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Facility Effluent Monitoring Plan Determinations for the 100 Area Facilities

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Prepared for the U.S. Department of Energy
Assistant Secretary for Environment,
Safety and Health

Westinghouse
Hanford Company Richland, Washington

Hanford Operations and Engineering Contractor for the
U.S. Department of Energy under Contract DE-AC06-87RL10930

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P.O. Box 1970
Richland, Washington 99352

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Prepared by: ______________________ 11/6/91
Columbia Energy and Environmental Services
Contract No. MDR-SVV-032193
Date

Approved by: ______________________ 11-6-91
K. A. Gano
Manager, Environmental Protection, 100 Areas
Date

Approved by: ______________________ 11-7-91
L. P. Diedeker
Manager, Environmental Protection, 200 Areas
Date

Approved by: ______________________ 11/7/91
G. D. Carpenter
Manager, Environmental Assurance
Date

Approved by: ______________________ 11/7/91
D. G. Farwick
Manager, Environmental Quality Assurance
Date

Approved by: ______________________ 11-6-91
R. J. Pyzel
Manager, N-Reactor Operations
Date

Approved by: ______________________ 11-6-91
D. J. Watson
Manager, N-Reactor Environmental Safety
Date

100 AREA FACILITIES

FACILITY EFFLUENT MONITORING PLAN DETERMINATIONS

ABSTRACT

The determination for Facility Effluent Monitoring Plans arose from evaluations conducted for the Westinghouse Hanford Company 100 Area facilities on the Hanford Site. The Facility Effluent Monitoring Plan determinations have been prepared in accordance with A Guide for Preparing Hanford Site Facility Effluent Monitoring Plans, *WHC-EP-0438 (WHC 1991).*

Ten Westinghouse Hanford Company facilities in the 100 Areas were evaluated: N Reactor, KE/KW Reactors, 1706 KE Laboratory, and the Surplus Reactors (B, C, D, DR, F, and H). The N Reactor, KE/KW Reactors, and 1706 KE Laboratory Facility Effluent Monitoring Plan determinations were prepared by Columbia Energy and Environmental Services of Richland, Washington. The determination for the Surplus Reactors was prepared by Westinghouse Hanford Company. Of the 10 facilities evaluated, two will require a Facility Effluent Monitoring Plan: N Reactor and the active spent fuel storage facilities and their contiguous support facilities at 100 KE and 100 KW.

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PART 1

N REACTOR SHUTDOWN FACILITY

FACILITY EFFLUENT MONITORING PLAN DETERMINATION

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ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
CAEM	continuous airborne effluent monitoring (system)
CFR	Code of Federal Regulations
DOE	U.S. Department of Energy
DOE-HQ	U.S. Department of Energy-Headquarters
EDE	effective dose equivalent
EF	exhaust fan
EPA	U.S. Environmental Protection Agency
FEMP	Facility Effluent Monitoring Plan
HEPA	high-efficiency particulate air (filter)
ICRP	International Commission on Radiological Protection
LWDF	Liquid Waste Disposal Facility
NPDES	National Pollutant Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission
PNL	Pacific Northwest Laboratory
RWR	raw water return
SNM	special nuclear materials
Supply System	Washington Public Power Supply System
WAC	Washington Administrative Code
Westinghouse Hanford	Westinghouse Hanford Company

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N REACTOR SHUTDOWN

FACILITY EFFLUENT MONITORING PLAN DETERMINATION

1.0 INTRODUCTION

1.1 PURPOSE

This report evaluates the gaseous and liquid effluent emissions from N Reactor and determines the potential annual radiation exposure to the maximally exposed individual offsite; this will determine the need for a Facility Effluent Monitoring Plan (FEMP). This evaluation will determine the degree to which Westinghouse Hanford Company (Westinghouse Hanford) must monitor N Reactor airborne emissions and liquid effluents. A FEMP will be developed for the normal shutdown condition for N Reactor, as required by U.S. Department of Energy (DOE) Orders 5400.1 (DOE 1988a), 5400.3 (DOE 1989a), 5400.4 (DOE 1989b), 5400.5 (DOE 1990), 5480.1 (DOE 1982), 5480.11 (DOE 1988b), and 5484.1 (DOE 1981), and U.S. Environmental Protection Agency (EPA) regulations in 40 Code of Federal Regulations (CFR) 61 (EPA 1989a).

1.2 STATUS OF OPERATION

N Reactor began operating in December 1963 and operated until January 1987. At that time DOE-Headquarters (DOE-HQ) directed Westinghouse Hanford to place N Reactor and associated facilities in a standby condition. In 1989, DOE-HQ ordered Westinghouse Hanford to put N Reactor in a dry layup mode. It is currently anticipated that DOE-HQ will direct N Reactor to be shut down in 1991.

To ensure the regulatory compliance for N Reactor, as required by DOE, it is necessary to determine the type of effluent monitoring system and effluent monitoring plan that will be required for the shutdown condition.

1.2.1 Radionuclide Effluent Releases

N Reactor releases radionuclides to the environment by way of gaseous and liquid discharges. There are 10 monitored airborne effluent release points. The primary airborne effluent release points are located at the main stack, 105-N Reactor Building, and the 109-N Heat Exchange Building, which constitutes nine of the 10 monitored airborne emission points. There are four liquid effluent release points to the Columbia River. N Springs and the 102-in. Outfall are the primary sources of radioactive liquid effluents discharged to the Columbia River. Radionuclides also enter the groundwater by way of N Reactor effluent discharges to the 1325-N Liquid Waste Disposal Facility (LWDF). The N Reactor effluent stream was evaluated and determined by Westinghouse Hanford in waste stream-specific report WHC-EP-0342-03 (WHC 1990a) to be nonhazardous pursuant to Washington State *Dangerous Waste Regulations*, WAC-173-303 (WAC 1989).

N Reactor is a source of hazardous air pollutants due to the release of radionuclides to the atmosphere at the various airborne effluent release points; therefore, N Reactor is subject to 40 CFR 61, Subpart H (EPA 1989).

N Reactor also is subject to DOE Orders 5400.1 (DOE 1988a), 5400.3 (DOE 1989a), 5400.4 (DOE 1989b), 5400.5 (DOE 1990), 5480.1 (DOE 1982), 5480.11 (DOE 1988b), and 5484.1 (DOE 1981) because of its release of radioactivity to both air and water. These orders require that radioactive effluents to the environment be as low as reasonably achievable and use the best available control technology to control effluents.

A monitoring plan and procedures must be in place to ensure that regulatory requirements are implemented and the effluents must be monitored to ensure that these requirements are met.

1.2.2 Nonradioactive Effluent Releases

The potential nonradioactive hazardous air pollutants that were considered in this report were those listed in 40 CFR 61 (EPA 1989a). It was determined after a thorough review of N Reactor plant processes that none of the chemicals listed in 40 CFR 61, with the exception of radionuclides, are present in the airborne releases from N Reactor. Therefore, radionuclides are the only hazardous air pollutant considered in this report.

The six potential liquid release points of nonradioactive chemicals at N Reactor were considered in this report. One stream was evaluated and determined by Westinghouse Hanford to be nonhazardous (WHC 1990b) pursuant to the Washington State *Dangerous Waste Regulations*, WAC-173-303 (WAC 1989).

The 009, 005, and 006 liquid effluent discharges from N Reactor are the 102-in. Outfall, the 36-in. Outfall, and the 42-in. Outfall, respectively, which are the thermal discharges from N Reactor and the 182-N Highlift Pump House discharges. These discharges are authorized under a National Pollutant Discharge Elimination System (NPDES) Permit and do not contain any hazardous waste components. They do, however, contain radionuclides.

Currently only the 009 NPDES discharge (102-in. Outfall) is in service. The use of the 005 (36-in. Outfall) and 006 (42-in. Outfall) was discontinued in October 1990. However, these outfalls are still connected to building drains and storm drains within the plant and may experience intermittent discharges due to rainfall runoff.

Included in this evaluation are the plant process chemicals that may be potentially released to either the groundwater or the Columbia River. A list of the process chemicals currently at N Reactor is given in Table 1-1. The potential for the release of these chemicals is very low with the plant in dry layup. The primary hazardous chemical being used in the plant is chlorine for the potable waste supply.

Table 1-1. N Reactor Chemical Inventory.

Chemical	Location	Maximum inventory	
		Date	Quantity (lb)
Aluminum sulfate	183-N	04/26/90	49,638
Ammonium hydroxide	109-N	01/01/90	125,712
Chlorine	163-N 183-N	04/26/90	21,943
Diesel fuel	166-N 182-N 184-N	01/01/90	1,020,316
Helium	105-N	01/01/90	8,161
Hydrazine	163-N	01/01/90	5,543
Morpholine	163-N	01/01/90	2,379
Fuel oil additive	163-N	01/01/90	5,950
Dispersant	163-N	01/01/90	2,035
Catalyst	163-N	01/01/90	6,695
Nitrogen	105-N	01/01/90	49,736
No. 6 fuel oil	166-N 184-N	01/01/90	3,456,035
Separan polyacrylamide (unhydrolized)	183-N	01/01/90	3,836
Sodium carbonate	1310-N 183-N	01/01/90	1,700
Sodium hydroxide	107-N 108-N 163-N	01/01/90	74,076
Sodium hypochlorite	109-N 182-N	11/23/90	948
Sulfuric acid	107-N 108-N 163-N	01/01/90	181,168

1.2.3 Summary of Effluent Release Components

In conclusion, this determination for developing a FEMP with respect to DOE and EPA requirements demonstrates that only the release of radionuclides to the environment via the air, water, and groundwater pathways occurs at N Reactor during shutdown. There are no other hazardous waste materials released by N Reactor via either the air emissions or liquid effluent pathways. While the plant is in dry layup there is little potential of releasing hazardous process chemicals to the environment.

2.0 FACILITY DESCRIPTION

2.1 GENERAL FACILITY DESCRIPTION

N Reactor is located on the Hanford Site 30 mi northwest of Richland, Washington, as shown in Figure 2-1. A photograph of N Reactor, which is located in the 100 Area, is shown in Figure 2-2. A complete listing of N Reactor and its support and office facilities is shown in Figure 2-3.

N Reactor began operation in December 1963. The reactor was designed to produce special nuclear materials (SNM) and byproduct steam for electrical power generation. The 100 N Area reactor complex consists of 126 buildings for reactor operations, maintenance, support facilities, and an office complex. Nine of the more important facilities (in terms of reactor operations) are as follows:

- 105-N Reactor Building
- 109-N Heat Exchange Building
- Washington Public Power Supply System (Supply System) Turbine Generator Building
- 183-N Water Filtration Plant
- 163-N Demineralization Plant
- 184-N Plant Service Power House
- 107-N Basin Recirculation Facility
- 181-N Low Lift Pump House (River Intake)
- 182-N High Lift Pump House.

The 105-N Reactor Building contains the nuclear reactor, which is a pressurized water reactor fueled with slightly enriched uranium. It operates at 1,600 lb/in^2 and 271 °C. The reactor process generates heat that is removed by the primary coolant loop to the 109-N Heat Exchange Building. This building transfers the heat from the primary coolant loop to the secondary loop via a steam generator. The secondary loop coolant is in the form of steam when it leaves the steam generator and is carried to the Supply System Turbine Generator Building, which drives the turbines to produce electricity.

N Reactor, by nature of its design, uses large quantities of water for cooling. To support these large water requirements N Reactor has the 183-N Water Filtration Plant and 163-N Demineralization Plant. These facilities produce the filtered water and demineralized water needed for plant operations.

Another water treatment facility is the 107-N Basin Recirculation Facility. This facility filters and demineralizes the water from the N Basin Fuel Storage Facility, removing radionuclides from the water and reducing

Figure 2-1. U.S. Department of Energy's Hanford Site.

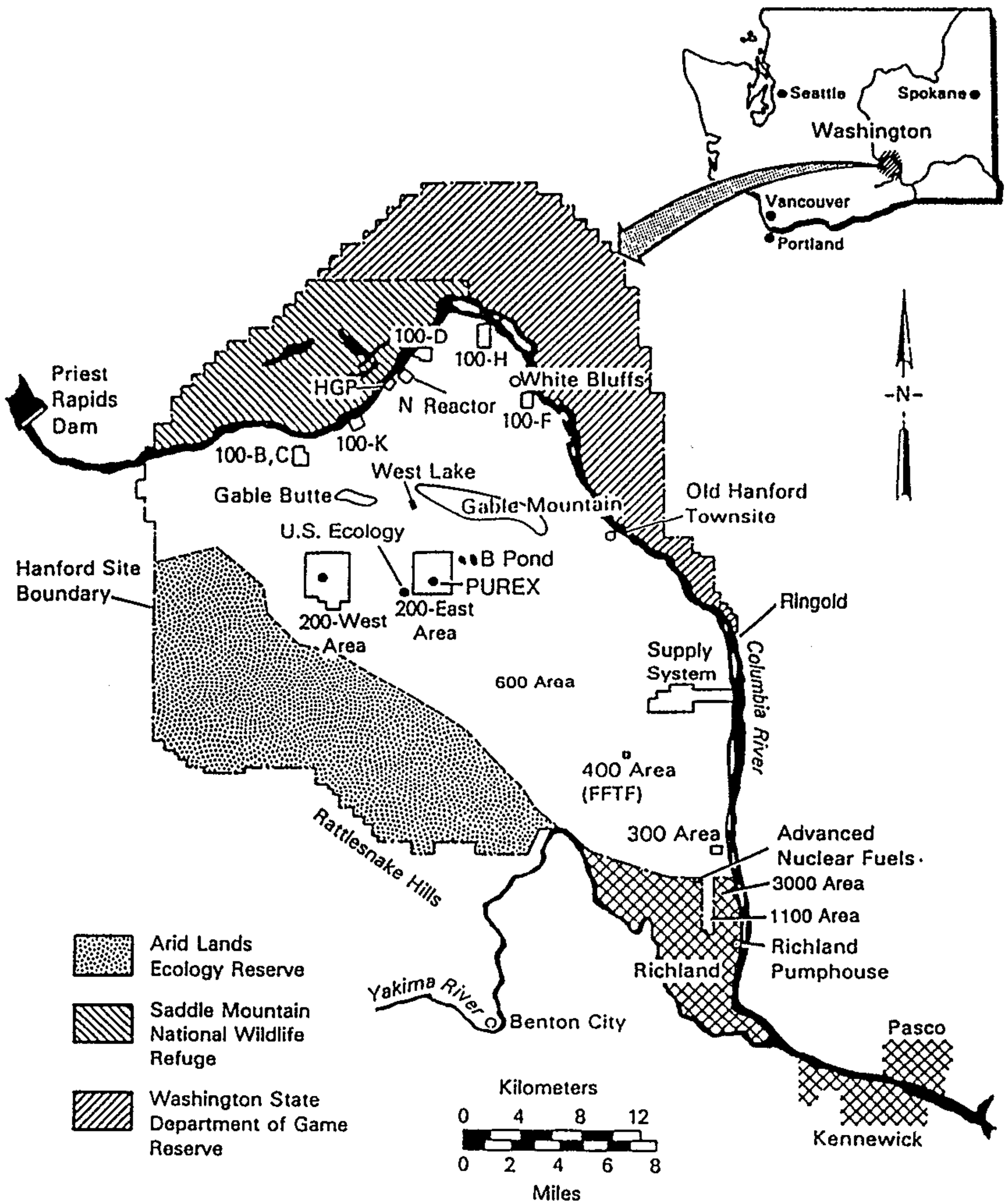
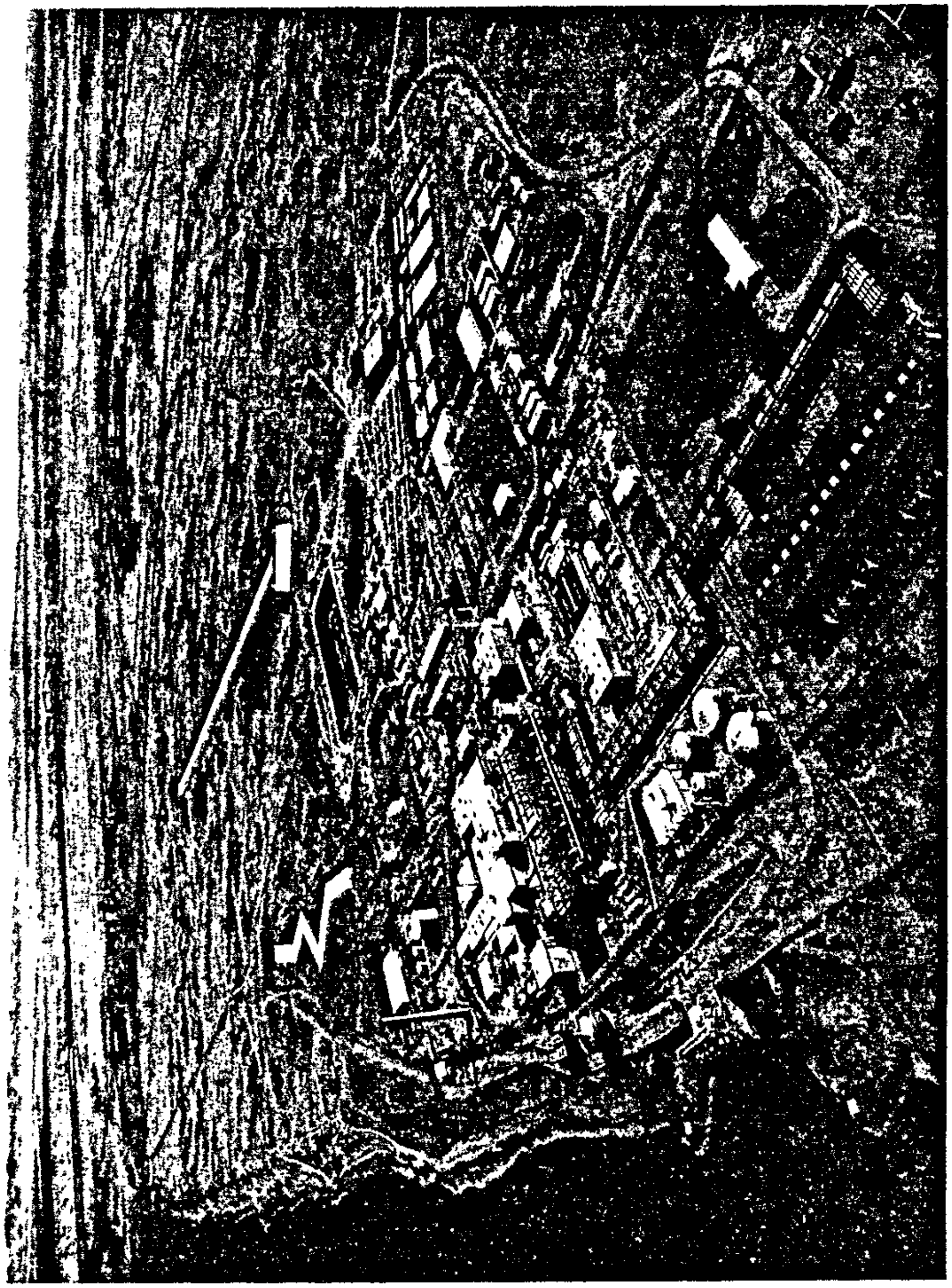


Figure 2-2. N Reactor.



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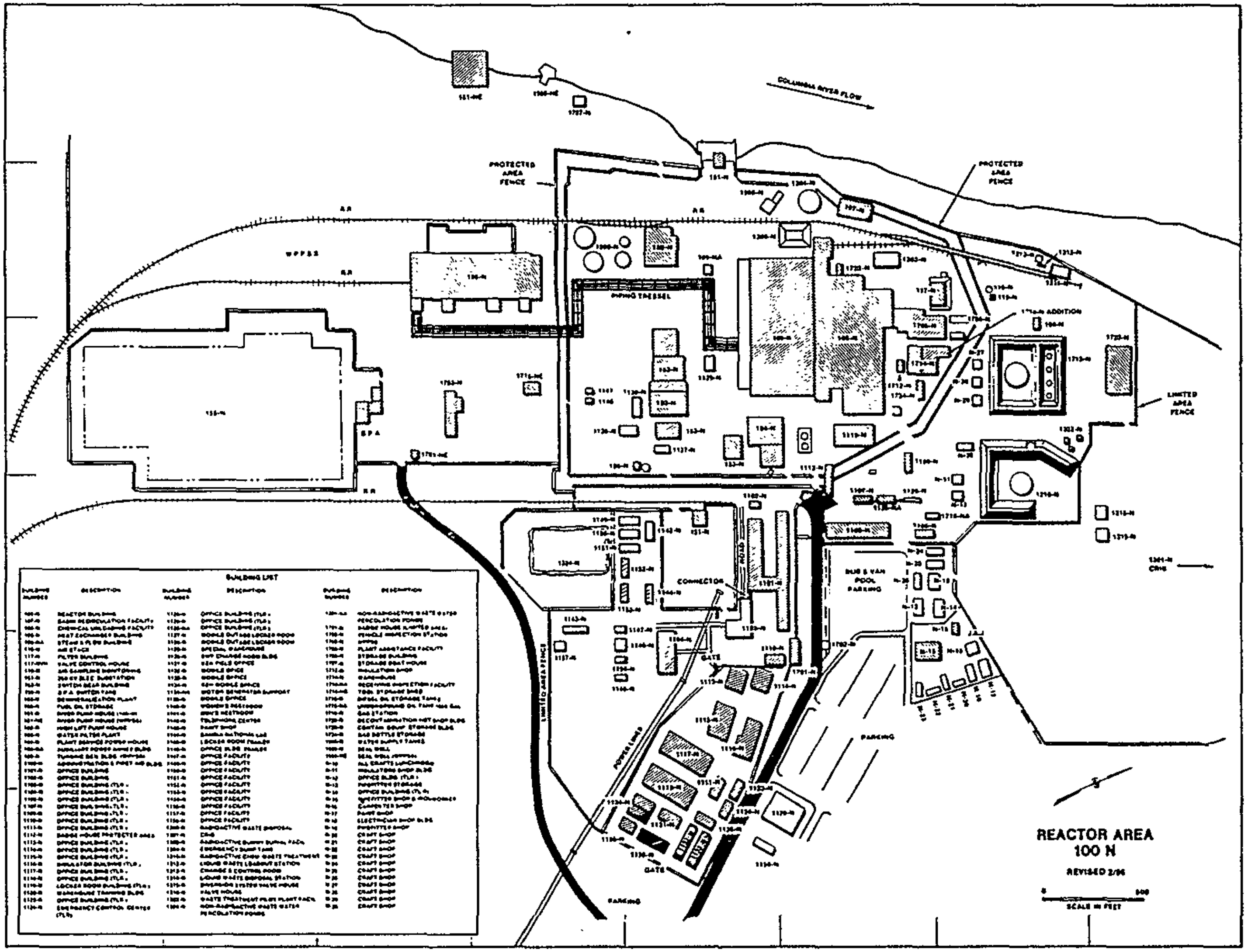


Figure 2-3. N Reactor Area.

personnel radiation exposure. The N Basin Fuel Storage Facility stores the irradiated fuel from the reactor until it is ready for transfer to the 200 Area Chemical Processing facility or 100 KE/KW Spent Fuel Basins for storage. The 181-N Low Lift Pump House provides the pump equipment for lifting the Columbia River water to the Water Filtration Plant.

The above mentioned facilities are only a few of the 126 buildings that comprise the N Reactor complex (Figure 2-3). Further details on this facility are available in the plant nuclear safety analysis report (WHC 1989) and other DOE documents.

2.2 REACTOR DESCRIPTION FROM THE NUCLEAR SAFETY ANALYSIS REPORT

N Reactor is a graphite-moderated, light-water-cooled, horizontal-pressure-tube nuclear reactor designed to produce SNM using slightly enriched uranium. The heat by-product of this process is used to produce steam, which drives a Supply System generator, producing electricity.

The reactor core is constructed of interlocking graphite bars. The graphite bars form a structure weighing 1,800 tons. The stacking pattern allows for venting from the core in the unlikely event of a pressure tube failure. This pattern also allows space for 1,072 horizontal channels through the moderator; 1,003 of these channels contain the pressure tubes which hold the fuel and primary cooling system. The stacking pattern also allows channels for the horizontal control rod system and for the vertical shafts of the ball safety system. The bars also contain the piping for the moderator cooling system, which runs through piping within the bars themselves.

A moderator atmosphere of dry helium is maintained around this graphite moderator. This helium is stored, dried, and recirculated through the core at a positive pressure, relative to that outside the core. This dry atmosphere also serves as a medium for detecting water or air leaks in the core.

The fuel elements consist of uranium metal slightly enriched to various levels of ^{235}U (0.94% to 1.25%). The fuel is clad in a zirconium alloy, zircaloy-2. This alloy is metallurgically bonded to the uranium fuel through a coextrusion process.

The level of fission in the reactor core is maintained by varying the amount of insertion of the horizontal control rods. There are 84 horizontal control rods; 45 enter from one side of the reactor while the remaining 39 enter from the other side. The rods contain boron carbide. The rods are water cooled and have individual hydraulic drives. These rods can be controlled individually for fine-controlling the power and flux level in the core or as a whole group for fast-scramming, or shutting down, the reactor. Each rod has its own accumulator which, in the event of a power failure, will depressurize, scramming the rod.

Another control system used for shutting down the reactor is the ball safety system. This system consists of hoppers of neutron-absorbing balls above the reactor core. These balls are approximately 1/2 in. in diameter and made of boron carbide. In the event of an emergency, these hoppers can be opened, releasing the balls into 107 channels in the graphite moderator. When these balls are released, excess neutrons are absorbed and the reactor shuts down. This system is completely independent of the horizontal control rod system.

There is a thermal barrier around the graphite moderator. This thermal barrier is made of 8-in. cast-iron blocks at the front and rear of the core, and 1-in. boron steel plates on all other sides. This barrier is designed to reduce the heat load on the biological shielding of the reactor. The biological shielding prevents activation of equipment and components in immediately adjacent parts of the reactor facility. The biological shielding is concrete, between 40 and 102 in. thick.

N Reactor is divided into five air quality zones. Three of these zones, Zones I, II, and III, are used in confining release of radionuclides. The remaining zones do not contribute to contamination confinement. This confinement effect is achieved by using atmospheric pressure differences between zones.

Zone I contains the reactor core and its immediate surrounding area. It has the highest potential to contain airborne radionuclides. It is kept at the lowest relative pressure, except for the core. This promotes positive airflow into this area, which assists in confining any airborne contamination that may be released into this area.

Zone II is the area immediately around Zone I. It has the second highest potential for containing airborne radionuclides. The air pressure in this zone is slightly higher than Zone I to promote the migration of any airborne contamination out of Zone II and to prevent airborne contamination migration from Zone I. The atmospheric pressure is kept lower than Zone III to prevent the migration of any airborne contamination to Zone III.

Zone III is the outermost area to have special atmospheric conditions. It has the lowest probability of the main confinement zones for becoming contaminated. It is kept at a lower pressure than the outside atmosphere to prevent the loss of any airborne contamination and at a higher pressure than Zone II to prevent migration of airborne contaminants from Zone II.

Zones IV and V are primarily office and nonradioactive support facilities. There are no special atmospheric conditions on these areas. These areas have a very slight potential for becoming contaminated by airborne radionuclides.

Because of these special properties, N Reactor is able to conform to emergency release requirements using the confinement and available process systems.

2.3 CHARACTERIZATION OF POLLUTANTS IN EFFLUENTS

2.3.1 Radioactivity (Radionuclides) in Air

N Reactor, by the very nature of its fission and activation process during operation, produces radioactive noble gases, radioactive iodines, and radioactive particulate material. A small fraction of the total fission and activated products in the plant are released to the air in the plant and removed by the plant's air filtration system. Some of these radioactive isotopes not removed by the air filtration system are released into the air environment. Radionuclides that are released are monitored in the air at the following effluent release points:

- 116-N Stack
- 109-N Heat Exchange Building Zone I Vent
- 109-N Heat Exchange Building Cell 6 Vent
- Zone II Effluent from Exhaust Fans 7 and 8
- Zone III Effluent from Exhaust Fan 10
- Zone IV Effluent from Exhaust Fans 14 and 15
- 105-N Transfer Area
- 105-N Dummy Spacer Decontamination Exhaust Room
- 105-N Tool and Equipment Decontamination Room
- 107-N Basin Recirculation Building Exhaust.

The liquid effluent release points are shown in Figure 2-4. A complete identification and description of the airborne effluent release points to the air is in Section 3.1 of this report.

