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Supplemental Information for a Notice of Construction for the Fueled Clad Fabrication System, the Radioisotope Power Systems Facility, and the Fuel Assembly Area

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United States
Department of Energy
Richland, Washington

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Date Published
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United States
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Richland, Washington 99352

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**SUPPLEMENTAL INFORMATION FOR A NOTICE OF CONSTRUCTION
FOR THE FUELED CLAD FABRICATION SYSTEM, THE
RADIOISOTOPE POWER SYSTEMS FACILITY, AND
THE FUEL ASSEMBLY AREA**

The following "Notice of Construction" is being submitted by the U.S. Department of Energy-Richland Operations Office (P.O. Box 550, Richland, Washington 99352), pursuant to WAC 402-80-070, for three new sources of radionuclide emissions at the Hanford Site in Washington State (Figure 1). The three new sources, the Fueled Clad Fabrication System (FCFS) the Radioisotope Power Systems Facility (RPSF) and the Fuel Assembly Area (FAA) will be located in one facility, the Fuels and Materials Examination Facility (FMEF) of the 400 Area as shown in Figures 2 and 3.

The FMEF was originally designed to provide for post-irradiation examination and fabrication of breeder reactor fuels. These FMEF missions were cancelled before the introduction of any fuel materials or any irradiated material. The current plans are to use the facility to fabricate power supplies to be used in space applications and to produce Fast Flux Test Facility (FFTF) fuel and target assemblies. The FCFS and the RPSF will produce materials and assemblies for application in space. The FAA project will produce FFTF fuel and target assemblies.

The FCFS and the RPSF will share the same building, stack, and, in certain cases, the same floor space. Given this relationship, to the extent possible, these systems will be dealt with separately. The FAA is a comparatively independent operation though it will share the FMEF complex, as shown in Figure 3.

Figure 1. Hanford Site Map.

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Figure 2. 400 Area Site Layout.

Figure 3. Fuels and Materials Examination Facility.

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RADIOACTIVE AIR EMISSIONS PROGRAM SUPPLEMENTAL INFORMATION FOR FUELED CLAD FABRICATION SYSTEM

1.0 FACILITY INFORMATION

1.1 DESCRIBE THE FACILITY

The Fueled Clad Facility System (FCFS) will be located in the Fuel and Materials Examination Facility (FMEF) Process Building on the -10.7-m level. Figure 4 shows those sections of the FMEF to be used by the FCFS.

The FMEF Process Building complex is qualified as necessary to withstand all design basis events while maintaining radiological control of its inventory. The FMEF features are summarized below.

- o The Process Building is a six-level, tornado-hardened, seismically qualified, concrete structure 79.2 m (260 ft) long and 35 m (155 ft) wide, extending from 10.7 m (35 ft) belowgrade to approximately 30.5 m (100 ft) abovegrade. Most of the facilities capabilities for handling radioactive materials are centered in the Process Building.
- o The Fuel Assembly Area (FAA) is a two story, tornado-hardened, seismically qualified structure, 54.9 m (180 ft) long, 39.6 m (130 ft) wide, and 7.9 m (26 ft) high, housing Fast Flux Test Facility (FFTF) core component assembly activities and the Entry Wing's heating and ventilation equipment.
- o The Mechanical Equipment Wing is a single-story, concrete structure 39.6 m (130 ft) long and 15.2 m (50 ft) wide, housing air compressors, chilled water cooling system pumps, refrigeration units, and associated electrical switchgear. There is no potential for radiological contamination in the Mechanical Equipment Wing nor is any of the enclosed equipment required for Process Building or FAA confinement. The Mechanical Equipment Wing is not tornado hardened or seismically qualified.
- o The Emergency Equipment Wing is a single-story, tornado-hardened, seismically qualified, concrete structure 19.8 m (65 ft) long and 17.7 m (58 ft) wide, housing the emergency electrical power system's turbine generators, the emergency cooling water system's cooling tower and circulating pumps, and associated electrical switchgear.

Figure 4. FMEF Hot Cells Located 10.7 Meters (35 Feet) Belowgrade in the Process Building.

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- o The Entry Wing is a two-story structure 47.2 m (155 ft) long and 40.2 m (132 ft) wide, housing office space, lunch room, and personnel change rooms required to support the activities of the Process Building and the FAA. The Entry Wing is not tornado hardened or seismically qualified.
- o The electrical substations, which supply the FMEF, and the cooling towers and underground fuel storage tank for the turbine generators are located north of the process building structure.

Modifications to the Process Building necessary to support the FCFS include structural (demolition, wall additions and replacements, decking) mechanical (HVAC, enclosure atmospheric control, process cooling systems, process services) interior electrical services (normal electrical power and emergency electrical power interior telecommunications and alarm systems, fire protection, energy conservation, radiation protection (criticality detection, contamination sampling), contamination confinement, and plutonium material safeguards. Integration into existing FMEF facilities and systems will be conducted whenever possible.

1.2 DESCRIBE THE FACILITY OPERATIONS

The FCFS will fabricate $^{238}\text{PuO}_2$ pellets from powder and encapsulate them in iridium cladding as fuel clads (FC) for use as heat sources in general purpose heat source (GPHS) modules. Figure 5 shows an FC in a GPHS module. The FCFS will have the capability to perform other plutonium oxide processing and encapsulation operations if needed. It will have a throughput capacity of 200 FCs, or approximately 30 kg (66.1 lb) of encapsulated plutonium dioxide per year. The cells to be used for $^{238}\text{PuO}_2$ pellet forming and encapsulation are shown in Figure 4. An overall process flow diagram is shown in Figure 6.

Plutonium dioxide will be received in rooms 524 and 526, located 12.8 m (42 ft) abovegrade in the FMEF. A nondestructive assay will be performed on the containers of plutonium dioxide. The containers will then be stored in cells 132 or 133.

Canisters of powder will be transferred from storage to cell 145 for processing. The canisters will be cut open and sampled for chemical characterization. The bulk of the powder will be loaded into furnace boats and placed in a furnace. In the furnace, $^{16}\text{O}_2$ will replace $^{17}\text{O}_2$ and $^{18}\text{O}_2$ in the $^{238}\text{PuO}_2$ powder. This results in a significant reduction of the neutron emission rate, which is necessary for the use of the $^{238}\text{PuO}_2$ in power sources. After oxygen exchange, the $^{238}\text{PuO}_2$ powder will be ball milled, sieved, cold pressed, and granulated. The granules will be sintered into shards in an atmosphere containing oxygen, atomic weight 16. Sixty percent of the granules will be sintered at 1100° C (2012° F) and 40% at 1600° C (2912° F). After sintering, the shards will be sieved to separate the agglomerated shards and recombined in a ball mill dedicated to shard blending.

Figure 5. General Purpose Heat Source Module Assembly.

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Figure 6. Overall Process Flow Diagram for the Fueled Clad Facility System.

The resulting granules will be transferred from cell 145 to the hot pressing glovebox in room 141. The hot pressing ensures good control of pellet dimensions and microstructure. After being hot pressed, the pellets will be transferred to cell 144 where they will be sintered in a dedicated production furnace at 1525° C (2777° F) in an atmosphere containing oxygen, atomic weight 16. The pellets will then be vacuum heat-treated in a sintering furnace at 1500° C (2732° F). The principal reason for the final sintering and outgassing operations is to ensure that the fuel pellet will remain dimensionally stable at expected operating temperatures. The sintering operation also burns off carbon introduced onto the pellet in the hot pressing operation and restores stoichiometry of the pellets to $^{238}\text{PuO}_2$. The outgassing operation further removes volatile impurities such as helium. After heat treatment, the fuel pellets will be sampled. The samples will be prepared in cell 139 by grinding, polishing, mounting, and etching. After sample preparation, the pellets will be characterized by ceramography in cell 142.

The remaining pellets will be transferred to cell 143 after the heat treatment operation. In cell 143, pellets will be loaded into iridium capsules and the capsules will be welded shut in a helium atmosphere. The fueled clads will then be transferred to cell 137 for decontamination and nondestructive examination. Nondestructive examination will include ultrasonic testing of the capsule welds and helium leak checks.

1.3 IDENTIFY THE FACILITIES AS THEY WERE IDENTIFIED ON THE SOURCE REGISTRATION FORMS

The FMEF was designed and constructed to produce production and test-fuel assemblies for the Liquid Metal Reactor program and provide a capability for examining fuels and materials following irradiation. These FMEF missions were cancelled before introducing fuel material or other irradiated material into the facility. The FMEF has not, therefore, been registered with the Washington State Department of Social and Health Services (DSHS) as a source of radioactive air emissions.

2.0 SOURCE INFORMATION

2.1 LIST THE SOURCE(S) TO WHICH THE INFORMATION IN THIS SECTION PERTAINS. IDENTIFY ALL SOURCES CONSISTENT WITH THE SOURCE REGISTRATION IDENTIFICATION

Figure 3 depicts the FMEF (RPSF/FCFS shared) stack, which will be the single discharge point (source) for FCFS to be registered with DSHS. When the source is registered with the DSHS, the "Source Registration For Radioactive Air Emissions" form will show the facility as the 427 Building and the discharge point as the FMEF Exhaust.

2.2 DESCRIBE THE SOURCES

2.2.1 System Function/Area Exhausted

The FCFS will be provided with ventilation Zones I, II, and III, and airlocks as required for zone separation in high traffic access areas. Areas denoted Zone I will contain the radioactive materials being processed and will be separated from surrounding ventilation Zone II areas. Ventilation Zone III areas will be those support areas that bound ventilation Zone II. There will be a negative pressure gradient from Zone III to I so that any contaminants will flow into Zone I and through the facility emissions abatement systems. All Zone I air flows out the FMEF stack.

Releases of radioactive materials to the ventilation system will occur in Zone I and may occur in Zone II. Releases of radioactive materials to the ventilation system from Zone III are unlikely. The process activities previously described in Section 1.2 will take place in these zones. Figure 7 depicts FCFS cell atmosphere flow and indicates points of emission to the environment.

Zone I

Cells 132, 133, 137, 139, 142, 143, 144, 145, and the glovebox in room 141 will be part of the Zone I ventilation system. With the exception of cells 132 and 133, these cells will be used in the processing of the plutonium dioxide powder into pellets and in the encapsulation of these pellets. Cells 132 and 133 will be used to store the plutonium dioxide powder. Because the plutonium dioxide powder will be contained in a canister, the potential for releases of radioactive materials to the ventilation system is small. The relative contributions of the processing steps to the radioactive releases is discussed below.

Cell 145 will be used for powder processing. Powder processing includes opening the canisters containing the powder, sampling the powder, transferring powder into furnace boats, performing the $^{16}\text{O}_2$ exchange, ball milling the powder, sieving the powder, cold pressing the powder, sintering the granules, sieving the shards, and ball milling the shards. These operations will produce the majority of the particulate radioactive materials that reach the ventilation system. Gaseous emissions from the $^{16}\text{O}_2$ furnace and the sintering furnace are not expected as plutonium dioxide is not volatile.

The glovebox in room 141 will be used for hot pressing the shards into pellets. Cell 144 will be used for sintering and vacuum heat treating the pellets. Powder will not be handled in cell 144 enclosures, nor will there be any operations performed, such as grinding, which may result in the production of particulate matter. However, because the plutonium dioxide is not yet encapsulated, the release of particulate radioactive materials to the ventilation system is expected to be relatively moderate in relation to other operations. Gaseous emissions from hot pressing and from the sintering

Figure 7. Fueled Clad Facility System Cell Atmosphere Systems.

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and vacuum heat treating furnaces are not expected, as plutonium dioxide is not volatile.

Cell 139 will be used to prepare sample pellets for ceramography in Cell 142. Sample preparation will include grinding, polishing, mounting, and etching. Grinding and polishing operations have the potential for the production of particulate matter, therefore releases of particulate matter from Cell 139 are expected. The potential for releases of radioactive materials during sample characterization by ceramography, in Cell 142, will be small.

In Cell 143, pellets will be loaded into iridium cladding and the cladding will be welded shut. In Cell 137, the FCs will be decontaminated. During pellet loading and decontamination, surface particulate contamination may become suspended. Releases are not expected to be nearly as great as during powder handling operations, therefore the release of particulate radioactive materials to the ventilation system from these cells is expected to be small.

Following decontamination, nondestructive examination of FCs will also be performed in Cell 137. Because the plutonium dioxide pellets will be encapsulated in a cladding that has been decontaminated, the potential for releases of radioactive materials is small.

Zone II

Rooms 126, 127, 174, 149, 153, 148, 141, 152, and operating corridors 131, 123, and 125W will be part of the Zone II ventilation system. Releases of radioactive materials to the Zone II ventilation system are not likely to occur because processing of radioactive materials will not occur in the Zone II rooms and the negative pressure gradient from Zone II to Zone I would carry any release to the Zone I ventilation system.

Zone III

Zone III includes those areas surrounding the Zone II ventilation area. Releases of radioactive materials to the Zone III ventilation system are highly unlikely because of the negative pressure gradient between Zone III and Zone II, and because radioactive materials will not be handled in the Zone III room.

2.2.2 Effluent System Layout

Because the radioactive airborne emissions from FCFS will consist primarily of particulate matter generated during the processing of the $^{238}\text{PuO}_2$ powder (Section 2.2.1) the emissions control system must be capable of containing micrometer- and submicrometer-size particles.

As discussed in Section 2.2.1, the FCFS operations are provided with ventilation Zones I, II, and III with a negative pressure gradient from Zone III to Zone I, to provide maximum confinement of radioactive contamination. Zone I gloveboxes will be operated at -0.50 ± 0.25 in. water gage (WG) pressure relative to Zone II atmosphere. Zone I cells, with manipulators, will be operated at -0.85 ± 0.15 in. WG pressure relative to Zone II atmosphere. Zone II will be operated at greater than -0.10 in. ± 0.05 in. WG pressure relative to Zone III. Zone III will be operated at greater than -0.10 in. WG pressure relative to Zone IV (outside atmosphere).

Zone I ventilation areas in which the radioactive materials are processed, use a recirculated argon atmosphere. Special sealed structures and structural penetrations are implemented to separate Zone I and Zone II areas. Zone I and Zone II exhausts are vented to separate primary high-efficiency particulate air (HEPA) filtration steps before being combined and routed to final filtration, consisting of three banks of HEPA filters, and subsequently discharged to the atmosphere. Zone III exhaust is ultimately routed along with other plant exhausts to the final filtration step and discharged to the atmosphere.

Provision of both primary and final particulate control measures, as described above, allows for high-efficiency removal of particulates and provides system redundancy in the event of a possible failure of one of the emission control units. In addition, the FCFS Zone I cells are equipped with non-testable HEPA filters on both the inlet and outlet flows to minimize the radionuclide contamination of the connected atmosphere control systems.

Final, high-efficiency particulate filtration before discharge of the radionuclide contaminated gases to the atmosphere is a nuclear industry standard. Generally, two-stage filtration is used for this purpose. Presently employed final filtration techniques in the nuclear industry include combination prefilter and HEPA's, deep-bed glass-fiber filters, and deep-bed sand filters. The best available radionuclide control technology (BARCT) assessment developed for this proposed project demonstrated that the prefilter and HEPA system provides the highest degree of removal efficiency (see Section 5.0).

2.2.3. Efficiency Values of Each Control Device for Removal of Radioactivity

As shown in Figure 7 and discussed in Section 2.2.2, HEPA filters are the control devices used for removal of radioactivity from the FCFS ventilation system. A HEPA filter is a throwaway, extended-pleated medium, dry-type filter. Hanford Site HEPA filters must meet the following requirements:

- o Permissible penetration at test airflows shall be no greater than 0.03% when tested in accordance with *Nuclear Standard Quality Assurance Testing of HEPA Filters* (NE F 3-43, Article 6).

- o Filters shall have a minimum particle collection efficiency of 99.97% for 0.3- μm particle size, thermally generated dioctyl phthalate (DOP) aerosol (or equivalent) at 100% and at 20% of rated flow capacity for filters with a nominal airflow rating of 3.5 m^3/min (size 3) and larger and 100% rated flow for filters with a nominal rating below 3.5 m^3/min (NE F 3-43, Article 4).
- o The pressure differential for air flow across a clean filter assembly when tested at appropriate nominal flows shall not exceed 1.3 in. WG for size 3 HEPA's and smaller, and 1.0 in. WG for HEPA's larger than size 3.

2.2.4 Means and Frequency of Testing Effluent System

The FMEF emissions abatement system comprises three HEPA filters in series. (The gloveboxes, hoods, and enclosures have an additional HEPA, but they are not testable.)

All Hanford Site HEPA filters are tested in place on an annual basis and must meet the following requirements:

- o All filters shall remove at least 99.95% of the DOP particles, or equivalent, ranging in size from 0.1 μm to 3.0 μm with a mean particle size of 0.5 μm .
- o The HEPA filters, which are held in the frame by turn and lock (cam-lock) devices, are permitted to have penetration values of up to 0.25% provided that leak tests are performed every 90 days. These filters shall be replaced if penetration values exceed 0.25%, or if the exposure rate or pressure drop limits cited below are exceeded.
- o The HEPA filter cartridges shall be replaced when continuous exposure rates exceed 1 R/h at 15.3 cm (6 in.), or when the pressure drop across the filter exceeds 4 in. WG. Remotely installed HEPA filters shall be replaced when the pressure drop across the filter exceeds 4 in. WG, or exposure rates exceed limits provided by Radiation Protection.

2.2.5 Operating Mode

The FCFS will fabricate FCs 8 hr/d (one shift), 5 d/wk, 52 wk/yr. This means the FCFS will be operating 23.8 % of the time (based on 24 hr/d, 7 d/wk, 52 wk/yr being equal to 100%).

2.2.6 Chemical and Physical Forms of the Releases

Airborne releases from the FCFS, subject to regulation, will be in particulate forms. The following radionuclides make up the projected controlled particulate releases from the FCFS:

- o ^{236}Pu
- o ^{238}Pu
- o ^{239}Pu
- o ^{240}Pu
- o ^{241}Pu
- o ^{242}Pu

International Commission of Radiation Protection (ICRP) Publications 26 through 30 list all plutonium isotopes in Solubility Class "Y" (years).

2.2.7 Stack (or Release Point) Data

2.2.7.1 Height from Ground/Inside Diameter. The FMEF stack is 35.7 m (117 ft) high with a 2.4-m (7-9 ft) by 5.1-m (16.7-ft) rectangular cross section (see drawing H-4-156199, Figure 8).

2.2.7.2 Building Height. The main process building structure is 30 m (98.4 ft) high. The north elevator/stairway roof extends to 32.6 m (107 ft); the southeast stairway roof to 34.1 m (111.9 ft); and the southwest stairway roof to 31 m (101.7 ft) (see drawing H-4-104301, Figure 9).

2.2.7.3 Building Width/Length. The FMEF process building is 39.3 m (128.9 ft) wide and 78.6 m (257.9 ft) long (see Figure 9).

2.2.7.4 Annual Average Stack and Ambient Air Temperatures. The annual average stack temperature is 26.7° C (80° F). The annual average ambient air temperature is 11.7° C (53° F). (This average was determined by the Hanford Meteorology Station using meteorology data for the Hanford Site area from the period 1912 to 1980.)

2.2.7.5 Windrose. The windrose for the 400 Area is shown in Figure 10.

2.2.7.6 Chi/Q Data, If It Exists. The χ/Q data is found in Figure 11. These data were broken out of the AIRDOSE-EPA computer code used to provide the demonstration required by Section 4.0.

2.2.7.7 Release Rates. The controlled release rates of particulate radionuclides from the FCFS were calculated based on an annual $^{238}\text{PuO}_2$ throughput of 30 kg (66.1 lb) and using a release adjustment factor (RAF) of 2.5×10^{-10} .

The RAF assumes that 1% (the release factor) of the throughput material will become entrained in the cell atmosphere and pass through the ventilation system. (This is an extremely conservative assumption because there are non-testable HEPA filters between the cells, gloveboxes, hoods, and enclosures

- GENERAL NOTES:
1. ALL MATERIAL, EQUIPMENT, AND PROCEDURES SHALL BE AS SPECIFIED, OR APPROVED EQUAL.
 2. FIELD VERIFY ALL DIMENSIONS (INCLUDING EXHAUST DUCT) BEFORE FABRICATION.
 3. TUBING SHALL CONFORM TO ASTM A268, TYPE 304, SEAMLESS AND WELDED AUSTENITIC STAINLESS STEEL TUBING FOR GENERAL SERVICE. TUBING WALL THICKNESS SHALL BE AS DELINEATED ON THE DRAWING.
 4. CARBON STEEL ANGLES, BAR, AND PLATE SHALL CONFORM TO ASTM A36, STANDARD SPECIFICATION FOR STRUCTURAL STEEL.
 5. CARBON STEEL SHEET SHALL CONFORM TO ASTM A596, STANDARD SPECIFICATION FOR STEEL, CARBON, HOT-ROLLED SHEET AND STRIP, COMMERCIAL QUALITY.
 6. STAINLESS STEEL BARS SHALL CONFORM TO ASTM A276, TYPE 304, STANDARD SPECIFICATION FOR STAINLESS AND HEAT-RESISTING STEEL BARS AND SHAPES.
 7. SHOP AND FIELD WELDING OF TUBING SHALL BE PERFORMED IN ACCORDANCE WITH ANSI B31.1, POWER PIPING CODE. PROCEDURES AND WELDER QUALIFICATION REQUIREMENTS FOR WELDING OF TUBING SHALL COMPLY WITH ANSI B31.1. WELDS SHALL BE VISUALLY EXAMINED IN ACCORDANCE WITH THE REQUIREMENTS OF ANSI B31.1, PARAGRAPH 136.4. WELD DEFECTS SHALL BE REPAIRED IN ACCORDANCE WITH ANSI B31.1, PARAGRAPH 127.4.11.
 8. SHOP AND FIELD WELDING OF STRUCTURAL SHAPES, BARS, AND PLATES SHALL BE PERFORMED IN ACCORDANCE WITH AWS D1.1, STRUCTURAL WELDING CODE, STEEL. PROCEDURES AND WELDER QUALIFICATION REQUIREMENTS FOR WELDING OF STRUCTURAL SHAPES AND PLATES SHALL COMPLY WITH AWS D1.1, OR ASME B & PV CODE, SECTION VIII. WELDS SHALL BE VISUALLY EXAMINED IN ACCORDANCE WITH THE REQUIREMENTS OF AWS D1.1, PARAGRAPH 8.15.1. WELD DEFECTS SHALL BE REPAIRED IN ACCORDANCE WITH AWS D1.1, PARAGRAPH 3.7.
 9. CARBON STEEL PARTS SHALL BE PAINTED WITH PHENOLINE 305 PRIMER AND PHENOLINE 305 FINISH AS MANUFACTURED BY THE CARBOLINE COMPANY. FINISH COLOR SHALL BE GRAY. PREPARATION OF SURFACES, AND APPLICATION OF PRIMER AND FINISH SHALL BE IN ACCORDANCE WITH THE MANUFACTURER'S INSTRUCTIONS. WIREBRUSH WELDED JOINTS AND REMOVE WELD SPATTER PRIOR TO APPLICATION OF PRIMER. DO NOT PAINT WITHIN 15 INCHES OF FIELD-WELDED JOINTS. SHOULD THE FRAMEWORK BE SHOP PAINTED; PAINT FIELD-WELDED JOINT AREAS AT THE INSTALLATION SITE.
 10. DIMENSIONAL TOLERANCES:
FRACTIONAL $\pm \frac{1}{16}$
ANGULAR $\pm 1^\circ$

ENGINEERING RELEASE BY WHC
REV 0 DATE 2-2-84
END # 0142GA

EXCEPT AS NOTED
QA TYPE
ENGINEER
DATE 2-2-84
END # 0142GA

Figure 8. Fuels and Materials Examination Facility Heating, Ventilation, and Air Conditioning Process Ventilation Exhaust Duct Air Sample Probe.

NO.	DATE	DESCRIPTION	BY	CHKD
1	11-11-83	PROCESS VENTILATION EXHAUST DUCT AIR SAMPLE PROBE	L. NITTEBERG	
2	11-11-83	PROCESS VENTILATION EXHAUST DUCT AIR SAMPLE PROBE	L. NITTEBERG	
3	11-11-83	PROCESS VENTILATION EXHAUST DUCT AIR SAMPLE PROBE	L. NITTEBERG	
4	11-11-83	PROCESS VENTILATION EXHAUST DUCT AIR SAMPLE PROBE	L. NITTEBERG	
5	11-11-83	PROCESS VENTILATION EXHAUST DUCT AIR SAMPLE PROBE	L. NITTEBERG	
6	11-11-83	PROCESS VENTILATION EXHAUST DUCT AIR SAMPLE PROBE	L. NITTEBERG	
7	11-11-83	PROCESS VENTILATION EXHAUST DUCT AIR SAMPLE PROBE	L. NITTEBERG	
8	11-11-83	PROCESS VENTILATION EXHAUST DUCT AIR SAMPLE PROBE	L. NITTEBERG	
9	11-11-83	PROCESS VENTILATION EXHAUST DUCT AIR SAMPLE PROBE	L. NITTEBERG	
10	11-11-83	PROCESS VENTILATION EXHAUST DUCT AIR SAMPLE PROBE	L. NITTEBERG	

U.S. Department of Energy
Richard Operations Office
Hartford Engineering Development Laboratory
Washinghouse Hartford Company

HVAC
PROCESS VENTILATION EXHAUST
DUCT AIR SAMPLE PROBE

AS SHOWN
FUELS AND MATERIALS EXAMINATION FACILITY

4-4-156199

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Figure 9. Fuels and Materials Examination Facility Structural Roof Level Framing Plan.

