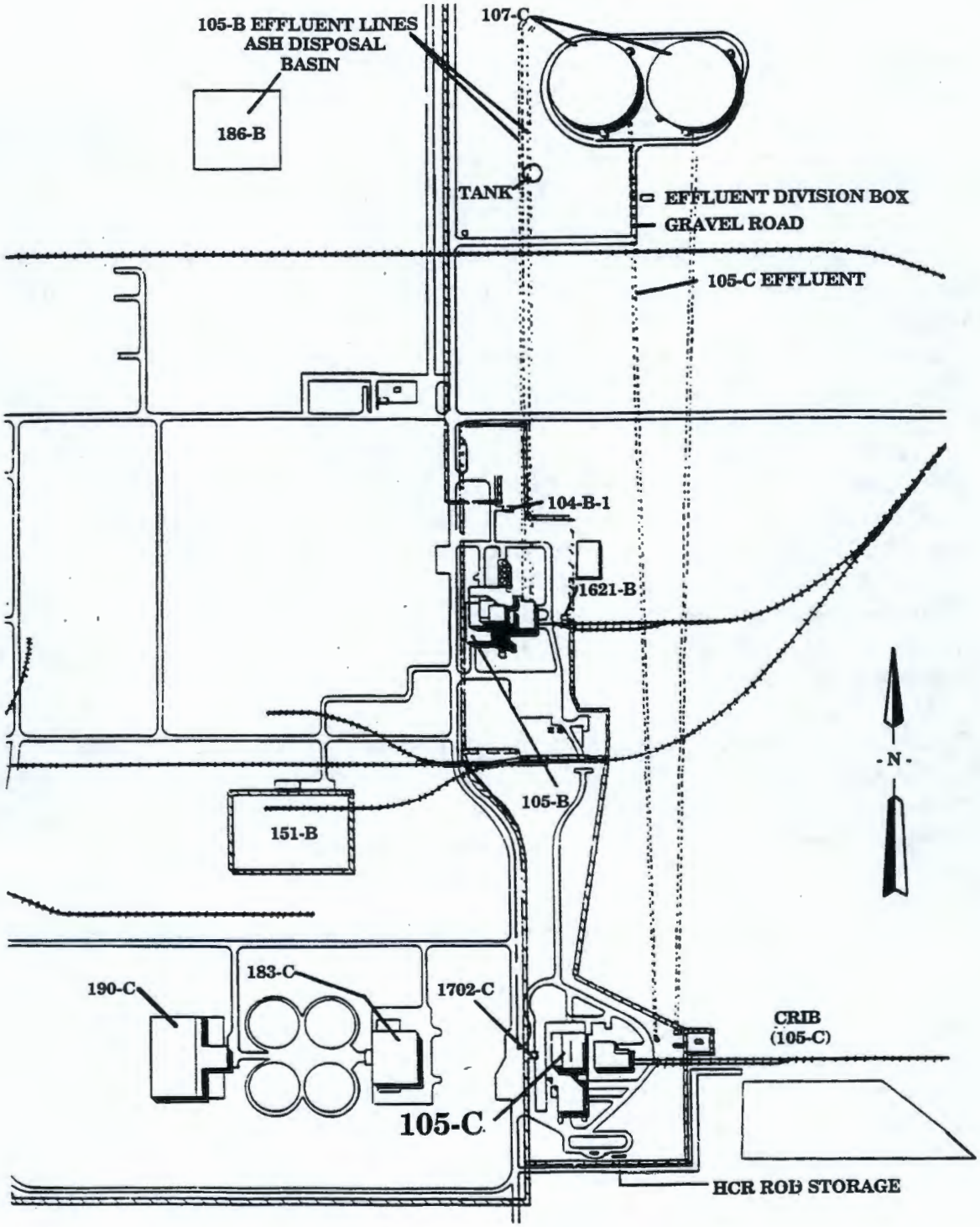


Figure 2. 105-C Reactor Building/Facilities.



Most of the upper portions and outer walls are concrete block or corrugated asbestos cement (transite). The massive reinforced concrete walls, 0.9 to 1.5 m (3 to 5 ft) thick, surrounding the reactor at the lower levels added additional radiation shielding. The roof is mainly constructed of cast concrete panels.

The reactor pile is located near the center of the building. The reactor pile consists of a graphite stack encased in a cast iron thermal shield, a biological shield consisting of alternating layers of masonite and steel on the four sides, and a 2.1 m (7-ft) thick heavy aggregate poured shield on top. The entire block rests on a massive concrete foundation. The block is 14 m high, 14 m wide by 12.2 m deep (46 ft high by 46 ft wide by 40 ft deep).

A ventilation system was installed to provide for personnel comfort and containment of radioactive contamination through controlled pressure zone air flow. Most of the main ventilation ducting was located outside and on top of the building superstructure. The ventilation air handling units were located at the south end of the 105-C Building and consists of two large air supply units and four exhaust fans.

The fuels storage basins, located on the east side of the 105-C Building, served as an underwater collection, storage, and transfer facility for the irradiated fuel elements discharged from the reactor. The fuel storage basin complex consists of the fuel element discharge pickup area, located adjacent to the reactor rear face; the fuel storage area; and the wash pad area used for decontaminating fuel handling equipment. Adjacent to the fuel storage basin, on the north side, is the metal examination facility. This facility was added later, specially designed to contain manipulators, viewing stations, and tools for handling and examining irradiated fuel remotely under water.

Deactivation of the 105-C facilities was initiated the same month of standby status. Considerable decommissioning and decontamination activities were initiated in 1975, and in 1984 and 1985 the fuel storage basins were stabilized. As the 105-C Building was deactivated, all rooms were either decontaminated or posted for radiological control.

3.0 RESPONSIBLE MANAGER (Response to Requirement 2)

Mr. J. D. Goodenough, Senior Project Manager
Environmental Operations Division PH: (509) 376-0893
U.S. Department of Energy, Richland Operations Office
P.O. Box 550, MSIN H0-12
Richland, Washington 99352

4.0 TYPE OF PROPOSED ACTION (Response to Requirement 3)

The proposed actions will modify the existing 105-C Reactor facility by: 1) D&D of the unnecessary structures and 2) constructing an interim safe-storage enclosure. The 105-C Reactor facility is not associated with any registered emission units, in accordance with WAC 246-247.

5.0 STATE ENVIRONMENTAL POLICY ACT (Response to Requirement 4)

The State of Washington Department of Health (DOH) requirements in WAC 246-03-020 adopted by reference the categorically exemption in WAC 197-11-845(1) from the State Environmental Policy Act (SEPA) checklist process, therefore the SEPA checklist process will not be required for proposed activities.

6.0 PROCESS DESCRIPTION (Response to Requirements 5 and 7)

The 105-C Reactor Interim Safe Storage project is divided into two phases; 1) D&D of the unnecessary structures and 2) construction of the interim safe-storage enclosure for the reactor block. This section provides detailed information regarding these two phases.

6.1 DECONTAMINATION AND DEMOLITION

To enable the efficient sequencing of D&D activities, the 105-C Reactor facility is divided into two modules. Module I encompasses the part of the facility outside the primary shield wall, most of which will be decontaminated, demolished, and removed. Module II includes everything within the primary shield wall. Module II is the part of the facility that will be cleared of any unnecessary equipment and enclosed in the safe-storage enclosure.

The Environmental Restoration Contractor (ERC) has removed the exterior air ductwork. This ductwork was used solely to supply atmospheric air to the building, and is free of contamination. The Phase 1 decontamination activity will begin with fixation or removal of surface contamination. Based on the radiological characterization surveys performed throughout the 105-C Reactor facility (Beckstrom et al. 1994), removal of the contamination ranges from very light, light, medium, to heavy decontamination. Very light and light decontamination techniques are nonaggressive methods such as wiping a surface or applying foam polymers, then wiping the surface area. Medium and heavy decontamination techniques are aggressive methods such as scabbling and vacuuming. In the event that these systems do not remove all the contamination, the associated Module I material will be sent to ERDF, Module II contaminant locations will be fixed with fixative paint for Module II components. All fixed contamination will be removed and handled separately.

After decontamination, demolition/removal will commence in the following general sequence:

Module I

- Remove process piping and equipment and seal all penetrations from the safe storage enclosure
- Remove nonstructural equipment and material
- Perform concrete demolition
- Remove the below grade rooms.

Module II

- Remove process piping and equipment
- Remove nonstructural equipment and material
- Dismantle/demolish and remove superstructure/wall to the 50-ft level elevation
- Install safe storage enclosure roof superstructure and roof
- Seal remaining openings/penetrations into the safe storage enclosure.

Demolition methods will be selected based on the structural elements to be demolished, remaining radionuclide contamination, location, and integrity of the safe-storage enclosure. Any fixed contamination will be segmented using techniques such as cutters, mechanical/power saws and handled separately.

