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Facilities Management

Facility Effluent Monitoring Plan for the 3720 Facility

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Summary

The Materials Science Laboratory (3720 Facility) provides office and laboratory space for Pacific Northwest Laboratory (PNL) scientific and engineering staff conducting multidisciplinary research in the areas of materials characterization and testing and waste management. The facility is designed to accommodate using radioactive and hazardous materials to conduct these activities.

Chemical storage and usage are well dispersed throughout the facility and consist of bulk materials (solvents, acids/bases), specimen materials used in materials characterization (e.g., beryllium alloys), substrate materials used to conduct laboratory experiments (e.g., chelating agents, nitrate, chromium and arsenic salts, inorganic oxides), and standards used for instrument calibration. A number of environmental or fabricated materials (i.e., grouts, coal, asphalts) are used to conduct leaching experiments or materials testing activities. The following summarizes the airborne emissions and liquid effluents, and the results of the Facility Effluent Monitoring Plan (FEMP) determination for the facility. The complete monitoring plan includes sampling effluent streams, monitoring/sampling design criteria, a description of the monitoring systems and sample analysis, and quality assurance requirements.

Airborne Effluents

Potential radioactive airborne emissions in the 3720 Facility have been characterized and all airborne release pathways have been verified. Stack monitors (samplers) were upgraded to meet 40 CFR 61 criteria. The primary stack at the 3720 Building (EP-3720-01-S) is currently registered with the Washington State Department of Health as required by WAC 246-247. Nonradioactive airborne effluents have not been characterized, but characterization efforts are planned and will proceed in the course of compliance with state air toxics regulations and as the Clean Air Act Amendments of 1990 are fully implemented.

Liquid Effluents

The 3720 Facility discharges to two sewer systems: the process sewer (PS) and the sanitary sewer (SNS). Liquid effluent releases in the 3720 Facility are either administratively or physically controlled. Most connections to the process sewer that had the potential to release regulated effluent have been plugged. The remaining drains have been posted with labels stating the type of drain and liquid effluent disposal controls. These are primarily laboratory sink and hood drains. Verification of the PS lines in the facility is planned to begin in 1996 as part of an ongoing program to verify liquid effluent lines in major PNL facilities in the 300 Area.

Liquid effluent lines from the facility enter into the 300 Area liquid effluent system, operated by Westinghouse Hanford Company (WHC). PS and SNS effluent streams are monitored by WHC at end of pipe before being released to the environment.

A program to sample liquid effluents in the 3720 Facility is underway. Liquid effluent monitoring equipment have been installed and include a flow proportional liquid sampler, online pH meter, and conductivity meter. Sampling of the liquid effluents began in 1994.

FEMP Determination

An inventory-based method was used to estimate the maximum potential offsite dose of airborne materials if releases from the building were unmitigated. The projected potential unmitigated dose met criteria ($>$ 0.1 mrem) for preparing a

FEMP. A list of chemicals in the building was also obtained and chemicals in greater than reportable quantity were identified to characterize the potential for emissions of nonradioactive hazardous materials. A method to determine the potential emissions of nonradioactive hazardous materials is being developed.

Glossary

AABC	Associated Air Balance Council
ACV	administrative control values
AED	aerodynamic equivalent diameter
AKART	all known, available, and reasonable technology
AMAD	activity median aerodynamic diameters
ANSI	American National Standards Institute
ASILs	Acceptable Source Impact Levels
BACT	best available control technology
CAA	Clean Air Act
CAM	continuous air monitor
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
DCGs	derived concentration guides
DOE	U.S. Department of Energy
DOE-RL	DOE Field Office, Richland
EC	Environmental Compliance Section of PNL
EPA	U.S. Environmental Protection Agency
ESP	exhaust sample point
FEMP	Facility Effluent Monitoring Plan
FWPCA	Federal Water Pollution Control Act
HEPA	high-efficiency particulate air
HVAC	heating, ventilation, and air conditioning
MASR	Missing Air Sample Report
MDA	minimum detectable activity
MPCs	maximum permissible concentrations
NAAQS	national ambient air quality standards
NESHAPs	National Emission Standards for Hazardous Air Pollutants
NPDES	national pollutant discharge elimination system
OED	offsite emission dose
ONE	off-normal event
PASR	Positive Air Sample Report
PM-10	particulate matter with diameter >10 mm
PNL	Pacific Northwest Laboratory
PS	process sewer
QC	quality control
RAM	radiation area monitor
RCRA	Resource Conservation and Recovery Act
RLWS	radioactive liquid waste system
RQ	reportable quantity

RPS	retention process sewer
RPT	radiation protection technician
SNM	special nuclear material
SNS	sanitary sewer
TAPs	toxic air pollutants
WAC	Washington Administrative Code
WCAA	Washington State Clean Air Act
WDOE	Washington State Department of Ecology
WDOH	Washington Department of Health
WHC	Westinghouse Hanford Company
WM	Waste Management

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1.0 Introduction

It is the policy of the U.S. Department of Energy (DOE) and the Pacific Northwest Laboratory (PNL) to conduct effluent monitoring to determine if the public and environment are adequately protected during DOE operations, and whether operations are in compliance with DOE and other applicable federal, state, and local radiation standards and requirements. It is also DOE and DOE-contractor policy that effluent monitoring programs meet high standards of quality and credibility.

1.1 Purpose

DOE Order 5400.1, "General Environmental Protection Programs," states the objective for environmental monitoring programs as to "demonstrate compliance with legal and regulatory requirements imposed by applicable federal, state, and local agencies; confirm adherence to DOE environmental protection policies; and support environmental management decisions" (DOE Order 5400.1, IV-1). Plans must be prepared for each site, facility, or process that uses "significant pollutants or hazardous materials" (DOE Order 5400.1, IV-2). These requirements are being met through the environmental monitoring program conducted for the Hanford Site and are described in the Hanford Site Environmental Monitoring Plan (EMP).

The EMP identifies and discusses two major activities, as specified by DOE Order 5400.1: (a) effluent monitoring, and (b) environmental surveillance. Because the Hanford Site contains a number of facilities with effluent monitoring needs, individual effluent monitoring plans are prepared for those facilities to support the discussion of effluent monitoring in the EMP. This report supplies information on effluent monitoring in the 3720 Building.

1.2 Background

A Facility Effluent Monitoring Plan (FEMP) was determined to be needed for the 3720 Facility because of the quantity of radionuclides in the building. The FEMP includes action plans and schedules that will be completed in the near term (FY 1995). This includes updating and verifying the effluent lines, sampling liquid effluent streams, and characterizing nonradioactive air emissions.

1.3 Discussion

Characterizing the radioactive and nonradioactive constituents present in inventory and in waste streams provides the underlying rationale for sampling and monitoring programs. Compliance assessments of the existing radioactive air monitoring equipment are included in this FEMP. Compliance sampling for liquid streams is conducted by Westinghouse Hanford Company (WHC).

A major activity of the FEMP effort is to verify all the liquid and air release pathways (i.e., verify all access points to the various sewers and all radioactive emission release pathways under normal operations and during process upset conditions). This plan also identifies effluent monitoring deficiencies and action plans for installing additional effluent monitoring equipment so that characterization can be completed.

The method of characterization discussed in this plan identifies potential pollutants at the point of generation, and potential upset conditions that are likely to occur, and evaluates the potential for those materials to enter an effluent stream.

2.0 Facility Mission and Description

2.1 Facility Mission

The Materials Science Laboratory (3720 Facility) provides office and laboratory space for PNL scientific and engineering staff conducting multidisciplinary research in the areas of materials characterization and testing and waste management. The facility is designed to accommodate using radioactive and hazardous materials to conduct these activities. The facility is occupied by staff from the Earth and Environmental Sciences Center and the Materials and Chemical Sciences Center. Funding sponsors include Energy Research, other federal agencies, and Hanford contractor support. The primary DOE sponsors supporting work in the facility include DOE/ER (Basic Energy Sciences) and DOE Field Office, Richland (DOE-RL) through Hanford's operations contractor (WHC). Other sponsors include the Electric Power Research Institute and the Power Reactor and Nuclear Fuel Development Corporation (Japan).

2.2 Geographical Location and Physical Description

The 3720 Facility was built in 1959 and is located in the northern most region of the 300 Area bounded on the north by the 300 Area fence. The facility is adjacent to the 333 Building on the east, the 3712 Building on the south, and 313 Building on the west (Figure 2.1).

The facility (24,412 ft^2) is an all-metal frame construction erected on concrete foundations, footings, and floor slab. The building includes 31 offices (4,188 ft^2), 27 laboratories (9,302 ft^2), 352 ft^2 of shop space, 369 and 308 ft^2 of work and storage space, respectively, and 9,893 ft^2 of common space. The facility also contains a 24 ft x 109 ft basement area at the southwest corner. The area above the basement (approximately 2,943 ft^2) has a limited capacity for heavy floor loading. The roof is of the medium-sloped gable type with insulated, built-up roofing, tar, and gravel placed on a corrugated sheet metal base.

A one-story concrete block annex (48 ft 2 in. x 40 ft 2 in.) was added to the north end of the building in 1980, with provisions made within the structural design to allow a second floor to be added at some future time. This addition is, essentially, independent of the rest of the building except for electrical service and air conditioning supply. The annex has its own ventilation exhaust system. An existing concrete slab at the south end of the building could be used as an area for additional building expansion. The basic floor plan of the facility, along with relevant functional systems and regions, is depicted in Figure 2.2.

The facility is completely air conditioned and fully protected from fire by a wet-pipe sprinkler system. Air conditioning units are located on the southeast side and the north end of the facility. Air conditioning chillers are located in the facility basement (Room 20). Building emergencies are covered by systems that consist of fire, evacuation, and crash alarms. All laboratory hoods are double high-efficiency particulate air (HEPA) filtered to minimize atmospheric emissions released through three exhaust stacks. The facility is conveniently divided into three ventilation regions. The main laboratory building is divided into a north and a south region, each served by an exhaust stack. The third region, the annex labs, also has an exhaust stack. The main electrical service to the facility is supplied by a 750-kVA transformer located exterior to the building. Service voltage in the building is 480/277 V, whereas distribution voltage via dry transformers is 120/240 V. Emergency power is provided for lights and alarms

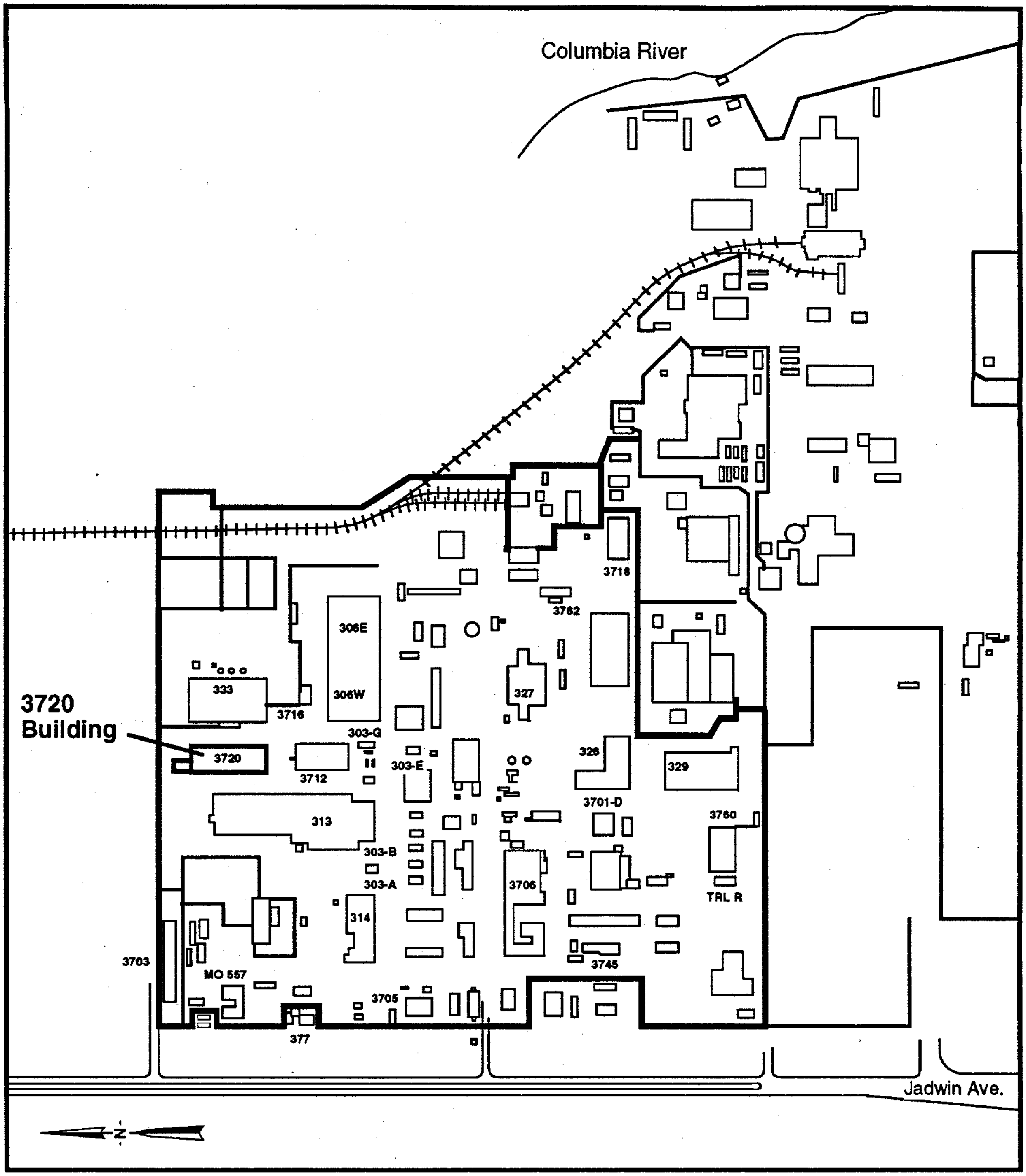

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Figure 2.1. Geographical Location of the 3720 Facility

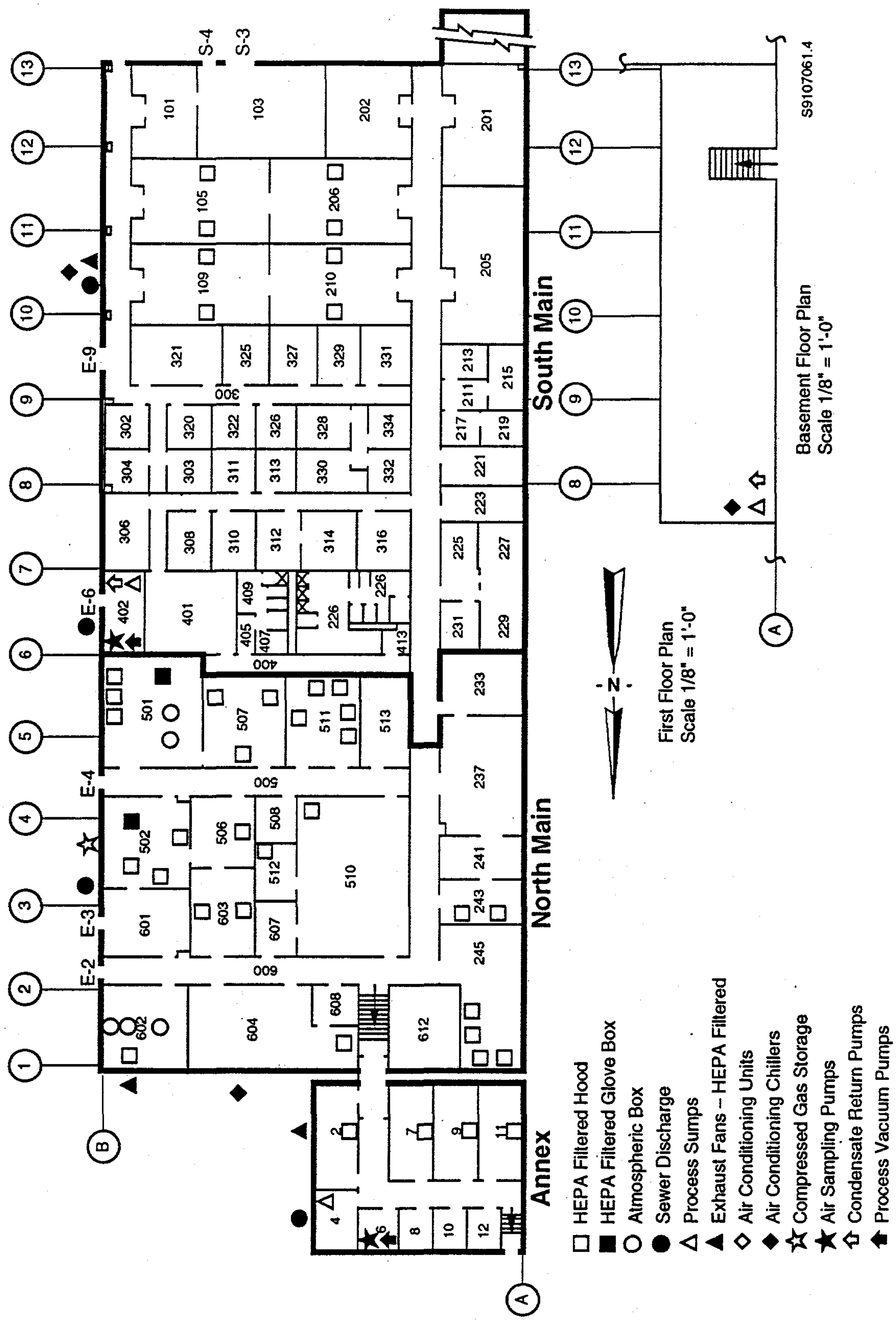


Figure 2.2. 3720 Facility Basic Floor Plan and Systems

(battery power) and two of the exhaust stacks. Emergency power to the exhaust fans is provided from a WHC diesel generator located in the 300 Area. Other standard safety features incorporated into the facility include fire extinguishers, safety showers, eye wash units, spill control kits, and gloveboxes.

Radiation monitoring is done by using hand and foot counters, radiation area monitors (RAMs), continuous air monitors (CAMs), and portable instrumentation. Approximately 10% of the building is estimated to be controlled as a radiological area. Stack effluent monitoring consists of a biweekly collection of filters that are analyzed for alpha and beta radioactivity. Liquid waste systems consist of sanitary and process sewers. Effluents from facility sinks empty into process sumps located in Rooms 6, 402, and 20, and are released from the facility at three discharge sewer locations into the main process sewer line located parallel to the east side of the building. Aqueous effluent sampling efforts started in 1994 and are summarized in Riley et al. 1994.

2.3 Brief Process Description

The primary facility processes that generate solid, liquid, and gaseous effluents are associated with conducting basic and applied research for supporting sponsors. Research performed by staff located in this facility include

- delineating the fundamental processes and mechanisms that influence the behavior of metals and radionuclides of environmental concern in the subsurface environment
- evaluating waste form stability and the ability of various materials (e.g., grout, glasses, cements) to immobilize contaminants of concern
- preparing and testing/analyzing materials/sample.

Processes associated with facility operation were also examined as potential contaminant releases. Processes within the 3720 Facility that could potentially result in such discharges include 1) stored chemicals or radionuclides and their usage; 2) experimental material usage; 3) liquid waste accumulation and storage; 4) programmatic sample storage; 5) research implementation (e.g., use of glove and atmospheric boxes); and 6) facility operation. In the facility operation area, process evaluation was targeted at the air conditioning system, HEPA filter system, compressed gas storage, and pump systems for condensate return, vacuum and air sampling.

2.4 Source Term Definition and Description

For the purposes of this section, a source term is a description of the nature and location of potential releases of radioactive and/or chemical materials within a building to the atmosphere or the process sewers due to process activities.

2.4.1 Source Terms Associated with Research Activities

Appendix A summarizes the nature and location of radionuclides associated with conducting research in the 3720 Facility that could contribute to releasing pollutants to the process sewers or the atmosphere.

Liquid effluent release pathways in the 3720 Facility are either administratively or physically controlled. All known process sewer discharge points have been traced back to the source and evaluated. Most connections to the process sewer that have the potential to release regulated effluent have been plugged. The remaining drains have been posted with labels stating the type of drain and liquid effluent disposal controls. These are primarily laboratory sink and hood drains. Selective floor drains in facility service tunnels that must remain open in case of main service line leaks or ruptures are also posted.

Source terms involving radionuclides are, for the most part (Lab 202 is the exception), contained within the north portion of the main region of the facility (Labs 245, 501, 507, 506, 603) and involve the use in experimental studies of tracer quantities of radionuclides or environmental samples containing low levels of radionuclides. Glove and atmospheric boxes are selectively used to conduct experiments involving radioactive materials, as well as for storing radioactive materials with limited stability. Fume hoods may be used in a similar fashion. The facility contains a Materials Balance Area (in Lab 501) for storage of Category 3 special nuclear materials [(SNM) isotopes of americium, neptunium, plutonium, and uranium] and a laboratory for specialized counting of radioactive samples (Lab 202). Radioactive liquid and solid wastes are accumulated in satellite storage areas and active inventories maintained. Wastes are disposed of as radioactive or mixed waste according to PNL-MA-8 guidelines.

