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Facility Effluent Monitoring Plan for the Plutonium Finishing Plant

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Prepared for the U.S. Department of Energy
Office of Environmental Restoration
and Waste Management

Westinghouse
Hanford Company Richland, Washington

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

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Facility Effluent Monitoring Plan for the Plutonium Finishing Plant

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FACILITY EFFLUENT MONITORING PLAN FOR THE PLUTONIUM FINISHING PLANT

ABSTRACT

A facility effluent monitoring plan is required by the U.S. Department of Energy in DOE Order 5400.1 for any operations that involve hazardous materials and radioactive substances that could impact employee or public safety or the environment. This document is prepared using the specific guidelines identified in* A Guide for Preparing Hanford Site Facility Effluent Monitoring Plans, WHC-EP-0438**. *This facility effluent monitoring plan assesses effluent monitoring systems and evaluates whether they are adequate to ensure the public health and safety as specified in applicable federal, state, and local requirements.*

This facility effluent monitoring plan is the first annual report. It shall ensure long-range integrity of the effluent monitoring systems by requiring an update whenever a new process or operation introduces new hazardous materials or significant radioactive materials. This document must be reviewed annually even if there are no operational changes, and it must be updated as a minimum every three years.

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*General Environmental Protection Program, *DOE Order 5400.1, U.S. Department of Energy, Washington, D.C., 1988.*

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

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LIST OF TERMS

ACGIH	American Conference of Governmental Industrial Hygienists
ACV	Administrative Control Value
ALARA	As Low As Reasonably Achievable
ANN	Aluminum Nitrate Nonahydrate
ANSI	American National Standards Institute
APCA	Benton, Franklin, and Walla Walla Counties Air Pollution Control Authority
ATD	Alpha Track Detector
BACT	Best Available Airborne Control Technology
BAT	Best Available Technology
BPT	Best Practical Control Technology
CAM	Continuous Air Monitor
CEM	Continuous Emission Monitoring
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CQL	Contractual Quantitation Limit
DBA	Design Basis Accident
DCG	Derived Concentration Guide
DL	Development Laboratory
DOE	U.S. Department of Energy
Ecology	Washington (State) Department of Ecology
ECL	Environmental Control Limit
ECM	Environmental Compliance Manual
EDE	Effective Dose Equivalent
EHW	Extremely Hazardous Waste
EL	Engineering Laboratory
EMP	Environmental Monitoring Plan
EMS	Effluent Monitoring/Sampling System
EP	Westinghouse Hanford Company Environmental Protection
EPA	U.S. Environmental Protection Agency
ES&H	Environmental Protection, Safety, & Health
FEMP	Facility Effluent Monitoring Plan
HA	Hazardous Airborne
HEPA	High Efficiency Particulate Air
HF	Hydrogen Fluoride
HL	Hazardous Liquid
HPT	Health Physics Technologist
HVAC	Heating, Ventilation, and Air Conditioning
ICRP	International Commission on Radiological Protection
MRP	Management Requirements and Procedures Manual
MT	Miscellaneous Treatment
NESHAP	National Emission Standards for Hazardous Air Pollutants
NPDES	National Pollutant Discharge Elimination System
OEC	Operations and Engineering Center
ONC	Occurrence Notification Center
OSR	Operational Safety Requirement
PCB	Polychlorinated Biphenyl

LIST OF TERMS (continued)

PFP	Plutonium Finishing Plant
PMT	Photomultiplier Tube
PNL	Pacific Northwest Laboratory
POP	Plant Operating Procedure
POTW	Publicly Owned Treatment Works
PPCW	Protected Process Cooling Water
ppmw	parts per million by weight
PRF	Plutonium Reclamation Facility
PSD	Prevention of Significant Deterioration
PSF	Plutonium Storage Facility
PVC	Polyvinyl Chloride
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
RA	Radioactive Airborne
RCG	Radioactivity Concentration Guide
RCRA	Resource Conservation and Recovery Act
RL	Radioactive Liquid
RMA	Remote Mechanical "A"
RMC	Remote Mechanical "C"
RPD	Relative Percentage Difference
RQ	Reportable Quantity
S&C	Slag and Crucible
SAR	Safety Analysis Report
SARA	Superfund Amendments and Reauthorization Act
SNM	Special Nuclear Material
SPCC	Spill Prevention Control and Countermeasure
TSD	Treatment, Storage, Disposal
UOR	Unusual Occurrence Report
WAC	Washington Administrative Codes
Westinghouse Hanford	Westinghouse Hanford Company
WT	Waste Treatment and Americium Recovery Facility

GLOSSARY

Administrative Control Values (ACVs). Contractor-imposed radionuclide and hazardous material release limits usually based upon ALARA goals for protection of the public.

Contractor. A company or entity that has entered into a prime contract to operate a Hanford facility or perform a function for DOE Field Office, Richland.

Crib. Subsurface liquid waste disposal that allows liquid waste to percolate into surrounding soil.

Dangerous Waste. Washington State designation for solid wastes specified in WAC 173-303-070 through 173-303-103 as dangerous or extremely hazardous waste.

Derived Concentration Guides (DCGs). The concentration of a radionuclide in air or water that, under conditions of continuous exposure for one year by one exposure mode, would result in an effective dose equivalent of 100 mrem. DCGs do not consider decay products when the parent radionuclide is the cause of the exposure. DCGs are listed in DOE Order 5400.5, Chapter III, and contractor safety and environmental compliance manuals.

Discharge Point or Effluent Discharge Point. The point at which an effluent or discharge enters the environment from the facility in which it was generated.

Effective Dose Equivalent (EDE). The summation of the products of the dose equivalent received by specified tissues of the body and a tissue-specific weighting factor. This sum is a risk-equivalent value and can be used to estimate the health-effects risk of the exposed individual. The tissue-specific weighting factor represents the fraction of the total health risk resulting from uniform whole-body irradiation that would be contributed by that particular tissue. The effective dose equivalent includes the committed effective dose equivalent from internal deposition of radionuclides and the effective dose equivalent because of penetrating radiation from sources external to the body. Effective dose equivalent is expressed in units of rem (or sievert).

Effluent. Any treated or untreated air emission or liquid discharge at a DOE site or from a DOE facility.

Effluent Monitoring. Measurement of liquid and gaseous effluents for the purpose of characterizing and quantifying contaminants, assessing radiation exposures of members of the public, providing a means to monitor and/or control effluents at or near the point of discharge, and demonstrating compliance with applicable standards and permit requirements.

Effluent Sampling. The continuous or intermittent collection and analysis of effluent samples for the purpose of characterizing and quantifying contaminants, assessing radiation exposures of members of the public, providing a means to control effluents at or near the point of discharge, and demonstrating compliance with applicable standards and permit requirements.

Environmental Control Limits. Contractor limits based upon permit limits and contractor policies as derived from DOE requirements.

Environmental Occurrence. Any sudden or sustained deviation (categorized as emergencies, unusual occurrences, or off-normal occurrences) from a regulated or planned performance at a DOE operation that has environmental protection and compliance significance. Typical occurrences of interest to this document include failure of primary or secondary facility effluent monitoring equipment or a monitored/unmonitored release of regulated materials exceeding administrative control values.

Environmental Surveillance. The collection and analysis of samples, or direct measurements, of air, water, soil, foodstuffs, biota, and other media from DOE sites and their environs for the purpose of determining compliance with applicable standards and permit requirements, assessing radiation exposures of members of the public, and assessing the effects, if any, on the local environment.

Extremely Hazardous Waste. Washington State designation for waste specified in WAC 173-303-070 through 173-303-103.

French Drain. A rock-filled encasement with an open bottom to allow drainage into the soil. A French drain is used for the disposal of relatively low volume, low level radioactive solution.

Hazardous Substance or Material. Solid, liquid, or gaseous material as defined by the following regulations:

a. Any CERCLA hazardous substance identified in 40 CFR 302.4.

b. Any Superfund Amendments and Reauthorization Act (SARA) extremely hazardous substance identified in Appendix A of 40 CFR 355.

c. Any dangerous waste regulated pursuant to WAC Chapter 173-303, "Dangerous Waste Regulations."

Hazardous Waste. Solid wastes designated by 40 CFR Part 261, and regulated as hazardous wastes by the EPA or Washington State (WAC 173-303). This term includes dangerous waste, extremely hazardous wastes, and toxic dangerous waste.