Soil sampling of the 105-C Reactor site will be performed, in coordination with the 100-BC Operable Unit EPA Project Manager, after demolition to identify any areas of contamination. If contamination is present the site may require remediation in accordance with the Record of Decision for the 100-BC-1 Operable Unit remedial action, or posted for radiological control.

The 105-C Reactor site will be restored to grade level using clean soil that will be brought in or excavated during concrete removal. The soil will be sloped away from the safe-storage enclosure and will be covered with gravel to allow drainage and minimize the growth of vegetation.

6.2 SAFE STORAGE ENCLOSURE CONSTRUCTION

The construction of the safe storage enclosure will begin during the demolition phase. The existing 105-C Reactor shield wall, which is in sound structural condition, will be used as the primary enclosure for safe storage. Upon removal of the building internals, and D&D of the structures surrounding the shield wall, a new roof will be constructed to enclose the top of the reactor block and adjacent rooms. The new roof will consist of prefabricated structural steel joists and joist girders with stainless steel metal roof decking. The roof will be supported by the shield wall. Openings between the new roof and top of the shield wall will be closed with a material similar to the new roof. Openings and penetrations within the shield wall will be closed: large openings by concrete block walls; smaller openings and penetrations by welded caps, foam sealant or fire plug, as appropriate. The reactor block will be stabilized by an encapsulating type material to prevent spread of contamination and deterioration. Figures 3 through 6 provide the layout of the safe-storage enclosure.

A single door entry into the safe-storage enclosure is provided to limit and control access, and will be welded shut. A ventilation system (described in Section 8.0) will be activated prior to and during entry for the surveillance and maintenance activities. A remote monitoring and control system will be in place so that key parameters can be monitored between surveillance and maintenance entries. The equipment associated with the ventilation, remote monitoring, and electrical power is installed in a room located outside the facility so that entry into the safe-storage enclosure is not necessary to serve this equipment.

7.0 ANNUAL POSSESSION QUANTITY AND PHYSICAL FORM (Response to Requirements 8, 10, 11, and 12)

A characterization survey (Beckstrom et al. 1994) for 105-C Reactor facility was conducted during the period of July 1994 through October 1994. The radiological survey was comprehensive using both random and bias sampling methodologies. At the random sample points, technical or gross smears were taken in addition to direct count rate readings. The bias sampling locations were left to the discretion of the survey technicians. These locations often included drains, pipes, equipment, and areas where residues and stains were visible.

Liquid and sediment samples were taken at locations where the material was found. Soil and concrete core samples were also taken in the fuel storage basin and metal examination area.

The radiological information from this report was used to determine the radionuclide inventory. Radionuclides present in the 105-C Reactor facility are in three physical forms; 1) sediment, 2) liquid, and 3) surface deposits on walls, floors, concrete. The radionuclide inventories and distributions (Table 1) were determined and averaged based on the sample data results. Radionuclides with less than 1% abundance were eliminated from the inventory (Appendix A). The basis for the inventories are discussed below.

Figure 3. Safe-Storage Preparation.

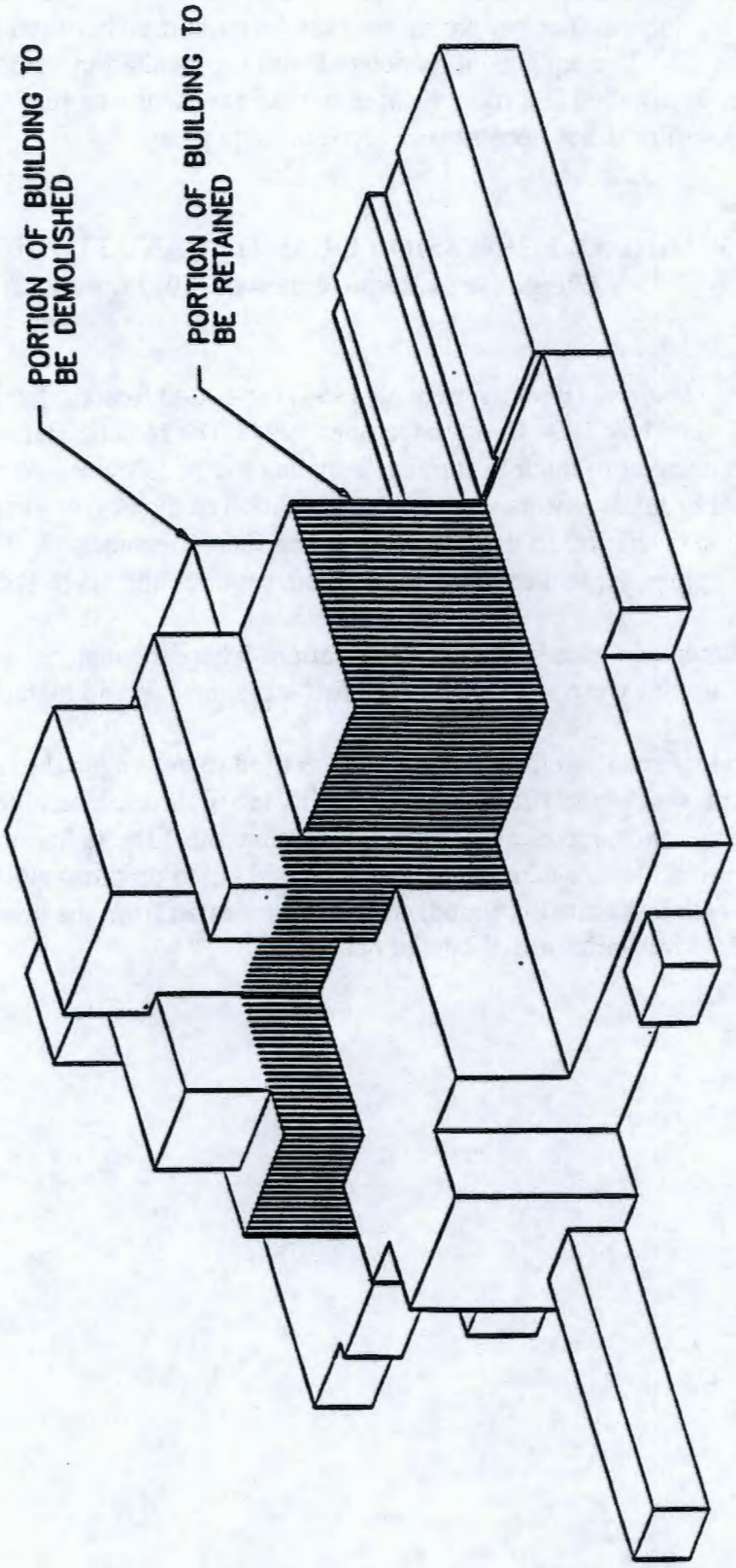


Figure 4. Plan View - Shield Wall.