Individual radionuclides within each of the three ventilation regions were categorized according to quantity, form, volatility, and usage, and these data were used in a model to project an offsite emission dose for the purpose of comparing to criteria established by the DOE and Environmental Protection Agency (EPA) for continuous emission sampling. This determination, summarized in Appendix A, resulted in the conclusion that only the north part of the main lab meets DOE and EPA criteria for continuous emission sampling. This region is exhausted via facility stack EP-3720-01-S.

Chemical storage and usage are well dispersed throughout the facility and consist of bulk materials (solvents, acids/bases), specimen materials used in materials characterization (e.g., beryllium alloys), substrate materials used to conduct laboratory experiments (e.g., chelating agents, nitrate, chromium and arsenic salts, inorganic oxides), and standards used for instrument calibration. A number of environmental or fabricated materials (e.g., grouts, coal, asphalts) are used to conduct leaching experiments or materials testing activities. Lab 101 is currently used for temporarily storing groundwater samples collected from the approximately 700 active wells located on the Hanford Site that support the site's Resource Conservation and Recovery Act (RCRA) program. Radiation protection monitors screen these samples for radioactivity before storage.

Many of the labs contain satellite accumulation areas for liquid and solid hazardous wastes. In most cases, liquid wastes are accumulated in carboys, and an active inventory of carboy contents is maintained. Liquid and solid wastes are disposed according to guidelines described in PNL-MA-8.

Volatile/particulate species (e.g., beryllium) are trapped on HEPA filters. In such cases, the HEPA filtering system serves as a secondary source term.

2.4.2 Source Terms Associated with Facilities Operations

Figure 2.3 describes the nature and location of facility systems. Processes examined included air conditioning; compressed gas storage; pump systems for

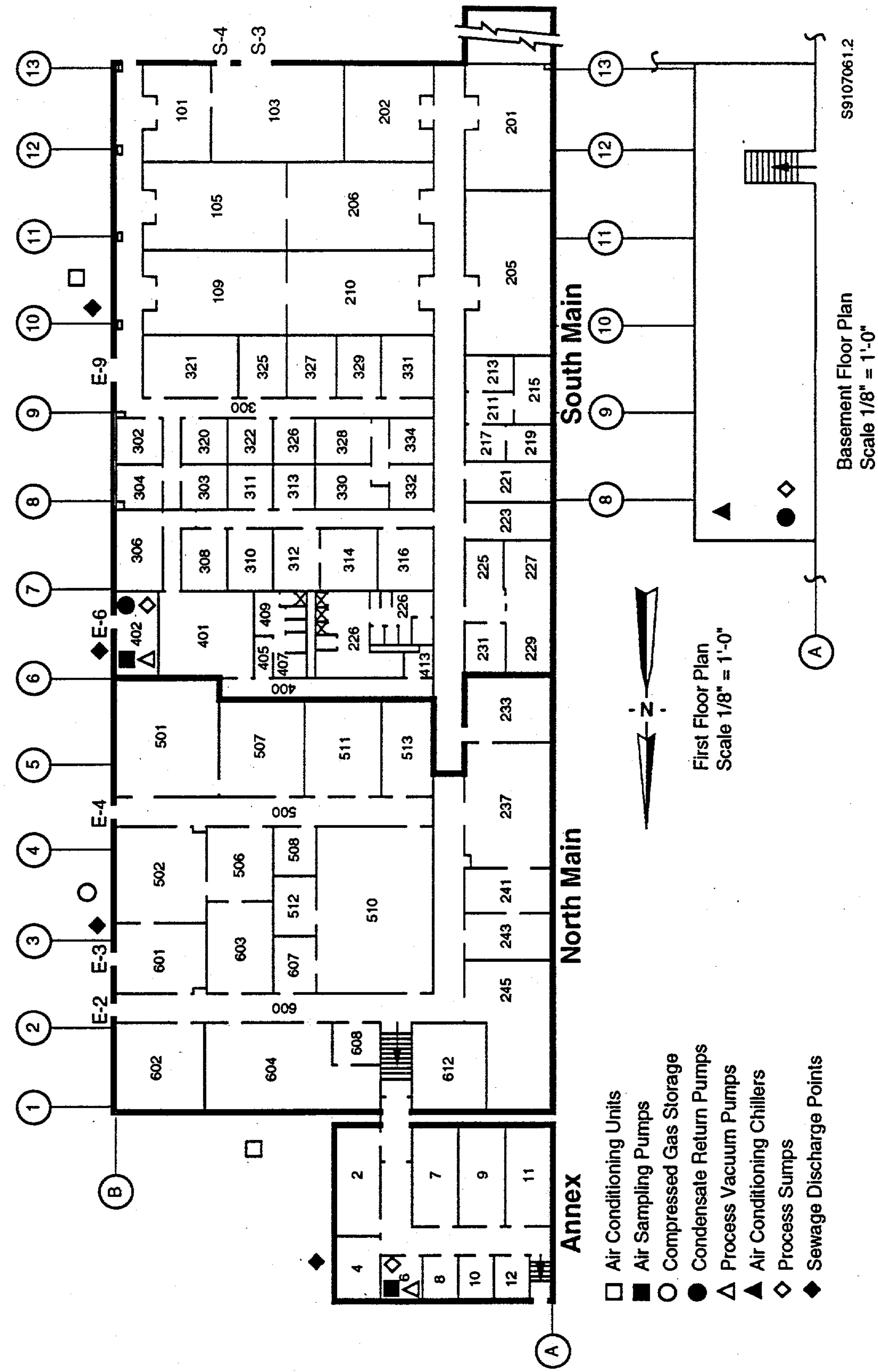


Figure 2.3. Processes Associated with Facility Operation

condensate return, vacuum and air sampling; and process sumps. Processes associated with facility operations do not appear to be major contributors to contaminant point sources.

Air conditioning units are located on the north end and east side of the facility. Air conditioning chillers (#1 and #3) are located in the basement mechanical room. These systems are checked yearly as part of spring maintenance, which includes the recycling and recharging of refrigerant (freon). Freon is obtained from the 331 Building, when needed, and is not kept in storage at the 3720 Facility.

Compressed gases are stored on the northeast side of the facility and consist of common benign (from a chemical standpoint) laboratory gases. Gases are also plumbed into the facility at this location providing in-house sources.

A number of pumps are located in the facility and are used for air sampling, providing house vacuum, and pumping of fluid (steam condensate return). Air sampling and process vacuum pumps are located in Room 6 and the east equipment room (Room 402). Condensate return pumps are located in Room 402 and the basement equipment room (Room 20). All the pumps are on a maintenance program that includes routine oil changes. Oils used in the maintenance program are nonregulated (oils are analyzed for regulated constituents before disposal).

Process streams from the 3720 Building enter the process sewer (PS). The PS stream from the building discharges into the 300 Area PS system, operated by WHC. Figure 2.4 is a diagram of this system.

2.5 References

Riley, R. G., M. Y. Ballinger, E. G. Damberg, S. C. Evans, A. S. Ikenberry, K. B. Olsen, R. M. Ozanich, C. J. Thompson, and K. L. Manke. 1994. *Characterization and Monitoring of 300 Area Facility Liquid Waste Streams Status Report*. PNL-10147, Pacific Northwest Laboratory, Richland, Washington.

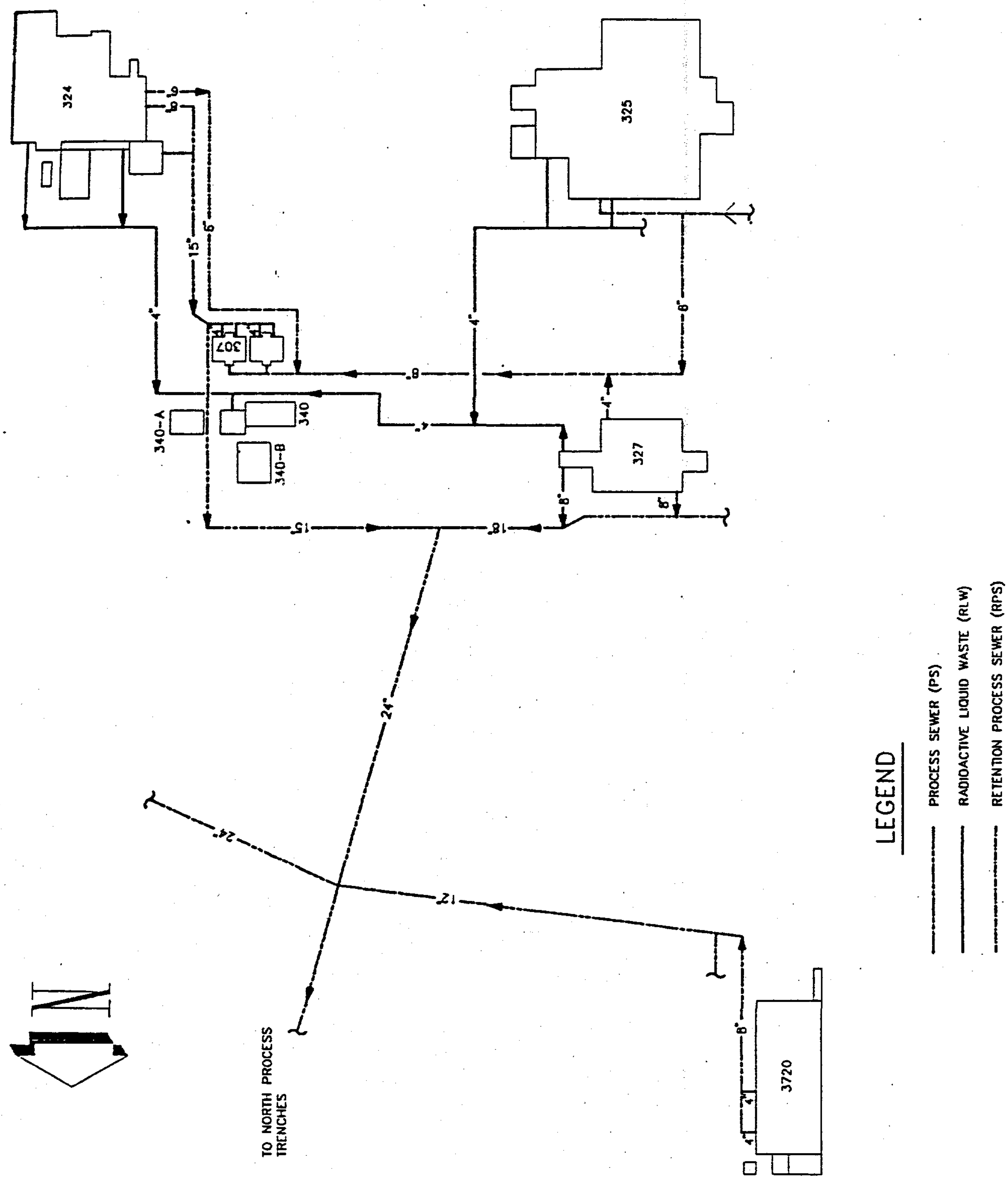


Figure 2.4. Schematic of PS, RPS, and RLWS

3.0 Applicable Regulations

3.1 Introduction

Among the primary concerns of PNL management and staff are complying with federal, state, and local regulations; DOE Orders; and protecting the environment and public health. PNL's FEMPs support overall compliance and are intended to ensure liquid effluents and air emissions produced by the Laboratory conform to all applicable standards. This chapter provides a brief description of those standards. This material is intended to help staff gain fuller understanding of those regulations that drive environmental compliance and better appreciate the significance of noncompliance. Instances of noncompliance could result in violations of the law and imposition of fines or penalties on the Laboratory and/or individual staff members, and possible criminal action against the Laboratory and/or individual staff members for willful neglect.

3.2 Environmental Regulations

This section identifies the major environmental laws (federal and state) that guide PNL in implementing environmental protection policies with respect to air emissions and liquid effluents.

Most major federal environmental laws contain specific language defining their applicability to federal facilities, and specifying the requirements for federal facilities to comply with certain state and local pollution-control regulations. Both federal and state laws are passed by act, statute, or executive order. Regulations are then prepared by an authorized agency, federal regulations are documented in the Code of Federal Regulations (CFR), and state regulations are documented in the Washington Administrative Code (WAC). In addition, policy and "guidance" documents are written, many of which must be strictly followed. A regulatory program is, therefore, composed of the act, CFR or WAC, and written guidance. Federal regulations are often incorporated, directly by reference, into programs, or states implement their own, often more stringent, regulations. DOE Orders often use federal regulations as bases, or may reference those regulations for compliance.

3.2.1 Federal Clean Air Act

The Clean Air Act (CAA) of 1970, and its 1977 amendments, established national ambient air quality standards and mechanisms for attaining and maintaining those standards. It also established standards and mechanisms for preserving air quality in areas already cleaner than the standards. The original CAA consisted of three titles. The Clean Air Act Amendments (CAAA) of 1990 greatly expanded the scope of the act, consisting of eleven titles. Some of the titles amend the three earlier titles; others are new. Regulations implementing the amendments have been, and will continue to be, promulgated for several years.

Regulations implementing the amended act that are applicable to current PNL operations and that require emission monitoring include 40 CFR 61, "National Emissions Standards for Hazardous Air Pollutants," Subpart H, "National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities." The requirements of this regulation are discussed below. The Washington State Department of Health (WDOH) has applied to the U.S. Environmental Protection Agency (EPA) for delegation of authority and is implementing this regulation.

Regulations being promulgated to implement Title III-Hazardous Air Pollutants, and Title V-Permits, may also apply to PNL operations and require emission monitoring. Title III lists 189 hazardous air pollutants for which emissions are to be controlled by maximum achievable control technology (MACT) for major sources. The EPA is to develop MACT standards for a list of source categories according to a schedule. The source categories have already been established and PNL operations are unlikely to fall into any category. Title III lists research laboratories as a source category for which standards are to be established, but no schedule for action has been published. Title V requires an operating permit program to ensure compliance with the CAA and to enhance enforcement. A permit is required for major sources, and thus, one will be submitted for Hanford, including the PNL facilities on the Site. The permit will be issued by the Washington State Department of Ecology (Ecology), once its program is approved by EPA, and will incorporate all federal, state, and local regulations. The permit must include sufficient monitoring (measurements or record keeping) to ensure compliance with applicable regulations and permit conditions. The impact of this requirement on emission monitoring will be determined by the final permit conditions. The permit application will be submitted in May 1995, and Ecology will have up to 18 months to approve, or disapprove, the application.

3.2.2 NESHAPs

Under the original CAA, the EPA established emissions standards, monitoring and testing requirements, and reporting tasks for the sources of eight pollutants considered to be carcinogenic or mutagenic hazards. The substances covered by these standards, known as National Emissions Standards for Hazardous Air Pollutants (NESHAPs), are arsenic (inorganic), asbestos, beryllium, mercury, vinyl chloride, benzene, Radon-222, and radionuclides. As these standards apply only to specifically named sources, only those standards regulating radionuclides apply to PNL operations.

Under Subpart H of 40 CFR 61, "NESHAPs for Hazardous Air Pollutants for Radionuclide Emissions," the EPA has established emission standards, monitoring and testing requirements, and reporting tasks for sources known to emit radionuclides. As of October 1994, WDOH is awaiting delegation of authority from EPA to regulate emissions within the state of Washington.

3.2.3 The Washington State Clean Air Act (WCAA)

The WCAA empowers Ecology to develop, implement, and enforce state air regulations. State air regulations are contained in the Washington Administrative Code (WAC-173-400 series). WAC 173-400, "General Regulations for Air Pollution Sources," would impose monitoring and control requirements for new or modified sources. Also, WAC 173-460, "Controls for New Sources of Toxic Air Pollutants," is applicable to NESHAP-regulated emission counts and could also require the application of T-BACT for new or modified sources of air toxics. WAC 173-401, "Operating Permit Regulation," when approved by the EPA as implementing CAA Title V, may result in monitoring requirements as a permit condition, as discussed above. A related state regulation, WAC 246-247, "Regulation of Radioactive Air Emissions," requires monitoring radioactive emissions, incorporating the requirements of 40 CFR 61, Subpart H.

3.2.4 Clean Water Act

Section 313 of the Clean Water Act (PL 92-500, 33 USC 1251, *et seq.*) requires federal facilities to obtain a national pollutant discharge elimination system (NPDES) permit to ensure that all appropriate discharges into "navigable waters" are within applicable water quality standards and technology-based requirements (see Section 3.2.6). Currently, the Laboratory operates under two site-wide NPDES permits for its five outfalls in the 300 Area and one outfall in the 100 Area.

The 3720 Building releases liquid effluent to 300 Area sewer and waste systems, operated by WHC. None of these systems are currently under an NPDES permit. However, future plans for the PS include treatment and discharge to the Columbia River for which an NPDES permit will be required.

3.2.5 WAC 173-220, "National Pollution Discharge Elimination System Permit Program"

WAC 173-220 implements authority delegated from the EPA to Ecology to issue NPDES permits under the Federal Water Pollution Control Act (FWPCA) amendments of 1972. Permits under this program are required for directly discharging pollutants, or other wastes or substances, from a point source into any navigable water of the state. The term "point source" includes any discrete conveyance, such as a ditch, pipe, well, container, or vessel from which pollutants may be discharged. "Pollutant" is defined broadly to include everything from sand to chemical, biological, and radioactive materials, as well as industrial, municipal, and agricultural waste. "Navigable waters" is defined very broadly to include all surface waters of the state. The term is not limited to waters that are, in fact, navigable. "Navigable waters" does not, however, include groundwater.

Permits under this program include effluent limitations, schedules of compliance, monitoring requirements, reporting requirements (including a requirement to report any new or increased discharge of pollutants), and any conditions necessary to prevent or control pollutant discharges. Effluent limitations may be based on federal technology-based standards or on "any more stringent limitation" imposed by state law, including applicable water quality standards or methods necessary to provide all known, available, and reasonable technologies (AKART) that exceed the requirements of federal law. Section 510 of the FWPCA reserves the state's the ability to promulgate additional effluent or treatment standards, so long as they are at least as stringent as the federal standards.

As stated in the previous section, future plans for the process streams from the 3720 Building and other 300 Area facilities include treatment and discharge to the Columbia River, thus an NPDES permit will be required for these discharges.

3.3 DOE Orders

A number of DOE Orders establish the framework for environmental safety and health, and environmental compliance by DOE and its contractor operations. These orders are, essentially, policy statements internal to DOE by which it commits operating contractors, such as PNL, to full compliance with all applicable federal, state, and local environmental standards. DOE Orders are essential components of PNL's environmental compliance program. The following are brief descriptions of major DOE Orders driving overall environmental compliance, including the development of FEMPs.

3.3.1 DOE 5400.1, "General Environmental Protection Program"

This order establishes environmental protection program requirements, authorities, and responsibilities for DOE operations to ensure compliance with all applicable federal, state, and local environmental protection laws and regulations, executive orders, and internal DOE policies. This order enumerates DOE's overall policy commitment to environmental compliance, as well as more specific commitments to a number of substantive objectives, including notification and reports for effluent releases, environmental protection program plans, and environmental monitoring requirements.

The development of FEMPs is driven by Chapter IV of this order, "Environmental Monitoring Requirements," which states:

> "A written environmental monitoring plan shall be prepared for each site, facility, or process that uses, generates, releases, or manages significant pollutants or hazardous materials."

3.3.2 DOE 5400.5, "Radiation Protection of the Public and the Environment"

This DOE Order establishes standards and requirements for DOE and DOE contractor operations with respect to protecting the public and the environment against undue risk from radiation. Airborne emissions are limited to the extent required by the CAA and its amendments. Accordingly, exposing members of the public to radioactive materials released to the atmosphere as a consequence of routine DOE activities shall not cause members of the public to receive, in a year, an effective dose equivalent (EDE) greater than 10 mrem (0.1 mSv).

DOE makes further provision for emissions and exposure to Radon-220, Radon-222, their respective decay products. These guidelines extend beyond federal guidelines in 40 CFR 61 and state guidelines in WAC 173-480 that explicitly exclude doses caused by these radionuclides.

3.3.3 DOE EH-0173T, *Environmental Regulatory Guide for Radiological Monitoring and Environmental Surveillance*

This document is significant because it provides guidance for DOE Orders concerning environmental safety and health, and sets conditions for radiological emissions. DOE mandates that all airborne emissions be monitored and evaluated, and the potential for releasing radionuclides be assessed. Furthermore, any airborne emissions that have the potential for causing doses exceeding 0.1 mrem EDE from emissions in a year shall be monitored in accordance with requirements set forth in DOE 5400.1 and 5400.5.

3.4 PNL-MA-8, *Waste Management and Environmental Compliance*

This document is an internal PNL guide to regulatory compliance. It is intended to supplement, not replace, compliance with applicable regulations and DOE Orders. PNL-MA-8 sets forth procedures and requirements that must be met for air and liquid discharges in the 300 Area.

4.0 Effluent Stream Characterization

During normal operations, the effluent streams from the 3720 Facility can contain materials released from a variety of research and development activities. Shutdown operations produce a small subset of the normal operating releases. In addition, upset conditions must be considered. An upset could result in either an unusual release that follows a normal effluent pathway, or a normal release that follows an unusual pathway.

This section identifies those effluent streams that require sampling and/or monitoring and the nature of the contaminants to be monitored. The need to monitor is determined based on the facility inventory available for release under the conditions cited above, the pathways available for discharging materials, and regulatory requirements. These have already been discussed in Sections 2.0 and 3.0.