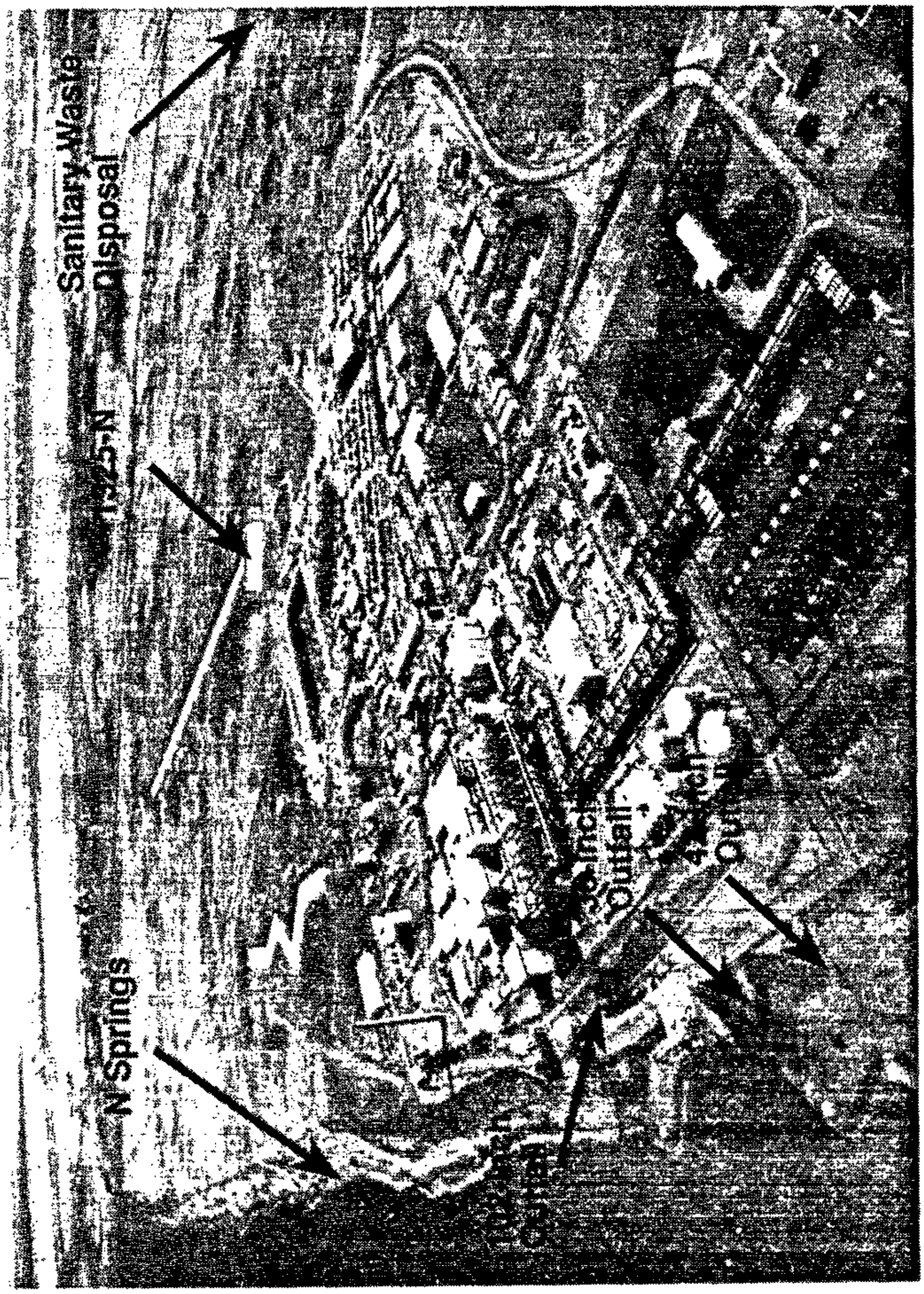
2.3.2 Nonradioactive Hazardous Air Pollutants

The list of air pollutants as designated by the EPA in 40 CFR 61.01(a) and (b) (EPA 1989a) have been reviewed with respect to the airborne effluents released from N Reactor. From the list of chemicals designated as hazardous air pollutants in 40 CFR 61.01(a), only radionuclides, via the airborne release pathways to the environment, are present at N Reactor. N Reactor does not emit asbestos, benzene, beryllium, coke, arsenic, mercury, or vinyl chloride. No processes could be identified as emitting any of the chemicals from the list designating hazardous air pollutants in 40 CFR 61.01(b). Thus, the radionuclides are the only hazardous air pollutant released.

2.3.3 Radioactivity in Liquid Releases

N Reactor fuel is cooled by demineralized water in the primary coolant system. In the process of coming into direct contact with the nuclear fuel, small amounts of radioactivity are released to the primary water.

Figure 2-4. N Reactor Liquid Effluent Release Points.



The radionuclides released to the primary water are noble gases, radioactive iodines, and radioactive metallic ions (^{60}Co, ^{59}Fe, ^{65}Zn, etc.). The radionuclides are released to the environment by the following effluent release points:

- 1301-N LWDF (until 1985)
- 1325-N LWDF (1985 to present)
- Columbia River via N Springs
- Columbia River via 102-in. Outfall*
- Columbia River via 36-in. Outfall*
- Columbia River via 42-in. Outfall.*

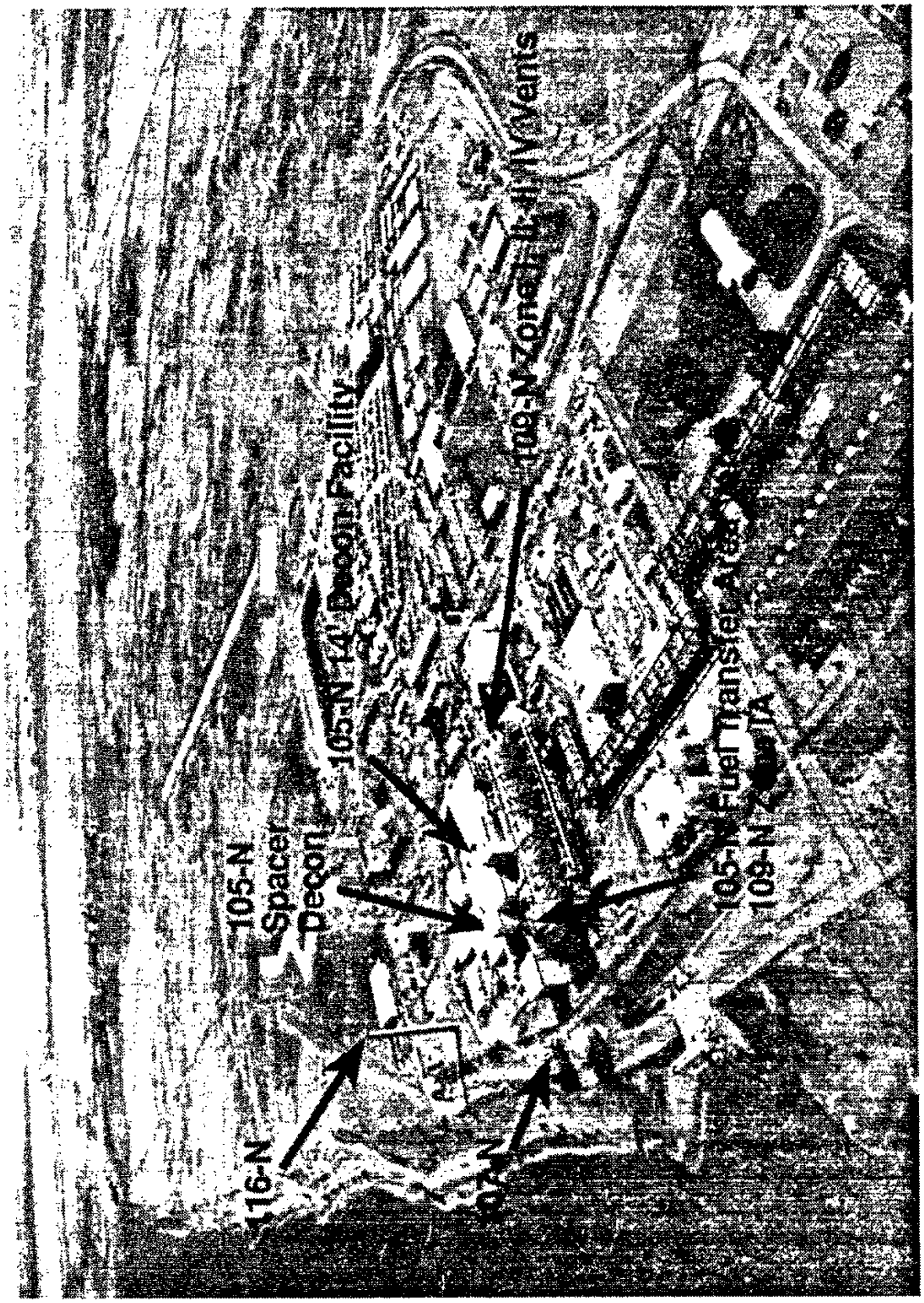
The air emission points are shown in Figure 2-5. The complete identification and description of the liquid effluent release points is listed in Section 3.2 of this report.

2.3.4 Nonradioactive Hazardous Pollutants in Liquid Releases

In August 1990, Westinghouse Hanford completed two stream-specific reports concerned with the discharge of hazardous materials to the water and groundwater environment, WHC-EP-0342-03 (WHC 1990a) and WHC-EP-0342-04 (WHC 1990b). The two reports concluded that there were no hazardous wastes being discharged by N Reactor to either 1325-N or 1324-N/NA.

*Minor contributors to the radioactive effluent.

Figure 2-5. N Reactor Air Emission Points.



3.0 FACILITY EFFLUENT RELEASE POINTS

3.1 AIR RELEASE POINTS

3.1.1 117-N Filter Building and 116-N Stack

Exhaust air from N Reactor passes through the 117-N Filter Building and is released at the 116-N Stack, which is the primary release point for N Reactor. Currently all of the exhaust air from Reactor Zone I and II is discharged through this system. Reactor Zone I is the confinement zone consisting of the reactor block and reactor coolant system pipe spaces. Reactor Zone II is the confinement zone that includes the control rod rooms, the fuel cladding failure monitor rooms, the gas system rooms, and the ball safety system control room. The filter building and stack also are the release system for all Reactor Zone III exhaust, with the exception of those exhausts listed for the 105-N Reactor Building in Section 3.1.2. The Reactor Zone III confinement zone includes the hot shops, fuel storage area, equipment rooms, and related support facilities.

The 117-N Building consists primarily of four cells of filters. Two of these cells are used to filter Reactor Zone I exhaust air. One is used to filter Reactor Zone II exhaust air and the exhaust from Reactor Zone III in the event of an emergency. One filter cell (fourth cell) is used as a standby or emergency backup.

The air exhaust from Reactor Zone I passes through two filtration cells consisting of three filter banks each. The first filter bank in each cell is a moisture separator consisting of an aluminum mesh screen. This screen is designed to remove any entrained moisture in the exhaust air. The second stage is a fire retardant high-efficiency particulate air (HEPA) filter designed to work at a maximum of 93 °C and a relative humidity of 100%. This filter minimum adsorption efficiency is 99.9%. The third filter bank is granular activated charcoal which removes 95% of the halogen radionuclides. Both of the Zone I filter cells have equivalent configurations.

The air exhaust from Reactor Zone II passes through two filters. The first filter is the HEPA, equivalent to that in the Zone I cell. The second filter is an activated charcoal absorber cell, also equivalent to that in the Zone I cell.

Normally exhaust air from Reactor Zone III does not pass through any filters. In the event of an emergency or release of airborne radionuclides, the exhausts from Zones II and III are combined for filtration. After passing through the normal Zone II filtration process, all of the exhaust air is released through the 116-N Stack.

The 117-N Filter Building is connected to the 105-N Building by three ducts which maintain the separation of air from Reactor Zones I, II, and III. It also is connected to the 116-N Stack by two ducts for transporting the filtered air for discharge.

The stack itself is 201 ft tall. It has an inside diameter at the top of 14 ft, and an outside diameter at the top of 15 ft. At the bottom the inside and outside diameters are 20 ft 1 in. and 22 ft 1 in., respectively. The normal flowrate for the stack is 230,000 ft^3/min. This gives an exit velocity of approximately 25 ft/s. The discharge temperature varies between 10 °C and 37.7 °C. The stack is equipped with a continuous airborne effluent monitoring (CAEM) system, which is currently out of service during standby. This monitor is connected to an alarm system which is activated when the concentration of airborne radionuclides passing through the stack becomes too high. This CAEM is configured to detect beta particulates, iodine, low-, mid-, and high-range noble gases, and ^{41}Ar. The unit is also fitted with a built-in gamma detector for determining remote exposure rates as well as background compensation data. It also has a solid state mass flow meter for gathering data to calculate mass sample flow.

3.1.2 105-N Reactor Building

There are three Zone III vents exhausting directly to the atmosphere from the 105-N Building. There are two intermittent use exhaust vents and one vent that is in continuous operation. The intermittent vents are exhausts for the Tool and Equipment Decontamination Room and from a hood in the Dummy Spacer Decontamination Room. These exhausts pass through HEPA filters before being discharged to the atmosphere. The typical flowrates for these vents are 6,400 ft^3/min and 4,800 ft^3/min, respectively. The continuous exhaust comes from the Fuel Transfer Area and is usually vented directly to the atmosphere at a rate of approximately 28,000 ft^3/min. In the event of a release of contamination, these exhausts can be shunted through the Zone II filter system in the 117-N Filter Building along with the other Zone III exhaust air.

3.1.3 109-N Heat Exchange Building

3.1.3.1 Zone I Vent. The 109-N Heat Exchange Building also is divided into confinement zones equivalent to those found in the reactor building. Zone I is the exhaust from Steam Generator Cells 1 to 5. Normally this area has a once-through flow that exhausts directly to the atmosphere through this vent on the roof at a rate of approximately 120,000 ft^3/min.

There are eight crossties to the 105-N Zone I exhaust system. In the event of an emergency or release of airborne contamination, these crossties are opened and the usual exhausts are closed. This diverts any contaminated or potentially contaminated air through the 117-N Filter Building for filtering with the Zone I air from the 105-N Building.

3.1.3.2 Zone IA Vent. This is the vent for Steam Generator Cell 6. It is normally the exhaust for the unfiltered, once-through air flow through Cell 6 at a rate of approximately 28,000 ft^3/min. In the event of an emergency or radioactive release, this exhaust is also redirected through the 117-N Filter Building with the exhaust from Cells 1 to 5 and Zone I from the 105-N Building.

3.1.3.3 Zone II Vent. This vent is the exhaust for Zone II of the 109-N Building. This vent originates from exhaust fans (EF) EF-7 and EF-8.

Zone II of the 109-N Building is primarily Corridor 19. Normally this vent is the exhaust for a once-through ventilation system, discharging directly to the atmosphere. These vents normally exhaust at a combined rate of 23,000 ft^3/min. This system functions with both the supply and exhaust fans operating at the same flowrate. In the event of a release of radioactive contaminants, both the supply and exhaust fans are shut off and the area sealed off from all other areas with no airflow through the area.

3.1.3.4 Zone III Vent. The primary fan on this exhaust is EF-10. Normally this is the exhaust for a once-through air ventilation system for Zone III in the 109-N Building. This fan normally exhausts at a rate of 130,000 ft^3/min. Zone III in the 109-N Building consists of all the areas listed as Zone III in Table 3-1. In the event of a release of radioactive contamination, trip switches put this area on 100% recirculation to confine any contaminants and prevent entry of any others.

3.1.3.5 Zone IV Vent. Zone IV in the 109-N Building is a normal access area adjacent to Zone III. It is comprised of the decontamination solutions' mixing area and the pumping equipment enclosure area. This area exhausts through exhaust fans EF-14 and EF-15 at a rate of 16,000 ft^3/min combined (8,000 ft^3/min each). In the event of a release of contamination, these exhaust vents are closed and the fans are shut off. Emergency exhaust fan EF-17 is then used with its radiological filter to remove the air from Zone IV at the rate of 1,000 ft^3/min.

3.1.4 Liquid Waste Handling Facilities

There are small radionuclide releases to the atmosphere from 1301-N, 1310-N, 1314-N, and 1325-N. These releases result from radionuclides entering the atmosphere through evaporation of water containing them and the handling of liquids containing them. These are ground releases with negligible quantities.

3.1.5 107-N Basin Recirculation Building

The exhaust air from this building is passed through a HEPA filter before being released to the atmosphere. The contaminants here result from the evaporation of spills and leaks in the fuel storage basin water treatment process.

3.2 LIQUID RELEASE POINTS

3.2.1 1325-N Liquid Waste Disposal Facility

The 1325-N facility began receiving effluent from N Reactor in 1983. In September 1985, upon ceasing operation of the 1301-N facility, 1325-N became the primary liquid radioactive waste system for N Reactor. This facility uses soil filtration properties to treat the effluents in the discharge streams. These include the natural absorption, precipitation, and ion exchange

Table 3-1. Air Emission Release Points.

Building	Description	Location	Zone	Monitoring
116-N	All Reactor Zone I, II	Stack	I, II	Alarm
	Reactor Zone III*	Stack	III	Sampling
105-N	Tool and Equipment Decontamination Room Exhaust	Roof	III	Sampling
	Dummy Decontamination Room Hood Exhaust	Roof	III	Sampling
	Transfer Area Exhaust	Roof	III	Sampling
109-N	Cells 1 to 5, auxiliary cells, pipe gallery pressurizer	Roof	I	Alarm
	Cell 6, Cell 6 pipe gallery	Roof	IA	Alarm
	Hot tool room, hot storage roof	Roof	II	Sampling
	Turbine bay, mechanical and electrical equipment rooms, storage, offices, lunch, and locker rooms	Roof	III	Sampling
	Hot water quality laboratories	Roof	III	Sampling
	Rooms 17, 112, 110, lockers, restrooms	Roof	III	Sampling
	Chemical cabinet Room 207	Roof	III	Sampling
	Cell 6 end of turbine bay	Roof	III	Sampling
	Chemical decontamination	Roof	III	Sampling
	Solution preparation area	80 ft 0 in.	III	Sampling
107-N	Building exhaust vent	Roof	III	Sampling
1301-N	Gaseous releases resulting from transfer of liquids	Ground	III	Not sampled
1310-N	Gaseous releases resulting from transfer of liquids	Ground	III	Not sampled
1314-N	Gaseous releases resulting from transfer of liquids	Ground	III	Not sampled

*All Reactor Zone III exhaust air except for exhaust air for the release points listed for the 105-N Building.

properties of the soil column. The 1325-N discharge stream comes from the sources listed in Table 3-2 during N Reactor's dry layup standby configuration.

The facility currently consists of a concrete header box connected to a covered rectangular basin, 240 ft by 250 ft and about 15 ft deep, which compromised the original facility. Attached to this facility is a covered extension trench which was added to the basin in 1985. The trench is approximately 3,000 ft long, 55 ft wide, and 7 ft deep. The trench connects to the northern and eastern corners of the basin through a common weir box.

3.2.2 N Springs Liquid Effluent Release to the Columbia River

Some constituents of the liquid effluents discharged to the 1301-N/1325-N LWDF are ultimately discharged to the Columbia River via the N Springs. The springs lie several feet above the river shoreline and extend for a downstream distance of 2,000 ft from the 107-N Building.

3.2.3 102-in. Outfall

This is the primary nonradioactive drain for N Reactor. It is a 102-in.-dia. pipe which discharges directly to the Columbia River. Its discharge currently includes the discharge from the 66-in. raw water return (RWR) as well. It is regulated as NPDES Discharge 009 on the N Reactor permit. The sources of the discharge are listed in Table 3-3. This outfall was part of the original reactor construction. The only modification to this Outfall was the construction of a dam to divert water from the 66-in. RWR through the 102-in. Outfall.

3.2.4 42-in. Outfall

This is a nonradioactive drain from 182-N. The NPDES Permit regulates this discharge as Outfall 006. This outfall is also sampled monthly for radionuclides in addition to NPDES sampling. The sources for this outfall include the drains from the pumphouse and fog spray pump cooling water discharge.

3.2.5 36-in. Outfall

This is also a nonradioactive drain from 182-N. It is regulated under the NPDES Permit as Discharge 005. In addition to NPDES sampling, this outfall is sampled monthly for radionuclides. The sources for this outfall include overflow and drainage from the water storage tanks.

Table 3-2. Sources for Liquid Effluents to 1325-N During Dry Layup.

Spent Fuel Storage Basin Coolant	
Decontamination Sump	
1314-N Railroad Car Loadout Facility	
Drains:	Water Quality Laboratories
	Radiation Tool Room
	Cask Car and Fuel Transfer Area
	Steam Generator Cells
	Pipe Gallery
	Nuclear Service Sump
	Building Equipment Decontamination Tank

Table 3-3. Sources for Liquid Effluents to 102-in. Outfall During Dry Layup.

Equipment Coolant Drains
105-N Drains (non-rad)
109-N Drains

3.2.6 1324-N/NA

This is a surface impoundment/percolation pond for receiving nonradioactive discharges from the 183-N Water Filter Plant and the 163-N Demineralization Plant. This discharge contains filter plant backwash and the demineralizer backwash and regeneration water to recharge the cation and anion ion exchange resin beds. This facility was placed in dry layup in 1990. As a result all discharges to this facility have ended.

4.0 N REACTOR NORMAL SHUTDOWN SOURCE TERM

4.1 N REACTOR RADIOACTIVE SHUTDOWN SOURCE TERM - 1990

The normal shutdown radioactive source term is based on the residual material left at N Reactor after the irradiated fuel has been removed from both the reactor and the fuel storage basin. The residual material left at N Reactor contains both activation and fission products. However, the remaining radionuclides within the N Reactor 105-N Building are predominately the activation products deposited on the inner piping surfaces and caught in the piping crud traps. Most of the radionuclides formed by the fission process are contained within the nuclear fuel element, which has been removed from the reactor and fuel storage basin to the 100 K Area Fuel Storage Basins.

The activation and fission products that remain in the facility are located primarily in four locations. Residual material is located in the N Reactor primary coolant system piping, the graphite reactor core, the N Fuel Storage Basin, and various sumps in the plant. The radionuclides that remain are primarily ^{60}Co, ^{154}Eu, ^{155}Eu, ^{54}Mn, ^{137}Cs, and ^{90}Sr. The total number of curies in the N Reactor Building in the shutdown condition is approximately 5.5×10^2 (Table 4-1).

However, the largest source of radioactivity that remains at the N Reactor site is located in the 1301-N and 1325-N LWDF. These two facilities, shown in Table 4-2, are soil columns used by the plant to dispose of liquid waste; 1301-N was retired from service in September 1985. They contain a combined total of 8.7×10^3 Ci held primarily in the soil beneath the cribs.

4.2 N REACTOR SHUTDOWN PROCESS CHEMICAL INVENTORY - 1990

The N Reactor Process Chemical Inventory is shown in Table 1-1. N Reactor currently is in dry layup and the only process chemical currently in use is chlorine for potable water production. The potential for the release of a process chemical during shutdown is very low. Also, process chemicals are being removed from N Reactor on an ongoing basis.

Table 4-1. Normal Shutdown Source Term.

N REACTOR PRIMARY COOLANT PIPING SYSTEM (1990 ESTIMATE)		
Isotope	Half-life (yr)	Ci
^{60}Co	5.26	118
^{54}Mn	291 d	36
Subtotal		154
GRAPHITE STACK (1990 ESTIMATE)		
Isotope	Half-life (yr)	Ci
^{154}Eu	16	57
^{155}Eu	1.7	58
^{60}Co	5.26	9.8
^{55}Fe	2.7	250
Subtotal		374.8
N FUEL STORAGE BASINS AND SUMPS (1990 ESTIMATE)		
Isotope	Half-life (yr)	Ci
^{54}Mn	303 d	0.7
^{60}Co	5.26	18.6
^{106}Ru	367	0.7
^{137}Cs	30	1.08
^{144}Ce	284 d	1.1
Subtotal		22.2
Total		551

Table 4-2. Liquid Waste Disposal Facilities Source Term.

Isotope	Half-life (yr)	Ci
1301-N LWDF (1990 ESTIMATE)		
^{60}Co	5.27	2,300
^{90}Sr	28	1,900
^{106}Ru	1.0	3.7
^{134}Cs	2.19	12
^{137}Cs	30	2,600
$^{239,240}Pu$	2.44 E+04	23
Subtotal		6,838.7
1325-N LWDF (1990 ESTIMATE)		
^{60}Co	5.27	1,300
^{90}Sr	28	200
^{106}Ru	1.0	66
^{134}Cs	2.19	14
^{137}Cs	30	320
$^{239,240}Pu$	2.44 E+04	2.6
Subtotal		1,902.6
Total		8,741.3

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5.0 REPRESENTATIVE EFFLUENT DATA

This report determines the type of FEMP needed for N Reactor during normal shutdown condition. Representative effluent data were selected from the plant historical files for this evaluation.

N Reactor began operating in December 1963 when the first criticality was achieved. Effluent records concerned with the release of radioactivity from the plant effluents are readily available from 1971 to 1989.

From 1970 to 1980, N Reactor was operated primarily to produce electricity and, from 1981 to 1989, for the express purpose of producing SNM. The last year the plant ran at full power for most of the time was 1986. N Reactor has been in transition from an operating facility to a shutdown facility since January 1987, when DOE-HQ ordered the plant to a standby condition. Since that time N Reactor has been steadily changing from a mode for operation to shutdown. In January 1989, N Reactor began defueling the reactor core for the last time and, by April 1989, the reactor core was completely defueled. By December 1989 all fuel had been removed from the N Fuel Storage Basin, resulting in a decrease of about 4 billion Ci at N Reactor. By September 1990 the plant was in dry layup, with the reactor system piping and most of the support systems dry. This eliminated the primary mechanism for residual radionuclides to be transported to the environment.

In selecting representative effluent data, it was decided to review the effluent data from 1981 to 1989 to determine in which year the effluent data was representative for the N Reactor shutdown configuration. Tables 5-1 and 5-2 show the airborne and liquid effluents discharged from 1981 to 1989. The discharges of radionuclides were fairly consistent from year to year from the viewpoint of all being within the same order of magnitude.

From the information in Tables 5-1 and 5-2 it was decided to use the 1989 effluent release data as the representative effluent case for the shutdown evaluation of N Reactor. The amount of potential release of radionuclides by way of the effluent release points for air is less than 0.001% of the operating airborne release quantities. However, the shutdown liquid release potential is still about 33% of the operating liquid release, based on the comparison of the 1986 liquid releases versus the 1989 liquid releases. The fraction released, however, is becoming smaller each year.

5.1 REPRESENTATIVE AIRBORNE EMISSIONS DATA DURING SHUTDOWN

The atmospheric releases to the environment from N Reactor in 1989 via the 10 monitored release points are shown in Table 5-3. The table shows that the curies released in 1989 to the air when the plant was shut down were 2.3×10^{-3} Ci as compared to the 1.3×10^{5} Ci released in 1986 when the plant was operating. The table shows that the air emissions no longer contain the

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Table 5-1. N Reactor Airborne Emissions 1981 to 1989 (Ci/yr).

	1981	1982	1983	1984	1985	1986	1987	1988	1989
116-N Stack	6.9 E+04	1.2 E+05	1.2 E+05	7.8 E+04	6.7 E+04	1.1 E+05	3.1 E+03	7.6 E-04	6.7 E-04
109-N Zone I Vent	7.7 E+03	1.8 E+04	1.7 E+03	7.0 E+03	5.4 E+03	1.8 E+04	1.4 E+03	5.9 E-04	9.1 E-04
Zone IA Vent	6.7 E+02	1.2 E+03	4.8 E+02	2.3 E+03	9.0 E+02	1.7 E+03	5.7 E+01	3.6 E-04	2.8 E-04
Zone II	7.8 E-04	4.4 E-04	4.3 E-04	2.7 E-04	1.7 E-03	1.2 E-03	7.1 E-04	4.5 E-04	6.5 E-05
Zone III	7.2 E-03	1.6 E-02	6.7 E-03	4.5 E-03	1.2 E-02	3.1 E-03	8.8 E-04	2.0 E-04	3.2 E-04
Zone IV	0.0 E+00	6.6 E-05	2.6 E-04	2.6 E-05	2.0 E-04	2.8 E-04	2.2 E-05	2.1 E-05	1.8 E-05
105-N Transfer Area	1.3 E-03	2.1 E-05	4.9 E-04	1.9 E-04	1.7 E-04	1.6 E-02	1.3 E-05	4.3 E-06	3.0 E-06
Dummy Decontamination Facility	3.1 E-03	5.2 E-03	1.0 E-04	2.3 E-05	2.3 E-05	1.2 E-04	1.9 E-06	2.5 E-05	2.4 E-06
Tool Decontamination Facility	0.0 E+00	6.8 E-04	1.5 E-04	1.6 E-05	6.0 E-04	4.8 E-04	2.7 E-04	6.3 E-06	1.1 E-05
107-N Exhaust	NA*	NA	NA	NA	1.7 E-04	2.8 E-04	1.0 E-04	2.2 E-05	2.8 E-05
Yearly Total	7.7 E+04	1.3 E+05	1.2 E+05	8.7 E+04	7.4 E+04	1.3 E+05	4.6 E+03	2.4 E-03	2.3 E-03

*Release quantities not available.

Table 5-2. N Reactor Liquid Effluent Emissions 1981 to 1989 (Ci/yr).

	1981	1982	1983	1984	1985	1986	1987	1988	1989
N Springs	9.0 E+01	3.7 E+02	1.9 E+02	1.6 E+02	2.9 E+02	2.3 E+02	1.0 E+02	6.6 E+01	7.6 E+01
1325-N	3.2 E+04	1.5 E+04	2.0 E+04	3.6 E+04	3.5 E+04	6.0 E+04	2.6 E+03	1.1 E+02	1.7 E+02
102-in. Outfall	6.7 E+00	4.5 E+00	5.4 E+00	1.5 E+01	8.0 E+00	1.1 E+00	4.7 E-01	5.9 E-01	1.1 E-01
36-in. Outfall	NA*	NA	NA	NA	NA	NA	NA	NA	6.3 E-02
42-in. Outfall	NA	NA	NA	NA	NA	NA	NA	NA	3.5 E-03
Yearly Total	3.2 E+04	1.5 E+04	2.0 E+04	3.6 E+04	3.6 E+04	6.0 E+04	2.7 E+03	1.8 E+02	2.4 E+02

*Release quantities not available.