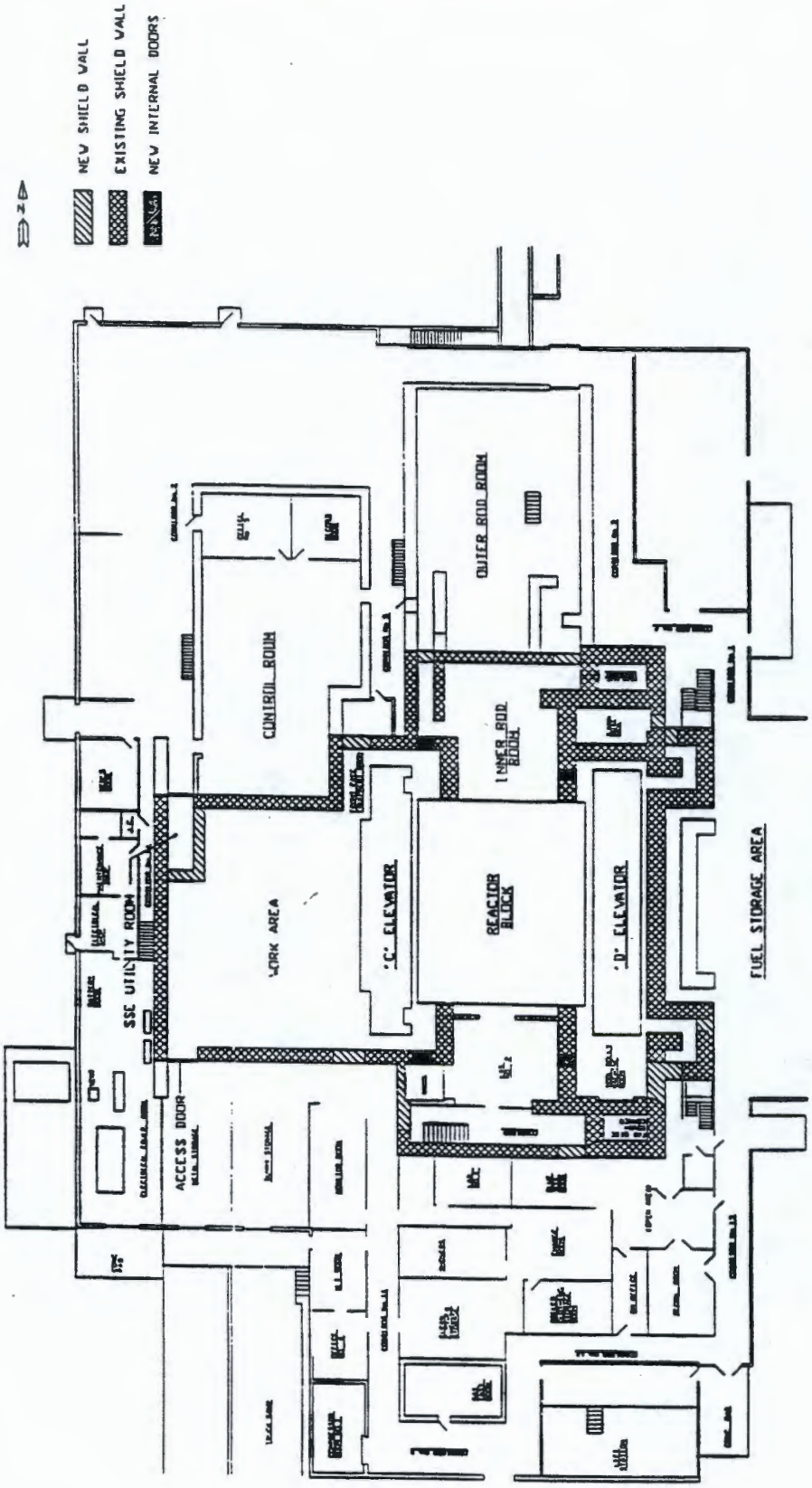


Figure 5. Isometric View of the Safe Storage Enclosure.

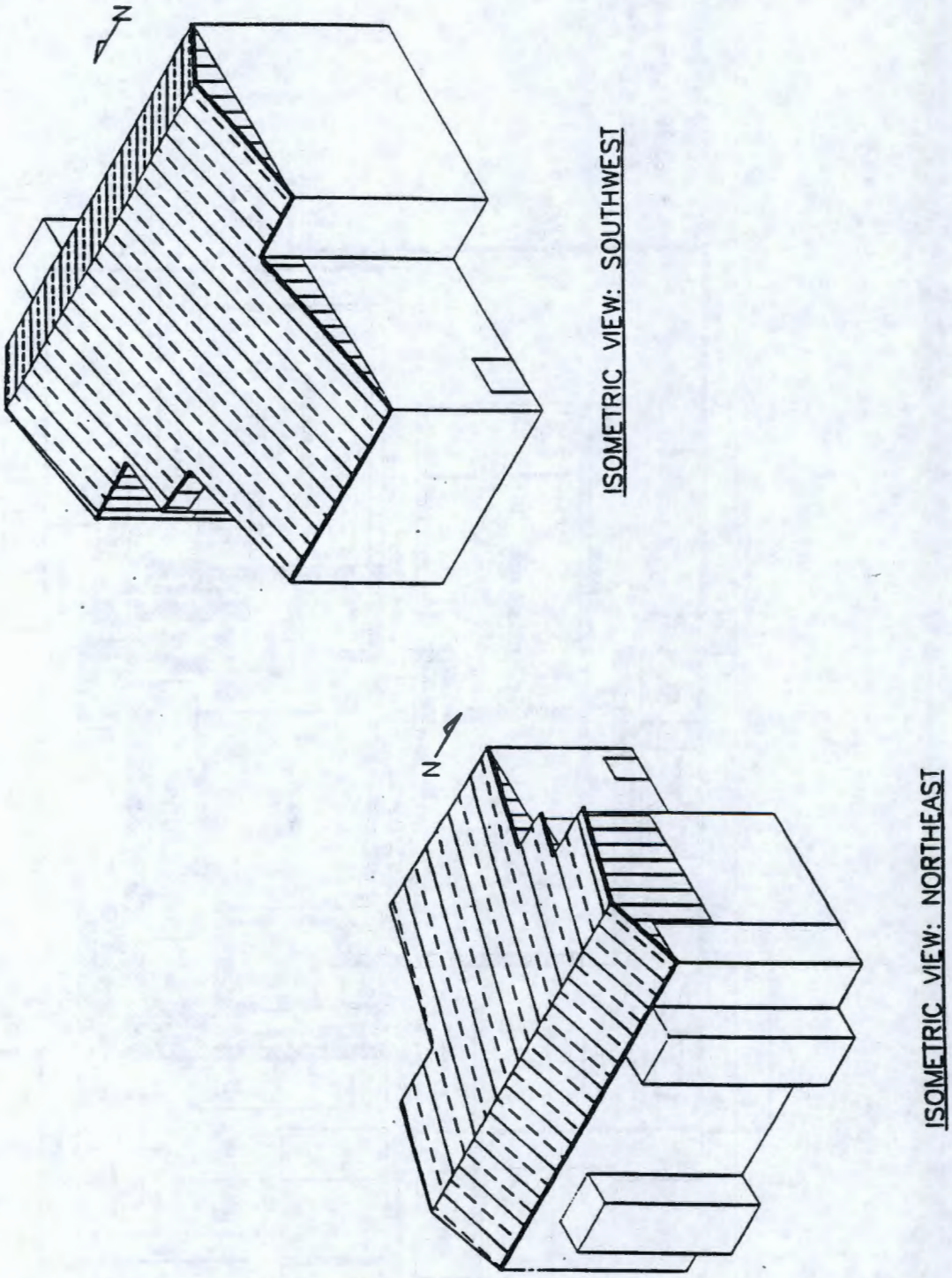
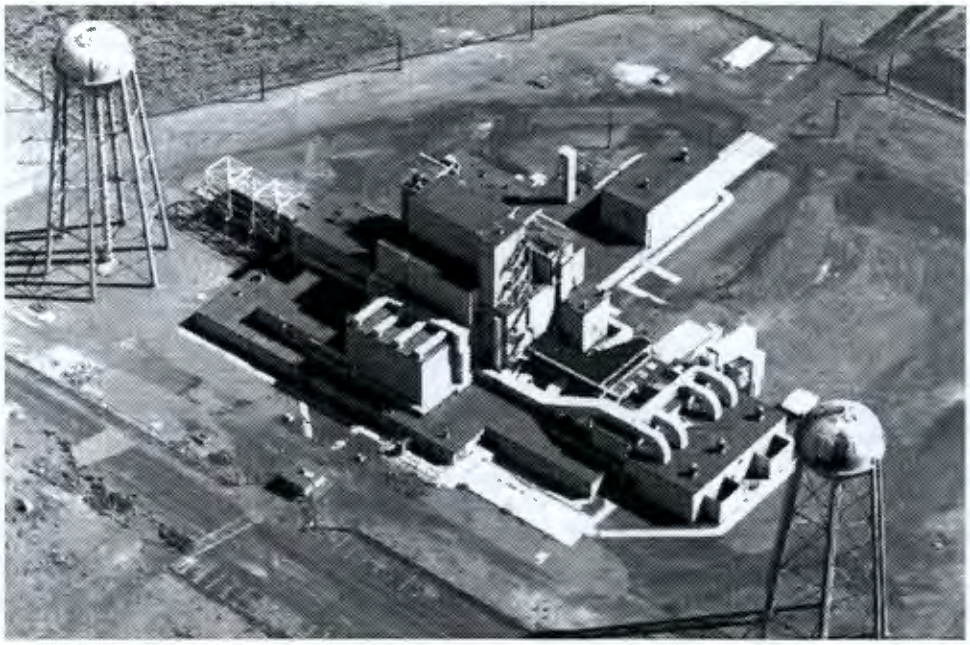


Figure 6. Aerial View, Before and After, of the Safe Storage Enclosure.