4.1 Identification of Effluent Pathways

The 3720 Facility produces both liquid and gaseous effluent streams, all of which are generated in the building, rather than being pass-throughs from other facilities. The effluent streams during normal and shutdown operations include two sewers and three ventilation stacks.

4.1.1 Gaseous and Aerosol Effluent Pathways

Figures 4.1 and 4.2 provide a simplified summary of the 3720 Facility exhaust system. Greater detail can be found in the schematics in Appendix D. These drawings were prepared and field verified in the summer of 1991, and reverified in 1993. They have been identified as critical building drawings. Any facility modification that changes building flow paths 1) must receive prior concurrence of the building manager (per PNL-MA-8), and 2) requires updating of the appropriate drawing before project close-out.

The entire 3720 Facility is in one ventilation zone, within which air balance keeps flow moving from less to greater areas of potential contamination and from the atmosphere into the building. Some confinement is also provided by conducting radiological operations in HEPA-filtered hoods, gloveboxes, atmospheric boxes, and canopies. No process off-gas systems exist. All potentially contaminated air flow passes through at least two stages of HEPA filtration before discharging to atmosphere through one of the monitored and sampled stacks.

Supply

Most of the air supplied to the laboratories in the main building comes from the main supply fan (SF-1) with no standby. The offices in the north part of the main building receive supply air from fans SF-2 and -3, and some labs have air recirculation units (AHU-1, -2, and -3). The offices, conference rooms, the lunch room, the change room, and restrooms in the "clean," central part of the building use partially or wholly recirculated air supplied by SF-1 and recirculated by AHU-4 and -5. In the south end of the building, SF-1 provides air directly to the offices and laboratories. The rooms in the northern annex have their own air supply fan, which uses 100% outside air.

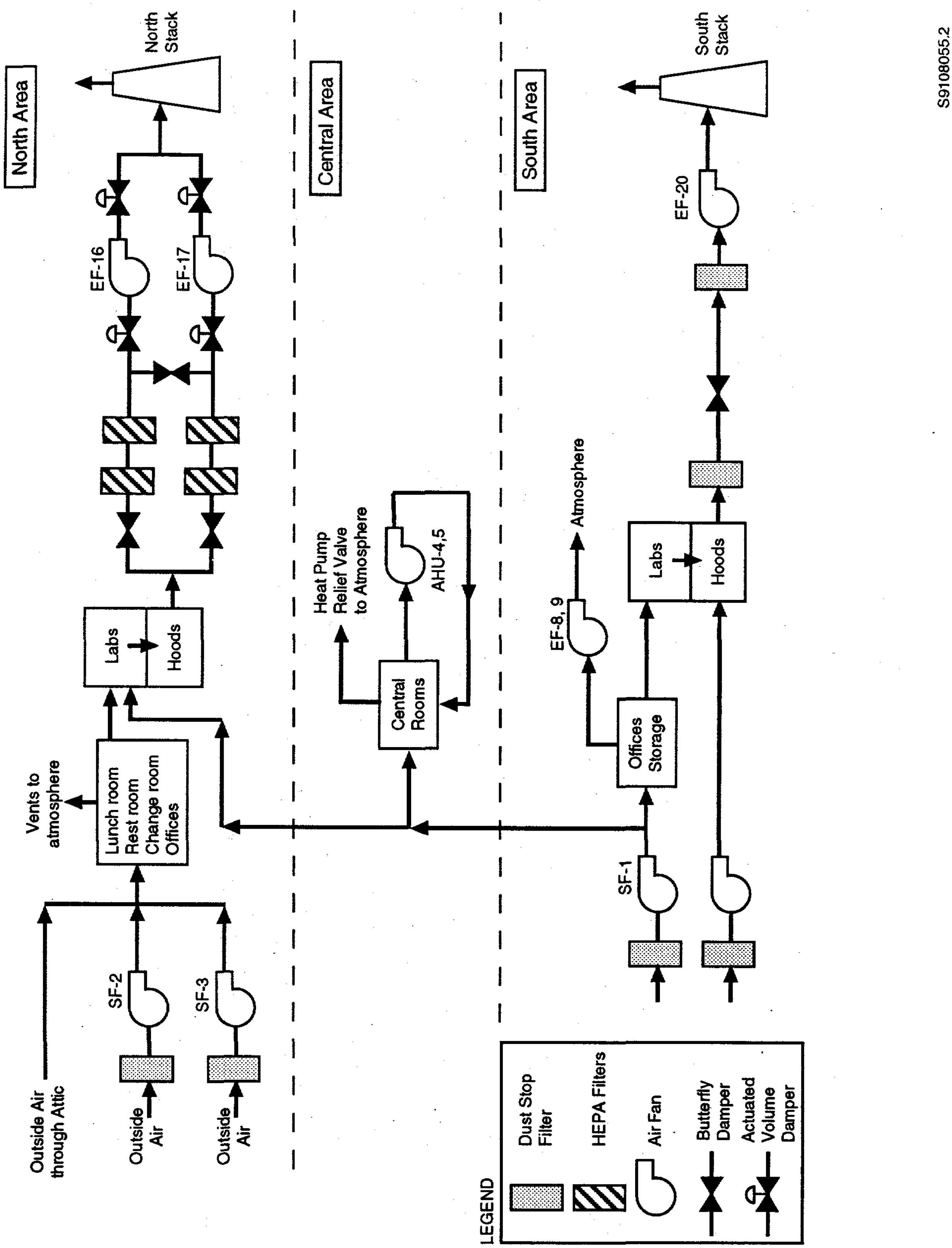


Figure 4.1. Schematic of the Ventilation System for the Main 3720 Facility

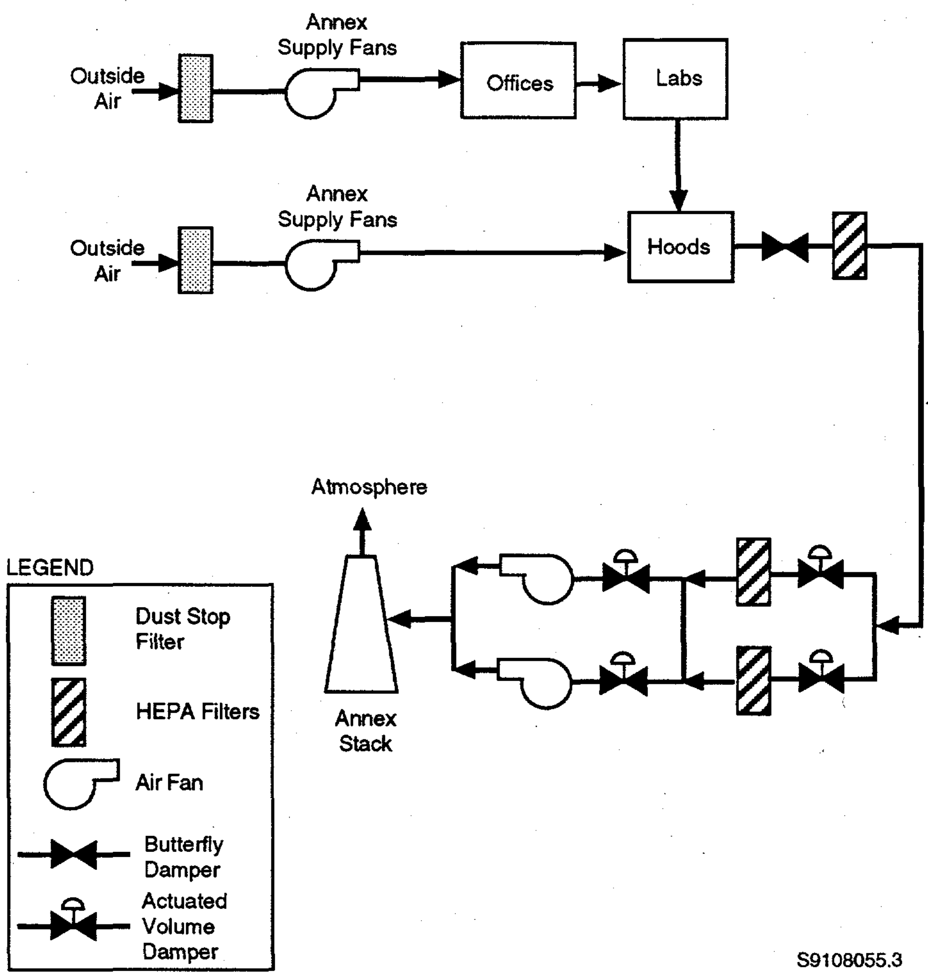


Figure 4.2. Schematic of the Ventilation System for the Northern Annex to the 3720 Facility

All of the hoods, gloveboxes, and atmospheric boxes in the north part of the main building are supplied with air by the rooms containing them. By contrast, the hoods in the south part of the main building and those in the northern annex each have their own air supply fan, with no standby fan.

Exhaust

During normal operation, the exhaust systems provide the only effluent path followed by in-building releases. Figures 4.1 and 4.2 show the exhaust systems in the north, central, south, and annex parts of the 3720 Facility. The potentially contaminated areas in the building are exhausted through at least two stages of HEPA filters. Each of these hot exhaust systems has its own filters and stack. Some individual rooms also have their own roof-mounted exhaust fans.

In the northern part of the main building, the two stages of HEPA filtration are located in a filter addition and are downstream of a final exhaust plenum that goes to the northern stack. Two parallel exhaust lines and fans exist. The air sampling vacuum pump and a few work stations have a third individual stage of HEPA filtration before exhausting to the northern final plenum. The relatively negative pressure in the northern part of the main building prevents flow into the clean center section of the building.

The clean central part of the building, the equipment room, and the process vacuum system either exhaust through fans or vent to atmosphere with no HEPA filtration. The restrooms and kitchen have fans that exhaust the rooms to atmosphere.

In the southern part of the building, rooms exhaust through single stages of HEPA filtration (one filter per room) to the southern final exhaust plenum and stack. The southern final plenum is exhausted by one fan (EF-20) with no standby and contains one more stage of HEPA filters (with no bypass). Two rooms exhaust directly to atmosphere through roof fans, with no HEPA filtration.

The laboratories in the northern annex have one stage of HEPA filtration each. The annex exhaust then goes to a common final exhaust plenum with two lines each containing a fan and single stage of HEPA filters, for a total of two stages of HEPA filtration.

Emergency electrical power is supplied to one of the exhaust fans for the north end of the main building (EF-16 or -17) to maintain minimum flow through hoods. The other fans in the main building and annex are on normal power. Failure of either of the north main building exhaust fans (EF-16 and -17) is detected by flow sensors and causes shut down of all the main building (but not annex) supply fans. Exhaust fan EF-20, in the south part of the building, and the recirculation fans in the central part of the building are not shut down. This interlock is intended to prevent pressurization of the north part of the main building. No interlock is believed to exist to shut down the building fans in the event of a failure of the southern exhaust fan, EF-20.

Vents

Most of the air vents in the 3720 Facility can be considered to be part of the ventilation exhaust system, and as such have already been discussed. The remaining vents are not part of ventilation. These include the equipment room vent, the attic air intakes, the sewer system vents, and other pathways that can be produced by potential air balance problems.

The equipment room vents directly to atmosphere, and contains the building vacuum pumps and other equipment. The attic air intakes provide part of the airflow into the northern part of the main building and have backdraft dampers.

The process and sanitary sewer systems vent to atmosphere. The sewer vents are unfiltered but sealed off from building atmosphere by liquid loop seals. An upset might cause a release to room air, a small part of which could then be entrained into the process sewer (PS) by concurrent liquid flow into the drain. In addition, small amounts of aerosol might be resuspended or vapor evaporated from the liquid contents of a PS line contaminated by an upset. However, these hypothetical drain paths are regarded as being implausible pathways for any significant release of regulated material.

Normal building leak paths may also act as vents. At average wind speeds, the normal air balance and pressure gradient ensure that all flow goes out the final exhaust plenum and stack, even if doors or the truck lock or smaller leak paths are open. The pressure of the northern part of the main building is the most negative; it is maintained at about 0.05 in. water negative (or 13 Pa negative) with respect to the atmospheric pressure measured on the roof. This same range of lower-than-roof pressure may be found on the sides of a flat-roofed building at wind speeds of 15 mph or greater. Thus, flow might leave the building through normal leak paths on the sides of the building that are parallel to a high wind. Such hypothetical situations may occur during normal operations, but could only produce releases if an upset source term had escaped its local containment (e.g., hot cell). Only a small part of the air flow in the building could escape in this manner.

4.1.2 Liquid Effluent Pathways

Two liquid waste systems serve the 3720 Facility: the sanitary sewer (SNS) and PS systems. The PS liquid effluents are sampled. The following sections describe the liquid effluent paths in the 3720 Facility.

Sanitary Sewer

The SNS serves only the lunchroom, water fountains, toilets, and other water uses in which no radioactive contamination is believed to be possible. Under normal operating conditions, no regulated materials are present in the SNS effluent. No connections exist between the SNS and the PS.

Process Sewer

The PS drains the laboratory sinks; heating, ventilation, and air conditioning (HVAC) cooling water; vacuum pump cooling water; and the equipment rooms. Floor drains are also routed to the PS, but all are blocked when the potential exists for regulated materials to be spilled. Under normal conditions, the PS lines do not contain regulated materials.

4.2 Building Inventories

The building and local inventories of radionuclides and hazardous chemicals are important to effluent characterization because of their potential for release. The chemical inventories in 3720 Facility are characterized in Appendix B. This section provides information on the types and forms of radionuclides in the building.

4.2.1 Radionuclides

A wide selection of radionuclides are found in the 3720 Facility. The radionuclides in the building are found in liquid or solid form, may or may not be heated or volatile, and may be used in gloveboxes, atmospheric boxes, or fume hoods. Appendix A lists the amounts and forms of radionuclides in the building for current operations.

Aside from nuclides that are in process, or potentially so, the building also contains materials stored for future use and wastes. Finally, an indeterminate but probably very small inventory of assorted radionuclides is believed to be present as "holdup" in HEPA filters and plated deposits in ventilation ducts and liquid pipes. This holdup inventory is believed to be fixed in place and irrelevant for monitoring purposes, so it is not further considered in this document.

Appendix A lists the quantity and form of radionuclides in the building. Most items are small; in the mCi, nCi, or even pCi range. The inventory items are divided between the northern and southern ends of the main building with most of the inventory in the northern end. Currently, no radionuclides are in the annex, and none are ever used in the center of the main building.

4.3 Characterization of Potential Releases

The characteristics of releases that could contribute to each effluent stream during normal operating, shut down, and upset conditions are described in this section. Potential air emissions are discussed first, followed by potential releases to liquid effluent streams.

4.3.1 Air Emissions

Normal Operations

Under normal operating conditions, all releases of radioactive materials undergo at least two stages of HEPA filtration and are then sampled and monitored while leaving the building through one of the stacks. The activities that may generate normal source terms, their locations, and the types of releases that may be added to effluent streams, are described below. Only the activities that have taken place in the last year, or are expected to take place in the near future, are included.

Normal operations can be broken down into storage and handling, sample preparation, experiments, and use of instrumentation. Storage and handling operations tend not to produce emissions. Sample preparation and experimentation is likely to include small-scale wet chemistry, and may include cutting some solid samples. Heating may or may not be involved. The source terms from testing use of instrumentation are less well defined, but probably small compared to others. All these source terms can be described in terms of three basic physical forms in which radioactive chemicals are found in the 3720 Facility: nonvolatile liquids, nondispersible crushable solids, and nondispersible metals.

Nonvolatile liquids are typically subjected to the physical processes of pouring, heating, boiling, sparging, stirring, and resuspension of aerosol from the liquid surface by airflow. The only operations normally performed on crushable solids (such as fuel pellets) are those that can be categorized as machining, such as cutting and grinding. However, the amounts of solid radionuclides that undergo such processes would be categorized as powders in Appendix A. Releases from unmachined solids are much lower than for powders. In general, releases from metals are even lower than those from crushable solids.

The releases from normal operating processes can be roughly estimated based on current methods for release calculation (Ayer et al. 1988). Judging by this information, the fraction of the building inventory that is made airborne within the building during a year of normal operations seems to be less than the annual release fraction that was assumed in Appendix A calculations for FEMP determination purposes. The Appendix A source term fractions--1.0 for gases and volatiles, 0.001 for nonvolatile powders and liquids, and 1×10^{-6} for solids and sealed sources--are therefore, upper limits on the estimated annual building release fraction within the building. The actual, in-building, source term estimates are easily a factor of 100 lower.

The radionuclide releases from the 3720 Facility during normal operations depend on the in-building source term, the effectiveness of effluent filtration, and the amount of inventory that undergoes normal operations during the year.

Shutdown Conditions

During shut down, all materials will be in a configuration that can be relied on not to undergo unexpected changes. All radionuclides and reactive chemicals will be stored in closed containers. No radionuclide releases are anticipated for shutdown conditions.

Upset Conditions

Upset conditions as considered in this document are nonroutine events that are likely to occur. These events may either cause an unusual source term that follows a normal effluent pathway (source-term upset), or a normal source term that follows an unusual pathway (flow-path upset). Both of these types of upset conditions are discussed in the following sections.

Flow-Path Upsets. Flow-path upsets occur when normal source terms follow unintended paths to be released at effluent exit points. In general, this results in increased release owing to bypassed engineered controls such as HEPA filters. Possible flow-path upsets in the 3720 Facility include many types of events.

Glovebox confinement failures could include damage to a glovebox glove or bag, failure of a glovebox airlock, or plugging of a glovebox outlet HEPA or damper closure causing overpressurization. The breach or leakage of a ventilation duct carrying glovebox effluent also falls into this category. The worst of these cases is that the normal source term from only one glovebox escapes unfiltered to room air, then goes through the normal two stages of HEPA filtration before reaching the stack. Much the same can be said for hood failures.

A HEPA filter could fail mechanically (expelling part of its contents as well as permitting particulates to flow through), or releases could wick through a HEPA wetted by a demister failure. The consequences of such a failure are limited to removing one stage of HEPA filtration from the normal source term for one glovebox. One stage of HEPA filtration would still exist. In the second case, the HEPA wetting, the release fraction for resuspension from solution would in effect be substituted for the release through the filter. Because these two release fractions are of about the same magnitude, a net change from normal emissions would not occur.

Possible supply system upsets are not likely to occur except under accident conditions which are beyond the scope of this document.

Source-Term Upsets. Source-term upsets occur when an upset creates an unusually large release, which then follows normal release paths. A source-term upset that is likely to occur involves only the contents of a single container. Because these upsets follow normal release paths, monitoring of the main stack is sufficient to detect and quantify them.

4.3.2 Liquid Source Terms

On exit from the 3720 Facility, control and monitoring responsibility for each of the two liquid waste systems passes from PNL to WHC. Because the streams are under WHC control at the point of discharge to the environment, sampling to demonstrate compliance with regulations is performed by WHC. Although PNL does not have responsibility for compliance sampling of these 300 Area streams, PNL does have the responsibility for maintaining control and accountability for operational discharges from its facility. This section, therefore, identifies the characteristics of the liquid effluent for each pathway, and notes the streams that should be sampled or monitored for characterization purposes. At the present time, PNL has initiated a routine sampling program of the 3720 Facility PS.

Source terms to the liquid effluent pathways are those entering the SNS or PS systems. Radioactive waste is sent out of the building in containers and is not released to the environment under normal operations. The following sections describe liquid effluent system releases under normal operating, shutdown, and upset conditions.

Normal Operations

Under normal operating conditions, the SNS only receives effluent from the restrooms, water fountains, lunchrooms, and change rooms. No radioactive source terms are normally released through this pathway. The PS, which serves a number of laboratory areas, also does not have a potential for containing radioactive material.

The current normal operations do not call for monitoring or sampling the 3720 Facility SNS or PS effluent. However, past operations are believed to have caused PS releases of materials that are now regulated (but then were not). The sampling program that has begun will help determine the impact of past operations on the effluent stream.

Shutdown Conditions

It is not likely that any liquid effluent source terms would occur during a building shut down. The rinsing and process activities that can normally cause releases do not occur during shut down. Maintenance activities do not employ radionuclides.

Upset Conditions

As for air effluent upsets, the liquid effluent upsets are the result of a failure of a system or control, or human error. Radioactive contamination of PS water could occur by spills, leaks of process inventories into cooling water, or carryover of inventory in off-gas streams drawn off by and condensed in the vacuum system. Of these, only the upper-limit spills can be estimated (as the maximum amount of soluble or liquid radionuclide in a single container).

4.4 Summary and Conclusions

Under normal operations, radioactive airborne source terms pass through two stages of HEPA filtration and are sampled and/or monitored before their release from the main stack or the decontamination cell stub stack. In many cases, radioactive aerosol generated under upset conditions is also carried through the main stack, though it may have undergone only one stage of HEPA filtration.

The only liquid effluent system that is released to the 300 Area PS system and has a potential for containing radionuclides under upset (but not normal) conditions is the PS. Radioactive sampling capability was added to the PS line in 1994.

4.5 References

40 CFR 61. 1990. *Subpart H--National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities*. 7-1-90 Edition. U.S. Environmental Protection Agency, Washington, D.C.