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Figure 10. Windrose for Fast Flux Test Facility.

Distance (m)	CHI/Q Toward Indicated Direction (Sec/M ³)							
	N	NNW	NW	WNW	W	WSW	SW	SSW
800	0.762 E-06	0.514 E-06	0.373 E-06	0.285 E-06	0.386 E-06	0.265 E-06	0.364 E-06	0.603 E-06
2,400	0.383 E-06	0.237 E-06	0.140 E-06	0.975 E-06	0.129 E-06	0.908 E-07	0.157 E-06	0.245 E-06
4,000	0.230 E-06	0.137 E-06	0.768 E-07	0.527 E-07	0.690 E-07	0.502 E-07	0.920 E-07	0.139 E-06
5,600	0.160 E-06	0.937 E-07	0.512 E-07	0.350 E-07	0.456 E-07	0.339 E-07	0.630 E-07	0.943 E-07
7,200	0.119 E-06	0.694 E-07	0.374 E-07	0.255 E-07	0.331 E-07	0.249 E-07	0.467 E-07	0.696 E-07
12,000	0.658 E-07	0.376 E-07	0.198 E-07	0.134 E-07	0.173 E-07	0.133 E-07	0.253 E-07	0.375 E-07
24,000	0.294 E-07	0.166 E-07	0.845 E-08	0.557 E-08	0.704 E-08	0.568 E-08	0.108 E-07	0.164 E-07
40,000	0.163 E-07	0.917 E-08	0.457 E-08	0.297 E-08	0.370 E-08	0.307 E-08	0.588 E-08	0.906 E-08
56,000	0.107 E-07	0.604 E-08	0.295 E-08	0.188 E-08	0.230 E-08	0.197 E-08	0.375 E-08	0.597 E-08
72,000	0.748 E-08	0.426 E-08	0.204 E-08	0.125 E-08	0.150 E-08	0.133 E-08	0.250 E-08	0.419 E-08
	S	SSE	SE	ESE	E	ENE	NE	NNE
800	0.524 E-06	0.453 E-06	0.591 E-06	0.441 E-06	0.458 E-06	0.324 E-06	0.477 E-06	0.710 E-06
2,400	0.273 E-06	0.218 E-06	0.292 E-06	0.204 E-06	0.217 E-06	0.143 E-06	0.220 E-06	0.304 E-06
4,000	0.165 E-06	0.129 E-06	0.170 E-06	0.116 E-06	0.125 E-06	0.819 E-07	0.127 E-06	0.172 E-06
5,600	0.114 E-06	0.880 E-06	0.115 E-06	0.781 E-07	0.846 E-07	0.555 E-07	0.859 E-07	0.116 E-06
7,200	0.848 E-07	0.654 E-07	0.854 E-07	0.573 E-07	0.623 E-07	0.410 E-07	0.634 E-07	0.860 E-07
12,000	0.463 E-07	0.354 E-07	0.461 E-07	0.306 E-07	0.333 E-07	0.220 E-07	0.342 E-07	0.464 E-07
24,000	0.203 E-07	0.155 E-07	0.202 E-07	0.132 E-07	0.142 E-07	0.947 E-08	0.149 E-07	0.205 E-07
40,000	0.112 E-07	0.851 E-08	0.111 E-07	0.718 E-08	0.765 E-08	0.515 E-08	0.818 E-08	0.113 E-07
56,000	0.724 E-08	0.557 E-08	0.726 E-08	0.464 E-08	0.484 E-08	0.331 E-08	0.533 E-08	0.748 E-08
72,000	0.494 E-08	0.388 E-08	0.509 E-08	0.319 E-08	0.320 E-08	0.225 E-08	0.368 E-08	0.529 E-08

Figure 11. Ground-Level CHI/Q Values for Particulate Releases at Various Distances
(Not Corrected for Radiological Decay).

and the ventilation system. The HEPA's are 99.97% efficient on installation. Therefore, for 1% of the entire throughput to become entrained in the ventilation system, over 100% of the entire throughput would have to be released.) The ventilation system is assumed to contain three HEPA filters in series, which is equivalent to a transmission factor of 2.5×10^{-8} . (It is understood that aggregate recoil particles from a source of alpha activity appear to penetrate HEPA filters much more effectively than would be expected on the basis of filter efficiency for similar sized stable aerosols. It is also understood [McDowell et al.] that where the aerosols are realistic in terms of what comes out of the facility, the recoil effect is not proven. In light of the possibility of the recoil effect, monitoring, appropriate filter changeouts, and other administrative controls will be implemented to ensure filter system integrity.) (As noted above, the hot cells, gloveboxes, hoods, and enclosures actually have an additional HEPA filter; however, this filter is not testable and the removal efficiency cannot be verified during operation. Therefore, no credit is taken for these filters in the dose calculations.) The RAF is the product of the release factor and the transmission factor. The projected controlled radioactive airborne particulate emissions releases for the FCFS are shown in Table 1-1.

Table 1-1. Controlled Particle Radionuclide Emission Rates for FCFS (Ci/yr) (Emissions at Stack).

<u>Nuclide</u>	<u>Emission rate</u>
²³⁶ Pu	2.79 E-08
²³⁸ Pu	9.95 E-05
²³⁹ Pu	3.14 E-08
²⁴⁰ Pu	1.49 E-08
²⁴¹ Pu	1.15 E-05
²⁴² Pu	4.39 E-10

2.3 DESCRIBE THE SAMPLING/MONITORING SYSTEM(S)

The FMEF stack monitoring and sampling system (Figures 8 and 9) was designed in accordance with the guidance provided in DOE Order 6430.1A, Section 1589-99.0.1 and ANSI N13.1-1969.

The FMEF stack exhaust is monitored with redundant Eberline PING-3 analyzers (Figure 8). The Eberline PING-3 is a self-contained, microprocessor-based, radiation detection system used to monitor for particulates, iodines, and noble gases in the air. The FMEF analyzers are capable of monitoring beta-emitting particulates, alpha-emitting particulates, iodine, and beta-emitting gases. The other components of the sampling/monitoring system are described below.

2.3.1 Stack Flow Measuring System

The FMEF stack flow rate of 2265.4 m³/min (80,000 ft³/min) is measured by summing the flow through the operating exhaust fans. The exhaust fan flows are measured by pitot tubes on each fan inlet and displayed in the FMEF control room. The exhaust fan flow control dampers are automatically adjusted as necessary to control the final, HEPA filter inlet header pressure. The FMEF supply fan outlet header pressure is controlled in a similar manner by adjusting the supply fan control dampers. The header pressure setpoints were determined during FMEF design, and experimentally confirmed during air balance testing from November 1986 through December 1986, as those necessary to maintain the internal FMEF flows and zone pressures.

2.3.2 Sample Probes

The FMEF stack sample probe is isokinetic, as required by DOE Order 430.1A, Section 1589-99.0.1.

2.3.3 Number and Location of Sampling Points

There are 32 stack sampling points located as shown in Figure 8.

2.3.4 Description of Sample Lines

Figure 8, provides the following information relative to sample lines: diameters, lengths, materials, bends (radii), entry points into effluent line, and angles of entry into effluent.

2.3.5 Sample Flow Regulation

The stack monitor flow is drawn from the stack to the analyzer with a regulated air pump. The sample flowrate is controlled with an adjustment on the pump and monitored with a differential pressure gauge (calibrated in liters/minute) connected across a flow orifice.

2.3.6 Sampling Media

Millipore membrane filters are used as the sampling medium. These filters are made of cellulose esters, and polyvinyl chloride or acrylonitrile. Because the filters are not very stiff, they are supported on a metal gauze or other grid. The filters are 140 μ m thick and have a porosity of 0.45 μ m.

2.3.7 Frequency of Sampling (Continuous or Batch)

The FMEF stack monitoring system provides for both continuous and batch sampling.

2.3.8 Frequency of Sample Collection

Batch samples from the FMEF stack monitoring system are collected weekly.

3.0 GENERAL INFORMATION

3.1 EFFLUENT SAMPLING/MONITORING SYSTEM DESIGNS, PROCEDURES, AND QUALITY ASSURANCE MUST BE CONSISTENT WITH ACCEPTED INDUSTRY STANDARDS. REFERENCE THE APPROPRIATE STANDARDS AND DESCRIBE HOW THEY HAVE BEEN USED. INCLUDE CALIBRATION SCHEDULE AND THE FREQUENCY OF AUDITS AND INSPECTIONS. SUBMIT PROCEDURES USED.

The Westinghouse Hanford Company defines a monitoring system as instrumentation that provides the near-real-time measurement of an airborne or liquid waste stream parameter. The system includes a detector and associated readout components. A continuous monitoring system measures the stream parameter on a near-real-time basis or as specified in applicable EPA regulations (e.g., 40 CFR 52, Appendix E; 40 CFR 51, Appendix P) or as defined in applicable ANSI standards. A radiation monitoring system is a system in which radiation or radioactivity is the measured parameter. An integrating monitoring system integrates the instantaneously measured parameter over some time period.

The Westinghouse Hanford Company defines a sampling system as instrumentation and equipment that remove a part of a liquid or airborne waste stream for subsequent quantitative determination of a stream parameter. The system generally employs such devices as filters, other sample collection media, or effluent traps of some kind. A continuous sampling system removes a part of the stream continuously except during sample change, maintenance, repair, or other necessary outages. A grab sampling system removes an instantaneous part of the stream or removes a part of the stream over a time period.

General guidance regarding the design of sampling and monitoring systems is found in DOE 6430.1A, Section 1589-99.0.1. This order requires that sampling systems be designed in accordance with ANSI N13.1 and associated appendices to ensure both representative sampling of the effluent stream, and that effluent monitoring systems comply with ANSI N42.18-1980 and pertinent portions of DOE 5480.

Following is a list of orders and codes that provide the guidance for the design and construction of the monitoring/sampling systems described in Section 2.0; provide guidance for sampling and monitoring procedures and provide guidance for quality assurance control procedures.

- o DOE Order 5480.1B - *Environment, Safety, and Health Program for Department of Energy Operations.*
- o DOE Order 5480.4 - *Environmental Protection, Safety, and Health Protection Standards.*

- o DOE Order 5484.1 - *Environmental Protection, Safety, and Health Protection Information Reporting Requirements.*
- o DOE Order 6430.1A - *General Design Criteria.*
- o 40 CFR 52 - *Approval and Promulgation of Implementation Plans.*
- o 40 CFR 61 - *National Emission Standards for Hazardous Air Pollutants (NESHAPS).*
- o General Regulation 80-7 - *Benton-Franklin-Walla Walla Counties Air Pollution Control Authority.*
- o ANSI/ASME NQA-1 - *Quality Assurance Program Requirements for Nuclear Facilities.*
- o ANSI N13.1-1969 - *Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities.*
- o ANSI N42.18-1980 - *Specification and Performance of On-Site Instrumentation for Continuously Monitoring Radioactivity in Effluents.*
- o ANSI N317-1980 - *Performance Criteria for Instrumentation Used for Inplant Plutonium Monitoring.*
- o ANSI N323-1978 - *Radiation Protection Instrumentation Testing and Calibration.*
- o DOE-RL - *Implementation Plan for Hanford Site Compliance to DOE Order 5820.2, Radioactive Waste Management.*

3.2 EFFLUENT SAMPLE ANALYSIS.

3.2.1 Methodology

The air sampling and monitoring program at Westinghouse Hanford Company is conducted by several groups within the Safety, Quality Assurance, and Security Organization. Health Physics directs and maintains the workplace air sampling programs. The Environmental Protection Group provides guidance for Health Physics' operation of effluent stack exhaust monitoring and sampling equipment and tracks collected sample data for trend analysis. The radioanalytical laboratories in the individual areas (100, 200, 300, 400) provide isotopic analysis and quantitative measurement (concentrations) when requested. Radiation Protection Technicians provide the actual sample exchange and sample volume data collection.

Air sampling and monitoring is performed for assessing the impact of any possible airborne releases to the environment, and to assess and evaluate the potential hazard of airborne radioactive materials in the work place.

In both applications the intent is to restrict airborne radioactive materials to "as low as reasonably achievable" (ALARA) levels, and not to exceed levels in applicable DOE orders.

Health Physics conducts the air sampling and monitoring program in accordance with the applicable DOE orders and ANSI requirements. The ultimate responsibility for the prevention of releases of airborne radioactive materials or contamination is placed on management of the individual facilities. Health Physics provides the technical direction for the required air sampling equipment and techniques, and the necessary personnel protection practices. The technical direction and practices are stressed most in the individual facility safety regulations, and in working procedures and documents.

Health Physics conducts air sampling in all areas where the potential exists for persons to be unknowingly exposed to airborne radioactive materials. A sufficient number of air samples are taken to represent the area of interest. Samples are collected for the length of time necessary to evaluate and document the extent and hazards of exposure to any airborne radioactive materials. Air sample concentration calculation data is available for trending when desired. In addition, when access by personnel to known areas of airborne radioactive material is necessary, representative air samples are taken to quantify the concentrations present so that proper respirator protection factor requirements may be calculated and used.

Air sampling equipment, techniques, and criteria for stack effluent samplers and monitoring systems include:

- o Facility exhaust stacks are sampled to provide an auditable record of long-term, low-level effluent releases.
- o Facility exhaust stacks are monitored by continuous air monitors (CAM) to provide rapid indication of a significant release of airborne radioactivity.
- o Stack particulate record samplers are run for a 1-wk interval (168 hr) whenever possible to obtain an adequate sample.
- o The Environmental Protection Group oversees the operation of stack sampling and monitoring systems.
- o In addition to particulate sampling, additional sampling for iodine, noble gases, tritium, or volatile vapors may be necessary, depending on the facility.

3.2.2 Procedure References

Following is a list of the procedures used on the Hanford Site to provide guidance to personnel involved in the monitoring and sampling of airborne radionuclides.

- o ANSI N13.1-1969 - *Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities.*
- o ANSI N13.10-1974 - *Specifications and Performance of Onsite Instrumentation for Continuously Monitoring Radioactivity in Effluents.*
- o ANSI N323-1978 - *Radiation Protection Instrumentation Testing and Calibration.*

3.2.3 Detection Limits

The standard Hanford Site detection limit for equipment monitoring the controlled release of airborne radionuclides has been established at a level equal to or less than 10% of the derived concentration guide (DCG) for the specific radionuclide(s) being monitored.

3.2.4 Quality Assurance (Include Internal Audit Schedule and Results)

Because the FMEF has not housed any active processes, there have not been any audits to date, internal or otherwise, of the quality assurance program relative to the effluent sampling/monitoring system. However, on start of operations, the FCFS sampling/monitoring quality assurance program will adhere to DOE-RL Order 5700.1A, *Quality Assurance*, and ANSI/ASME NQA-1, *Quality Assurance Program Requirements for Nuclear Facilities*.

3.3 ENVIRONMENTAL MONITORING PROGRAM

3.3.1 Give a Description of the Program and a Summary of the Data

The environmental monitoring program assessing the offsite impact of the controlled release of airborne radionuclides as well as nonradioactive pollutants from the Hanford Site is conducted by PNL. The program includes a network of 50 continuously operating air samplers at locations on and off the Hanford Site. The data gathered from these locations are collated and published by PNL in the annual *Hanford Site Environmental Report*, copies of which are provided the DSHS upon publication. Chapter 4.1 of the report provides a complete description of the program and methodology as well as summary data pertinent to the monitoring of the controlled release of airborne radionuclides from the Hanford Site. The following, taken from page 4.1 of the report, summarizes the results of the study of the data for 1988.

In 1988, the annual average Hanford Site perimeter concentrations of airborne ^3H , ^{90}Sr , ^{137}Cs , and uranium were numerically greater than levels measured at distant monitoring stations, but the differences were not statistically significant (at the 5% significance level). Krypton-85 and ^{129}I concentrations were numerically greater at the perimeter stations than at the distant stations, and the differences were statistically significant (beyond the 5% significance level). However, even the maximum single perimeter sample for any radionuclide was only 0.3% of the applicable DOE Derived Concentration Guide (DCG) (Appendix B, Table B.6). The total dose from air emissions is compared to Clean Air Act and DOE dose standards in Section 4.8, "Potential Radiation Doses from 1988 Hanford Operations." Annual average NO_2 concentrations at all sampling locations remained well below federal and Washington State ambient air standards.

4.0 DEMONSTRATION OF COMPLIANCE

4.1 GIVE METHODOLOGY USED TO DEMONSTRATE COMPLIANCE

The AIRDOSE-EPA (Clean Air Act Code) computer code was used to calculate the dose from FCFS to the maximally exposed offsite individual, and thus demonstrate compliance with 40 CFR 61, Subpart H; WAC 402-80-50; and WAC 173-480-040.

4.2 INCLUDE ALL INPUT DATA USED

Meteorological data input to the AIRDOSE-EPA code include mixing height, rainfall rate, average air temperature, vertical temperature gradient, wind direction frequency, wind speed, and atmospheric stability. This information was obtained from the data base compiled by the Hanford Meteorological Station (HMS). The HMS data on airspeed, direction, and temperature are collected at a 125-m (410-ft) tower located on the Hanford Site between the 200 East and 200 West Areas, and at a second tower at the 400 Area. Wind speed and direction are based on hourly data collected at the 400 Area meteorological tower 10-m (32.8-ft) level during the years 1983 to 1987. Atmospheric stability was estimated from the temperature gradient between the 9.1-m (30-ft) and 61-m (200-ft) levels at the HMS for the same period using standard methods of the U.S. Nuclear Regulatory Commission. Air temperature and mixing height are also 5-yr averages of hourly data. Temperature is measured at the tower 61-m (200-ft) level, and mixing height data are collected by onsite acoustic sounders.

Joint frequency data, as reported by the HMS, are modified for input into AIRDOSE-EPA by conversion to true average and reciprocal average wind speeds for each direction and stability class. The meteorological data are then used to calculate X/Q values for each radionuclide, which are also a function of radiological half-life and dry deposition velocity. For purposes of this calculation, deposition velocities are assigned as follows: 1.0×10^{-3} m/s

for all particulate materials, 1.0×10^{-2} m/s for iodine isotopes, and zero for all gases.

Source Terms: Projected annual releases from FCFS as presented in Table 1-1.

Release Height: The FMEF stack height is 35.7 m (117 ft).

Inhalation Rate: 8,500 m³/yr (300,173 ft³/yr).

Maximally Exposed Individual: Doses were estimated for an individual living 8.7 km (5.4 mi) south of the 427 Building.

Meteorology: The HMS data and onsite meteorological data as discussed above.

4.3 PRESENT THE RESULTS

Maximum individual doses were much less than 1 mR. Bone surface and lung were the organs receiving the highest dose, primarily from ²³⁸Pu. Inhalation was the dominant pathway for exposures.

Table 1-2 shows the whole body and critical organ doses to the offsite individual receiving maximum exposure to airborne radiological emissions from the FCFS.

Table 1-2. Offsite Dose Estimates for an Individual Receiving Maximum Exposure to Airborne Radiological Emissions from FCFS (mR).

<u>Whole body</u>	<u>Critical organ (bone surface)</u>
7.0 E-04	9.0 E-03

Both WAC 402-80-50 and WAC 173-480-040 state the following:

The WDOE ambient standard requires that emissions of radionuclides to the air shall not cause a dose equivalent of more than 25 mrem/y to the whole body or 75 mrem/y to a critical organ of any member of the public.

National ambient air quality standards for DOE facilities are stated in 40 CFR 61.92, as follows:

Emissions of radionuclides to air from DOE facilities shall not exceed those amounts that cause a dose equivalent of 25 mrem/y to the whole body or 75 mrem/y to the critical organ of any member of the public.

A comparison of the data presented in Table 1-2 with the cited statutory limits shows that the projected whole body and critical organ doses of

airborne radionuclides from the FCFS to the maximally exposed offsite individual would not violate either State or Federal standards.

Further, the *Hanford Site Environmental Report for Calendar Year 1988*, PNL-6825 (Jacquish 1989) states that the effective dose equivalent (whole body dose) to the maximally exposed offsite individual from all Hanford Site operations air emissions was 0.3 mR in 1988. If the projected whole body dose from the FCFS, as listed in Table 1-2, is added to the historic releases for 1988, it is clear that the FCFS projected emissions will not cause a violation of either State or Federal standards.

4.4 DESCRIBE ANY INTERNAL STANDARDS USED TO ENSURE COMPLIANCE WITH APPLICABLE STATE AND FEDERAL LAWS AND REGULATIONS.

Westinghouse Hanford Company policy regarding compliance with State and Federal laws pertinent to protection of the environment is defined as follows:

- o Operate and maintain company-managed facilities according to DOE Orders and in compliance with the letter and spirit of other applicable Federal, State, and local regulations.
- o Design and construct new facilities in a manner that ensures that exposure of individuals and population groups to radioactive and other hazardous materials is ALARA.
- o Treat, dispose of, and store radioactive and other hazardous material in a manner that minimizes waste volumes and provides the maximum protection for the environment.
- o Manage facilities and activities in a cost effective and environmentally responsible manner.
- o Environmental controls and programs shall be consistent with the environmental policy stated above and with contractual provisions with DOE. These formalized controls shall be based on the following orders and regulations:

DOE Order 5440.1C - *National Environmental Policy Act*

DOE Order 5480.1A - *Safety and Health Policy Statement*

DOE Order 5480.1B, - *Environment, Safety and Health Program for Department Energy Operations*

DOE Order 5480.4 - *Environmental Protection, Safety, and Health Protection Standards*

DOE Order 5482.1B - *Environment, Safety and Health Appraisal Program*

DOE Order 5484.1 - *Environmental Protection, Safety, and Health Appraisal Program*

DOE Order 5820.2 - *Radioactive Waste Management*

DOE Order 6430.1A - *General Design Criteria*

DOE-RL Order 5440.1A - *Implementation of National Environmental Policy Act at the Richland Operations Office*

DOE-RL Order 5480.1A - *Environment, Safety, and Health Program for Department of Energy Operations for Richland Operations*

DOE-RL Order 5480.5 - *Safety of Nuclear Facilities*

DOE-RL Order 5482.1B - *Environment Safety, Health, and Quality Assurance Appraisal and Surveillance Program*

DOE-RL Order 5484.2A - *Unusual Occurrence Reporting System for RL*

DOE N5400.1 - *Environmental Policy Statement*

40 CFR - *Protection of Environment*

WAC 173-303 - *Dangerous Waste Regulations*

WAC 173-400 - *General Regulations for Air Pollution Sources*

WAC 402-80 - *Monitoring and Enforcement of Air Quality and Emission Standards for Radionuclides.*

- o Environmental controls and implementing procedures used by the company shall be maintained current and shall promptly reflect regulatory changes.

5.0 BEST AVAILABLE RADIONUCLIDE CONTROL TECHNOLOGY ASSESSMENT

A BARCT is defined by WAC-402-80-40 as follows:

Technology which will result in a radionuclide emission limitation based on the maximum degree of reduction for radionuclides which would be emitted from any proposed stationary source or modification of a source which the permitting authority on a case-by-case basis, taking into account energy, environmental, and economic impacts and other costs, determines is achievable for such source or modification through application of production processes or available methods, systems, and techniques. In no event shall application of best available radionuclide technology result in emissions of radionuclides which would exceed the ambient annual standard limitation specified in this chapter.

The selection of the emissions control system described in Section 2.2.2 is supported as BARCT for the pollutants to be emitted by the FCFS by the following.

Control Alternatives

Radionuclide emissions from the FCFS are limited to particulate matter generated during the processing of $^{238}\text{PuO}_2$ powder. Based on the handling operations that will be performed and the physical characteristics of the powder, suspended particulate matter is anticipated to be in the micrometer- and submicrometer-size range.

In order to identify all possible emission controls for this process, a nuclear-and cross-industry survey for high-efficiency particulate matter controls was conducted (Appendix A). Therefore, devices capable of collecting only large-diameter particles are not included in the survey. All of the controls identified have been previously applied in radiochemical processing operations. High-efficiency particulate controls in the industrial sector are limited to HEPA filters, used for cleanroom applications and packed fiber filters, for high quality product gas filtration (essentially, high-efficiency mist eliminators [HEME]). Potential control devices identified in the surveys are presented in Table 1-3. Detailed process descriptions and evaluations are presented in Appendix B.

Of the potential particulate controls identified in Table 1-3, only the prefilter and HEPA can be applied to primary particulate control in this application.

Table 1-3. FCFS Control Technology Survey Results.