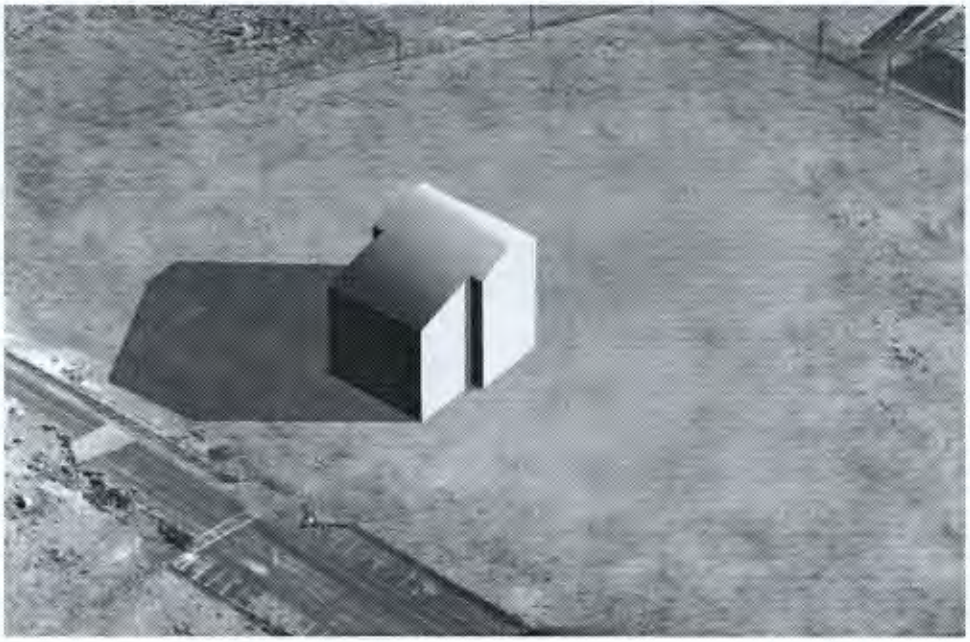


Table 1. Radionuclide Inventory and Distribution.

Radionuclide Surface Deposits	Distribution (%)
Co-60	1.38
Cs-137	71.3
Eu-152	8.05
Eu-154	2.03
Sr-90	16.7
Sediment	
Cs-137	43.21
Eu-152	45.93
Eu-154	2.41
Sr-90	3.02
Am-241	4.44
Liquid	
Sr-90	99.9

Surface Deposits. Radiological survey records were used to determine average contamination levels throughout the 105-C Reactor facility. Average contamination levels were determined for each elevation of the 105-C Reactor facility for each contamination range. As discussed in Section 6.1, the contamination ranges were very light/light and medium/heavy, with very light/light subject to nonaggressive decontamination methods and medium/heavy subject to aggressive decontamination methods. The estimated area per elevation to be decontaminated was taken from the *Engineering and Planning for Reactor 105-C Interim Safe Storage Project Subcontract No. 0100C-SC-G0001 Conceptual Design Report* (BHI 1996). Based on the contamination levels and area to be decontaminated the radioactivity, in curies, was calculated (Appendix B) for the two contamination ranges. The radionuclide inventory (based on the concrete core samples) presented in Table 2 was determined by multiplying the total curies for each contamination range by the radionuclide distribution percentage. The very light/light decontamination method is 100% of the calculated activity. In addition to the 100%, 20% more (a total of 120%) would be subject to the vacuuming decontamination methods.

Table 2. Surface Deposits.

Radionuclides	Very Light to Light (Total Curies)	Vacuuming Methods (Total Curies)	Medium to Heavy (Total Curies)
Co-60	1.05E-05	2.10E-06	1.27E-03
Cs-137	5.42E-04	1.08E-04	6.60E-02
Eu-152	6.12E-05	1.22E-05	7.41E-03
Eu-154	1.54E-05	3.09E-06	1.87E-03
Sr-90	1.27E-04	2.54E-05	1.54E-02

Sediment. There is an estimated 50 tons of sediment in the 105-C Reactor facility (UNC 1986). Based on the sediment samples the radioactivity, in curies, was calculated (Appendix B). The radionuclide inventory, presented in Table 3, was determined by multiplying the total curies by the radionuclide distribution percentage. The sediment will be removed by a material conveyor, and if necessary, dewatered into containers/tanks for disposal.

Table 3. Sediment.

Radionuclide	Total Curies
Cs-137	6.70E+00
Eu-152	7.12E+00
Eu-154	3.74E+01
Sr-90	4.68E-01
Am-241	6.89E-01

Liquid. There is an estimated 5,000 gal of liquid in the 105-C Reactor facility (Beckstrom, et. al. 1994). Based on the liquid samples the radioactivity (in curies) was calculated (Appendix B). The radionuclide inventory presented in Table 4, was determined by multiplying the total curies by the radionuclide distribution percentage. The liquid will be pumped into containers/tanks for disposal.

Table 4. Liquids.

Radionuclide	Total Curies
Sr-90	4.39E-02

If airborne releases occur from this project, they will be in particulate form and could occur during the D&D phase of the project. The construction of the interim safe-storage enclosure will not have a potential of radioactive air emissions, because all contamination will be removed or fixed.

As stated in Section 6.1, D&D will consist of nonaggressive methods such as wiping a surface or applying foam polymers, then wiping the surface area, or aggressive methods such as scabbling and vacuuming. For aggressive methods, the release fraction of "1" will be applied per direction provided by DOH (letter dated August 1, 1994, from A. W. Conklin to S. H. Wisness). Whether a release fraction of "1" (or some lesser fraction) is appropriate is still a subject of discussion with DOH. For the nonaggressive methods the release fraction of 1E-03 will be applied in accordance with WAC 246-247-030 (21) (a).

8.0 CONTROL SYSTEM (Response to Requirement 6)

During the use of aggressive decontamination methods, local containments utilizing high-efficiency particulate air (HEPA)-filtered units will be used. By connecting a HEPA-filtered unit to the tools, the dust and debris can be collected into containers as it is generated.

The safe-storage enclosure ventilation system is designed to maintain air quality in the enclosure and provide fresh air supply during surveillance and maintenance activities which are expected to occur every 5 years. The ventilation system is shown schematically in Figure 7.

The system consists of adjustable supply and exhaust fans, supply and exhaust air ducts, two prefilters, one HEPA filter, dampers (backdraft and balancing), a recirculation duct and a continuous air monitoring system.

The supply fan is capable of forcing about 4,000 L/s (10,000 cfm) of outdoor filtered air into below grade tunnels and relatively clean areas. The air distribution to below grade tunnels is primarily for the removal of radon that may be present. The exhaust air flows primarily from the rear face area and is controlled to maintain the enclosure at slightly negative pressure. The exhaust flow is maintained higher than the supply flow by an amount equal to the infiltration. The proposed ventilation flow rate will provide about one air exchange per hour.

Use of supply and exhaust fans (balanced flow) provides greater control of air flow for radon removal. For proper air flow distribution, several new penetrations were created in the interior walls and floors and each penetration is provided with a balancing damper.

The exhaust air is taken from two areas, inner rod room and safety rod room at higher elevations, filtered, monitored, and exhausted to atmosphere at 14.5 m (48 ft) above grade. The supply air is taken at about 3 m (10 ft) above grade, and is forced into below grade tunnels and front face work area through openings in floors and walls. This arrangement is utilized to minimize installation of new duct work.

The ventilation system is manually initiated in the recirculation mode using both supply and exhaust fans with a HEPA filter installed to preserve the clean side of the system. The air contamination will be continuously monitored in the recirculation mode to determine if HEPA filtration is necessary. If HEPA filtration is not required, then the system will be switched to normal mode for purging the enclosure. If HEPA filtration is required the system will be placed in the normal mode only after the acceptance testing of the HEPA filter.

Use of recirculation duct is helpful for periodic surveillance of the fan/motor. This arrangement allows testing without HEPA filtration and without exhausting to the atmosphere. The effluent air stream is continuously monitored while the exhaust fan is running.

9.0 MONITORING SYSTEM (Response to Requirement 9)

The potential unabated dose, 5.51E-02 mrem/yr (Section 10.0), is not greater than 0.1 mrem/yr; therefore, this air emission source is not subject to the radionuclide National Emission Standards for Hazardous Air Pollutants (NESHAP) for continuous monitoring systems as defined in 40 Code of Federal Regulations (CFR) 61.93(b). However, periodic confirmatory measurements will take place throughout the duration of the project.

The HEPA-filtered units shall have a minimum efficiency of 99.95% for the removal of airborne particulates. The basis for this is *The Nuclear Air cleaning Handbook, Section 8.2 (U.S. Energy Research and Development Agency* [ERDA] 1976), which states by definition, that a HEPA unit must exhibit an installed decontamination factor of 2,000 which is an efficiency of 99.95% for the removal of aerosols having a nominal median diameter of less than 1 micrometer.