Ayer, J. E., A. T. Clark, P. Loysen, M. Y. Ballinger, J. Mishima, P. C. Owczarski, W. S. Gregory, and B. D. Nichols. 1988. *Nuclear Fuel Facility Accident Analysis Handbook*. NUREG-1320, U.S. Nuclear Regulatory Commission, Washington, D.C.

5.0 Effluent Point-of-Discharge Description

The term "point of discharge," as used in this chapter, refers to the point at which the effluent leaves PNL control. For airborne emissions, the discharge point coincides with the point of effluent entry into the uncontrolled environment. Thus, "discharges" of airborne emissions must comply with DOE, EPA, and WDOH emission control and monitoring requirements. Liquid effluents originating in the 3720 Facility, on the other hand, remain in a controlled system at the point of discharge. At this point, the responsibility for the effluent stream, including its ultimate disposition, passes from PNL to the site operations contractor, WHC. As such, WHC has the responsibility for monitoring and controlling environmental discharges of liquid effluents.

WHC has established a separate FEMP for 300 Area liquid effluent discharge monitoring and control systems. Although PNL does not control the discharge of liquid effluent from 300 Area facilities, PNL does have responsibility for characterizing effluents originating in its facilities, and for exercising appropriate control over these effluent sources.

This section provides information on the final point of discharge of liquid and airborne effluents originating in the 3720 Facility.

5.1 Airborne Emission Exhaust Points

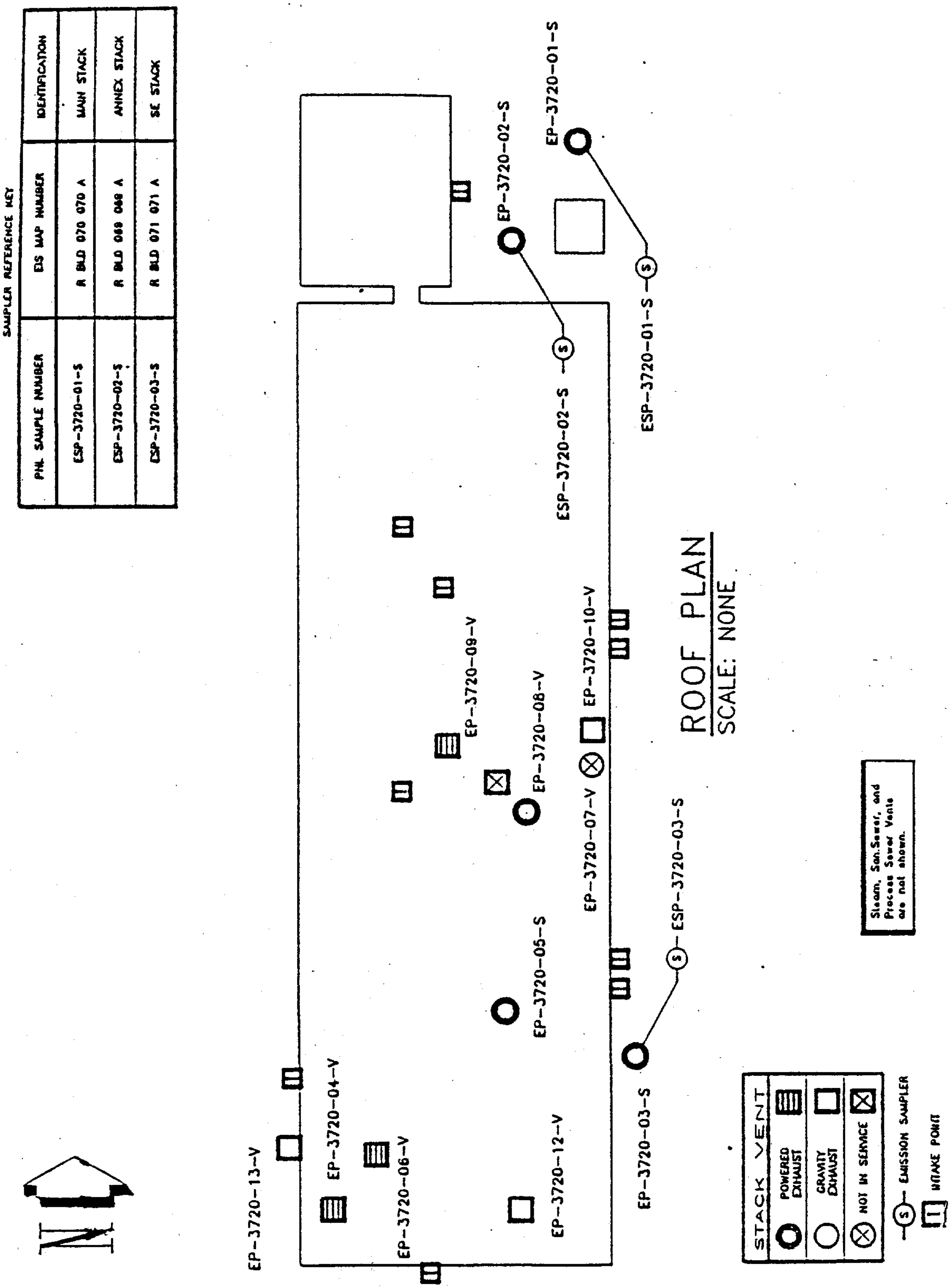
Airborne emissions from the 3720 Facility are primarily via stacks and vents, although as discussed in Section 4.0, in some upset situations, minor outleakage is possible via doorways and building leaks.

5.1.1 Numbered Exhaust Points

Numbered exhaust points include all point-source discharge locations except for sanitary and process sewer vents. These exhaust points are listed in Table 5.1 and their locations are shown in Figure 5.1 on a plan view of the 3720 Facility. Each exhaust point is identified by a unique "EP" number in the table and on the figure. The EP numbers also correspond to exhaust points identified on the 3720 Facility exhaust flow diagrams in Section 4.0. Thus, with the information provided in this plan, it is possible to start with an identified exhaust point on the building, and determine the origins within the facility of emissions at this point.

Compliance emission sampling is performed at the main facility stack, shown as exhaust sample point ESP-3720-01-S in Figure 5.1. Confirmatory sampling is performed at two locations: the north annex stack, shown as ESP-3720-02-S, and the southeast lab stack, shown as ESP-3720-03-S. These monitoring locations are also shown on the building exhaust flow diagram in Section 4.0. The sampling/monitoring systems are described in detail in Section 7.0.

Where the exhaust system is powered by fans or blowers, nominal exhaust flow rates are given in Table 5.1. Measurements of exhaust system flow are performed quarterly for EP 3720-01 and annually for EP 3720-02 and EP 3720-03. Before 1991, the exhaust flow rate at these points was measured using the Associated Air Balance Council (AABC) national standards (AABC 1982). Since 1991, the exhaust gas velocities and volumetric flow rates have been measured using the EPA Method 2 (40 CFR 60) velocity traverse procedure at the sampling location. The use of quarterly measurements was implemented in 1994.



PNL SAMPLE NUMBER	EIS MAP NUMBER	IDENTIFICATION
ESP-3720-01-S	R BLD 070 070 A	MAIN STACK
ESP-3720-02-S	R BLD 069 069 A	ANNEX STACK
ESP-3720-03-S	R BLD 071 071 A	SE STACK

Figure 5.1. Roof-Top Drawing

Table 5.1. 3720 Facility Ventilation Exhaust Points

Point Number[a]	Placement[b]	Outlet Dim.	Volumetric Flow Rate, cfm[c]	Principal Contributing Locations[d]	Sampled[e]	Additional Comments
EP-3720-01-S	Separate (30'AGL)	48-in. dia.	27,400	All contaminated areas	Yes	EIS No: R BLD 070 070 A
EP-3720-02-S	Separate (17'AGL)	24-in. dia.	2,200	Annex labs	Yes	EIS No: R BLD 069 069 A
EP-3720-03-S	Separate (30'AGL)	30-in. dia.	5,760	South lab areas	Yes	EIS No: R BLD 071 071 A
EP-3720-04-V	Roof	6 in. x 6 in.	Unknown	Rm. 201 hood		
EP-3720-05-S	Roof	12-in. dia.	Inactive	Rm. 105 canopy		
EP-3720-06-V	Roof	3 ft x 3 ft	Unknown	Rm. 205		
EP-3720-07-S	Roof	4-in. dia.	Blanked off	Disconnected		
EP-3720-08-V	Roof	8-in. dia.	Unknown	Kitchen		
EP-3720-09-V	Roof	18 in. x 18 in.	Unknown	Restrooms		
EP-3720-10-V	Roof	18 in. x 18 in.	Natural draft	Mechanical room		
EP-3720-11-V	(None assigned)					
EP-3720-12-V	Roof	48 in. x 48 in.	Natural draft	Rm. 101, 103		
EP-3720-13-V	Wall	32-in. dia.	Natural draft	Mechanical room		

(a) The last character in the number identifies the exhaust point as a stack or vent. A stack is defined as a vertical structure extending at least 2.5-equivalent diameters beyond a flow disturbance. All other exhaust points are classified as vent.

(b) Placement refers to how the exhaust structure is placed on the building. A structure penetrates the roof, a wall, or is separate from the main building. If the outlet is significantly above the building roof, the height above ground level (AGL) is given.

(c) Based on most recent volumetric flow rate determination.

(d) Detailed information on locations exhausted is provided on ventilation flow diagrams in Appendix D.

(e) Sampler design and placement details are provided in Section 7.0.

Annual stack volumetric flow rate determinations show the main exhaust stack to have a relatively constant flow rate. Results of annual volumetric flow rate measurements for the 3720 main exhaust stack over the past 7 years are shown in Table 5.2.

5.1.2 Other Potential Exhaust Points

Sanitary and process sewer vents constitute a pathway for exhaust to the environment; however, the systems do not contain radioactive contamination and flow rates are cyclicle as liquids pass through the piping.

Ventilation air supply units have louvers, but do not have backdraft dampers. At least one control zone separates outside access points from locations where radionuclide contamination could be present.

5.2 Liquid Effluent Discharge Points

Liquids effluents are discharged from the 3720 Facility via the SNS and the PS systems. These systems come under WHC control just after their exit from the building. Table 5.3 summarizes the characteristics of these systems, and Figure 2.5 shows the general layout of liquid effluent systems in the 300 Area. Liquid effluent samplers and monitors were installed in March 1994. The system consists of a composite sampler, flow meter, pH meter, and conductivity meter.

Table 5.2. Volumetric Flow Rate Measurements - 3720 Main Stack

Year	Volumetric Flow Rate, cfm[a]
1987	22,000
1988	22,000
1989	22,000
1990	21,000
1991	27,000[b](3/28/91)
1992	29,000[b](4/13/92)
1993	22,000[b](3/26/93)
1993	21,000[b](10/26/93)

(a) Rounded to two significant figures.
(b) Measured using EPA Method 2 (40 CFR 60).

Table 5.3. Liquid Effluent Discharge Lines

Liquid Discharge System	Pipe Size	Building Exit Point
Sanitary sewer	4-in. dia.	East Service Tunnel
Process sewer	4-in. dia.	East Service Tunnel

Rainwater from the building roof and runoff from the loading dock drain to the soil at various locations around the building. No radioactive or chemical contamination is present on external building surfaces.

5.3 Reference

Associated Air Balance Council. 1982. *National Standards for Total System Balance.* AABC, Washington D.C.

6.0 Effluent Monitoring/Sampling System Requirements and Criteria

This section discusses design criteria for the 3720 Facility airborne emissions measurement program.[a] Criteria are established to ensure that effluent measurements are performed according to applicable regulations and guidance and are appropriate for existing facility operations.

In this section, the terms "sampling" and "monitoring" are used to distinguish between two types of airborne emissions measurement processes:

> "Sampling" refers to collecting a representative portion of the emission over a period of time, with subsequent analysis for constituents of interest. "Sampling" is an "after-the-fact" measurement.
>
> "Monitoring", on the other hand, is measuring radionuclide emission rates by means of a detector located in the sample stream. "Monitoring" is a "real-time" measurement.

Airborne emission sampling is performed to demonstrate compliance with emission standards, to identify emission trends, and to provide evidence regarding the effectiveness of emission control systems (procedures and equipment). Emission monitoring is performed as a means to provide timely indication of a significant change in emission rate.

Section 7.0 describes design and operation of the airborne emission sampling/ monitoring system at the 3720 Facility with specific reference to the criteria discussed in this section.

6.1 Basis for Design Criteria

Effluent sampling and monitoring system design and operation criteria are based on the following regulations and guidance:

40 CFR 60. Environmental Protection Agency, "Regulations on Standards of Performance for New Stationary Sources, Appendix A: Reference Methods." U.S. Code of Federal Regulations.

40 CFR 61. 1990. "National Emission Standards for Hazardous Air Pollutants." U.S. Code of Federal Regulations.

American National Standards Institute (ANSI). 1980. "Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities." ANSI N13.1 - 1980.

American National Standards Institute (ANSI). 1980. "Specifications and Performance of Onsite Instrumentation for Continuously Monitoring Radioactivity in Effluents." ANSI N42.18 1980b.

(a) Effluent streams from the 3720 Facility are sent to one of the 300 Area liquid effluent systems (operated by WHC for DOE-RL). However, a sampling of the PS stream has been initiated. Thus, the 3720 Facility does not have a liquid discharge directly to the environment.

U.S. Department of Energy. 1988. "General Environmental Protection Program." DOE 5400.1.

U.S. Department of Energy. 1990. "Radiation Protection of the Public and the Environment." DOE 5400.5.

U.S. Department of Energy. 1987. "General Design Criteria." DOE 6430.1A.

U.S. Department of Energy. 1991. *Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance*. DOE/EH-0173T. (Regulatory Guide)

Additional requirements for sampling/monitoring at the 3720 Facility are prescribed in PNL operational and programmatic documents. These are:

Washington Department of Health. 1994. Radiation Protection - Air Emissions. Chapter 246-247 Washington Administrative Code.

6.2 Criteria for Airborne Radionuclide Emission Sampling

Airborne radionuclide emission points at PNL are classified as either "major" or "minor". These two categories are defined as follows.

Major emission points are those where radionuclide emissions could cause an offsite emission dose[a] of 0.1 mrem, if emission controls were not applied. Sampling of major emission points is performed according to requirements in 40 CFR 61 Subpart H.

Minor emission points are those that potentially could release radionuclides, but not at the levels of a "major" point.

6.2.1 Sampling System Performance

Sampling at each major emission point shall be capable of detecting an annual radionuclide release quantity resulting in an offsite emission dose (OED) of 0.1 mrem.

All radionuclides anticipated to contribute greater than 10% of the emission dose from the sampled emission point shall be accounted for, either by direct analysis or by inference from an indicator measurement.

(a) The annual offsite emission dose (OED) is the maximum committed effective dose equivalent that could be expected to be received by an offsite individual from facility airborne radionuclide emissions if the facility was operated without any HEPA filtration or other emission controls. The method for calculating the OED, as described in PNL-MA-8, consists of identifying the radionuclide inventory potentially available for release, multiplying this by a fractional release value, and multiplying this product times an emission dose factor calculated by the EPA Clean Air Act compliance code CAP-88. PNL 10061 provides additional discussion of this assessment method.

Biases in emission measurements, arising from the sample collection and analysis process, shall be minimized through the judicious application of design and operation practices according to American National Standards Institute (ANSI) N13.1 and DOE/EH-0173T.

6.2.2 Sampling System Design Criteria

Samplers shall be located according to criteria in EPA Method 1 in Appendix A of 40 CFR 60. Method 1 states that

> "Sampling or velocity measurement are to be performed at a site located at least eight stack or duct diameters downstream and two diameters upstream from any flow disturbance such as a bend, expansion, or contraction in the stack, or from a visible flame." However, the method also states that, "if necessary, an alternative location may be selected, at a position at least two stack or duct diameters downstream and 0.5 diameters upstream from any flow disturbance".

Representative samples shall be withdrawn on a continuous basis at the sampling site following the guidance in ANSI N13.1, Appendix A, Section A3.2, which recommends a minimum of six extraction points for the 3720 Facility stack (ESP-3720-01-S). Furthermore, ANSI N13.1 recommends that each withdrawal point within a cylindrical stack be centered in an annular area of size equal to the cross sectional area divided by the number of probes. Withdrawal points may be on a single traverse or spaced to obtain samples from the total cross section. Additional design criteria for particulate and gaseous radionuclides are specified by ANSI N13.1 and DOE/EH-0173T.

6.2.3 Sampling System Operation

Sampling system operating criteria are based on regulations and guidance documents listed in 6.1.

Sampling shall be performed to quantify emissions over a calendar year period. Sample collection frequency shall be based on the need for unbiased samples while maximizing sensitivity and minimizing analytical costs. The period of sample collection, thus, should be as long as possible considering the half-life of the radionuclide, the capacity of the collection media, and the need for timely return of sampling data.

Because quarterly reports of facility emission trends are required by DOE (per Hanford RadCon Manual), the maximum sampling period should be three months. Where sample collection media with limited capacity are used (e.g., silica gel for water vapor collection, glass-fiber filter for particulate collection) sampling periods need to be reduced accordingly. Also, for sampling of short half-life radionuclides, the duration of the collection period should not exceed three half-lives; and a correction for decay of the nuclide should be made.

Laboratory analysis of samples shall be according to procedures required by Appendix B, Method 114 "Test Methods for Measuring Radionuclide Emissions from Stationary Sources" in 40 CFR 61. Analyses should be conducted by radioanalytical laboratories according to prescribed statements of work. Work statements specify analytical performance requirements including minimum detectable activity (MDA), turnaround time, reporting requirements, quality control (QC) requirements, and sample handling.

Sampling program criteria in Section 6.2.1 specify an emission detection level of 0.01-mrem OED. The analytical MDA required to meet this criterion depends on a combination of factors, including sample size, stack flow rate, collection period, radionuclide half-life, and radionuclide emission dose factor.

Historically, laboratory analysis of particulate emission samples consisted of total activity (total alpha, total beta) measurements. Total activity measurements were performed because

- emissions have historically been very low
- potentially significant constituents of the emission stream were known
- the gross activity measurement is nondestructive; radionuclide-specific measurement could be performed on the sample if gross activity measurements show a potentially significant release quantity.

When gross activity measurements were used for assessing offsite dose, dose factors for the most restrictive radionuclide potentially contributing 10% or more to the annual emission dose were applied.

Since 1993, airborne particulate samples must be analyzed for several specific radionuclides in addition to the gross activity measurements. These specific analyses included those radionuclides potentially contributing 10% of the offsite dose from the building.

Exhaust stream flow rates at sampling locations shall be measured using EPA Method 2 (40 CFR 60). Beginning calendar year 1994, access to the vertical stack has permitted use of this method to measure flow in the 3720 Facility stack. Flow rate measurements should be performed on a periodic basis, as well as following modifications to the exhaust system that could be expected to cause the average exhaust rate to differ by +/-10% from the previously measured rate. Normally, stack flow rates should be measured on a quarterly frequency. However, if instantaneous flow rate at the sample location is expected to deviate from the mean flow rate by a factor of two more than 10% of the time, and the OED exceeds or is expected to exceed 1 mrem, continuous stack exhaust flow rate monitoring and totalizing should be provided (DOE/EH-0173T).

Air emission samplers should be designed to maximize the sensitivity of the sample, considering the capacity of the collection media, radioactive decay, and sample analysis costs.

Isokinetic sampling is required where particulate emissions are expected.[a]

(a) Emissions from the 3720 stack are filtered using HEPA filters prior to discharge. Unless failure of a HEPA filter system occurs (an unlikely event), particle emissions are expected to be relatively small. Based on criteria in ANSI N13.1, isokinetic sampling for systems emitting particles less than 5-μm aerodynamic diameter is not necessary. The DOE Regulatory Guide recommends isokinetic sampling when particles are greater than 0.5-μm aerodynamic median diameter.

Under most operating conditions, isokinetic sampling can be adequately accomplished by operating the sampler so that 1) sample probes are aligned axially with the stack and point into the direction of stack flow, and 2) sample nozzle inlet velocity is maintained within a factor of two of the mean stack exhaust velocity at the sample location.[a]

At the "major" emission points, the sampler is operated continuously, except during planned sampler maintenance or testing outages. When continuous sampling is required, the loss of sampling capability is limited to 24 h/month. If this limit is exceeded, special interim sampling is provided or pertinent facility operations are shut down.

6.3 Criteria for Emission Monitoring

6.3.1 General

Continuous emission monitoring is required for any emission system where

- a potential of greater than once per year exists for exceeding 20% of the OED standard of 10 mrem/yr (credit may be taken for emission control equipment such as HEPA filters) per DOE/EH-0173T
- continuous emission monitoring is specified by a SAR or operational safety requirement (OSR).

The main stack of the 3720 Facility (EP-3720-01-S) meets the criteria in the second bullet. The 3720 Facility SAR requires continuous alpha and beta particulate and radioiodine monitoring.

6.3.2 Monitor Performance

Continuous emission monitoring detects significant increases in stack emission rate. Rapid detection of such an increase may assist operational response actions. The 3720 Facility stack monitoring system is not used to activate engineered control systems, is not relied on as a primary means for detecting an abnormal operating situation, and is not used to continuously monitor radionuclide release rates during normal facility operations.