Control	Removal efficiency
<u>Particulate matter</u>	
HEPA filter	99.97% for 0.3- μm particles
Deep-bed sand filter	99.95% for 0.3- μm particles
Deep-bed glass-fiber filter	99.9% for 0.3- μm particles
HEME	99.5% for 1- μm particles
Prefilter	85% (max) for 0.3- μm particles

In the nuclear industry, prefilters are generally used in combination with HEPA's to remove the larger particles in the exhaust stream, thus increasing the service life of the HEPA's. Extremely large units, such as the deep-bed sand and deep-bed fiber filters cannot be considered as primary filters because adequate floor space is not available. Although the HEME is relatively small (about 0.9 m [3 ft] in length), it is significantly less effective than the HEPA in its removal of small particles, it requires additional plumbing (for possible filter cleaning with a water-wash) and it is normally not used for dry room offgas systems. Therefore, a combination

prefilter/HEPA assembly is considered the only applicable particulate control alternative based on performance and operating/physical constraints for primary FCFS exhaust treatment, and is thus proposed as BARCT for this particular application. No further analysis of energy, environmental, or economic impacts is required because the control technology identified has been determined to be the technology that is appropriate and allows the lowest emission rate of radionuclides. Any other control technology would not provide a comparable low environmental impact, regardless of energy or economic impact. The BARCT analysis will therefore be limited to the final filtration processes only.

After primary treatment, all the exhaust from the FCFS operations is combined and routed to a final filtration step before discharge through the main building stack. Final high-efficiency particle filtration before discharge of radionuclide-contaminated gases to the atmosphere is a nuclear industry standard. Generally, two-stage filtration is used for this purpose. Presently employed final filtration techniques in the nuclear industry include combination prefilter and HEPA's, deep-bed glass-fiber filters, and deep-bed sand filters (Table 1-3). Deep-bed glass-fiber and sand filters are normally installed upstream of a final contact HEPA filter. Therefore, the alternative control systems for the final FCFS exhaust that will be evaluated are the following:

Alternative 1 - deep-bed glass-fiber filter/one-stage HEPA

Alternative 2 - deep-bed sand filter/one-stage HEPA

Alternative 3 - two-stage HEPA

The following will present an evaluation of these final emission control alternatives based on environmental, energy, and economic impacts to demonstrate BARCT for the FCFS emissions.

Environmental

All of the three alternatives incorporate a HEPA filter as the second-stage control device. Studies have shown that the removal efficiency of a HEPA placed downstream of another high-efficiency particulate control device (such as a deep-bed sand filter or another HEPA) is lower than that of a single-stage HEPA (Zippler 1974). It is postulated that this results from the extraction of the more readily collected particles in the initial filter (Moore and Fullam 1984). Sufficient data are not available to determine the effect that this would have on the overall removal efficiency of each alternative control system. For the purposes of this analysis, it is assumed that the second-stage HEPA performs identically for each system. Therefore, the overall efficiency is directly related to the removal efficiency of the first-stage unit. As shown in Table 1-3, alternative 3 (two-stage HEPA) would provide somewhat higher performance than alternatives 2 and 1, respectively. Because ground-level radionuclide impacts are directly dependent on emission rate (and thus removal efficiency), the implementation of alternative 3 would result in the lowest air quality impact.

All three alternatives use standalone dry processes, so the only wastes associated with these systems would be the spent filters. Alternative 1 has the largest volume of waste for disposal (i.e., the sand) and therefore poses the greatest potential environmental impacts (landfill space and possible contamination). Alternative 3 would produce less waste material than alternative 2, although only relative quantities can be estimated at this time.

Energy

Energy requirements for the three alternatives are associated with operating a sufficiently large exhaust fan(s) to overcome the pressure drop of each system (as the final exhaust temperature of 26.6° C [80° F] is within the operating range of the filters). Based on the anticipated pressure drops of the initial control stage of each alternative (Appendix B), alternative 2 (sand filter pressure drop = 11 in. WC) would have the highest energy impacts of the alternatives, followed by alternative 1 (fiber filter pressure drop = 8 in. WC) and Alternative 3 (HEPA pressure drop = 4 in. WC).

Economic

Installed costs of the three alternatives are presented below, based on previously installed exhaust cleaning systems at various nuclear fuel reprocessing plants (Burchsted 1976):

	<u>Cost (\$/ft³/min)</u>
Alternative 1 (deep-bed fiber and HEPA)	30.34
Alternative 2 (deep-bed sand filter only)	46.88 (cost of additional HEPA not available)
Alternative 3 (2 stage HEPA)	7.43

These cost estimates show that alternative 3 costs only about 24% of alternative 1 and 16% of alternative 2 (percentage would be less if costs of HEPA were included in alternative 2). Although operating costs such as utilities, maintenance, operations, service life, and consumables are not available, it has been shown that alternative 2 has the highest utility cost (largest fan requirements) and higher overall operating costs than alternative 1 (Moore and Fullam 1984). Alternative 1 has the second highest utility cost and alternative 3 has the lowest utility cost. On the other hand, alternative 3 is expected to have higher maintenance costs than alternative 2 because of the frequency of filter changeouts.

Summary

Alternative 3 is considered to be the BARCT for the final FCFS exhaust. Its use of available, proven control methods for reducing radionuclides is confirmed by comparing its effectiveness to the other available alternatives. It is the most cost effective alternative, having the lowest capital and operating costs. Alternative 3 also has the lowest energy consumption of the three systems evaluated.

REFERENCES

- ANSI N13.1-1969, *Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities*, American National Standards Institute, New York, New York.
- ANSI N13.10-1974, *Specifications and Performance of Onsite Instrumentation for Continuously Monitoring Radioactivity in Effluents*, American National Standards Institute, New York, New York.
- ANSI N323-1978, *Radiation Protection Instrumentation Testing and Calibration*, American National Standards Institute, New York, New York.
- ANSI N42.18-1980, *Specification and Performance of On-Site Instrumentation for Continuously Monitoring Radioactivity in Effluents*, American National Standards Institute, New York, New York.
- ANSI N317-1980, *Performance Criteria for Instrumentation Used for Inplant Plutonium Monitoring*, American National Standards Institute, New York, New York.
- ANSI/ASME NQA-1, *Quality Assurance Program Requirements for Nuclear Facilities*, American National Standards Institute, New York, New York.
- Burchsted et al. 1976, *Nuclear Air Cleaning Handbook--Design, Construction, and Testing of High-Efficiency Air Cleaning Systems for Nuclear Application*, C.A. Burchsted, J.E. Kahn, and A.B. Fuller, ERDA-76-21, Oak Ridge National Laboratory, Oak Ridge, Tennessee.
- DOE Order 5400.1, *General Environmental Protection Program*, U.S. Department of Energy, Washington, D.C., November 9, 1988.
- DOE Order 5400.3, *Hazardous and Radioactive Mixed Waste*, U.S. Department of Energy, Washington, D.C., February 23, 1989.
- DOE Order 5440.1C, *National Environmental Policy Act*, U.S. Department of Energy, Washington, D.C., April 9, 1985.
- DOE Order 5480.1A, *Safety and Health Policy Statement*, U.S. Department of Energy, Washington, D.C., May 13, 1988.
- DOE Order 5480.1B, *Environment, Safety, and Health Program for Department of Energy Operations*, U.S. Department of Energy, Washington, D.C., September 23, 1986.
- DOE Order 5480.4, *Environmental Protection, Safety, and Health Protection Standards*, U.S. Department of Energy, Washington, D.C., May 15, 1984.

- DOE Order 5482.1B, *Environment, Safety, and Health Appraisal Program*, U.S. Department of Energy, Washington, D.C., September 23, 1986.
- DOE Order 5484.1, *Environmental Protection, Safety, and Health Protection Information Reporting Requirements*, U.S. Department of Energy, Washington, D.C., February 24, 1981
- DOE Order 5820.2A, *Radioactive Waste Management*, U.S. Department of Energy, Washington, D.C., September 26, 1988.
- DOE Order 6430.1A, *General Design Criteria*, U.S. Department of Energy, Washington, D.C., April 6, 1989.
- DOE-RL Order 5440.1A, *Implementation of the National Environmental Policy Act at the Richland Operations Office*, U.S. Department of Energy, Richland, Washington, February 3, 1987.
- DOE-RL Order 5480.1A, *Environment, Safety, and Health Protection Program for Department of Energy Operations for Richland Operations*, U.S. Department of Energy-Richland Operations Office, Richland, Washington, September 7, 1988.
- DOE-RL 5480.4A, *Environmental Protection, Safety, and Health Protection Standards for RL*, U.S. Department of Energy-Richland Operations Office, Richland, Washington, December 1, 1987.
- DOE-RL Order 5480.5, *Safety of Nuclear Facilities*, U.S. Department of Energy-Richland Operations Office, Richland, Washington, September 23, 1986.
- DOE-RL Order 5482.2B, *Environmental Safety, Health, and Quality Assurance Appraisal and Surveillance Program*, U.S. Department of Energy-Richland Operations Office, Richland, Washington, March 4, 1987.
- DOE-RL Order 5484.1, *Environmental Protection, Safety and Health Protection Information Reporting Requirements*, U.S. Department of Energy-Richland Operations Office, Richland, Washington, September 26, 1983.
- DOE-RL Order 5484. 2A, *Unusual Occurrence Reporting System for RL*, U.S. Department of Energy-Richland Operations Office, Richland, Washington, September 24, 1984.
- DOE-RL 5700.1A, *Quality Assurance*, U.S. Department of Energy-Richland Operations Office, Richland, Washington, July 14, 1983.
- General Regulation 80-7, *Benton-Franklin-Walla Walla Counties Air Pollution Control Authority*, Washington State, July 1980.
- Implementation Plan for Hanford Site Compliance to DOE Order 5820.2, Radioactive Waste Management*, U.S. Department of Energy-Richland Operations Office, Richland, Washington, August 1985.

- Recommendations of the International Commission of Radiological Protection*, Publication, Publication 26, International Commission on Radiological Protection, Elmsford, New York, 1977.
- Limits on Intakes of Radionuclides by Workers*, Publication 30, International Commission on Radiological Protection, Elmsford, New York, July 1979.
- Jacquish, R.E. 1989, *Hanford Site Environmental Report for Calendar Year 1988*, PNL-6825, Pacific Northwest Laboratory, Richland, Washington.
- McDowell et al. 1976, *Penetration of HEPA Filters by Alpha Recoil Aerosols*, W.J. McDowell and F.G. Seeley, (Oak Ridge National Laboratory) and M.T. Ryan (University of Lowell, Massachusetts), 14th ERDA Air Cleaning Conference, Sun Valley, Idaho, August 11-13, 1976.
- Moore, E.B. and H.T. Fullam 1984, *Control Technology for Radioactive Emissions to the Atmosphere at U.S. Department of Energy Facilities*, PNL-4621-Final, Pacific Northwest Laboratory, Richland, Washington.
- NE F 3-43, *Nuclear Standard's Quality Assurance Testing of HEPA Filters*, Office of Scientific and Technical Information, Oak Ridge, Tennessee, October, 1988.
- Zippler, D.B. 1974, "Evaluation of Multistage Filtration to Reduce Sand Filter Exhaust Activity," *Proceedings of the 13th AEC Nuclear Air Cleaning Conference*, Vol. 1, San Francisco, California, March 1975, pp. 609-619.

**RADIOACTIVE AIR EMISSIONS PROGRAM
SUPPLEMENTAL INFORMATION FOR
RADIOISOTOPE POWER SYSTEMS FACILITY**

1.0 FACILITY INFORMATION

1.1 DESCRIBE THE FACILITY

The Radioisotope Power System Facility (RPSF) will be located in the Fuel and Materials Examination Facility (FMEF) Process Building on the -5.2-m (-17 ft) and -10.7-m (-35-ft) levels. Figures 12 and 13 detail those sections of the FMEF to be used by the RPSF.

The FMEF Process Building complex is qualified as necessary to withstand all design basis events while maintaining radiological control of its inventory. The FMEF features are summarized below.

- o The Process Building is a six-level, tornado-hardened, seismically qualified concrete structure 79.2 m (260 ft) long and 47.2 m (155 ft) wide, extending from 10.7 m (35 ft) belowgrade to approximately 30.5 m (100 ft) abovegrade. Most of the FMEF capabilities for handling radioactive materials are centered in the Process Building.
- o The Fuel Assembly Area (FAA) is a two-story, tornado-hardened, seismically qualified structure 54.9 m (180 ft) long, 39.6 m (130 ft) wide, and 7.9 m (26 ft) high, housing Fast Flux Test Facility (FFTF) fuel assembly activities and the Entry Wing's heating and ventilation equipment.
- o The Mechanical Equipment Wing is a single-story concrete structure 39.6 m (130 ft) long and 15.2 m (50 ft) wide, housing air compressors, chilled water cooling system pumps and refrigeration units, and associated electrical switchgear. There is no potential for radiological contamination in the Mechanical Equipment Wing nor is any of the enclosed equipment required for Process Building or FAA confinement. The Mechanical Equipment Wing is not tornado hardened or seismically qualified.
- o The Emergency Equipment Wing is a single-story, tornado-hardened, seismically qualified concrete structure 19.8 m (65 ft) long and 17.7 m (58 ft) wide, housing the emergency electrical power system's turbine generators, the emergency cooling water system's cooling tower and circulating pumps, and associated electrical switchgear.
- o The Entry Wing is a two-story structure 47.2 m (155 ft) long and 40.2 m (132 ft) wide, housing office space, lunch room, and personnel change rooms required to support the activities of the

Figure 12. Radioisotope Power Systems Facility
Floor Plan -5.2-Meters (-17-Foot) Elevation.

Figure 13. Radioisotope Power Systems Facility
Floor Plan -10.7-Meters (-35-Feet) Elevation.

Process Building and the Fuel Assembly Area. The Entry Wing is not tornado hardened or seismically qualified.

- o The electrical substations, which supply the FMEF, and the cooling towers and underground fuel storage tank for the turbine generators are located north of the Process Building structure.

Modifications to the Process Building necessary to support RPSF activities include structural (demolition, wall additions and replacements, decking); mechanical (heating-air conditioning, and ventilation [HVAC] enclosure atmospheric control, process cooling systems, emergency cooling system, process services); interior electrical services (normal electrical power, emergency electrical power, uninterruptible power supply); interior telecommunications and alarm systems; fire protection; efficient control and monitoring of solid waste disposal; energy conservation; radiation protection (criticality detection, contamination sampling); additional safety modification/upgrades (instrumentation and control, emergency cooling water, oxygen monitoring, enclosure atmospheric control, finished product monitoring, HVAC); contamination confinement; and plutonium material safeguards. Integration into existing FMEF facilities and systems will be conducted whenever possible.

1.2 DESCRIBE THE FACILITY OPERATIONS

The RPSF will join encapsulated plutonium oxide fuel pellets (fuel clads) with graphite aeroshells to form general purpose heat source (GPHS) modules (Figure 5). The GPHS modules will be grouped into various numbers and configurations to produce heat source assemblies (HSA). The HSAs will then be used in either radioisotope thermoelectric generators (RTG) (Figure 14) or dynamic isotope power systems (DIPS). The RTGs will be assembled in the RPSF. The DIPSs will be assembled at another site. An overall process flow diagram is depicted in Figure 15.

Fuel clads (FC) may be accepted from other manufacturing sites as well as the FCFS. Those FCs shipped from other manufacturing sites will be removed from their shipping canisters in cell 134 and will be decontaminated in cell 137. These steps will not be performed for the FCs manufactured at the FMEF by the FCFS.

Assembly of the GPHS modules will take place in cells 135 and 136 of the RPSF. A sintered metal vent on four FCs will be activated and two FCs will then be inserted into a graphite sleeve. Two graphite sleeves will then be inserted into the aeroshell to produce a GPHS module. The assembled GPHS modules will be transferred to cell 138 where they will be loaded into storage canisters. Two GPHS modules will then be loaded into each canister and the canister will be welded shut. Each storage canister will be equipped with an isolation valve and a tubing connector. The storage canisters will be transferred to room 229 where carbon monoxide and carbon dioxide contaminants are removed by successive evacuation and back filling of the

Figure 14. General Purpose Heat Source Radioisotope Thermoelectric Generator.

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Figure 15. Overall Process Flow Diagram for Radioisotope Power Systems Facility.

storage canister with argon. (A beneficial side effect of this process is a slight reduction of the PuO_2 to about $\text{PuO}_{1.97}$.) The storage canisters will then be stored in room 229 until they are required for power source assembly.

Before assembly of the HSAs and the RTGs, the GPHS modules must be removed from their storage canisters. This operation will be performed in the decanning chamber in room 226A. The GPHS modules will then be assembled into HSAs and RTGs inside the inert atmosphere assembly chambers located in room 226A. Three inert atmosphere assembly chambers are planned to accommodate the variety of HSAs and RTGs to be produced in the RPSF. The chambers will contain an argon environment and each will have an argon purification system to control oxygen and moisture.

Following assembly, the HSAs and RTGs will be tested as required by the specifications for that power source. The RPSF will have vibration testing, mass properties testing, magnetic properties testing, radiation mapping, and thermal vacuum testing capabilities.

Vibration testing will be provided in room 226C to subject the completed power sources to random, transient, and shock vibration loads along three discrete axial directions. Mass properties testing will be performed in room 226B. A computer-controlled floating spin table with load cells will be used to determine the center of gravity for the power source. The weight of the power source will also be determined. The magnetic field for the power source will be measured and, if necessary, adjusted in room 236. Radiation mapping will be performed with portable instrumentation in the FMEF shipping and receiving area using instruments capable of measuring neutron flux, neutron energy spectra, gamma flux, and gamma energy spectra. Thermal vacuum testing will be performed in room 237 to determine the performance of the power source in simulated space conditions.

The completed HSAs and RTGs will be stored in the RPSF until they are ready to be used by the customer. Instrumentation to alarm off-normal conditions will be provided to monitor the RTGs and HSAs during storage. The RTGs will be stored in room 112. Room 112 will have a nitrogen atmosphere to minimize the deleterious effects of oxygen, carbon dioxide, and carbon monoxide on the thermoelectric components. The HSAs will be stored in rooms 116A and 116B until shipped off site to be joined with the generator systems. Rooms 116A and 116B will have an air atmosphere.

1.3 IDENTIFY THE FACILITIES AS THEY WERE IDENTIFIED ON THE SOURCE REGISTRATION FORMS

The FMEF was designed and constructed to produce production and test-fuel assemblies for the Liquid Metal Reactor program and provide a capability for examining fuels and materials following irradiation. These FMEF missions were cancelled before introducing fuel material or other irradiated material into the facility. The FMEF has not, therefore, been registered with the Washington State Department of Social and Health Services (DSHS) as a source of radioactive air emissions.

2.0 SOURCE INFORMATION

2.1 LIST THE SOURCE(S) TO WHICH THE INFORMATION IN THIS SECTION PERTAINS. IDENTIFY ALL SOURCES CONSISTENT WITH THE SOURCE REGISTRATION IDENTIFICATION

Figure 3 depicts the FMEF (RPSF/FCFS shared) stack, which will be the single discharge point (source) for RPSF to be registered with DSHS. When the source is registered with the DSHS, the "Source Registration For Radioactive Air Emissions" form will show the facility as the 427 Building and the discharge point as FMEF Exhaust.

2.2 DESCRIBE THE SOURCES

2.2.1 System Function/Area Exhausted

The RPSF will be provided with ventilation Zones I, II, and III. Areas denoted Zone I will contain the radioactive materials being processed and will be separated from surrounding ventilation Zone II areas. Ventilation Zone III areas will be those support areas that bound ventilation Zone II. There will be a negative pressure gradient from Zone III to I so that any contaminants will flow into Zone I and through the facility emissions abatement systems. All Zone I air flows out the RPSF/FCFS stack. Figure 16 depicts RPSF cell air flow and indicates points of emission to the air.

Releases of radioactive materials to the ventilation system will occur in Zone I and may occur in Zone II. Releases of radioactive materials to the ventilation system from Zone III are unlikely. The RPSF activities taking place in each cell are summarized below.

Zone I

Cells 132, 133, 134, 135, 136, 137, and 138 will be part of the Zone I ventilation system. These enclosures will be used to assemble the FCs into GPHS modules. One percent of the plutonium dioxide contaminating the surface of the FCs is assumed to be released to the ventilation system during the assembly process.

The exhausts from the inert atmosphere assembly chambers, room 112, the room 229 vacuum pumps, and the room 237 thermal vacuum chambers will contain inert gases. These areas will be connected to the Zone I exhaust because of a concern for breathing air safety rather than radionuclide control.

Zone II

Rooms 123, 125, 131, 141, and 163 will be part of the Zone II ventilation system. Releases of radioactive materials to the Zone II ventilation system

Figure 16. Radioisotope Power Systems Facility Cell Atmosphere Systems.

are not likely to occur because of the pressure differential between Zone II and Zone I.

Zone III

Zone III includes those areas surrounding the Zone II ventilation area. Releases of radioactive materials to the Zone III ventilation system are highly unlikely because of the negative pressure differential and because no radioactive materials will be stored or processed in Zone III. (Radioactive materials in transport containers will pass through Zone III to Zones I and II.)

2.2.2 Effluent System Layout

Because the radioactive airborne emissions from RPSF will consist primarily of particulate matter generated during the assembly of GPHS modules, the emissions control system must be capable of containing micrometer- and submicrometer-size particles.

As discussed in Section 2.2.1, the RPSF operations are provided with ventilation Zones I, II, and III with negative pressure gradient from Zone III to Zone I, to provide maximum confinement of radioactive contamination. Zone I will be operated at -1.00 ± 0.25 in. water gage (WG) pressure relative to outside atmosphere. Zone II will be operated at -0.25 ± 0.05 in. WG pressure relative to outside atmosphere. Zone III will be operated at -0.10 ± 0.05 in. WG pressure relative to outside atmosphere.

Zone I ventilation areas in which the GPHS modules are assembled use a recirculated argon atmosphere while the remaining Zone I cells use an air atmosphere. Special sealed structures and structural penetrations are implemented to separate Zone I and Zone II areas. Zone I and Zone II exhausts are vented to separate primary high-efficiency particulate air (HEPA) filtration steps before being combined and routed to final filtration consisting of three banks of HEPA filters and subsequently discharged to the atmosphere (Figure 16). Zone III exhaust is ultimately routed with other plant exhausts to the final HEPA filtration step and discharged to the atmosphere.

Provision of both primary and final particulate control measures as described above allows for high-efficiency removal and provides system redundancy in the event of a possible failure of one of the emission control units. In addition, the RPSF Zone I cells are equipped with non-testable HEPA filters on both the inlet and outlet flows to minimize the radionuclide contamination of the connected atmosphere control systems.

Final high-efficiency particulate filtration before discharge of the radionuclide contaminated gases to the atmosphere is a nuclear industry standard. Generally, two-stage filtration is used for this purpose. Presently employed final filtration techniques in the nuclear industry include combination prefilter and HEPA, deep-bed glass-fiber filters, and deep-bed sand filters. Industry and cross-industry emissions abatement

systems assessment shows that the prefilter and HEPA system provides the highest degree of removal efficiency (see Section 5.0).

2.2.3 Efficiency Values of Each Control Device for Removal of Radioactivity

As shown in Figure 16 and discussed in Section 2.2.2, HEPA filters are the control devices used for removal of radioactivity from the RPSF ventilation system. A HEPA filter is a throwaway, extended-pleated medium, dry-type filter. Hanford Site HEPA filters must meet the following requirements.

- o Permissible penetration at test airflows shall be no greater than 0.03% when tested in accordance with DOE NE F 3-43, Article 6.
- o Filters shall have a minimum particle collection efficiency of 99.97% for 0.3- μm particle size, thermally generated diacetyl phthalate (DOP) aerosol (or equivalent) at 100% and at 20% of rated flow capacity for filters with a nominal airflow rating of 3.5 m^3/min (125 ft^3/min) size 3 and larger and 100% rated flow for filters with a nominal rating below 3.5 m^3/min (125 ft^3/min).
- o The pressure differential for air flow across a clean filter assembly when tested at appropriate nominal flows shall not exceed 1.3 in. WG for size 3 HEPA's and smaller, and 1.0 in. WG for HEPA's larger than size 3.

2.2.4 Means and Frequency of Testing Effluent System

The RPSF emissions abatement system comprises three HEPA filters in series. (The gloveboxes, hoods, and enclosures have an additional HEPA, but they are not testable.)

All Hanford Site HEPA filters are tested in place on an annual basis and must meet the following requirements.

- o All filters shall remove at least 99.95% of the DOP particles, or equivalent, ranging in size from 0.1 μm to 3.0 μm with a mean particle size of 0.5 μm .
- o The HEPA filters that are held in the frame by turn and lock (cam-lock) devices are permitted to have penetration values of up to 0.25% provided that leak tests are performed every 90 days. These filters shall be replaced if penetration values exceed 0.25%, or if the exposure rate or pressure-drop limits cited below are exceeded.
- o The HEPA filter cartridges shall be replaced when continuous exposure rates exceed 1 R/h at 15.3 cm (6 in), or when the pressure drop across the filter exceeds 4 in. WG. Remotely installed HEPA filters shall be replaced when the pressure drop across the filter

exceeds 4 in. WG, or exposure rates exceed limits provided by Radiation Protection.