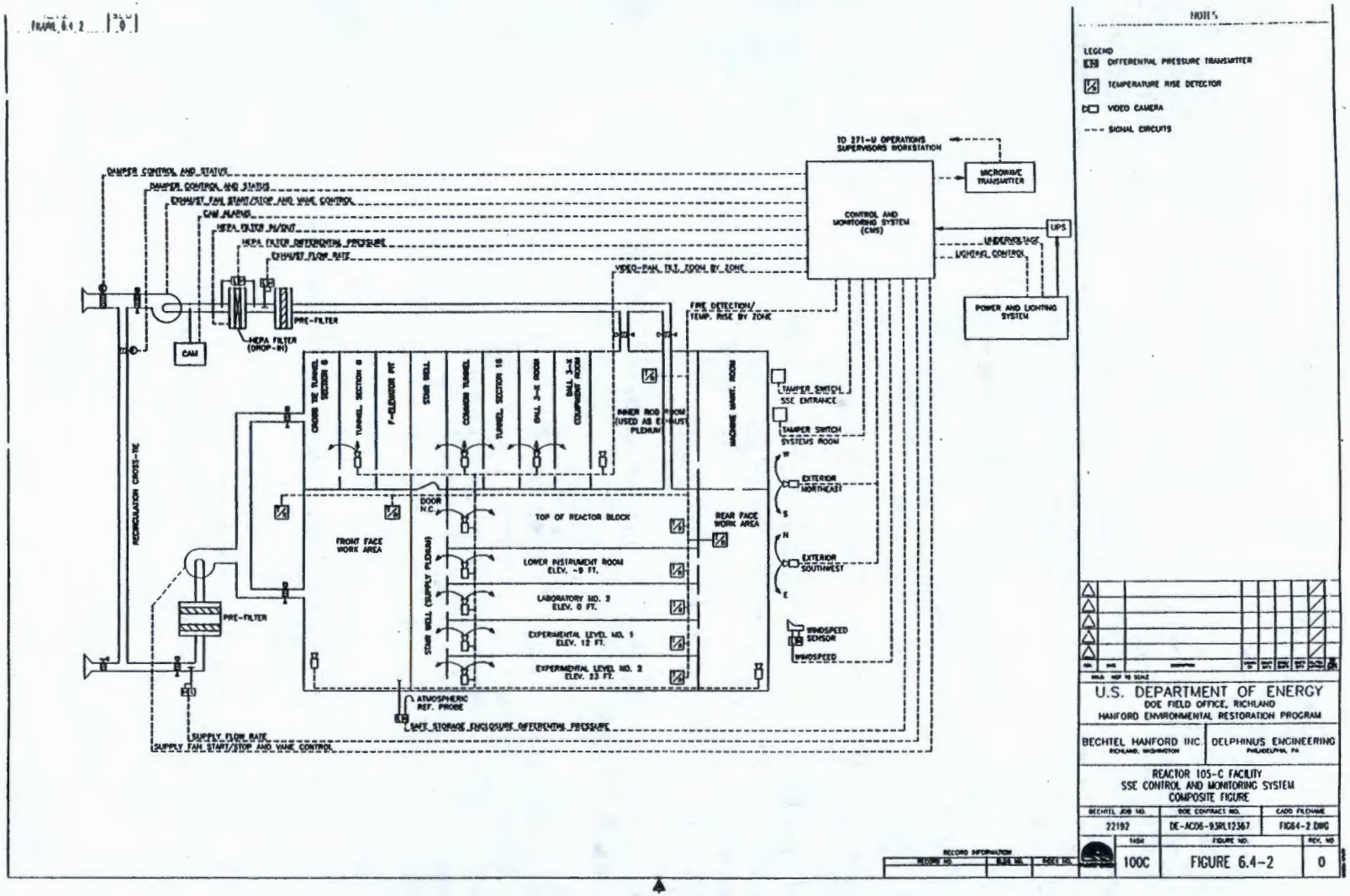


Figure 7. Ventilation System.

10.0 RELEASE RATES (Response to Requirements 13, 14 and 15)

10.1 UNABATED RELEASE RATES AND OFFSITE DOSE

Tables 5 and 6 present the potential emission release rates expected from the D&D of the 105-C Reactor facility without taking into account the emission (HEPA) control units. Since the D&D of the surface deposits will occur over a two year period, the total curies for those activities were divided by two. Also included is the offsite total effective dose equivalent (TEDE) to the maximally exposed individual (MEI) resulting from the unabated emissions. A Clean Air Assessment Package 1988 (CAP-88) evaluation was run specifically for the projected releases from the 105-C Reactor facility (Appendix C).

The total unabated dose for all D&D activities associated with the 105-C Reactor facility was calculated to be 5.51E-02 mrem/yr.

10.2 ABATED RELEASE RATES AND OFFSITE DOSE

Tables 7 and 8 present the abated release rates and offsite dose resulting from D&D activities. Since HEPA filtration is the control system used for the vacuuming and aggressive methods, a removal efficiency of 99.95% can be applied to the unabated release rates to determine the abated release rates and abated offsite dose.

The total abated dose for all D&D activities associated with the 105-C Reactor facility was calculated to be 1.25E-03 mrem/yr.

The dose resulting from all Hanford Site operations in 1994 was determined to be 0.05 mrem/yr for an individual located at a farm on Sagemore Road, Riverview directly across the Columbia River from the site boundary to the east of the 300 Area (PNNL 1995). The emissions, as a result of the activities associated with the 105-C Reactor facility, in conjunction with other operations at the Hanford Site will not result in a violation of the National Emission Standard of 10 mrem/yr.

11.0 COST FACTORS (Response to Requirement 16)

A best available radionuclide control technology (BARCT) discussion is provided in Appendix D. As such, cost factors for construction, operation, and maintenance of the proposed control technology components and system are not required if a BARCT discussion is provided.

12.0 FACILITY LIFETIME (Response to Requirement 17)

The D&D of the 105-C Reactor facility and the construction of the safe-storage enclosure is scheduled to begin October 1996 and will take approximately 24 months.

13.0 TECHNOLOGY STANDARDS (Response to Requirement 18)

Since EPA-compliant monitoring is not required for this project and the potential unabated dose is less than 0.1 mrem/yr, application of American National Standards Institute (ANSI) N13.1 and 40 CFR 61 monitoring control methods will not be applied. Testing of the HEPA units used will be performed in accordance with the intent of American Society of Mechanical Engineers (ASME)/ANSI N509 and N510.

14.0 REFERENCES

Beckstrom, J. F., Crocker, J. W., Harvey, Jon, R. C., Hunter, J. C., Meyer, E. M., 1994, *105-C Building Characterization Survey Data Report*, Columbia Energy and Environmental Services, Inc., Richland, Washington.

BHI, 1996, *Engineering and Planning for Reactor 105-C Interim Safe Storage Project Subcontract No. 0100C-SC-G0001 Conceptual Design Report*, BHI-00537, Rev. 0, Bechtel Hanford Inc., Richland, Washington.

PNNL, 1995, *Hanford Site Environmental Report for Calendar Year 1993*, PNNL-10574, UC-602, Pacific Northwest National Laboratory, Richland, Washington.

UNC, 1986, *Radionuclide Inventory and Source Terms for the Surplus Production Reactors at the Hanford Site*, UNI-3714, UNC Nuclear Industries, Washington, D.C.

Table 5. Annual Unabated Release Rate and Dose from D&D Activities (Surface Deposits).

Radionuclides	Nonaggressive Ci/yr*	Release Fraction	Annual Release Rate Ci/yr	CAP-88 Factor mrem/Ci	Annual Unabated Dose (mrem/yr)
Nonaggressive Methods					
Co-60	5.25E-06	1E-03	5.25E-09	2.94E-01	1.54E-09
Cs-137	2.71E-04	1E-03	2.71E-07	5.20E-02	1.41E-08
Eu-152	3.06E-05	1E-03	3.06E-08	2.88E-01	8.81E-09
Eu-154	7.70E-06	1E-03	7.70E-09	2.32E-01	1.79E-09
Sr-90	6.35E-05	1E-03	6.35E-08	1.62E-01	1.03E-08
				Total	**3.65E-08**
Vacuuming Methods					
Co-60	1.05E-05	1.0	1.05E-06	2.94E-01	3.09E-07
Cs-137	5.40E-05	1.0	5.40E-05	5.20E-02	2.81E-06
Eu-152	6.10E-06	1.0	6.10E-06	2.88E-01	1.76E-06
Eu-154	1.55E-06	1.0	1.55E-06	2.32E-01	3.58E-07
Sr-90	1.27E-05	1.0	1.27E-05	1.62E-01	2.06E-06
				Total	**7.29E-06**
Aggressive Methods					
Co-60	6.35E-04	1.0	6.35E-04	2.94E-01	1.87E-04
Cs-137	3.30E-02	1.0	3.30E-02	5.20E-02	1.72E-03
Eu-152	3.71E-03	1.0	3.71E-03	2.88E-01	1.07E-03
Eu-154	9.35E-04	1.0	9.35E-04	2.32E-01	2.17E-04
Sr-90	7.70E-03	1.0	7.70E-03	1.62E-01	1.25E-03
				Total	**4.43E-03**

*Total curies from Table 2 and assumed over a 2 year period.

Table 6. Annual Unabated Release Rate and Dose from D&D Activities (Sediment and Liquid).