Table 5-3. Normal Airborne Shutdown Emissions at 100 N--1989.
(sheet 1 of 2)

Radionuclide	CY 1989 Release (Ci)	CY 1989 Average concentration (µCi/mL)	DOE Derived concentration guide (DCG) (µCi/mL)	Fraction of DCG
SHUTDOWN EMISSIONS FROM THE 116-N STACK--1989				
^{60}Co	4.7 E-04	1.5 E-13	8.0 E-11	1.9 E-03
^{90}Sr	3.7 E-07	1.2 E-16	9.0 E-12	1.3 E-05
^{137}Cs	2.0 E-04	6.4 E-14	4.0 E-10	1.6 E-04
^{238}Pu	7.1 E-08	2.3 E-17	3.0 E-14	7.7 E-04
$^{239,240}Pu$	1.0 E-07	3.2 E-17	2.0 E-14	1.6 E-03
Subtotal (Ci)	6.7 E-04		Subtotal DCG:	4.4 E-03
SHUTDOWN EMISSIONS FROM THE 109-N ZONE I VENT--1989				
^{54}Mn	1.0 E-04	5.9 E-14	2.0 E-09	3.0 E-05
^{60}Co	5.3 E-04	3.0 E-13	8.0 E-11	3.8 E-03
^{90}Sr	2.1 E-06	1.2 E-15	9.0 E-12	1.3 E-04
^{137}Cs	1.1 E-04	6.0 E-14	4.0 E-10	1.5 E-04
^{155}Eu	1.7 E-04	1.0 E-13	3.0 E-10	3.3 E-04
^{238}Pu	2.6 E-08	1.4 E-17	3.0 E-14	4.7 E-04
$^{239,240}Pu$	5.7 E-08	3.2 E-17	2.0 E-14	1.6 E-03
Subtotal (Ci)	9.1 E-04		Subtotal DCG:	6.5 E-03
SHUTDOWN EMISSIONS FROM THE 109-N CELL 6 VENT--1989				
^{54}Mn	1.6 E-05	7.8 E-14	2.0 E-09	3.9 E-05
^{60}Co	2.3 E-04	1.1 E-12	8.0 E-11	1.4 E-02
^{90}Sr	7.2 E-07	3.5 E-15	9.0 E-12	3.9 E-04
^{137}Cs	1.5 E-05	7.5 E-14	4.0 E-10	1.9 E-04
^{155}Eu	2.1 E-05	1.1 E-13	3.0 E-10	3.7 E-04
^{238}Pu	1.3 E-08	6.3 E-17	3.0 E-14	2.1 E-03
$^{239,240}Pu$	7.8 E-08	3.8 E-16	2.0 E-14	1.9 E-02
Subtotal (Ci)	2.8 E-04			
Grand total (Ci)	2.3 E-03		Total	3.6 E-02

Table 5-3. Normal Airborne Shutdown Emissions at 100 N--1989. (Sheet 2 of 2)

Emission point	Radionuclide	CY 1989 Release (Ci)	CY 1989 Average concentration (μCi/mL)	DOE Derived concentration guide (DCG) (μCi/mL)	Fraction of DCG
109-N Zone II EF 7, 8	^{60}Co	6.5 E-05	1.9 E-13	8.0 E-11	2.4 E-03
109-N Zone III EF 10	^{60}Co	3.2 E-04	1.7 E-13	8.0 E-11	2.1 E-03
109-N Zone IV EF 14, 15	^{60}Co	1.8 E-05	7.5 E-14	8.0 E-11	9.4 E-04
105-N Transfer Area	^{60}Co	3.0 E-06	7.3 E-15	8.0 E-11	9.1 E-05
105-N Spacer	^{60}Co	1.3 E-06	1.8 E-14	8.0 E-11	2.3 E-04
Decontamination	^{134}Cs	5.2 E-07	7.3 E-15	2.0 E-10	3.7 E-05
Facility	^{137}Cs	5.4 E-07	7.5 E-15	4.0 E-10	1.9 E-05
			Facility Subtotal		2.9 E-04
105-N 14-ft Decontamination Facility	^{60}Co	1.1 E-05	1.1 E-13	8.0 E-11	1.4 E-03
107-N Exhaust	^{54}Mn	6.2 E-06	5.7 E-14	2.0 E-09	2.9 E-05
	^{60}Co	1.5 E-05	1.3 E-13	8.0 E-11	1.6 E-03
	^{137}Cs	6.4 E-06	5.9 E-14	4.0 E-10	1.5 E-04
Subtotal (Ci)		4.4 E-04	Facility Subtotal		1.8 E-03
Total (Ci)		2.3 E-03	TOTAL		2.1 E-03

EF = exhaust fan

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fission products of the noble gases or iodines, barium, ceriums, or any of the short-lived isotopes. The airborne emissions 2 yr after shutdown are predominately the long-lived isotopes of cobalt, manganese, strontium, cesium, and plutonium.

5.2 REPRESENTATIVE LIQUID EFFLUENT DATA DURING SHUTDOWN

The radioactive liquid effluent released from N Reactor in 1989 to the 1325-N LWDF was 1.7 x 10^2 Ci as shown in Table 5-4. The radioactivity discharged to the Columbia River was 76.8 Ci, with 74 Ci of the radioactive effluent being tritium and 1.8 Ci being strontium as shown in Table 5-5. The remaining curies consisted of ^{125}Sb, ^{60}Co, ^{137}Cs, and ^{239}Pu.

The liquid effluent discharge to the Columbia River via the 36-in. Outfall and 42-in. Outfall was 0.06 Ci and 0.004 Ci, respectively, for a total of 0.067 Ci as shown in Table 5-6.

The discharge of 76.8 Ci to the Columbia River is a decrease of 33% from the curie discharges in 1986. However, the nontritium portion of the discharge has decreased 72%. The greater decrease in the nontritium portion of the curie discharge is due to absorption of the radioactive cations by the soil column of the LWDF.

Table 5-4. Shutdown Discharges to the 1325-N Liquid Waste Disposal Facility--1989.

Radionuclide	CY 1989 Release (Ci)	Average concentration (mCi/mL)	CY 1989 Concentration guide (mCi/mL)	DOE Derived fraction of DCG
^{3}H	7.4 E+01	1.2 E-04	2.0 E-03	6.0 E-02
^{54}Mn	5.0 E+00	8.0 E-06	5.0 E-05	1.6 E-01
^{60}Co	3.3 E+01	5.3 E-05	5.0 E-06	1.1 E+01
^{90}Sr	2.8 E+01	4.5 E-05	1.0 E-06	4.5 E+01
^{125}Sb	1.0 E+00	1.6 E-06	5.0 E-05	3.2 E-02
^{134}Cs	5.2 E-01	8.3 E-07	2.0 E-06	4.2 E-01
^{137}Cs	2.3 E+01	3.6 E-05	3.0 E-06	1.2 E+01
^{144}Ce	1.8 E+00	2.9 E-06	7.0 E-06	4.1 E-01
^{238}Pu	4.6 E-03	7.4 E-09	4.0 E-08	1.9 E-01
^{239}Pu	2.3 E-02	3.7 E-08	3.0 E-08	1.2 E+00
Subtotal (Ci)		1.7 E+02	Total	7.0 E+01

DCG = Derived Concentration Guide

Table 5-5. Shutdown Discharges to the Columbia River from N Springs and the 102-in. Outfall.

Radionuclide	CY 1989 Release (Ci)	CY 1989 Average concentration (μCi/mL)	DOE Derived concentration guide (DCG) (μCi/mL)	Fraction of DCG
		DISCHARGES FROM N SPRINGS		
^{3}H	7.4 E+01*	6.2 E-05	2.0 E-03	3.1 E-02
^{60}Co	1.2 E-02	3.9 E-08	5.0 E-06	7.8 E-03
^{90}Sr	1.8 E+00	5.5 E-06	1.0 E-06	5.5 E+00
^{125}Sb	1.2 E-02	3.6 E-08	5.0 E-05	7.2 E-04
^{137}Cs	1.6 E-03	4.9 E-09	3.0 E-06	1.6 E-03
^{238}Pu	5.3 E-06	1.7 E-09	4.0 E-08	4.3 E-02
$^{239,240}Pu$	4.5 E-06	1.4 E-09	3.0 E-08	4.7 E-02
Subtotal (Ci)		7.6 E+01	Total	5.6 E+00
		DISCHARGES FROM THE 102-IN. OUTFALL		
^{60}Co	7.6 E-02	3.2 E-10	5.0 E-06	6.4 E-05
^{137}Cs	3.1 E-02	1.3 E-10	3.0 E-06	4.3 E-05
Subtotal (Ci)		1.1 E-01	Total	1.1 E-04

*This release value is the same for ^{3}H (tritium) discharged to 1325-N. Because of its high affinity with water, all ^{3}H discharged to 1325-N is conservatively assumed to reach the Columbia River, although probably not within 1 yr from the time of discharge. The average concentration of ^{3}H at the N Springs for 1988 was calculated from analyses of samples routinely collected using a continuous composite sampling system located there.

Table 5-6. Discharges to the Columbia River via the 36-in. and 43-in. Outfalls.

Radionuclide	CY 1989 Release (Ci)	CY 1989 Average concentration (mCi/mL)	DOE Derived Concentration Guide (DCG) (mCi/mL)	Fraction of DCG
DISCHARGES FROM THE 36-IN. OUTFALL				
^{60}Co	3.4 E-02	3.4 E-10	5.0 E-06	2.8 E-05
^{137}Cs	2.9 E-02	1.3 E-10	3.0 E-06	4.0 E-05
Subtotal (Ci)		6.3 E-02	Total	6.8 E-05
DISCHARGES FROM THE 42-IN. OUTFALL				
^{60}Co	2.1 E-03	1.8 E-10	5.0 E-06	3.6 E-05
^{137}Cs	1.4 E-03	1.1 E-10	3.0 E-06	3.7 E-05
Subtotal (Ci)		3.5 E-03	Total	7.3 E-05

6.0 MODELS FOR DOSE ASSESSMENT

6.1 BACKGROUND

On October 31, 1989, the EPA issued the final regulations for radioactive emissions to the air under 40 CFR 61 (EPA 1989a), "National Emission Standards for Hazardous Air Pollutants."

The regulations require the use of an EPA-approved dose assessment model to determine compliance of DOE facilities with 40 CFR 61.93(a). The two EPA-approved models that were considered for use in this assessment were CAP-88 (Beres 1990) and AIRDOS-PC (EPA 1989b).

The EPA dose assessment models are designed to calculate the effective dose equivalent value to the maximally exposed individual. The model will also calculate the organ dose equivalents.

Because of the size of this model, CAP-88 was loaded into the Pacific Northwest Laboratory (PNL) computing system where it was used to calculate the doses resulting from releases on the Hanford Site.

Using the results of these calculations, PNL developed tables of unit dose conversion factors for each radionuclide. The unit dose conversion factors are numbers that give the effective dose equivalent (EDE) for a 1 Ci release of a specific radionuclide to the maximally exposed individual. These calculated doses are a 50-yr committed EDE for all internal deposition pathways. The dose conversion table based on the CAP-88 (Beres 1990) model and developed by PNL is in Table 6-1.

The CAP-88 model handles the ingrowth of long-lived radioactive daughters slightly differently than the PNL Generation II (GENII) Hanford Site-specific model (Napier et al. 1988). It will now calculate activities for ingrowth of daughter radionuclides following release of the parent, but will estimate the dose from very short-lived daughters where the parent-to-daughter activity ratio is effectively 1:1. The Hanford Site-specific GENII model results were compared to the results from the CAP-88 dose model.

It is important to recognize that the AIRDOS-PC (EPA 1989b) computer model was not used due to the number of limitations that may result in the model having a significant degree of inaccuracy. The limitations are described below.

- The model will only accept data from six release points and then uses the information as though it were released from one release point.
- No corrections are made for building wake factors.
- The model can accept data for only 18 radionuclides. The model is not capable of handling the large number of radionuclides that are released from nuclear reactors and nuclear chemical processing plants.

Table 6-1. CAP-88 Dose Estimates for 1 Ci Radionuclide Releases--100 Areas (Location to the Individual: 9,900 m West).

Nuclide	10-m Stack dose equivalent (mrem)*	89-m Stack dose equivalent (mrem)*
^{3}H	3.36 E-05	8.85 E-06
^{24}Na	2.19 E-04	6.72 E-05
^{41}Ar	1.41 E-05	4.38 E-06
^{51}Cr	9.32 E-05	2.80 E-05
^{54}Mn	8.11 E-03	2.44 E-03
^{56}Mn	3.56 E-05	1.20 E-05
^{59}Fe	4.72 E-03	1.42 E-03
^{58}Co	4.75 E-03	1.43 E-03
^{60}Co	4.28 E-02	1.29 E-02
^{76}As	1.81 E-04	5.50 E-05
^{85m}Kr	2.62 E-06	7.35 E-07
^{85}Kr	7.49 E-08	1.97 E-08
^{87}Kr	7.18 E-06	2.41 E-06
^{88}Kr	3.11 E-05	9.07 E-06
^{89}Sr	3.11 E-03	9.35 E-04
^{90}Sr	6.45 E-02	1.94 E-02
^{91}Sr	5.39 E-05	1.67 E-05
^{95}Zr	3.90 E-03	1.17 E-03
^{95}Nb	2.60 E-03	7.81 E-04
^{99}Mo	2.41 E-04	7.28 E-05
^{103}Ru	2.10 E-03	6.31 E-04
^{106}Ru**	3.08 E-02	9.26 E-03
^{124}Sb	8.90 E-03	2.68 E-03
^{132}Te	6.29 E-04	1.90 E-04
^{131}I	1.84 E-02	1.65 E-02
^{132}I	2.48 E-05	2.54 E-05
^{133}I	1.72 E-04	1.56 E-04
^{135}I	5.99 E-05	5.62 E-05
^{133}Xe	7.71 E-07	2.04 E-07
^{135}Xe	4.73 E-06	1.28 E-06
^{134}Cs	4.62 E-02	1.39 E-02
^{137}Cs**	3.53 E-02	1.06 E-02
^{138}Cs	7.20 E-06	3.77 E-06
^{140}Ba	1.86 E-03	5.60 E-04
^{140}La	4.49 E-04	1.36 E-04
^{141}Ce	1.21 E-03	3.65 E-04
^{144}Ce	2.02 E-02	6.08 E-03
^{153}Sm	1.13 E-04	3.42 E-05
^{154}Eu	2.69 E-02	8.10 E-03
^{155}Eu	2.73 E-03	8.20 E-04
^{238}Pu	1.18 E+01	3.56 E+00
^{239}Np	1.70 E-04	5.13 E-05
^{239}Pu	1.28 E+01	3.85 E+00

*Doses calculated with CAP-88 are for the parent nuclide only, and do not include contributions from long-lived daughter chains.

**Short-lived daughters are included in dose from parent nuclides.

- There also is a restriction on which radionuclides can be used in the model.
- The meteorological data that are in the model have been preloaded and may be significantly different than the local meteorology in the immediate area of the facility.
- There is no provision for the buildup of the uranium and thorium decay series in the soil.
- The environmental decay constant is a constant 2%/yr.

Based on the above limitations it was decided that AIRDOS-PC is inappropriate for use with the reactor fission products inventory at N Reactor for this FEMP determination.

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7.0 ANNUAL DOSE ASSESSMENT FOR N REACTOR WITH CONTROLS

The total dose was calculated by multiplying the specific radionuclide release in curies by the appropriate dose conversion factor for that radionuclide. The dose for each radionuclide was summed to obtain the total offsite dose from the specific release point.

The unit dose conversion factors give the EDE for a 1 Ci release of a specific radionuclide to the maximally exposed individual. These doses were calculated as 50-yr committed EDEs for all internal deposition pathways.

The maximally exposed individual for liquid releases was determined to be located at Ringold, Washington. For airborne releases the maximum individual was determined to be located 9,900 m west of N Reactor. This location was determined to be the offsite location with the highest radionuclide concentration due to releases from N Reactor under average atmospheric conditions.

7.1 NORMAL SHUTDOWN AIRBORNE DOSE ASSESSMENT

The N Reactor airborne dose assessment for the 10 airborne release points was performed using the CAP-88 (Beres 1990) unit dose conversion factors provided by PNL. The individual radionuclide release quantities were multiplied by their corresponding unit dose conversion factor and these results were summed for each release point. The resulting numbers give the 50 yr committed EDE for the maximally exposed individual living 9,900 m west of N Reactor.

For the purposes of this evaluation environmental controls (HEPA filters) are assumed to offer a decontamination factor of 3,000. When no controls are present it can be shown that, based on prior operating data, the potential release can conservatively increase the release by a factor of 1,000. The results of the determination are shown in Table 7-1. The results show that during shutdown the 116-N Stack and the 109-N Zone 1 vent effluents result in an offsite radiation exposure of 8.8×10^{-6} and 2.9×10^{-5} mrem EDE, respectively. The remaining eight effluent release points result in radiation exposures ranging from 1.4×10^{-5} to 9.9×10^{-8} mrem and are on an order of magnitude less than the 116-N Stack or the 109-N Zone I vent. Dose rates of this magnitude during shutdown are on the order of 3.0×10^{-6} of a percent of the background radiation of 7.9 x 10 mrem. The number of curies released to the air from 1986 to 1989 has decreased to 2.3×10^{-3} Ci/yr (Table 5-1).

7.2 NORMAL SHUTDOWN LIQUID EFFLUENT DOSE ASSESSMENT

The liquid effluent dose assessment based on the liquid effluent streams from the 102-in., 42-in., and 36-in. Outfalls and N Springs was determined using the PNL GENII (Napier et al. 1988) unit dose conversion factors. The individual radionuclide release quantities were multiplied by their corresponding unit dose conversion factor, and these results were summed to give the 50-yr committed EDE for the maximally exposed individual located at Ringold, Washington.

Table 7-1. Normal Shutdown Airborne Emissions Dose Assessment--1989.

Release point	Curies released	Effective dose equivalent with control equipment (mrem)	
		CAP-88	GEN II
116-N Stack	6.7 E-04	8.8 E-06	5.0 E-06
109-N Zone I Vent	9.1 E-04	2.9 E-05	1.4 E-05
109-N Zone IA Vent	2.8 E-04	1.2 E-05	5.3 E-06
109-N Zone II Vent	6.5 E-05	2.8 E-06	1.0 E-06
109-N Zone III Vent	3.2 E-04	1.4 E-05	5.1 E-06
109-N Zone IV Vent	1.8 E-05	7.7 E-07	2.9 E-07
105-N Transfer Facility Vent	3.0 E-06	1.3 E-07	4.8 E-08
105-N Tool Decon Facility Vent	1.1 E-05	4.7 E-07	6.8 E-08
105-N Dummy Decon Facility Vent	2.4 E-06	9.9 E-08	1.8 E-07
107-N Exhaust	2.8 E-05	9.2 E-07	4.9 E-07

The results of the liquid dose determination for normal shutdown are shown in Table 7-2. The results show that none of the liquid effluents result in an annual dose in excess of 0.1 mrem. The N Springs discharge during shutdown results in an annual dose of 1.2×10^{-2} mrem. The 102-in. Outfall, 36-in. Outfall, and 42-in. Outfall discharges also result in an annual dose of 1.0×10^{-2}, 9.3×10^{-3}, and 4.5×10^{-4}, respectively. None of the liquid effluent discharges during normal shutdown conditions result in an annual dose of 0.1 mrem/yr.

Table 7-2. Normal Shutdown Liquid Effluents Dose Assessment--1989.

Release point	Curies released	Effective dose equivalent with control equipment (mrem)
N Springs	7.6 E+01	1.2 E-02
102-in. Outfall	1.1 E-01	1.0 E-02
36-in. Outfall	6.3 E-02	9.4 E-03
42-in. Outfall	3.5 E-03	4.5 E-04

8.0 ANNUAL DOSE ASSESSMENT WITHOUT CONTROLS

The DOE (1991) document requires a dose assessment without controls to determine the need for effluent monitoring. For the purpose of this evaluation the 1989 effluent release report (Rokkan 1991) with its subsequent dose assessment, was used to determine the normal shutdown dose assessment without controls.

Two additional Hanford Site-specific effluent monitoring practices are also applicable in determining effluent monitoring requirements. These criteria are listed below.

- If an effluent release point emits radioactive material or has the potential to emit radioactive material that is greater than or exceeds 1.0×10^{-5} Ci/yr, then effluent monitoring should be required.
- If an effluent release point emits less than detectable quantities of radioactivity, then effluent monitoring is not required. The minimum detectable concentrations for this study are assumed to be:
  - 1.0×10^{-2} pCi/m^3 for airborne
  - 8.0 pCi/L for liquids.

8.1 NORMAL SHUTDOWN AIRBORNE DOSE ASSESSMENT WITHOUT CONTROLS

The DOE (1991) document requires that a dose assessment be conducted on each effluent release point in the absence of control equipment. Because of the possibility of the various plant conditions, it was assumed for the purposes of this assessment that air release points at N Reactor that had air filtration systems operating at a minimum efficiency of 99.97% (3,000) and those that did not could have a release rate increase by a factor of 1,000. For example, the 105-N Transfer Area in 1982 released 2.1×10^{-5} Ci to the air and in 1986 the Transfer Area released 1.6×10^{-2} Ci to the air for an annual increase of a factor of 762. It is recognized that many of the N Reactor airborne effluent release points do not have any environmental controls in operation. However, it is intended that this conservative approach will encompass any possible effluent increases due to various plant conditions and activities.

The results of applying these factors to the airborne dose assessment performed for N Reactor is the shutdown mode with controls as shown in Table 8-1.

The results in Table 8-1 show that all of the airborne effluent release points during shutdown are below 0.1 mrem and, therefore, do not require continuous effluent monitoring.

Table 8-1. Normal Shutdown Dose Assessment Airborne Emissions Without Control Equipment (1989 Effluent Discharges).

Release point	Actual curies released	Effective Dose Equivalent			
		Normal operation (mrem)		Potential increase (mrem)	
		CAP-88	GENII	CAP-88	GENII
116-N Stack	6.7 E-04	8.8 E-06	5.0 E-06	2.6 E-02	1.5 E-02
109-N Zone I Vent	9.1 E-04	2.9 E-05	1.4 E-05	2.9 E-02	1.4 E-02
109-N Zone IA Vent	2.8 E-04	1.2 E-05	5.3 E-06	1.2 E-02	5.3 E-03
109-N Zone II Vent	6.5 E-05	2.8 E-06	1.0 E-06	2.8 E-03	1.0 E-03
109-N Zone III Vent	3.2 E-04	1.4 E-05	5.1 E-06	1.4 E-02	5.1 E-03
109-N Zone IV Vent	1.8 E-05	7.7 E-07	2.9 E-07	7.7 E-04	2.9 E-04
105-N Transfer Facility Vent	3.0 E-06	1.3 E-07	4.8 E-08	1.3 E-04	4.8 E-05
105-N Tool Decon Facility	1.1 E-05	4.7 E-07	6.8 E-08	4.7 E-04	6.8 E-05
105-N Dummy Decon Facility	2.4 E-06	9.9 E-08	1.8 E-07	9.9 E-05	1.8 E-04
107-N Exhaust Vent	2.8 E-05	9.9 E-08	4.9 E-07	3.0 E-04	1.5 E-03

However, the airborne effluent release points still emit measurable quantities of radionuclides and should be monitored.

It is therefore recommended that airborne effluent monitoring be continued at the effluent release points until it can be shown that measurable quantities of radioactivity are no longer emitted.

8.2 NORMAL SHUTDOWN LIQUID EFFLUENT DOSE ASSESSMENT WITHOUT CONTROLS

The DOE (1991) document requires that a dose assessment be conducted on each effluent release point in the absence of control equipment. For the purpose of this assessment it was assumed that the plant liquid effluent bypasses the 1325-N LWDF and is discharged directly to the Columbia River. The results of this evaluation are shown in Table 8-2. The table shows the annual effective dose to the maximally exposed individual at Ringold from N Springs discharges is 7.9 mrem and, therefore, requires monitoring.

It should be noted that even when the 1325-N LWDF is conservatively assumed not to retain radionuclides, which is the worst case, the annual dose is only 7.9% of the annual limit.

The other three liquid effluent discharges do not have positive environmental controls on them. For this reason there is no potential for increase in their release quantities. As shown in Section 7.2, their discharges result in a downstream dose assessment of less than 0.1 mrem and, therefore, do not require continuous monitoring in accordance with the DOE (1991) document. However, these three release points still emit measurable quantities of radioactivity and should be monitored until they are no longer of any significance (i.e., <8 pCi/L).

Table 8-2. Normal Shutdown Dose Assessment Liquid Effluents Without Control Equipment (1989 Effluent Discharges).

Release point	Curies released	Effective dose equivalent	
		Normal operation (mrem)	Potential[a] increase (mrem)
N Springs	1.7 E+02	1.1 E-02	7.9 E+00
102-in. Outfall	1.1 E-01	1.1 E-02	Same as normal operation
42-in. Outfall[b]	6.3 E-02	9.3 E-03	Same as normal operation
36-in. Outfall[b]	3.5 E-03	4.5 E-04	Same as normal operation

[a]Assumes upset condition.

[b]There are no longer any routine effluents from these outfalls; therefore, monitoring is limited to periodic confirmatory measurements.

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9.0 POTENTIAL UPSET-OPERATING CONDITIONS

No potential upset conditions have been identified or deemed credible. No mechanisms were identified for routine release of the N Reactor-contained radionuclides offsite and, therefore, no analyses were performed for operational radiological impact to the offsite population. Ecological impacts from this facility are essentially unchanged from present conditions.

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10.0 SUMMARY

10.1 PURPOSE

This report evaluates the degree to which N Reactor must monitor plant effluents during shutdown. The results show that during plant shutdown a much less extensive monitoring plan is needed to assure the public that N Reactor is operating within applicable regulatory requirements.

10.2 SOURCE TERM

This evaluation shows the decrease in the radioactive source term at N Reactor since it has changed from an operating facility to a shutdown facility. The number of curies of radioactivity within the reactor facility during operation was approximately 4 billion Ci. As the shutdown activities have progressed, the number of curies remaining at N Reactor in the 105-N Building is approximately 550 Ci.

The evaluation also showed that the largest radioactive source remaining at N Reactor is the 1301-N Liquid Waste Disposal Facility (LWDF), with 6,838.7 Ci, followed by the 1325-N LWDF, with 1,902.6 Ci. The dose assessment was based on 1989 shutdown effluent release data.

The evaluation showed that the airborne emissions have declined from 130,000 Ci/yr in 1986 to 0.002 Ci/yr in 1989. The liquid effluents released to the Columbia River have declined from 230 Ci/yr to 76 Ci/yr, with 74 Ci being tritium. In 1989, 1.8 Ci of ^{90}Sr were released to the Columbia River.

The evaluation showed that with the plant in dry layup, there is little potential of the process chemicals being released to either the groundwater or the Columbia River.

10.3 FACILITY EFFLUENT MONITORING DURING PLANT SHUTDOWN

Using data from the first year of the plant shutdown, a Facility Effluent Monitoring Plan determination for N Reactor was performed assuming the effluent controls are not functioning. The determination evaluated the 10 airborne and 7 liquid effluent release points. The results indicated that none of the airborne effluents have the potential for exposing the maximum individual to greater that 0.1 mrem. Therefore, according to DOE/EH-0173T (DOE 1991), continuous airborne effluent monitoring is not required at N Reactor during shutdown.

It is recommended, however, that as long as they are active, the airborne emission points be monitored since they emit measurable quantities of radioactivity.

The evaluation for liquid effluents indicated that N Springs should continue to be monitored during shutdown since the radionuclides discharged to the Columbia River result in a potential dose of 7.9 mrem. The potential N Springs evaluation was based on the conservative assumption that the

1325 LWDF does not retain radionuclides. Even the use of this conservative assumption results in an annual dose that is only 7.9% of the DOE 5400.5 (DOE 1990) annual limit of 100 mrem. It is also recommended that the 102-in. Outfall be monitored periodically because it has the potential to release measurable quantities of radioactivity to the Columbia River.

Based on the first year of standby effluent data (obtained for 1989), it was determined that none of the airborne emission release points exceeded 0.1 mrem; therefore, only periodic confirmatory monitoring is required for airborne radioactivity.

There are also three liquid effluent release points that require monitoring because of radioactivity release to the groundwater and Columbia River. These are N Springs, the 102-in. Outfall, and the 1325-N LWDF.

Since N Reactor is a nuclear facility that is progressing toward shutdown, the conclusions arrived at in this report should be reevaluated annually as effluents continue to decline and various plant systems are shut down.

11.0 CONCLUSIONS OF THE FACILITY EFFLUENT MONITORING PLAN DETERMINATION

The DOE (1991) document requires a determination of dose to the maximally exposed individual without effluent controls and the dose to the maximum individual from an upset plant condition to determine the degree to which effluents must be monitored.

This FEMP evaluation for these conditions was based on actual effluent release data from 1989 for the normal shutdown case.

11.1 FACILITY EFFLUENT MONITORING PLAN DETERMINATION FOR NORMAL SHUTDOWN WITHOUT CONTROLS

The dose evaluation in Section 7.1 shows that none of the airborne effluents during shutdown exceeded 0.1 mrem. The dose to the maximally exposed individual at the various effluent release points ranges from 5.8×10^{-2} to 2.0×10^{-4} mrem. Therefore continuous airborne effluent monitoring is not required at N Reactor by the DOE (1991) document.

However, measurable quantities of radionuclides (>1.8×10^{-5} Ci/yr) are released by some of the airborne release points as shown in Table 7-1. Thus effluent monitoring is recommended during shutdown.

Although N Reactor has been in a nearly complete shutdown state since 1989, the airborne effluent monitoring should be maintained until it can be shown that measurable quantities of radionuclides are no longer emitted.

During plant shutdown the dose assessment for liquid effluents shown in Section 8.2 indicates that only one liquid effluent needed to be monitored, N Springs, with an assessed potential dose of 7.9 mrem.