2.2.5 Operating Mode

The RPSF will assemble GPHS modules 8 hr/d (one shift), 5 d/wk, 52 wk/yr. This means the RPSF will be operating 23.8 % of the time (based on 24 hr/d, 7 d/wk, 52 wk/yr being equal to 100%).

2.2.6 Chemical and Physical Forms of the Releases

Airborne releases from the RPSF subject to regulation will be in particulate forms. The following radionuclides make up the controlled particulate releases projected for the RPSF:

o ^{236}Pu	o ^{240}Pu
o ^{238}Pu	o ^{241}Pu
o ^{239}Pu	o ^{242}Pu

International Commission of Radiation Protection (ICRP) Publications 26 through 30 list all plutonium isotopes in Solubility Class "Y" (years).

2.2.7 Stack (or Release Point) Data

2.2.7.1 Height from Ground/Inside Diameter. The RPSF stack is 35.7 m (117 ft) high with a 2.4-m (7.9-ft) by 5.1-m (16.6-ft) rectangular cross-section (see Figure 8).

2.2.7.2 Building Height. The main Process Building structure is 30 m (98.4 ft) high. The north elevator/stairway roof extends to 32.6 m (107 ft); the southeast stairway roof to 34.1 m (111.9 ft); and the southwest stairway roof to 31 m (101.7 ft) (see Figure 9).

2.2.7.3 Building Width/Length. The FMEF process building is 39.3 m (128.9 ft) wide and 78.6 m (257.9 ft) long (see Figure 9).

2.2.7.4 Annual Average Stack and Ambient Air Temperatures. The annual average stack temperature is 26.7° C (80° F). The annual average ambient air temperature is 11.7° C (53° F). (This average was determined by the Hanford Meteorology Station using meteorology data for the Hanford Site area from the period 1912 to 1980.)

2.2.7.5 Windrose. The windrose for the 400 Area is shown in Figure 10.

2.2.7.6 Chi/Q data, if it Exists. The χ/Q data is found in Figure 11. These data were broken out of the AIRDOSE-EPA computer code used to provide the demonstration required by Section 4.0.

2.2.7.7 Release Rates. The controlled release rates for radionuclides from the RPSF were calculated based on an annual throughput of 960 FCs. Because the FCs have been decontaminated for shipping purposes, the surface contamination is estimated to be only 8.6×10^{-6} Ci/yr. (Shipping requirements are no more than 20,000 dpm/FC. There are 4.5×10^{-13} Ci/dpm, and there are 960 FC.) A release adjustment factor (RAF) of 2.5×10^{-10} was then applied to the 8.6×10^{-6} Ci/yr.

The RAF assumes that 1% (the release factor) of the PuO_2 powder contaminating the capsule surfaces will become entrained in the cell atmosphere and pass into the ventilation system. (This is an extremely conservative assumption because there are non-testable HEPA filters between the gloveboxes and the ventilation system. The HEPA's are 99.97% efficient on installation. Therefore, for 1% of the entire throughput to become entrained in the ventilation system, over 100% of the entire throughput would have to be released.) The ventilation system is assumed to contain three HEPA filters in series, which is equivalent to a transmission factor of 2.5×10^{-8} . (It is understood that aggregate recoil particles from a source of alpha activity appear to penetrate HEPA filters much more effectively than would be expected on the basis of filter efficiency for similar sized stable aerosols. It is also understood [McDowell et al. 1976] that where the aerosols are realistic in terms of what comes out of the facility, the recoil effect is not proven. In light of the possibility of the recoil effect, monitoring, appropriate filter changeouts, and other administrative controls will be implemented to ensure filter system integrity.) The RAF is the product of the release factor and the transmission factor. For purposes of the dose calculation, the RPSF is assumed to contain only three HEPA filters in series. The gloveboxes, hoods, and enclosures actually have an additional HEPA filter; however, this filter is not testable, and the removal efficiency cannot be verified during operation. Therefore, no credit is taken for these HEPA filters in the dose calculations. The particulate radionuclide emission rates for the RPSF are shown in Table 2-1.

Table 2-1. Controlled Particle Radionuclide Emission Rates for RPSF (Ci/yr) (Emissions at Stack).

<u>Nuclide</u>	<u>Emission rate</u>
^{238}Pu	5.58 E-19
^{239}Pu	1.99 E-15
^{240}Pu	6.27 E-19
^{241}Pu	2.98 E-19
^{242}Pu	2.30 E-16
^{243}Pu	8.77 E-21

2.3 DESCRIBE THE SAMPLING/MONITORING SYSTEM(S)

The FMEF stack monitoring/sampling system (Figures 8 and 9) was designed in accordance with the guidance provided in DOE 6430.1A, Section 1589-99.0.1 and ANSI N13.1-1969.

The FMEF stack exhaust is monitored with redundant Eberline PING-3 analyzers (Figure 9). The Eberline PING-3 is a self-contained, microprocessor-based radiation detection system used to monitor for particulates, iodines, and noble gases in the air. The FMEF analyzers are capable of monitoring beta-emitting particulates, alpha-emitting particulates, iodine, and beta-emitting gases. The other components of the sampling/monitoring system are described below.

2.3.1 Stack Flow Measuring System

The FMEF stack flow rate of $2265.4 \text{ m}^3/\text{min}$ ($80,000 \text{ ft}^3/\text{min}$) is measured by summing the flow through the operating exhaust fans. The exhaust fan flows are measured by pitot tubes on each fan inlet and displayed in the FMEF control room. The exhaust fan flow control dampers are automatically adjusted as necessary to control the final HEPA filter inlet header pressure. The FMEF supply fan outlet header pressure is controlled in a similar manner by adjusting the supply fan control dampers. The header pressure setpoints were determined during FMEF design, and experimentally confirmed during air balance testing from November 1986 through December 1986, as those necessary to maintain the internal FMEF flows and zone pressures.

2.3.2 Sample Probes

The FMEF stack sample probe is isokinetic, as required by DOE Order 6430.1A, Section 1589-99.0.1.

2.3.3 Number and Location of Sampling Points

There are 32 FMEF stack sampling points, located as shown in Figure 8.

2.3.4 Description of Sample Lines

Figure 8 provides the following information about sample lines: diameters, lengths, materials, bends (radii), entry points into effluent line, and angles of entry into effluent.

2.3.5 Sample Flow Regulation

The stack monitor flow is drawn from the stack to the analyzer with a regulated air pump. The sample flowrate is controlled with an adjustment

on the pump and monitored with a differential pressure gauge (calibrated in liters/minute) connected across a flow orifice.

2.3.6 Sampling Media

Millipore membrane filters are used as the sampling medium. These filters are made of cellulose esters and polyvinyl chloride or acrylonitrile. Because the filters are not very stiff, they are supported on a metal gauze or other grid. The filters are 140 μm thick and have a porosity of 0.45 μm .

2.3.7 Frequency of Sampling (Continuous or Batch)

The FMEF stack monitoring system provides for both continuous and batch sampling.

2.3.8 Frequency of Sample Collection

Batch samples from the FMEF stack monitoring system are collected weekly.

3.0 GENERAL INFORMATION

3.1 EFFLUENT SAMPLING/MONITORING SYSTEM DESIGNS, PROCEDURES AND QUALITY ASSURANCE MUST BE CONSISTENT WITH ACCEPTED INDUSTRY STANDARDS. REFERENCE THE APPROPRIATE STANDARDS AND DESCRIBE HOW THEY HAVE BEEN USED. INCLUDE CALIBRATION SCHEDULE AND THE FREQUENCY OF AUDITS AND INSPECTIONS. SUBMIT PROCEDURES USED.

Westinghouse Hanford Company defines a monitoring system as instrumentation that provides the near-real-time measurement of an airborne or liquid waste stream parameter. The system includes a detector and associated readout components. A continuous monitoring system measures the stream parameter on a near-real-time basis or as specified in applicable EPA regulations (e.g., 40 CFR 52, Appendix E; 40 CFR 51, Appendix P) or as defined in applicable ANSI standards. A radiation monitoring system is a system in which radiation or radioactivity is the measured parameter. An integrating monitoring system integrates the instantaneously measured parameter over some time period.

Westinghouse Hanford Company defines a sampling system as instrumentation and equipment that remove a part of a liquid or airborne waste stream for subsequent quantitative determination of a stream parameter. The system generally employs such devices as filters, other sample collection media, or effluent traps of some kind. A continuous sampling system removes a part of the stream continuously except during sample change, maintenance, repair, or

other necessary outages. A grab sampling system removes an instantaneous part of the stream or removes a part of the stream over a time period.

General guidance regarding the design of sampling and monitoring systems is found in DOE Order 6430.1A, Section 1589-99.0.1. This order requires that sampling systems be designed in accordance with ANSI N13.1 and associated appendices to ensure representative sampling of the effluent stream, and that effluent monitoring systems comply with ANSI N42.18-1980 and DOE Order 5480.

Following is a list of orders and codes that provided the guidance for the design and construction of the monitoring/sampling systems described in Section 2.0; provide guidance for sampling and monitoring procedures; and provide guidance for quality assurance control procedures:

- o DOE Order 5480.1B - *Environment, Safety, and Health Program for Department of Energy Operations.*
- o DOE Order 5480.4 - *Environmental Protection, Safety, and Health Protection Standards.*
- o DOE Order 5484.1 - *Environmental Protection, Safety, and Health Protection Information Reporting Requirements.*
- o DOE Order 6430.1A - *General Design Criteria.*
- o 40 CFR 52 - *Approval and Promulgation of Implementation Plans.*
- o 40 CFR 61 - *National Emission Standards for Hazardous Air Pollutants (NESHAPS).*
- o General Regulation 80-7 - *Benton-Franklin-Walla Walla Counties Air Pollution Control Authority*
- o ANSI/ASME NQA-1 - *Quality Assurance Program Requirements for Nuclear Facilities.*
- o ANSI N13.1-1969 - *Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities.*
- o ANSI N42.18-1980 - *Specification and Performance of On-Site Instrumentation for Continuously Monitoring Radioactivity in Effluents.*
- o ANSI N317-1980 - *Performance Criteria for Instrumentation Used for In-Plant Plutonium Monitoring.*
- o ANSI N323-1978 - *Radiation Protection Instrumentation Testing and Calibration.*
- o DOE-RL - *Implementation Plan for Hanford Site Compliance to DOE Order 5820.2, "Radioactive Waste Management."*

3.2 EFFLUENT SAMPLE ANALYSIS

3.2.1 Methodology

The air sampling and monitoring program at Westinghouse Hanford is conducted by several groups within the Safety, Quality Assurance, and Security Organization. Health Physics directs and maintains the work place air sampling programs. The Environmental Protection Group provides guidance for Health Physics' operation of effluent stack exhaust monitoring and sampling equipment and tracks collected sample data for trend analysis. The radioanalytical laboratories for the individual areas (100, 200, 300, 400) provide isotopic analysis and quantitative measurement (concentrations) when requested. Radiation Protection Technicians provide the actual sample exchange and sample volume data collection.

Air sampling and monitoring is performed for assessing the impact of any possible airborne releases to the environment, and to assess and evaluate the potential hazard of airborne radioactive materials in the work place. In both applications, the intent is to restrict airborne radioactive materials to "as low as reasonably achievable" (ALARA) levels and not to exceed levels in applicable DOE orders.

Health Physics conducts the air sampling and monitoring program in accordance with the applicable DOE orders and ANSI requirements. The ultimate responsibility for the prevention of releases of airborne radioactive materials or contamination is placed upon the individual facilities' management. Health Physics provides the technical direction for the required air sampling equipment and techniques and for the necessary personnel protection practices. The technical direction and practices are stressed most in the individual facility safety regulations and in working procedures and documents.

Health Physics conducts air sampling in all areas where the potential exists for people to be unknowingly exposed to airborne radioactive materials. A sufficient number of air samples are taken to represent the area of interest. Samples are collected for the length of time necessary to evaluate and document the extent and hazards of exposure to any airborne radioactive materials. Air sample concentration calculation data are available for trending when desired. In addition, when access by personnel to known areas of airborne radioactive material is necessary, representative air samples are taken to quantify the concentrations present so that proper respirator protection factor requirements may be calculated and used.

Air sampling equipment, techniques, and criteria for stack effluent samplers and monitoring systems include the following:

- o Facility exhaust stacks are sampled to provide an auditable record of long-term, low-level effluent releases.

- o Facility exhaust stacks are monitored by CAMs to provide rapid indication of a significant release of airborne radioactivity.
- o Stack particulate record samplers are run for a 1-wk interval (168 hr) whenever possible to obtain an adequate sample.
- o The Environmental Protection Group oversees the operation of stack sampling and monitoring systems.
- o In addition to particulate sampling, additional sampling for iodine, noble gases, tritium, or volatile vapors may be necessary, depending upon the facility.

3.2.2 Procedure References

Following is a list of the procedures used on the Hanford Site to provide guidance to personnel involved in the monitoring and sampling of airborne radionuclides.

- o DOE Order 5480.1B - *Environment, Safety, and Health Program for Department of Energy Operations.*
- o DOE Order 5480.4 - *Environmental Protection, Safety, and Health Protection Standards.*
- o DOE Order 5484.1 - *Environmental Protection, Safety, and Health Protection Information Reporting Requirements.*
- o DOE Order 6430.1A - *General Design Criteria.*
- o 40 CFR 52 - *Approval and Promulgation of Implementation Plans.*
- o 40 CFR 61, *National Emission Standards for Hazardous Air Pollutants (NESHAPS).*
- o General Regulation 80-7 - *Benton-Franklin-Walla Walla Counties Air Pollution Control Authority.*
- o ANSI/ASME NQA-1 - *Quality Assurance Program Requirements for Nuclear Facilities.*
- o ANSI N13.1-1969 - *Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities.*
- o ANSI N42.18-1980 - *Specification and Performance of On-Site Instrumentation for Continuously Monitoring Radioactivity in Effluents.*
- o ANSI N317-1980 - *Performance Criteria for Instrumentation Used for Inplant Plutonium Monitoring.*

- o ANSI N323-1978 - *Radiation Protection Instrumentation Testing and Calibration.*
- o DOE-RL, *Implementation Plan for Hanford Site Compliance to DOE Order 5820.2, Radioactive Waste Management.*

3.2.3 Detection Limits

The standard Hanford Site detection limit for equipment monitoring the controlled release of airborne radionuclides has been set at a level equal to or less than 10% of the derived concentration guide (DCG) for the specific radionuclide(s) being monitored.

3.2.4 Quality Assurance (Include Internal Audit Schedule and Results)

Because the FMEF has not housed any active processes, there have not been any audits to date, internal or otherwise, of the quality assurance program relative to the effluent sampling/monitoring system. However, on start of operations, the RPSF sampling/monitoring quality assurance program will adhere to DOE-RL Order 5700.1A, *Quality Assurance* and ANSI/ASME NQA-1, *Quality Assurance Program Requirements for Nuclear Facilities.*

3.3 ENVIRONMENTAL MONITORING PROGRAM

3.3.1 Give a Description of the Program and a Summary of the Data

The environmental monitoring program assessing the offsite impact of the controlled release of airborne radionuclides as well as nonradioactive pollutants from the Hanford Site is conducted by PNL. The program includes a network of 50 continuously operating air samplers at locations on and off the Hanford Site. The data gathered from these locations are collated and published by PNL in the annual *Hanford Site Environmental Report* (copies of which are provided the DSHS on publication). Chapter 4.1 of the report provides a complete description of the program and methodology as well as summary data pertinent to the monitoring of the controlled release of airborne radionuclides from the Hanford Site. The following, taken from page 4.1 of the report, summarizes the results of the study of the data for 1988.

In 1988, the annual average Hanford Site perimeter concentrations of airborne ^3H , ^{90}Sr , ^{137}Cs , and uranium were numerically greater than levels measured at distant monitoring stations, but the differences were not statistically significant (at the 5% significance level). Krypton-85 and ^{129}I concentrations were numerically greater at the perimeter stations than at the distant stations, and the differences were statistically significant (beyond the 5% significance level). However, even the maximum single perimeter sample for any radionuclide was only 0.3% of the applicable DOE DCG (Appendix B, Table B.6). The total dose from air emissions is compared to Clean Air Act and DOE dose standards in Section 4.8, "Potential Radiation Doses from 1988 Hanford Operations." Annual average NO_2 concentrations at all sampling locations remained well below Federal and Washington State ambient air standards.

4.0 DEMONSTRATION OF COMPLIANCE

4.1 GIVE METHODOLOGY USED TO DEMONSTRATE COMPLIANCE

The AIRDOSE-EPA (Clean Air Act Code) computer code was used to calculate the dose from RPSF to the maximally exposed offsite individual, and thus demonstrate compliance with 40 CFR 61, Subpart H; WAC 402-80-50; and WAC 173-480-040.

4.2 INCLUDE ALL INPUT DATA USED

Meteorological data input to the AIRDOSE-EPA code include mixing height, rainfall rate, average air temperature, vertical temperature gradient, wind direction frequency, wind speed, and atmospheric stability. This information was obtained from the data base compiled by the Hanford Meteorological Station (HMS). The HMS data on airspeed, direction, and temperature are collected at a 125-m (410-ft) tower located on the Hanford Site between the 200 East and 200 West Areas, and at a second tower at the 400 Area. Wind speed and direction are based on hourly data collected at the 400 Area meteorological tower 10-m (32.8-ft) level during the years 1983 to 1987. Atmospheric stability was estimated from the temperature gradient between the 9.1-m (30-ft) and 61-m (200-ft) levels at the HMS for the same period using standard methods of the U.S. Nuclear Regulatory Commission. Air temperature and mixing height are also 5-yr averages of hourly data. Temperature is measured at the tower 61-m (200-ft) level, and mixing height data are collected by onsite acoustic sounders.

Joint frequency data, as reported by the HMS, are modified for input into AIRDOSE-EPA by conversion to true average and reciprocal average wind speeds for each direction and stability class. The meteorological data are then used to calculate X/Q values for each radionuclide, which are also a function of radiological half-life and dry deposition velocity. For purposes of this calculation, deposition velocities are assigned as follows: 1.0×10^{-3} m/s for all particulate materials, 1.0×10^{-2} m/s for iodine isotopes, and zero for all gases.

Source Terms: Projected annual releases from RPSF as presented in Table 2-1.

Release Height: The FCFS/RPSF stack height is 35.7 m (117 ft).

Inhalation Rate: 8,500 m³/yr (300,173 ft³/yr).

Maximally Exposed Individual: Doses were estimated for an individual living 8.7 km (5.4 mi) south of the 427 Building.

Meteorology: The HMS data and onsite meteorological data, as discussed above.

4.3 PRESENT THE RESULTS

Maximum individual doses were much less than 1 mR. Bone surface and lung were the organs receiving the highest dose, primarily from ²³⁸Pu. Inhalation was the dominant pathway for exposures.

Table 2-2 shows the whole body and critical organ doses to the offsite individual receiving maximum exposure to airborne radiological emissions from the RPSF.

Table 2-2. Offsite Dose Estimates for an Individual Receiving Maximum Exposure to Airborne Radiological Emissions from RPSF (mR).

<u>Whole body</u>	<u>Critical organ (bone surface)</u>
1.4 E-14	1.8 E-13

Both WAC 402-80-50 and WAC 173-480-040 state the following:

The WDOE ambient standard requires that emissions of radionuclides to the air shall not cause a dose equivalent of more than 25 mrem/y to the whole body or 75 mrem/y to a critical organ of any member of the public.

National ambient air quality standards for DOE facilities, are stated in 40 CFR 61.92 as follows:

Emissions of radionuclides to air from DOE facilities shall not exceed those amounts that cause a dose equivalent of 25 mrem/y to the whole body or 75 mrem/y to the critical organ of any member of the public.

A comparison of the data presented in Table 2-2 with the cited statutory limits clearly shows that the projected whole body and critical organ doses of radionuclides to the offsite individual receiving maximum exposure to airborne radiological emissions from the RPSF will not violate either State or Federal standards.

Further, the *Hanford Site Environmental Report for Calendar Year 1988*, (Jacquish 1989) states that the effective dose equivalent (whole body dose) to the maximally exposed offsite individual from all Hanford Site operations air emissions was 0.3 mR in 1988. If the projected whole body dose (from Table 2-2), to the maximally exposed offsite individual from the RPSF is added to the historic releases for 1988, it is clear that the RPSF projected emissions will not cause a violation of either State or Federal standards.

4.4 DESCRIBE ANY INTERNAL STANDARDS USED TO ENSURE COMPLIANCE WITH APPLICABLE STATE AND FEDERAL LAWS AND REGULATIONS.

Westinghouse Hanford Company policy regarding compliance with State and Federal laws pertinent to protection of the environment has been defined as follows.

- o Operate and maintain company-managed facilities according to DOE Orders and in compliance with the letter and spirit of other applicable Federal, State, and local regulations.
- o Design and construct new facilities in a manner that ensures that exposure of individuals and population groups to radioactive and other hazardous materials is ALARA.
- o Treat, dispose of, and store radioactive and other hazardous material in a manner that minimizes waste volumes and provides the maximum protection for the environment.
- o Manage facilities and activities in a cost effective and environmentally responsible manner.
- o Environmental controls and programs shall be consistent with the environmental policy stated above and with contractual provisions with DOE. These formalized controls shall be based on the following orders and regulations:

DOE Order 5440.1C - *National Environmental Policy Act*

DOE Order 5480.1A - *Safety and Health Policy Statement*

DOE Order 5400.3 - *Hazardous and Radioactive Mixed Waste Management*

DOE Order 5480.4 - *Environmental Protection, Safety, and Health Protection Standards*

DOE Order 5482.1B - *Environment, Safety and Health Appraisal Program*

DOE Order 5484.1 - *Environmental Protection, Safety, and Health Protection Information Reporting Requirements*

DOE Order 5820.2A - *Radioactive Waste Management*

DOE Order 6430.1A - *General Design Criteria*

DOE-RL Order 5440.1A - *Implementation of National Environmental Policy Act at the Richland Operations Office*

DOE-RL Order 5480.1A - *Environmental Protection, Safety, and Health Protection Program for Richland Operations*

DOE-RL Order 5480.5 - *Safety of Nuclear Facilities*

DOE-RL Order 5482.2B - *Environmental Safety, Health and Quality Assurance Appraisal and Surveillance Program*

DOE-RL Order 5484.2A - *Unusual Occurrence Reporting System for RL*

DOE Order 5400.1 - *General Environmental Protection Program*

40 CFR - *Protection of Environment*

WAC 173-303 - *Dangerous Waste Regulations*

WAC 173-400 - *General Regulations for Air Pollution Sources*

WAC 402-80 - *Monitoring and Enforcement of Air Quality and Emission Standards for Radionuclides.*

- o Environmental controls and implementing procedures used by the company shall be maintained current and shall promptly reflect regulatory changes.

5.0 BEST AVAILABLE RADIONUCLIDE CONTROL TECHNOLOGY ASSESSMENT

A BARCT is defined by WAC-480-60 as follows:

Technology which will result in a radionuclide emission limitation based on the maximum degree of reduction for radionuclides which would be emitted from any proposed stationary source or modification of a source which the permitting authority on a case-by-case basis, taking into account energy, environmental, and economic impacts and other costs, determines is achievable for such source or modification through application of production processes or available methods, systems, and techniques. In no event shall application of best available radionuclide technology result in emissions of radionuclides which would exceed the ambient annual standard limitation specified in this chapter.

The selection of the emissions control system described in Section 2.2.2 is supported as BARCT for the pollutants to be emitted by the RPSF by the following.

Control Alternatives

Radionuclide emissions from the RPSF are limited to particulate matter entrained in cell and room exhausts from the handling and decontamination of iridium-encapsulated fuel clads, as discussed in Section 2.2.1. Because of the anticipated nature of this source (i.e., very low quantities of micrometer- and submicrometer-size particulate matter), only high-efficiency particulate matter controls were investigated through a literature search of industrial and nuclear applications (Appendix A). Mechanical dust collectors used in many industrial applications for the removal of large particulates were not considered for the survey. Potential control devices identified in the surveys are presented in Table 2-3. Detailed process descriptions and evaluations are presented in Appendix B.

Table 2-3. RPSF Control Technology Survey Results.

Control	Removal efficiency
<u>Particulate matter</u>	
HEPA filter	99.97% for 0.3- μ m particles
Deep-bed sand filter	99.95% for 0.3- μ m particles
Deep-bed glass-fiber filter	99.9% for 0.3- μ m particles
High-efficiency mist eliminator	99.5% for 1- μ m particles
Prefilter	85% (max) for 0.3- μ m particles

Of the potential particulate controls identified in Table 2-3, only the prefilter and HEPA can be applied to primary particulate control in this application.