In-Line Monitor. A system in which a detector or other measuring device is placed in the effluent stream for the purpose of performing measurements on the effluent stream.

Inventory at Risk. The quantity and/or type of radioactive and/or nonradioactive hazardous material present in a facility with the potential to enter a gaseous or liquid effluent stream.

Isokinetic. A condition that exists when the velocity of air entering a sampling probe held in an airstream is identical to the velocity axis of flow of the airstream being sampled at that point.

Mixed Waste. Waste containing both radioactive and hazardous components regulated by the Atomic Energy Act and the Resource Conservation and Recovery Act (RCRA), respectively.

Non-Complexed. Waste that does not contain the chelating agents ethylenediaminetetraacetic acid, hydroxyethylethylenediaminetriacetic acid, citric acid, or hydroxyacetic acid.

Non-Conformance. A non-conformance exists when any of the following have occurred, and the appropriate recovery actions are implemented:

a. Exceeding an Environmental Control Limit (ECL).

b. Failure to meet an environmental surveillance requirement.

c. Failure to implement an environmental administrative control.

d. Failure of primary environmental monitoring equipment to pass a surveillance check.

Normal Operations. A plant operating condition where all processes and safety control devices are operating as designed.

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

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 spoil.

Plutonium Finishing Plant (PFP). As used in this report, the entire PFP complex, which includes the primary processing facility and the ancillary and support buildings. The primary processing facility itself is commonly referred to as PFP.

PFP Complex. The PFP primary processing facility and the ancillary and support buildings.

PFP Complex Facilities. Individual facilities, buildings, or structures within the PFP Complex.

Primary Environmental Monitors. Monitoring equipment legally required to monitor ongoing discharges. In general, this term applies to monitors closest to the point of discharge which are used to determine if discharges are within specified limits.

Radioactive Component. Refers only to the actual radionuclides dispersed or suspended in the waste substance.

Releases. 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 an unenclosed containment structure.

Reportable Quantities. That quantity of hazardous substances as listed in 40 CFR 302 which, if released, requires notification as per 40 CFR 302. These quantities also provide a criteria for requiring FEMPs with respect to nonradioactive hazardous substances.

Riser. A pipe connected to the top of an underground storage tank and extended to the surface of the ground. Pumps and instruments are inserted into a waste tank through a riser.

Secondary Environmental Monitors. Environmental monitoring equipment or activities which, if degraded, will produce a more than minor disruption of a monitoring program. An example of a minor effect would be the failure of a unit whose place in the program is effectively duplicated by overlap between one or more components.

Shutdown Condition. A plant condition where all processes involving radioactive and/or hazardous materials are inactive and otherwise stable.

Source Term. The amount, activity, or concentration and the effective release height of a hazardous or radioactive material in a facility effluent stream at the point of discharge that is available to expose personnel either within the facility or beyond the site boundary.

Statistically Significant Increase. When used in reference to a continuous release of a hazardous substance listed in 40 CFR 302.4, this term refers to the largest 5 percent of all continuous releases. Determination of statistical significance shall be based on any of the following:

a. The non-parametric statistical test.

b. The control chart or student *t* test.

c. Other tests that have equivalent sensitivity to (a) or (b).

Tank Farm. An area of underground tanks designed to store high-level liquid wastes generated by the processing of nuclear fuel.

Toxic Dangerous Wastes. Washington State designation for wastes meeting the criteria specified in WAC 173-303-101.

Transuranic. Any radionuclide having an atomic number greater than 92.

Underground Injection. Subsurface emplacement of fluids through a bored, drilled, or driven well or through a drywell where the depth of the drywell is greater than the largest surface dimension.

<u>Upset Condition</u>. Any one condition that is outside the normal process operating parameters, or an unusual plant operating condition where one material confinement/containment barrier or engineered or administrative control has failed.

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FACILITY EFFLUENT MONITORING PLAN FOR THE PLUTONIUM FINISHING PLANT

1.0 PLUTONIUM FINISHING PLANT FACILITY EFFLUENT MONITORING PLAN (FEMP)

1.1 INTRODUCTION

The purpose of this section is to provide information on the policy, purpose, and scope of the Plutonium Finishing Plant (PFP) Facility Effluent Monitoring Plan (FEMP). This section also provides background information on the preparation of the FEMP.

1.1.1 Policy

It is the policy of the U.S. Department of Energy (DOE) and Westinghouse Hanford Company (Westinghouse Hanford) to conduct effluent monitoring to determine whether the public and the environment are adequately protected during the DOE operations and whether operations are in compliance with the DOE and other applicable Federal, State, and local emission standards and requirements. It is also the policy of DOE and Westinghouse Hanford that effluent monitoring programs meet high standards of quality and credibility.

1.1.2 Purpose

The purpose of this FEMP is to assess the magnitude of routine and potential liquid and airborne effluent releases from the PFP to determine the compliance of effluent monitoring systems and sampling programs with applicable Federal, State, and local regulations.

1.1.3 Scope

The scope of this document includes program plans for monitoring and characterizing radioactive and nonradioactive hazardous materials discharged in the PFP complex effluents. This FEMP includes complete documentation for both gaseous and liquid effluent monitoring systems that monitor radioactive and nonradioactive hazardous pollutants that could be discharged to the environment under routine and/or upset conditions. This documentation is provided for each facility that uses, generates, releases, or manages significant quantities of radioactive and nonradioactive hazardous materials that could impact public and employee safety and the environment. This FEMP describes the airborne and liquid effluent paths and the associated sampling and monitoring systems of the PFP complex facilities. Sufficient information is provided on the effluent characteristics and the effluent monitoring systems so that a compliance assessment against requirements may be performed. Adequate details are supplied such that radioactive and hazardous material source terms may be related to specific effluent streams which are, in turn, related to discharge points and finally, compared to the effluent monitoring system capability. Details are provided only for those streams determined previously to require a FEMP.

1.1.4 Discussion

The characterization of the radioactive and nonradioactive hazardous constituents in each effluent stream provides the underlying rationale for the sampling and monitoring programs. The method of characterization discussed in this FEMP identifies potential pollutants at the point of generation and tracks the constituents in effluent streams as they move from their generation point to the point of discharge.

Included is information from the *Facility Effluent Monitoring Plan Determination for the 200 Area Facilities* (WHC 1991a), evaluating whether PFP complex facilities meet the criteria for requiring a FEMP. The determinations were made in accordance with "A Guide for Preparing Hanford Facility Effluent Monitoring Plans" dated September 1990 (WHC 1990b). The evaluations were made based upon information obtained in documents, interviews with cognizant engineers, and personal observations.

A FEMP is required if the total projected dose from radionuclides exceeds 0.1 mrem effective dose equivalent (EDE) from any one discharge point or if any one regulated material discharged from a facility exceeds 100% of a reportable quantity (RQ) as listed in 40 Code of Federal Regulations (CFR) 302.4 (EPA 1985a) or is designated a Dangerous Waste in Washington Administrative Codes (WAC) 173-303-70 through 173-303-103 (WAC 1989) (e.g., a permitted quantity). DOE Orders also require a FEMP evaluation to consider anticipated facility upset conditions.

Data used in this evaluation converting projected radionuclide releases to offsite doses were developed by the Pacific Northwest Laboratory (PNL). Airborne releases were assumed to occur from either an 89 m stack or at ground level from a central location in the 200 West Area. The distance from the 200 West release point to the offsite location was assumed to be 24,000 m.

Where possible, actual monitoring data were used to project the radiation dose to offsite individuals. When actual data were used, a multiplication factor of 3000 was assumed for gaseous effluent systems that were normally filtered with high efficiency particulate air (HEPA) filters. This was consistent with the U.S. Environmental Protection Agency (EPA) requirement that no pollution control equipment be considered in estimating radionuclide release rates (EPA 1989). Where no actual monitoring data existed, the best available source term data were used. Also where possible, individual radionuclides were used to calculate radiation doses. In some cases, only total alpha and total beta figures were available. In those cases, ^{239}Pu and ^{90}Sr were used to represent total alpha and beta, respectively.