However, it is recommended that the remaining two liquid effluent release points continue to be monitored because they emit measurable quantities of radionuclides. These liquid effluent release points are the 102-in. Outfall and 1325-N LWDF.

New information recently obtained in the third quarter of 1990 suggests that the effluent monitoring at the 42-in. Outfall and the 36-in. Outfall may be eliminated because there are no longer routine discharges at these points due to completion of dry layup. New information will be evaluated in the FEMP for N Reactor.

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ATTACHMENT 1

DETERMINATION OF FACILITY EFFLUENT MONITORING PLAN REQUIREMENT

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ATTACHMENT I

DETERMINATION OF FACILITY EFFLUENT MONITORING PLAN REQUIREMENT

FACILITY N REACTOR **DISCHARGE POINT** 116-N STACK

FACILITY INVENTORY AT RISK OF RADIOACTIVE MATERIALS

Radionuclide	Quantity Released (Curies) w/ Controls	Quantity Released (Curies) w/o Controls	Projected Dose (mrem) w/o Controls CAP-88	Projected Dose (mrem) w/o Controls GENII
1. Co-60	4.7E-04	1.4E+00	1.82E-02	6.6E-03
2. Sr-90	3.7E-07	1.1E-03	2.15E-05	2.0E-05
3. Cs-137	2.0E-04	6.0E-01	6.36E-03	6.6E-03
4. Pu-238	7.1E-08	2.1E-04	7.58E-04	6.8E-04
5. Pu-239/240	1.0E-07	3.0E-04	1.16E-03	9.9E-04
Total	6.7E-04	2.0E+00	2.65E-02	1.5E-02

FACILITY INVENTORY AT RISK OF NONRADIOACTIVE HAZARDOUS MATERIALS

Regulated Material	Quantity (lbs)	Quantity Released	RQ (lbs)
1.			
2.			
3.			
4.			

Identification of Reference Material

WHC-EP-0165-2

If the total projected dose from radionuclides exceeds 0.1 mrem ede from any one discharge point or if any one regulated material discharged from a facility exceeds 100% of a reportable quantity or a permitted quantity, a FEMP is required for that facility. Check the appropriate space below.

FEMP is required ___ FEMP is not required X

EVALUATOR [signature] DATE 3/19/91

MANGER, ENVIRONMENTAL [signature] DATE 3-15-91

FACILITY MANAGER [signature] DATE 3-19-91

ATTACHMENT I

DETERMINATION OF FACILITY EFFLUENT MONITORING PLAN REQUIREMENT

FACILITY N REACTOR **DISCHARGE POINT** 109-N ZONE I VENT

FACILITY INVENTORY AT RISK OF RADIOACTIVE MATERIALS

Radionuclide	Quantity Released (Curies) w/ Controls	w/o Controls	Projected Dose (mrem) w/o Controls CAP-88	GENII
1. Mn-54	1.0E-04	1.0E-04	8.11E-07	1.8E-07
2. Co-60	5.3E-04	5.3E-04	2.27E-05	8.5E-06
3. Sr-90	2.1E-06	2.1E-06	1.35E-07	1.2E-07
4. Cs-137	1.1E-04	1.1E-04	3.88E-06	4.2E-06
5. Eu-155	1.7E-04	1.7E-04	4.64E-07	3.4E-07
6. Pu-238	2.6E-08	2.6E-08	3.07E-07	2.9E-07
7. Pu-239/240	5.7E-08	5.7E-08	7.30E-07	6.3E-07
Total	9.1E-04	9.1E-04	2.90E-05	1.4E-05

FACILITY INVENTORY AT RISK OF NONRADIOACTIVE HAZARDOUS MATERIALS

Regulated Material	Quantity (lbs)	Quantity Released	RQ (lbs)
1.			
2.			
3.			

Identification of Reference Material

WHC-EP-0165-2

If the total projected dose from radionuclides exceeds 0.1 mrem ede from any one discharge point or if any one regulated material discharged from a facility exceeds 100% of a reportable quantity or a permitted quantity, a FEMP is required for that facility. Check the appropriate space below.

FEMP is required ___ FEMP is not required X

EVALUATOR [signature] DATE 3/19/91

MANGER, ENVIRONMENTAL [signature] DATE 3-15-91

FACILITY MANAGER [signature] DATE 3-19-91

ATTACHMENT I

DETERMINATION OF FACILITY EFFLUENT MONITORING PLAN REQUIREMENT

FACILITY N REACTOR **DISCHARGE POINT** 109-N ZONE IA VENT

FACILITY INVENTORY AT RISK OF RADIOACTIVE MATERIALS

Radionuclide	Quantity Released (Curies) w/ Controls	Quantity Released (Curies) w/o Controls	Projected Dose (mrem) w/o Controls CAP-88	Projected Dose (mrem) w/o Controls GENII
1. Mn-54	1.6E-05	1.6E-05	1.30E-07	2.9E-08
2. Co-60	2.3E-04	2.3E-04	9.84E-06	3.7E-06
3. Sr-90	7.2E-07	7.2E-07	4.64E-08	4.2E-08
4. Cs-137	1.5E-05	1.5E-05	5.30E-07	5.7E-07
5. Eu-155	2.1E-05	2.1E-05	5.73E-08	4.2E-08
6. Pu-238	1.3E-08	1.3E-08	1.53E-07	1.4E-07
7. Pu-239/240	7.8E-08	7.8E-08	9.98E-07	8.6E-07
Total	2.8E-04	2.8E-04	1.18E-05	5.4E-06

FACILITY INVENTORY AT RISK OF NONRADIOACTIVE HAZARDOUS MATERIALS

Regulated Material	Quantity (lbs)	Quantity Released	RQ (lbs)
1.			
2.			
3.			
4.			

Identification of Reference Material

WHC-EP-0165-2

If the total projected dose from radionuclides exceeds 0.1 mrem ede from any one discharge point or if any one regulated material discharged from a facility exceeds 100% of a reportable quantity or a permitted quantity, a FEMP is required for that facility. Check the appropriate space below.

FEMP is required __ FEMP is not required X

EVALUATOR [signature] DATE 3/19/91
MANGER, ENVIRONMENTAL [signature] DATE 3-15-91
FACILITY MANAGER [signature] DATE 3-19-91

ATTACHMENT I

DETERMINATION OF FACILITY EFFLUENT MONITORING PLAN REQUIREMENT

FACILITY N REACTOR **DISCHARGE POINT** 109-N ZONE II VENT

FACILITY INVENTORY AT RISK OF RADIOACTIVE MATERIALS

Radionuclide	Quantity Released (Curies) w/ Controls	w/o Controls	Projected Dose (mrem) w/o Controls CAP-88	GENII
1. Co-60	6.5E-05	6.5E-05	2.78E-06	1.0E-06
2.				
3.				
4.				
Total	6.5E-05	6.5E-05	2.78E-06	1.0E-06

FACILITY INVENTORY AT RISK OF NONRADIOACTIVE HAZARDOUS MATERIALS

Regulated Material	Quantity (lbs)	Quantity Released	RQ (lbs)
1.			
2.			
3.			
4.			

Identification of Reference Material

WHC-EP-0165-2

If the total projected dose from radionuclides exceeds 0.1 mrem ede from any one discharge point or if any one regulated material discharged from a facility exceeds 100% of a reportable quantity or a permitted quantity, a FEMP is required for that facility. Check the appropriate space below.

FEMP is required ___ FEMP is not required X

EVALUATOR [signature] DATE 3/19/91

MANGER, ENVIRONMENTAL KA Gano DATE 3-15-91

FACILITY MANAGER [signature] DATE 3-19-91

ATTACHMENT I

DETERMINATION OF FACILITY EFFLUENT MONITORING PLAN REQUIREMENT

FACILITY N REACTOR DISCHARGE POINT 109-N ZONE III VENT

FACILITY INVENTORY AT RISK OF RADIOACTIVE MATERIALS

Radionuclide	Quantity Released (Curies) w/ Controls	Quantity Released (Curies) w/o Controls	Projected Dose (mrem) w/o Controls CAP-88	Projected Dose (mrem) w/o Controls GENII
1. Co-60	3.2E-04	3.2E-04	1.37E-05	5.1E-06
2.				
3.				
4.				
Total	3.2E-04	3.2E-04	1.37E-05	5.1E-06

FACILITY INVENTORY AT RISK OF NONRADIOACTIVE HAZARDOUS MATERIALS

Regulated Material	Quantity (lbs)	Quantity Released	RQ (lbs)
1.			
2.			
3.			
4.			

Identification of Reference Material

WHC-EP-0165-2

If the total projected dose from radionuclides exceeds 0.1 mrem ede from any one discharge point or if any one regulated material discharged from a facility exceeds 100% of a reportable quantity or a permitted quantity, a FEMP is required for that facility. Check the appropriate space below.

FEMP is required ___ FEMP is not required X

EVALUATOR [signature] DATE 3/19/91

MANGER, ENVIRONMENTAL [signature] DATE 3-15-91

FACILITY MANAGER [signature] DATE 3-19-91

ATTACHMENT I

DETERMINATION OF FACILITY EFFLUENT MONITORING PLAN REQUIREMENT

FACILITY N REACTOR **DISCHARGE POINT** 109-N ZONE IV VENT

FACILITY INVENTORY AT RISK OF RADIOACTIVE MATERIALS

Radionuclide	Quantity Released (Curies) w/ Controls	Quantity Released (Curies) w/o Controls	Projected Dose (mrem) w/o Controls CAP-88	Projected Dose (mrem) w/o Controls GENII
1. Co-60	1.8E-05	1.8E-05	7.70E-07	2.9E-07
2.				
3.				
4.				
Total	1.8E-05	1.8E-05	7.70E-07	2.9E-07

FACILITY INVENTORY AT RISK OF NONRADIOACTIVE HAZARDOUS MATERIALS

Regulated Material	Quantity (lbs)	Quantity Released	RQ (lbs)
1.			
2.			
3.			
4.			

Identification of Reference Material

WHC-EP-0165-2

If the total projected dose from radionuclides exceeds 0.1 mrem ede from any one discharge point or if any one regulated material discharged from a facility exceeds 100% of a reportable quantity or a permitted quantity, a FEMP is required for that facility. Check the appropriate space below.

FEMP is required ___ FEMP is not required X

EVALUATOR [signature] DATE 3/19/91

MANGER, ENVIRONMENTAL [signature] DATE 3-15-91

FACILITY MANAGER [signature] DATE 3-19-9[illegible]

ATTACHMENT I

DETERMINATION OF FACILITY EFFLUENT MONITORING PLAN REQUIREMENT

FACILITY N REACTOR EXHAUST **DISCHARGE POINT** 105-N TRANSFER AREA

FACILITY INVENTORY AT RISK OF RADIOACTIVE MATERIALS

Radionuclide	Quantity Released (Curies) w/ Controls	Quantity Released (Curies) w/o Controls	Projected Dose (mrem) w/o Controls CAP-88	Projected Dose (mrem) w/o Controls GENII
1. Co-60	3.0E-06	3.0E-06	1.28E-07	4.8E-08
2.				
3.				
4.				
Total	3.0E-06	3.0E-06	1.28E-07	4.8E-08

FACILITY INVENTORY AT RISK OF NONRADIOACTIVE HAZARDOUS MATERIALS

Regulated Material	Quantity (lbs)	Quantity Released	RQ (lbs)
1.			
2.			
3.			
4.			

Identification of Reference Material

WHC-EP-0165-2

If the total projected dose from radionuclides exceeds 0.1 mrem ede from any one discharge point or if any one regulated material discharged from a facility exceeds 100% of a reportable quantity or a permitted quantity, a FEMP is required for that facility. Check the appropriate space below.

FEMP is required ___ FEMP is not required X

EVALUATOR [signature] DATE 3/19/91

MANGER, ENVIRONMENTAL [signature] DATE 3-15-91

FACILITY MANAGER [signature] DATE 3-19-91

ATTACHMENT I

DETERMINATION OF FACILITY EFFLUENT MONITORING PLAN REQUIREMENT

FACILITY N REACTOR **DISCHARGE POINT** 105-N DUMMY DECON FAC

FACILITY INVENTORY AT RISK OF RADIOACTIVE MATERIALS

Radionuclide	Quantity Released (Curies) w/ Controls	Quantity Released (Curies) w/o Controls	Projected Dose (mrem) w/o Controls CAP-88	Projected Dose (mrem) w/o Controls GENII
1. Co-60	1.3E-06	3.9E-03	1.67E-04	6.2E-05
2. Cs-134	5.2E-07	1.6E-03	7.21E-05	8.1E-05
3. Cs-137	5.4E-07	1.6E-03	5.72E-05	6.2E-05
4.				
Total	2.4E-06	7.1E-03	2.96E-04	2.1E-04

FACILITY INVENTORY AT RISK OF NONRADIOACTIVE HAZARDOUS MATERIALS

Regulated Material	Quantity (lbs)	Quantity Released	RQ (lbs)
1.			
2.			
3.			
4.			

Identification of Reference Material

WHC-EP-0165-2

If the total projected dose from radionuclides exceeds 0.1 mrem ede from any one discharge point or if any one regulated material discharged from a facility exceeds 100% of a reportable quantity or a permitted quantity, a FEMP is required for that facility. Check the appropriate space below.

FEMP is required ___ FEMP is not required X

EVALUATOR ______ DATE 3/19/91

MANGER, ENVIRONMENTAL ______ DATE 3-15-91

FACILITY MANAGER ______ DATE 3-18-91

ATTACHMENT I

DETERMINATION OF FACILITY EFFLUENT MONITORING PLAN REQUIREMENT

FACILITY N REACTOR **DISCHARGE POINT** 105-N TOOL & EQUIP DECON FAC

FACILITY INVENTORY AT RISK OF RADIOACTIVE MATERIALS

Radionuclide	Quantity Released (Curies) w/ Controls	Quantity Released (Curies) w/o Controls	Projected Dose (mrem) w/o Controls CAP-88	Projected Dose (mrem) w/o Controls GENII
1. Co-60	1.1E-05	3.3E-02	1.41E-03	5.3E-04
2.				
3.				
4.				
Total	1.1E-05	3.3E-02	1.41E-03	5.3E-04

FACILITY INVENTORY AT RISK OF NONRADIOACTIVE HAZARDOUS MATERIALS

Regulated Material	Quantity (lbs)	Quantity Released	RQ (lbs)
1.			
2.			
3.			
4.			

Identification of Reference Material

WHC-EP-0165-2

If the total projected dose from radionuclides exceeds 0.1 mrem ede from any one discharge point or if any one regulated material discharged from a facility exceeds 100% of a reportable quantity or a permitted quantity, a FEMP is required for that facility. Check the appropriate space below.

FEMP is required ___ FEMP is not required X

EVALUATOR [signature] DATE 3/19/91

MANGER, ENVIRONMENTAL [signature] DATE 3-15-91

FACILITY MANAGER [signature] DATE 3-19-91

ATTACHMENT I

DETERMINATION OF FACILITY EFFLUENT MONITORING PLAN REQUIREMENT

FACILITY N REACTOR **DISCHARGE POINT** 107-N EXHAUST

FACILITY INVENTORY AT RISK OF RADIOACTIVE MATERIALS

Radionuclide	Quantity Released (Curies) w/ Controls	Quantity Released (Curies) w/o Controls	Projected Dose (mrem) w/o Controls CAP-88	Projected Dose (mrem) w/o Controls GENII
1. Mn-54	6.2E-06	1.9E-02	1.51E-04	3.3E-05
2. Co-60	1.5E-05	4.5E-02	1.93E-03	7.2E-04
3. Cs-137	6.4E-06	1.9E-02	2.04E-04	2.1E-04
4.				
Total	2.8E-05	8.3E-02	2.28E-03	9.6E-04

FACILITY INVENTORY AT RISK OF NONRADIOACTIVE HAZARDOUS MATERIALS

Regulated Material	Quantity (lbs)	Quantity Released	RQ (lbs)
1.			
2.			
3.			
4.			

Identification of Reference Material

WHC-EP-0165-2

If the total projected dose from radionuclides exceeds 0.1 mrem ede from any one discharge point or if any one regulated material discharged from a facility exceeds 100% of a reportable quantity or a permitted quantity, a FEMP is required for that facility. Check the appropriate space below.

FEMP is required ___ FEMP is not required X

EVALUATOR [signature] DATE 3/19/91

MANGER, ENVIRONMENTAL KA Gano DATE 3-15-91

FACILITY MANAGER [signature] DATE 3-19-91

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ATTACHMENT I

DETERMINATION OF FACILITY EFFLUENT MONITORING PLAN REQUIREMENT

FACILITY N REACTOR **DISCHARGE POINT** 105-N (Non-rad)

FACILITY INVENTORY AT RISK OF RADIOACTIVE MATERIALS

Radionuclide	Quantity Released (Curies) w/ Controls	Quantity Released (Curies) w/o Controls	Projected Dose (mrem) w/o Controls CAP-88	Projected Dose (mrem) w/o Controls GENII
1.				
2.				
3.				
4.				
Total				

FACILITY INVENTORY AT RISK OF NONRADIOACTIVE HAZARDOUS MATERIALS

Regulated Material	Quantity (lbs)	Quantity Released	RQ (lbs)
1. 1,1,2-Trichloro- 1,2,2-trifluoroethane[1]			
2.	900	NR	1
3.			
4.			

Identification of Reference Material

SARA Tier II Emergency and Hazardous Materials Inventory
1 - Classified as F002 Halogenated Solvent

If the total projected dose from radionuclides exceeds 0.1 mrem ede from any one discharge point or if any one regulated material discharged from a facility exceeds 100% of a reportable quantity or a permitted quantity, a FEMP is required for that facility. Check the appropriate space below.

FEMP is required ___ FEMP is not required X

EVALUATOR [signature] DATE 3/19/91

MANGER, ENVIRONMENTAL KA Hans DATE 3-15-91

FACILITY MANAGER [signature] DATE 3-19-91

ATTACHMENT I

DETERMINATION OF FACILITY EFFLUENT MONITORING PLAN REQUIREMENT

FACILITY N REACTOR　　　**DISCHARGE POINT** 107-N

FACILITY INVENTORY AT RISK OF RADIOACTIVE MATERIALS

Radionuclide	Quantity Released (Curies) w/ Controls	Quantity Released (Curies) w/o Controls	Projected Dose (mrem) w/o Controls CAP-88	Projected Dose (mrem) w/o Controls GENII
1.				
2.				
3.				
4.				
Total				

FACILITY INVENTORY AT RISK OF NONRADIOACTIVE HAZARDOUS MATERIALS

Regulated Material	Quantity (lbs)	Quantity Released	RQ (lbs)
1. Sodium Hydroxide	10582	NR	1000
2. Sulfuric Acid	25881	NR	1000
3.			
4.			

Identification of Reference Material

SARA Tier II Emergency and Hazardous Materials Inventory

If the total projected dose from radionuclides exceeds 0.1 mrem ede from any one discharge point or if any one regulated material discharged from a facility exceeds 100% of a reportable quantity or a permitted quantity, a FEMP is required for that facility. Check the appropriate space below.

FEMP is required ___　　　FEMP is not required X

EVALUATOR ______ DATE 3/19/91

MANGER, ENVIRONMENTAL ______ DATE 3-15-91

FACILITY MANAGER ______ DATE 3-15-91

ATTACHMENT I

DETERMINATION OF FACILITY EFFLUENT MONITORING PLAN REQUIREMENT

FACILITY N REACTOR **DISCHARGE POINT** 108-N

FACILITY INVENTORY AT RISK OF RADIOACTIVE MATERIALS

Radionuclide	Quantity Released (Curies) w/ Controls	Quantity Released (Curies) w/o Controls	Projected Dose (mrem) w/o Controls CAP-88	Projected Dose (mrem) w/o Controls GENII
1.				
2.				
3.				
4.				
Total				

FACILITY INVENTORY AT RISK OF NONRADIOACTIVE HAZARDOUS MATERIALS

Regulated Material	Quantity (lbs)	Quantity Released	RQ (lbs)
1. Sodium Hydroxide	74076	NR	1000
2. Sulfuric Acid	181168	NR	1000
3.			
4.			

Identification of Reference Material

SARA Tier II Emergency and Hazardous Materials Inventory

If the total projected dose from radionuclides exceeds 0.1 mrem ede from any one discharge point or if any one regulated material discharged from a facility exceeds 100% of a reportable quantity or a permitted quantity, a FEMP is required for that facility. Check the appropriate space below.

FEMP is required ___ FEMP is not required X

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MANGER, ENVIRONMENTAL [signature] DATE 3-15-91

FACILITY MANAGER [signature] DATE 3-19-91

ATTACHMENT I

DETERMINATION OF FACILITY EFFLUENT MONITORING PLAN REQUIREMENT

FACILITY N REACTOR **DISCHARGE POINT** 109-N (Non-rad)

FACILITY INVENTORY AT RISK OF RADIOACTIVE MATERIALS

Radionuclide	Quantity Released (Curies) w/ Controls	Quantity Released (Curies) w/o Controls	Projected Dose (mrem) w/o Controls CAP-88	Projected Dose (mrem) w/o Controls GENII
1.				
2.				
3.				
4.				
Total				

FACILITY INVENTORY AT RISK OF NONRADIOACTIVE HAZARDOUS MATERIALS

Regulated Material	Quantity (lbs)	Quantity Released	RQ (lbs)
1. Ammonium Hydroxide	12712	NR	1000
2. Sodium Hypochlorite	338	NR	100
3.			
4.			

Identification of Reference Material

SARA Tier II Emergency and Hazardous Materials Inventory

If the total projected dose from radionuclides exceeds 0.1 mrem ede from any one discharge point or if any one regulated material discharged from a facility exceeds 100% of a reportable quantity or a permitted quantity, a FEMP is required for that facility. Check the appropriate space below.

FEMP is required ___ FEMP is not required X

EVALUATOR [signature] DATE 3/19/91

MANGER, ENVIRONMENTAL KA Gano DATE 3-15-91

FACILITY MANAGER [signature] DATE 3-19-91

ATTACHMENT I

DETERMINATION OF FACILITY EFFLUENT MONITORING PLAN REQUIREMENT

FACILITY N REACTOR **DISCHARGE POINT** 166-N

FACILITY INVENTORY AT RISK OF RADIOACTIVE MATERIALS

Radionuclide	Quantity Released (Curies) w/ Controls	Quantity Released (Curies) w/o Controls	Projected Dose (mrem) w/o Controls CAP-88	Projected Dose (mrem) w/o Controls GENII
1.				
2.				
3.				
4.				
Total				

FACILITY INVENTORY AT RISK OF NONRADIOACTIVE HAZARDOUS MATERIALS

Regulated Material	Quantity (lbs)	Quantity Released	RQ (lbs)
1. Diesel Fuel	1020316	NR	10000
2. No. 6 Fuel Oil	3456035	NR	100
3.			
4.			

Identification of Reference Material

SARA Tier II Emergency and Hazardous Materials Inventory

If the total projected dose from radionuclides exceeds 0.1 mrem ede from any one discharge point or if any one regulated material discharged from a facility exceeds 100% of a reportable quantity or a permitted quantity, a FEMP is required for that facility. Check the appropriate space below.

FEMP is required ___ FEMP is not required X

EVALUATOR [signature] DATE 3/19/91

MANGER, ENVIRONMENTAL [signature] DATE 3-15-91

FACILITY MANAGER [signature] DATE 3-19-91

ATTACHMENT I

DETERMINATION OF FACILITY EFFLUENT MONITORING PLAN REQUIREMENT

FACILITY N REACTOR **DISCHARGE POINT** 182-N

FACILITY INVENTORY AT RISK OF RADIOACTIVE MATERIALS

Radionuclide	Quantity Released (Curies) w/ Controls	Quantity Released (Curies) w/o Controls	Projected Dose (mrem) w/o Controls CAP-88	Projected Dose (mrem) w/o Controls GENII
1.				
2.				
3.				
4.				
Total				

FACILITY INVENTORY AT RISK OF NONRADIOACTIVE HAZARDOUS MATERIALS

Regulated Material	Quantity (lbs)	Quantity Released	RQ (lbs)
1. Diesel Fuel	103032	NR	10000
2. Sodium Hypochlorite	948	NR	100
3.			
4.			

Identification of Reference Material

SARA Tier II Emergency and Hazardous Materials Inventory

If the total projected dose from radionuclides exceeds 0.1 mrem ede from any one discharge point or if any one regulated material discharged from a facility exceeds 100% of a reportable quantity or a permitted quantity, a FEMP is required for that facility. Check the appropriate space below.

FEMP is required ___ FEMP is not required X

EVALUATOR ______ DATE 3/19/91

MANGER, ENVIRONMENTAL ______ DATE 3-15-91

FACILITY MANAGER ______ DATE 3-19-91

ATTACHMENT I

DETERMINATION OF FACILITY EFFLUENT MONITORING PLAN REQUIREMENT

FACILITY N REACTOR **DISCHARGE POINT** 183-N

FACILITY INVENTORY AT RISK OF RADIOACTIVE MATERIALS

Radionuclide	Quantity Released (Curies) w/ Controls	Quantity Released (Curies) w/o Controls	Projected Dose (mrem) w/o Controls CAP-88	Projected Dose (mrem) w/o Controls GENII
1.				
2.				
3.				
4.				
Total				

FACILITY INVENTORY AT RISK OF NONRADIOACTIVE HAZARDOUS MATERIALS

Regulated Material	Quantity (lbs)	Quantity Released	RQ (lbs)
1. Aluminum Sulfate	49638	NR	5000
2. Chlorine	5486	NR	10
3. Separan	3836	NR	unknown
4.			

Identification of Reference Material

SARA Tier II Emergency and Hazardous Materials Inventory

If the total projected dose from radionuclides exceeds 0.1 mrem ede from any one discharge point or if any one regulated material discharged from a facility exceeds 100% of a reportable quantity or a permitted quantity, a FEMP is required for that facility. Check the appropriate space below.

FEMP is required ___ FEMP is not required X

EVALUATOR [signature] DATE 3/19/91

MANGER, ENVIRONMENTAL [signature] DATE 3-15-91

FACILITY MANAGER [signature] DATE 3-19-91

ATTACHMENT I

DETERMINATION OF FACILITY EFFLUENT MONITORING PLAN REQUIREMENT

FACILITY N REACTOR **DISCHARGE POINT** 184-N

FACILITY INVENTORY AT RISK OF RADIOACTIVE MATERIALS

Radionuclide	Quantity Released (Curies) w/ Controls	Quantity Released (Curies) w/o Controls	Projected Dose (mrem) w/o Controls CAP-88	Projected Dose (mrem) w/o Controls GENII
1.				
2.				
Total				

FACILITY INVENTORY AT RISK OF NONRADIOACTIVE HAZARDOUS MATERIALS

Regulated Material	Quantity (lbs)	Quantity Released	RQ (lbs)
1. Diesel Fuel	102032	NR	10000
2. No. 6 Fuel Oil	864009	NR	100
3.			
4.			

Identification of Reference Material

SARA Tier II Emergency and Hazardous Materials Inventory

If the total projected dose from radionuclides exceeds 0.1 mrem ede from any one discharge point or if any one regulated material discharged from a facility exceeds 100% of a reportable quantity or a permitted quantity, a FEMP is required for that facility. Check the appropriate space below.

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EVALUATOR [signature] DATE 3/19/91

MANGER, ENVIRONMENTAL [signature] DATE 3-15-91

FACILITY MANAGER [signature] DATE 3-19-91

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ATTACHMENT I

DETERMINATION OF FACILITY EFFLUENT MONITORING PLAN REQUIREMENT

FACILITY N REACTOR **DISCHARGE POINT** 163-N

FACILITY INVENTORY AT RISK OF RADIOACTIVE MATERIALS

Radionuclide	Quantity Released (Curies) w/ Controls	Quantity Released (Curies) w/o Controls	Projected Dose (mrem) w/o Controls CAP-88	Projected Dose (mrem) w/o Controls GENII
1.				
2.				
3.				
4.				
Total				

FACILITY INVENTORY AT RISK OF NONRADIOACTIVE HAZARDOUS MATERIALS

Regulated Material	Quantity (lbs)	Quantity Released	RQ (lbs)
1. Chlorine	9	NR	10
2. Hydrazine	5543	NR	1
3. Morpholine	2379	NR	10000
4. Nalco 158	5950	NR	
5. Nalco 7958-D	2035	NR	
6. Nalco 8258	6695	NR	
7. Sodium Hydroxide	21165	NR	1000
8. Sulfuric Acid	51762	NR	1000

Identification of Reference Material

SARA Tier II Emergency and Hazardous Materials Inventory

If the total projected dose from radionuclides exceeds 0.1 mrem ede from any one discharge point or if any one regulated material discharged from a facility exceeds 100% of a reportable quantity or a permitted quantity, a FEMP is required for that facility. Check the appropriate space below.