Radionuclides	Ci/yr*	Release Fraction	Annual Release Rate Ci/yr	CAP-88 Factor mrem/Ci	Annual Unabated Dose (mrem/yr)
Sediment					
Cs-137	6.70E+00	1E-03	6.70E-03	5.20E-02	3.48E-04
Eu-152	7.12E+00	1E-03	7.12E-03	2.88E-01	2.05E-03
Sr-90	4.68E-01	1E-03	4.68E-04	1.62E-01	7.58E-05
Am-241	6.89E-01	1E-03	6.89E-04	2.64E+01	1.82E-02
				Total	**2.07E-02**
Liquid					
Sr-90	4.43E-02	1E-03	4.39E-05	1.62E-01	7.11E-06

*From Tables 3 and 4.

Table 7. Annual Abated Release Rate and Dose from D&D Activities (Surface Deposits).

Radionuclides	Annual Release Rate Ci/yr*	Control Efficiency %	Abated Release Rate	CAP-88 Factor mrem/Ci	Abated Dose mrem/yr
Vacuuming Methods					
Co-60	1.05E-06	99.95	5.25E-08	2.94E-01	1.54E-08
Cs-137	5.40E-05	99.95	2.70E-06	5.20E-02	1.40E-07
Eu-152	6.10E-06	99.95	3.05E-07	2.88E-01	8.78E-08
Eu-154	1.55E-06	99.95	7.73E-08	2.32E-01	1.79E-08
Sr-90	1.27E-05	99.95	6.35E-07	1.62E-01	1.03E-07
				Total	**3.64E-07**
Aggressive Methods					
Co-60	6.35E-04	99.95	3.18E-05	2.94E-01	9.33E-06
Cs-137	3.30E-02	99.95	1.65E-03	5.20E-02	8.58E-05
Eu-152	3.71E-03	99.95	1.85E-04	2.88E-01	5.34E-05
Eu-154	9.35E-04	99.95	4.68E-05	2.32E-01	1.08E-05
Sr-90	7.70E-03	99.95	3.85E-04	1.62E-01	6.24E-05
				Total	**2.22E-04**

*Nonaggressive methods do not utilize HEPA units; therefore, the abated offsite dose is the unabated dose of 3.65E-08.

Table 8. Annual Abated Release Rate and Dose from D&D Activities (Sediment and Liquid).

Radionuclides	Annual Release Rate Ci/yr*	Efficiency Factor (%)	Abated Release Rate	CAP-88 Factor mrem/Ci	Annual Abated Dose mrem/yr
Sediment					
Cs-137	6.70E-03	99.95	3.35E-04	5.20E-02	1.74E-05
Eu-152	7.12E-03	99.95	3.56E-04	2.88E-01	1.03E-04
Sr-90	4.68E-04	99.95	2.34E-05	1.62E-01	3.79E-06
Am-241	6.89E-04	99.95	3.45E-05	2.64E+01	9.0E-04
				Total	**1.03E-03**
Liquid					
Sr-90	4.39E-05	99.95	2.20E-06	1.62E-01	3.56E-07

*From Table 6.

APPENDIX A

MEETING MINUTES DATED MAY 13, 1996

031890

Environmental Restoration Contractor **ERC Team**

Meeting Minutes

Job No. 22192
Written Response Required? NO
Closes CCN: N/A
OU: N/A
TSD: N/A
ERA: N/A
Subject Code: 4170; 8300

SUBJECT 105-C Reactor Interim Safe Storage Working Session With DOH

TO Distribution

FROM E. T. Coenenberg

DATE June 12, 1996

ATTENDEES	DISTRIBUTION
E. T. Coenenberg H9-11	Attendees
A. W. Conklin, DOH	J. M. Bruggeman H0-12
J. T. Hadley H9-11	G. R. Eidam H0-09
B. A. Ward H0-12	J. D. Goodenough H0-12
S. L. Winslow X0-23	R. J. Landon H0-18
	J. J. McGuire X5-53
	W. L. Pamplin H0-18
	H. M. Rodriguez A5-15
	BHI Document Control H0-09

A meeting on the above subject was held on May 13, 1996, at the Sigma II Cougar Room.

The meeting was held as a working session to discuss and agree on 1) Methodology for determining the potential-to-emit (PTE) radionuclide emissions from activities associated with the 105-C Safe storage project and 2) the level of detail for the Best Available Radionuclide Control Technology (BARCT) demonstration. Appropriate representatives from Washington State Department of Health (DOH), the U.S. Department of Energy (DOE) Richland Operations Office (RL) and the Environmental Restoration Contractor (ERC) Team were present at the meeting. The working session followed the attached outline (attachment 1).

It was explained that the safe storage project is divided into two phases; 1) decontamination and decommissioning (D&D) and demolition of the 105-C Reactor's unnecessary structures, and 2) the construction of the interim safe storage enclosure for the 105-C Reactor's block. The PTE is expected to occur during the D&D of the unnecessary structures. The construction of the interim safe storage enclosures would not have a potential of radioactive air emissions, because all contamination would be fixed or removed during D&D.

Decontamination and Decommissioning PTE Methodology

The methodology proposed for determining the PTE was explained as follows. The *105-C Building Characterization Survey Data Report* was the basis for determining the PTE emissions. Sample results (Appendix B of the report) identified radionuclides present in three physical forms, sediment, liquids and surface deposits on walls, floors, and concrete. From the sample information, a radionuclide inventory list and percent distribution was compiled for each physical form (attachment 2). It was discussed with and agreed by DOH that the radionuclides with less than 1% distribution could be eliminated from the inventory. For the surface deposits, it was agreed that the radionuclide inventory be based on the concrete sample data and extrapolate for Sr-90.

031890

The radionuclide survey records from the report would be used to determine average contamination levels throughout the facility. These average contamination levels were determined by each elevation of the facility for a contamination range. The Engineering and Planning for Reactor 105-C Interim Safe Storage Project Subcontract No. 0100C-SC-G0001 Conceptual Design Report identified contamination ranges from very light, light, medium to heavy decontamination. This report provided an estimated area per elevation for each of these ranges. Very light and light decontamination techniques would be considered non-aggressive methods such as wiping or applying foam polymers, then wiping the surface area. Medium and heavy decontamination techniques would be aggressive methods such as scabbling and vacuuming. It was explained that based on the contamination levels and area to be decontaminated, the radioactivity, in curies, would be calculated. Then, the release fractions allowed by the WAC 246-247-030 (21) (a) would be applied to determine the PTE release rates. A CAP-88 evaluation would be done to determine the unabated offsite dose. The unabated offsite dose would determine the level of emission monitoring. If the dose would be greater than 0.1 mrem/yr, then National Emission Standards for Hazardous Air Pollutants (NESHAP) compliant monitoring would be required and further discussions would be held with DOH.

DOH asked how representative the samples were of the material identified in the facility. It was explained the samples were taken whenever there was an adequate amount of material to sample.

DOH agreed with the proposed methodology and stated that it appeared to be a conservative approach.

Construction of the Safe Storage Building PTE Methodology

As stated above, the construction of the interim safe storage enclosure would not have a potential of radioactive air emissions, because all contamination would be fixed or removed during D&D and the reactor block would be sealed. The DOH agreed with statement, provided the NOC verifies that statement.

It was explained that although there is no potential emissions, a High Efficiency Air Particulate (HEPA) filter ventilation system would be installed to maintain air quality in the enclosure and provide fresh air supply during surveillance and maintenance activities. The system would be described in the NOC.

Level of Detail for BARCT Demonstration

Based on the information provided, DOH was questioned as to what level of detail the BARCT demonstration would be required The DOH stated that HEPA filters are generally accepted as BARCT for emissions that are particulate radionuclides and are not heated to greater than 100°C. If the project's PTE emissions would be only in particulate form, then the use of HEPA filters would satisfy BARCT. It was explained that it is anticipated that the emissions would only be particulates and the aggressive decontamination methods would utilize HEPA filtration. The NOC would provide a BARCT discussion that reflects the above information.