One PFP complex liquid effluent stream was identified as requiring a FEMP based on the calculated EDE exceeding 0.1 mrem: the 216-Z-20 Crib. Also, one PFP complex stack was identified as requiring a FEMP: the 291-Z-1 Main Stack. A second stack, the 296-Z-14 Stack, was determined to not require a FEMP based on the 0.1 mrem criterion, although the calculated dose was much closer to 0.1 mrem than the calculated dose provided in the FEMP Determination Report. The 296-Z-14 Stack exhausts air from the 232-Z Building Incinerator, which is currently not operational and is being prepared for decontamination and decommissioning. The new dose estimate for this effluent stream was based on a reevaluation of the potential releases based on recent source term information. Although it was determined that a FEMP was not required, future detailed evaluations of upset conditions based on planned decontamination efforts may necessitate a reevaluation of the need for a FEMP.

In-depth details of the two effluent streams requiring a FEMP and the associated monitoring systems are included in this FEMP. Information on all other effluent streams identified previously in the FEMP Determination Report is also included in this FEMP but not in the detail provided for the effluent streams mentioned above.

Calculations were made for the EDEs for each effluent stream and were documented in the FEMP Determination Report. These calculations were based on both normal operational data and upset conditions. For this FEMP, these calculations have been performed again with some reevaluations or corrections where necessary. Information that summarizes the calculations has been included as part of this report as Attachment 16.2. In the FEMP Determination Report, two additional effluent streams were designated as requiring a FEMP: the 216-Z-13, 216-Z-14 and 216-Z-15 French drains for the 291-Z Building and the 2734-ZL Heating, Ventilation, and Air Conditioning (HVAC) Exhaust for the 2734-ZL Building. The French drains have been reevaluated as not requiring a FEMP based on the availability of more detailed information on the potential source term. The 2734-ZL Building has been reevaluated as not requiring a FEMP based on the recent and permanent removal of the source term from the facility.

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2.0 FACILITY DESCRIPTION

This section contains brief descriptions of the physical characteristics of the PFP complex, the primary facility process, and information with respect to potential process source terms present in the facility. Information on certain support buildings is also presented.

2.1 BRIEF FACILITY PHYSICAL DESCRIPTION

The PFP complex includes a number of operations involved in the recovery and chemical conversion of plutonium. It is located in the 200 West Area of the Hanford Site, which is located in the south central region of Washington State. The complex consists of one primary processing facility and several ancillary buildings. The PFP complex process and support buildings include 234-5Z, 236-Z, 231-Z, 232-Z, 241-Z, 242-Z, 270-Z, 291-Z, 2736-Z, 2736-ZA, and 2736-ZB. Auxiliary facilities were described briefly in the PFP FEMP Determination Report. Figure 2.1 shows the arrangement of the PFP complex.

2.1.1 The 234-5Z Building

The 234-5Z Building, also referred to as PFP or the 234-5 Building, has approximate dimensions of 180 ft wide by 500 ft long. The 234-5Z Building extends from 9.5 ft below grade to 46.8 ft above grade. Floor levels are designated as the basement, first floor, duct level, second floor, and roof level. Noncombustible materials of construction are used. The frame is of structural steel with an outer sheathing of aluminum panels over rock wool insulation and 16-gauge sheet steel. The first floor is a concrete slab, the duct level is sheet-metal roof decking, and the second floor is a concrete slab. The roof is insulated metal decking. Interior walls are reinforced concrete steel structure, or metal studs, metal lath, and plaster. The vault and process area doors are constructed of steel with combination safe-type locks.

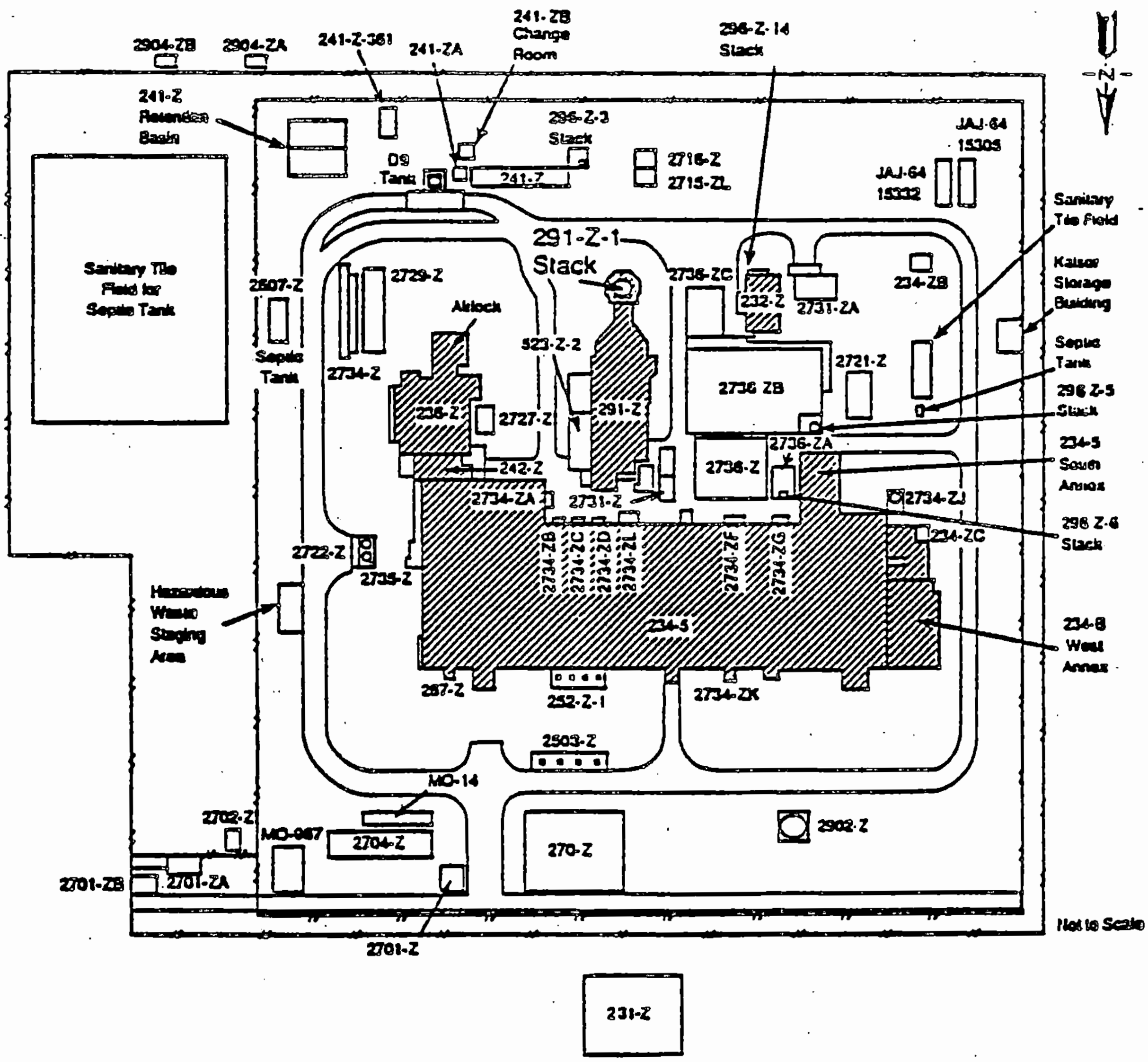
2.1.2 The 236-Z Building

The 236-Z Building is located south of the southeastern corner of the 234-5Z Building and is connected to it by the 242-Z Building. The 236-Z Building, built as the CAC-880 Project, houses the Plutonium Reclamation Facility (PRF). It is also referred to as 880, PRF, Plutonium Nitrate Production Facility, or 236. Building air is exhausted through the 291-Z-1 Stack.

The building is essentially a four-story structure, surmounted by a two-story penthouse. Its dimensions are about 79 ft wide by 71 ft long. Its outstanding internal structural feature is a single process equipment cell that is 32 ft wide by 52 ft long, extending through the third floor.

The building is of reinforced concrete construction, with the exception of the roof and the fourth floor ceiling. The roof is of open-web steel joist framing, steel decking, rigid insulation, and graveled built-up roofing.

Figure 2-1. PFP Complex Facilities.



A portion of the southern building wall is also the south wall of the process cell and includes an opening in the reinforced concrete wall for moving large equipment. This opening is filled by a door and surrounding block wall. The concrete block wall has been steel plated and reinforced to withstand seismic effects.