In the nuclear industry, prefilters are generally used in combination with HEPA's to remove the larger particles in the exhaust stream, thus increasing the service life of the HEPA's. Extremely large units such as the deep-bed sand and deep-bed fiber filters cannot be considered as primary filters because adequate floor space is not available. Although the high-efficiency mist eliminator (HEME) is relatively small (about 0.9 m [3 ft] in length), it is significantly less effective than the HEPA in its removal of small particles, it requires additional plumbing (for possible filter cleaning with a water-wash), and it is normally not used for dry room offgas systems. Therefore, a combination prefilter/HEPA assembly is considered the only applicable particulate control alternative based on performance and operating/physical constraints for primary RPSF exhaust treatment, and is thus proposed as BARCT for this particular application. No further analysis

of energy, environmental, or economic impacts is required because the control technology identified has been determined to be the technology that is appropriate and allows the lowest emission rate of radionuclides. Any other control technology would not provide a comparable low environmental impact, regardless of energy or economic impact. The BARCT analysis will therefore be limited to the final filtration processes only.

After primary treatment, all the exhaust from the RPSF operations is combined and routed to a final filtration step before discharge through the main building stack. Final high-efficiency particle filtration before discharge of radionuclide-contaminated gases to the atmosphere is a nuclear industry standard. Generally, two-stage filtration is used for this purpose. Presently employed final filtration techniques in the nuclear industry include combination prefilter and HEPA's, deep-bed glass-fiber filters, and deep-bed sand filters (Table 2-3). Deep-bed glass-fiber and sand filters are normally installed upstream of a final contact HEPA filter. Therefore, the alternative control systems for the final RPSF exhaust that will be evaluated are the following:

Alternative 1 - deep-bed glass-fiber filter/one-stage HEPA

Alternative 2 - deep-bed sand filter/one-stage HEPA

Alternative 3 - two-stage HEPA

The following will present an evaluation of these final emission control alternatives based on environmental, energy, and economic impacts to demonstrate BARCT for the RPSF emissions.

Environmental

All of the three alternatives incorporate a HEPA filter as the second-stage control device. Studies have shown that the removal efficiency of a HEPA placed downstream of another high-efficiency particulate control device (such as a deep-bed sand filter or another HEPA) is lower than that of a single-stage HEPA (Zippler 1974). It is postulated that this results from the extraction of the more readily collected particles in the initial filter (Moore and Fullam 1984). Sufficient data are not available to determine the effect that this would have on the overall removal efficiency of each alternative control system. For the purposes of this analysis, it is assumed that the second-stage HEPA performs identically for each system. Therefore, the overall efficiency is directly related to the removal efficiency of the first-stage unit. As shown in Table 2-3, alternative 3 (two-stage HEPA) would provide somewhat higher performance than alternatives 2 and 1, respectively. Because ground-level radionuclide impacts are directly dependent on emission rate (and thus removal efficiency), the implementation of alternative 3 would result in the lowest air quality impact.

All three alternatives use standalone dry processes so that the only wastes associated with these systems would be the spent filters. Alternative 1 has the largest volume of waste for disposal (i.e., the sand) and therefore poses the greatest potential environmental impacts (landfill space and

possible contamination). Alternative 3 would produce less waste material than alternative 2, although only relative quantities can be estimated at this time.

Energy

Energy requirements for the three alternatives are associated with operating a sufficiently large exhaust fan(s) to overcome the pressure drop of each system (as the final exhaust temperature of 26.7° C (80° F) is within the operating range of the filters). Based on the anticipated pressure drops of the initial control stage of each alternative (see Appendix B), alternative 2 (sand filter pressure drop = 11 in. WC) would have the highest energy impacts of the alternatives, followed by alternative 1 (fiber filter pressure drop = 8 in. WC) and alternative 3 (HEPA pressure drop = 4 in. WC).

Economic

Installed costs of the three alternatives are presented below, based on previously installed exhaust cleaning systems at various nuclear fuel reprocessing plants (Burchsted 1976).

	<u>Cost (\$/ft³/min)</u>
Alternative 1 (deep-bed fiber and HEPA)	30.34
Alternative 2 (deep-bed sand filter only)	46.88 (cost of additional HEPA not available)
Alternative 3 (two-stage HEPA)	7.43

These cost estimates show that alternative 3 costs only about 24% of alternative 1 and 16% of alternative 2 (percentage would be less if costs of HEPA were included in alternative 2). Although operating costs such as utilities, maintenance, operations, service life, and consumables are not available, it has been shown that alternative 2 has the highest utility cost (largest fan requirements) and higher overall operating costs than (alternative 1) (Moore and Fullam 1984). Alternative 1 has the second highest utility cost and alternative 3 has the lowest utility cost. On the other hand, alternative 3 is expected to have higher maintenance costs than alternative 2 because of the frequency of filter changeouts.

Summary

Alternative 3 is considered to be the BARCT for the final RPSF exhaust. Its use of available, proven control methods for reducing radionuclides is confirmed by comparing its effectiveness to the other available alternatives. It is the most cost effective alternative, having the lowest capital and operating costs. Alternative 3 also has the lowest energy consumption of the three systems evaluated.

REFERENCES

- ANSI N13.1-1969, *Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities*, American National Standards Institute, New York, New York.
- ANSI N13.10-1974, *Specifications and Performance of Onsite Instrumentation for Continuously Monitoring Radioactivity in Effluents*, American National Standards Institute, New York, New York.
- ANSI N323-1978, *Radiation Protection Instrumentation Testing and Calibration*, American National Standards Institute, New York, New York.
- ANSI N42.18-1980, *Specification and Performance of On-Site Instrumentation for Continuously Monitoring Radioactivity in Effluents*, American National Standards Institute, New York, New York.
- ANSI N317-1980, *Performance Criteria for Instrumentation Used for Inplant Plutonium Monitoring*, American National Standards Institute, New York, New York.
- ANSI/ASME NQA-1, *Quality Assurance Program Requirements for Nuclear Facilities*, American National Standards Institute, New York, New York.
- Burchsted et al. 1976, *Nuclear Air Cleaning Handbook--Design, Construction, and Testing of High-Efficiency Air Cleaning Systems for Nuclear Application*, C.A. Burchsted, J.E. Kahn, and A.B. Fuller, ERDA-76-21, Oak Ridge National Laboratory, Oak Ridge, Tennessee.
- DOE Order 5400.1, *General Environmental Protection Program*, U.S. Department of Energy, Washington, D.C., November 9, 1988.
- DOE Order 5400.3, *Hazardous and Radioactive Mixed Waste*, U.S. Department of Energy, Washington, D.C., February 23, 1989.
- DOE Order 5440.1C, *National Environmental Policy Act*, U.S. Department of Energy, Washington, D.C., April 9, 1985.
- DOE Order 5480.1A, *Safety and Health Policy Statement*, U.S. Department of Energy, Washington, D.C., May 13, 1988.
- DOE Order 5480.1B, *Environment, Safety, and Health Program for Department of Energy Operations*, U.S. Department of Energy, Washington, D.C., September 23, 1986.
- DOE Order 5480.4, *Environmental Protection, Safety, and Health Protection Standards*, U.S. Department of Energy, Washington, D.C., May 15, 1984.

- DOE Order 5482.1B, *Environment, Safety, and Health Appraisal Program*, U.S. Department of Energy, Washington, D.C., September 23, 1986.
- DOE Order 5484.1, *Environmental Protection, Safety, and Health Protection Information Reporting Requirements*, U.S. Department of Energy, Washington, D.C., February 24, 1981
- DOE Order 5820.2A, *Radioactive Waste Management*, U.S. Department of Energy, Washington, D.C., September 26, 1988.
- DOE Order 6430.1A, *General Design Criteria*, U.S. Department of Energy, Washington, D.C., April 6, 1989.
- DOE-RL Order 5440.1A, *Implementation of the National Environmental Policy Act at the Richland Operations Office*, U.S. Department of Energy, Richland, Washington, February 3, 1987.
- DOE-RL Order 5480.1A, *Environment, Safety, and Health Protection Program for Department of Energy Operations for Richland Operations*, U.S. Department of Energy-Richland Operations Office, Richland, Washington, September 7, 1988.
- DOE-RL 5480.4A, *Environmental Protection, Safety, and Health Protection Standards for RL*, U.S. Department of Energy-Richland Operations Office, Richland, Washington, December 1, 1987.
- DOE-RL Order 5480.5, *Safety of Nuclear Facilities*, U.S. Department of Energy-Richland Operations Office, Richland, Washington, September 23, 1986.
- DOE-RL Order 5482.2B, *Environmental Safety, Health, and Quality Assurance Appraisal and Surveillance Program*, U.S. Department of Energy-Richland Operations Office, Richland, Washington, March 4, 1987.
- DOE-RL Order 5484.1, *Environmental Protection, Safety and Health Protection Information Reporting Requirements*, U.S. Department of Energy-Richland Operations Office, Richland, Washington, September 26, 1983.
- DOE-RL Order 5484. 2A, *Unusual Occurrence Reporting System for RL*, U.S. Department of Energy-Richland Operations Office, Richland, Washington, September 24, 1984.
- DOE-RL 5700.1A, *Quality Assurance*, U.S. Department of Energy-Richland Operations Office, Richland, Washington, July 14, 1983.
- General Regulation 80-7, *Benton-Franklin-Walla Walla Counties Air Pollution Control Authority*, Washington State, July 1980.
- Implementation Plan for Hanford Site Compliance to DOE Order 5820.2, Radioactive Waste Management*, U.S. Department of Energy-Richland Operations Office, Richland, Washington, August 1985.

Recommendations of the International Commission of Radiological Protection, Publication, Publication 26, International Commission on Radiological Protection, Elmsford, New York, 1977.

Limits on Intakes of Radionuclides by Workers, Publication 30, International Commission on Radiological Protection, Elmsford, New York, July 1979.

Jacquish, R.E. 1989, *Hanford Site Environmental Report for Calendar Year 1988*, PNL-6825, Pacific Northwest Laboratory, Richland, Washington.

McDowell et al. 1976, *Penetration of HEPA Filters by Alpha Recoil Aerosols*, W.J. McDowell, and F.G. Seeley, (Oak Ridge National Laboratory), and M.T. Ryan (University of Lowell, Massachusetts), 14th ERDA Air Cleaning Conference, Sun Valley, Idaho, August 11-13, 1976.

Moore, E.B. and H.T. Fullam 1984, *Control Technology for Radioactive Emissions to the Atmosphere at U.S. Department of Energy Facilities*, PNL-4621-Final, Pacific Northwest Laboratory, Richland, Washington.

NE F 3-43, *Nuclear Standard's Quality Assurance Testing of HEPA Filters*, Office of Scientific and Technical Information, Oak Ridge, Tennessee, October, 1988.

Zippler, D.B. 1974, "Evaluation of Multistage Filtration to Reduce Sand Filter Exhaust Activity," *Proceedings of the 13th AEC Nuclear Air Cleaning Conference*, Vol. 1, San Francisco, California, March 1975, pp. 609-619.

**Radioactive Air Emissions Program
Supplemental Information For
Fuel Assembly Area**

1.0 FACILITY INFORMATION

1.1 DESCRIBE THE FACILITY

The Fuel Assembly Area (FAA) will be located in Building 4862 of the Fuels and Materials Examination Facility (FMEF) (Figure 3). Figure 17 depicts the layout of the FAA within Building 4862.

The FMEF process building complex is qualified as necessary to withstand all design basis events while maintaining radiological control of its inventory. The FMEF features are summarized below.

- o The Process Building is a six-level, tornado-hardened, seismically qualified, concrete structure 79.2 m (260 ft) long and 47.2 m (155 ft) wide, extending from 10.7 m (35 ft) belowgrade to approximately 30.5 m (100 ft) abovegrade. Most of the facilities capabilities for handling radioactive materials are centered in the Process Building.
- o The Fuel Assembly Area (FAA) is a two-story, tornado hardened, seismically qualified structure 54.9 m (180 ft) long, 39.6 m (130 ft) wide, and 7.9 m (26 ft) high, housing Fast Flux Test Facility fuel assembly activities and the Entry Wing's heating and ventilation equipment.
- o The Mechanical Equipment Wing is a single-story concrete structure 39.6 m (130 ft) long and 15.2 m (50 ft) wide housing air compressors, chilled water cooling system pumps and refrigeration units, and associated electrical switchgear. There is no potential for radiological contamination in the Mechanical Equipment Wing nor is any of the enclosed equipment required for Process Building or FAA confinement. The Mechanical Equipment Wing is not tornado hardened or seismically qualified.
- o The Emergency Equipment Wing is a single-story, tornado hardened, seismically qualified concrete structure 19.8 m (65 ft) long and 17.7 m (58 ft) wide, housing the emergency electrical power system's turbine generators, the emergency cooling water system's cooling tower and circulating pumps, and associated electrical switchgear.
- o The Entry Wing is a two-story structure 47.2 m (155 ft) long and 40.2 m (132 ft) wide, housing office space, lunch room and personnel change rooms required to support the activities of the Process Building and the FAA. The Entry Wing is not tornado hardened or seismically qualified.

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Figure 17. Fuel Assembly Area Floor Plan.

- o The electrical substations, which supply the FMEF, and the cooling towers, and the underground fuel storage tank for the turbine generators are located north of the process building structure.

Modifications to the FAA Building necessary to support FAA activities include structural (demolition, wall additions and replacements, decking) mechanical (HVAC, enclosure atmospheric control, process cooling systems, emergency cooling system, process services) interior electrical services (normal electrical power, emergency electrical power, uninterruptible power supply) interior telecommunications and alarm systems, fire protection, efficient control and monitoring of solid waste disposal, energy conservation, radiation protection (criticality detection, contamination sampling) additional safety modification/upgrades (instrumentation and control, emergency cooling water, oxygen monitoring, enclosure atmospheric control, finished product monitoring, HVAC) contamination confinement, and plutonium material safeguards. Integration into existing FMEF facilities and systems will be conducted whenever possible.

1.2 DESCRIBE THE FACILITY OPERATIONS

The FAA will fabricate and store enriched uranium oxide driver fuel and neptunium oxide target pins for the Fast Flux Test Facility (FFTF). At a later date, mixed uranium plutonium oxide (MOX) fuel may be processed within the FAA. Because the production of MOX fuel will use basically the same process as the enriched uranium, and because the enriched uranium will be the initial fuel processed, the following process description refers only to enriched uranium, though it is applicable to MOX.

A process flow diagram for the production of the enriched uranium oxide driver fuel is shown in Figure 18. A process flow diagram for the neptunium oxide target pin fabrication and storage is shown in Figure 19.

Enriched Uranium Oxide Driver Fuel Fabrication

Shipments of powder and pellets will be received in standard shipping containers. The containers will be unloaded and transferred to the high bay area (room 101) and stored until they can be unloaded. From room 101, the containers will be transferred to rooms 104, 107, or 109 for unloading. Inside the container will be a sealed fuel shipping canister, that contains the powder or pellets. The fuel shipping canisters will be removed from the containers. Within each canister will be up to four cans, each containing approximately 1 kg (2.2 lb) of fissile powder, or two cans, each containing approximately 2.5 kg (5.5 lb) of fissile pellets. The cans will be removed, surveyed, cleaned, and processed through nondestructive assay. The cans will then be transferred to room 110 for storage.

The first major process step will be powder conditioning and pressing. Within the pressing enclosures in room 110, powder and binder will be weighed and blended; blended powder will be preslugged; slugs will be granulated; and granules and binder will be weighed, blended, and repackaged in cans for storage or transfer to the next operation. The granule-binder mixture will

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Figure 18. Overall Process Flow Diagram for Enriched Uranium Oxide Driver Fuel Fabrication.

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Figure 19. Overall Process Flow Diagram for Neptunium Target Pin Fabrication in the Fuel Assembly Area.

be pelletized and transferred to the sintering/debind enclosure. Three single-cavity presses will be available for performing the preslugging and pelletizing.

Within the sintering/debind enclosure in room 110, the pellets will be loaded into a furnace for debinding and then into a second furnace for sintering. Once the pellets have been removed from the sintering furnace, some of the pellets will be sent to a laboratory for analysis. The remaining pellets will be repackaged in cans and returned to storage in room 110.

Pellets will be transferred from storage to the fuel pin loading glovebox in room 109. At this station, the fuel pellets will be visually inspected, the fuel annulus verified, the fuel column assembled, and the fuel column and other pin internal components loaded into the fuel cladding. After loading, the top end of the fuel pin cladding will be cleaned to reduce gross contamination and the end of the cladding will be sealed and surveyed. The loaded pins will then be placed in a pin box for transfer to room 107. In room 107, the pin will undergo further decontamination. The decontaminated pins will be resealed, replaced in the pin box, and returned to room 109 for end cap final closure weld.

There the pins will be placed in an evacuation chamber and the temporary plug will be removed. The chamber will be evacuated and backfilled in rapid succession until all of the air has been replaced with helium fill-gas. The chamber will then be opened to the weld enclosure and the tag gas capsule and top end cap will be inserted and the top end cap welded to the cladding. The pins will then be removed from the welding enclosure and taken to the leak test enclosure, also located in room 109. The pins will then either be transferred to room 111 for storage or processed through final inspection.

Final inspection operations will be performed in room 101 and will include tag gas rupture, X-radiography, fuel enrichment verification, pin workmanship, final visual inspection, end cap drill, and wire wrap.

When pins are ready for assembly into the driver fuel, they will be taken to the final assembly table in room 101. Here, the individual pins will be assembled into pin bundles (217 pins/bundle). The pin bundles will then be inspected. After inspection, the pin bundles will be transferred to the assembly pit where the direct-handling subassembly will be lowered over the pin bundle. The pin bundle will then be returned to the assembly table and the duct welded to the shield inlet assembly. The weld will be examined and a final wipe of the assembly will be taken. Final inspection of the driver fuel assembly will include an air flow test and weight and center of gravity measurements. After all standard inspection and measurements are performed, the assembly will be returned to the storage pit or prepared for shipment.

Neptunium Oxide Target Pin Fabrication

The neptunium oxide will be received and stored in an enclosure in the target pin fabrication line in room 112. If necessary, the powder will be milled and screened to meet feed powder specifications. The powder will be

mixed with binder in a blender and will then be preslugged in a cold press. The slugs will be granulated and screened. The resulting granules will be mixed with binder in a blender, and will then be pressed into pellets. The pellets will be transferred to a furnace for debinding and then to a second furnace for sintering. After sintering, the pellets will be inspected for conformance to specifications. The pellets conforming with specifications will be stored temporarily before being sent to target pin fabrication. Pellets not meeting specifications will be ground into powder to be used to make new pellets.

From temporary storage, cans of pellets will be transferred to the pin loading area of room 112. The pellets will be removed from the cans, and loaded into the pin. The pin will then be decontaminated at the loading station. When decontamination has been completed, the pin will be transported to the welding station in room 112 for the final closure weld. The assembled pins will be leak tested before storage. Final operations on the pins will be preformed in room 101, and will include tag gas rupture, weld radiography, inspection, pin workmanship, and final visual inspection.

When pins are ready for fabrication into neptunium target pin assemblies, They will be taken to the final assembly station in room 101. Here, the individual pins will be inserted into pin bundles. The assembled neptunium pin bundles will then be stored in the storage pit in room 101.

1.3 IDENTIFY THE FACILITIES AS THEY WERE IDENTIFIED ON THE SOURCE REGISTRATION FORMS

The FMEF was designed and constructed to produce production and test-fuel for the Liquid Metal Reactor program and provide a capability for examining fuels and materials following irradiation. These FMEF missions were cancelled before start-up of any processing activities, or the introduction of fuel material, or other irradiated material into the facility. The FMEF has, therefore, not been registered with the Washington State Department of Social and Health Services (DSHS) as a source of radioactive air emissions.

2.0 SOURCE INFORMATION

2.1 LIST THE SOURCE(S) TO WHICH THE INFORMATION IN THIS SECTION PERTAINS. IDENTIFY ALL SOURCES CONSISTENT WITH THE SOURCE REGISTRATION IDENTIFICATION

Figure 3 shows the FAA stack, which will be the single discharge point (source) for FAA to be registered with DSHS. When the source is registered with the DSHS, the "Source Registration For Radioactive Air Emissions" form will show the facility as the 4862 Building and the Discharge Point as the FAA Exhaust.

2.2 DESCRIBE THE SOURCES

2.2.1 System Function/Area Exhausted

The FAA will be provided with ventilation Zones I, II, III, IV, and airlocks, as required, for zone separation in high-traffic access areas. Areas denoted Zone I will contain the unencapsulated radioactive materials being processed and will be separated from surrounding ventilation Zone II areas. Ventilation Zone II areas will process encapsulated radioactive materials and will bound Zone I. Ventilation Zone III will comprises "a" and "b" areas. Ventilation Zone IIIa areas will bound Zone II and will be those areas in which encapsulated radioactive materials are handled. Ventilation Zone IIIb areas will be buffer zones and will not contain radioactive materials. Ventilation Zone IV will be at atmospheric pressure and will not contain any radioactive materials.

There will be a negative pressure gradient from Zone III to II to I so that any contaminants will flow into Zone I and through the facility emissions abatement systems. All Zone I air flows out the FAA stack. Figure 20 depicts FAA cell air flow and indicates points of emission to the air.

Zone I

Gloveboxes in Rooms 109, 110, and 112 and open-face hoods in rooms 107, 109, and 112 will be part of the Zone I ventilation system. These enclosures will be used in the processing of uranium dioxide and neptunium oxide powder into pellets and in the encapsulation of these pellets into pins, as described in Section 2.0, above. Releases of radioactive materials to the ventilation system will occur in Zone I.

Zone II

Rooms 104, 107, 109, 110 and 112 will be part of the Zone II ventilation system. Releases of radioactive materials to the Zone II ventilation system are not likely to occur because the processing of unencapsulated radioactive materials is only in Zone I areas and because of the pressure differential between Zone II and Zone I.

Zone III

Rooms 101, 274 and 279 shall be Zone IIIa. Rooms 107, 108, 271, 276, 277 and 278 and corridors 105 and 272 shall be Zone IIIb. Releases of radioactive materials to the Zone III ventilation system are highly unlikely because they will not contain any unencapsulated radioactive materials.

Zone IV

Rooms 124, 125, and 102 will be at atmospheric pressure and will thus be considered part of Zone IV. Releases of radioactive materials will not take place in Zone IV because not radioactive materials will be handled in those areas.

▨ Non-Testable HEPA - One Filter is Located on Outlet of Each Glovebox.

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Figure 20. Fuel Assembly Area
Zone I Exhaust Flow Diagram.

2.2.2 Effluent System Layout

Because the radioactive airborne emissions from FAA will consist primarily of particulate matter generated during the processing of EuO_2 and ^{237}Np oxide powders (Section 2.2.1) the emissions control system must be capable of containing micrometer- and submicrometer-size particles.

As discussed in Section 2.2.1, the FAA operations are provided with ventilation Zones I, II, and III with a negative pressure gradient from Zone III to Zone I, to provide maximum containment of radioactive contamination. All powder handling operations will take place in Zone I gloveboxes. Zone I gloveboxes shall be operated at -0.55 to -0.75 in. WG pressure relative to outside atmosphere. Zone II shall be operated at -0.20 to -0.30 in. WG pressure relative to outside atmosphere. Zone IIIa radiological operating and equipment areas shall be operated at -0.05 to -0.15 in. WG pressure relative to outside atmosphere. Zone IIIb shall be operated at -0.05 to -0.10 in. WG pressure relative to outside atmosphere, Zone IV.

Zone I ventilation areas draw air from the surrounding Zone II rooms. Figure 15 shows FAA Zone I exhaust flow. Zone II ventilation areas use a recirculated air atmosphere. Special sealed structures and structural penetrations are implemented to separate Zone I and Zone II areas. Zone I and Zone II exhausts are vented to separate primary filtration steps before being combined and routed to final filtration and subsequently discharged to the atmosphere. Some Zone III exhaust is routed directly to Zone II areas to supply ventilation air to Zone II. The remainder of Zone III exhaust is ultimately routed along with other plant exhausts to a single final filtration step and discharged to the atmosphere.

The exhaust from the FAA process operations will be provided with both primary and final particulate control measures as described above. This allows for high-efficiency removal and provides system redundancy in the event of a possible failure of one of the emission control units. In addition, the gloveboxes (Zone I) are equipped with non-testable HEPA filters on both the inlet and outlet flows to minimize the radionuclide contamination of the connected atmosphere control systems. The fumehoods in rooms 107, 109, and 112 will not be equipped with non-testable HEPAs because the distance to the testable HEPAs is relatively short.

After primary treatment, all the exhaust from FAA operations is combined and routed to a final filtration step before discharge through the main building stack. Final, high-efficiency particulate filtration before discharge of the radionuclide contaminated gases to the atmosphere is a nuclear industry standard. Generally, two-stage filtration is used for this purpose. Final filtration techniques presently employed in the nuclear industry include combination prefilter and HEPAs, deep-bed glass-fiber filters, and deep-bed sand filters. Industry and cross-industry assessment of emissions abatement systems demonstrates that the prefilter and HEPA system provides the highest degree of removal efficiency (see Section 5.0).