Concurrence:

A. W. Conklin, DOH	6/13/96 DATE	H. M Rodriguez, RL	6/14/96 DATE

031890

Attachment 1

Working Session Outline

031890

Working Session on
Methodology for Determining Potential
Radionuclide Air Emissions
for the 105-C Safe Storage

Location: May 13, 1996
1:00 to 3:00 pm
Sigma II, Cougar Rm

Attendees:

Proposed Methodology for:

1) Decommissioning/Demolition of Structures

2) Construction of the Safe Storage Building

Level of Detail for BARCT Demonstration:

031890

Attachment 2

Radionuclide Inventory and Percent Distribution

031890

PARTICULATES

NUCLIDE	DISTRIBUTION (%)
Co60	1.38E+00
Cs137	7.13E+01
Eu152	8.05E+00
Eu154	2.03E+00
Sr90	1.67E+01
Am241	5.59E-01
TOTALS:	100

LIQUID

NUCLIDE	AVERAGE CONCENTRATION (pCi/g)	ABUNDANCE (%)
Co58	5.45E-03	0.00
Co60	8.07E-03	0.00
Cs137	1.87E+00	0.10
Eu152	2.92E-02	0.00
Eu154	1.67E-02	0.00
Eu155	4.14E-03	0.00
Fe59	9.05E-03	0.00
Sr90	1.95E+03	99.90
Total U	4.19E-03	0.00
TOTALS:	1.95E+03	100

SEDIMENT

NUCLIDE	AVERAGE CONCENTRATION (pCi/g)	ABUNDANCE (%)
Nb95	3.48E+02	0.11
Co58	1.96E+01	0.01
Co60	1.14E+01	0.00
Cs137	1.43E+05	43.21
Eu152	1.52E+05	45.93
Eu154	7.97E+03	2.41
Eu155	6.96E+02	0.21
Fe59	2.04E+01	0.01
Sr90	1.00E+04	3.02

031890

Total U	2.66E+01	0.01
Zr95	2.13E+03	0.64
Am241	1.47E+04	4.44
TOTALS:	3.31E+05	100

APPENDIX B

RADIOACTIVITY CALCULATIONS

105-C Reactor Interim Safe Storage Emissions Estimate Calculations

By: Susan Winslow

Checked By: John Hadley

Project Number: UBCE4

OBJECTIVE:

Calculate emissions estimated from the decontamination and demolition of the 105-C Reactor in preparation for interim safe storage.

ASSUMPTIONS:

The inventory identified in 105-C Building Characterization Survey Data Report is acceptable for estimating the potential emissions.

METHOD:

Emissions were calculated by separating the inventory into three groups: particulate, liquid and sediment. The estimates were then determined as follows:

Particulate

Surveys from the characterization survey report (Beckstrom et al. 1994) were categorized by elevation. Individual survey points from each survey record were averaged to result in average contamination levels for smearable and fixed beta/gamma and smearable alpha. From these numbers, average contamination levels were calculated for each elevation.

Average activity levels were then converted to calculate activity levels based on the surface area of material expected to be removed (Conceptual Design Report BHI 1996). The surface area of material to be decontaminated is given per elevation and category of decontamination. Activity values for smearable contamination apply to very light and light decontamination techniques, which are nonaggressive. Fixed contamination activity values apply to medium and heavy decontamination techniques which are considered to be aggressive.

Liquid and Sediment

Actual sample data from the characterization report (Beckstrom et al. 1994) was used for the quantities of radionuclides. All of the sample data for liquid media were averaged together, as were the sediment media samples. This resulted in an average concentration for each nuclide.

Nuclide Distribution

Within each media type, sample data were averaged for each nuclide and then a percent distribution for each nuclide was calculated based on the total activity for each media type. Nuclides that were less then 1% for the total for each media were not included due to insignificant dose contribution. For particulate data, the total activity from the surveys and for the liquid and sediment, the sample data was then multiplied by the percent distribution for each nuclide to result in a calculated activity for each media type.

CALCULATION:

Calculations are presented for tables (1 to 3).

PARTICULATES (Below Grade)

Assume:
1 cm^2 = 1.08 E-03 ft^2
Area = 5000 ft^2 for below grade medium/heavy decontamination.
2.22E+12 dpm/1.00E+00 Ci

(Smearable(dpm/cm^2) + Non-smearable(dpm/cm^2)) * 1.00E+00 cm^2/1.08E-3 ft^2 * Area =
Total dpm for elevation

Example for below grade level.

(3.73E+4 dpm/1.00E+02 cm^2 + 7.1480E+04 dpm/1.00E+02 cm^2) *
1.00E+00 cm^2/1.08E-3 ft^2 * 5.00E+02 ft^2 = 5.04E+09 dpm

5.04 E+09 dpm / (2.22 E+12 dpm/Ci) = 2.27 E-03 Ci
Note assume all medium/heavy decontamination.

All levels for nuclides , including those less than 1%, were then summed for a total of 7.6E-04 Ci for very light/light decontamination and 9.20 E-02 Ci. for medium/heavy decontamination.

The tables of nuclides and their distributions that follow include all nuclides even those less than 1% of the total inventory for each media type.

NUCLIDE	DISTRIBUTION (%)
Co60	1.38E+00
Cs137	7.13E+01
Eu152	8.05E+00
Eu154	2.03E+00
Sr90	1.67E+01
Am241	5.59E-01
TOTALS:	100

Examples:

Very light/light decontamination for Co60 = 100% of nonaggressive Curie total
7.6E-04 Ci * 1.38E-02 = 1.05E-05 Ci

Vacuum Activities for Co60 = Additional 20% of nonaggressive Curie total
7.6E-04 Ci * 1.38E-02 * 2.00E-01 = 2.10E-6 Ci

Medium/heavy decontamination for Co60 = 100% of aggressive Curie total
9.20E-02 Ci*1.38E-2 = 1.27E-3 Ci

Curies were determined for all isotopes.

LIQUID

Assumption:
Estimate 5000 gallons of liquid in 105 C Reactor.
Estimate 1 gallon = 10 lbs
453.59 g = 1 lb

5.00 E+03 gal * 1.00E+01 lbs/1.00E+00 gal * 4.54E+02 g = 2.27 E+07 g

NUCLIDE	AVERAGE CONCENTRATION (pCi/g)	ABUNDANCE (%)
Co58	5.45E-03	0.00
Co60	8.07E-03	0.00
Cs137	1.87E+00	0.10
Eu152	2.92E-02	0.00
Eu154	1.67E-02	0.00
Eu155	4.14E-03	0.00
Fe59	9.05E-03	0.00
Sr90	1.95E+03	99.90
Total U	4.19E-03	0.00
TOTALS:	1.95E+03	100

All nuclides are < 1% of the total concentration except Sr90.

(2.27 E+07 g * 1.95E+03 pCi/g)/1.00E+12 pCi/Ci = 4.43E-02 Ci

SEDIMENT

Assumption:
1 ton = 2000 lbs
4.54E+02 g = 1 lb
50 tons of sediment in 105 C

5.0E+01 ton * 2.00 E+03 lbs/1.00 E+00 tons * 4.54 E+02 g/1.00 E+00 lbs = 4.54E+07 g

NUCLIDE	AVERAGE CONCENTRATION (pCi/g)	ABUNDANCE (%)
Nb95	3.48E+02	0.11
Co58	1.96E+01	0.01
Co60	1.14E+01	0.00
Cs137	1.43E+05	43.21
Eu152	1.52E+05	45.93
Eu154	7.97E+03	2.41
Eu155	6.96E+02	0.21
Fe59	2.04E+01	0.01
Sr90	1.00E+04	3.02
Total U	2.66E+01	0.01
Zr95	2.13E+03	0.64
Am241	1.47E+04	4.44
TOTALS:	3.31E+05	100

4.54 E+07 g * 3.31 E+05 pCi/g = 1.50E+13 pCi = 1.50E+01 Ci

Note isotopes less than 1 % were not included in calculations.

1.50E+01 Ci * 4.321E-01 for Cs137 = 6.49E+00 Ci Cs137

Curies for all radionuclides were determined and an offsite dose was calculated.

RELEASE RATE AND ANNUAL DOSE CALCULATIONS

Annual Unabated Release Rate (Table 5 and 6 in main text)

Annual Release Rate (Ci/yr) = Ci/yr for each nuclide * Release Fraction

Annual Unabated Dose (mrem/yr) = Annual Release Rate (Ci/yr) * CAPP-88 Factor (mrem/Ci)

Annual Abated Release Rate (Table 7 and 8 in main text)

Abated Release Rate (Ci/yr) = Annual Release Rate (Ci/yr) * Control Efficiency (%)

Annual Abated Dose (mrem/yr) = Abated Release Rate (Ci/yr) * CAPP-88 Factor (mrem/Ci)

REFERENCES:

Beckstrom, J.F., Crocker, J.W., Harvey, Jon R.C., Hunter, J.C., Meyer, E.M., 1994, 105-C Building Characterization Survey Data Report, Columbia Energy and Environmental Services, Inc., Richland, Washington.