2.1.3 The 231-Z Building

The 231-Z Building consists of two stories of reinforced concrete and concrete block construction. The second floor is essentially one large open bay with floor area of approximately 23,500 ft^2 used for piping, ventilation ducts, filter cages, miscellaneous storage, and supporting facilities (vacuum pumps, hydraulic equipment, etc.) for equipment on the first floor. The first floor area is approximately 27,000 ft^2, of which 5,300 ft^2 is used for building service machinery. The remaining 21,700 ft^2 is laboratory area. In addition to the main structure, there is a 3,000-ft^2 office extension of concrete block construction. The office building is attached to the laboratory structure and is isolated by air locks. The office building has refrigerated air conditioning completely separated from the laboratory ventilation system. Building air is exhausted through the 296-Z-10 and 296-Z-11 Stacks.

2.1.4 The 232-Z Building

The 232-Z Building houses the layaway Contaminated Waste Recovery Process. It was commonly called the "Incinerator." It was constructed by Project CGC-013, Plutonium Recovery from Contaminated Material. The Contaminated Waste Recovery Process was partially decontaminated and decommissioned in 1984.

The 232-Z Building is of concrete block construction. Its approximate dimensions are 37 ft wide by 57 ft long. It is divided into areas for process, storage, changeroom, chemical preparation, ventilation, and electrical equipment. Except for ventilation supply and exhaust filtration, it uses electrical and steam services from the 234-5Z and 291-Z Buildings.

2.1.5 The 241-Z Building

The 241-Z Building is designated as the Waste Treatment Facility. It is commonly called the 241-Z Sumps and in the past was called the 216-Z Large Waste Sump Tanks. It is a buried structure, with a sheet-metal enclosure over the top of it, which houses a hoist for removing cell covers. It consists of five separate enclosures or ventilated cells, each containing a 20,000-L tank used to accumulate the liquid wastes generated in the PFP before transfer to the tank farms. Built of reinforced concrete, its approximate dimensions are 20 ft wide, 92 ft long, and 22 ft deep. It is located approximately 330 ft south of the 234-5Z Building.

At the southwest corner of the 241-Z Vault Deck is the equipment for the 241-Z vessel vent and vault ventilation system. The 24-ft-high 296-Z-3 Stack and its associated fans, filters, and controls are located on a 14-ft by 18-ft concrete pad. Building air is exhausted through the 296-Z-3 Stack.

2.1.6 The 242-Z Building

The 242-Z Building houses portions of the Waste Treatment and Americium Recovery Facility, which are in layaway and planned for future decontamination and decommissioning. Built primarily by Project CGC-912, it is usually referred to as "912" or "WT".

2.1.7 The 270-Z Building

The 270-Z Building, also known as the PFP Operations Support Building, is a wood-frame structure with sheetrock inner walls. This building houses Plant Management, Engineering, and Nuclear Facility Safety Personnel.

2.1.8 The 291-Z Building

The 291-Z Building (known as the Exhaust Fan House, Exhaust Air Stack Building, and Compressor and Fan House) is a reinforced-concrete structure located approximately 53 ft south of the central part of the 234-5Z Building. Of irregular shape, its approximate dimensions are 74 ft wide by 143 ft long. Its overall height is approximately 23 ft, with only 4 ft above grade. This building houses the exhaust fans, the mechanical service equipment, and the substation.

Auxiliary to the 291-Z Building is the 200-ft-high 291-Z-1 Stack. Constructed of reinforced concrete, its center is 63 ft from the near end of the 291-Z Building and 230 ft from the south wall of the 234-5Z Building.

2.1.9 The 2736-Z and 2736-ZA Buildings

The 2736-Z Building is the primary PFP Plutonium Storage Facility (PSF). Building 2736-Z is approximately 65 ft long by 56 ft wide. The building consists of four rooms for the storage of special nuclear material (SNM), divided by a corridor running the width of the building. The building is constructed of reinforced concrete walls, 14 in. thick, supported by cast-in-place concrete columns. The roof is a cast-in-place 6.5-in.-thick concrete slab. The 2736-ZA Building provides ventilation for the 2736-Z Building. Air from the 2736-Z Building is exhausted through the 296-Z-6 Stack located on the roof of the 2736-ZA Building.

2.1.10 The 2736-ZB Building

The 2736-ZB Building is located immediately to the south of the 2736-Z Building. The building is approximately 132 ft by 90 ft with reinforced concrete walls (except for administrative areas) and roof.

Air from the 2736-ZB Building is exhausted through the 296-Z-5 Stack, which is located on the roof of the 2736-ZB Building. The building is used primarily for shipping and receiving plutonium products and miscellaneous solid scrap materials. It contains approximately 2,000 ft^2 of floor space to accommodate shipping containers.

2.2 BRIEF PROCESS DESCRIPTION

The following is a brief description of the process that generates potential liquid and gaseous effluents in the PFP complex. A process flow diagram is provided in Figure 2.2.

2.2.1 The 234-5Z Building Process

In the past, the primary plutonium process in the 234-5Z Building converted plutonium nitrate solution to metallic plutonium. Future operations will convert plutonium nitrate solution to plutonium oxide powder. Past and future process operations are the following:

- Receipt of plutonium nitrate
- Precipitation and filtration of plutonium oxalate
- Calcination of the oxalate to plutonium dioxide
- Fluorination of the oxide to plutonium fluoride (Inactive)
- Reduction of the fluoride to metallic plutonium (Inactive).

Plutonium nitrate solutions are transferred from various containers into one of three designated 30-L batch tanks located in a glovebox. From the glovebox tanks, the solution is vacuum transferred to one of the six 22-L storage tanks, eventually to be processed in the Remote Mechanical "C" (RMC) Line, where conversion to plutonium oxide powder occurs.

After the plutonium solutions are blended in the batch tanks by recirculation, the nitric acid concentration is adjusted, if required. The solution is then continuously pumped to another tank for reaction with oxalic acid to form plutonium oxalate precipitate. The precipitate is collected on a drum filter and fed to a calciner. The filtrate is treated with potassium permanganate ($KMnO_4$) to initiate destruction of the excess oxalic acid and then is sent to the 236-Z Building (PRF) for concentration and destruction of the remaining oxalic acid. The oxide powder product is then placed into storage.

The 234-5Z Building also contains the shut down Remote Mechanical "A" (RMA) Line, which has produced plutonium dioxide powders, and is located north of the RMC Line. The equipment in the RMA Line is similar to that for the RMC Line through the calciner step and for canning powder. It will not be described here because it produces no emissions and is in lay-away pending decommissioning.

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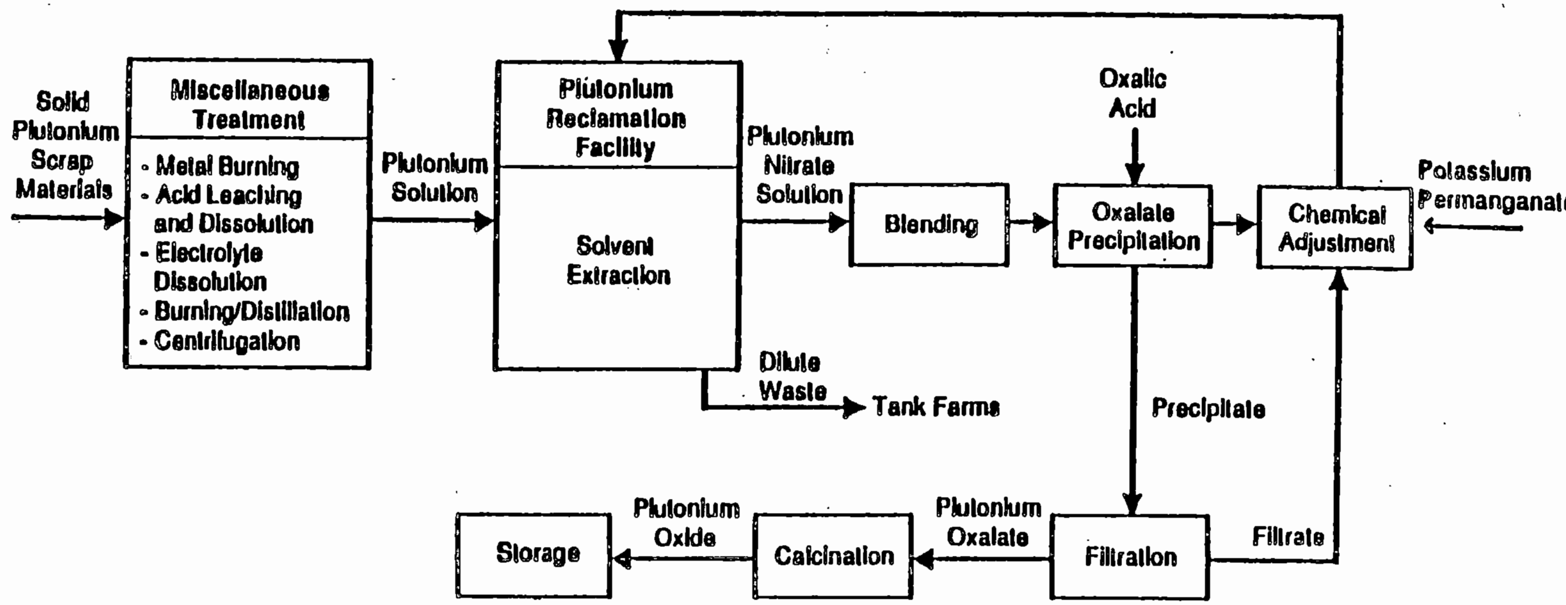

Figure 2-2. Process Flow Diagram for the PFP Complex.