FEMP is required ___ FEMP is not required X

EVALUATOR [signature] DATE 3/19/91
MANGER, ENVIRONMENTAL KA [signature] DATE 3-15-91
FACILITY MANAGER [signature] DATE 3-18-91

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ATTACHMENT 2

PACIFIC NORTHWEST LABORATORY GENII UNIT DOSE CONVERSION FACTORS

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GENII Dose Estimates for 1 Ci Radionuclide Releases--100 Areas; Location to the Individual: 9,900 m West. (2 sheets)

Nuclide	Ground level dose equivalent (rem)*	89-m Stack dose equivalent (rem)*
^{3}H	3.5 E-08	1.0 E-08
^{24}Na	1.1 E-07	4.5 E-08
^{41}Ar	9.0 E-09	6.9 E-09
^{51}Cr	3.6 E-08	1.1 E-08
^{54}Mn	1.8 E-06	5.5 E-07
^{56}Mn	2.3 E-08	1.1 E-08
^{59}Fe	1.9 E-06	5.8 E-07
^{58}Co	1.5 E-06	4.5 E-07
^{60}Co	1.6 E-05	4.7 E-06
^{76}As	1.6 E-07	5.1 E-08
^{85m}Kr	1.9 E-09 (100)*	9.1 E-10 (100)
^{85}Kr	2.7 E-11	1.4 E-11
^{87}Kr	4.4 E-09	2.8 E-09
^{88}Kr	2.4 E-08	1.3 E-08
^{89}Sr	2.0 E-06	5.8 E-07
^{90}Sr	5.9 E-05 (94)	1.8 E-05 (94)
^{91}Sr	5.4 E-08 (73)	1.9 E-08 (76)
^{95}Zr	1.9 E-06 (75)	5.7 E-07 (75)
^{95}Nb	7.2 E-07	2.2 E-07
^{99}Mo	1.4 E-07 (98)	4.4 E-08 (98)
^{103}Ru	8.8 E-07 (100)	2.6 E-07 (100)
^{106}Ru	2.4 E-05	7.1 E-06
^{124}Sb	3.4 E-06	1.0 E-06
^{132}Te	5.8 E-07 (86)	1.7 E-07 (86)
^{131}I	9.0 E-05 (100)	2.6 E-05 (100)
^{132}I	3.6 E-08	1.7 E-08
^{133}I	1.4 E-06 (100)	4.1 E-07 (100)
^{135}I	9.6 E-08 (95)	3.5 E-08 (95)
^{133}Xe	6.9 E-10	3.0 E-10

GENII Dose Estimates for 1 Ci Radionuclide Releases--100 Areas; Location to the Individual: 9,900 m West. (2 sheets)

Nuclide	Ground level dose equivalent (rem)*	89-m Stack dose equivalent (rem)*
^{135}Xe	3.4 E-09	1.5 E-09
^{134}Cs	5.2 E-05	1.6 E-05
^{137}Cs	3.8 E-05	1.1 E-05
^{138}Cs	5.2 E-09	5.0 E-09
^{140}Ba	1.7 E-06 (50)	5.1 E-07 (51)
^{140}La	2.2 E-07	7.3 E-08
^{141}Ce	6.9 E-07	2.0 E-07
^{144}Ce	1.8 E-05 (100)	5.4 E-06 (100)
^{153}Sm	9.4 E-08	2.8 E-08
^{154}Eu	1.5 E-05	4.3 E-06
^{155}Eu	2.0 E-06	5.8 E-07
^{238}Pu	1.1 E-02	3.2 E-03
^{239}Np	1.3 E-07 (100)	3.9 E-08 (100)
^{239}Pu	1.1 E-02	3.3 E-03

*Doses calculated with GENII include contributions from the parent nuclide, long-lived daughter chains, and short-lived daughters. Numbers in parenthesis indicate the percent of the total dose attributable to the parent nuclide in chains with long-lived daughters.

GENII Dose Estimates for 1 Ci Liquid Releases to the Columbia River. (2 sheets)

Nuclide	100 and 200 Areas MI* at Ringold dose equivalent (rem)**	300 Area MI* at Riverview dose equivalent (rem)**
^{3}H	6.4 E-10	
^{24}Na	2.7 E-08	
^{32}P	2.5 E-04	
^{51}Cr	3.3 E-09	
^{54}Mn	6.6 E-07	
^{59}Fe	6.1 E-06	
^{58}Co	5.4 E-07	
^{60}Co	2.4 E-06	
^{65}Zn	1.6 E-05	
^{89}Sr	3.1 E-07	
^{90}Sr	6.1 E-06	6.1 E-06
^{95}Zr	4.6 E-07	
^{99}Mo	1.7 E-08	
^{99}Tc	3.9 E-07	3.9 E-07
^{103}Ru	1.7 E-07	
^{106}Ru	1.6 E-06	
^{124}Sb	1.1 E-06	
^{125}Sb	4.0 E-07	
^{129}I	1.7 E-05	
^{131}I	1.8 E-06	
^{133}I	1.2 E-07	
^{133}Xe	1.4 E-10	
^{134}Cs	4.6 E-04	
^{137}Cs	3.2 E-04	
^{140}Ba	1.1 E-06	
^{141}Ce	6.6 E-07	
^{144}Ce	4.9 E-06	
^{234}U	8.9 E-07	8.9 E-07
^{235}U	9.6 E-07	9.6 E-07

GENII Dose Estimates for 1 Ci Liquid Releases to the Columbia River. (2 sheets)

Nuclide	100 and 200 Areas MI* at Ringold dose equivalent (rem)**	300 Area MI* at Riverview dose equivalent (rem)**
^{238}U	9.5 E-07	9.5 E-07
^{238}Pu	5.8 E-06	
^{239}Pu	6.0 E-06	
^{241}Pu	9.7 E-08	
^{241}Am	2.0 E-04	
^{239}Np	2.8 E-06	

*MI = Maximally exposed individual.

**Doses calculated with GENII include contributions from the parent nuclide, long-lived daughter chains, and short-lived daughters.

PART 2

100 AREA SURPLUS REACTORS

FACILITY EFFLUENT MONITORING PLAN DETERMINATION

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CONTENTS

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100 AREA SURPLUS REACTORS
FACILITY EFFLUENT MONITORING PLAN DETERMINATION

1.0 INTRODUCTION

The Hanford Restoration Operations department is responsible for determining Facility Effluent Monitoring Plan (FEMP) applicability to the surplus Hanford Site reactors: B, C, D, DR, F, and H. Evaluation for determining the need for preparing a FEMP was conducted by Hanford Restoration Operations using WHC-EP-0438 (WHC 1991).

2.0 STATUS OF OPERATION

The Hanford Site surplus reactors are currently shut down. Decommissioning activities are scheduled to begin following approval of the Environmental Impact Statement (EIS) which addresses how these activities are to be performed. The retired reactors are in a surveillance and maintenance mode until decommissioning activities begin.

3.0 SOURCE TERMS

In the surveillance and maintenance mode, the inactive reactor facilities do not use, generate, release, or manage significant pollutants of radioactive or nonradioactive hazardous materials. There are no gaseous or liquid effluents, nor are there any active effluent monitoring systems associated with these facilities. They are not identified in WHC-EP-0165-2 (Rokkan 1991), which classifies all 100 Area facilities with gaseous and liquid effluents. (See Attachment 1.)

4.0 POTENTIAL UPSET-OPERATING CONDITIONS

No potential upset conditions have been identified or deemed credible. No mechanisms were identified for routine release of the surplus reactor-contained radionuclides offsite and, therefore, no analyses were performed for operational radiological impact to the offsite population. Ecological impacts from these facilities are essentially unchanged from present conditions.

5.0 SUMMARY

The *Draft Environmental Impact Statement for the Decommissioning of 8 Surplus Production Reactors at the Hanford Site, Richland WA*, DOE/EIS-0119D, supports the decision that there is no inventory at risk requiring a FEMP. Section 5.2 of the draft EIS briefly discusses the radiological release potential of the reactors in their current state and concludes there are no identifiable mechanisms for routine offsite releases of radionuclides and hazardous materials from the surplus reactors. Therefore, a FEMP is not required.

6.0 REFERENCES

DOE, 1989, *Draft Environmental Impact Statement for the Decommissioning of 8 Surplus Production Reactors at the Hanford Site, Richland WA*, DOE/EIS-0199D, U.S. Department of Energy, Washington, D.C.

WHC, 1991, *A Guide for Preparing Hanford Site Facility Effluent Monitoring Plans*, WHC-EP-0438, Westinghouse Hanford Company, Richland, Washington.

Rokkan, D. J., 1991, *Westinghouse Hanford Company 100 Area Environmental Releases for 1989*, WHC-EP-0165-2, Westinghouse Hanford Company, Richland, Washington.

ATTACHMENT 1

DETERMINATION OF FACILITY EFFLUENT MONITORING PLAN REQUIREMENTS

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DETERMINATION OF FACILITY EFFLUENT MONITORING PLAN REQUIREMENT

FACILITY 100-B Reactor **DISCHARGE POINT** None

FACILITY INVENTORY AT RISK OF RADIOACTIVE MATERIALS

	Radionuclide	Physical/Chemical Form	Quantity (Curies)	Quantity Released	Projected Dose (mrem)
1.	No radioactive material "at risk."				
2.					
3.					
4.					
Total					

FACILITY INVENTORY AT RISK OF NONRADIOACTIVE HAZARDOUS MATERIALS

	Regulated Material	Quantity (lbs)	Quantity Released	Reportable Quantity (lbs)	% of Reportable Quantity/Year
1.	No nonradioactive hazardous material "at risk."				
2.					
3.					
4.					

Identification of Reference Material

DOE/EIS-0119D, "Decommissioning of Eight Surplus Production Reactors at the Hanford Site, Richland, Washington, DEIS."

If the total projected dose from radionuclides exceeds 0.1 mrem ede from any one discharge point or if any one regulated material discharged from a facility exceeds 100% of a reportable quantity or a permitted quantity, a FEMP is required for that facility. Check the appropriate space below.

FEMP is required ____ FEMP is not required X

EVALUATOR J. R. Brehm [signature] DATE 1-25-91

MANAGER, ENVIRONMENTAL [signature] DATE 3-12-91

FACILITY MANAGER B. F. Weaver [signature] DATE 1-25-91

DETERMINATION OF FACILITY EFFLUENT MONITORING PLAN REQUIREMENT

FACILITY 100-C Reactor **DISCHARGE POINT** None

FACILITY INVENTORY AT RISK OF RADIOACTIVE MATERIALS

	Radionuclide	Physical/Chemical Form	Quantity (Curies)	Quantity Released	Projected Dose (mrem)
1.	No radioactive material "at risk."				
2.					
3.					
4.					
Total					

FACILITY INVENTORY AT RISK OF NONRADIOACTIVE HAZARDOUS MATERIALS

	Regulated Material	Quantity (lbs)	Quantity Released	Reportable Quantity (lbs)	% of Reportable Quantity/Year
1.	No nonradioactive hazardous material "at risk."				
2.					
3.					
4.					

Identification of Reference Material

DOE/EIS-0119D, "Decommissioning of Eight Surplus Production Reactors at the Hanford Site, Richland, Washington, DEIS."

If the total projected dose from radionuclides exceeds 0.1 mrem ede from any one discharge point or if any one regulated material discharged from a facility exceeds 100% of a reportable quantity or a permitted quantity, a FEMP is required for that facility. Check the appropriate space below.

FEMP is required ____ FEMP is not required X

EVALUATOR J. R. Brehm *[signature]* DATE 1-25-91

MANAGER, ENVIRONMENTAL *[signature]* DATE 3-12-91

FACILITY MANAGER B. F. Weaver *[signature]* DATE 1-25-91

DETERMINATION OF FACILITY EFFLUENT MONITORING PLAN REQUIREMENT

FACILITY 100-D Reactor **DISCHARGE POINT** None

FACILITY INVENTORY AT RISK OF RADIOACTIVE MATERIALS

	Radionuclide	Physical/Chemical Form	Quantity (Curies)	Quantity Released	Projected Dose (mrem)
1.	No radioactive material "at risk."				
2.					
3.					
4.					
Total					

FACILITY INVENTORY AT RISK OF NONRADIOACTIVE HAZARDOUS MATERIALS

	Regulated Material	Quantity (lbs)	Quantity Released	Reportable Quantity (lbs)	% of Reportable Quantity/Year
1.	No nonradioactive hazardous material "at risk."				
2.					
3.					
4.					

Identification of Reference Material

DOE/EIS-0119D, "Decommissioning of Eight Surplus Production Reactors at the Hanford Site, Richland, Washington, DEIS."

If the total projected dose from radionuclides exceeds 0.1 mrem ede from any one discharge point or if any one regulated material discharged from a facility exceeds 100% of a reportable quantity or a permitted quantity, a FEMP is required for that facility. Check the appropriate space below.

FEMP is required ____ FEMP is not required X

EVALUATOR J. R. Brehm [signature] DATE 1-25-91

MANAGER, ENVIRONMENTAL [signature] DATE 3-12-91

FACILITY MANAGER B. F. Weaver [signature] DATE 1-25-91

DETERMINATION OF FACILITY EFFLUENT MONITORING PLAN REQUIREMENT

FACILITY 100-DR Reactor **DISCHARGE POINT** None

FACILITY INVENTORY AT RISK OF RADIOACTIVE MATERIALS

	Radionuclide	Physical/Chemical Form	Quantity (Curies)	Quantity Released	Projected Dose (mrem)
1.	No radioactive material "at risk."				
2.					
3.					
4.					
Total					

FACILITY INVENTORY AT RISK OF NONRADIOACTIVE HAZARDOUS MATERIALS

	Regulated Material	Quantity (lbs)	Quantity Released	Reportable Quantity (lbs)	% of Reportable Quantity/Year
1.	No nonradioactive hazardous material "at risk."				
2.					
3.					
4.					

Identification of Reference Material

DOE/EIS-0119D, "Decommissioning of Eight Surplus Production Reactors at the Hanford Site, Richland, Washington, DEIS."

If the total projected dose from radionuclides exceeds 0.1 mrem ede from any one discharge point or if any one regulated material discharged from a facility exceeds 100% of a reportable quantity or a permitted quantity, a FEMP is required for that facility. Check the appropriate space below.

FEMP is required ____ FEMP is not required X

EVALUATOR J. R. Brehm *J. R. Brehm* DATE 1-25-91

MANAGER, ENVIRONMENTAL *[signature]* DATE 3-12-91

FACILITY MANAGER B. F. Weaver *B. F. Weaver* DATE 1-25-91

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DETERMINATION OF FACILITY EFFLUENT MONITORING PLAN REQUIREMENT

FACILITY 100-F Reactor DISCHARGE POINT None

FACILITY INVENTORY AT RISK OF RADIOACTIVE MATERIALS

	Radionuclide	Physical/Chemical Form	Quantity (Curies)	Quantity Released	Projected Dose (mrem)
1.	No radioactive material "at risk."				
2.					
3.					
4.					
Total					

FACILITY INVENTORY AT RISK OF NONRADIOACTIVE HAZARDOUS MATERIALS

	Regulated Material	Quantity (lbs)	Quantity Released	Reportable Quantity (lbs)	% of Reportable Quantity/Year
1.	No nonradioactive hazardous material "at risk."				
2.					
3.					
4.					

Identification of Reference Material

DOE/EIS-0119D, "Decommissioning of Eight Surplus Production Reactors at the Hanford Site, Richland, Washington, DEIS."

If the total projected dose from radionuclides exceeds 0.1 mrem ede from any one discharge point or if any one regulated material discharged from a facility exceeds 100% of a reportable quantity or a permitted quantity, a FEMP is required for that facility. Check the appropriate space below.

FEMP is required ____ FEMP is not required X

EVALUATOR J. R. Brehm *J R Brehm* DATE *1-25-91*

MANAGER, ENVIRONMENTAL *[signature]* DATE *2-12-91*

FACILITY MANAGER B. F. Weaver *B F Weaver* DATE *1-25-91*

DETERMINATION OF FACILITY EFFLUENT MONITORING PLAN REQUIREMENT

FACILITY 100-H Reactor **DISCHARGE POINT** None

FACILITY INVENTORY AT RISK OF RADIOACTIVE MATERIALS

	Radionuclide	Physical/Chemical Form	Quantity (Curies)	Quantity Released	Projected Dose (mrem)
1.	No radioactive material "at risk."				
2.					
3.					
4.					
Total					

FACILITY INVENTORY AT RISK OF NONRADIOACTIVE HAZARDOUS MATERIALS

	Regulated Material	Quantity (lbs)	Quantity Released	Reportable Quantity (lbs)	% of Reportable Quantity/Year
1.	No nonradioactive hazardous material "at risk."				
2.					
3.					
4.					

Identification of Reference Material

DOE/EIS-0119D, "Decommissioning of Eight Surplus Production Reactors at the Hanford Site, Richland, Washington, DEIS."

If the total projected dose from radionuclides exceeds 0.1 mrem ede from any one discharge point or if any one regulated material discharged from a facility exceeds 100% of a reportable quantity or a permitted quantity, a FEMP is required for that facility. Check the appropriate space below.

FEMP is required ____ FEMP is not required X

EVALUATOR J. R. Brehm *J R Brehm* DATE 1-25-91

MANAGER, ENVIRONMENTAL *[signature]* DATE 3-12-91

FACILITY MANAGER B. F. Weaver *B F Weaver* DATE 1-25-91

ATTACHMENT 2

PACIFIC NORTHWEST LABORATORY
GENII DOSE ESTIMATES

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Table 1. GENII Dose Estimates for 1 Ci Radionuclide Releases - 100 Areas. Location to the Individual: 9,900 m West. (2 sheets)

Nuclide	Ground level dose equivalent (rem)*	89-m Stack dose equivalent (rem)*
^{3}H	3.5 E-08	1.0 E-08
^{24}Na	1.1 E-07	4.5 E-08
^{41}Ar	9.0 E-09	6.9 E-09
^{51}Cr	3.6 E-08	1.1 E-08
^{54}Mn	1.8 E-06	5.5 E-07
^{56}Mn	2.3 E-08	1.1 E-08
^{59}Fe	1.9 E-06	5.8 E-07
^{58}Co	1.5 E-06	4.5 E-07
^{60}Co	1.6 E-05	4.7 E-06
^{76}As	1.6 E-07	5.1 E-08
^{85m}Kr	1.9 E-09 (100)*	9.1 E-10 (100)
^{85}Kr	2.7 E-11	1.4 E-11
^{87}Kr	4.4 E-09	2.8 E-09
^{88}Kr	2.4 E-08	1.3 E-08
^{89}Sr	2.0 E-06	5.8 E-07
^{90}Sr	5.9 E-05 (94)	1.8 E-05 (94)
^{91}Sr	5.4 E-08 (73)	1.9 E-08 (76)
^{95}Zr	1.9 E-06 (75)	5.7 E-07 (75)
^{95}Nb	7.2 E-07	2.2 E-07
^{99}Mo	1.4 E-07 (98)	4.4 E-08 (98)
^{103}Ru	8.8 E-07 (100)	2.6 E-07 (100)
^{106}Ru	2.4 E-05	7.1 E-06
^{124}Sb	3.4 E-06	1.0 E-06
^{132}Te	5.8 E-07 (86)	1.7 E-07 (86)
^{131}I	9.0 E-05 (100)	2.6 E-05 (100)
^{132}I	3.6 E-08	1.7 E-08
^{133}I	1.4 E-06 (100)	4.1 E-07 (100)
^{135}I	9.6 E-08 (95)	3.5 E-08 (95)
^{133}Xe	6.9 E-10	3.0 E-10
^{135}Xe	3.4 E-09	1.5 E-09
^{134}Cs	5.2 E-05	1.6 E-05
^{137}Cs	3.8 E-05	1.1 E-05

Table 1. GENII Dose Estimates for 1 Ci Radionuclide Releases - 100 Areas. Location to the Individual: 9,900 m West. (2 sheets)

Nuclide	Ground level dose equivalent (rem)*	89-m Stack dose equivalent (rem)*
^{138}Cs	5.2 E-09	5.0 E-09
^{140}Ba	1.7 E-06 (50)	5.1 E-07 (51)
^{140}La	2.2 E-07	7.3 E-08
^{141}Ce	6.9 E-07	2.0 E-07
^{144}Ce	1.8 E-05 (100)	5.4 E-06 (100)
^{153}Sm	9.4 E-08	2.8 E-08
^{154}Eu	1.5 E-05	4.3 E-06
^{155}Eu	2.0 E-06	5.8 E-07
^{238}Pu	1.1 E-02	3.2 E-03
^{239}Np	1.3 E-07 (100)	3.9 E-08 (100)
^{239}Pu	1.1 E-02	3.3 E-03

*Doses calculated with GENII include contributions from the parent nuclide, long-lived daughter chains, and short-lived daughters. Numbers in parenthesis indicate percent of the total dose attributable to the parent nuclide in chains with long-lived daughters.

Table 2. CAP-88 Dose Estimates for 1 Ci Radionuclide Releases - 100 Areas. Location to the Individual: 9,900 m West. (2 sheets)

Nuclide	10-m Stack dose equivalent (mrem)*	89-m Stack dose equivalent (mrem)*
^{3}H	3.36 E-05	8.85 E-06
^{24}Na	2.19 E-04	6.72 E-05
^{41}Ar	1.41 E-05	4.38 E-06
^{51}Cr	9.32 E-05	2.80 E-05
^{54}Mn	8.11 E-03	2.44 E-03
^{56}Mn	3.56 E-05	1.20 E-05
^{59}Fe	4.72 E-03	1.42 E-03
^{58}Co	4.75 E-03	1.43 E-03
^{60}Co	4.28 E-02	1.29 E-02
^{76}As	1.81 E-04	5.50 E-05
^{85m}Kr	2.62 E-06	7.35 E-07
^{85}Kr	7.49 E-08	1.97 E-08
^{87}Kr	7.18 E-06	2.41 E-06
^{88}Kr	3.11 E-05	9.07 E-06
^{89}Sr	3.11 E-03	9.35 E-04
^{90}Sr	6.45 E-02	1.94 E-02
^{91}Sr	5.39 E-05	1.67 E-05
^{95}Zr	3.90 E-03	1.17 E-03
^{95}Nb	2.60 E-03	7.81 E-04
^{99}Mo	2.41 E-04	7.28 E-05
^{103}Ru	2.10 E-03	6.31 E-04
^{106}Ru**	3.08 E-02	9.26 E-03
^{124}Sb	8.90 E-03	2.68 E-03
^{132}Te	6.29 E-04	1.90 E-04
^{131}I	1.84 E-02	1.65 E-02
^{132}I	2.48 E-05	2.54 E-05
^{133}I	1.72 E-04	1.56 E-04
^{135}I	5.99 E-05	5.62 E-05
^{133}Xe	7.71 E-07	2.04 E-07
^{135}Xe	4.73 E-06	1.28 E-06
^{134}Cs	4.62 E-02	1.39 E-02
^{137}Cs***	3.53 E-02	1.06 E-02
^{138}Cs	7.20 E-06	3.77 E-06

Table 2. CAP-88 Dose Estimates for 1 Ci Radionuclide Releases - 100 Areas. Location to the Individual: 9,900 m West. (2 sheets)

Nuclide	10-m Stack dose equivalent (mrem)*	89-m Stack dose equivalent (mrem)*
^{140}Ba	1.86 E-03	5.60 E-04
^{140}La	4.49 E-04	1.36 E-04
^{141}Ce	1.21 E-03	3.65 E-04
^{144}Ce	2.02 E-02	6.08 E-03
^{153}Sm	1.13 E-04	3.42 E-05
^{154}Eu	2.69 E-02	8.10 E-03
^{155}Eu	2.73 E-03	8.20 E-04
^{238}Pu	1.18 E+01	3.56 E+00
^{239}Np	1.70 E-04	5.13 E-05
^{239}Pu	1.28 E+01	3.85 E+00

*Doses calculated with CAP-88 are for the parent nuclide only and do not include contributions from long-lived daughter chains.

**Short-lived daughters are included in dose from parent nuclides.

Table 3. GENII Dose Estimates for 1 Ci Liquid Releases to the Columbia River.

Nuclide	100 and 200 Areas MI* at Ringold dose equivalent (rem)**	300 Area MI* at Riverview dose equivalent (rem)**
^{3}H	6.4 E-10	
^{24}Na	2.7 E-08	
^{32}P	2.5 E-04	
^{51}Cr	3.3 E-09	
^{54}Mn	6.6 E-07	
^{59}Fe	6.1 E-06	
^{58}Co	5.4 E-07	
^{60}Co	2.4 E-06	
^{65}Zn	1.6 E-05	
^{89}Sr	3.1 E-07	
^{90}Sr	6.1 E-06	6.1 E-06
^{95}Zr	4.6 E-07	
^{99}Mo	1.7 E-08	
^{99}Tc	3.9 E-07	3.9 E-07
^{103}Ru	1.7 E-07	
^{106}Ru	1.6 E-06	
^{124}Sb	1.1 E-06	
^{125}Sb	4.0 E-07	
^{129}I	1.7 E-05	
^{131}I	1.8 E-06	
^{133}I	1.2 E-07	
^{133}Xe	1.4 E-10	
^{134}Cs	4.6 E-04	
^{137}Cs	3.2 E-04	
^{140}Ba	1.1 E-06	
^{141}Ce	6.6 E-07	
^{144}Ce	4.9 E-06	
^{234}U	8.9 E-07	8.9 E-07
^{235}U	9.6 E-07	9.6 E-07
^{238}U	9.5 E-07	9.5 E-07
^{238}Pu	5.8 E-06	
^{239}Pu	6.0 E-06	

Table 3. GENII Dose Estimates for 1 Ci Liquid Releases to the Columbia River.

Nuclide	100 and 200 Areas MI* at Ringold dose equivalent (rem)**	300 Area MI* at Riverview dose equivalent (rem)**
^{241}Pu	9.7 E-08	
^{241}Am	2.0 E-04	
^{239}Np	2.8 E-06	

*MI = maximally exposed individual

**Doses calculated with GENII include contributions from the parent nuclide, long-lived daughter chains, and short-lived daughters.

PART 3

K AREA FUEL STORAGE BASINS

AND ENGINEERING LABORATORY

FACILITY EFFLUENT MONITORING PLAN DETERMINATION

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CONTENTS

CONTENTS (continued)

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LIST OF TERMS

ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
CFR	Code of Federal Regulations
D&D	decontamination and decommissioning
DOE	U.S. Department of Energy
EDE	effective dose equivalent
EPA	U.S. Environmental Protection Agency
FEMP	Facility Effluent Monitoring Plan
HEPA	high-efficiency particulate air (filter)
ICRP	International Commission on Radiological Protection
MT	metric ton
NPDES	National Pollutant Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission
PNL	Pacific Northwest Laboratory
QA	quality assurance
WAC	Washington Administrative Code
Westinghouse Hanford	Westinghouse Hanford Company

K AREA FUEL STORAGE BASINS AND ENGINEERING LABORATORY

FACILITY EFFLUENT MONITORING PLAN DETERMINATION

1.0 INTRODUCTION

1.1 PURPOSE

The purpose of this report is to evaluate the gaseous emissions and liquid effluent of KE/KW Fuel Storage Basins, KE Environmental and Engineering Demonstration Laboratory (hereinafter referred to as the engineering laboratory), and the KE Water Studies Recirculation Building to determine the potential annual radiation exposure to the maximally exposed individual offsite. This evaluation will determine the degree to which Westinghouse Hanford Company (Westinghouse Hanford) must monitor the KE/KW airborne emissions and liquid effluents. A Facility Effluent Monitoring Plan (FEMP) will be developed for the normal operating condition of the basins and the engineering laboratory as required by the U.S. Department of Energy (DOE) Orders 5400.1 (DOE 1988a), 5400.3 (DOE 1989a), 5400.4 (DOE 1989b), 5400.5 (DOE 1990), 5480.1 (DOE 1982), 5480.11 (DOE 1988b), and 5484.1 (DOE 1981), and U.S. Environmental Protection Agency (EPA) regulation 40 Code of Federal Regulations (CFR) 61 (EPA 1989b).

1.2 STATUS OF OPERATION

1.2.1 Radionuclide Effluent Releases

Radionuclides are emitted from KE/KW at four locations for air emissions and one liquid effluent discharge. Radionuclides are discharged to the air from the 105-KE Fuel Storage Basin, the 105-KW Fuel Storage Basin, the engineering laboratory, and the 1706-KE Water Studies Recirculation Building. Radionuclides are discharged to the Columbia River from one discharge point located at the 1908-KE Outfall, also known as National Pollutant Discharge Elimination System (NPDES) Outfall 004. The radionuclides emitted from the effluent release points via the air pathway and the liquid effluent pathway are ^{3}H, ^{60}Co, ^{90}Sr, ^{134}Cs, ^{137}Cs, ^{238}Pu, ^{239}Pu, and ^{240}Pu.

Due to the release of these radioisotopes to the air environment, the KE/KW Fuel Storage Basins, 1706-KE, and 1706-KER effluents are subject to 40 CFR 61, Subpart H (EPA 1989b).

The KE/KW operating facilities also are subject to DOE Orders 5400.1 (DOE 1988a), 5400.3 (DOE 1989a), 5400.4 (DOE 1989b), 5400.5 (DOE 1990), 5480.1 (DOE 1982), 5480.11 (DOE 1988b), and 5484.1 (DOE 1981) because of their release of radioactivity to both air and water. These orders require that radioactive effluents to the environment be as low as reasonably achievable and use the best available control technology to control effluents. The effluents must be monitored to ensure that regulatory requirements are met, and a monitoring plan and procedures must be in place to ensure they are implemented.

1.2.2 Nonradioactive Chemical Effluent Releases

The potential nonradioactive hazardous air pollutants that were considered in this report were those listed in 40 CFR 61.01(a) and (b) (EPA 1989b). It was determined, after a thorough review of the KE/KW operating facilities, that none of the chemicals listed in either 40 CFR 61.01(a) or (b), with the exception of radionuclides, are present in the airborne releases from KE or KW. Therefore, radionuclides are the only hazardous air pollutant considered in this report.

For the KE and KW operating facilities, the single liquid release point to the Columbia River was reviewed to determine the potential to release hazardous waste. The 1908-KE Outfall is a permitted NPDES outfall and the analysis performed on this outfall for the permit does not indicate any presence of hazardous waste.

Hazardous process chemicals currently stored onsite at the 100 K Area are listed in Table 1-1 and Attachment I. The potential for their release via the airborne or liquid effluent pathway has been reviewed. This review has determined that there is very little potential for these chemicals to be released via any of the effluent release points. The process chemicals that may be discharged are shown in Table 1-1 and Attachment 1.