The emission monitor should be able to detect a sudden release that could (assuming 95th percentile atmospheric dispersion under 2-h meteorological conditions) result in an OED of 2 mrem (i.e., 20% of the emission standard). The monitoring program should effectively provide notification to responsible personnel within 4 hours of onset of such a release.

6.3.3 Monitor Design

General criteria for design of monitoring systems are provided in DOE/EH-0173T.

6.3.4 Monitor Operation

Monitors are operated continuously, except

- when the monitored exhaust system is not operating, if approved by the Building Manager and EC

(a) From Table C1 in ANSI N13.1, a sampler operating at an inlet velocity of within a factor of two of the stack velocity of within a factor of two of the stack velocity will have a particle interception bias of 14% for a 4-μm aerodynamic equivalent diameter (AED) particulate emission.

- during planned maintenance or testing of the monitoring system if scheduled through the Building Manager.

During periods when the exhaust system is operating and sampling is required, loss of monitoring capability is not to exceed 4 hours at a time. If monitor outage exceeds this time, EC is required to specify requirements for interim sampling of emissions or shut down of pertinent operations.

Continuous stack monitors must provide easily discernible alarms to responsible personnel in continuously or frequently occupied areas. A frequently occupied area is one that is occupied at least once every 4 clock hours.

Flow rates through monitors should, in combination with other operating parameters, be sufficient to enable the monitor to detect an emission meeting the above dose criteria.

7.0 Characterization of Current Effluent Measurement Systems

Three exhaust points are continuously sampled for radionuclide emissions: the "3720 Facility Stack", the "Southeast Stack", and the "Annex Stack". Only the "3720 Facility Stack" meets criteria for continuous compliance sampling; although the other two stacks are sampled continuously as well.

The "3720 Facility Stack" (EP-3720-01-S) is a 9.1-m-high by 1.2-m-diameter stainless steel cylinder located on the north side of the building. Exhaust from laboratories containing open-faced hoods and gloveboxes discharge via the stack. Building pressures are maintained nearly constant relative to ambient levels by use of control dampers in the intake and exhaust ducts, resulting in relatively constant stack flow rates. Measured stack flow rates have averaged 27,000 cfm over the past several years[(a)]. The main stack is continuously sampled in accordance with requirements in 40 CFR 61 Subpart H.

The "Southeast Stack" (EP-3720-03-S) is a 9.1-m-high by 30-in.-diameter steel cylindrical stack located on the east side of the building. The stack exhausts offices and laboratories in the south portion of the building. Measured stack flow rates have averaged 2,600 cfm over the past several years[(b)]. Building ventilation systems effectively isolate the south portion of the building from the main and annex laboratory areas. The stack is sampled continuously to provide "confirmatory" measurements of emissions in accordance with requirements in 40 CFR 61 Subpart H regulations.

The "Annex Stack" (EP-3720-02-S) is a 17-ft-high by 24-in.-diameter steel cylindrical stack located on the north side of the 3720 Facility, adjacent to the annex laboratory addition. The stack exhausts laboratories from this addition. Measured stack flow rates have averaged 5,400 cfm over the past several years[(c)]. Building ventilation systems effectively isolate the annex addition from the remainder of the building. The stack is sampled continuously to provide "confirmatory" measurements of emissions in accordance with requirements in 40 CFR 61 Subpart H regulations.

Building ventilation air comprises the major portion of the building exhaust flow in each of the three stacks; thus, stack gas specific gravity, humidity, and temperature are typical for ventilation exhaust from occupied buildings. Processes containing acids, caustics, organics, or other chemicals that could potentially affect sampling systems are limited to relatively small amounts associated with laboratory operations.

To support developing a stack emission measurement program for the 3720 Facility, knowledge of the types and quantities of radionuclides potentially present in the ventilation exhaust is necessary. An index of emission potential is used by PNL so that the relative significance of different radionuclides and different emission points can be compared. The index, expressed in terms of a projected potential dose equivalent to a maximum offsite receptor, is based on emission assessment methods in 40 CFR Part 60, Appendix D. It is assumed that

(a) Average of annual stack flow from 1991 - 1993 annual release reports.
(b) Average of annual stack flow from 1991 - 1993 annual release reports.
(c) Average of annual stack flow from 1991 - 1993 annual release reports.

no engineered emission controls (e.g., HEPA filters) are provided in the ventilation system, and that without such controls, the potential for radionuclide emissions is related to the quantity and physical form of radioactive material in the facility. This assessment method is described in PNL-10061 (Sula and Jette 1994).

Radionuclides of primary importance in the 3720 Facility from an emission sampling standpoint were determined, using the above methods, to be plutonium-238 and americium-241.

7.1 Sampling/Monitoring System Description

A new particulate radionuclide emission sampling system was installed at the 3720 Facility Stack (ESP-3720-01-S) in 1992. This stack, for which continuous sampling is required by 40 CFR Part 61 Subpart H (NESHAP), complies with continuous sampling requirements in the NESHAP. Figure 7.1 is a schematic representation applicable to all three of the stack sampling systems at the 3720 Facility. Detailed descriptions of each of the systems are provided below.

ESP-3720-01-S (3720 Main Facility Stack)

The airborne particulate sampling system on the 3720 Main Facility Stack incorporates a five-nozzle, isokinetic sampling probe assembly with probe nozzle inlet diameter = 0.264" (Figure 7.2). The probe assembly is positioned in the 33 ft high stack, 22.9 ft (5.7 equivalent diameters) downstream of the exhaust duct entrance to the stack, and 2.6 ft (0.7 equivalent diameters) upstream of the stack exit (Figure 7.3).

ESP-3720-02-S (Annex Stack)

The airborne particulate sampling system on the "Annex Stack" incorporates an eight-nozzle, isokinetic sampling probe assembly with probe nozzle inlet diameter = 0.246" (Figure 7.4). The probe assembly is positioned in the 17 ft high stack, 12.5 ft (6.3 equivalent diameters) downstream of the exhaust duct entrance to the stack, and 1.3 ft (0.7 equivalent diameters) upstream of the stack exit.

ESP-3720-03-S (Southeast Stack)

The airborne particulate sampling system on the "Southeast Stack" incorporates a single-nozzle, isokinetic sampling probe assembly with probe nozzle inlet diameter = 0.557" (Figure 7.4). The probe assembly is positioned in the 30.5 ft high stack, 13.1 ft (5.2 equivalent diameters) downstream of the exhaust duct entrance to the stack, and 11.6 ft (4.6 equivalent diameters) upstream of the stack exit.

At each of the stacks, a sample transport line extends from the probe assembly to the stack base, where a sample collection filter is located. The transport line is of stainless steel tubing and is heat traced, thermally insulated, and electrically grounded.

The sampling rate is manually controlled using a valve located downstream of the particulate sampling filter. The control valve is adjusted so that the velocity of air entering the sample system through the sample probe assembly equals the average

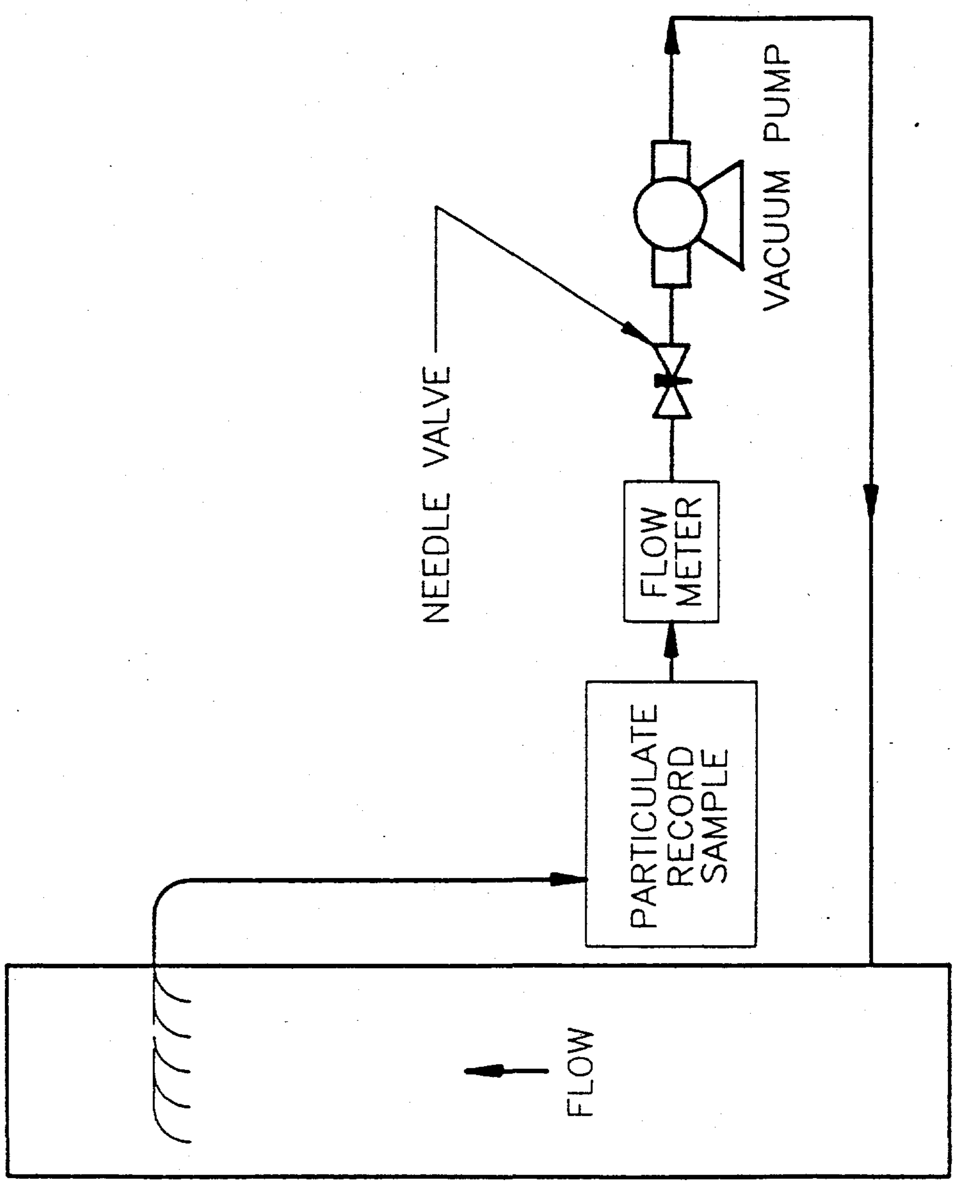


Figure 7.1. Schematic Diagram of Isokinetic Stack Sampling Systems

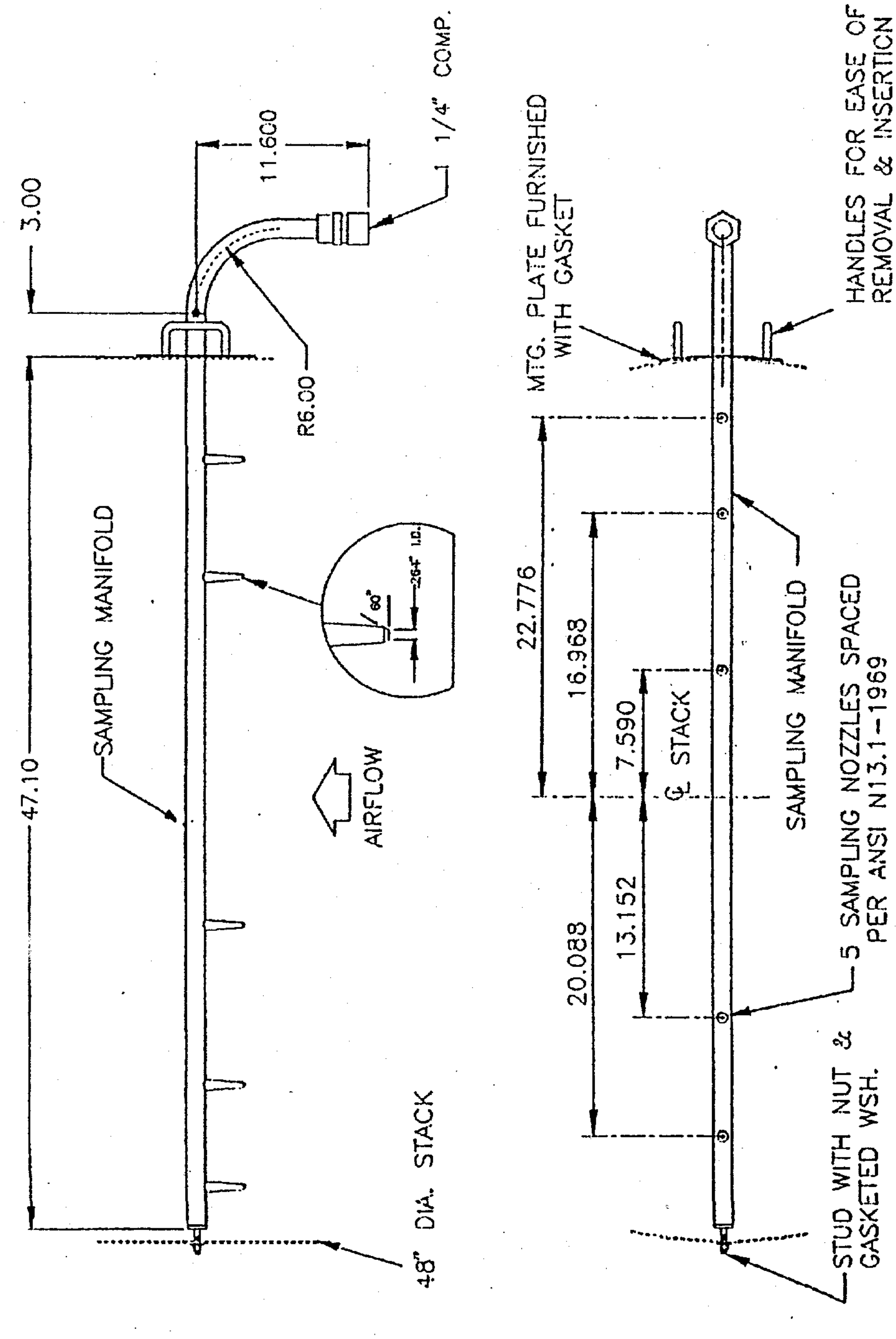


Figure 7.2. Isokinetic Sample Probe Design

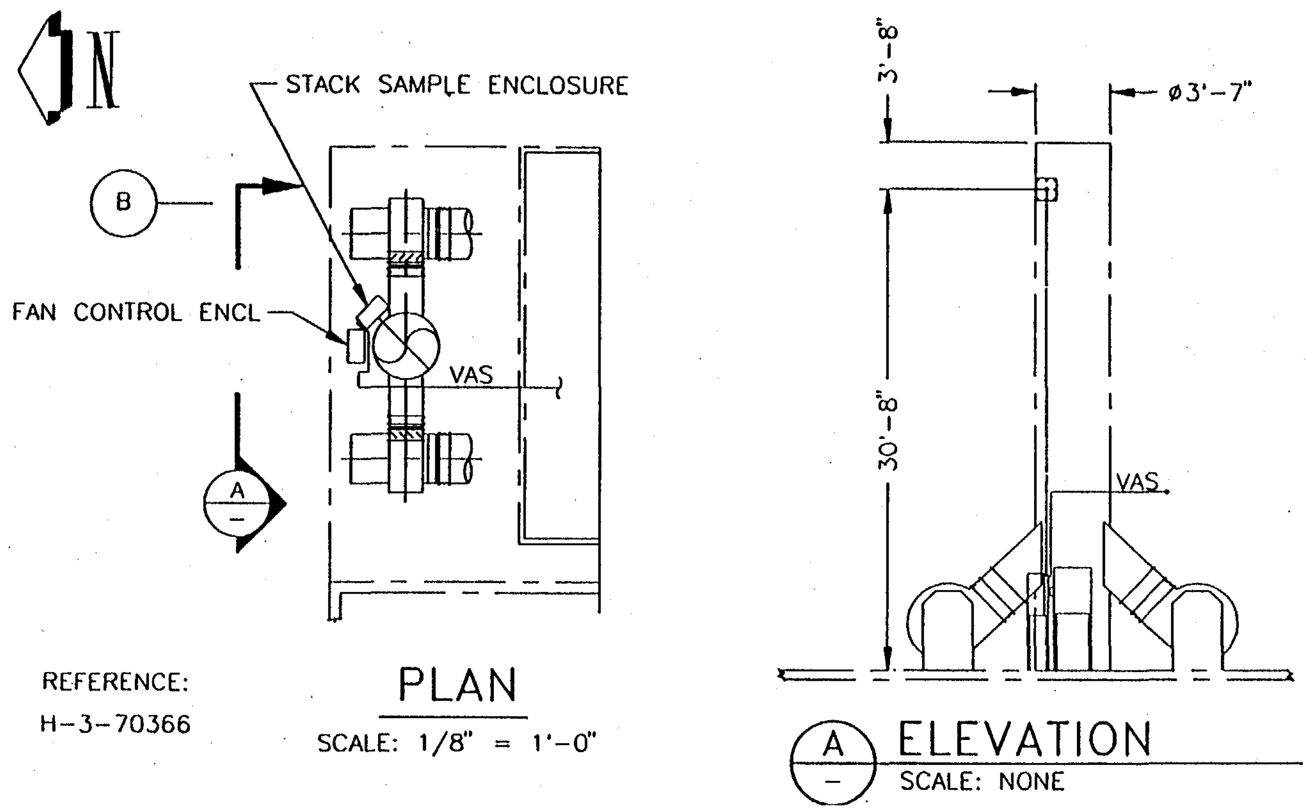


Figure 7.3. ESP-3720-01-S Location in Stack

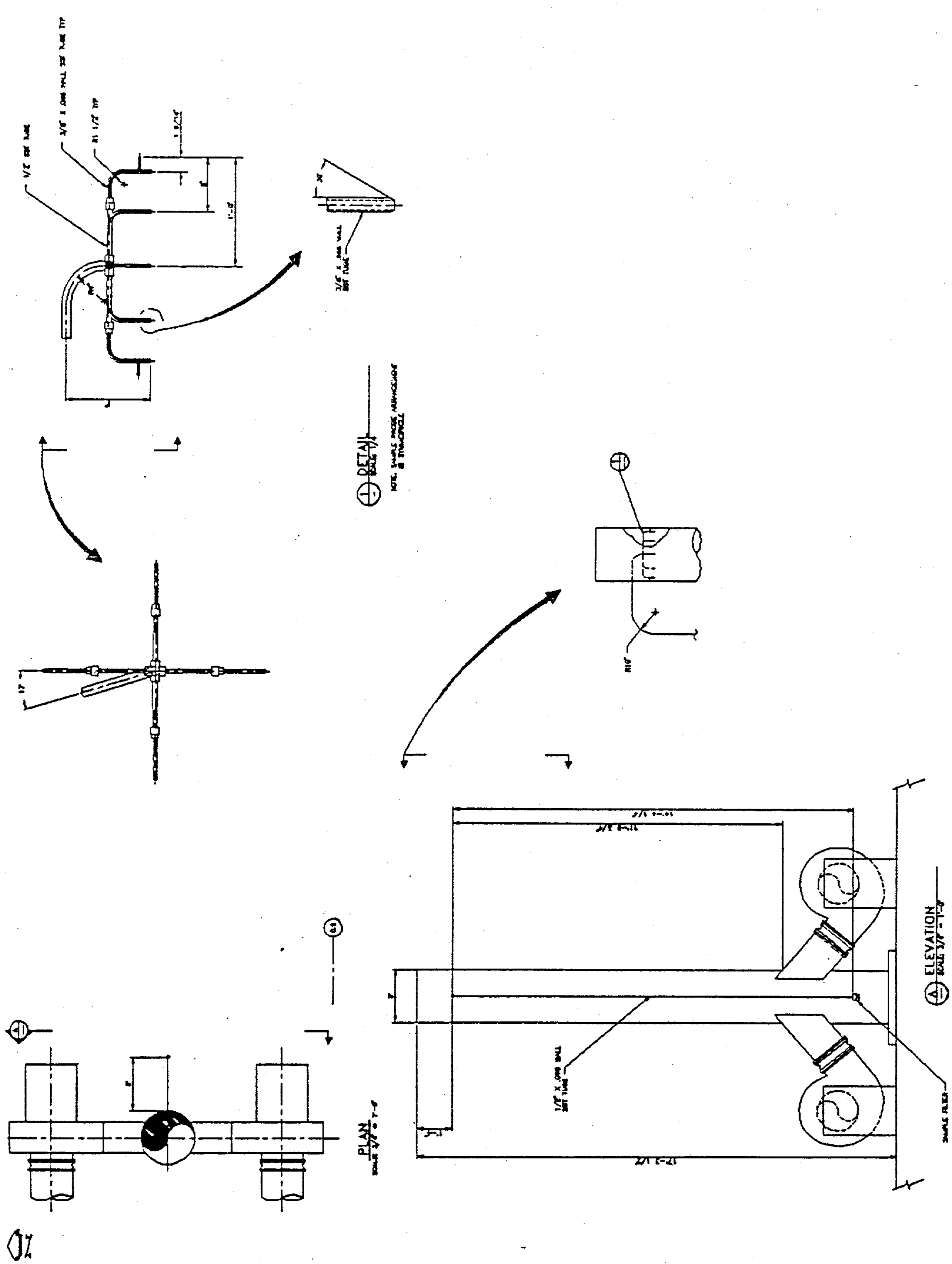


Figure 7.4. ESP-3720-02-S Probe Design and Location in Stack

velocity of the stack gas at the sampling location based on the most recent stack velocity measurement. Sample flow is measured by a rotameter upstream of the control valve (Figure 7.6). Rotameter readings are corrected for pressure and expressed in standard units. Stack velocities are measured on an annual frequency using EPA Method 2 (40 CFR 60). Transport efficiency of the sample through the stack particulate sampling system has been calculated to be as shown in Table 7.1 for an assumed 1 micron AMAD aerosol at nominal sampler and stack flow rates:[(a)]

Airborne particles are collected on a 47-mm diameter glass fiber filter (Hollingsworth and Vose, Model LB5211). The LB5211 has an estimated retention efficiency for 0.3 micron particles of greater than 99.87% at face velocities of 180 fpm.[(b)] The filter itself has a maximum rated flow of 26 cfm (Hi-Q Product Catalog) and a pressure drop of about 2-in. water at 4 cfm (Hering 1989).