2.2.2 The 236-Z Building Process

The 236-Z Building houses the PRF process equipment and services for miscellaneous treatment (MT), slag and crucible dissolution, filtrate concentration, feed preparation, plutonium solvent extraction, product concentration, and waste treatment processes. The PRF is capable of producing a high-purity plutonium nitrate solution from a variety of feed sources by means of continuous countercurrent solvent extraction process equipment located in a canyon cell.

A cluster of five gloveboxes contains the MT processes. The MT is a multipurpose facility previously capable of small-scale processes for plutonium recovery from scrap, portions of which are in active status. Its primary equipment includes dissolver pots, hot plates, centrifuges, condensers, and furnaces. Capabilities included metal oxidation (Glovebox 1), acid leaching and dissolution (Glovebox 5), electrolytic dissolution (Glovebox 3), and distillation and oxidation of plutonium-bearing organics (Glovebox 4). Glovebox 6 contains centrifuges and a vacuum pump. Glovebox 2 no longer exists. Only operations in Gloveboxes 5 and 6 are in active status.

2.2.3 The 232-Z, 242-Z, and 291-Z Building Processes

The 232-Z, 242-Z, and 291-Z Buildings do not house active processes at the present time. The 232-Z Building contains an incinerator facility that is in lay-away status. The 242-Z Building previously housed the Waste Treatment and Americium Recovery Facility. The 291-Z Building houses a substation, mechanical service equipment, and exhaust fans.

2.3 IDENTIFICATION AND CHARACTERIZATION OF POTENTIAL SOURCE TERMS

This section summarizes the potential process source terms present in the PFP complex. Tables 2-1 and 2-2 summarize the source term information developed in the FEMP Determination Report for both radioactive and hazardous materials. Some of the values presented in the tables are different from those presented in the FEMP Determination Report because each effluent stream was reevaluated in order to incorporate the most recently available source term information.

Table 2-1. Radioactive Material Potential Source Terms in the PFP Complex.

Radionuclide	Form	Facility	Discharge Point	Releasable Quantity (Ci/yr)(a)	Projected Dose (mrem/yr)(b)
^{90}Sr	Liquid	234-5Z, 291-Z, 236-Z, 2736-ZB, 231-Z	216-Z-20 Crib	6.7E-3	4.1E-5(c)
^{137}Cs	Liquid	234-5Z, 291-Z, 236-Z, 2736-ZB, 231-Z	216-Z-20 Crib	1.4E-2	4.5E-3(c)
^{238}Pu	Liquid	234-5Z, 291-Z, 236-Z, 2736-ZB, 231-Z	216-Z-20 Crib	4.5E-3	2.6E-5(c)
^{239}Pu	Liquid	234-5Z, 291-Z, 236-Z, 2736-ZB, 231-Z	216-Z-20 Crib	7.8E-3	4.7E-5(c)
^{241}Pu	Liquid	234-5Z, 291-Z, 236-Z, 2736-ZB, 231-Z	216-Z-20 Crib	5.1E-2	4.9E-6(c)
^{241}Am	Liquid	234-5Z, 291-Z, 236-Z, 2736-ZB, 231-Z	216-Z-20 Crib	7.2E-3	1.4E-3(c)
^{239}Pu	Particulate	234-5Z, 236-Z, 242-Z	291-Z-1 Main Stack	1.2E-0	1.9E-0(d)
^{90}Sr	Particulate	234-5Z, 236-Z, 242-Z	291-Z-1 Main Stack	1.4E-1	1.1E-3(d)
^{239}Pu	Particulate	241-Z	296-Z-3 Stack	2.2E-3	1.2E-2(d)
^{90}Sr	Particulate	241-Z	296-Z-3 Stack	1.3E-3	3.4E-5(d)
^{239}Pu	Particulate	2736-ZB	296-Z-5 Stack	1.3E-3	6.7E-3(d)
^{90}Sr	Particulate	2736-ZB	296-Z-5 Stack	4.5E-3	1.2E-4(d)
^{239}Pu	Particulate	2736-Z	296-Z-6 Stack	1.6E-3	8.2E-3(d)
^{90}Sr	Particulate	2736-Z	296-Z-6 Stack	5.4E-3	1.4E-4(d)
Pu(e)	Particulate	231-Z	296-Z-10, 11 Stacks	4.2E-4	2.8E-4(d)
^{241}Am	Particulate	231-Z	296-Z-10, 11 Stacks	1.0E-4	8.0E-4(d)
Pu(e)	Particulate	232-Z	296-Z-14 Stack	1.0E-1	7.5E-2(d)
^{241}Am	Particulate	232-Z	296-Z-14 Stack	9.5E-4	7.3E-3(d)

(a) Releasable quantities based on information provided in the FEMP Determination Report (WHC 1991a) and updated as described in this report.
(b) Projected doses were calculated from the releasable quantities using conversion factors provided by WHC (1991).
(c) Value calculated using the GENII conversion factors from WHC (1991a) for direct release to Columbia River. Because the actual releases are not directly to the Columbia River, the value is conservative.
(d) Value calculated using the CAP88 conversion factors from WHC (1991a).
(e) Various isotopes.

Table 2-2. Hazardous Material Potential Source Terms in the PFP Complex.

Chemical	Facility	Discharge Point	Releasable Quantity (lb)(a)	Reportable Quantity (lb)
HNO_3	234-5Z, 236-Z	216-Z-20 Crib	6(b)	1000
CCl_4	234-5Z, 236-Z	291-Z-1 Main Stack	75/d	10
NO_x	234-5Z, 236-Z	291-Z-1 Main Stack	100/yr, <10/d	10
HCl	234-5Z, 236-Z	291-Z-1 Main Stack	20/yr	5000
Acetone	234-5Z, 236-Z	291-Z-1 Main Stack	140/yr(b)	5000
CCl_4	241-Z	296-Z-3 Stack	<10(b)	10
NO_x	241-Z	296-Z-3 Stack	<10(b)	10

(a) Releasable quantities based on information provided in the FEMP Determination Report (WHC 1991a) and updated as described in this report.
(b) Upset condition.

3.0 APPLICABLE REGULATIONS

The purpose of this section is to present information on the regulations governing effluent monitoring requirements for radioactive, nonradioactive hazardous, and mixed waste materials in effluents. It also focuses on the applicable environmental standards and statutes.

3.1 REGULATIONS

Regulations pertaining to effluent releases at Hanford have been developed by several regulatory agencies including the EPA, DOE, Washington State, and the Benton-Franklin-Walla Walla Counties Air Pollution Control Authority (APCA). A summary of applicable regulations and standards is presented in Table 3-1. Because the regulations enforced by these agencies are sometimes inconsistent, Westinghouse Hanford may enforce more restrictive requirements as a matter of policy. Westinghouse Hanford has documented the policies for compliance in the *Environmental Compliance Manual* (ECM) (WHC 1991c).

3.1.1 Protection of the Public and the Environment

To ensure the health and safety of the public, DOE-controlled facilities are required to monitor effluents that have the potential to contain regulated materials. Regulations pertaining to the monitoring and environmental surveillance of effluents are typically based on the effluent release limits for specific materials that are associated with risk to the public. Monitoring requirements and associated limitations may also be based on best available technology (BAT for liquid control technology, BACT for airborne control technology), best practical control technology (BPT) currently available, or other technology-based criteria. In addition, some monitoring requirements and associated limitations are based on environmental protection criteria, such as water quality-based release standards. The effluent release limits for nonradioactive and radioactive materials are designed to ensure that the risk to the public and the environment posed by these facilities is at an acceptable level.