Table B-1 105 C Reactor Particulate Source Term

ELEVATION	AVERAGE CONTAMINATION SMEARABLE (dpm/100cm2)	AVERAGE CONTAMINATION NON-SMEARABLE (dpm/100cm2)	AREA TO BE DECONTAMINATED (ft2)	CALCULATED ACTIVITY very light & light (CURIES)	CALCULATED ACTIVITY medium & heavy (CURIES)
BELOW GRADE	3.73E+04	7.15E+04	5.00E+03		2.27E-03
-9 FOOT	1.30E+03	5.16E+04	5.00E+03		1.10E-03
GROUND LEVE	2.40E+04	6.14E+04	1.38E+04		4.91E-03
FUEL STORAGE	5.00E+04	2.73E+05	4.20E+04		5.66E-02
10 FOOT	4.20E+04	0.00E+00	3.00E+03	5.26E-04	
10 FOOT	0.00E+00	5.85E+05	9.00E+03		2.19E-02
20 FOOT	6.20E+03	0.00E+00	3.00E+03	7.76E-05	
20 FOOT	0.00E+00	8.39E+04	9.00E+03		3.15E-03
30 FOOT	2.30E+03	0.00E+00	3.00E+03	2.88E-05	
30 FOOT	0.00E+00	3.87E+04	9.00E+03		1.45E-03
41 FOOT	1.20E+03	0.00E+00	3.00E+03	1.50E-05	
41 FOOT	0.00E+00	1.14E+05	5.50E+03		2.60E-03
52 FOOT	4.00E+03	0.00E+00	3.00E+03	5.01E-05	
52 FOOT	0.00E+00	3.48E+04	5.00E+02		7.27E-05
76 FOOT	5.00E+03	0.00E+00	3.00E+03	6.26E-05	
76 FOOT	0.00E+00	9.68E+04	5.00E+02		2.02E-04
			TOTALS:	7.60E-04	9.20E-02
NUCLIDE	AVERAGE CONCENTRATION (pCi/g)	DISTRIBUTION (%)	ACTIVITY FOR NUCLIDES > 1% very light/light (Ci)	ACTIVITY FOR NUCLIDES > 1% medium/heavy (Ci)	
Co60	1.96E+01	1.38E+00	1.05E-05	1.27E-03	
Cs137	1.01E+03	7.13E+01	5.42E-04	6.56E-02	
Eu152	1.14E+02	8.05E+00	6.11E-05	7.41E-03	
Eu154	2.87E+01	2.03E+00	1.54E-05	1.86E-03	
Sr90	2.36E+02	1.67E+01	1.27E-04	1.53E-02	
Am241	7.92E+00	5.59E-01			
TOTALS:	1.42E+03	100	7.55E-04	9.15E-02	

Constants used in the above calculations are as follows:

$1cm^2 = 1.08E\text{-}3ft^2$

1Ci = 2.22E12 dpm

Table B-2 105 C Reactor Liquid Source Term

NUCLIDE	AVERAGE CONCENTRATION (pCi/g)	ABUNDANCE (%)	QUANTITY (gallons)	CALCULATED ACTIVITY FOR NUCLIDES > 1% (Curies)
Co58	5.45E-03	0.00		
Co60	8.07E-03	0.00		
Cs137	1.87E+00	0.10		
Eu152	2.92E-02	0.00		
Eu154	1.67E-02	0.00		
Eu155	4.14E-03	0.00		
Fe59	9.05E-03	0.00		
Sr90	1.95E+03	99.90		4.39E-02
Total U	4.19E-03	0.00		
TOTALS:	1.95E+03	100	5000	4.39E-02
Constants used in the above calculations		are as follows:	1 Gallon = 10lbs	
			10lbs = 4.5E3 gms	
			1pCi = 1E-12 Ci	

Table B-3 105 C Reactor Sediment Source Term

NUCLIDE	AVERAGE CONCENTRATION (pCi/g)	ABUNDANCE (%)	QUANTITY (Tons)	CALCULATED ACTIVITY FOR NUCLIDES > 1% (Curies)
Nb95	3.48E+02	0.11		
Co58	1.96E+01	0.01		
Co60	1.14E+01	0.00		
Cs137	1.43E+05	43.21		6.49
Eu152	1.52E+05	45.93		6.89
Eu154	7.97E+03	2.41		0.36
Eu155	6.96E+02	0.21		
Fe59	2.04E+01	0.01		
Sr90	1.00E+04	3.02		0.45
Total U	2.66E+01	0.01		
Zr95	2.13E+03	0.64		
Am241	1.47E+04	4.44		0.67
TOTALS:	3.31E+05	100	50	14.86
Constants used in the above calculations		are as follows:	1 Ton = 2000 lbs	
			1lb = 453.59 g	
			1pCi = 1E-12 Ci	

APPENDIX C

CAP-88 EVALUATION

C A P 8 8 - P C

Version 1.00

Clean Air Act Assessment Package - 1988

D O S E A N D R I S K E Q U I V A L E N T S U M M A R I E S

Non-Radon Individual Assessment
Apr 14, 1996 9:55 am

Facility: 105-C Reactor Safe Storage
Address: 100 C Area
City: Richland
State: WA Zip: 99352

Source Category: DOE Facilities
Source Type: Area
Emission Year: 1996

Comments: 105-C Reactor Safe Storage Ci=1

Dataset Name: 105-C Reactor
Dataset Date: Apr 14, 1996 9:55 am
Wind File: WNDFILES\JF10010.WND

Apr 14, 1996 9:55 am

SUMMARY
Page 1

ORGAN DOSE EQUIVALENT SUMMARY

Organ	Selected Individual (mrem/y)
GONADS	7.10E+00
BREAST	1.74E+00
R MAR	3.98E+01
LUNGS	9.68E+01
THYROID	1.72E+00
ENDOST	4.74E+02
RMNDR	2.23E+01
EFFEC	3.94E+01

PATHWAY EFFECTIVE DOSE EQUIVALENT SUMMARY

Pathway	Selected Individual (mrem/y)
INGESTION	2.28E+00
INHALATION	3.62E+01
AIR IMMERSION	2.60E-04
GROUND SURFACE	9.22E-01
INTERNAL	3.84E+01
EXTERNAL	9.23E-01
TOTAL	3.94E+01

NUCLIDE EFFECTIVE DOSE EQUIVALENT SUMMARY

Nuclide	Selected Individual (mrem/y)
CO-58	6.84E-03
CO-60	2.94E-01
AM-241	2.64E+01
CS-137	5.20E-02
EU-152	2.88E-01
EU-154	2.32E-01
EU-155	1.02E-02
FE-59	6.01E-03
NB-95	5.46E-03
SR-90	1.62E-01
U-238	5.75E+00
ZR-95	5.00E-03
U-235	6.12E+00
TOTAL	3.94E+01

CANCER RISK SUMMARY

Cancer	Selected Individual Total Lifetime Fatal Cancer Risk
LEUKEMIA	3.74E-05
BONE	2.13E-05
THYROID	5.77E-07
BREAST	4.90E-06
LUNG	1.64E-04
STOMACH	3.04E-06
BOWEL	1.75E-06
LIVER	7.40E-05
PANCREAS	2.09E-06
URINARY	3.26E-06
OTHER	2.56E-06
TOTAL	3.15E-04

PATHWAY RISK SUMMARY

Pathway	Selected Individual Total Lifetime Fatal Cancer Risk
INGESTION	1.48E-05
INHALATION	2.78E-04
AIR IMMERSION	6.25E-09
GROUND SURFACE	2.20E-05
INTERNAL	2.93E-04
EXTERNAL	2.20E-05
TOTAL	3.15E-04

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NUCLIDE RISK SUMMARY

Nuclide	Selected Individual Total Lifetime Fatal Cancer Risk
CO-58	1.74E-07
CO-60	7.35E-06
AM-241	1.35E-04
CS-137	1.36E-06
EU-152	6.94E-06
EU-154	5.63E-06
EU-155	2.30E-07
FE-59	1.47E-07
NB-95	9.49E-08
SR-90	2.73E-06
U-238	7.47E-05
ZR-95	1.19E-07
U-235	8.03E-05
TOTAL	3.15E-04

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SUMMARY
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INDIVIDUAL EFFECTIVE DOSE EQUIVALENT RATE (mrem/y)
(All Radionuclides and Pathways)

	Distance (m)
Direction	9200
N	1.2E+01
NNW	9.6E+00
NW	1.4E+01
WNW	1.7E+01
W	2.6E+01
WSW	1.4E+01
SW	1.1E+01
SSW	1.1E+01
S	1.5E+01
SSE	1.3E+01
SE	1.6E+01
ESE	2.3E+01
E	3.9E+01
ENE	2.4E+01
NE	1.4E+01
NNE	9.8E+00

INDIVIDUAL LIFETIME RISK (deaths)
(All Radionuclides and Pathways)

	Distance (m)
Direction	9200
N	9.2E-05
NNW	7.7E-05
NW	1.1E-04
WNW	1.3E-04
W	2.1E-04
WSW	1.1E-04
SW	8.5E-05
SSW	8.5E-05
S	1.2E-04
SSE	1.0E-04
SE	1.2E-04
ESE	1.8E-04
E	3.1E-04
ENE	1.9E-04
NE	1.1E-04
NNE	7.8E-05

APPENDIX D

BARCT DISCUSSION

BARCT DISCUSSION

This discussion of BARCT does not present a detailed evaluation of all of the available radionuclide control technologies nor does it rank the relative benefits with respect to the environment, economical, and energy impacts of each technology. The DOH has provided guidance that HEPA filters are generally accepted as BARCT for particulate radionuclides. At the May 1996 Routine Technical Review Meeting, DOH reaffirmed that a BARCT assessment would not be required if the effluent is 100% particulates and the particulates are not heated to greater than 100°C.

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