The sample collection filter is replaced biweekly. The sample filter is stored for 7 days after removal from the sampler to permit decay of radon and thoron daughter radionuclides. The filter is then analyzed for radioactivity.

Each sample is screened individually for gross alpha and gross beta activity. The samples from ESP-3720-01-S are then composited over each three month period (calendar quarter) and analyzed for specific radionuclides (^{90}Sr, ^{137}Cs, ^{238,239}Pu, and ^{241}Am). Sample analyses are performed by a subcontracted analytical laboratory using methods described in Chapter 9.0. Sample analysis results are evaluated as described in Section 7.3.

7.2 Sampling System Performance

Performance criteria for sampling are provided in Section 6.0. Two of the criteria concern measurement sensitivity and the third concerns measurement bias. The criteria for bias is based on conformance of the system to design and operational guidance in ANSI N13.1(1980) and DOE/EH-0173T(1991). System description information in Section 7.1, for the compliance sampling system (ESP-3720-01-S) are consistent with the design and operational guidance; thus, the bias criterion is met.

Table 7.1. Sampler Efficiency for 1-micron Aerosol

System	System Efficiency
ESP-3720-01-S	95%
ESP-3720-02-S	85%
ESP-3720-03-S	90%

(a) Loss calculations were performed using DEPO Version 2.0 (Wong 1991). A 1-micron AMAD polydisperse aerosol was assumed for the calculations based on the assumption that building operations and controls (HEPA filters) are "normal".

(b) Extrapolated from tests conducted by Hollingsworth and Vose at face velocities ranging from 11 to 60 fpm. (Reference Airborne Emission Monitoring Project Report-"Evaluating Effluent Sampling Data", February 1993).

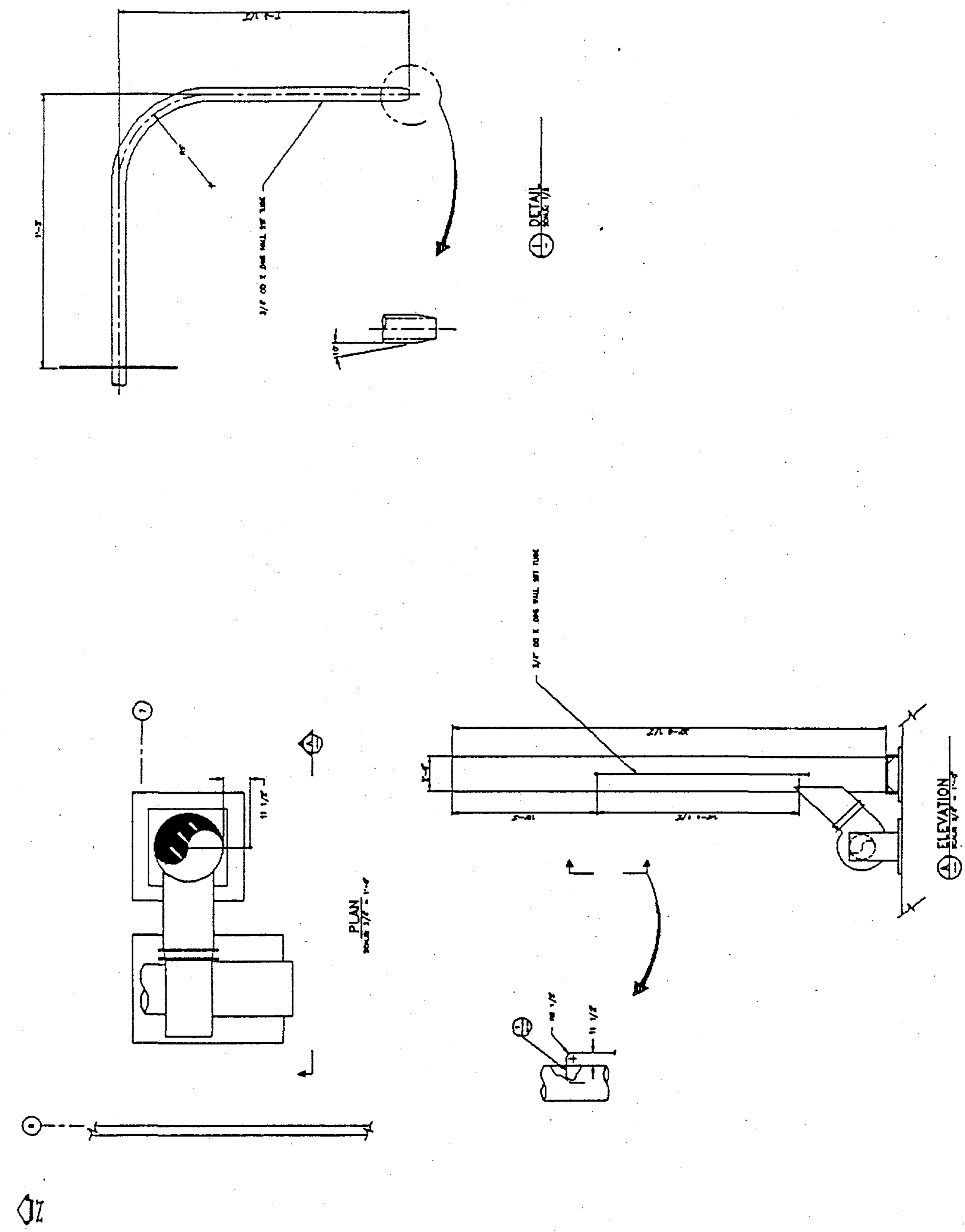


Figure 7.5. ESP-3720-03-S Probe Design and Location in Stack

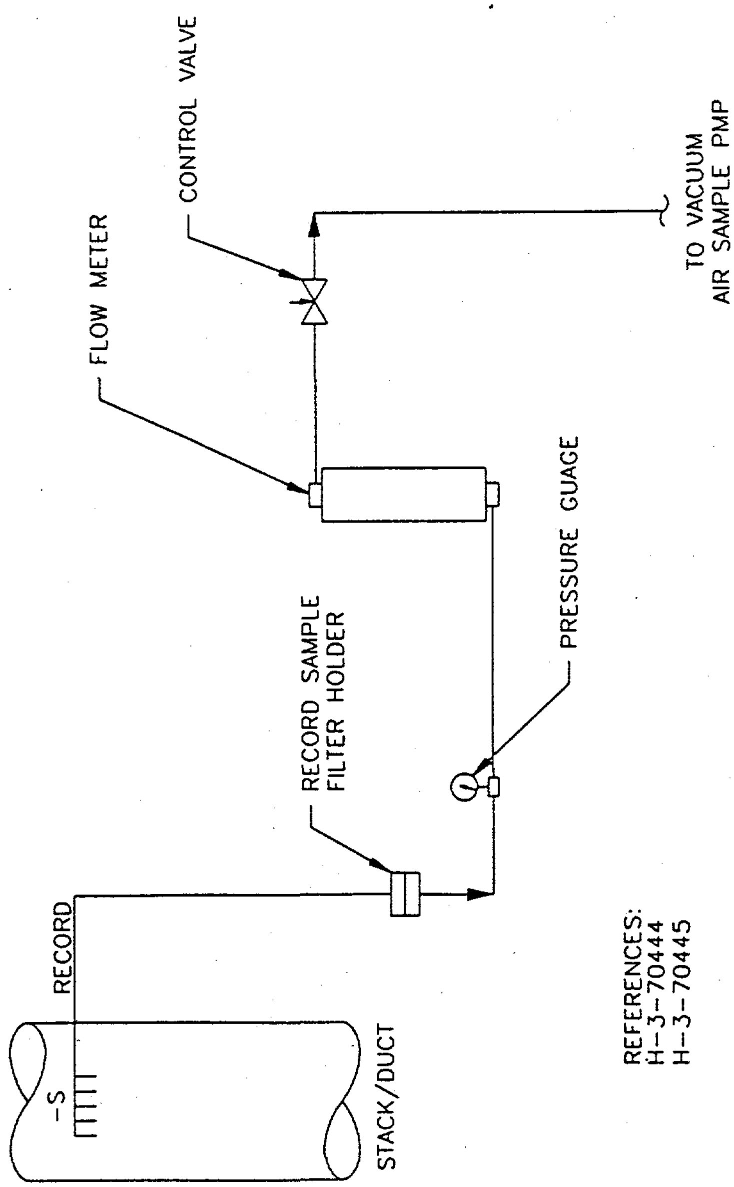


Figure 7.6. Particulate Emission Sample Collection Unit

Sensitivity criteria (Section 6.0) for sampling are stated in terms of detectable offsite dose[a]. According to the criteria, compliance sampling should include measurement of radionuclides which could contribute greater than 10% of the potential effective dose equivalent for the release point. Per criteria in Section 6.0, these radionuclides should be detectable at emission levels resulting in an annual committed effective dose equivalent of 0.01 mrem. For the 3720 Facility, radionuclides measured at the compliance stack (ESP-3720-01-S) are cesium-137, strontium-90, plutonium-238/239, and americium-241. Total alpha activity and total beta activity are also measured at all stacks to screen for the presence of particulate radionuclides.

Annual release quantities associated with an effective dose equivalent of 0.01 mrem were calculated from dose factors calculated using the EPA compliance code CAP-88 (Sula and Jette 1994). These values are shown in Table 7.2.

The sensitivity of particulate radionuclide sampling is proportional to the collection efficiency of the sampler, the fraction of the emission quantity that is collected by the sampler(i.e., sampler efficiency), and the level at which the radionuclide can be detected in the collected sample. Using the contractual minimum detection level specified in the analytical laboratory statement of work (Table 7.2), the annual minimum detectable release for specific radionuclides for the three stacks are as shown in Table 7.2.

From Table 7.2, it is apparent that the capability of the 3720 Facility stack sampling systems exceed the minimum criteria for detection of radionuclides in emissions.

Table 7.2. Detection of Significant Radionuclides in 3720 Stack Emissions

Radionuclide	Analytical Limit (pCi/sample)[a]	Detectable Annual Release (Ci) ESP-3720-XX-S			Release Resulting in 0.01 Mrem (Ci)[c]
		01	02	03	
Beta Activity	2.8[b]	5.1E-7	1.6E-7	1.8E-7	2.0E-3 (as ^{137}Cs)
Alpha Activity	0.94[b]	1.7E-7	5.3E-8	6.0E-8	5.4E-5 (as ^{238}Pu)
^{90}Sr	0.15	4.4E-9	NA	NA	2.0E-3
^{137}Cs	15	4.4E-7	NA	NA	2.0E-3
^{241}Am	1.0	2.8E-8	NA	NA	3.4E-5
^{238}Pu	0.0075	2.1E-10	NA	NA	5.0E-5
^{239}Pu	0.0075	2.1E-10	NA	NA	5.4E-5

NA = Sample not analyzed for these radionuclides.
(a) From ITAS Contract No. 108722-A-MI.
(b) Includes correction for 15% reduction of the alpha and beta emissions originating from the sample that are absorbed by the sample media and surface dirt on the filter (Higby 1984).
(c) Based on dose per release factors calculated using CAP-88 (Sula and Jette 1994).

(a) The determination is expressed in terms of the offsite dose potentially resulting from a release; and this determination is based on a series of worst case exposure scenario assumptions, resulting in calculations of upper bound doses. Thus, the methods used here to evaluate system capability are not appropriate for assessment of actual releases. A realistic assessment of the significance of a sample measurement can be made only by considering the actual operational and environmental conditions.

7.3 Handling of Sampling Data

Results obtained from the record sampling program are used to evaluate existing facility emission levels and to calculate annual emission quantities for compliance determination and reporting purposes. Results are also used to prepare a quarterly emission trends report.

Particulate samples are collected as described in Section 7.1. Analysis of samples by a laboratory is described in Chapter 9. Data is evaluated as described in an internal procedure titled: "Evaluating Effluent Sampling Data" (issued February 1993). Data evaluation procedures are based on guidance in DOE/EH-0173T, *Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance*, and EPA 520/1-80-012, *Upgrading Environmental Radiation Data.*

Airborne emission sampling data are reviewed for anomalies and trends. Provisional release estimates are updated throughout the sampling year (calendar year) as data are received. At the completion of the calendar year, data are reviewed and the provisional release estimate is refined, as necessary, to account for anomalies or missing data as well as a significantly skewed data set. Anomalous data are investigated and conclusions of the investigation are documented.

Final release quantities include corrections for isokinetic sampling efficiency, sample transport losses, sample self-absorption, decay, counting efficiency, background, and collection media efficiency.

7.4 Calibration and Maintenance of Equipment

Sampling equipment is maintained according to predetermined schedules. Stack flow rates are measured using a standard-type pitot tube, recognized by EPA as a primary calibration standard. Rotameters are calibrated or checked as described in preceding sections.

Sampling systems are inspected weekly by the PNL Radiation Protection Section for proper flow rate setting and system operation.

7.5 Alternative Sampling Methods

Alternative methods exist for assessing impacts of facility emissions. Workplace air monitoring systems provide evidence of the presence or absence of radionuclides in room air. Contamination surveys, routinely performed throughout the facility, provide additional evidence of contamination spreads. Air emission control systems are routinely checked for leaks. Differential pressure gauges installed across each filter bank would provide evidence of filter plugging or breakthrough. An extensive environmental surveillance program is operated for the Hanford Site by PNL. This program is described in detail in the Hanford Site Environmental Monitoring Plan. The program performs ambient air sampling around the 300 Area perimeter as well as along the Hanford Site boundary and in adjacent communities. In addition to ambient air sampling, the environmental surveillance program samples groundwater, river water, drinking water, foodstuffs, soil, native vegetation, and aquatic and terrestrial animals. Annual reports issued by the Hanford Environmental Surveillance Program document the results of these samples.

7.6 References

American National Standards Institute (ANSI). 1980. *Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities.* ANSI N13.1-1980.

U.S. Department of Energy. 1990. DOE 5400.5, *Radiation Protection of the Public and Environment.*

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Higby, D. P. 1984. *Effects of Particle Size and Velocity on Burial Depth of Airborne Particles in Glass Fiber Filters.* PNL-5278, Pacific Northwest Laboratory, Richland, Washington.

Sula, M. J., and S. J. Jette. 1994. *Pacific Northwest Laboratory Facility Radionuclide Inventory Assessment, CY 1993-1994.* PNL-10061, Pacific Northwest Laboratory, Richland, Washington.

Wong, F. S., N. K. Anand, and A. R. McFarland. 1991. *Software Program for Characterizing Aerosol Penetration Through Transport Systems.* Aerosol Technology Laboratory, Department of Mechanical Engineering, Texas A&M University.

8.0 Historical Monitoring/Sampling Data for Effluent Streams

The 3720 Facility was built in the early 1960s for laboratory-scale research and development activities and chemical analyses. Some of the effluent streams from the facility have been sampled over the history of operations. Information from historical sampling is provided in this section to aid in providing a basis for future monitoring needs. A description of historic sampling data under normal operating conditions for air and liquid effluent streams is given in Section 8.1. Estimates of the types of releases and release pathways experienced during plant operations under upset conditions are given in Section 8.2.

8.1 Normal Conditions

Sampling of some of the air and liquid effluent streams has occurred since the 3720 Facility started operations. The types and location of sampling and methods of analysis are described in this section for normal operations. Discussion is generally limited to the past 7 years (1988 to 1994) because this time period is the most relevant to future operations and monitoring needs. The discussion in this section is divided into two parts: air effluent monitoring/sampling and liquid effluent monitoring/sampling.

8.1.1 Air Effluent Monitoring/Sampling

Over the last 7 years, effluent air from the 3720 Facility has been sampled for radioactive particles at several locations: the main stack, the annex stack, the southeast stack, and EF-12. The last location (EF-12) was a stack that served the exhaust from some gloveboxes and hoods. In 1984 this stack was removed and the exhaust routed to the main stack. The southeast stack was built around this time and started operation in 1985. None of the air effluent release points have been monitored with CAMs. Except for the elimination of the EF-12 sampling system in 1984 and the addition of the southeast stack in 1985, the sampling systems currently in place (see Section 7.0) were not significantly changed until 1993 when the system was upgraded. The upgraded systems are described in Section 7.0.

Effluent air from the 3720 Facility main exhaust has been sampled and monitored downstream of the final HEPA filters for radioactive particles. Monitoring and sampling for particulate gross alpha and beta has been provided in the way of continuous air monitors and a record sampler for the past 7 years. In 1993 PNL began compositing the record particulate sample on a quarterly basis and analyzing them for ^{241}Am, ^{125}Sb, ^{137}Cs, ^{154}Eu, $^{238/239/240}$Pu, and ^{90}Sr.

The sampling and monitoring system was upgraded in 1992 to meet the 40 CFR NESHAP requirements for continuous sampling. There was a multiple nozzle sampling array in the 3720 stack that was used for sampling prior to the upgrade, but there was little information available on the actual configuration or design of the system. The new system is well documented and is described in Section 7.0. The sample collection system prior to the upgrades did not provide for an isokinetic sample, but the new sampler does.

Monitoring is performed by passing a continuous stream of stack gas through continuous air monitors that detect alpha and beta activity. Samples were collected by passing stack air through a particulate filter for gross alpha and beta.

Estimated emissions calculated from the sampling data from 1988 to 1994 are shown in Table 8.1. This table lists estimates of total alpha and total beta emitted from the stack for each year.

The sampling method described in Section 7.0 provides values with some degree of uncertainty. However, these data show that releases of contaminant from the stack can be measured. A longer collection period (two-week samples) was instated in 1991 to provide larger samples and better resolution of the data.

8.1.2 Liquid Effluent Monitoring/Sampling

Liquid waste streams in the 3720 Facility have been served by two systems, as described in Section 4.0. Historically, no monitoring of the sanitary waste took place at the 3720 Facility. However, sampling of the composite liquid waste from the 300 Area was done before the waste was disposed of in trenches. A brief description of the sampling and analysis program is given in the *Westinghouse Hanford Company Effluent Report for 300, 400, and 1100 Area Operations* (McCarthy 1990). Because this sampling program is not specific to the 3720 Facility, the historical data from it are not given in this report.

Table 8.1. 3720 Facility Stack Sampling Data

Year	Total Alpha, Ci	Total Beta, Ci
Main Stack		
1988	1.3E-6	4.2E-5
1989	1.8E-7	2.6E-5
1990	2.8E-7	4.3E-6
1991	3.2E-7	1.5E-5
1992	5.0E-8	3.8E-8
1993	3.3E-8	1.2E-7
Annex Stack		
1988	1.1E-7	3.8E-6
1989	3.6E-8	3.3E-6
1990	2.6E-8	8.0E-7
1991	1.8E-8	1.1E-6
1992	4.8E-8	4.3E-7
1993	6.0E-8	2.7E-7
Southeast Stack		
1988	5.7E-7	1.9E-5
1989	7.3E-8	8.9E-6
1990	7.4E-8	8.3E-6
1991	3.6E-8	3.5E-6
1992	ND	5.7E-7
1993	4.7E-8	1.3E-7

ND = not detectable

The PS drained nonradioactive waste water from the laboratories and process areas with a low probability of contamination. Process waste water from non-radioactive work areas in the 3720 Facility was discharged to the 300 Area PS system without being monitored at the 3720 Facility. However, time proportional samples of the 300 Area PS line just downstream of the 3720 and 333 Facilities were taken on a routine basis. Sampling from this system was discontinued in 1991, to be replaced with a new monitoring system using EPA-approved procedures. Data from the historic sampling system are not included in this report because the values do not add useful information and cannot be validated.

A pH monitor located in the 334 Building has been used to detect high and low pH levels in the PS from the 333 and 3720 Facilities. This system has alarmed at low pH levels indicating releases of acids to the PS stream. Sources of the releases were investigated when the alarm sounded.

Radioactive waste water was put into barrels or bottles and shipped to locations able to handle the level of radioactivity. Because this effluent was never released to the environment and future effluent of this type also will not be released, a discussion of sampling and monitoring of the waste is not pertinent to the FEMP.

A sampling project was undertaken in 1989 to provide some data to characterize liquid waste streams contributing to the 300 Area Process Trench. The 300 Area PS line was sampled at a point downstream of the 3720 Facility. Four samples were taken from this point in May and July of 1989 with a special baseline sample taken over the Labor Day weekend of the same year. The samples were scheduled, collected, preserved, shipped, and analyzed according to the procedures of EPA protocol SW-846 (EPA 1986). A detailed description of the collection and analysis is given in the *Waste Stream Characterization Report* (Westinghouse Hanford Company 1989).