As documented in 40 CFR Part 61, *National Emission Standards for Hazardous Air Pollutants* (NESHAP) (EPA 1989a), effluent release limits for radioactive materials are based on limiting risk to the public by limiting the potential dose to the maximally exposed member of the public. Similarly, for most nonradioactive materials, the risk to the public and the environment is controlled by limiting the quantities of materials released.

In the case of nonradioactive effluents, monitoring requirements may also exist at the point of generation for the protection of the worker. To provide a safe workplace environment, monitoring of nonradioactive effluents is based on the level or quantity of material present at the point of generation within the facility. Currently, an accurate method does not exist for projecting from the inventory at risk to the estimated release source term at the release

Table 3-1. Applicable Regulations and Standards.

Agency/Originator	Regulation No.	HA	HL	RA	RL	Summary/Application
U.S. Department of Energy, (DOE) Washington, D.C.	DOE Order 5400.1, 1988 General Environmental Protection Program	X	X	X	X	Outlines effluent monitoring requirements
	DOE Order 5400.5, 1990 Radiation Protection of the Public and Environment			X	X	Protects public/environment from radiation associated with DOE operations
	DOE Order 5480.4, 1989 Environmental Protection, Safety, and Health Protection Standards	X	X	X	X	Sets requirements for the application of the mandatory environmental protection, safety, and health (ES&H) standards; lists reference ES&H standards
	DOE Order 5484.1, 1981 Environmental Protection, Safety, and Health Protection Information Reporting Requirements	X	X	X	X	Sets requirements for reporting information having environmental protection, safety and health protection significance
	DOE Order 5820.2A, 1988 Radioactive Waste Management	X	X	X	X	Sets radioactive waste management requirements
U.S. Environmental Protection Agency, (EPA) Washington, D.C.	40 CFR 61, 1989 National Emission Standards for Hazardous Air Pollutants	X		X		Sets national emission standards for hazardous air pollutants (NESHAP)
	Subpart A General Provisions	X				Regulates hazardous pollutants
	Subpart H National Emission Standards for Emissions of Radionuclides other than Radon from Department of Energy Facilities			X		Sets emissions standards/monitoring requirements for radionuclides
	40 CFR 122, 1983 EPA Administered Permit Programs: The National Pollutant Discharge Elimination System		X			Governs release of nonradioactive liquids
	40 CFR 141.16, 1989 Safe Drinking Water Act (National Interim Primary Drinking Water Regulations)				X	Sets maximum contaminant levels in public water systems
	40 CFR 191, 1985 Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes				X	Regulates radioactive waste disposal
	40 CFR 261, 1989 Identification and Listing of Hazardous Waste		X			Identifies and lists hazardous wastes
	40 CFR 302.4, 1980 Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA): Designation, Reportable Quantities and Notification	X	X	X	X	Designates hazardous materials, reportable quantities, notification process

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Table 3-1. Applicable Regulations and Standards.

Agency/Originator	Regulation No.	HA	HL	RA	RL	Summary/Application
EPA (Cont'd)	40 CFR 355, 1987 Superfund Amendments and Reauthorization Act of 1986 (SARA): Emergency Planning and Notification	X	X			Identifies threshold planning quantities for extremely hazardous substances
	40 CFR 403-471, 1990 Effluent Guidelines and Standards		X			Sets pretreatment standards for wastewater discharged to Public-Owned Treatment Works (POTW)
American National Standards Institute, (ANSI) New York, New York	N 13.1 - 1969* Guidance to Sampling Airborne Radioactive Materials in Nuclear Facilities			X		Sets standards for effluent monitoring systems
	N 42.18*, 1974 Specification and Performance of On-site Instrumentation for Continuously Monitoring Radioactivity in Effluents			X	X	Recommendations for the selection of instrumentation for the monitoring of radioactive effluents
Washington State Department of Ecology, (Ecology) Olympia, Washington	WAC 173-216, 1989 State Waste Discharge Permit Program		X			Governs discharges to ground and surface waters
	WAC 173-220, 1988 National Pollutant Discharge Elimination system Permit		X		X	Governs wastewater discharges to navigable waterways; controls NPDES permit process
	WAC 173-240, 1990 Submission of Plans and Reports for Construction of Wastewater Facilities		X			Controls release of nonradioactive liquids
	WAC 173-303, 1989 Dangerous Waste Regulations		X			Regulates dangerous wastes; prohibits direct release to soil columns
	WAC 173-400, 1976 General Regulations for Air Pollution Sources	X				Sets emissions standards for hazardous air pollutants
Benton-Franklin Walla-Walla Counties Air Pollution Control Authority, (APCA) Richland, Washington	General Regulation 80-7, 1980	X				Regulates air quality

HA = hazardous airborne.
HL = hazardous liquid.
RA = radioactive airborne.
RL = radioactive liquid.
*Refers to standards that are referenced in the DOE and EPA regulations.

point. However, limited guidance is provided in 40 CFR Part 61, Appendix D (EPA 1989a), "Methods for Estimating Radionuclide Emissions." Although this guidance applies specifically to radionuclide emissions in select circumstances, the release fractions can also be applied to nonradioactive effluents. Any alternative method or procedure must receive prior approval of the EPA.

It is important to review the dose limits to the public from operations at DOE-controlled facilities. The NESHAP, promulgated by the EPA, mandates that radionuclide air emissions from each DOE facility shall not cause any individual (maximally exposed individual) to receive a dose of greater than 10 mrem/yr EDE (see Section 61.92). A single site or facility, as used here, means all the buildings, structures and operations within one contiguous site. For example, the entire DOE facility at the Hanford Site, rather than each building, must meet the 10 mrem/yr EDE standard. The date for mandatory compliance with the proposed revision to the NESHAP is now December 15, 1991 for DOE facilities. A detailed description of the NESHAP appears in Section 16.2 of this document.

Radiation Protection of the Public and the Environment, DOE Order 5400.5 (DOE 1990a) provides dose limits from all DOE sources of radiation and all exposure modes of 100 mrem/yr EDE and 5 rem/yr dose equivalent limit for any tissue (including the skin and lens of the eye) to the public from operations at DOE facilities. These limits apply to doses from exposures to radiation sources from routine activities and from remedial actions that are in progress on the same site. Although the DOE limit is 100 mrem/yr, the NESHAP limit is controlling and FEMPs are to be prepared based on the 10 mrem/yr EDE limit. Effluent monitoring for each gaseous discharge point of a facility and the associated FEMP would be required at a level of 1% of the 10 mrem/yr EDE standards; that is, at 0.1 mrem/yr EDE.

The method used to assess radiation dose impacts the requirements for effluent monitoring. The limit of 100 mrem/yr EDE is the sum of the EDE (or deep dose equivalent, if dosimeter data are used) from exposures during the year to radiation sources external to the body plus the committed EDE from radionuclides taken into the body. The calculation of doses from routine DOE activities should be based upon a "reference man," as defined by the International Commission on Radiological Protection (ICRP), and the dosimetry models and parameters presented in ICRP Publication 30 (ICRP 1983) and subsequent ICRP publications. The weighting factors and time periods for integrating doses endorsed by the ICRP are to be used for dose commitment calculations. Other requirements are presented in the order including how doses from other man-made or enhanced natural radionuclide sources must be addressed.

Dose limits to the public dictate effluent monitoring requirements. DOE Order 5400.5, Chapter II, Paragraph 1.b. (DOE 1990a), presents limits for exposure of the public to radioactive materials as a consequence of DOE activities from all DOE sources of radiation. The Order states that DOE activities shall not cause any member of the public to receive, in a year, a dose equivalent greater than 100 mrem to the whole body. The Order also alerts the reader to the fact that DOE must comply with legally applicable requirements, including 40 CFR 61 (EPA 1989a) for airborne emissions. Doses resulting from ^{220}Rn, ^{222}Rn, and their respective decay products are specifically excluded from the NESHAP dose standard; however, they are regulated by DOE Order 5400.5.

To demonstrate compliance with the dose limit requirements using analytical techniques, evaluations of potential doses to individuals through the air pathway shall be evaluated using only AIRDOS/RADRISK or other computer codes or models specifically approved by EPA, as specified in NESHAP (see Section 61.93). Compliance may also be demonstrated through environmental measurements using approved techniques. When this method is used to determine compliance, the doses estimated shall be to individuals in an unrestricted area assumed to reside at the point of maximum annual air concentration.