1.2.3 Summary of Effluent Release Components

In conclusion, this determination for developing a FEMP, with respect to DOE orders and 40 CFR 61 (EPA 1989b), demonstrates that only the release of radionuclides to the environment via the air, water, and groundwater pathways occurs at KE and KW operating facilities. There are no other hazardous waste

Table 1-1. Process Chemicals Stored at KE/KW.

Chemical stored	Pounds stored	Pounds released	Building location
Sodium hypochlorite	120	NR*	165-KW
Chlorine	6,000	NR	183-KE
Polyacrylamide	50	NR	183-KE
Sodium hydroxide	18,970	NR	1706-KE
Sulfuric acid	31,681	NR	1706-KE

*None Released.

materials released by KE and KW operating facilities via either the air emissions pathway or the liquid effluent pathway. Hazardous materials are stored at 100 K Area; however, there is very little potential for their release to the effluents from KE or KW.

1.3 SCOPE

The KE/KW Reactor Facilities were built in the 1950's and shut down in 1971; however, the fuel storage basins and the engineering laboratory continued to operate. In 1975 the KE/KW basins were modified to provide temporary storage for the irradiated fuel from N Reactor until it could be processed at the Plutonium-Uranium Extraction Plant. Since the 1970's the air emissions and liquid effluents emitted from KE/KW originated from only the Fuel Storage Basins and the engineering laboratory. Effluents from the KE/KW Reactor facilities ended in the early 1970's (refer to the retired reactor FEMP determination, Part 2 of this document, for details); therefore, this FEMP determination is limited to the effluents from the Fuel Storage Basins at KE and KW and the engineering laboratory at KE.

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2.0 FACILITY DESCRIPTION

The 100 K Area is located on the Hanford Site approximately 25 mi northwest of Richland, Washington, as shown in Figure 2-1. The 100 K Area itself is shown in Figure 2-2.

The KE and KW reactors are two of nine water-cooled, graphite-moderated plutonium production reactors built along the Columbia River between 1943 and 1963. All of these reactors, with the exception of N Reactor, have been retired and are inactive.

The KE and KW reactors were identical reactors built approximately 0.25 mi apart. They were graphite-moderated, plutonium-producing reactors using once-through cooling. The reactors and their support facilities were constructed between 1952 and 1954. Both reactors began service in 1955 with KW ceasing operation in February 1970 and KE in February 1971. The reactors share a few ancillary structures; however, major support facilities were exactly duplicated.

After they were shut down the KE and KW reactor systems were deactivated and decontaminated. When the initial decontamination was completed, approximately 1 yr was spent cleaning and modifying the 105-KE and 105-KW Basins for storing N Reactor irradiated fuel. Additional modifications and repairs of the fuel storage basin system included modification to the basin cooling systems to closed system, and a leak repair in the 105-KE Basin. Actual storage of N Reactor irradiated fuel began in 1975 and currently continues. Shipment of this fuel to the basins for storage ceased in 1989.

Current operations at the 100 K Facilities include N Reactor irradiated fuel storage in the 105-KE and 105-KW Fuel Storage Basins and environmental laboratory work being performed in the 1706-KE Facility. Work is currently being planned for re-encapsulating the fuel in the 105-KE and 105-KW Basins.

2.1 FUEL STORAGE BASINS

The 105-KE and 105-KW Fuel Storage Basins were constructed identically. Since then, minor modifications have resulted in slight differences. The basins are both constructed of reinforced concrete. They are rectangular, 125 ft long by 67 ft wide by 21 ft deep. A depth of 16 ft of water is maintained in each basin. Modifications were performed on both basins to allow storage of spent N fuels. Each basin was modified to include a recirculation system for the basin water including in-line filters, an ion exchange system, a sand filter system, heat exchangers, and instrumentation to monitor radiation levels, heat generation rate, and basin water level. This included a remote alarm system. Both basins have racks installed on their floors for storing the N Reactor fuel canisters.

The minor differences in the two basins result from later modifications. The KE Basin is equipped with the equipment for segregation of the N Reactor fuel. Some fuel stored in the KE Basin is in open containers. Presently there is only fuel segregation equipment in the KE Basin; thus, fuel segregation activities can only be performed in the KE Basin.

Figure 2-1. U.S. Department of Energy's Hanford Site.

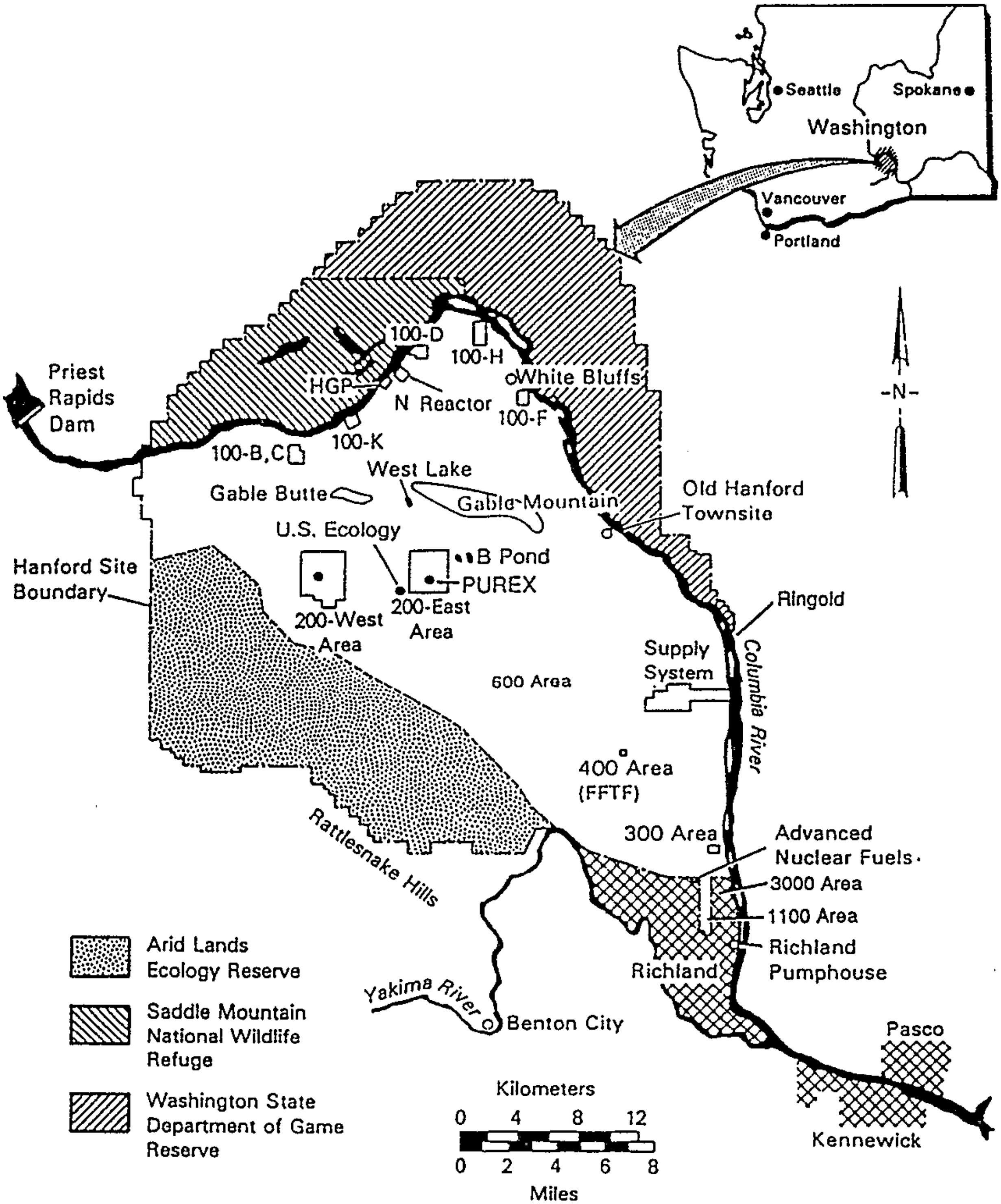
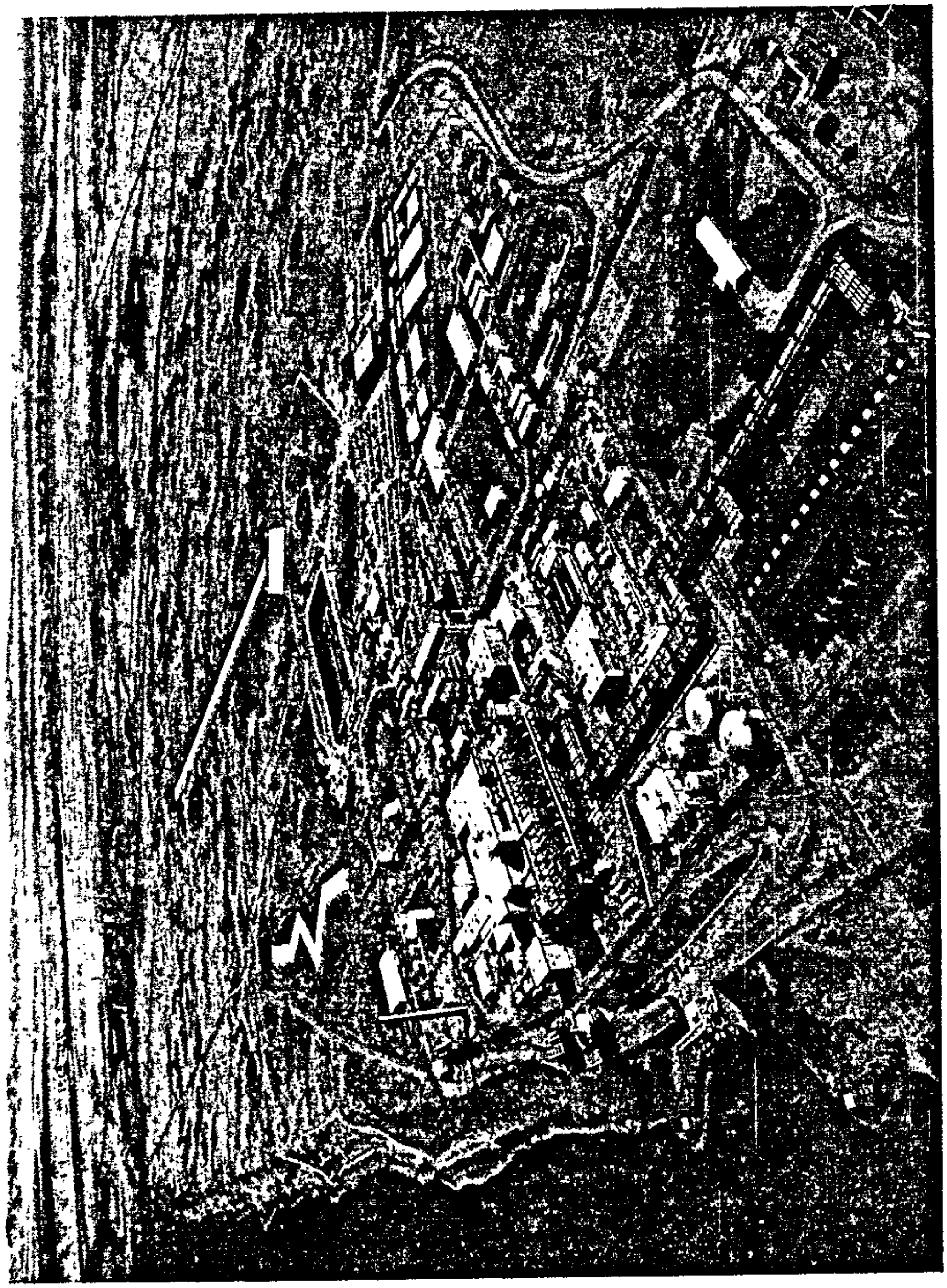


Figure 2-2. 100 K Area.



The 105-KW Basin was coated with a pliable epoxy sealant and only encapsulated fuel canisters are stored in the basin.

In an effort to increase fuel storage capacity both basins were modified to provide the capability to hang fuel canisters over those canisters stored on the floor of the basin. This increased the fuel storage capacity of each basin by a potential 375 metric tons (MT). Additionally, water chillers were installed in both basins to increase the heat exchange capacity. This was in an effort to lower the basin water temperature and reduce the dose rate to the personnel in the basin areas.

2.2 1706-KE FACILITY

The engineering laboratory was designed as a testing complex for single pass and recirculating in-reactor test loops and prototype out-of-test reactor loops. The loops were used for studying the effects of water quality and decontamination solvents on the corrosion characteristics of reactor hardware and fuel element material.

The facility was used to perform testing for operational support for N Reactor startup in 1963 and KE reactor shutdown in 1971. Among the testing programs performed were water quality control, corrosion, decontamination, procedure development, waste treatment systems development, ion exchange, evaluations, and materials testing.

Currently some corrosion testing is performed at this facility in support of N Reactor standby. The old Pacific Northwest Laboratory (PNL) is currently undergoing modification to become the 242-A Evaporator Pilot Plant. The ion exchangers in this building supply the demineralized water to the K Area Fuel Storage Basins. This facility also performs some testing in support of D&D activities.

3.0 EFFLUENT RELEASE POINT DESCRIPTION

3.1 AIRBORNE DISCHARGE POINTS

3.1.1 105-KE Exhaust Vent

This exhaust is the vent for the area that contains the fuel storage basin in the 105-KE Building. This vent exhausts at a rate of approximately 27,000 ft^3/min. This exhaust vents the air directly from the fuel storage area without treatment. The exhaust vent is located on the north face of the building approximately 42 ft above the ground. This exhaust is continuously sampled for radionuclides.

3.1.2 1706-KEL

This exhaust is the vent for the 1706-KE Laboratory. This exhaust releases air at an approximate rate of 12,000 ft^3/min. The air from this vent is first passed through a high-efficiency particulate air (HEPA) filter before being released to the atmosphere. The release point is located approximately 25 ft above the ground.

3.1.3 1706-KER

This is the exhaust for the basement area of the 1706-KE Laboratory. This vent is located approximately 3 ft above the ground and discharges at an approximate rate of 2,500 ft^3/min. The air from this exhaust is passed through a HEPA filter before being released to the atmosphere.

3.1.4 105-KW Exhaust Vent

This exhaust is the vent for the area that contains the fuel storage basin in the 105-KW Building. Because the 105-KE and 105-KW Buildings are of identical design, the characteristics of this vent are identical to those of the 105-KE vent. This vent also exhausts at a rate of approximately 27,000 ft^3/min. This exhaust vents the air directly from the fuel storage area without treatment. The exhaust vent is located on the north face of the building approximately 42 ft above the ground. This exhaust is continuously sampled for radionuclides.

3.2 LIQUID DISCHARGE POINT

The only liquid effluent discharge point at the K Area is the 1908-K Outfall. This is a permitted NPDES discharge--NPDES Outfall 004. This outfall discharges cooling water used in the heat exchangers, which are used to maintain the fuel storage basin water temperature. It also discharges the neutralized regeneration waste water from the 1706-KE Building ion exchange columns and water from the KE and KW clearwell and settling basin. This outfall discharges liquids to the Columbia River at a rate of approximately 3.7×10^8 gal/yr. This outfall is continuously sampled for radionuclides and periodically for NPDES requirements.

4.0 KE/KW FUEL STORAGE BASINS SOURCE TERM

The KE and KW Fuel Storage Basins are located in the 105-KE and 105-KW Reactor Buildings, respectively. These two buildings are identically constructed and separated by a distance of approximately 0.25 mi. The basins contain irradiated fuel from N Reactor. The irradiated fuel in each basin was produced by a different mode of reactor operation during different time periods. The KE Basin contains recently irradiated fuel produced during the 1980's for weapons production, while the fuel in KW Basin was produced primarily in the 1970's in the process of producing electricity. Therefore, the source terms of the basins are similar but not identical. A summary of the KE/KW Storage Basin inventories is provided in Attachment 1.

4.1 KE FUEL STORAGE BASIN SOURCE TERM

The KE Basin contains approximately 1,150 MT of irradiated fuel. Because it requires approximately 380 MT of fuel for a full reactor load, this translates into approximately 3.0 full reactor loads. A source term for KE Basin was calculated using the knowledge of the radionuclide inventory at the end of the fuel cycle, and the fact that the fuel is at least 4 yr old.

As shown in Table 4-1, the inventory in one full reactor load fuel is approximately 4.11 x 10^9 Ci. This inventory is a conservative approach to the number of curies produced by fission in the reactor. It assumes the entire fuel core is in equilibrium at the end of the fuel cycle; actually, only about one-third of the core reaches equilibrium.

To calculate the current KE Basin source term, this inventory was broken down by radionuclide and decayed for 4 yr using standard radioactivity decay calculations. This inventory was then multiplied by the number of reactor loads of fuel in the basin, giving a current radionuclide inventory in KE Basin which was calculated to be approximately 8.5 x 10^6 Ci, as shown in Table 4-1.

Because some of the stored fuel contains approximately 7 to 10% failed fuel cladding and is stored in open canisters, some of the fission products have migrated into the water environment of the basin. Table 4-2 shows the inventory in the water is approximately 56 Ci.

4.2 KW FUEL STORAGE BASIN SOURCE TERM

The KW Basin contains approximately 956 MT of fuel, which is approximately 2.5 full reactor loads of fuel. Using the knowledge of the N Reactor core fission products inventory for a single reactor load of fuel at the end of the fuel cycle, a source term for KW Basin can be calculated by considering that the fuel at KW has decayed for at least 12 yr and multiplying the remaining inventory amounts by 2.5.

Table 4-1. Fission Product Inventory in Fuel Storage Basins. (2 sheets)

Radio-nuclide	Reactor load inventory[1] (Ci)	KE Basin[2] (Ci)	KW Basin[3] (Ci)
^{85}Kr	1.113 E+05	2.600 E+05	1.287 E+05
^{85m}Kr	4.271 E+07	0.000 E+00	0.000 E+00
^{87}Kr	8.229 E+07	0.000 E+00	0.000 E+00
^{88}Kr	1.164 E+08	0.000 E+00	0.000 E+00
^{86}Rb	8.564 E+03	0.000 E+00	0.000 E+00
^{89}Sr	9.672 E+07	5.824 E-01	0.000 E+00
^{90}Sr	9.170 E+05	2.520 E+06	1.728 E+06
^{91}Sr	1.927 E+08	0.000 E+00	0.000 E+00
^{90}Y	8.906 E+05	3.857 E-01	0.000 E+00
^{91}Y	1.095 E+08	1.182 E+01	0.000 E+00
^{95}Zr	1.138 E+08	4.691 E+01	0.000 E+00
^{97}Zr	2.033 E+08	0.000 E+00	0.000 E+00
^{95}Nb	5.865 E+07	0.000 E+00	0.000 E+00
^{99}Mo	2.109 E+08	0.000 E+00	0.000 E+00
^{99m}Tc	1.820 E+08	0.000 E+00	0.000 E+00
^{103}Ru	8.103 E+07	1.726 E-03	0.000 E+00
^{105}Ru	4.933 E+07	0.000 E+00	0.000 E+00
^{106}Ru	2.431 E+06	4.671 E+05	1.565 E+03
^{105}Rh	4.261 E+07	0.000 E+00	0.000 E+00
^{127}Sb	5.564 E+06	0.000 E+00	0.000 E+00
^{129}Sb	2.448 E+07	0.000 E+00	0.000 E+00
^{127}Te	4.830 E+06	9.550 E+02	0.000 E+00
^{127m}Te	2.700 E+05	0.000 E+00	0.000 E+00
^{129}Te	2.200 E+07	0.000 E+00	0.000 E+00
^{129m}Te	4.607 E+05	0.000 E+00	0.000 E+00
^{131m}Te	1.340 E+07	0.000 E+00	0.000 E+00
^{132}Te	1.483 E+08	0.000 E+00	0.000 E+00
^{131}I	9.979 E+07	0.000 E+00	0.000 E+00
^{132}I	1.493 E+08	0.000 E+00	0.000 E+00

Table 4-1. Fission Product Inventory in Fuel Storage Basins. (2 sheets)

Radio-nuclide	Reactor load inventory[1] (Ci)	KE Basin[2] (Ci)	KW Basin[3] (Ci)
^{133}I	2.340 E+08	0.000 E+00	0.000 E+00
^{134}I	2.613 E+08	0.000 E+00	0.000 E+00
^{135}I	2.184 E+08	0.000 E+00	0.000 E+00
^{133}Xe	2.332 E+08	0.000 E+00	0.000 E+00
^{135}Xe	3.641 E+07	0.000 E+00	0.000 E+00
^{134}Cs	3.853 E+04	3.115 E+04	1.848 E+03
^{136}Cs	4.710 E+05	0.000 E+00	0.000 E+00
^{137}Cs	9.395 E+05	2.592 E+06	1.791 E+06
^{140}Ba	2.103 E+08	0.000 E+00	0.000 E+00
^{140}La	2.103 E+08	0.000 E+00	0.000 E+00
^{141}Ce	1.548 E+08	0.000 E+00	0.000 E+00
^{143}Ce	2.011 E+08	0.000 E+00	0.000 E+00
^{144}Ce	2.864 E+07	2.458 E+06	1.644 E+03
^{143}Pr	1.946 E+08	0.000 E+00	0.000 E+00
^{147}Nd	6.670 E+07	0.000 E+00	0.000 E+00
^{239}Pu	5.380 E+04	1.628 E+05	1.353 E+05
TOTAL (Ci)	4.110 E+09	8.493 E+06	3.789 E+06

[1]At end of fuel cycle.
[2]KE Basin contains approximately 3.03 reactor loads of fuel aged 4 yr.
[3]KW Basin contains approximately 2.52 reactor loads of fuel aged 12 yr.
[4]Fuel quantities from K Basin accountability records.

The methodology used for this calculation was the same as that used for KE Basin. The resulting inventory obtained for the fuel stored in KW Basin was 3.79 x 10^6 Ci as shown in Table 4-1. Some of the fuel in KW Basin is stored in closed aluminum canisters; therefore, only a very small amount of fission products has dissolved into the basin water. For the KW Basin, the amount of radioactivity in the water is about 2.9 Ci as shown in Table 4-2.

Table 4-2. Fission Product Inventory in KE/KW Storage Basin Water.

KE/KW Basin radio-nuclide	KE Basin water (Ci)	KW Basin water (Ci)
^{3}H	2.1 E+01	7.9 E-01
^{54}Mn	6.2 E-02	9.1 E-04
^{60}Co	4.7 E-02	2.2 E-03
^{90}Sr	1.5 E+01	1.8 E+00
^{125}Sb	1.5 E-01	NA
^{134}Cs	6.8 E-02	5.0 E-03
^{137}Cs	1.9 E+01	3.5 E-01
^{238}Pu	1.6 E-02	9.7 E-06
^{239}Pu	9.1 E-02	5.0 E-05
Total	5.6 E+01	2.9 E+00

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5.0 REPRESENTATIVE KE/KW EFFLUENT RELEASE DATA

The objective of this report was to determine the extent to which a FEMP is needed for KE/KW operating facilities. Representative effluent data were selected from the plant historical effluent reports from 1981 to 1989 to make this determination. This evaluation provides the information for the type of FEMP needed for plant operation at KE/KW fuel storage basins, 1706-KEL, and 1706-KER.

The 105-KE/KW Reactor facilities were constructed in the 1950's, operated for 21 yr, and then shut down in 1971. However, the KE/KW Fuel Storage Basins continued to operate. They were modified in 1975 and 1981 to store N Reactor irradiated fuel. The source of the KE/KW radioactive effluents is the N Reactor fuel stored in the basins since 1975.

Effluent data were reviewed from 1981 to 1989 to determine if the data from any one of these years were representative of the 9-yr period. It was determined from Table 5-1 that the 1989 effluents were representative of the discharges during the 1980's and newly irradiated fuel had not been added to the basin since 1987. There is little potential in the future that newly irradiated fuel containing short-lived isotopes will be added to the basins at KE/KW. Therefore, it was decided to use the 1989 effluent release data to determine the need for continuous monitoring at each release point.

5.1 KE/KW BASIN AND LABORATORY AIRBORNE EMISSIONS RELEASE DATA

The K Area operations release radioactivity from the 105-KE and 105-KW Fuel Storage Basins, and the 1706-KEL and 1706-KER laboratories. The radioactivity is released from the roof vents over the KE/KW fuel storage basins without the use of environmental control equipment. The isotopes released are ^{60}Co, ^{90}Sr, ^{134}Cs, ^{137}Cs, ^{238}Pu, ^{239}Pu, and ^{240}Pu. In 1989 the facilities airborne releases ranged from a high of 4.4×10^{-5} Ci of ^{137}Cs at 105-KE to a low of 5.5×10^{-10} Ci of ^{238}Pu at 1706-KER. The total airborne release in 1989 was 1.9×10^{-4} Ci. The details of the releases from the specific release points in 1989 are shown in Table 5-2.

5.2 KE/KW NORMAL OPERATIONS LIQUID EFFLUENT RELEASE DATA

The K Area operations liquid releases of radioactivity occur at a single release point known as the 1908-KE Outfall or NPDES Outfall 004. The isotopes released to the Columbia River via this release point are ^{3}H, ^{60}Co, ^{90}Sr, ^{137}Cs, ^{239}Pu, and ^{240}Pu. In 1989 the release of radioactivity from this outfall ranged from 2.6×10^{-1} Ci of ^{3}H to 9.2×10^{-6} Ci of ^{239}Pu and ^{240}Pu. The total liquid release in 1989 was 3.4×10^{-1} Ci. The details of the release are shown in Table 5-3.

Table 5-1. K Area Airborne Emissions and Liquid Effluents 1981 to 1989 (Ci).

	1981	1982	1983	1984	1985	1986	1987	1988	1989
AIRBORNE RELEASES									
105-KE	6.26 E-03	1.22 E-03	1.72 E-03	2.29 E-03	1.31 E-03	2.85 E-04	7.44 E-04	1.64 E-04	1.25 E-04
105-KW	NA*	NA	7.39 E-05	4.18 E-04	1.18 E-04	9.64 E-05	6.71 E-05	9.23 E-05	5.74 E-05
1706-KEL	5.54 E-06	6.40 E-06	3.64 E-06	1.38 E-07	5.96 E-07	1.14 E-05	7.30 E-06	3.62 E-06	3.21 E-06
1706-KER	NA*	NA	NA	NA	NA	NA	NA	NA	1.71 E-06
Total	6.26 E-03	1.22 E-03	1.8 E-03	2.71 E-03	1.43 E-03	3.93 E-04	8.18 E-04	2.60 E-04	1.88 E-04
LIQUID RELEASES									
1908-KE	7.79 E-02	7.54 E-02	7.72 E-02	3.44 E-02	3.48 E-02	2.43 E-02	4.36 E-02	2.95 E-02	3.4 E-01

*Release quantities not available.

Table 5-2. Normal Operations Radioactive Airborne Emissions from K Area.

1989 Emissions			
	Release point		Release quantity (Ci)
105-KE	^{60}Co		3.70 E-05
	^{90}Sr		1.90 E-05
	^{134}Cs		2.50 E-05
	^{137}Cs		4.40 E-05
	^{238}Pu		5.70 E-08
	^{239,240}Pu		3.20 E-07
		Subtotal	1.26 E-04
1706-KEL	^{60}Co		3.20 E-06
	^{238}Pu		2.40 E-09
	^{239,240}Pu		3.00 E-09
		Subtotal	3.20 E-06
1706-KER	^{60}Co		1.00 E-06
	^{90}Sr		2.10 E-08
	^{137}Cs		6.90 E-07
	^{238}Pu		5.50 E-10
	^{239,240}Pu		1.80 E-09
		Subtotal	1.71 E-06
105-KW	^{60}Co		3.30 E-05
	^{90}Sr		4.10 E-07
	^{137}Cs		2.40 E-05
	^{238}Pu		6.00 E-09
	^{239,240}Pu		1.10 E-08
		Subtotal	5.74 E-05

Table 5-3. Normal Operations Radioactive Liquid Effluents from K Area.

1989 Emissions		
Release point		Release quantity (Ci)
1908-KE	^{3}H	2.6 E-01
	^{60}Co	6.6 E-02
	^{90}Sr	1.0 E-03
	^{137}Cs	1.0 E-02
	$^{239,240}Pu$	9.2 E-06
	Subtotal	3.37 E-01

5.3 KE/KW UNPLANNED-UPSET POTENTIAL EFFLUENT DATA

The unplanned-upset potential effluent data were developed using two assumptions. For airborne releases, the unplanned-upset condition was a conservative, hypothetical release of 1.0×10^{-3} the fission products inventory from the 10% failed fuel, to the basin water and, subsequently, 1.0×10^{-6} the basin water fission products inventory to the atmosphere for an overall partition coefficient of 1.0×10^{-10}.

For liquid releases the unplanned-upset condition was a conservative, hypothetical release of 1% of the basin water radioactivity assuming the basin level overflows the basin weirs and the plugs fail to function. Radioactivity is released directly to the Columbia River by this pathway. These releases were treated as being emitted over an entire year. The assumption that an upset condition lasts an entire year is a further conservative assumption required by DOE Orders 5400.1 (DOE 1988a), 5400.3 (DOE 1989a), 5400.4 (DOE 1989b), 5400.5 (DOE 1990), 5480.1 (DOE 1982), 5480.11 (DOE 1988b), and 5484.1 (DOE 1981) to evaluate the need for continuous effluent monitoring.

The potential upset airborne emission as shown in Table 5-4 shows the potential or hypothetical airborne emission to be 8.5×10^{-4} Ci from 105-KE and 3.8×10^{-4} Ci from 105-KW.