2.2.3 Efficiency Values Of Each Control Device For Removal Of Radioactivity

As shown in Figure 20, and discussed in Section 2.2.2, HEPA filters are the control devices used for removal of radioactivity from the FAA ventilation system. A HEPA filter is a throwaway, extended-pleated medium, dry-type filter. Hanford Site HEPA filters must meet the following requirements:

- o Permissible penetration at test airflows shall be no greater than 0.03% when tested in accordance with NE F 3-43, Article 6.
- o Filters shall have a minimum particle collection efficiency of 99.97% for 0.3- μm particle size thermally generated dioctyl phthalate (DOP) aerosol (or equivalent) at 100% and at 20% of rated flow capacity for filters with a nominal airflow rating of 3.5 m^3/min (125 ft^3/min size 3) and larger and 100% rated flow for filters with a nominal rating below 3.5 m^3/min (125 ft^3/min) (NE F 3-43, Article 4).
- o The pressure differential for air flow across a clean filter assembly when tested at appropriate nominal flows shall not exceed 1.3 in. WG for size 3 HEPA's and smaller, and 1.0 in. WG for HEPA's larger than size 3.

2.2.4 Means And Frequency Of Testing Effluent System

The FAA emissions abatement system comprise three HEPA filters in series. (The gloveboxes have an additional HEPA, but they are not testable.) All Hanford Site HEPA filters are tested in place on an annual basis and must meet the following requirements:

- o All filters shall remove at least 99.95% of the DOP particles, or equivalent, ranging in size from 0.1 μm to 3.0 μm with a mean particle size of 0.5 μm .
- o The HEPA filters, which are held in the frame by turn and lock (cam-lock) devices, are permitted to have penetration values of up to 0.25% provided that leak tests are performed every 90 d. These filters shall be replaced if penetration values exceed 0.25%, or if the exposure rate or pressure-drop limits cited below are exceeded.
- o The HEPA filter cartridges shall be replaced when continuous exposure rates exceed 1 R/hr at 15.2 cm (6 in.), or when the pressure drop across the filter exceeds 4 in. WG. Remotely installed HEPA filters shall be replaced when the pressure drop across the filter exceeds 4 in. WG, or exposure rates exceed limits provided by radiation protection.

2.2.5 Operating mode

The FAA will fabricate fuel pins 8 hr/d (one shift), 5 d/wk, 44 wk/yr. This means FAA will be operating 20% of the time (based on 24 hr/d, 7 d/wk, 52 wk/yr being equal to 100%).

2.2.6 Chemical And Physical Forms Of The Releases

Airborne releases from the FAA will be in particulate and gas forms. The following radionuclides make up the projected controlled particulate releases from the FAA:

o ^{232}U	o ^{238}Pu
o ^{234}U	o ^{239}Pu
o ^{235}U	o ^{240}Pu
o ^{236}U	o ^{241}Pu
o ^{238}U	o ^{242}Pu
o ^{236}Pu	o ^{237}Np

International Commission of Radiation Protection (ICRP) Publications 26 and 30 list all plutonium and uranium oxide isotopes in Solubility Class "Y" (years) and neptunium oxide isotopes in Solubility Class "W" (weeks).

2.2.7 Stack (or release point) Data

2.2.7.1 Height From Ground/Inside Diameter. The FAA building stack is 109.7 m (360 ft) high with a rectangular area of 0.56 m² (6.0 ft²).

2.2.7.2 Building Height. The FAA building is 7.9 m (25.9 ft) high.

2.2.7.3 Building Width/Length. The FAA building is 39.6 m (130 ft) wide and 54.8 m (180 ft) long.

2.2.7.4 Annual Average Stack And Ambient Air Temperatures. The annual average stack temperature is 25.6° C (78° F). The annual average ambient air temperature is 11.7° C (53° F). (This average was determined by the Hanford Meteorology Station using meteorology data for the Hanford Site area from the period 1912 to 1980.)

2.2.7.5 Windrose. The windrose for the 400 Area is Figure 10.

2.2.7.6 Chi/Q Data, if it exists. The Chi/Q data is found in Figure 11. This data was broken out of the AIRDOSE-EPA computer code used to provide the demonstration required by Section 4.0.

2.2.7.7 Release Rates. The projected controlled emission rates of particulate radionuclides for the FAA were calculated based on an annual MOX throughput of 100 kg (220.5 lb), an annual enriched uranium oxide throughput of 1850 kg (4078.5 lb), an annual ^{237}Np oxide throughput of 115 kg (253.5 lb) and using a release adjustment factor (RAF) of 2.5×10^{-10} . Though the MOX fuel and enriched uranium fuel will not be processed simultaneously, complete annual campaigns for both fuels were used as source terms in order to permit the change-over from one fuel to the other.

The RAF assumes that 1% (the release factor) of the throughput material will become entrained in the cell atmosphere and pass through the ventilation system. (This is an extremely conservative assumption because there are non-testable HEPA filters between the gloveboxes and the ventilation system. The HEPAs are 99.97% efficient on installation. Therefore, for 1% of the entire throughput to become entrained in the ventilation system, over 100% of the entire throughput would have to be released.) The ventilation system is assumed to contain three HEPA filters in series, which is equivalent to a transmission factor of 2.5×10^{-8} . (It is understood that aggregate recoil particles from a source of alpha activity appear to penetrate HEPA filters much more effectively than would be expected on the basis of filter efficiency for similar sized stable aerosols. It is also understood [McDowell et al. 1976] that where the aerosols are realistic in terms of what comes out of the facility, the recoil effect is not proven. In light of the possibility of the recoil effect, monitoring, appropriate filter changeouts, and other administrative controls will be implemented to ensure filter system integrity.) (As noted above, the gloveboxes actually have an additional HEPA filter, however because this filter is not testable and the removal efficiency cannot be verified during operation, no credit is taken for these filters in the dose calculations.) The RAF is the product of the release factor and the transmission factor. The projected controlled radioactive airborne particulate emissions releases for the FAA are shown in Table 3-1.

Table 3-1. Controlled Particle Radionuclide Emission Rates Projected for Fuel Assembly Area (Emissions at Stack).

<u>Nuclide</u>	<u>Emission rate (Ci/yr)</u>
^{232}U	4.36 E-09
^{234}U	3.06 E-08
^{235}U	3.52 E-10
^{236}U	6.33 E-09
^{238}U	5.32 E-11
^{238}Pu	8.76 E-12
^{239}Pu	5.65 E-08
^{240}Pu	2.79 E-07
^{241}Pu	2.08 E-07
^{242}Pu	7.93 E-06
^{242}Pu	8.64 E-11
^{237}Np	1.79 E-08

2.3 DESCRIBE THE SAMPLING/MONITORING SYSTEMS(S)

The design of the FAA sampling/monitoring system is being developed. Considerations are being given to the existing systems and projected environmental conditions, pursuant to the guidance of DOE Order 6430.1A, Section 1589-99.0.1 and ANSI N13.1-1969.

The existing FAA system currently includes continuous monitoring of both alpha and beta particulates. The alpha monitor is an Eberline Alpha 5 (or equal) with a range of 1,000 to 10,000 counts per minute (c/min). The beta monitor is an Eberline AMS 3 (or equal) with a range of 10,000 to 100,000 cpm. The filter from the alpha monitor will be removed weekly and saved as the primary record sample. The beta continuous air monitor (CAM) filter will be removed and saved as a backup.

2.3.1 Stack Flow Measuring System

The FAA exhaust fan variable inlet vanes are automatically adjusted as necessary to control the final HEPA filter inlet header pressure. The FAA supply fan outlet header pressure is controlled in a similar manner by adjusting the supply fan variable inlet vanes. The header pressure setpoints will be determined during the design phase and experimentally confirmed during air balance testing. A near constant flow (approximately $\pm 05\%$) is maintained by these pressure set points.

2.3.2 Sample Probes

The FAA sample probes are isokinetic, as required by DOE 6430.1A, Section 1589-99.0.1.

2.3.3 Description Of Sample Lines

The existing FAA probe was designed as a single probe with multiple branches adjacent to the duct, as shown on drawing H-4-159182, detail F (Figure 21). Two branches are taken off the main at 30 deg. The third branch is the main branch reduced a distance of approximately four tubing diameters downstream of the branch. The sum of the area at the two branches is about one-half that of the main.

The bend radius of each sample nozzle is 3 in. (9.8 orifice diameters) (Figure 21). The inside diameter of the sample nozzles is 0.305 in. (7.7 mm) (Figure 21). The length of the straight portion of each nozzle is 2 in. (6.5 orifice diameters).

Two transport tubes will be installed, one to each CAM. The flow in each will be 0.06 m³/min (2.2 ft³/min). Each tube will be 1.3 cm (0.5 in.) by 0.09 cm (0.035 in.) wall and will have an inside diameter of 1.092 cm (0.43 in.). The flow velocity will be 11.1 m/s (36.4 ft/s) with a Reynolds number of 8070. The flow will be turbulent and particulate deposition,

Figure 21. Heating, Ventilation, and Air Conditioning Duct Air Sample Probe for the Fuel Assembly Area Recirculation and Exhaust System.

REVISIONS		DESCRIPTION
1	1	1
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3	3	3
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5	5	5
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gravitational settling, and Brownian diffusion will be minimized. The total length of sample tube will be between 3.7 and 4.6 m (12 and 15 ft). Based on data provided in ANSI N13.1-1969, Table B3, turbulent deposition of particles should be less than 10% for those particles in the 1- and 2- μm range.

2.3.5 Sample Flow Regulation

Sample flow for the FAA exhaust CAMs will be provided by the FAA sample vacuum system 34C. The FAA sample vacuum system will include redundant blowers. The system will be designed to operate at a constant 10 lb/in.² (actual). A portable air pump will be installed to provide sample flow in the case of failure of the 34C system.

Sample flow indication is provided by the alpha and beta, which are accurate to $\pm 4\%$ of full scale (100 L/min).

2.3.6 Sampling Media

Millipore membrane filters are used as the sampling medium. These filters are made of cellulose esters and polyvinyl chloride or acrylonitrile. Because the filters are not very stiff, they are supported on a metal gauze or other grid. The filters are 140 μm thick and have a porosity of 0.45 μm .

2.3.7 Frequency of Sampling (Continuous or Batch)

The FAA stack monitoring system uses both continuous and batch sampling methods.

2.3.8 Frequency of Sample Collection

Samples from the FAA stack monitoring system are collected weekly.

3.0 GENERAL INFORMATION

3.1 EFFLUENT SAMPLING/MONITORING SYSTEM DESIGNS, PROCEDURES, AND QUALITY ASSURANCE MUST BE CONSISTENT WITH ACCEPTED INDUSTRY STANDARDS. REFERENCE THE APPROPRIATE STANDARDS AND DESCRIBE HOW THEY HAVE BEEN USED. INCLUDE CALIBRATION SCHEDULE AND THE FREQUENCY OF AUDITS AND INSPECTIONS. SUBMIT PROCEDURES USED.

The Westinghouse Hanford Company defines a monitoring system as instrumentation that provides the near-real-time measurement of an airborne or liquid waste stream parameter. The system includes a detector and associated readout components. A continuous monitoring system measures the stream parameter on a near-real-time basis or as specified in applicable EPA

regulations (e.g., 40 CFR 52, Appendix E; 40 CFR 51, Appendix P) or as defined in applicable ANSI standards. A radiation monitoring system is a system in which radiation or radioactivity is the measured parameter. An integrating monitoring system integrates the instantaneously measured parameter over some time period.

The Westinghouse Hanford Company defines a sampling system as instrumentation and equipment that remove a part of a liquid or airborne waste stream for subsequent quantitative determination of a stream parameter. The system generally employs such devices as filters, other sample collection media, or effluent traps of some kind. A continuous sampling system removes a part of the stream continuously except during sample change, maintenance, repair, or other necessary outages. A grab sampling system removes an instantaneous part of the stream or removes a part of the stream over a time period.

General guidance regarding the design of sampling and monitoring systems is found in DOE 6430.1A, Section 1589-99.0.1. This order requires that sampling systems be designed in accordance with ANSI N13.1-1969 and associated appendices to ensure both representative sampling of the effluent stream, and that effluent monitoring systems comply with ANSI N42.18-1980 and pertinent portions of DOE 5480.

Following is a list of orders and codes that provide the guidance for the design and construction of the monitoring/sampling systems described in Section 2.0; provide guidance for sampling and monitoring procedures and provide guidance for quality assurance control procedures.

- o DOE Order 5480.1B - *Environment, Safety, and Health Program for Department of Energy Operations.*
- o DOE Order 5480.4 - *Environmental Protection, Safety, and Health Protection Standards.*
- o DOE Order 5484.1 - *Environmental Protection, Safety, and Health Protection Information Reporting Requirements.*
- o DOE Order 6430.1A - *General Design Criteria.*
- o 40 CFR 52 - *Approval and Promulgation of Implementation Plans.*
- o 40 CFR 61 - *National Emission Standards for Hazardous Air Pollutants (NESHAPS).*
- o General Regulation 80-7 - *Benton-Franklin-Walla Walla Counties Air Pollution Control Authority.*
- o ANSI/ASME NQA-1 - *Quality Assurance Program Requirements for Nuclear Facilities.*
- o ANSI N13.1-1969 - *Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities.*

- o ANSI N42.18-1980 - *Specification and Performance of On-Site Instrumentation for Continuously Monitoring Radioactivity in Effluents.*
- o ANSI N317-1980 - *Performance Criteria for Instrumentation Used for Implant Plutonium Monitoring.*
- o ANSI N323-1978 - *Radiation Protection Instrumentation Testing and Calibration.*
- o DOE-RL, - *Implementation Plan for Hanford Site Compliance to DOE Order 5820.2, Radioactive Waste Management.*

3.2 EFFLUENT SAMPLE ANALYSIS

3.2.1 Methodology

The air sampling and monitoring program at Westinghouse Hanford Company is conducted by several groups within the Safety, Quality Assurance, and Security Organization. Health Physics directs and maintains the workplace air sampling programs. The Environmental Protection Group provides guidance for Health Physics' operation of effluent stack exhaust monitoring and sampling equipment and tracks collected sample data for trend analysis. The radioanalytical laboratories in the individual areas (100, 200, 300, 400) provide isotopic analysis and quantitative measurement (concentrations) when requested. Radiation Protection Technicians provide the actual sample exchange and sample volume data collection.

Air sampling and monitoring is performed for assessing the impact of any possible airborne releases to the environment, and to assess and evaluate the potential hazard of airborne radioactive materials in the work place. In both applications the intent is to restrict airborne radioactive materials to "as low as reasonably achievable" (ALARA) levels, and not to exceed levels in applicable DOE orders.

Health Physics conducts the air sampling and monitoring program in accordance with the applicable DOE orders and ANSI requirements. The ultimate responsibility for the prevention of releases of airborne radioactive materials or contamination is placed on management of the individual facilities. Health Physics provides the technical direction for the required air sampling equipment and techniques, and the necessary personnel protection practices. The technical direction and practices are stressed most in the individual facility safety regulations, and in working procedures and documents.

Health Physics conducts air sampling in all areas where the potential exists for persons to be unknowingly exposed to airborne radioactive materials. A sufficient number of air samples are taken to represent the area of interest. Samples are collected for the length of time necessary to

evaluate and document the extent and hazards of exposure to any airborne radioactive materials. Air sample concentration calculation data is available for trending when desired. In addition, when access by personnel to known areas of airborne radioactive material is necessary, representative air samples are taken to quantify the concentrations present so that proper respirator protection factor requirements may be calculated and used.

Air sampling equipment, techniques, and criteria for stack effluent samplers and monitoring systems include:

- o Facility exhaust stacks are sampled to provide an auditable record of long-term, low-level effluent releases.
- o Facility exhaust stacks are monitored by CAMs to provide rapid indication of a significant release of airborne radioactivity.
- o Stack particulate record samplers are run for a 1-wk interval (168 hr) whenever possible to obtain an adequate sample.
- o The Environmental Protection Group oversees the operation of stack sampling and monitoring systems.
- o In addition to particulate sampling, additional sampling for iodine, noble gases, tritium, or volatile vapors may be necessary, depending on the facility.

3.2.2 Procedure References

Following is a list of the procedures used on the Hanford Site to provide guidance to personnel involved in the monitoring and sampling of airborne radionuclides.

- o ANSI N13.1-1969 - *Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities.*
- o ANSI N13.10-1974 - *Specifications and Performance of Onsite Instrumentation for Continuously Monitoring Radioactivity in Effluents.*
- o ANSI N323-1978 - *Radiation Protection Instrumentation Testing and Calibration.*

3.2.3 Detection Limits

The standard Hanford Site detection limit for equipment monitoring the controlled release of airborne radionuclides has been established at a level equal to or less than 10% of the derived concentration guide (DCG) for the specific radionuclide(s) being monitored.

3.2.4 Quality Assurance (Include Internal Audit Schedule and Results)

Because the FMEF/FAA has not housed any active processes, there have not been any audits to date, internal or otherwise, of the quality assurance program relative to the effluent sampling/monitoring system. However, on start of operations, the FMEF/FAA sampling/monitoring quality assurance program will adhere to DOE-RL Order 5700.1A, *Quality Assurance*, and ANSI/ASME NQA-1, *Quality Assurance Program Requirements for Nuclear Facilities*.

3.3 ENVIRONMENTAL MONITORING PROGRAM

3.3.1 Give a Description of the Program and a Summary of the Data

The environmental monitoring program assessing the offsite impact of the controlled release of airborne radionuclides as well as nonradioactive pollutants from the Hanford Site is conducted by PNL. The program includes a network of 50 continuously operating air samplers at locations on and off the Hanford Site. The data gathered from these locations are collated and published by PNL in the annual *Hanford Site Environmental Report* (copies of which are provided the DSHS on publication). Chapter 4.1 of the report provides a complete description of the program and methodology as well as summary data pertinent to the monitoring of the controlled release of airborne radionuclides from the Hanford Site. The following, taken from page 4.1 of the report, summarizes the results of the study of the data for 1988.

In 1988, the annual average Hanford Site perimeter concentrations of airborne ^3H , ^{90}Sr , ^{137}Cs , and uranium were numerically greater than levels measured at distant monitoring stations, but the differences were not statistically significant (at the 5% significance level). Krypton-85 and ^{129}I concentrations were numerically greater at the perimeter stations than at the distant stations, and the differences were statistically significant (beyond the 5% significance level). However, even the maximum single perimeter sample for any radionuclide was only 0.3% of the applicable DOE Derived Concentration Guide (DCG) (Appendix B, Table B.6). The total dose from air emissions is compared to Clean Air Act and DOE dose standards in Section 4.8, "Potential Radiation Doses from 1988 Hanford Operations." Annual average NO_2 concentrations at all sampling locations remained well below Federal and Washington State ambient air standards.

4.0 DEMONSTRATION OF COMPLIANCE

4.1 GIVE METHODOLOGY USED TO DEMONSTRATE COMPLIANCE

The AIRDOSE-EPA (Clean Air Act Code) computer code was used to calculate the dose from FCFS to the maximally exposed offsite individual, and thus demonstrate compliance with 40 CFR 61, Subpart H, and WAC 402-80-50 and WAC 173-480-040.

4.2 INCLUDE ALL INPUT DATA USED

Meteorological data input to the AIRDOSE-EPA code include mixing height, rainfall rate, average air temperature, vertical temperature gradient, wind direction frequency, wind speed, and atmospheric stability. This information was obtained from the data base compiled by the Hanford Meteorological Station (HMS). The HMS data on airspeed, direction, and temperature are collected at a 125-m (410-ft) tower located on the Hanford Site between the 200 East and 200 West Areas, and at a second tower at the 400 Area. Wind speed and direction are based on hourly data collected at the 400 Area meteorological tower 10-m (32.8-ft) level during the years 1983 to 1987. Atmospheric stability was estimated from the temperature gradient between the 9.1-m (30-ft) and 61-m (200-ft) levels at the HMS for the same period using standard methods of the U.S. Nuclear Regulatory Commission (NRC). Air temperature and mixing height are also 5-yr averages of hourly data. Temperature is measured at the tower 61-m (200-ft) level, and mixing height data are collected by onsite acoustic sounders.

Joint frequency data, as reported by the HMS, are modified for input into AIRDOSE-EPA by conversion to true average and reciprocal average wind speeds for each direction and stability class. The meteorological data are then used to calculate X/Q values for each radionuclide, which are also a function of radiological half-life and dry deposition velocity. For purposes of this calculation, deposition velocities are assigned as follows: 1.0×10^{-3} m/s for all particulate materials, 1.0×10^{-2} m/s for iodine isotopes, and zero for all gases.

Source terms: Projected annual releases from FCFS as presented in Table 3-1.

Release height: The FAA stack height is 109.7 m (359.9 ft).

Inhalation rate: 8,500 m³/yr (300,173 ft³/yr).

Maximally exposed individual: Doses were estimated for an individual living 8.7 km (5.4 mi) south of the 4862 Building.

Meteorology: The HMS data and onsite meteorological data, as discussed above.

4.3 PRESENT THE RESULTS

Maximum individual doses were much less than 1 mR. Bone surface and lung were the organs receiving the highest dose, primarily from ²³⁸Pu. Inhalation was the dominant pathway for exposures.

Table 3-2 shows the whole body and critical organ doses to the offsite individual receiving maximum exposure to airborne radiological emissions from the FCFS.

Table 3-2. Offsite Dose Estimates for an Individual Receiving Maximum Exposure to Airborne Radiological Emissions from Fuel Assembly Area (mR).

<u>Whole body</u>	<u>Critical organ (bone surface)</u>
4.8 E-06	7.2 E-05

Both WAC 402-80-50 and WAC 173-480-040 state the following:

The WDOE ambient standard requires that emissions of radionuclides to the air shall not cause a dose equivalent of more than 25 mrem/y to the whole body or 75 mrem/y to a critical organ of any member of the public.

National ambient air quality standards for DOE facilities are stated in 40 CFR 61.92, as follows:

Emissions of radionuclides to air from DOE facilities shall not exceed those amounts that cause a dose equivalent of 25 mrem/y to the whole body or 75 mrem/y to the critical organ of any member of the public.

A comparison of the data presented in Table 3-2 with the cited statutory limits shows that the projected whole body and critical organ doses of airborne radionuclides from the FAA to the maximally exposed offsite individual would only 1.0×10^{-4} of those cited limits.

Further, the *Hanford Site Environmental Report for Calendar Year 1988*, PNL-6825, (Jacquish 1989) states that the effective dose equivalent (whole body dose) to the maximally exposed offsite individual from all Hanford Site operations air emissions was 0.3 mR in 1988. If the projected whole body dose from the FAA, as listed in Table 3-2, is added to the historic releases for 1988, it is clear that the FAA projected emissions will not cause a violation of either State or Federal standards.

4.4 DESCRIBE ANY INTERNAL STANDARDS USED TO ENSURE COMPLIANCE WITH APPLICABLE STATE AND FEDERAL LAWS AND REGULATIONS.

Westinghouse Hanford Company policy regarding compliance with State and Federal laws pertinent to protection of the environment is defined as follows:

- o Operate and maintain company-managed facilities according to DOE Orders and in compliance with the letter and spirit of other applicable Federal, State, and local regulations.

- o Design and construct new facilities in a manner that ensures that exposure of individuals and population groups to radioactive and other hazardous materials is ALARA.
- o Treat, dispose of, and store radioactive and other hazardous material in a manner that minimizes waste volumes and provides the maximum protection for the environment.
- o Manage facilities and activities in a cost effective and environmentally responsible manner.
- o Environmental controls and programs shall be consistent with the environmental policy stated above and with contractual provisions with DOE. These formalized controls shall be based on the following orders and regulations:

DOE Order 5440.1C - *National Environmental Policy Act*

DOE Order 5480.1A - *Policy Statement, Safety and Health Protection Program*

DOE Order 5480.2 - *Hazardous and Radioactive Mixed Waste Management*

DOE Order 5480.4 - *Environmental Protection, Safety, and Health Protection Standards*

DOE Order 5482.1B - *Environment, Safety and Health Appraisal Program*

DOE Order 5484.1 - *Environmental Protection, Safety, and Health Appraisal Protection Information Reporting Requirements*

DOE Order 5820.2 - *Radioactive Waste Management*

DOE Order 6430.1A - *General Design Criteria*

DOE-RL Order 5440.1A - *Implementation of National Environmental Policy Act at the Richland Operations Office*

DOE-RL Order 5480.1A - *Environment, Safety, and Health Program for Department of Energy Operations for Richland Operations*

DOE-RL Order 5480.5 - *Safety of Nuclear Facilities*

DOE-RL Order 5482.1B - *Environment Safety, Health, and Quality Assurance Appraisal and Surveillance Program*

DOE-RL Order 5484.2A - *Unusual Occurrence Reporting System for RL*

DOE Order 5400.1 - *General Environmental Protection Program*

40 CFR - *Protection of Environment*

WAC 173-303 - *Dangerous Waste Regulations*

WAC 173-400 - *General Regulations for Air Pollution Sources*

WAC 402-80 - *Monitoring and Enforcement of Air Quality and Emission Standards for Radionuclides.*

- o Environmental controls and implementing procedures used by the company shall be maintained current and shall promptly reflect regulatory changes.