Chapter III of DOE Order 5400.5 (DOE 1990a), provides Derived Concentration Guides (DCG) for air and water to assist facilities in conducting radiological environmental protection programs. The DCGs are the concentrations of radionuclides in air or water that, under conditions of continuous exposure for 1 yr by one exposure mode, would result in an EDE of 100 mrem. Westinghouse Hanford applies the DCGs to the effluent point of discharge, which is a conservative practice because of the significant reduction in concentration that occurs between the release point and the maximally exposed individual offsite.

3.2 REGULATIONS PERTAINING TO MONITORING REQUIREMENTS AT DOE FACILITIES

The monitoring requirements for effluents resulting from the operation of DOE-controlled sites can be presented in two categories. These categories relate to the effluent release pathway; that is, whether the release pathway is airborne or liquid. In addition, information on the monitoring requirements is presented according to whether the effluent is radioactive or nonradioactive material. Before presenting this material, however, it is useful to review in detail the requirements outlined by DOE for FEMPs.

3.2.1 DOE FEMPs

Requirements for a FEMP are provided in *General Environmental Protection Program*, DOE Order 5400.1 (DOE 1988). The order provides specific information in Chapter IV on the requirements for effluent monitoring systems and programs at the Hanford Site. Environmental monitoring requirements are different for new and existing facilities. For a new facility with the potential for adverse impact on the environment, an environmental survey must be conducted before actual start-up. The survey shall establish background levels of radioactive and toxic pollutants, characterize pertinent environmental and ecological parameters, and identify potential pathways for human exposure or environmental impact as a basis for determining the nature and extent of the subsequent routine operational effluent and environmental monitoring program.

Radioactive and nonradioactive pollutant effluents released at the Hanford Site shall be monitored to determine compliance with the DOE 5400 series of Orders. The monitoring is performed to evaluate the effectiveness of effluent treatment and control, for radioactive material inventory purposes, and to determine compliance with all DOE, EPA, State, and local requirements pertaining to effluents and pollutants. Radioactive material released to onsite waste treatment or disposal systems shall be monitored to assess the effectiveness of treatment and control and to provide both a qualitative and quantitative annual summary of the radioactive material released onsite.

The DOE Order 5400.1 (DOE 1988) also provides guidance on effluent monitoring. As a general rule, monitoring should be conducted in a manner that provides accurate measurements of the quantity and/or concentration of liquid and airborne pollutants in effluents as a basis for (1) determining compliance with applicable release and effluent control limits, including self-imposed administrative limits designed to ensure compliance with in-plant operating limits, effluent standards or guides, and with environmental standards and guides; (2) evaluating the adequacy and effectiveness of containment and waste treatment and control, as well as of efforts toward achieving levels of radioactivity that are As Low as Reasonably Achievable (ALARA) considering technical and economical constraints; and, (3) compiling an annual inventory of the radioactive material released in effluents and onsite releases.

Because the requirements in DOE Order 5400.1 (DOE 1988) are relatively general, interpretation of the requirements is necessary in order to determine the effluent monitoring practices required to meet the intent of the Order and associated regulations. In the case of airborne releases, 40 CFR 61 (EPA 1989a), *Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities* (ANSI 1969), and associated documents provide specific requirements and guidelines for effluent monitoring. In the case of liquid releases, however, no currently accepted guidance exists that provides consolidated, detailed requirements. Therefore, required practices are based on industry-accepted standards and good practices that are sufficient to meet the intent of the regulations, including the primary requirement that all effluent samples obtained be representative of the effluent released. The following discussion summarizes the primary monitoring and sampling practices that are necessary to comply with DOE Order 5400.1 and associated regulations.

Effluent monitoring data collected should include volume, rate of release, and content as close as possible to the point of release. Effluent monitoring data pertaining to the release of nonradioactive pollutant material should include the total quantity (amount). Effluent monitoring data pertaining to the release of radioactive material includes the total activity (number of Curies) released in airborne and liquid effluents and the specific radionuclides comprising a significant portion (>10%) of the radiation dose. Although exceptions exist, this requirement indicates that the measurement should be made at the point of release. An exception should include the portion of the effluent stream close to the point of generation that can be monitored to provide a more accurate estimate of the hazardous material being released from the facility.

Effluents should be monitored at the point that the applicable standards apply. For example, onsite releases may be monitored at the waste treatment and disposal system; effluents may be monitored after all treatment and control, including retention and decay, has occurred. In many cases, the monitoring location is specified in the release or operating permit.

The sampling method and frequency should be determined by considering the purpose or need for the data collected. Data are collected to evaluate the effectiveness of waste treatment and control, demonstrate compliance with operating limits of applicable effluent or performance standards, and compile and trend effluent characteristics. Continuous or proportional sampling is recommended and may be required where there is significant variation in the concentrations and mixtures of potential pollutants in the effluent stream. Periodic sampling may be adequate when the concentrations and mixtures are reasonably constant and there is minimal likelihood of unusual variations. Similarly, proportional sampling may be necessary when effluent flow rates fluctuate, whereas a representative grab-sample may suffice for batch releases. The method of sampling is usually specified in the applicable regulation or permit.

In reporting radiological data, gross radioactivity measurements are generally inadequate. However, they can be appropriate when (1) gross radioactivity releases are a small fraction of the offsite Radioactivity Concentration Guides (RCG) for "unidentified mixtures" and are of no health or environmental significance; (2) the relative concentrations of specific radionuclides are so well known by other means that gross radioactivity measurements are truly indicative of the activity being released; or (3) the activity of waste streams is so low as to preclude specific nuclide measurements.

Radioactive effluents and onsite release monitoring and reporting must be adequate to provide an annual average concentration and an annual summary of the quantities of radioactive materials released. The summary should be complete to the extent that all significant releases are reported. It is required, therefore, that the annual average flow and pollutant concentration be determined for each waste stream.

EPA regulations pertaining to the release of hazardous substances from DOE facilities are presented in 40 CFR 302 (EPA 1985a). This regulation, in accordance with Sections 101(14) and 102(a) of the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA), designates those substances in the statutes of CERCLA, identifies reportable quantities of those substances, and sets forth the notification requirements for releases of these substances. This regulation also sets forth reportable quantities for hazardous substances designated under Section 311(b)(2)(A) of the *Clean Water Act of 1977*.

3.2.2 Airborne Effluents

Airborne emissions of radioactive materials from DOE-controlled facilities at the Hanford Site are subject to EPA regulations. The primary regulation is 40 CFR Part 61 (NESHAP). The list of hazardous air pollutants regulated under the NESHAP is provided in Subpart A, "General Provisions." The specific emissions standards and monitoring requirements for radionuclides are contained in Subpart H, "National Emission Standards for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities," of 40 CFR Part 61. Subpart H standards cover all DOE operations that emit radionuclides other than radon to the air, except for facilities subject to

40 CFR Part 191 (EPA 1985b), Subpart B (disposal of spent nuclear fuel, high-level and transuranic radioactive wastes) and 40 CFR Part 192 (EPA 1983a) (uranium and thorium mill tailings).

Subpart H of the NESHAP (EPA 1989a) presents detailed requirements for emissions monitoring and test procedures (61.93), compliance and reporting (61.94), record-keeping requirements (61.95) and exemptions from the reporting and testing requirements of 40 CFR Part 61.10 (61.97). Radionuclide emission rates from stacks and vents must be measured at all release points that have the potential to release radionuclides into the air in quantities that could cause an EDE in excess of 1% of the standard. The potential to release radionuclides must be evaluated based on the assumption that all pollution control equipment does not exist, but that facility operation(s) are otherwise normal [40 CFR part 61.93 (b)(4)(ii)]. For release points that have a potential to release radionuclides into the air, but have effluents below the continuous monitoring standard, periodic confirmatory measurements must be made to verify low emissions. Furthermore, all radionuclides which could contribute greater than 10% of the potential EDE for each release point must be measured. With prior EPA approval, alternate methods to the one described, including process knowledge, can be substituted for measurement to determine the emission levels of individual radionuclides.