Table 5-5 illustrates that the hypothetical potential liquid effluent release is 5.9×10^{-1} Ci from the 1908-KE Outfall to the Columbia River from the KE and KW fuel storage basins.

Table 5-4. Normal Operations Airborne Emissions for K Area Unplanned-Upset Conditions.

Release point	Release quantity (Ci)
105-KE	8.5 E-04
105-KW	3.8 E-04

Note: (8.49 E+06 Ci in KE Basin) x (1.0 E-04 radionuclides to water) x (1.0 E-06 radionuclides to air) = 0.0085 Ci (8.5 E-04 Ci)

Table 5-5. Normal Operations Liquid Effluent Release for K Area Unplanned-Upset Condition.

Release point	Release quantity (Ci)
1908-KE	5.9 E-01

Note: 1% of the curies in KE and KW basin water are assumed to be released to the Columbia River.

6.0 MODELS FOR DOSE ASSESSMENT

6.1 BACKGROUND

On October 31, 1989, the EPA issued the final regulations for radioactive emissions to the air under 40 CFR 61 (EPA 1989b).

The regulations require the use of an EPA-approved dose assessment model to determine compliance of DOE facilities with 40 CFR 61.93(a) (EPA 1989b). The two EPA-approved models that were considered for use in this assessment were CAP-88 (Beres 1990) and AIRDOS-PC (EPA 1989a).

The EPA dose assessment models are designed to calculate the effective dose equivalent (EDE) value to the maximally exposed individuals. The model will also calculate the organ dose equivalent.

Because of the size of the CAP-88 model, it was loaded into the PNL computing system where it was used to calculate the doses resulting from releases on the Hanford Site.

Using the results of these calculations PNL developed tables of unit dose conversion factors for each radionuclide. The unit dose conversion factors are numbers that give the EDE for a 1 Ci release of a specific radionuclide to the maximally exposed individual. These doses calculated are a 50-yr committed EDE for all internal deposition pathways. The dose conversion table based on the CAP-88 (Beres 1990) model and developed by PNL appears in Table 6-1.

The CAP-88 model handles the ingrowth of long-lived radioactive daughters slightly differently than the PNL Generation II (GENII) Hanford Site-specific model (Napier et al. 1988). It will not calculate activities for ingrowth of daughter radionuclides following release of the parent, but will estimate the dose from very short-lived daughters where the parent-to-daughter activity ratio is effectively 1:1. The Hanford Site-specific GENII model results were compared to the EPA CAP-88 dose model results.

It is important to recognize that the AIRDOS-PC (EPA 1989a) computer model has a number of limitations that result in the model having a significant degree of inaccuracy. The limitations are described below.

- The model will only accept data from six release points and then uses the information as though it were released from one release point.
- No corrections are made for building wake factors.
- The model can accept data for only 18 radionuclides. The model is not capable of handling the large number of radionuclides that are released from nuclear reactors and nuclear chemical processing plants.
- There also is a restriction on which radionuclides can be used in the model.

Table 6-1. CAP-88 Dose Estimates for 1 Ci Radionuclide Releases - 100 Areas; Location to the Individual: 9,900 m West. (2 sheets)

Nuclide	10-m Stack dose equivalent (mrem)*	89-m Stack dose equivalent (mrem)*
^{3}H	3.36 E-05	8.85 E-06
^{24}Na	2.19 E-04	6.72 E-05
^{41}Ar	1.41 E-05	4.38 E-06
^{51}Cr	9.32 E-05	2.80 E-05
^{54}Mn	8.11 E-03	2.44 E-03
^{56}Mn	3.56 E-05	1.20 E-05
^{58}Co	4.75 E-03	1.43 E-03
^{60}Co	4.28 E-02	1.29 E-02
^{76}As	1.81 E-04	5.50 E-05
^{85m}Kr	2.62 E-06	7.35 E-07
^{85}Kr	7.49 E-08	1.97 E-08
^{87}Kr	7.18 E-06	2.41 E-06
^{88}Kr	3.11 E-05	9.07 E-06
^{89}Sr	3.11 E-03	9.35 E-04
^{90}Sr	6.45 E-02	1.94 E-02
^{91}Sr	5.39 E-05	1.67 E-05
^{95}Zr	3.90 E-03	1.17 E-03
^{95}Nb	2.60 E-03	7.81 E-04
^{99}Mo	2.41 E-04	7.28 E-05
^{103}Ru	2.10 E-03	6.31 E-04
^{106}Ru**	3.08 E-02	9.26 E-03
^{124}Sb	8.90 E-03	2.68 E-03
^{132}Te	6.29 E-04	1.90 E-04
^{131}I	1.84 E-02	1.65 E-02
^{132}I	2.48 E-05	2.54 E-05
^{133}I	1.72 E-04	1.56 E-04
^{135}I	5.99 E-05	5.62 E-05
^{133}Xe	7.71 E-07	2.04 E-07
^{135}Xe	4.73 E-06	1.28 E-06

Table 6-1. CAP-88 Dose Estimates for 1 Ci Radionuclide Releases - 100 Areas; Location to the Individual: 9,900 m West. (2 sheets)

Nuclide	10-m Stack dose equivalent (mrem)*	89-m Stack dose equivalent (mrem)*
^{134}Cs	4.62 E-02	1.39 E-02
^{137}Cs**	3.53 E-02	1.06 E-02
^{138}Cs	7.20 E-06	3.77 E-06
^{140}Ba	1.86 E-03	5.60 E-04
^{140}La	4.49 E-04	1.36 E-04
^{141}Ce	1.21 E-03	3.65 E-04
^{144}Ce	2.02 E-02	6.08 E-03
^{153}Sm	1.13 E-04	3.42 E-05
^{154}Eu	2.69 E-02	8.10 E-03
^{155}Eu	2.73 E-03	8.20 E-04
^{238}Pu	1.18 E+01	3.56 E+00
^{239}Np	1.70 E-04	5.13 E-05
^{239}Pu	1.28 E+01	3.85 E+00

*Doses calculated with CAP-88 (Beres 1990) are for the parent nuclide only, and do not include contributions from long-lived daughter chains.

**Short-lived daughters are included in dose from parent nuclide.

- The meteorological data that is in the model has been preloaded and may be significantly different than the local meteorology in the immediate area of the facility.
- There is no provision for the buildup of the uranium and thorium decay series products in the soil.
- The environmental decay constant is a constant 2%/yr.

Based on the above limitations, it was decided this model is inappropriate for the reactor fission product inventory in the KE/KW Fuel Storage Basins and the AIRDOS-PC model was not used in this determination.

7.0 ANNUAL DOSE ASSESSMENT WITH CONTROLS

The KE/KW dose assessment was performed using the unit dose conversion factors provided by PNL. The total dose expected from the releases from each facility were obtained by multiplying the quantity, in curies, for each radionuclide released from the facility by its corresponding unit dose conversion factor. The results for all the radionuclides emitted are summed to get the total dose for that facility.

The maximally exposed individual for the liquid releases was determined to be located at Ringold, Washington. For airborne releases the maximally exposed individual was determined to be located 9,900 m west of the K Area. This location was determined to be the offsite location with the highest offsite radionuclide concentration due to releases from the K Area under average atmospheric conditions.

7.1 KE/KW NORMAL OPERATIONS AIRBORNE DOSE ASSESSMENT

The KE/KW airborne dose assessment for the four airborne release points, three in KE and one in KW, was performed using the CAP-88 (Beres 1990) unit dose conversion factors provided by PNL. The individual radionuclide release quantities were multiplied by their corresponding unit dose conversion factor, and these results were summed for each release point. The resulting numbers give the 50-yr committed EDE for the maximally exposed individual living 9,900 m west of K Area.

The KE/KW fuel storage basins do not have positive environmental controls; therefore, a decontamination factor of 1.0 was used for the normal operation of the basins. The results of the dose determination are shown in Table 7-1. The results show that the primary contributor to the offsite dose from K Area is 105-KE with an offsite exposure of 1.0×10^{-5} mrem. All four of the airborne release points, assuming controls, resulted in very low offsite radiation exposures, ranging from 1.0×10^{-5} to 9.8×10^{-8} mrem.

The evaluation shows that none of the four airborne emission points at KE/KW during normal operation in 1989 resulted in radiation exposures greater that 0.1 mrem. However, the number of curies released from 105-KE and 105-KW is measurable, as discussed in Section 9.0, and should be monitored.

7.2 KE/KW NORMAL OPERATIONS LIQUID EFFLUENT DOSE ASSESSMENT

The liquid effluent dose assessment based on the one liquid effluent stream at the 1908-KE Outfall was determined using the PNL GENII (Napier et al. 1988) unit dose conversion factors. The individual radionuclide release quantities were multiplied by their corresponding unit dose conversion factor, and these results were summed to give the 50-yr committed EDE for the maximally exposed individual located at Ringold, Washington.

Table 7-1. K Area Normal Operations Dose Assessment for Airborne Emissions - 1989.

		Effective dose equivalent (mrem)	
Release point	Release (Ci)	CAP-88	GENII
105-KE	1.25 E-04	1.0 E-05	8.8 E-06
1706-KEL	3.21 E-06	2.0 E-07	1.1 E-07
1706-KER	1.71 E-06	9.8 E-08	6.9 E-08
105-KW	5.74 E-05	2.5 E-06	1.7 E-06

The results of the determination are shown in Table 7-2. The results show that the dose to the maximally exposed individual from radioactivity discharged to the Columbia River was 3.4×10^{-3} mrem. This dose is below the 0.1 mrem dose requiring continuous monitoring; however, the number of curies released to the Columbia River from this release point in Table 7-2 is measurable. It is therefore recommended that this release point be monitored.

Table 7-2. K Area Normal Operations Dose Assessment for Liquid Effluents - 1989.

Release point	Release (Ci)	Effective dose equivalent (mrem)
1908-KE Outfall	3.4 E-01	3.4 E-03

7.3 KE/KW UNPLANNED-UPSET RELEASE DOSE ASSESSMENT

The unplanned-upset airborne dose assessment is based on the conservative, hypothetical release from the failed fuel of 1.0×10^{-3} of the curies in the 10% failed fuel being released to the basin water and 1.0×10^{-6} of the radionuclides in the basin water being released to the atmosphere. The liquid release dose assessment assumed 1% of the basin water radioactivity assuming the basin level overflows the basin weirs and the plugs fail to function. Radioactivity was released directly to the Columbia River by this pathway.

The KE/KW airborne dose assessment for the unplanned-upset release was performed using the CAP-88 (Beres 1990) unit dose conversion factors provided by PNL, and the liquid dose assessment for the unplanned-upset release was performed using the PNL GENII (Napier et al. 1988) unit dose conversion factors. The unit dose conversion factors were used in the same manner as before. The results give the airborne dose to the maximally exposed individual located 9,900 m west of K Area, and the liquid dose to the maximally exposed individual located at Ringold, Washington. It was further assumed for the purpose of this evaluation that the release occurred over a 1-yr period with no additional radioactive decay.

7.3.1 KE Unplanned-Upset Airborne and Liquid Release Dose Assessment

The unplanned-upset dose assessment at KE Fuel Storage Basin was 10% based on the hypothetical release of 1.0×10^{-3} of its fission products in the failed fuel to the basin water, and 1.0×10^{-6} of the basin water inventory being released to the atmosphere over a period of 1 yr (1.0×10^{-10}). It was further conservatively assumed that the fuel has been stored at KE for 4 yr, taking into consideration radioactive decay.

The results of the dose assessment for KE Basin effluents are shown in Table 7-3. The results show the hypothetical radiation dose from air releases at 105-KE to the maximally exposed individual was 2.4×10^{-4} mrem, which requires periodic monitoring.

The radiation dose from the liquid effluent stream from the 1908-KE Outfall was 6.3×10^{-2} mrem. Potential effluent streams of this magnitude are required to be monitored by DOE Orders 5400.1 (DOE 1988a), 5400.3 (DOE 1989a), 5400.4 (DOE 1989b), 5400.5 (DOE 1990), 5480.1 (DOE 1982), 5480.11 (DOE 1988b), and 5484.1 (DOE 1981).

The dose assessment for 1706-KEL and 1706-KER is determined in Section 8.0, which determines the need for effluent monitoring at these release points.

7.3.2 KW Unplanned-Upset Airborne Release Dose Assessment

The unplanned-upset dose assessment at the KW Fuel Storage Basin was based on the release from the failed fuel of 1.0×10^{-3} the fission products in the 10% failed fuel stored in KW Basin to the basin water, and 1.0×10^{-6} of this subsequent basin water inventory being released to the atmosphere. It was further conservatively estimated that the fuel has been stored at KW for 12 yr and has undergone radioactive decay.

The results of the dose assessment for KW Basin's potential effluents also are shown in Table 7-3. The results show that the radiation dose from 105-KW airborne emissions is 1.9×10^{-4} mrem. Since the potential dose from this effluent release is less than 0.1 mrem, the 105-KW air release point must be periodically monitored.

Table 7-3. Normal Operations Unplanned-Upset Dose Assessment.

Release point	Release (Ci)	Effective dose equivalent (mrem)	
		CAP-88	GENII
105-KE	8.5 E-04	2.4 E-04	2.1 E-04
1706-KEL	9.62 E-03	6.1 E-04	3.3 E-04
1706-KER	5.14 E-03	2.9 E-04	2.1 E-04
105-KW	3.79 E-04	1.9 E-04	1.7 E-04

Release point	Release (Ci)	Effective dose equivalent (mrem)
1908-KE Outfall	5.80 E-01	6.3 E-02

8.0 KE/KW BASIN'S DOSE ASSESSMENT WITHOUT CONTROLS

The DOE Orders 5400.1 (DOE 1988a), 5400.3 (DOE 1989a), 5400.4 (DOE 1989b), 5400.5 (DOE 1990), 5480.1 (DOE 1982), 5480.11 (DOE 1988b), and 5484.1 (DOE 1981) and 40 CFR 61 (EPA 1989b) require a dose assessment without controls to determine the need for effluent monitoring. For this report the 1989 effluent release report quantities were used to determine the operational dose assessment without controls.

8.1 KE/KW DOSE FROM AIRBORNE EMISSIONS WITHOUT CONTROLS

The 105-KE and 105-KW Fuel Storage Basins do not have positive environmental controls; therefore, a decontamination factor of 1.0 would be used for the dose calculation without controls. However, DOE Orders 5400.1 (DOE 1988a), 5400.3 (DOE 1989a), 5400.4 (DOE 1989b), 5400.5 (DOE 1990), 5480.1 (DOE 1982), 5480.11 (DOE 1988b), and 5484.1 (DOE 1981) require that the dose due to potential release be calculated. For this requirement operational data show there is a potential for the airborne emissions to conservatively increase by a factor of 1,000 and the liquid effluents to increase by a factor of 100.

A good example of this potential is the 1986 1706-KEL annual airborne release of 1.14×10^{-5} Ci which was 83 times higher than the 1984 annual airborne release of 1.3×10^{-7} Ci as shown in Table 5-1. It can thus be conservatively estimated for the purpose of monitoring design that the airborne effluent can increase by a factor of 1,000 on a short-term basis.

To determine the annual dose from the various air emission points at 105-KE without controls, the dose assessment with controls was simply multiplied by a factor of 1,000 to obtain the annual dose assessment without controls for airborne effluents. The results of this evaluation are shown in Table 8-1. The 1706-KEL and 1706-KER airborne effluent release points have HEPA filters before release; therefore, a decontamination factor of 3,000 was used for these determinations.

Table 8-1 shows that none of the three KE air emission effluent points resulted in an annual radiation dose in excess of 0.1 mrem. The results ranged from 1.0×10^{-2} mrem for 105-KE, which was the highest value, to 2.9×10^{-4} mrem for 1706-KER, which was the lowest value. However, it should be recognized that 105-KE still releases measurable quantities of radioactivity and should be periodically monitored.

The airborne dose assessment for KW Fuel Storage Basin without controls was calculated in the same manner as the KE Fuel Storage Basin dose assessment without controls. The annual dose from 105-KW without controls was determined, as in the case of 105-KE, by multiplying the decontamination factor, 1,000, by the annual dose assessed with controls at 105-KW. The results of this evaluation are shown in Table 8-2.

Table 8-2 shows that the annual dose from 105-KW without controls is 2.5×10^{-3} mrem. The annual dose without controls is well below the 0.1 mrem that requires continuous effluent monitoring.

Table 8-1. KE Normal Operations Dose Assessment Without Controls for Airborne Emissions - 1989.

		Effective dose equivalent			
		Normal operation (mrem)		Potential increase (mrem)	
Release point	Release (Ci)	CAP-88	GENII	CAP-88	GENII
105-KE	1.3 E-04	1.0 E-05	8.8 E-06	1.0 E-02	8.8 E-03
1706-KEL	3.2 E-06	2.0 E-07	1.1 E-07	6.0 E-04	3.3 E-04
1706-KER	1.7 E-06	9.8 E-08	6.9 E-08	2.9 E-04	2.1 E-04

Table 8-2. KW Normal Operations Dose Assessment Without Controls for Airborne Emissions - 1989.

		Effective dose equivalent			
		Normal operation (mrem)		Potential increase (mrem)	
Release point	Release (Ci)	CAP-88	GENII	CAP-88	GENII
105-KW	5.7 E-05	2.5 E-06	1.7 E-06	2.5 E-03	1.7 E-03

8.2 KE/KW DOSE FROM LIQUID EFFLUENTS WITHOUT CONTROLS

The DOE Orders 5400.1 (DOE 1988a), 5400.3 (DOE 1989a), 5400.4 (DOE 1989b), 5400.5 (DOE 1990), 5480.1 (DOE 1982), 5480.11 (DOE 1988b), and 5484.1 (DOE 1981) require that a dose assessment be conducted on each effluent release point in the absence of control equipment. Operational data show the liquid effluents may increase from operational activities; therefore, a factor of 100 was used to determine the potential dose. The dose assessment with controls was simply multiplied by a factor of 100 to obtain the potential dose assessment. The results of this dose assessment are shown in Table 8-3.

The results show that the EDE without controls from the 1908-KE Outfall is 0.34 mrem. The DOE Orders 5400.1 (DOE 1988a), 5400.3 (DOE 1989a), 5400.4 (DOE 1989b), 5400.5 (DOE 1990), 5480.1 (DOE 1982), 5480.11 (DOE 1988b), and 5484.1 (DOE 1981) require that the release of any and all radionuclides to surface waters be monitored.

Table 8-3. KE Normal Operations Dose Assessment Without Controls for Liquid Effluents - 1989.

Release point	Release (Ci)	Effective dose equivalent: Normal operation mrem	Effective dose equivalent: Potential increase mrem
1908-KE	3.4 E-01	3.4 E-03	3.4 E-01

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9.0 SUMMARY

9.1 PURPOSE

This report evaluates the degree to which the KE and KW Fuel Storage Basins and the Environmental and Engineering Demonstration Laboratory effluents must be monitored because of the presence of N Reactor irradiated fuel in the basins and radioactive and hazardous materials in the engineering laboratory.

The results show that the KE and KW Fuel Storage Basin airborne emissions and liquid effluents must be periodically monitored as long as N Reactor fuel is present. These results indicate a Facility Effluent Monitoring Plan will be required for the KE and KW Fuel Storage Basins.

9.2 SOURCE TERM

The K Area accountability records indicate that there are 1,150 metric tons (MT) of irradiated fuel in the KE Fuel Storage Basin and 956 MT of irradiated fuel in the KW Fuel Storage Basin. From the probabilistic risk assessment reactor inventory performed by Westinghouse Hanford Company for N Reactor, it was calculated that the KE Basin contains approximately 8.5 MCi and the KW Basin contains approximately 3.8 MCi.

Since some of the fuel at KE is stored in open top canisters and approximately 7 to 10% of the fuel cladding has failed, the water in the basin contains approximately 56 Ci of radioisotopes that have migrated from the fuel to the water. By contrast the KW Basin, which has water-tight containers, has approximately 2.2 Ci of radioactivity that have migrated from the fuel to the water in the basin.

9.3 EFFLUENT RELEASE DATA

This report was based on the airborne emissions and liquid effluents that were emitted from the facilities in 1989. The evaluation shows the 105 KE and 105 KW airborne emissions in 1989 were 1.25×10^{-4} and 5.74×10^{-5} Ci, respectively. The liquid effluent released from the facilities is released from a single effluent point known as the 1908-KE Outfall. In 1989 the release from this outfall was 3.4×10^{-1} Ci. The airborne emissions from the 1706-KE Laboratory and the 1706-KE Recirculation Facility were 3.21×10^{-6} and 1.71×10^{-6} Ci, respectively.

9.4 MODELS FOR THE DOSE ASSESSMENT

The models that were used for the dose assessments were the EPA CAP-88 model (Beres 1990) and the Pacific Northwest Laboratory Generation II (GENII) model (Napier et al. 1988). The EPA AIRDOS-PC model (EPA 1989a) was shown to be inappropriate for a nuclear reactor and its fission product inventory.

9.5 KE/KW POTENTIAL DOSE ASSESSMENT

The evaluation shows that all five of the effluent points (four air emission points and one liquid effluent point) for normal operations were all less than 0.1 mrem when the actual effluents are considered; however, DOE orders require the potential release also be assessed.

The potential release evaluation indicated that the 1706-KEL and 1706-KER release points do not have the potential to result in a dose in excess of 0.1 mrem; therefore, these release points require only periodic confirmatory monitoring. The evaluation indicated that the airborne releases from 105-KE and 105-KW have the potential to result in a dose of 2.4×10^{-4} mrem and 1.9×10^{-4} mrem, respectively.

The potential release evaluation indicated the dose resulting from the liquid effluent from 1908-KE has the potential to be 6.3×10^{-2} mrem. This release point will require monitoring because of potential releases of radionuclides to the Columbia River.

9.6 KE/KW ANNUAL DOSE ASSESSMENT WITHOUT CONTROLS

The DOE (1991) document and 40 Code of Federal Regulations (CFR) 61 (EPA 1989b) require an annual dose assessment without controls to determine the need for effluent monitoring. The KE and KW fuel storage basins, however, do not have positive environmental controls. From releases in prior years it can be shown that for the purpose of determining the need for monitoring, there is a potential to increase the effluent emission rate by 1,000 for airborne emissions from 105-KE and 105-KW, a factor of 100 for liquid effluents from 1908-KE, and a factor of 3,000 for releases from 1706-KEL and 1706-KER. For example, the 1986 1706-KEL annual airborne release of 1.14×10^{-5} Ci was 83 times higher than the 1984 annual release of 1.38×10^{-7} Ci as shown in Table 5-1. The results of this evaluation are below.

Facility	Radiation Dose (mrem)
105-KE	1.0 E-02
1705-KEL	6.0 E-04
1706-KER	2.9 E-04
105-KW	2.5 E-03
1908-KE	3.4 E-01

In this evaluation dose assessment from the airborne emissions points are less than 0.1 mrem. The effluent release points will require only periodic confirmatory monitoring. However, the one liquid effluent point, known as the 1908-KE Outfall, would have to be monitored because of the release of radionuclides to the Columbia River.

9.7 SUMMARY CONCLUSIONS

Based on the potential radiation release and the release dose, none of the airborne effluent release points at KE or KW will require continuous effluent monitoring to comply with the DOE (1991) document.

The 1908-KE Outfall will require effluent monitoring because of the potential radiation release and the resulting dose of 3.4×10^{-1} mrem, and because radioactivity is released to the Columbia River.

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10.0 CONCLUSIONS OF 100-KE/KW FACILITY EFFLUENT MONITORING PLAN DETERMINATION

The DOE Orders 5400.1 (DOE 1988a), 5400.3 (DOE 1989a), 5400.4 (DOE 1989b), 5400.5 (DOE 1990), 5480.1 (DOE 1982), 5480.11 (DOE 1988b), and 5484.1 (DOE 1981) require a determination of dose to the maximally exposed individual without effluent controls and the dose to the maximally exposed individual from an upset plant condition to determine the degree to which effluents must be monitored.

This FEMP determination was based on the actual effluent release data from 1989 for the normal operating case potential release, and the hypothetical release of fission products from the fuel in the KE/KW Fuel Storage Basins for the upset condition.

10.1 100-KE FACILITY EFFLUENT MONITORING PLAN DETERMINATION CONCLUSIONS

The airborne dose assessment for 100-KE shows in Table 7-1 that the three airborne effluent release points during normal operation are well below the 0.1 mrem dose that requires continuous monitoring.

The airborne dose assessment considering potential release shows in Table 8-1 that none of the three airborne effluent release points, hypothetically operating without controls, exceed 0.1 mrem. The annual dose of the three emission points was determined to be as follows:

- 105-KE--1.0 x 10^{-2} mrem
- 1706-KEL--6.0 x 10^{-4} mrem
- 1706-KER--2.9 x 10^{-4} mrem.

The results indicate that none of the airborne emissions at 100-KE require continuous monitoring as required by DOE Orders 5400.1 (DOE 1988a), 5400.3 (DOE 1989a), 5400.4 (DOE 1989b), 5400.5 (DOE 1990), 5480.1 (DOE 1982), 5480.11 (DOE 1988b), and 5484.1 (DOE 1981). However, the 105-KE air emission point still emits measurable quantities of radioactivity as shown in Table 8-1. It is recommended that the 105-KE air emission point be monitored periodically.

As shown in Table 7-2, the dose resulting from releases from the 1908-KE Outfall is well below the 0.1 mrem dose that requires continuous monitoring. However, the 1908-KE Outfall should be monitored as long as there is a measurable release of radioactivity.

Table 8-3 shows that the potential release for liquid effluents will exceed the 0.1 mrem dose requiring continuous effluent monitoring. Because there are measurable quantities of radioactivity being released at this point, as well as this potential for exceeding the minimum dose monitoring level, it is recommended that the 1908-KE Outfall be continuously monitored.

10.2 100-KW FACILITY EFFLUENT MONITORING PLAN DETERMINATION CONCLUSIONS

The airborne dose assessment for 105-KW during normal operation shows in Table 7-1 that the dose from the single airborne release point with controls is 2.5×10^{-6} mrem.

The airborne dose assessment for 105-KW airborne release point potential release, shown in Table 8-2, is 2.5×10^{-3} mrem which is well below the required continuous effluent monitoring level of 0.1 mrem required by DOE Orders 5400.1 (DOE 1988a), 5400.3 (DOE 1989a), 5400.4 (DOE 1989b), 5400.5 (DOE 1990), 5480.1 (DOE 1982), 5480.11 (DOE 1988b), and 5484.1 (DOE 1981).

However, the 105-KW facility still emits measurable quantities of radioactivity as shown in Table 7-1. It is recommended that the 105-KW air emission point be monitored.

10.3 KE/KW FACILITY EFFLUENT MONITORING PLAN DETERMINATION FOR UNPLANNED-UPSET RELEASES

The potential airborne dose assessment for 100 KE/KW airborne emission without controls is shown in Table 7-3. The table shows the following:

- 105-KE--2.4×10^{-4} mrem
- 1706-KEL--6.1×10^{-4} mrem
- 1706-KER--2.9×10^{-4} mrem
- 105-KW--1.9×10^{-4} mrem.

Table 7-3 also shows that the doses from 105-KE and 105-KW are below the 0.1 mrem continuous monitoring requirement limit. Since these airborne effluent points emit measurable amounts of radioactivity, periodic monitoring is required.

The dose assessment for the potential liquid release point at the 1908-KE Outfall, as shown in Table 7-3, indicates a potential dose of 6.3×10^{-2} mrem. A dose of this magnitude requires that the 1908-KE Outfall be monitored continuously according to DOE Orders 5400.1 (DOE 1988a), 5400.3 (DOE 1989a), 5400.4 (DOE 1989b), 5400.5 (DOE 1990), 5480.1 (DOE 1982), 5480.11 (DOE 1988b), and 5484.1 (DOE 1981).

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ATTACHMENT 1

DETERMINATION OF FACILITY EFFLUENT MONITORING PLAN REQUIREMENT

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ATTACHMENT I

DETERMINATION OF FACILITY EFFLUENT MONITORING PLAN REQUIREMENT

FACILITY K AREA **DISCHARGE POINT** 105-KE

FACILITY INVENTORY AT RISK OF RADIOACTIVE MATERIALS

Radionuclide	Quantity Released (Curies) w/ Controls	Quantity Released (Curies) w/o Controls	Projected Dose (mrem) w/o Controls CAP-88	Projected Dose (mrem) w/o Controls GENII
1. Co-60	3.7E-05	3.7E-02	1.58E-03	5.9E-04
2. Sr-90	1.9E-05	1.9E-02	1.23E-03	1.1E-03
3. Cs-134	2.5E-05	2.5E-02	1.16E-03	1.3E-03
4. Cs-137	4.4E-05	4.4E-02	1.55E-03	1.7E-03
5. Pu-238	5.7E-08	5.7E-05	6.73E-04	6.3E-04
6. Pu-239/240	3.2E-07	3.2E-04	4.10E-03	3.5E-03
Total	1.3E-04	1.3E-01	1.03E-02	8.8E-03

FACILITY INVENTORY AT RISK OF NONRADIOACTIVE HAZARDOUS MATERIALS

Regulated Material	Quantity (lbs)	Quantity Released	RQ (lbs)
1.			
2.			
3.			
4.			

Identification of Reference Material

WHC-EP-0165-2

If the total projected dose from radionuclides exceeds 0.1 mrem ede from any one discharge point or if any one regulated material discharged from a facility exceeds 100% of a reportable quantity or a permitted quantity, a FEMP is required for that facility. Check the appropriate space below.