5.0 BEST AVAILABLE RADIONUCLIDE CONTROL TECHNOLOGY ASSESSMENT

A BARCT is defined by WAC-402-80-40 as follows:

Technology which will result in a radionuclide emission limitation based on the maximum degree of reduction for radionuclides which would be emitted from any proposed stationary source or modification of a source which the permitting authority on a case-by-case basis, taking into account energy, environmental, and economic impacts and other costs, determines is achievable for such source or modification through application of production processes or available methods, systems, and techniques. In no event shall application of best available radionuclide technology result in emissions of radionuclides which would exceed the ambient annual standard limitation specified in this chapter.

The selection of the emissions control system described in Section 2.2.2 is supported as BARCT for the pollutants to be emitted by the FCFS by the following.

Control Alternatives

Radionuclide emissions from the FAA will consist primarily of particulate matter generated during the processing and fabrication of the enriched uranium oxide or mixed oxide fuels and of neptunium oxide target assemblies. Based on the handling operations that will be performed and the physical characteristics of the powder, suspended particulate matter is anticipated to be in the micrometer- and submicrometer-size range.

In order to identify all possible emission controls for this process, a nuclear- and cross-industry survey for high-efficiency particulate matter controls was conducted (Appendix A). Therefore, devices capable of collecting only large-diameter particles are not included in the survey. All of the controls identified have been previously applied in radiochemical processing operations. High-efficiency particulate controls in the industrial sector are limited to HEPA filters, used for cleanroom applications and packed fiber filters, for high quality product gas filtration (essentially, high-efficiency mist eliminators [HEME]). Potential control devices identified

in the surveys are presented in Table 3-3. Detailed process descriptions and evaluations are presented in Appendix B.

Of the potential particulate controls identified in Table 3-3, only the prefilter and HEPA can be applied to primary particulate control in this application.

Table 3-3. Fuel Assembly Area Control Technology Survey Results.

Control	Removal efficiency
<u>Particulate matter</u>	
HEPA filter	99.97% for 0.3- μ m particles
Deep-bed sand filter	99.95% for 0.3- μ m particles
Deep-bed glass-fiber filter	99.9% for 0.3- μ m particles
HEME	99.5% for 1- μ m particles
Prefilter	85% (max) for 0.3- μ m particles

In the nuclear industry, prefilters are generally used in combination with HEPA's to remove the larger particles in the exhaust stream, thus increasing the service life of the HEPA's. Extremely large units, such as the deep-bed sand and deep-bed fiber filters cannot be considered as primary filters because adequate floor space is not available. Although the HEME is relatively small (about 0.9 m [3 ft] in length), it is significantly less effective than the HEPA in its removal of small particles, it requires additional plumbing (for possible filter cleaning with a water-wash) and it is normally not used for dry room offgas systems. Therefore, a combination prefilter/HEPA assembly is considered the only applicable particulate control alternative based on performance and operating/physical constraints for primary FCFS exhaust treatment, and is thus proposed as BARCT for this particular application. No further analysis of energy, environmental, or economic impacts is required because the control technology identified has been determined to be the technology that is appropriate and allows the lowest emission rate of radionuclides. Any other control technology would not provide a comparable low environmental impact, regardless of energy or economic impact. The BARCT analysis will therefore be limited to the final filtration processes only.

After primary treatment, all the exhaust from the FAA operations is combined and routed to a final filtration step before discharge through the FAA building stack. Final high-efficiency particle filtration before discharge of radionuclide-contaminated gases to the atmosphere is a nuclear industry standard. Generally, two-stage filtration is used for this purpose. Presently employed final filtration techniques in the nuclear industry include combination prefilter and HEPA's, deep-bed glass-fiber filters, and deep-bed sand filters (Table 3-3). Deep-bed glass-fiber and sand filters are normally installed upstream of a final contact HEPA filter. Therefore, the alternative control systems for the final FAA exhaust that will be evaluated the following:

Alternative 1 - deep-bed glass-fiber filter/one-stage HEPA

Alternative 2 - deep-bed sand filter/one-stage HEPA

Alternative 3 - two-stage HEPA

The following will present an evaluation of these final emission control alternatives based on environmental, energy, and economic impacts to demonstrate BARCT for the FAA emissions.

Environmental

All of the three alternatives incorporate a HEPA filter as the second-stage control device. Studies have shown that the removal efficiency of a HEPA placed downstream of another high-efficiency particulate control device (such as a deep-bed sand filter or another HEPA) is lower than that of a single-stage HEPA (Zippler 1974). It is postulated that this results from the extraction of the more readily collected particles in the initial filter (Moore and Fullam 1984). Sufficient data are not available to determine the effect that this would have on the overall removal efficiency of each alternative control system. For the purposes of this analysis, it is assumed that the second-stage HEPA performs identically for each system. Therefore, the overall efficiency is directly related to the removal efficiency of the first-stage unit. As shown in Table 3-3, alternative 3 (two-stage HEPA) would provide somewhat higher performance than alternatives 2 and 1, respectively. Because ground-level radionuclide impacts are directly dependent on emission rate (and thus removal efficiency), the implementation of alternative 3 would result in the lowest air quality impact.

All three alternatives use standalone dry processes, so the only wastes associated with these systems would be the spent filters. Alternative 1 has the largest volume of waste for disposal (i.e., the sand) and therefore poses the greatest potential environmental impacts (landfill space and possible contamination). Alternative 3 would produce less waste material than alternative 2, although only relative quantities can be estimated at this time.

Energy

Energy requirements for the three alternatives are associated with operating a sufficiently large exhaust fan(s) to overcome the pressure drop of each system (as the final exhaust temperature of 26.6° C [80° F] is within the operating range of the filters). Based on the anticipated pressure drops of the initial control stage of each alternative (Appendix B), alternative 2 (sand filter pressure drop = 11 in. WC) would have the highest energy impacts of the alternatives, followed by alternative 1 (fiber filter pressure drop = 8 in. WC) and alternative 3 (HEPA pressure drop = 4 in. WC).

Economic

Installed costs of the three alternatives are presented below, based on previously installed exhaust cleaning systems at various nuclear fuel reprocessing plants (Burchsted 1976):

	<u>Cost (\$/ft³/min)</u>
Alternative 1 (deep-bed fiber and HEPA)	30.34
Alternative 2 (deep-bed sand filter only)	46.88 (cost of additional HEPA not available)
Alternative 3 (two stage HEPA)	7.43

These cost estimates show that alternative 3 costs only about 24% of alternative 1 and 16% of alternative 2 (percentage would be less if costs of HEPA were included in alternative 2). Although operating costs such as utilities, maintenance, operations, service life, and consumables are not available, it has been shown that alternative 2 has the highest utility cost (largest fan requirements) and higher overall operating costs than alternative 1 (Moore and Fullam 1984). Alternative 1 has the second highest utility cost and alternative 3 has the lowest utility cost. On the other hand, alternative 3 is expected to have higher maintenance costs than alternative 2 because of the frequency of filter changeouts.

Summary

Alternative 3 is considered to be the BARCT for the final FAA exhaust. Its use of available, proven control methods for reducing radionuclides is confirmed by comparing its effectiveness to the other available alternatives. It is the most cost effective alternative, having the lowest capital and operating costs. Alternative 3 also has the lowest energy consumption of the three systems evaluated.

REFERENCES

- ANSI N13.1-1969, *Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities*, American National Standards Institute, New York, New York.
- ANSI N13.10-1974, *Specifications and Performance of Onsite Instrumentation for Continuously Monitoring Radioactivity in Effluents*, American National Standards Institute, New York, New York.
- ANSI N323-1978, *Radiation Protection Instrumentation Testing and Calibration*, American National Standards Institute, New York, New York.
- ANSI N42.18-1980, *Specification and Performance of On-Site Instrumentation for Continuously Monitoring Radioactivity in Effluents*, American National Standards Institute, New York, New York.
- ANSI N317-1980, *Performance Criteria for Instrumentation Used for Inplant Plutonium Monitoring*, American National Standards Institute, New York, New York.
- ANSI/ASME NQA-1, *Quality Assurance Program Requirements for Nuclear Facilities*, American National Standards Institute, New York, New York.
- Burchsted et al. 1976, *Nuclear Air Cleaning Handbook--Design, Construction, and Testing of High-Efficiency Air Cleaning Systems for Nuclear Application*, C.A. Burchsted, J.E. Kahn, and A.B. Fuller, ERDA-76-1, Oak Ridge National Laboratory, Oak Ridge, Tennessee.
- DOE Order 5400.1, *General Environmental Protection Program*, U.S. Department of Energy, Washington, D.C., November 9, 1988.
- DOE Order 5400.3, *Hazardous and Radioactive Mixed Waste*, U.S. Department of Energy, Washington, D.C., February 23, 1989.
- DOE Order 5440.1C, *National Environmental Policy Act*, U.S. Department of Energy, Washington, D.C., April 9, 1985.
- DOE Order 5480.1A, *Safety and Health Policy Statement*, U.S. Department of Energy, Washington, D.C., May 13, 1988.
- DOE Order 5480.1B, *Environment, Safety, and Health Program for Department of Energy Operations*, U.S. Department of Energy, Washington, D.C., September 23, 1986.
- DOE Order 5480.4, *Environmental Protection, Safety, and Health Protection Standards*, U.S. Department of Energy, Washington, D.C., May 15, 1984.

- DOE Order 5482.1B, *Environment, Safety, and Health Appraisal Program*, U.S. Department of Energy, Washington, D.C., September 23, 1986.
- DOE Order 5484.1, *Environmental Protection, Safety, and Health Protection Information Reporting Requirements*, U.S. Department of Energy, Washington, D.C., February 24, 1981
- DOE Order 5820.2A, *Radioactive Waste Management*, U.S. Department of Energy, Washington, D.C., September 26, 1988.
- DOE Order 6430.1A, *General Design Criteria*, U.S. Department of Energy, Washington, D.C., April 6, 1989.
- DOE-RL Order 5440.1A, *Implementation of the National Environmental Policy Act at the Richland Operations Office*, U.S. Department of Energy, Richland, Washington, February 3, 1987.
- DOE-RL Order 5480.1A, *Environment, Safety, and Health Protection Program for Department of Energy Operations for Richland Operations*, U.S. Department of Energy-Richland Operations Office, Richland, Washington, September 7, 1988.
- DOE-RL 5480.4A, *Environmental Protection, Safety, and Health Protection Standards for RL*, U.S. Department of Energy-Richland Operations Office, Richland, Washington, December 1, 1987.
- DOE-RL Order 5480.5, *Safety of Nuclear Facilities*, U.S. Department of Energy-Richland Operations Office, Richland, Washington, September 23, 1986.
- DOE-RL Order 5482.2B, *Environmental Safety, Health, and Quality Assurance Appraisal and Surveillance Program*, U.S. Department of Energy-Richland Operations Office, Richland, Washington, March 4, 1987.
- DOE-RL Order 5484.1, *Environmental Protection, Safety and Health Protection Information Reporting Requirements*, U.S. Department of Energy-Richland Operations Office, Richland, Washington, September 26, 1983.
- DOE-RL Order 5484. 2A, *Unusual Occurrence Reporting System for RL*, U.S. Department of Energy-Richland Operations Office, Richland, Washington, September 24, 1984.
- DOE-RL 5700.1A, *Quality Assurance*, U.S. Department of Energy-Richland Operations Office, Richland, Washington, July 14, 1983.
- General Regulation 80-7, *Benton-Franklin-Walla Walla Counties Air Pollution Control Authority*, Washington State, July 1980.
- Implementation Plan for Hanford Site Compliance to DOE Order 5820.2, "Radioactive Waste Management,"* U.S. Department of Energy-Richland Operations Office, Richland, Washington, August 1985.

- Jacquish, R.E. 1989, *Hanford Site Environmental Report for Calendar Year 1988*, PNL-6825, Pacific Northwest Laboratory, Richland, Washington.
- McDowell et al. 1976, *Penetration of HEPA Filters by Alpha Recoil Aerosols*, W.J. McDowell and F.G. Seeley (Oak Ridge National Laboratory), and M.T. Ryan (University of Lowell, Massachusetts), 14th ERDA Air Cleaning Conference, Sun Valley, Idaho, August 11-13, 1976.
- Moore, E.B. and H.T. Fullam 1984, *Control Technology for Radioactive Emissions to the Atmosphere at U.S. Department of Energy Facilities*, PNL-4621-Final, Pacific Northwest Laboratory, Richland, Washington.
- NE F 3-43, *Nuclear Standard's Quality Assurance Testing of HEPA Filters*, Office of Scientific and Technical Information, Oak Ridge, Tennessee, October, 1988.
- Zippler, D.B. 1974, "Evaluation of Multistage Filtration to Reduce Sand Filter Exhaust Activity," *Proceedings of the 13th AEC Nuclear Air Cleaning Conference*, Vol. 1, San Francisco, California, March 1975, pp. 609-619.

APPENDIX A
LITERATURE SEARCH

POLLUTION ABSTRACTS

POLLUTION ABSTRACTS is a leading resource to environmentally related technical literature on pollution, its sources, and its control. References in Pollution Abstracts are drawn from approximately 2,500 primary sources from around the world, including books, conference papers/proceedings, periodicals, research papers, and technical reports. As of October 1988 the database consisted of 240,000 records covering the period 1970 to the present and updated bimonthly.

78908035.1

1. Partitioning of natural radionuclides in the waste streams of coal-fired utilities
 Roeck, D.R.; Reavey, T.C.; Hardin, J.M.
 Alliance Technol. Corp., 213 Burlington Rd., Bedford, MA 01730, USA
 HEALTH PHYS VOL. 52, NO. 3, pp. 311-323, Publ.Yr: 1987
2. Radiation Protection and Environmental Monitoring for Radioactive Waste Storage in a Salt Mine
 Stippler, R.; Kleimann, H.
 Gesellschaft Strahlen & Umweltforschung mbH, Muenchen FRG
 7th Regional Cong. IRPA/13th Annl. Conf. Fachverband fur Strahlenschutz "Radioactive Wastes" Cologne, FRG 16-19 Oct. 1979 IN "PROC. 7TH REGIONAL CONG. IRPA/13TH ANNUL. CONF. FACHVERBAND FUR STRAHLENSCHUTZ Publ.Yr: 1979
 L.F.FRANZEN, GRS, POSTFACH 10 16 50, D-5000 KOLN 1, FRG
3. Radioactive airborne effluents from the radiopharmaceutical industry.
 Leventhal, L.; Chakoff, E. H.; Savage, E.; Strom, K. A.; Trent, M. G.; Fielder, D. R.; Cehn, J. I.
 LFE-EAL, Richmond, CA 94804
 Twenty-fourth annual meeting of the Health Physics Society Philadelphia, Pennsylvania Jun 24-29, 1979
 Health Physics Society
 HEALTH PHYSICS 37(6), 799-800, Publ.Yr: Dec 1979 Coden: HLTPAO
 Doc Type: CONFERENCE PAPER
4. (Ensuring radiation safety of the population in connection with the development of the atomic energy industry).
 Vorob'ev, E. I.
 Acad. of Medical Sciences USSR, Leninsky Prospekt 14, Moscow V-71, USSR
 GIGIENA I SANITARIYA No. 6, 3-7, Publ.Yr: 1979 Coden: GISAAA
 Languages: Russian
 Doc Type: JOURNAL PAPER
5. Bioindication of the aerosol products of nuclear fission with the aid of the needles of the common pine tree.
 Piskunov, L. I.; Treiger, S. I.
 ATOMNAIA ENERGIYA 45(3), 223-225, Publ.Yr: Sep 1978 Coden: AENGAB
 SOVIET ATOMIC ENERGY 45(3), 913-915, Coden: SATEAZ
 Doc Type: JOURNAL PAPER
6. The remote control and monitoring system for nuclear reactors operational in Bavaria. Dornstetter, P.
 DORNIER POST No. 2, 9-14, Publ.Yr: 1979 Coden: DOPOAC
 ISSN: 0012-5563
 Doc Type: JOURNAL PAPER

7. Experience pratique du traitement des effluents gazeux a l'usine
de\retraitement
Eurochemic. (Operational experience of gaseous effluent treatment of
the Eurochemic reprocessing plant).
Osipenco, A.; Detilleux, E.
Eurochemic, 2400 Mol, Bel.
Seminar on radioactive effluents from nuclear fuel reprocessing plants
Karlsruhe, FRG
Nov. 22-25, 1977
Radioactive effluents from nuclear fuel reprocessing plants: Seminar
proceedings
Publ.Yr: 1978 pp. 71-80
Publ: Luxembourg Commission of the European Communities
Eng., Fr., Ger. sums.
Languages: French
Doc Type: CONFERENCE PAPER

NTIS

NTIS is produced by the National Technical Information Service of the U.S. Department of Commerce. The database consists of government-sponsored research, development, and engineering reports as well as other analyses prepared by government agencies, their contractors, or grantees. The database contains 1.4 million records as of January 1989 covering dates from 1964 to the present and is updated biweekly.

78908035.2

1. Second Progress Report for the WERF (Waste Experimental Reduction Facility) Incinerator
Dalton, J. D.
EG and G Idaho, Inc., Idaho Falls.
Sponsor: Department of Energy, Washington, DC.
Report No.: EGG-WM-8154
Jun 88 59p
2. Measurement and Modeling of External Radiation During 1985 from LAMPF (Los Alamos Meson Physics Facility) Emissions
Bowen, B. M.; Olsen, W. A.; Chen, I.; Van Etten, D. M.
Los Alamos National Lab., NM.
Sponsor: Department of Energy, Washington, DC.
Report No.: LA- 1 1 150-MS
Nov 87 31p
3. Radiation Dose Resulting from the Releases of Fly Ash in the Environment
Koester, H. W.; Leenhouts, H. P.; Frissel, M. J.
Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer, The Hague (Netherlands). Directie Stralenbescherming.
Report No.: VROM-DSB-86-21; VROM-60250/6-86
Jun 86 102p
Languages: Dutch
4. Waldsterben, natuerliche und kerntechnisch erzeugte Radioaktivitaet. Gutachten zumoeglichen Zusammenhaengen zwischen der Emission radioaktiver Edelgase auskerntechnischen Anlagen und dem Waldsterben und zum Vergleich natuerlicher undkuenstlicher Radioaktivitaet. Forest decline, natural and technically generated radioactivity. Expertise on possible relations between effluent radioactive rare gas from nuclear plants and forest decline and regarding the comparability of natural and artificial radioactivity)
Teufel, D.
Institut fuer Energie- und Umweltforschung e.V., Heidelberg (Germany, F.R.).
Report No.: IFEU--25
Jun 83 42p
Languages: German
5. OLDES - ein KFUE-integrierbares System zur Diagnose und Prognose der Strahlenexposition bei erhoekten Emissionen aus kerntechnischen Anlagen. (OLDES - an on-line dose evaluation system that can be integrated into the remote monitoring system of nuclear power stations for additional monitoring and prognostic assessment in case of major accidental activity release)
Witt, H.; Brenk, H.D.; Kruschel, K.P.; Knaup, A.G.
Bundesministerium fuer Umwelt, Naturschutz und Reaktorsicherheit, Bonn (Germany, F.R.).
Report No.: BMU--1986-135
1986 228p
Languages: German

6. Atmospheric Tracer Study of the Emissions from the University of Michigan Cyclotron/PET Facility
(Thesis)
Scofield, P. A.
Michigan Univ., Ann Arbor.
Sponsor: Oak Ridge Associated Universities, Inc., TN.; Department of Energy, Washington, DC.
Report No.: DOE/OR/00033-T308
23 Mar 86 145p
7. Influence of Industry on Pollution of the Environment and Human Population with Natural Radionuclides and Heavy Metals
Jaworowski, Z.
Central Lab. for Radiological Protection, Warsaw (Poland).
Report No.: CLOR-116/D
1982 152p
8. Overview of Airborne Radioactive Emissions at Los Alamos National Laboratory
Guevara, F. A.; Dvorak, R. F.
Los Alamos National Lab., NM.
Sponsor: Department of Energy, Washington, DC.
Report No.: LA-UR-87-1103; CONF-870620-2
1987 28p
9. Calculation Program of Consequences Developed for the Crisis Technical Center of the Protection and Nuclear Safety Institut
Crabot, B.; Manesse, D.; Bouscatie, F.
CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses (France). Dept. d'Analyse de Surete.
Report No.: CEA-CONF-8586; CONF-8509130-5; CEA-DAS---220
Sep 85 15p
Languages: French Document Type: Conference proceeding
10. Berechnung der Strahlenexposition durch Ableitungen radioaktiver Stoffe mit der Abluft aus Anlagen von Isotopenanwendern (Calculation of Radiation Exposure from Emissions of Radioactive Materials with Off-Air from Facilities Using Isotopes)
Haubelt, R.; Fischer, P.; Sonnabend, H. R.
Bundesgesundheitsamt, Neuherberg (Germany, F.R.). Inst. fuer Strahlenhygiene.
Report No.: ISH-46; ISBN-3-924403-21-X
Aug 84 35p
Languages: German

11. Untersuchungen ueber die Emission von Eisen-55 und Nickel-63 mit der Abluft aus Kernkraftwerken in der Bundesrepublik Deutschland in den Jahren 1979-1981 (Investigations into the Emission of Iron-55 and Nickel-63 from Off-Gas of Nuclear Power Plants in the Federal Republic of Germany in the Years 1979-1981)
Gesewsky, P.; Vogl, K.; Winkelmann, I.
Bundesgesundheitsamt, Neuherberg (Germany, F.R.). Inst. fuer Strahlenhygiene.
Report No.: ISH-11
Dec 82 50p
Languages: German
12. Assessment of Atmospherically-Released Radionuclides Using the Computerized Radiological Risk Investigation System
Nelson, C. B.; Sjoreen, A. L.; Miller, C. W.; Baes, III, C. F.
Office of Radiation Programs, Washington, DC.
Sponsor: Oak Ridge National Lab., TN.; Department of Energy, Washington, DC.
Report No.: CONF-861165-4
1986 5p
13. Modeling of External Radiation from the Transport of Radionuclides Across a Canyon
Bowen, B. M.; Olsen, W. A.; Van Etten, D.; Chen, I-li
Los Alamos National Lab., NM.
Sponsor: Department of Energy, Washington, DC.
Report No.: LA-UR-86-2838; CONF-861165-2
1986 5p
14. In Situ Vitrification Large-Scale Operational Acceptance Test Analysis
Buelte, J. L.; Carter, J. G.
Battelle Pacific Northwest Labs., Richland, WA.
Sponsor: Department of Energy, Washington, DC.
Report No.: PNL-5828
May 86 52p
15. Inhalation Toxicology Research Institute Annual Report, October 1, 1984-September 30, 1985
Medinsky, M. A.; Muggenburg, B. A.
Lovelace Biomedical and Environmental Research Inst., Albuquerque, NM.
Inhalation Toxicology Research Inst.
Sponsor: Department of Energy, Washington, DC.
Report No.: LMF-114
Dec 85 540p
16. GASPAR; Evaluation of Atmospheric Releases (NRC Code) (Software)
Eckerman, K. F.
Oak Ridge National Lab., TN.
Report No.: ANL/NESC-963
1985 mag tape

17. Suitability of Bees as an Indicator for Environmental Problems
Drescher, W.
Report No.: LA-TR-84-13
1982 14p
18. Control Technology for Radioactive Emissions to the Atmosphere at
U.S. Department of Energy Facilities: The Los Alamos Meson Physics
Facility
Moore, E. B.; Fullam, H. T.
Battelle Pacific Northwest Labs., Richland, WA.
Sponsor: Eastern Environmental Radiation Facility, Montgomery, AL.
Report No.: PNL-4621-ADD-1
Mar 85 26p
19. Sensitivity, Applicability and Validation of Bi-Gaussian off- and on-Line
Models for the Evaluation of the Consequences of Accidental Releases
in Nuclear Facilities
Kretzschmar, J. G.; Mertens, I.; Vanderborcht, B.
Commission of the European Communities, Luxembourg.
Report No.: EUR-9385
1984 177p
20. Technology of Off-Gas Treatment for Liquid-Fed Ceramic Melters
Scott, P. A.; Goles, R. W.; Peters, R. D.
Battelle Pacific Northwest Labs., Richland, WA.
Sponsor: Department of Energy, Washington, DC.
Report No.: PNL-5446
May 85 113p
21. Control Technology for Radioactive Emissions to the Atmosphere at US
Department of Energy Facilities: The Los Alamos Meson Physics
Facility.
Addendum 1
Moore, E. B.; Fullam, H. T.
Battelle Pacific Northwest Labs., Richland, WA.
Sponsor: Department of Energy, Washington, DC.
Report No.: PNL-4621-ADD. 1
Mar 85 22p
22. Calculation of Radionuclide Migration Via the Air and Food Pathway and
of the Potential Radiation Exposure Resulting from Surface, Facilities
for Nuclear Waste Management. Summarizing Interim Report. Pt. 4
Hahn-Meitner-Inst. fuer Kernforschung Berlin G.m.b.H. (Germany, F.R.).
Project Sicherheitsstudien Entsorgung.
Report No.: INIS-MF-9188
May 83 92p
Languages: German