Several buildings (333, 334, 334-A, 303-M, and 313) other than the 3720 Facility contributed to the effluent that was sampled. In one sample, the concentration of alpha and beta activity in the effluent exceeded the administrative control values (ACVs) used by WHC to ensure that releases meet regulatory requirements. The baseline and the other three samples showed concentrations of less than the ACVs. Because the PS, at the point sampled, was a composite of several buildings, the contribution from the 3720 Facility alone is unknown. The data from this sampling effort can be found in the *Waste Stream Characterization Report* (Westinghouse Hanford Company 1989). Since no data specific to the 3720 Facility alone were measured, none are supplied in this document.

A sampling system on the 3720 PS was installed in 1994 and preliminary data collected. This sampling program is described in Riley et al. (1994) and the data from 3720 is summarized in Appendix C.

8.2 Upset Conditions

The nature of upset conditions that have occurred since 1980 in the 3720 Facility is shown by Table 8.2, which summarizes the reportable unusual occurrences and off-normal occurrences that took place in this time period.

The events shown in Table 8.2 did not result in significant releases to the environment. Although some of these events (e.g., chemical spills) could be expected to occur during future operations, the consequences are not expected to

Table 8.2. Unusual Occurrences in the 3720 Facility

Date	Classification[a]	Description
01/29/80	UO	Unexpected loss of building water supply. PNL was not notified of a planned outage by HEDL.
07/11/81	UO	Water flooding of the 3720 annex basement caused by sump overflowing during scheduled power outage. Anoxic chamber imploded due to excess negative water pressure.
03/8/85	UO	Implosion of anoxic chamber window. Rubber stoppers improperly placed in vacuum relief line.
03/13/87	UO	Chemical spill. Mixture of methyl alcohol and bromine reacted during moving the solution between labs. Three staff members splashed with solution, but no adverse effects.
07/14/88	RE	Fire in drying oven.
11/13/90	ONO	Radioactive contamination found under sink.
12/5/90	ONO	Radioactive contamination found outside of normal confinement.
12/19/90	ONO	Limited operations in the building due to failure of a ventilation fan motor.
02/19/91	ONO	Loss of stack emissions sample due to wind blowing the sample paper out of the RPT's hand.
03/5/91	ONO	Radioactive contamination found under cabinet.
8/14/91	ONO	Loss of air pressure to ventilation damper actuator resulting in loss of air to laboratory fume hoods.
10/18/91	ONO	Mercury spill absorbed with spill kit, then disposed as hazardous waste.
1/3/92	ONO	Replaced fan bearings and shaft.
11/10/93	ONO	R&D technician found a speck of beta-gamma, 8,000 dpm, on shoe sole. Shoe covering had not been required for work performed.
12/28/93	ONO	Craftsman severed thumb when he became distracted during exhaust fan maintenance.

(a) UO = Unusual occurrence
RE = Reportable event
ONO = Off-normal occurrence.

be significant since the chemicals are generally handled in small quantities. No additional release pathways or release of contaminants not already monitored are indicated with the data for historical upset conditions.

8.3 References

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9.0 Analysis of Effluent Samples

This section provides information on the analytical laboratories and procedures used to analyze samples collected in support of the PNL effluent monitoring program. As stated in previous sections, these samples may contain radioactivity associated with emissions from the 3720 Facility main stack. Since liquid discharges from the 3720 Facility are sampled by WHC at the point of discharge to the uncontrolled environment, and since sampling for chemical constituents is currently not performed, analysis of PNL-collected effluent samples is limited to determination of radioactivity in samples collected from the main building stack.

Section 7.0 describes the types of samples collected by the main building stack sampling system. These are particulate radionuclides on filter paper, and radon gas. The laboratories and procedures used to perform these analyses are described in Section 9.1. Section 9.2 provides a description of the chain-of-custody procedures employed by PNL and its supporting analytical laboratories.

9.1 Analytical Procedures

Analytical procedures for alpha and beta particulate radioactivity and isotopic analysis are provided in this section. The principal radionuclides in 3720 Facility emissions are described in Section 6.0. These radionuclides are detectable using procedures described in this section.

9.1.1 Determination of Alpha and Beta Activity on Particulate Air Filter

Particulate air filter samples are collected every two weeks, as described in Section 7.0. The samples are initially delivered to a laboratory in the 3745 Building operated by PNL's Radiation Protection Section. The samples are held at the 3745 Building to allow adequate decay of Radon daughter radionuclide.

Record Alpha and Beta Activity Determination by ITAS-Richland

Following the hold time for Radon daughter decay, each particulate filter is delivered to the International Technology Analytical Services-Richland (ITAS) analytical laboratory. ITAS operates under contract to Battelle and performs analyses on a large variety of effluent and environmental samples. Work under the contract is performed according to documented requirements in a Statement of Work.

Samples are received, logged in, classified, and analyzed according to procedures documented as Standard Operating Procedures (SOPs).

The ITAS particulate alpha and beta analysis method is described in SOP 30-05. Samples are counted on an alpha and beta proportional counter. The counters are operated with a full open energy window and are calibrated using ^{239}Pu and ^{90}Sr sources corrected for self-absorption. As specified in the Statement of Work, required detection levels are 0.8-pCi alpha and 2.4-pCi beta activity on a filter for Type I and Type II errors of 0.05. For the 3720 Facility stack, this equates to a detectable concentration of 4E-16 $\mu Ci/cm^3$ alpha and 1E-15 $\mu Ci/cm^3$ beta. Section 7.0 addresses the performance capability of the particulate emission sampling program in terms of detectable offsite dose.

9.1.2 Isotopic Analysis

The record particulate filters analyzed by ITAS for alpha and beta discussed in Section 9.1.1 are further analyzed for ^{90}Sr, ^{241}Am, ^{238}Pu, $^{239/240}Pu$, and by gamma scan. These analyses are performed by ITAS on particulate samples composited on a quarterly basis.

The ITAS composite preparation and analysis methods used for the above isotopes are listed in Table 9.1. As specified in the Statement of Work, required detection levels are also listed in Table 9.1.

Before digesting the particulate filters for isotopic analysis, the filters are grouped by quarter and transferred to a standard geometry container for counting on the gamma detectors. Hyper Pure Germanium (HPGE) detectors are used to detect isotopes with gamma ray energies between 5 and 200 Kev. The "n-type" HPGE or Low Energy Photon Detectors (LEPD) are generally used for isotopes with gamma ray energies less than 200 Kev. Activity is determined using software provided by a Canberra Nuclear Data acquisition system.

Following the gamma scan, the quarterly groups are digested and the radionuclides of interest are separated from other radionuclides and the sample matrix by radiochemical procedure. The activity of strontium-90 is determined by the radiochemical separation and counting of a daughter, yttrium-90. The strontium is separated from other elements radiochemically, then yttrium-90 is permitted to grow into equilibrium with the strontium-90. The yttrium-90 is then separated and processed to determine the chemical recovery and counted on a low background beta proportional counter. The quantity of strontium-90 is then determined based on the quantity of the daughter yttrium-90 produced.

Plutonium is separated from other elements and the sample matrix by adsorption on an anion exchange column. The plutonium is then processed radiochemically and electroplated or coprecipitated as rare earth fluorides. The isotopic activity of the deposited material is determined by alpha spectrometry. Following the removal of the plutonium, the sample matrix is further processed radiochemically and the americium and curium removed by passing the sample through a cation exchange column. The americium and curium are eluted from the column and either electroplated or coprecipitated. As with the plutonium, isotopic of the deposited material is determined by alpha spectrometry.

Table 9.1. Isotopic Separation and Analysis Methods

Method	ITAS SOP	MDA, pCi
Air Filter Preparation and Compositing	RD-3242	-NA-
Gamma Analysis Sample Preparation, All Matrices	RD-3219	200[(a)]
Electrodeposition Procedure for the Actinides	30-ED-02	-NA-
Strontium Determination for Environmental Matrices	20-Sr-03	10
Isotopic Plutonium Determination, All Matrices	RD-3209	1
Isotopic Americium/Curium Determination	RD-3206	1

(a) MDA for Cs-137.

9.2 Chain-of-Custody Procedures

Chain-of-custody procedures for air emission samples are documented in PNL-MA-508. Procedures include provisions for transfer of samples between operational staff, to and from regulated storage areas, and to the analytical laboratory. Both PNL and its offsite analytical services contractor implement chain of custody within the Laboratory.

Analytical laboratory chain-of-custody procedures are documented in PNL-MA-508 for the preliminary analyses of particulate emission samples, and in ITAS SOP RD-20800 and Laboratory Support Manual RD-2201 for record analysis of particulate air filters and silica gel collectors.

Samples are stored for one year before being discarded.

10.0 Notifications and Reporting Requirements

10.1 Off-Normal Event Notification and Reporting

This section identifies the requirements and provides an overview of the procedural steps for the notification, investigation, and reporting of all environmental off-normal events for Pacific Northwest Laboratories operations. This section provides a basic outline of the environmental off-normal event information available in PNL-MA-7, *Off-Normal Event Reporting System*, and DOE 5000.3B, "Occurrence Reporting and Processing of Operations Information."

NOTE: In this section, all discussion of off-normal events refers only to the environmental category of these events.

The basic objective of the system is to gather data on environmental off-normal events to

- obtain immediate resources required to deal with the off-normal event and coordinate activities
- alert PNL management to off-normal operating conditions and activities
- make proper notification to DOE and regulatory agencies
- allow management to make decisions concerning any corrective action to prevent recurrence
- perform analyses using all available data to identify any trends in events
- distribute findings useful to others.

10.1.1 Definitions

Emergency: The most serious occurrence category requiring an increased alert status for onsite personnel and, in specified cases, for offsite authorities.

Event: A real-time occurrence (e.g., pipe break, valve failure, loss of power).

Federally permitted release: Any release that satisfies the definition of "federally permitted release" in 40 CFR 302.3.

Hazardous substance or material: Any solid, liquid, or gaseous material that satisfies the regulatory definition provided in 40 CFR 300. Oil is excluded from this definition.

Logbook only off-normal event: An off-normal event that has a low potential for creating a serious safety hazard.

Occurrence Classifier: A senior staff member who is knowledgeable and experienced in off-normal event reporting who concurs with the facility manager on the final decision on categorizing occurrences.

Occurrence Report: A written evaluation of an event or condition that is prepared in sufficient detail to enable a reader to assess its significance, consequences, or implications, and to evaluate the actions being proposed or used to correct the condition or to avoid recurrence.

Off-normal event (ONE): An unplanned or unexpected event, or the discovery of a deficiency in a procedure, plan, or system. The event must have real or potentially undesirable effects on personnel, equipment, facilities, or programs. Effects can include damage, loss, failure, or delays that can have undesirable results.

Off-normal occurrence: Abnormal or unplanned events or conditions that adversely affect, potentially affect, or are indicative of degradation in the safety, security, environmental or health protection performance, or operation of a facility.

Oil: Oil of any kind or in any form, including but not limited to petroleum, fuel oil, sludge, oil refuse, and oil mixed with wastes other than dredged soil.

Release: Any spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or otherwise disposing of substances into the environment. This includes abandoning/discarding any type of receptacle containing substances or the stockpiling of a reportable quantity of a hazardous substance in unenclosed containment structures.

Reportable occurrence: Events or conditions to be reported in accordance with the criteria defined in DOE 5000.3A.

Reportable quantity: For any Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) hazardous substance, the quantity established in Table 302.4 and Appendix B of 40 CFR 302, the release of which requires notification unless federally permitted.

Unusual occurrence: A nonemergency occurrence that has significant impact, or potential for impact, on safety, environment, health, security, or operations.

10.1.2 Categorization of ONE

ONE reporting requirements vary depending primarily on the categorization of the event. A ONE may be categorized as an emergency, an unusual occurrence, an off-normal occurrence, or a logbook entry only.

NOTE: Any of the above categories could easily become elevated to a higher severity event.

PNL-MA-7, Appendix B, "Categorization of Reportable Occurrences," provides a generic list of occurrences to guide the occurrence classifier in categorizing reportable occurrences. Occurrences have been arranged into nine groups that relate to DOE operations. Only the environmental group is addressed in this section.

Within each environmental grouping is a list of occurrences derived from DOE 5000.3A. They are categorized as emergency, unusual occurrences, or off-normal occurrences. The list presents a minimum set of standards that reflect the DOE-desired degree of significance in categorization. The information contained in these categories is presented in Table 10.1.

Table 10.1. Categorization of Off-Normal Events

Condition/Event	Definition	E	UO	ONO
Group 2) Environmental				
2)A. Radionuclide Releases	Any release of radionuclide material to controlled or uncontrolled areas in concentrations which, if averaged over a period of 24 hours, would exceed 5 times the respective Reportable Quantities (RQs) specified for such materials in 40 CFR 302.	X		
	Release of a radionuclide material that exceeds a Federally permitted release by the amount of a CERCLA RQ or, where no Federally permitted release exists, the release exceeds the RQ.		X	
	Release of radionuclide material that violates environmental requirements in Federal permits, Federal regulations, or DOE standards.		X	
	Release below Emergency levels which requires immediate (less than four hours) reporting to Federal regulatory authorities or triggers specific action levels for an outside Federal agency.		X	
	Any release of radionuclide material to controlled or uncontrolled areas that is not part of a normal monitored release and exceeds 50% of a CERCLA RQ specified for such material per 40 CFR 302.			X
	Any controlled release of radionuclide material that occurs as a monitored part of normal operations which exceeds what historical data and/or analysis show is expected as a result of normal operations.			X
	Any monitored facility or site boundary where exposure or concentrations exceed what historical data and/or analysis show is expected as a result of normal operations.			X
	Any detection of a radionuclide in a sanitary or storm sewer, waste or process stream, or any holding points where such a material is not expected.			X
	Any controlled, uncontrolled, or accidental release which is not classified as an Unusual Occurrence but which will be reported in writing to State/local agencies in a format other than routine monthly or quarterly reports.			X
2)B. Release of Hazardous Substances/Regulated Pollutants/Oil (Spills or releases of ethylene glycol and glycol ethers reported at levels in excess of 100 pounds)	Any actual or potential release of material to the environment that results in or could result in significant offsite consequences (e.g., need to relocate people, major wildlife kills, major wetland degradation, major aquifer contamination, need to secure downstream water supply intakes, etc.).	X		
	Any release of hazardous substances or regulated pollutants in concentrations which exceed 5 times the respective RQs specified for such materials in 40 CFR 302.	X		
	Release of a hazardous substance or regulated pollutant that exceeds a CERCLA RQ per 40 CFR 302 or exceeds a Federally permitted release by an RQ.		X	
	Release of a hazardous substance, regulated pollutant, or oil that violates environmental requirements in Federal permits, Federal regulations, or DOE standards.		X	
	Release below Emergency levels that requires immediate (less than four hours) reporting to Federal regulatory agencies or triggers specific action levels for an outside Federal agency.		X	

Table 10.1. (contd)

Condition/Event	Definition	E	UO	ONO
Group 2) Environmental				
2)B. Release of Hazardous Substances/Regulated Pollutants/Oil (contd)	Any release of 100 gallons or more of oil.		X	
	Release of a hazardous substance or regulated pollutant to controlled or uncontrolled areas that is not part of a normal, monitored release and exceeds 50% of a CERCLA RQ as specified for such material per 40 CFR 302.			X
	Any release of oil less than Unusual Occurrence level but greater than 10 gallons.			X
	Any detection of a toxic or hazardous substance in a sanitary or storm sewer, waste or process stream, or any holding points where such a material is not expected.			X
	Any controlled, uncontrolled, or accidental release which is not classified as an Unusual Occurrence but which will be reported in writing to State/local agencies in a format other than routine monthly or quarterly reports.			X
	Any controlled release of hazardous/regulated material that occurs as a monitored part of normal operations which exceeds what historical data and/or analysis shows is expected as a result of normal operations.			X
	Any general environmental monitoring where concentration increases to a level which exceeds what historical data and/or analysis shows is expected as a result of normal operations.			X
2)C. Hazardous material contamination due to PNL operations	Discovery of contamination that results or could result in significant consequences (i.e., exceeding safe exposure limits to workers or public).	X		
	Discovery of onsite or offsite hazardous material contaminations in concentrations that exceed 5 times the respective RQs specified for such materials in 40 CFR 302.	X		
	Discovery of onsite or offsite contamination due to PNL operations which does not represent an immediate threat to the public, that exceeds a reportable quantity for such materials per 40 CFR 302.		X	
	Any discovery of groundwater contamination that is not part of an existing plume previously identified in either an annual report or in any CERCLA/RCRA activity or report.		X	
	Discovery of onsite contamination attributable to PNL operations that exceeds 50% of a reportable quantity for such material per 40 CFR 302.			X
2)D. Ecological Resources	Any occurrence causing significant impact to any ecological resource for which PNL is a trustee (i.e., destruction of a critical habitat, damage to a historic/archeological site, damage to wetlands, etc.).		X	
2)E. Agreement/Compliance Activities	Any agreement, compliance, remediation, or permit-mandated activity for which formal notification has been received from the relevant regulatory agency that a site plan is not satisfactory, or that a site is considered to be in noncompliance with schedules or requirements.		X	
	Any occurrence under any agreement or compliance area that requires notification of an outside regulatory agency within four hours or less, or triggers an outside regulatory agency action level, or otherwise indicates specific interest/concern from such agencies.		X	
	Any occurrence under any agreement or compliance area that will be reported in writing to outside agencies in a format other than routine monthly or quarterly reports.			X

10.1.3 Event Notification Procedure

Staff members must make notifications to ensure activation of emergency response personnel and proper communication of facts to PNL management, DOE, and others.

NOTE: First priority is always given to the appropriate emergency action necessary to control an event.

PNL-MA-7 provides specific procedures in off-normal events requiring immediate emergency assistance, event notification procedures, off-normal event investigation, off-normal event reporting, and off-normal event recovery.

10.2 Periodic Routine Effluent Monitoring Reports

On a periodic basis, effluent monitoring data are gathered by PNL on specific DOE Richland Operations Office (RL) facilities for compilation and reporting to DOE and the various regulatory agencies.

The following report is submitted on a monthly basis.

- Ecology is provided with a status of all reportable spills from the previous month through RL.

The following reports are submitted on an annual basis.

- The Air Emissions Report for the Hanford Site is submitted to the EPA and the WDOH for the Hanford Site radiological emissions.

- The Annual Radioactive Effluent and Onsite Discharge Data Report is submitted to DOE-Headquarters, the EPA, and WDOH through RL after compilation by EG&G Idaho.

- The Hanford Site Environmental Report is submitted to DOE-Headquarters, the EPA, Ecology, and WDOH through RL.

11.0 Interface with the Operational Environmental Surveillance Program

Environmental surveillance of the 300 Area and the surrounding onsite and offsite areas is performed by the PNL Hanford Site Surface Environmental Surveillance Project and the PNL Site-Wide Groundwater Monitoring Project. These projects should be notified in the event of actual or apparent new or off-normal discharges to the soil, surface waters, or air so they can assist in assessing their environmental and compliance significance. The data from these programs are also useful to verify the occurrence or nonoccurrence of facility releases. These surveillance projects are described in detail in the Hanford Site Environmental Monitoring Plan.

12.0 Quality Assurance Plan

A Quality Assurance Plan (Quality Assurance Plan for PNL Radionuclide Air Emission Monitoring, FO-011) was developed to address quality assurance with regard to radionuclide air emission monitoring. The QA Plan applies to PNL's facility airborne radionuclide emission monitoring activities.

The QA program described by the plan is based on the following documentation:

- the U.S. Environmental Protection Agency (EPA) QAMS-005/80, *Interim Guidelines for Preparing Quality Assurance Project Plans*
- DOE 5700.6C, "Quality Assurance"
- DOE 5400.1, "General Environmental Protection Program"
- DOE/EH-0173T, "Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance"
- applicable criteria of ASME NQA-1, *Quality Assurance Requirements for Nuclear Facilities*, as reflected in PNL's *Quality Assurance Manual*, PNL-MA-70, and associated implementing procedures.

Additions to, or deviations, from PNL-MA-70 procedures are documented in the plan under the appropriate criteria headings.

The QA Plan addresses the sections of QAMS-005/80, with additional sections added to incorporate necessary modifications or clarifications to the supporting NAQ-1-and DOE Order 5700.6C-based QA Program, as documented in PNL-MA-70. A cross reference between the format used in the plan and the format recommended in DOE 5400.1 is provided in Appendix A to the plan. Where DOE Order 5400.1 requirements appear primarily in PNL-MA-70 instead of the plan, a reference to PNL-MA-70 is provided.

A QA Plan addressing monitoring of liquid effluents is being developed in concert with the installation and development of PNL's liquid effluent monitoring program. A plan has been drafted and will be completed in 1995.

13.0 Internal and External Plan Review

DOE 5400.1 (DOE 1988a), states that the EMP will be reviewed annually and updated every three years. As a support document for the EMP, the FEMP will also be updated every three years. Additionally, this plan will be updated, as necessary, after each major change in facility processes, structure, ventilation and liquid collection systems, monitoring equipment, waste treatment, or a significant change to SARs or safety assessments. At a minimum, the FEMP assessment will be performed annually.