FEMP is required ___ FEMP is not required X

EVALUATOR [signature] DATE 3/19/91

MANGER, ENVIRONMENTAL [signature] DATE 3-15-91

FACILITY MANAGER [signature] DATE 3-19-91

ATTACHMENT I

DETERMINATION OF FACILITY EFFLUENT MONITORING PLAN REQUIREMENT

FACILITY K AREA **DISCHARGE POINT** 105-KE UPSET

FACILITY INVENTORY AT RISK OF RADIOACTIVE MATERIALS

Radionuclide	Quantity Released (Curies) Upset Condition	Projected Dose (mrem) Upset Condition CAP-88	Projected Dose (mrem) Upset Condition GENII
1. Kr-85	2.60 E-05	1.95 E-12	7.0 E-12
2. Sr-89	5.82 E-11	1.81 E-13	1.2 E-13
3. Sr-90	2.52 E-04	1.63 E-05	1.5 E-05
4. Zr-95	4.69 E-09	1.83 E-11	8.9 E-12
5. Ru-103	1.73 E-13	3.62 E-06	1.5 E-17
6. Ru-106	4.67 E-05	1.44 E-06	1.1 E-06
7. Te-132	9.55 E-08	6.01 E-11	5.5 E-11
8. Cs-134	3.12 E-06	1.44 E-06	1.6 E-07
9. Cs-137	2.59 E-04	9.15 E-06	9.8 E-06
10. Ce-144	2.46 E-04	4.97 E-06	4.4 E-06
11. Pu-239	1.63 E-05	2.08 E-04	1.8 E-04
Total	8.49 E-04	2.40 E-04	2.1 E-04

FACILITY INVENTORY AT RISK OF NONRADIOACTIVE HAZARDOUS MATERIALS

Regulated Material	Quantity (lbs)	Quantity Released	RQ (lbs)
NONE			

Identification of Reference Material

SARA Tier II Emergency and Hazardous Materials Inventory

If the total projected dose from radionuclides exceeds 0.1 mrem ede from any one discharge point or if any one regulated material discharged from a facility exceeds 100% of a reportable quantity or a permitted quantity, a FEMP is required for that facility. Check the appropriate space below.

FEMP is required ___ FEMP is not required X

EVALUATOR [signature] DATE 3/19/91

MANAGER, EVIRONMENTAL KA Gano DATE 3-15-91

FACILITY MANAGER [signature] DATE 3-19-91

ATTACHMENT I

DETERMINATION OF FACILITY EFFLUENT MONITORING PLAN REQUIREMENT

FACILITY K AREA **DISCHARGE POINT** 105-KW

FACILITY INVENTORY AT RISK OF RADIOACTIVE MATERIALS

Radionuclide	Quantity Released (Curies) w/ Controls	Quantity Released (Curies) w/o Controls	Projected Dose (mrem) w/o Controls CAP-88	Projected Dose (mrem) w/o Controls GENII
1. Co-60	3.3E-05	3.3E-02	1.41E-03	5.3E-04
2. Sr-90	4.1E-07	4.1E-04	2.64E-05	2.4E-05
3. Cs-137	2.4E-05	2.4E-02	8.47E-04	9.1E-04
4. Pu-238	6.0E-09	6.0E-06	7.08E-05	6.6E-05
5. Pu-239/240	1.1E-08	1.1E-05	1.41E-04	1.2E-04
Total	5.7E-05	5.7E-02	2.50E-03	1.7E-03

FACILITY INVENTORY AT RISK OF NONRADIOACTIVE HAZARDOUS MATERIALS

Regulated Material	Quantity (lbs)	Quantity Released	RQ (lbs)
1.			
2.			
3.			
4.			

Identification of Reference Material

WHC-EP-0165-2

If the total projected dose from radionuclides exceeds 0.1 mrem ede from any one discharge point or if any one regulated material discharged from a facility exceeds 100% of a reportable quantity or a permitted quantity, a FEMP is required for that facility. Check the appropriate space below.

FEMP is required ___ FEMP is not required X

EVALUATOR [signature] DATE 3/19/91

MANGER, ENVIRONMENTAL [signature] DATE 3-15-91

FACILITY MANAGER [signature] DATE 3-19-91

ATTACHMENT I

DETERMINATION OF FACILITY EFFLUENT MONITORING PLAN REQUIREMENT

FACILITY K AREA **DISCHARGE POINT** 105-KW UPSET

FACILITY INVENTORY AT RISK OF RADIOACTIVE MATERIALS

Radionuclide	Quantity Released (Curies) Upset Condition	Projected Dose (mrem) Upset Condition CAP-88	GENII
1. Kr.-85	1.29 E-05	9.64 E-13	3.5 E-13
2. Sr-90	1.73 E-04	1.11 E-05	1.0 E-05
3. Ru-106	1.57 E-07	4.82 E-09	3.8 E-09
4. Cs-134	1.85 E-07	8.54 E-09	9.6 E-09
5. Cs-137	1.79 E-04	6.32 E-06	6.8 E-06
6. Ce-144	1.64 E-07	3.32 E-09	3.0 E-09
7. Pu-239	1.35 E-05	1.73 E-04	1.5 E-04
Total	3.79 E-04	1.91 E-04	1.7 E-04

FACILITY INVENTORY AT RISK OF NONRADIOACTIVE HAZARDOUS MATERIALS

Regulated Material	Quantity (lbs)	Quantity Released	RQ (lbs)
NONE			

Identification of Reference Material

SARA Tier II Emergency and Hazardous Materials Inventory

If the total projected dose from radionuclides exceeds 0.1 mrem ede from any one discharge point of if any one regulated material discharged from a facility exceeds 100% of a reportable quantity or a permitted quantity, a FEMP is required for that faciltiy. Check the appropriate space below.

FEMP is required __ FEMP is not required X

EVALUATOR [signature] DATE 3/19/91

MANAGER,ENVIRONMENTAL K A Haas DATE 3-15-91

FACILITY MANAGER [signature] DATE 3-15-91

ATTACHMENT I

DETERMINATION OF FACILITY EFFLUENT MONITORING PLAN REQUIREMENT

FACILITY K AREA **DISCHARGE POINT** 1706-KEL

FACILITY INVENTORY AT RISK OF RADIOACTIVE MATERIALS

Radionuclide	Quantity Released (Curies) w/ Controls	Quantity Released (Curies) w/o Controls	Projected Dose (mrem) w/o Controls CAP-88	Projected Dose (mrem) w/o Controls GENII
1. Co-60	3.2E-06	9.6E-03	4.11E-04	1.5E-04
2. Pu-238	2.4E-09	7.2E-06	8.49E-05	7.8E-05
3. Pu-239/240	3.0E-09	9.0E-06	1.15E-04	9.9E-05
4.				
Total	3.2E-06	9.6E-03	6.12E-04	3.3E-04

FACILITY INVENTORY AT RISK OF NONRADIOACTIVE HAZARDOUS MATERIALS

Regulated Material	Quantity (lbs)	Quantity Released	RQ (lbs)
1.			
2.			
3.			
4.			

Identification of Reference Material

WHC-EP-0165-2

If the total projected dose from radionuclides exceeds 0.1 mrem ede from any one discharge point or if any one regulated material discharged from a facility exceeds 100% of a reportable quantity or a permitted quantity, a FEMP is required for that facility. Check the appropriate space below.

FEMP is required ___ FEMP is not required X

EVALUATOR [signature] DATE 3/19/91

MANGER, ENVIRONMENTAL [signature] DATE 3-15-91

FACILITY MANAGER [signature] DATE 3-19-91

ATTACHMENT I

DETERMINATION OF FACILITY EFFLUENT MONITORING PLAN REQUIREMENT

FACILITY K AREA **DISCHARGE POINT** 1706-KER

FACILITY INVENTORY AT RISK OF RADIOACTIVE MATERIALS

Radionuclide	Quantity Released (Curies) w/ Controls	Quantity Released (Curies) w/o Controls	Projected Dose (mrem) w/o Controls CAP-88	Projected Dose (mrem) w/o Controls GENII
1. Co-60	1.0E-06	3.0E-03	1.28E-04	4.8E-05
2. Sr-90	2.1E-08	6.3E-05	4.05E-06	3.6E-06
3. Cs-137	6.9E-07	2.1E-03	7.32E-05	7.8E-05
4. Pu-238	5.5E-10	1.7E-06	1.95E-05	1.8E-05
5. Pu-239/40	1.8E-09	5.4E-06	6.90E-05	6.0E-05
Total	1.7E-06	5.1E-03	2.94E-04	2.1E-04

FACILITY INVENTORY AT RISK OF NONRADIOACTIVE HAZARDOUS MATERIALS

Regulated Material	Quantity (lbs)	Quantity Released	RQ (lbs)
1.			
2.			
3.			
4.			

Identification of Reference Material

WHC-EP-0165-2

If the total projected dose from radionuclides exceeds 0.1 mrem ede from any one discharge point or if any one regulated material discharged from a facility exceeds 100% of a reportable quantity or a permitted quantity, a FEMP is required for that facility. Check the appropriate space below.

FEMP is required ___ FEMP is not required X

EVALUATOR ____________ DATE 3/19/91

MANGER, ENVIRONMENTAL ____________ DATE 3-15-91

FACILITY MANAGER ____________ DATE 3-17-91

ATTACHMENT I

DETERMINATION OF FACILITY EFFLUENT MONITORING PLAN REQUIREMENT

FACILITY K AREA **DISCHARGE POINT** 1908-KE Upset

FACILITY INVENTORY AT RISK OF RADIOACTIVE MATERIALS

	Radionuclide	Quantity Released (Curies) w/ Controls	Quantity Released (Curies) w/o Controls	Projected Dose (mrem) w/o Controls GENII
1.	H-3	2.6 E-01	2.6 E+01	1.6 E-05
2.	Co-60	6.6 E-02	6.6 E+00	1.6 E-02
3.	Sr-90	1.0 E-03	1.0 E-01	6.1 E-04
4.	Cs-137	1.0 E-02	1.0 E+00	3.2 E-01
5.	Pu-239/240	9.2 E-06	9.2 E-04	5.5 E-06
Total		3.4 E-01	3.4 E+01	3.4 E-01

FACILITY INVENTORY AT RISK OF NONRADIOACTIVE HAZARDOUS MATERIALS

	Regulated Material	Quantity (lbs)	Quantity Released	RQ (lbs)
1.				
2.				
3.				
4.				

Identification of Reference Material

WHC-EP-0165-2

If the total projected dose from radionuclides exceeds 0.1 mrem ede from any one discharge point or if any one regulated material discharged from a facility exceeds 100% of a reportable quantity or a permitted quantity, a FEMP is required for that facility. Check the appropriate space below.

FEMP is required X FEMP is not required ___

EVALUATOR [signature] DATE 3/19/91

MANGER, ENVIRONMENTAL [signature] DATE 3-15-91

FACILITY MANAGER [signature] DATE 3-19-91

ATTACHMENT I

DETERMINATION OF FACILITY EFFLUENT MONITORING PLAN REQUIREMENT

FACILITY K AREA **DISCHARGE POINT** 165-KW

FACILITY INVENTORY AT RISK OF RADIOACTIVE MATERIALS

Radionuclide	Quantity Released (Curies) w/ Controls	Quantity Released (Curies) w/o Controls	Projected Dose (mrem) w/o Controls CAP-88	Projected Dose (mrem) w/o Controls GENII
1.				
2.				
3.				
4.				
Total				

FACILITY INVENTORY AT RISK OF NONRADIOACTIVE HAZARDOUS MATERIALS

Regulated Material	Quantity (lbs)	Quantity Released	RQ (lbs)
1. Sodium Hypochlorite	120	NR	100
2.			
3.			
4.			

Identification of Reference Material

SARA Tier II Emergency and Hazardous Materials Inventory

If the total projected dose from radionuclides exceeds 0.1 mrem ede from any one discharge point or if any one regulated material discharged from a facility exceeds 100% of a reportable quantity or a permitted quantity, a FEMP is required for that facility. Check the appropriate space below.

FEMP is required ___ FEMP is not required X

EVALUATOR ______ DATE 3/19/91

MANGER, ENVIRONMENTAL ______ DATE 3-15-91

FACILITY MANAGER ______ DATE 3-19-91

ATTACHMENT I

DETERMINATION OF FACILITY EFFLUENT MONITORING PLAN REQUIREMENT

FACILITY K AREA **DISCHARGE POINT** 183-KE

FACILITY INVENTORY AT RISK OF RADIOACTIVE MATERIALS

Radionuclide	Quantity Released (Curies) w/ Controls	Quantity Released (Curies) w/o Controls	Projected Dose (mrem) w/o Controls CAP-88	Projected Dose (mrem) w/o Controls GENII
1.				
2.				
3.				
4.				
Total				

FACILITY INVENTORY AT RISK OF NONRADIOACTIVE HAZARDOUS MATERIALS

Regulated Material	Quantity (lbs)	Quantity Released	RQ (lbs)
1. Chlorine	6000	NR	10
2. Polyacrylamide	50	NR	unknown
3.			
4.			

Identification of Reference Material

SARA Tier II Emergency and Hazardous Materials Inventory

If the total projected dose from radionuclides exceeds 0.1 mrem ede from any one discharge point or if any one regulated material discharged from a facility exceeds 100% of a reportable quantity or a permitted quantity, a FEMP is required for that facility. Check the appropriate space below.

FEMP is required ___ FEMP is not required X

EVALUATOR [signature] DATE 3/19/91

MANGER, ENVIRONMENTAL KA Gano DATE 3-15-91

FACILITY MANAGER [signature] DATE 3-19-91

ATTACHMENT I

DETERMINATION OF FACILITY EFFLUENT MONITORING PLAN REQUIREMENT

FACILITY K AREA **DISCHARGE POINT** 1706-KE

FACILITY INVENTORY AT RISK OF RADIOACTIVE MATERIALS

Radionuclide	Quantity Released (Curies) w/ Controls	Quantity Released (Curies) w/o Controls	Projected Dose (mrem) w/o Controls CAP-88	Projected Dose (mrem) w/o Controls GENII
1.				
2.				
3.				
4.				
Total				

FACILITY INVENTORY AT RISK OF NONRADIOACTIVE HAZARDOUS MATERIALS

Regulated Material	Quantity (lbs)	Quantity Released	RQ (lbs)
1. Sodium Hydroxide	18970	NR	1000
2. Sulfuric Acid	31681	NR	1000
3.			
4.			

Identification of Reference Material

SARA Tier II Emergency and Hazardous Materials Inventory

If the total projected dose from radionuclides exceeds 0.1 mrem ede from any one discharge point or if any one regulated material discharged from a facility exceeds 100% of a reportable quantity or a permitted quantity, a FEMP is required for that facility. Check the appropriate space below.

FEMP is required ___ FEMP is not required X

EVALUATOR [signature] DATE 3/19/91

MANGER, ENVIRONMENTAL [signature] DATE 3-15-91

FACILITY MANAGER [signature] DATE 3/19/91

ATTACHMENT 2

PACIFIC NORTHWEST LABORATORY GENII
UNIT DOSE CONVERSION FACTORS

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GENII Dose Estimates for 1 Ci Radionuclide Releases--100 Areas; Location to the Individual: 9,900 m West. (2 sheets)

Nuclide	Ground level dose equivalent (rem)*	89-m Stack dose equivalent (rem)*
^{3}H	3.5 E-08	1.0 E-08
^{24}Na	1.1 E-07	4.5 E-08
^{41}Ar	9.0 E-09	6.9 E-09
^{51}Cr	3.6 E-08	1.1 E-08
^{54}Mn	1.8 E-06	5.5 E-07
^{56}Mn	2.3 E-08	1.1 E-08
^{59}Fe	1.9 E-06	5.8 E-07
^{58}Co	1.5 E-06	4.5 E-07
^{60}Co	1.6 E-05	4.7 E-06
^{76}As	1.6 E-07	5.1 E-08
^{85m}Kr	1.9 E-09 (100)*	9.1 E-10 (100)
^{85}Kr	2.7 E-11	1.4 E-11
^{87}Kr	4.4 E-09	2.8 E-09
^{88}Kr	2.4 E-08	1.3 E-08
^{89}Sr	2.0 E-06	5.8 E-07
^{90}Sr	5.9 E-05 (94)	1.8 E-05 (94)
^{91}Sr	5.4 E-08 (73)	1.9 E-08 (76)
^{95}Zr	1.9 E-06 (75)	5.7 E-07 (75)
^{95}Nb	7.2 E-07	2.2 E-07
^{99}Mo	1.4 E-07 (98)	4.4 E-08 (98)
^{103}Ru	8.8 E-07 (100)	2.6 E-07(100)
^{106}Ru	2.4 E-05	7.1 E-06
^{124}Sb	3.4 E-06	1.0 E-06
^{132}Te	5.8 E-07 (86)	1.7 E-07 (86)
^{131}I	9.0 E-05 (100)	2.6 E-05 (100)
^{132}I	3.6 E-08	1.7 E-08
^{133}I	1.4 E-06 (100)	4.1 E-07 (100)
^{135}I	9.6 E-08 (95)	3.5 E-08 (95)
^{133}Xe	6.9 E-10	3.0 E-10

GENII Dose Estimates for 1 Ci Radionuclide Releases--100 Areas; Location to the Individual: 9,900 m West. (2 sheets)

Nuclide	Ground level dose equivalent (rem)*	89-m Stack dose equivalent (rem)*
^{135}Xe	3.4 E-09	1.5 E-09
^{134}Cs	5.2 E-05	1.6 E-05
^{137}Cs	3.8 E-05	1.1 E-05
^{138}Cs	5.2 E-09	5.0 E-09
^{140}Ba	1.7 E-06 (50)	5.1 E-07 (51)
^{140}La	2.2 E-07	7.3 E-08
^{141}Ce	6.9 E-07	2.0 E-07
^{144}Ce	1.8 E-05 (100)	5.4 E-06 (100)
^{153}Sm	9.4 E-08	2.8 E-08
^{154}Eu	1.5 E-05	4.3 E-06
^{155}Eu	2.0 E-06	5.8 E-07
^{238}Pu	1.1 E-02	3.2 E-03
^{239}Np	1.3 E-07 (100)	3.9 E-08 (100)
^{239}Pu	1.1 E-02	3.3 E-03

*Doses calculated with GENII include contributions from the parent nuclide, long-lived daughter chains, and short-lived daughters. Numbers in parenthesis indicate the percent of the total dose attributable to the parent nuclide in chains with long-lived daughters.

GENII Dose Estimates for 1 Ci Liquid Releases to the Columbia River. (2 sheets)

Nuclide	100 and 200 Areas MI* at Ringold dose equivalent (rem)**	300 Area MI* at Riverview dose equivalent (rem)**
^{3}H	6.4 E-10	
^{24}Na	2.7 E-08	
^{32}P	2.5 E-04	
^{51}Cr	3.3 E-09	
^{54}Mn	6.6 E-07	
^{59}Fe	6.1 E-06	
^{58}Co	5.4 E-07	
^{60}Co	2.4 E-06	
^{65}Zn	1.6 E-05	
^{89}Sr	3.1 E-07	
^{90}Sr	6.1 E-06	6.1 E-06
^{95}Zr	4.6 E-07	
^{99}Mo	1.7 E-08	
^{99}Tc	3.9 E-07	3.9 E-07
^{103}Ru	1.7 E-07	
^{106}Ru	1.6 E-06	
^{124}Sb	1.1 E-06	
^{125}Sb	4.0 E-07	
^{129}I	1.7 E-05	
^{131}I	1.8 E-06	
^{133}I	1.2 E-07	
^{133}Xe	1.4 E-10	
^{134}Cs	4.6 E-04	
^{137}Cs	3.2 E-04	
^{140}Ba	1.1 E-06	
^{141}Ce	6.6 E-07	
^{144}Ce	4.9 E-06	
^{234}U	8.9 E-07	8.9 E-07
^{235}U	9.6 E-07	9.6 E-07

GENII Dose Estimates for 1 Ci Liquid Releases to the Columbia River. (2 sheets)

Nuclide	100 and 200 Areas MI* at Ringold dose equivalent (rem)**	300 Area MI* at Riverview dose equivalent (rem)**
^{238}U	9.5 E-07	9.5 E-07
^{238}Pu	5.8 E-06	
^{239}Pu	6.0 E-06	
^{241}Pu	9.7 E-08	
^{241}Am	2.0 E-04	
^{239}Np	2.8 E-06	

*MI = Maximally exposed individual.

**Doses calculated with GENII include contributions from the parent nuclide, long-lived daughter chains, and short-lived daughters.

APPENDIX A

UNIT DOSE CONVERSION FACTOR PREPARED BY PACIFIC NORTHWEST LABORATORY TO BE USED IN OFFSITE DOSE CALCULATIONS

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UNIT DOSE CALCULATIONS FOR WHC FACILITY EFFLUENT MONITORING PLANS

K. Rhoads January 3, 1991

INTRODUCTION

Dose calculations for unit (1 Ci) radionuclide releases were performed in support of efforts by Westinghouse Hanford Company (WHC) to develop Effluent Monitoring Plans for all WHC facilities on the Hanford site. Atmospheric releases from generic locations in the 100, 200 E, 200 W, and 300 areas were modeled for both elevated and ground-level releases; 400 area releases were modeled for ground level only. Impacts of liquid releases were evaluated for individuals at Ringold (100 and 200 area effluents) and Riverview (300 Area effluents). Both the CAP-88 (Beres 1990) and GENII (Napier et al 1988) code packages were used to model atmospheric releases in order to satisfy requirements of the U. S. Environmental Protection Agency (USEPA 1989) and the U. S. Department of Energy. The GENII code was used to model liquid releases.

METHODS

Standard parameters for Hanford dose calculations were included in the calculations where possible (McCormack, et al 1984). Meteorology data were collected at weather stations in each of the Hanford operating areas and represent the five-year average of data taken between 1983 and 1987. The location of the maximally exposed individual for each area is included in the attached tables with results of the dose calculations. Individual locations were based on the site boundary location having the greatest radionuclide air concentration under average atmospheric conditions. Doses were calculated as 50-year committed effective dose equivalents for all internal deposition pathways using the EPA model specified in 40 CFR 61. Default solubility classes were used for all radionuclides in these preliminary calculations. These should be appropriate for most facilities evaluated, except where plutonium or uranium are released in soluble form and contribute substantially to the overall dose from a given facility. Default classes for uranium and plutonium assume these radionuclides are released as insoluble compounds; this will result in a lower overall dose than would be the case if they were released in more soluble form.

RESULTS

Results of the evaluation are presented in Tables 1 - 11, and represent the 50-year committed dose equivalent following a chronic annual release of 1 Ci of each radionuclide. The CAP-88 and GENII codes handle ingrowth of long-lived radioactive daughter products differently, as noted in the tables. GENII calculates doses for all radionuclides in each decay chain, therefore the doses reported in Tables 1 -6 include contributions from both parent and ingrown daughters. CAP-88 does not calculate activities for ingrowth of daughter radionuclides following release of the parent, but will estimate the dose from very short-lived daughters where the parent-to-daughter activity ratio is effectively 1:1. CAP-88 doses reported in Tables 7 - 11 are for the parent nuclide only, except in the case where very short-lived daughters have been included in the parent dose as noted. CAP-88 doses including contributions from daughter ingrowth should be estimated using the fractional contribution from the parent nuclide reported in the GENII results.

The total dose expected from emissions at a given facility can be obtained by multiplying the release quantity in Ci for each radionuclide by the corresponding unit dose factor in the tables, and summing the contributions for all nuclides in the effluent stream. Please note that doses calculated using the GENII code are reported as rem to the maximum individual from an annual release; those from CAP-88 are reported in mrem. Values in the tables were taken directly from code outputs, and have been left in the units reported by each code to avoid transcription errors.

REFERENCES

Beres, D. A., 1990. The Clean Air Act Assessment Package -1988 (CAP-88). A Dose and Risk Assessment Methodology for Radionuclide Emissions to Air. Vols. 1-3, U. S. Environmental Protection Agency, Washington, D. C.

McCormack, W. D., J. V. Ramsdell, and B. A. Napier. 1984. Hanford Dose Overview Program: Standardized Methods and Data for Hanford Environmental Dose Calculations. PNL-3777, Rev. 1, Pacific Northwest Laboratory, Richland, Washington.

Napier, B. A., R. A. Peloquin, D. L. Strenge, and J. V. Ramsdell. 1988. GENII - The Hanford Environmental Radiation Dosimetry Software System. PNL-6584, Vols. 1-3. Pacific Northwest Laboratory, Richland, Washington.

U. S. Environmental Protection Agency. 1989. National Emission Standards for Hazardous Air Pollutants; Radionuclides; Final Rule and Notice of Reconsideration. 40 CFR Part 61, Federal Register 54 (240):51654-51715.

TABLE 1. GENII DOSE ESTIMATES FOR 1 Ci RADIONUCLIDE RELEASES - 100 AREAS
Location to the individual: 9900 METERS WEST

NUCLIDE	GROUND LEVEL DOSE EQUIVALENT (REM)*	89 m STACK DOSE EQUIVALENT (REM)*
H 3	3.5E-08	1.0E-08
NA 24	1.1E-07	4.5E-08
AR 41	9.0E-09	6.9E-09
CR 51	3.6E-08	1.1E-08
MN 54	1.8E-06	5.5E-07
MN 56	2.3E-08	1.1E-08
FE 59	1.9E-06	5.8E-07
CO 58	1.5E-06	4.5E-07
CO 60	1.6E-05	4.7E-06
AS 76	1.6E-07	5.1E-08
KR 85M	1.9E-09 (100)*	9.1E-10 (100)
KR 85	2.7E-11	1.4E-11
KR 87	4.4E-09	2.8E-09
KR 88	2.4E-08	1.3E-08
SR 89	2.0E-06	5.8E-07
SR 90	5.9E-05 (94)	1.8E-05 (94)
SR 91	5.4E-08 (73)	1.9E-08 (76)
ZR 95	1.9E-06 (75)	5.7E-07 (75)
NB 95	7.2E-07	2.2E-07
MO 99	1.4E-07 (98)	4.4E-08 (98)
RU 103	8.8E-07 (100)	2.6E-07 (100)
RU 106	2.4E-05	7.1E-06
SB 124	3.4E-06	1.0E-06
TE 132	5.8E-07 (86)	1.7E-07 (86)
I 131	9.0E-05 (100)	2.6E-05 (100)
I 132	3.6E-08	1.7E-08
I 133	1.4E-06 (100)	4.1E-07 (100)
I 135	9.6E-08 (95)	3.5E-08 (95)
XE 133	6.9E-10	3.0E-10
XE 135	3.4E-09	1.5E-09
CS 134	5.2E-05	1.6E-05
CS 137	3.8E-05	1.1E-05
CS 138	5.2E-09	5.0E-09
BA 140	1.7E-06 (50)	5.1E-07 (51)
LA 140	2.2E-07	7.3E-08
CE 141	6.9E-07	2.0E-07
CE 144	1.8E-05 (100)	5.4E-06 (100)
SM 153	9.4E-08	2.8E-08
EU 154	1.5E-05	4.3E-06
EU 155	2.0E-06	5.8E-07
PU 238	1.1E-02	3.2E-03
NP 239	1.3E-07 (100)	3.9E-08 (100)
PU 239	1.1E-02	3.3E-03

* Doses calculated with GENII include contributions from the parent nuclide, long-lived daughter chains, and short-lived daughters. Numbers in parenthesis indicate percent of the total dose attributable to the parent nuclide in chains with long-lived daughters.

TABLE 7. CAP-88 DOSE ESTIMATES FOR 1 Ci RADIONUCLIDE RELEASES - 100 AREAS
Location to the individual: 9900 METERS WEST

NUCLIDE	10 m STACK DOSE EQUIVALENT (MREM)*	89 m STACK DOSE EQUIVALENT (MREM)*
H-3	3.36E-05	8.85E-06
NA-24	2.19E-04	6.72E-05
AR-41	1.41E-05	4.38E-06
CR-51	9.32E-05	2.80E-05
MN-54	8.11E-03	2.44E-03
MN-56	3.56E-05	1.20E-05
FE-59	4.72E-03	1.42E-03
CO-58	4.75E-03	1.43E-03
CO-60	4.28E-02	1.29E-02
AS-76	1.81E-04	5.50E-05
KR-85M	2.62E-06	7.35E-07
KR-85	7.49E-08	1.97E-08
KR-87	7.18E-06	2.41E-06
KR-88	3.11E-05	9.07E-06
SR-89	3.11E-03	9.35E-04
SR-90	6.45E-02	1.94E-02
SR-91	5.39E-05	1.67E-05
ZR-95	3.90E-03	1.17E-03
NB-95	2.60E-03	7.81E-04
MO-99	2.41E-04	7.28E-05
RU-103	2.10E-03	6.31E-04
RU-106**	3.08E-02	9.26E-03
SB-124	8.90E-03	2.68E-03
TE-132	6.29E-04	1.90E-04
I-131	1.84E-02	1.65E-02
I-132	2.48E-05	2.54E-05
I-133	1.72E-04	1.56E-04
I-135	5.99E-05	5.62E-05
XE-133	7.71E-07	2.04E-07
XE-135	4.73E-06	1.28E-06
CS-134	4.62E-02	1.39E-02
CS-137**	3.53E-02	1.06E-02
CS-138	7.20E-06	3.77E-06
BA-140	1.86E-03	5.60E-04
LA-140	4.49E-04	1.36E-04
CE-141	1.21E-03	3.65E-04
CE-144	2.02E-02	6.08E-03
SM-153	1.13E-04	3.42E-05
EU-154	2.69E-02	8.10E-03
EU-155	2.73E-03	8.20E-04
PU-238	1.18E+01	3.56E+00
NP-239	1.70E-04	5.13E-05
PU-239	1.28E+01	3.85E+00

* Doses calculated with CAP88 are for the parent nuclide only, and do nc include contributions from long-lived daughter chains.

** Short-lived daughters are included in dose from parent nuclides.

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