23. Control Technology for Radioactive Emissions to the Atmosphere at US
Department of Energy Facilities
Moore, E. B.
Battelle Pacific Northwest Labs., Richland, WA.
Sponsor: Department of Energy, Washington, DC.
Report No.: PNL-4621-FINAL
Oct 84 612p
24. Radionuclides: Background Information Document for Final Rules.
Volume 2 (Final rept)
Office of Radiation Programs, Washington, DC.
Sponsor: PEI Associates, Inc., Cincinnati, OH.; Battelle Columbus Labs.,
OH.; Kilkelly Environmental Associates, Inc., Raleigh, NC.
Report No.: EPA/520/1-84/002/2
Oct 84 441p
25. Radionuclides: Background Information Document for Final Rules.
Volume 1 Office of Radiation Programs, Washington, DC.
Sponsor: PEI Associates, Inc., Cincinnati, OH.; Battelle Columbus
Labs., OH.;
Kilkelly Environmental Associates, Inc., Raleigh, NC.
Report No.: EPA/520/1-84/022/1
Oct 84 282p
26. Scientific Critique of Available Models for Real-Time Simulations of
Dispersion (Technical rept.)
Lewellen, W. S.; Sykes, R. I.
Aeronautical Research Associates of Princeton, Inc., NJ.
Sponsor: Nuclear Regulatory Commission, Washington, DC. Office of Nuclear
Regulatory Research.
Report No.: ARAP-472
Mar 85 170p
27. Method of Instantaneous Approximation of the Atmospheric Dispersion
Doury, A.
CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses (France).
Inst. de Protection et de Surete Nucleaire.
Report No.: CEA-CONF-7187; DAS-43; CONF--831032--4
Dec 83 12p
Languages: French Document Type: Conference proceeding
28. Continuous Vent Sampler for Monitoring Radionuclide Emissions
Orlett, M. J.
Goodyear Atomic Corp., Piketon, OH. Chemical and Materials
Technology Dept.
Sponsor: Department of Energy, Washington, DC.
Report No.: GAT-T-3282; CONF-841187-15
19 Oct 84 15p

29. Uranium Content in Surface Air in Vienna During the Years 1963/64 and 1974 - 1978
Irlweck, K.; Pichlmayer, F.
Oesterreichisches Forschungszentrum Seibersdorf G.m.b.H.
Report No.: OEFZS-4187; ST-103/82; PH---351/82
Nov 82 14p
Languages: German

30. Recent Field Studies of Dry Deposition to Surfaces in Plant Canopies
Lindberg, S. E.; Lovett, G. M.; Bondietti, E. A.; Davidson, C. I.
Oak Ridge National Lab., TN.
Sponsor: Carnegie-Mellon Univ., Pittsburgh, PA. Dept. of Civil Engineering.; Department of Energy, Washington, DC.
Report No.: CONF-840612-17
1984 20p

31. EFFDOS - A FORTRAN-77-Code for the Calculation of the Effective Dose Equivalent
Baer, M.; Honcu, S.; Huebschmann, W.
Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Hauptabteilung Sicherheit.
Report No.: KFK-3631
Jan 84 66p
Languages: German

32. Radionuclides: Regulatory Impact Analysis of Emission Standards for Elemental Phosphorus Plants
Faucett (Jack) Associates, Inc., Chevy Chase, MD.
Sponsor: Environmental Protection Agency, Washington, DC.
Report No.: EPA/520/1-84/025
Oct 84 84p

33. RETADD-II: A Long-Range Atmospheric Trajectory Model with Consistent Treatment of Deposition Loss and Species Growth and Decay
Murphy, B. D.; Ohr, S. Y.; Begovich, C. L.
Oak Ridge National Lab., TN.
Sponsor: Department of Energy, Washington, DC.
Report No.: ORNL/CSD-99
Aug 84 37p

34. Mobilization of Heavy Metals from Fossil-Fuelled Power Plants, Potential Ecological and Biochemical Implications. Part 4. Assessment Studies of the European Situation
Sabbioni, E.; Goetz, L.
Commission of the European Communities, Ispra (Italy). Joint Research Centre.
Report No.: ISBN-92-825-3839-7; EUR-6998-EN-PT-4
1983 179p

35. Survey of Five Utility Boilers for Radionuclide Emissions (Final rept.)
 Roeck, D. R.; White, M. O.; Kiddie, A. M.; Young, C. W.
 GCA Corp., Bedford, MA. GCA Technology Div.
 Sponsor: Office of Radiation Programs, Washington, DC.
 Report No.: GCA-TR-83-56-G
 Dec 83 150p

36. Emitted and Decayed Values of Radionuclides in Gaseous Wastes Discharged to the Atmosphere from the Separation Facilities Through Calendar Year 1972
 Anderson, J. D.
 Atlantic Richfield Hanford Co., Richland, WA. Sponsor: Department of Energy, Washington, DC.
 1 Mar 74 9p

37. Airborne Emission Control Technology for the Elemental Phosphorus Industry (Final rept.)
 Stula, R. T.; Belanger, R. E.; Clary, C. L.; May, R. F.; Spaeth, M. E.
 Science Applications, Inc., La Jolla, CA.
 Sponsor: Environmental Protection Agency, Washington, DC.
 Jan 84 412p

38. Balance of the Tropospheric Ozone and Its Relation to Stratospheric Intrusions Indicated by Cosmogenic Radionuclides. Part IX and Part X. Combined Annual Report, 1 November 1977-31 October 1979
 Reiter, R.; Kanter, H. J.; Jaeger, H.; Munzert, K.
 Fraunhofer-Gesellschaft zur Foerderung der Angewandten Forschung e.V., Garmisch-Partenkirchen (Germany, F.R.). Inst. fuer Atmosphaerische Umweltforschung.
 Sponsor: Department of Energy, Washington, DC.
 Report No.: DOE/ET/03425-23/24
 Aug 83 72p

39. GASPAR; Evaluation of Atmospheric Releases (Software)
 Eckerman, K. F.; Lash, D. G.; Shields, J. A.
 Oak Ridge National Lab., TN.
 Sponsor: Nuclear Regulatory Commission, Washington, DC. Div. of Automatic Data Processing.; Department of Energy, Washington, DC.
 Report No.: ANL/NESC-963
 1984 mag tape

40. Estimation of Radionuclide Releases from Specific Large Coal-Fired Industrial and Utility Boilers
 Greiner, N. R.; Williams, M. D.; Wagner, P.
 Los Alamos National Lab., NM.
 Sponsor: Department of Energy, Washington, DC.
 Report No.: LA-9845-MS
 Aug 83 227p

41. Radionulides in Western Coal. Final Report
Abbott, D. T.; Styron, C. E.; Casella, V. R.
Monsanto Research Corp., Miamisburg, OH. Mound.
Sponsor: Department of Energy, Washington, DC.
Report No.: MLM-3026
23 Sep 83 28p

42. Background Information on Sources of Low-Level Radionuclide Emissions
to Air
Corbit, C. D.; Herrington, W. N.; Higby, D. P.; Stout, L. A.; Corley,
J. P.
Battelle Pacific Northwest Labs., Richland, WA.
Sponsor: Department of Energy, Washington, DC.
Report No.: PNL-4670
Sep 83 49p

43. Choosing the Best Meteorological Conditions for Atmospheric Diffusion
Experiments at the Angra Site
Nicolli, D.; Thomas, P.
Comissao Nacional de Energea Nuclear de Brasil, Rio De Janeiro
Report No.: CNEN-DIN-01/83
Jan 83 19p

44. Inhalation Toxicology Research Institute. Annual Report, October 1,
1981-September 30, 1982
Snipes, M. B.; Marshall, T. C.; Martinez, B. S.
Inhalation Toxicology Research Inst., Albuquerque, NM.
Sponsor: Department of Energy, Washington, DC.
Report No.: LMF-102
Dec 82 589p

45. Atlantic Coast Unique Regional Atmospheric Tracer Experiment (ACURATE)
Schubert, J. F.; Heffter, J. L.; Mead, G. A.
Du Pont de Nemours (E.I.) and Co., Aiken, SC. Savannah River Lab.
Sponsor: Department of Energy, Washington, DC.
Report No.: DP-1651
May 83 16p

46. Background Information Document Proposed Standards for Radionuclides
(Draft rept)
Office of Radiation Programs, Washington, DC.
Report No.: EPA-520/1-83-001
Mar 83 390p

47. Emmissions of Naturally Occuring Radioactivity: Stauffer Elemental
Phosphorus Plant
Andrews, Veron E.
Office of Radiation Programs-Las Vegas Facility, NV.
Report No.: EPA-520/6-82-019
Nov 82 36p

48. Plutonium-Aerosol Emission Rates and Human Pulmonary Deposition
Calculations for Nuclear Site 201, Nevada Test Site
Shinn, J. H.; Homan, D. N.
Lawrence Livermore National Lab., CA.
Sponsor: Department of Energy, Washington, DC.
Report No.: UCRL-53301
21 Jun 82 21p
49. ETADDII: Modeling Long-Range Atmospheric Transport of Radionuclides
Murphy, B. D.
Oak Ridge National Lab., TN.
Sponsor: Department of Energy, Washington, DC.
Report No.: CONF-820609-47
1982 29p
50. Scaled-Up Testing of Alternative Trapping Agents for Radioactive
Constituents in Plant Vent Streams
Saraceno, A. J.; Reiter, N. F.
Goodyear Atomic Corp., Piketon, OH.
Sponsor: Department of Energy, Washington, DC.
Report No.: GAT-T-3115; CONF-820418-3
1982 22p
51. SESAM: A Model for the Calculation of Radiation Exposure by Emission of
Pollutants with the Exhaust Air in the Case of a Multi-Source Situation
Ehrlich, H. G.; Vogt, K. J.; Brunen, E.
Oak Ridge National Lab., TN.
Sponsor: Department of Energy, Washington, DC.
Report No.: ORNL-TR-4794
Aug 80 81p
52. POPFOOD - A Computer Code for Calculating Ingestion Collective Doses from
Continuous Atmospheric Releases
Hotson, J.; Stacey, A.; Nair, S.
Central Electricity Generating Board, Berkeley (England). Berkeley
Nuclear Labs.
Jul 80 47p
53. MILDOS - A Computer Program for Calculating Environmental Radiation Doses
from Uranium Recovery Operations
(Research rept.)
Streng, D. L.; Bander, T. J.
Battelle Pacific Northwest Labs., Richland, WA.
Sponsor: Nuclear Regulatory Commission, Washington, DC. Div. of Waste
Management
Report No.: PNL-3767
Apr 81 179p

54. Investigations of the Emission of Radionuclides from Coal Fired Power Plants. Methods of Analysis and Measured Results for a Hard Coal Power Plant and a Brown Coal Power Plant
Chatterjee, B.; Hoetzl, H.; Rosner, G.; Winkler, R.
Gesellschaft fuer Strahlen- und Umweltforschung m.b.H., Neuherberg bei Munich (Germany, F.R.). Inst. fuer Strahlenschutz.
Feb 80 44p
Languages: German

55. Sources of Ozone and Sulfate in Northeastern United States. Annual Progress Report
Husain, L.
New York State Dept. of Health, Albany.
Sponsor: Health Research, Inc., Albany, NY.; Department of Energy, Washington, DC.
0 Jun 80 225p

56. Air Pathway 3
Hessisches Ministerium fuer Wirtschaft und Technik, Wiesbaden (Germany, F.R.).
Report No.: CONF-770778-
1977 176p
Languages: German Document Type: Conference proceeding

57. LIGA - A Program to Calculate the Local Individual gamma Submersion Dose Due to Waste Air Plumes of Nuclear Facilities
Brenk, H. D.; Rohloff, F.; Brunen, E.; Geiss, H.; Vogt, K. J.
Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Zentralabteilung Strahlenschutz.
Jan 79 77p
Languages: German

58. Air Pathway 3
Hessisches Ministerium fuer Wirtschaft und Technik, Wiesbaden (Germany, F.R.). Report No.: CONF-770778-1977
176p

59. Characterization of Gaseous and Particulate Effluents from the Nuclear Vitrification Project
Goles, R.W.; Hamilton, D. C.; Brauer, F. P.; Rieck, Jr., H. G.; Robertson, D. M.
Battelle Pacific Northwest Labs., Richland, WA.
Sponsor: Department of Energy.
Oct 79 39p

60. Pyrotechnical Production of Labelled Aerosols and Their Use in the Ground Atmosphere
Kuehn, W. K. G.; Alps, W.
Zentralstelle fuer Atomkernenergie-Dokumentation, Eggenstein-Leopoldshafen (Germany, F.R.).
Report No.: CONF-7710173-6
1977 7p
Languages: German Document Type: Conference proceeding

61. Source Category Survey: Uranium Refining Industry (Final rept.)
Stelling III, John H. E.
Radian Corp., Durham, NC.
Sponsor: Environmental Protection Agency, Research Triangle Park, NC.
Office of Air Quality Planning and Standards.
Report No.: EPA-450/3-80-010
May 80 25p

62. Computer Program for Calculating the Radiological Consequences of Shorttime Radioactive Releases from Nuclear Installations
Boeck, H.; Strubegger, M.
Atominstitut der Oesterreichischen Univ., Vienna.
Sep 78 38p
Languages: German

63. Diffusion and Exhalation of Radon from Uranium Tailings
Silker, W. B.; Heasler, P. G.
Battelle Pacific Northwest Labs., Richland, WA.
Sponsor: Nuclear Regulatory Commission, Washington, DC. Office of Nuclear Regulatory Research.; Department of Energy, Washington, DC.
Report No.: PNL-3207
Mar 80 136p

64. Radiological Impact Caused by Emissions of Radionuclides into Air in the United States: Preliminary Report
(Technical rept)
Office of Radiation Programs, Washington, DC.
Report No.: EPA/520/7-79-006
Aug 79 48 1p

65. Physical and Chemical Characterization of Aerosol Emissions from Coal-Fired Power Plants
Ondov, J. M.; Biermann, A. H.
California Univ., Livermore. Lawrence Livermore Lab.
Sponsor. Department of Energy.
Report No.: CONF-790458-3
25 Jun 79 16p

66. Assessment of the Radiological Impact of Coal Utilization. I. Preliminary Studies on Western Coal
 Styron, C. E.; Casella, V. R.; Farmer, B. M.; Hopkins, L. C.; Jenkins, P. H.
 Mound Facility, Miamisburg, OH.
 Sponsor: Department of Energy.
 12 Feb 79 100p

67. Application-Oriented Concept for Calculating Environmental Impacts Through Exhaust Air Emissions from Nuclear Facilities for Sites in the Federal Republic of Germany
 Brenk, H. D.
 Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Zentralabteilung Strahlenschutz.
 Sponsor: Technische Hochschule, Aachen (Germany, F.R.).
 Feb 78 225p
 Languages: German Document Type: Thesis

68. Analysis for Radionuclides in SRC and Coal Combustion Samples (Final rept. Nov 77-Jul 78)
 Koester, Pamela A.; Zieger, Warren H.
 Hittman Associates, Inc., Columbia, MD.
 Sponsor: Industrial Environmental Research Lab., Research Triangle Park, NC.
 Report No.: EPA/600/7-78/185
 Sep 78 33p

69. AREAS: A Computer Code for Estimating Air Pollutant Concentrations from Dispersed Sources
 Moore, R. E.
 Oak Ridge National Lab., Tenn.
 Sponsor: Department of Energy.
 May 78 42p

70. Methodology for Assessing Dose Commitment to Individuals and to the Population from Ingestion of Terrestrial Foods Contaminated by Emissions from a Nuclear Fuel Reprocessing Plant at the Savannah River Plant
 Ng, Y. C.; Phillips, W. A.; Ricker, Y. E.; Tandy, R. K.; Thompson, S. E.
 California Univ., Livermore. Lawrence Livermore Lab.
 Sponsor: Department of Energy.
 15 Mar78 73p

71. Area Source Radiological Emission Analysis Code (AREAC)
 Michlewicz, David
 Office of Radiation Programs, Washington, D.C. Environmental Analysis Div. Report No.: ORP/EAD-76/6
 Oct 76 63p

72. Preliminary Assessment of the Impact of Radionuclides in Western Coal on Health and Environment
Styron, C. E.
Mound Lab., Miamisburg, Ohio.
Sponsor: Department of Energy.
Report No.: CONF-780109-1
1978 6p
73. Interlaboratory Comparison of Neutron Activation and Atomic Absorption Analyses of Size-Classified Stack Fly Ash
Ondov, J. M.; Ragaini, R. C.; Heft, R. E.; Fisher, G. L.;
Silberman, D.
California Univ., Livermore. Lawrence Livermore Lab.
Sponsor: Energy Research and Development Administration.
Report No.: CONF-760985-2
29 Jun 77 14p
74. AIREM Program Manual. A Computer Code for Calculating Doses, Population Doses, and Ground Depositions Due to Atmospheric Emissions of Radionuclides Final rept.)
Martin, Jr., J. A.; Nelson, J. C. B.; Cuny, P. A.
Office of Radiation Programs, Washington, D.C. Field Operations Div.
Report No.: EPA-520/1-74-004
May 74 134p
75. Industrial Wood/Coal Co-Utilization in the Northeast: Technology Assessment and Case Studies. Final Report
White, A. L.
Boston Planning Group, Inc., MA.
Sponsor: Department of Energy, Washington, DC.
Report No.: DOE/OR/21389-T3
Sep 85 41p

APPENDIX B
ALTERNATIVE CONTROL EQUIPMENT

APPENDIX B
ALTERNATIVE CONTROL EQUIPMENT

HIGH-EFFICIENCY PARTICULATE AIR (HEPA) FILTER

Pollutants Controlled:

Particulate matter

Process Description:

By definition, a HEPA filter is a disposable, extended medium, dry-type filter having (1) a minimum particle removal efficiency of greater than 99.97% for 0.3- μ m particles; (2) a maximum resistance when clean of 250 Pa (1 in. water column (WC) when operated at rated air flow capacity; and (3) a rigid casing extending the full depth of the medium. The core of the HEPA is generally made by pleating a continuous web of fiberglass paper back and forth over corrugated separators that add strength to the core and provide air passages between the pleats. The core is then sealed in a wood or steel casing (frame) with an elastomeric sealant. The filter paper itself is composed of very fine (submicron) glass fibers in a matrix of larger (1-4- μ m) fibers and held with an organic binder. Increased particle removal can be attained by using HEPA filters in series.

Current Applications:

Filtration for "cleanroom" environments
Nuclear industry ventilation systems

Design Characteristics/Performance:

Efficiencies of at least 99.97% for 0.3- μ m or smaller particles
Relatively low pressure drop (1 in. WC new, 4 in. WC at replacement)

System Advantages:

Extremely high efficiency	Simple design; no moving parts
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System Disadvantages:

Spent filters become solid waste	Somewhat fragile
Must be kept dry to avoid fouling	

References:

Fluor 1988	EPA 1984
Burchsted 1976	

ALTERNATIVE CONTROL EQUIPMENT

DEEP-BED SAND FILTER

Pollutants Controlled:

Particulate matter

Process Description:

Sand filters are deep beds (several feet thick) of rock, gravel, and sand constructed in layers graded with about 2 to 1 variation in granule size from layer to layer. Gas flow is upward through the bed, with the granules decreasing in size in the direction of flow. A top layer of moderately coarse sand is added to prevent fluidization. Below the sand bed is a course of hollow tiles that serve to distribute the gas evenly throughout the bed. In principle, the larger granules remove most of the large particles and particulate mass, while the layers of finer sands provide high efficiency removal.

Current Applications:

Radiochemical processing facility ventilation systems

Design Characteristics/Performance:

Pressure drop of a 7-layer, 3 in. WC down to 50-mesh filter is 7-11 in. WC
Removal efficiency fabricated to be 99.95% for 0.3- μ m particles

System Advantages:

Low maintenance
Fire resistant
High heat capacity

Can accommodate large fluctuations
in gas flow
Inert to chemical attack

System Disadvantages:

High initial cost
Large space requirement

High pressure drop
Spent sands become solid waste

References:

Burchsted 1976

ALTERNATIVE CONTROL EQUIPMENT

DEEP-BED GLASS-FIBER FILTER

Pollutants Controlled:

Particulate matter

Process Description:

Deep-bed glass-fiber filters are deep (8 to 84 in.) beds of compacted fiberglass insulating wool contained in stainless steel boxes having opaque sides and perforated screens at the top and bottom. Different packing densities are used for each stage of the deep-bed filter (much like the sand filter), with the low-density packing stage at the gas inlet and the high-density packing stage at the exit. Gas flow is in the upward direction. Although various fibers were tested, only one was found to have sufficient curl to resist matting. The other fibers were straight and therefore when packed together caused extremely high pressure drops at even low airflows.

Current Applications:

Radiochemical processing facility ventilation systems

Design Characteristics/Performance:

Pressure drop; 1.5 in. WC, clean filter, 8 in. WC spent filter
Removal efficiency less than deep-bed sand filter (about 99.9% total)

System Advantages:

Predictable physical characteristics Relatively small space requirements
Simple design

System Disadvantages:

Lower particle collection efficiency than sand filter
Relatively high pressure drop
Spent filters become solid waste

References:

Moore and Fullam 1984
Burchsted 1976

ALTERNATIVE CONTROL EQUIPMENT

PREFILTER (ROUGHING FILTER)

Pollutants Controlled:

Particulate matter

Process Description:

Prefilters can be classified as either low (Group I), moderate (Group II), or high (Group III) efficiency filters. Group I panel filters are shallow, tray-like assemblies of coarse fibers or crimped metal mesh enclosed in a steel or cardboard casing. Group II and III filters are extended medium, dry-type units. The medium is pleated or formed as bags to increase surface area. Group II filters are effective in removing 5- μm + particles, while Group III filters can filter even smaller particles. Filter media can be chosen to minimize damage from corrosion.

Current Applications:

Various air filtering systems
Heating and ventilation systems

Design Characteristics/Performance:

Effective in removing large (5- μm) particles
Pressure drop approximately 4 in. WC

System Advantages:

Simple design; no moving parts
Low initial and operating cost
Easily replaced
High dust loading capacity

System Disadvantages:

Spent filters become solid waste
Somewhat high pressure drop

References:

Fluor 1988
Burchsted 1976

ALTERNATIVE CONTROL EQUIPMENT

HIGH-EFFICIENCY MIST ELIMINATOR (HEME)

Pollutants Controlled:

Fine mists, particulate matter, aerosols

Process Description:

The HEMEs are composed of regenerable deep-bed fiber filters configured in an annular shape to remove submicrometer aerosols. Gas flows from the outside to the inside hollow core from which the clean gas exits at the top and the collected liquid exits at the sealed bottom through a drain pipe. Various fibers and other materials of construction can be selected for their resistance to gas constituents. The HEMEs can also be operated wet to allow simultaneous removal of both liquid and solid aerosols. Soluble particles become part of the liquid film and drop to the drain, while the insoluble particles lodge on the fiber and become physically bonded. Continuous or intermittent water spraying of the filter elements has been used to wash down and cleanse accumulated debris, thus extending the service life of the devices. However, water soluble compounds can migrate through the filter and become re-entrained.

Current Applications:

Acid and caustic mist removal

Radiochemical plant service

Design Characteristics/Performance:

100% removal of particles larger than 3 μm

99.5% removal of particles less than 3 μm in size

Pressure drops up to 25 in. WC

System Advantages:

High efficiencies

Simple design; no moving parts

Life can be extended by backwashing filter elements

System Disadvantages:

Solid and liquid wastes produced

Sensitive to process variations
(i.e., upsets)

High pressure drops

Relatively large space requirements

References:

Fluor 1988

Burchsted 1976

Scott et al. 1985

REFERENCES

- Burchsted et al. 1976. *Nuclear Air Cleaning Handbook--Design, Construction, and Testing of High-Efficiency Air Cleaning Systems for Nuclear Application*, C. A. Burchsted, J. E. Kahn, and A. B. Fuller, ERDA-76-21, Oak Ridge National Laboratory, Oak Ridge, Tennessee.
- Moore, E. B. and H. T. Fullam 1984, *Control Technology for Radioactive Emissions to the Atmosphere at U.S. Department of Energy Facilities*, PNL-4621-Final, Battelle Pacific Northwest Laboratory, Richland, Washington.
- Scott et al. 1985, *Technology of Off-Gas Treatment For Liquid-Fed Ceramic Melter*, P. A. Scott, R. W. Gales, and R. D. Peter, PNL-5446, Pacific Northwest Laboratory, Richland, Washington, May 1985.
- EPA 1984, *Radionuclides: Background Information Document for Final Rules*, Vol. 1, EPA/520/1-84/022/1, U.S. Environmental Protection Agency, Office of Radiation Programs, Washington, D.C.
- Fluor 1988, *Melter Off-Gas Design Evaluation, Final Issue*, Fluor Technology Inc., Advanced Technology Division, Irvine California.

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