14.0 Compliance Assessment

The sampling systems for radioactive air emissions have been upgraded to meet 40 CFR 61 requirements.

The point of environmental release of liquid effluents from the 3720 Facility is the 300 Area process trench. Monitoring of 300 Area liquid effluents is conducted by WHC. PNL has initiated liquid effluent sampling for the 3720 Facility PS during FY 1994 as part of a program to characterize building contributions to the 300 Area liquid waste streams.

14.1 Basis for Compliance Assessment

Standards and criteria used for system design and operation have been listed previously in Section 6.1. These include EPA requirements in 40 CFR 61, "National Emission Standard for Hazardous Air Pollutants" and DOE/EH-0173T, *Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance*. These requirements are communicated to PNL management and staff via PNL-MA-8, *Waste Management and Environmental Compliance*.

14.2 Summary of Existing Sampler Compliance Deficiencies and Scheduled Corrective Actions

No compliance-related deficiencies have been identified for the existing 3720 Facility stack sampling/monitoring system (Section 7.0).

14.3 Program Upgrades

A significant effort has been made to upgrade PNL's effluent monitoring program. The upgrades are summarized as follows:

- The sampling system for radioactive air emissions have been upgraded to meet 40 CFR 61 requirements.
- Revisions to the liquid effluents chapters of PNL-MA-8 are being made. The revised chapters include administrative guidelines and practices for monitoring and controlling effluents to the liquid waste streams. Revisions will be issued by the end of 1994.
- Procedures for collection and analysis of record air samplers have been updated.
- The quality assurance plan, covering all elements of the PNL radioactive air emissions monitoring program, has been updated.
- Air sample line loss assessments have been performed using the DEPO computer code.
- Stack velocity and volumetric flow rate measurement procedures, conforming to EPA Method 2, have been implemented.
- Data accessibility, management, and security have been improved through database upgrades.

- Documented statements of work have been prepared for required support functions such as sample collection, sample analysis, stack velocity measurement, instrument calibration, and maintenance.
- Data handling procedures have been documented.
- Liquid effluent sampling systems were installed on building process sewer lines.

Additional program upgrades are planned. These are as follows:

- Documented statements of work will be prepared for database support.

Appendix A

Projection of Offsite Emission Dose

DOE Order 5400.1 states that Environmental Monitoring Plans (EMPs) "shall be prepared for each site, facility, or process that uses, generates, releases, or manages significant pollutants or hazardous materials" (DOE Order 5400.1, IV-2). To support the EMP, FEMPs are being prepared for those facilities that have the potential to release significant pollutants or hazardous materials. A methodology has been developed to determine whether potential releases of radioactive material are significant. This method is that same as that used to determine whether monitoring is required for the National Emission Standards for Hazardous Air Pollutants (NESHAPs - U.S. Code of Federal Regulations, Title 40 Part 161, Subparts H and I) and is described in *Pacific Northwest Laboratory Facilities Radionuclide Inventory Assessment CY 1992-1993* (Sula and Jette 1994, PNL-10061).

The first step in the method (called the FEMP Determination when used to determine whether or not a FEMP is needed for a facility) is to obtain a listing of the facility inventory. The inventory includes the radionuclide, isotope, quantity, and form. Form can be gas, liquid or powder, solid (nondispersible), contained (in sealed sourced or DOT containers), or exempt (sealed sources meeting certain criteria). At PNL, radioactive source and material information is maintained using three separate inventory systems: (1) facilities management radioactive materials inventory, (2) composite radioactive materials inventory, and (3) nuclear materials inventory. An identifier on the inventory listing indicates the inventory system that the information was obtained from. Additional detail on the FEMP Determination method is provided in PNL-10061.

The attached table contains the inventory information for the 3720 Building for 1994. The total unmitigated dose from the inventory is 0.77 mrem using the inventory-based method. Almost all of the dose is from locations in the north part of the building which is served by the main stack. A small fraction of the potential unmitigated dose (3E-7 mrem) is from inventory in rooms (202, 109) in the south part of the building and served by the southeast stack. The primary radionuclides are Pu-238 and Am-241. These contribute 86% of the dose. No other radionuclides individually contribute more than 10% of the dose. (Am-243 and Pu-239 are the next highest contributors with 8% and 5% of the dose respectively.)

Table A.1.

3720-ALL.XLS 9/30/948:59 AM

Nuclide	Quantity	Units	Form	Inv.	Spec.Loc.	Dose Fact.	Dose
U-238	3.60E-07	Ci	S	1	Rm. 245	6.40E+01	2.3E-11
U-238	1.47E-07	Ci	S	1	Rm. 245	6.40E+01	9.4E-12
TH-232	2.88E-07	Ci	S	1	Rm. 245	1.98E+02	5.7E-11
CS-137	5.00E-04	Ci	S	1	Rm. 612	5.02E+00	2.5E-09
CO-60	2.50E-05	Ci	S	1	Rm. 612	5.11E+00	1.3E-10
EU-152	5.00E-05	Ci	S	1	Rm. 612	4.98E+00	2.5E-10
C-14	2.50E-04	Ci	S	1	Rm. 507	5.06E-02	1.3E-11
CS-137	5.00E-04	Ci	S	1	Rm. 507	5.02E+00	2.5E-09
H-3	5.00E-05	Ci	L	1	Rm. 507	4.23E-04	2.1E-11
CO-60	5.00E-05	Ci	L	1	Rm. 507	5.11E+00	2.6E-07
TC-99	1.00E-03	Ci	S	1	Rm. 507	6.33E-01	6.3E-10
U-238	5.00E-08	Ci	S	1	Rm. 507	6.40E+01	3.2E-12
AM-241	2.60E-08	Ci	L	1	Rm. 507	2.94E+02	7.6E-09
CS-137	5.00E-03	Ci	L	1	Rm. 507	5.02E+00	2.5E-05
CS-137	8.50E-03	Ci	L	1	Rm. 507	5.02E+00	4.3E-05
H-3	1.60E-07	Ci	L	1	Rm. 507	4.23E-04	6.8E-14
H-3	4.00E-03	Ci	L	1	Rm. 507	4.23E-04	1.7E-09
I-129	3.90E-09	Ci	L	1	Rm. 507	5.79E+01	2.3E-10
PU-238	1.20E-08	Ci	L	1	Rm. 507	1.85E+02	2.2E-09
TC-99	5.00E-04	Ci	L	1	Rm. 507	6.33E-01	3.2E-07
TC-99	1.00E-03	Ci	L	1	Rm. 507	6.33E-01	6.3E-07
TC-99	1.00E-03	Ci	L	1	Rm. 507	6.33E-01	6.3E-07
TC-99	1.05E-03	Ci	L	1	Rm. 507	6.33E-01	6.6E-07
U-238	4.80E-07	Ci	S	1	Rm. 507	6.40E+01	3.1E-11
U-238	3.00E-06	Ci	L	1	Rm. 507	6.40E+01	1.9E-07
CO-60	2.00E-03	Ci	L	1	Rm. 507	5.11E+00	1.0E-05
CO-60	2.50E-03	Ci	L	1	Rm. 507	5.11E+00	1.3E-05
CS-137	2.50E-03	Ci	L	1	Rm. 507	5.02E+00	1.3E-05
CS-137	2.00E-03	Ci	L	1	Rm. 507	5.02E+00	1.0E-05
NA-22	2.00E-03	Ci	L	1	Rm. 507	2.49E+00	5.0E-06
PB-210	6.18E-06	Ci	L	1	Rm. 507	6.41E+01	4.0E-07
NI-63	1.00E-03	Ci	L	1	Rm. 507	1.05E-02	1.1E-08
SR-89	1.00E-03	Ci	L	1	Rm. 507	7.73E-02	7.7E-08
TC-99	1.50E-02	Ci	L	1	Rm. 507	6.33E-01	9.5E-06
CO-60	2.50E-04	Ci	L	1	Rm. 507	5.11E+00	1.3E-06
CO-60	1.00E-03	Ci	L	1	Rm. 507	5.11E+00	5.1E-06
C-14	5.00E-04	Ci	L	1	Rm. 507	5.06E-02	2.5E-08
C-14	2.50E-04	Ci	L	1	Rm. 507	5.06E-02	1.3E-08
EU-152	1.00E-04	Ci	L	1	Rm. 507	4.98E+00	5.0E-07
EU-154	1.00E-05	Ci	L	1	Rm. 507	4.06E+00	4.1E-08
EU-155	1.00E-04	Ci	L	1	Rm. 507	1.71E-01	1.7E-08
U-235	1.00E-06	Ci	L	1	Rm. 507	6.85E+01	6.9E-08
U-238	1.00E-06	Ci	L	1	Rm. 507	6.40E+01	6.4E-08
BA-133	5.00E-04	Ci	L	1	Rm. 507	1.54E+00	7.7E-07
CR-51	1.00E-03	Ci	L	1	Rm. 507	2.29E-03	2.3E-09
AG-110	1.30E-04	Ci	L	1	Rm. 507	9.82E-01	1.3E-07
C-14	5.00E-06	Ci	L	1	Rm. 507	5.06E-02	2.5E-10
CS-137	5.00E-03	Ci	L	1	Rm. 507	5.02E+00	2.5E-05
CS-137	5.00E-06	Ci	L	1	Rm. 507	5.02E+00	2.5E-08
H-3	2.00E-03	Ci	L	1	Rm. 507	4.23E-04	8.5E-10
I-129	1.30E-09	Ci	L	1	Rm. 507	5.79E+01	7.5E-11

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Table A.1. (contd)

I-129	5.00E-06	*Ci*	L	1	Rm. 507	*5.79E+01*	2.9E-07
PU-238	5.00E-06	*Ci*	L	1	Rm. 507	*1.85E+02*	9.3E-07
RA-226	1.00E-03	*Ci*	L	1	Rm. 507	*1.75E+01*	1.8E-05
NP-237	7.00E-05	*Ci*	L	1	Rm. 507	*2.71E+02*	1.9E-05
TC-99	5.00E-06	*Ci*	L	1	Rm. 507	*6.33E-01*	3.2E-09
CD-109	5.00E-08	*Ci*	S	1	Rm 202	*1.20E-01*	6.0E-15
CO-57	5.00E-08	*Ci*	S	1	Rm 202	*6.18E-02*	3.1E-15
CO-60	5.00E-08	*Ci*	S	1	Rm 202	*5.11E+00*	2.6E-13
CS-137	5.00E-08	*Ci*	S	1	Rm 202	*5.02E+00*	2.5E-13
EU-154	5.00E-08	*Ci*	S	1	Rm 202	*4.06E+00*	2.0E-13
EU-155	5.00E-08	*Ci*	S	1	Rm 202	*1.71E-01*	8.6E-15
HG-203	5.00E-08	*Ci*	S	1	Rm 202	*4.51E-02*	2.3E-15
SB-125	5.00E-08	*Ci*	S	1	Rm 202	*6.32E-01*	3.2E-14
SN-113	5.00E-08	*Ci*	S	1	Rm 202	*4.70E-02*	2.4E-15
Y-90	5.00E-08	*Ci*	S	1	Rm 202	*1.12E-02*	5.6E-16
H-3	1.00E-06	*Ci*	S	1	Rm 202	*4.23E-04*	4.2E-16
C-14	1.00E-06	*Ci*	S	1	Rm 202	*5.06E-02*	5.1E-14
U-238	1.00E-03	*Ci*	S	1	G109/603	*6.40E+01*	6.4E-08
TH-232	1.00E-03	*Ci*	S	1	G109/603	*1.98E+02*	2.0E-07
EU-152	1.00E-03	*Ci*	S	1	G109/603	*4.98E+00*	5.0E-09
CO-60	1.00E-03	*Ci*	S	1	G109/603	*5.11E+00*	5.1E-09
CS-137	1.00E-03	*Ci*	S	1	G109/603	*5.02E+00*	5.0E-09
TC-99	8.93E-04	*Ci*	L	1	Rm. 501	*6.33E-01*	5.7E-07
BA-133	1.00E-03	*Ci*	L	1	Rm. 501	*1.54E+00*	1.5E-06
SR-90	1.00E-03	*Ci*	L	1	Rm. 501	*4.96E+00*	5.0E-06
U-238	2.70E-06	*Ci*	S	1	Rm. 501	*6.40E+01*	1.7E-10
U-238	2.70E-06	*Ci*	S	1	Rm. 501	*6.40E+01*	1.7E-10
U-238	3.92E-05	*Ci*	S	1	Rm. 501	*6.40E+01*	2.5E-09
U-238	3.92E-05	*Ci*	S	1	Rm. 501	*6.40E+01*	2.5E-09
TH-232	1.84E-05	*Ci*	S	1	Rm. 501	*1.98E+02*	3.6E-09
TH-232	1.84E-05	*Ci*	S	1	Rm. 501	*1.98E+02*	3.6E-09
TH-232	9.20E-06	*Ci*	S	1	Rm. 501	*1.98E+02*	1.8E-09
TH-232	9.20E-06	*Ci*	S	1	Rm. 501	*1.98E+02*	1.8E-09
TH-232	4.60E-06	*Ci*	S	1	Rm. 501	*1.98E+02*	9.1E-10
U-238	5.00E-05	*Ci*	S	1	Rm. 501	*6.40E+01*	3.2E-09
U-238	1.00E-08	*Ci*	S	1	Rm. 501	*6.40E+01*	6.4E-13
CO-60	4.46E-06	*Ci*	C	2	Rm. 612	*5.11E+00*	0.0E+00
NA-22	1.02E-06	*Ci*	C	2	Rm. 612	*2.49E+00*	0.0E+00
CO-57	1.07E-06	*Ci*	C	2	Rm. 612	*6.18E-02*	0.0E+00
AM-241	3.00E-08	*Ci*	C	2	Rm. 612	*2.94E+02*	0.0E+00
RA-226	3.00E-07	*Ci*	C	2	Rm. 612	*1.75E+01*	0.0E+00
RA-226	2.46E-06	*Ci*	C	2	Rm. 612	*1.75E+01*	0.0E+00
TH-228	2.29E-06	*Ci*	C	2	Rm. 612	*1.19E+02*	0.0E+00
AM-241	6.73E-06	*Ci*	C	2	Rm. 612	*2.94E+02*	0.0E+00
RA-226	4.11E-05	*Ci*	C	2	Rm. 612	*1.75E+01*	0.0E+00
RA-226	5.74E-05	*Ci*	C	2	Rm. 612	*1.75E+01*	0.0E+00
RA-226	1.00E-06	*Ci*	C	2	Rm. 612	*1.75E+01*	0.0E+00
RA-226	4.50E-03	*Ci*	C	2	Rm. 612	*1.75E+01*	0.0E+00
TH-230	1.00E-08	*Ci*	C	2	Rm. 612	*1.21E+02*	0.0E+00
Pu-238	6.00E-02	*grams*	L	3	Rm. 501	*3.16E+03*	1.9E-01
Np-237	2.10E+00	*grams*	L	3	Rm. 501	*1.84E-01*	3.9E-04
Pu-239	3.20E+00	*grams*	L	3	Rm. 501	*1.24E+01*	4.0E-02

Table A.1. (contd)

Am-243	1.10E+00	*grams*	L	3	Rm. 501	*5.47E+01*	6.0E-02
Am-241	5.00E-01	*grams*	L	3	Rm. 501	*9.50E+02*	4.7E-01
U(90%)	2.00E+00	*grams*	L	3	Rm. 501	*4.25E-03*	8.5E-06
U(nat)	3.27E+03	*grams*	L	3	Rm. 501	*4.40E-05*	1.4E-04
U(nat)	4.20E+03	*grams*	L	3	Rm. 245	*4.40E-05*	1.8E-04
Th-232	5.00E+02	*grams*	S	3	Rm. 245	*2.18E-05*	1.1E-08
AM-241	3.00E+00	*CI*	E	3,2		*2.94E+02*	0.0E+00
AM-241	3.00E+00	*CI*	E	3,2		*2.94E+02*	0.0E+00
AM-241	5.00E-02	*CI*	C	2		*2.94E+02*	0.0E+00
CS-137	2.00E-01	*CI*	C	2		*5.02E+00*	0.0E+00
CS-137	2.00E-01	*CI*	C	2		*5.02E+00*	0.0E+00
CO-57	6.24E-02	*CI*	C	2		*6.18E-02*	0.0E+00
NI-63	1.50E-02	*CI*	C	2		*1.05E-02*	0.0E+00

Appendix B

Nonradioactive Hazardous Materials Characterization

DOE Order 5400.1 states that Environmental Monitoring Plans (EMPs) "shall be prepared for each site, facility, or process that uses, generates, releases, or manages significant pollutants or hazardous materials" (DOE Order 5400.1, IV-2). The Facility Effluent Monitoring Plans (FEMPs) that are being prepared to support the EMP include the consideration of nonradioactive hazardous materials. No methodology has been developed to determine the potential release of nonradioactive hazardous chemicals, but hazardous chemicals are considered for the facilities that are determined to need a FEMP from potential radioactive airborne emissions.

A listing of the chemicals used in the building is obtained using the PNL Chemical Inventory System. The inventory information includes the location, chemical name, and quantity. In some cases the manufacturer and individual container quantities are also tracked. In addition, the CIS data includes the reportable quantity (RQ) of the chemical. RQs are obtained from 40 CFR 302 and are the amounts which, if released to the environment from a facility, require notification to the National Response Center. RQs can indicate the relative hazard of a chemical. For the FEMP facilities, chemicals that may be present in greater than RQ amounts were identified to characterize the potential for emissions of nonradioactive hazardous materials. These chemicals are listed in Table B.1 for the 3720 Facility. This table gives the location, type, and quantity of chemicals present in greater than RQs. The quantity for each container and the number of containers are listed. If no units are provided, only one container is present at the listed quantity.

Table B.1.

Bldg	Rm	Chemical	Qty, lbs	Units	RQ, lbs
3720	105	Cadmium Oxide	2.2		1
		Hydrogen Peroxide	1.06		1
	2	Chloroform	13.15	2	10
		Hydrogen Peroxide	1.25	2	1
			1.32		1
		Phosphorous Pentoxide	1.1		1
	210	Mercury	5.97		1
			2.98	4	1
	233	Lead	1.05		1
	303	Hydrogen Peroxide	1.32	2	1
	508	Chromic Chloride	1.1		1
		Hydroquinone	1.1	2	1
		Lead	2		1
		Lead Metal	5		1
		Mercury Metal	5	4	1
			2		1
			8		1
			16		1
			6		1
		Phosphorous Pentoxide	1.1		1
	510	Chlorotrimethlysilane	1.1		1
	512	Acrolein	1.1	2	1
		Acryloyl chloride	1.1		1
		Carbon Tetrachloride	14.04		10
		Methacrylyl Chloride	2.64		1
	602	Hydrogen Peroxide	1.25	2	1
		Phosphorous Pentoxide	1.1		1
	7	Lead	1.05		1

Appendix C

Data from Waste Stream Measurements

Data for a number of chemical constituents measured in the 3720 PS in 1994 is listed in Table C.1. In addition to these, gross alpha measurements ranging from 8 to 45 pCi/L and gross beta measurements ranging from 2 to 18 pCi/L were measured. All measurements were made on 24 hr flow-proportional composites.

Table C.1. Building 3720: Constituents in Liquid Effluent

Constituent	Frequency[a]	Concentration (μg/L)		
		Range	Average	Standard Deviation
General Chemical Parameters				
Alkalinity	11/11	40,000-80,000	59,100	11,362
Chemical oxygen demand	9/13	7,000-51,000	14,322	13,906
Cyanide	4/10	2-10	5	3.5
Sulfides	4/12	200-300	225	50
Total carbon	9/9	14,000-30,000	20,778	4,494
Total dissolved solids	12/12	80,000-150,000	108,333	18,990
Total organic carbon	10/10	2,000-16,000	4,400	4,195
Anions				
Chloride	12/12	3,800-4,700	4,250	261
Fluoride	12/12	400-600	492	79
Nitrate	12/12	100-2,000	600	564
Sulfate	12/12	15,000-18,000	16,417	793
Cations				
Aluminum	9/9	50-190	105	42
Barium	9/9	24-66	33.7	12.9
Calcium	9/9	20,000-29,000	22,000	2,828
Copper	9/9	6.8-130	26.1	39.1
Iron	9/9	53-110	82.7	18.6
Lead	9/9	1.1-7.1	3.4	1.8
Magnesium	9/9	4,300-6,400	5,000	620
Manganese	9/9	2-10	4.2	2.5
Mercury	11/12	0.10-0.87	0.24	0.23
Potassium	8/9	960-1,700	1,270	256
Sodium	9/9	3,100-13,000	6,456	2,878
Tin	4/9	34-65	52.8	14.1
Zinc	9/9	31-280	73.3	79.1
Organic Compounds				
Acetone	5/10	22-530	133	223
Bis(2-ethylhexyl)phthalate	5/8	1.2-7.6	3.8	2.5
Bromodichloromethane	4/6	0.75-1.3	0.98	0.2
Chloroform	10/10	5-18	11.9	3.9
Trichloroethene	10/10	1.0-1.8	1.3	0.2

(a) Number of samples with detectable constituent/total number of samples analyzed.

Appendix D

Ventilation System Flow Pathways