Subpart H, Section 61.93, of the NESHAP (EPA 1989a) specifies the monitoring requirements for determining radionuclide emission rates. These requirements include sampling points, appropriate sampling methods, flow rate determinations, sampling frequency, analytical methods, and quality assurance procedures, or via other procedures approved by the EPA. Direct measurement of air concentrations of radionuclides at the receptor point is acceptable if the criteria in Section 61.93(b)(5) are met. These criteria include continuous monitoring of released radionuclides, satisfactory detection limits, quality assurance, and prior EPA approval.

The NESHAP (EPA 1989a) requires facilities to monitor their operations continuously and keep records of the results of their monitoring onsite for 5 yr (see Section 61.105). Facility operators will have to certify on a semiannual basis that no changes in operations that would require new testing have occurred. Although the report is based on the calendar year, the emission limit applies to any period of 12 consecutive mo.

Additional EPA requirements on hazardous substances are contained in 40 CFR Part 302.4 (EPA 1985a). This regulation provides information on reportable quantities of nonradioactive hazardous substances. Unlisted hazardous substances designated by 40 CFR Part 302.4 are regulated in accordance with the EPA toxicity classification of the contaminant.

Several DOE Orders provide requirements for monitoring of radioactive and nonradioactive airborne effluents from DOE facilities at the Hanford Site. These orders state that DOE-controlled facilities must comply with 40 CFR Part 61 (NESHAP) (EPA 1989a). The two principal Orders are *Radiation Protection of the Public and the Environment*, DOE Order 5400.5 (DOE 1990a) and DOE Order 5400.1, Chapter IV, "Environmental Monitoring Requirements" (DOE 1988). Airborne emissions from DOE-controlled facilities that have the potential for radioactive contamination must be monitored in accordance with the requirements of DOE Order 5400.1 and DOE Order 5400.5.

In Washington State, airborne effluents are regulated by the *Washington Clean Air Act of 1967*. General regulations for air pollution sources are presented in Washington Administrative Code 173-400 (WAC 1991), including emission standards for sources emitting hazardous air pollutants in WAC 173-400-075. State regulations pertaining specifically to radioactive airborne effluents are found in WAC 246-247 (WAC 1990) and WAC 173-480 (WAC 1990a), although these requirements are generally less restrictive than the Federal requirements.

The DOE, Field Office, Richland, contractor policies for radioactive airborne releases are discussed in Westinghouse Hanford's Environmental Compliance Manual, WHC-CM-7-5. This manual refers to the applicable regulations governing the monitoring of radioactive airborne effluents in NESHAP. Other regulations, including 40 CFR Part 52, "Approval and Promulgation of Implementation Plans," and DOE Orders 5400.1, 5400.5, and 5484.1, state that DOE facilities must comply with the requirements set forth in the NESHAP.

3.2.3 Liquid Effluents

Requirements limiting the exposure of the public to radioactive materials from DOE-controlled activities through the drinking water pathway are presented in DOE Order 5400.5, Chapter II, paragraph 1.d (DOE 1990a). Although the radiological criteria of the public community drinking water standards of 40 CFR Part 141 (EPA 1989c) are not applicable to DOE-operated drinking water systems, it is the policy of DOE to provide an equivalent level of protection for all persons consuming the water from a drinking water supply operated by, or for, the DOE. These systems shall not cause any person consuming the water to receive an EDE greater than 4 mrem in a year, excluding naturally occurring radionuclides. In addition, DOE facility operators shall ensure that the liquid effluents from DOE activities shall not cause private or public drinking water systems downstream of the facility discharge to exceed the drinking water radiological limits of 40 CFR Part 141.

The dose limit is consistent with the drinking water criteria in 40 CFR 141, *National Primary Drinking Water Regulations* (Safe Drinking Water Act). The dose limit is the EDE to an individual whose exclusive source of drinking water contains a radionuclide, or a mixture of radionuclides, at a level of four percent of the appropriate DCG value. The maximum contaminant levels in public water systems are found in 40 CFR 141.15 (generally radium and alpha emitters) and in 40 CFR 141.16 (beta and gamma emitters).

Liquid effluents from DOE-controlled facilities that have the potential for radioactive contamination must be monitored in accordance with the requirements of DOE Orders 5400.1 and 5400.5 (DOE 1988 and DOE 1990a). Facility operators must provide monitoring of liquid waste streams adequate to: (1) demonstrate compliance with the applicable requirements of DOE 5400.5, Chapter II, (2) quantify radionuclides released from each discharge point, and (3) alert affected process supervisors of upsets in processes and emissions controls.

Depending on where a liquid effluent (wastewater) is discharged, certain regulations apply. These regulations are implemented through issuance of permits by Federal, State, and/or local agencies. It is the responsibility of the facility, through DOE Field Office, Richland, to apply for the permit appropriate to the effluent being discharged. Before applying for any permits, the applicant must know the sources of its wastewater discharges and where the wastewater is being discharged. The following regulations apply based on where the wastewater is discharged:

- Wastewater discharged to a POTW is subject to Federal regulations found in 40 CFR Parts 403 to 471 (EPA 1988) and may also be subject to local regulations and limitations. Permits for such discharges are obtained from the local sewerage agency into which the effluent is discharged, or in some cases, from the State.

- Wastewater discharged into a navigable waterway is subject to Washington State regulations WAC 173-220 (WAC 1990b) under the NPDES. The State issues NPDES permits for such discharges.

- Washington State controls discharges to ground and surface waters of the State, under WAC 173-216 (WAC 1989). The State issues permits for such discharges. A permit of this type would be necessary for any discharges to land which could infiltrate to groundwater. This program is much like the NPDES program as required by the *Clean Water Act OF 1977* and implemented by WAC 173-220 (WAC 1990b). The regulations under WAC 173-216 (WAC 1990c) establish a number of conditions that will be addressed in an issued permit. These include:

  (a) use of all known, available, and reasonable methods of prevention, control, and treatment

  (b) pretreatment requirements

  (c) requirements pursuant to other laws, including RCRA as they apply

  (d) conditions necessary to meet applicable water quality standards for surface waters or to preserve beneficial uses for groundwater

  (e) conditions necessary to prevent and control pollutant discharges from plant site runoff, spillage or leaks, sludge or waste disposal, or raw material storage

  (f) appropriate monitoring, reporting, and recordkeeping requirements

  (g) schedules of compliance.

There are discussions currently underway between DOE and Ecology regarding the applicability of WAC 173-216 (WAC 1989) to the Hanford Site and to liquid releases to cribs specifically. The DOE has entered into an agreement to pursue permitting of liquid effluents that will be discharged over the long-term, although no specific schedules have yet been established.

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Each type of discharge permit identified above will typically contain discharge limitations and monitoring requirements. However, the limitations and monitoring requirements will vary depending on the source and type of wastewater being discharged. For instance, discharges to a POTW will be subject to pretreatment standards, which are based on the production process that generates the wastewater for those processes that have been categorized by the EPA. Categorical processes are identified in 40 CFR Parts 403-471 (EPA 1988a). Specific limitations, monitoring, and reporting requirements have been promulgated for each categorical process. In addition to the EPA's requirements, the State and local sewerage agency may impose additional limitations, monitoring, and reporting requirements. Discharges to a navigable waterway will also be subject to certain standards based on the industrial process which generated the wastewater; certain additional limitations are also imposed in the NPDES permit. In all cases, the specific pollutants to be monitored and the frequency of monitoring and reporting will be based on the applicable regulations and the language of the permit.

The DOE Field Office, Richland, contractor policies for nonradioactive and radioactive liquid effluents are discussed in Westinghouse Hanford's *Environmental Compliance Manual* (WHC 1991c). This manual describes current contractor requirements for monitoring and restricting liquid effluents. Applicable requirements are discussed in Section 3.4 of this document.

3.3 STANDARDS/REFERENCES

Environmental Protection, Safety, and Health Protection Standards, DOE Order 5480.4 (DOE 1984), presents a listing of mandatory and good practice environmental standards.

3.4 WESTINGHOUSE HANFORD EFFLUENT MONITORING REQUIREMENTS

Westinghouse Hanford's policy for monitoring effluents is presented in the Westinghouse Hanford *Environmental Compliance Manual* (WHC 1991c). Although the Westinghouse Hanford manual contains some requirements that are more restrictive than those found in the regulations, this FEMP is only documenting Westinghouse Hanford's compliance with the requirements of the regulations. The sole purpose of referencing the Westinghouse Hanford manual is to indicate Westinghouse Hanford policy.

The purpose of the Westinghouse Hanford ECM is to establish guidelines to be used by Westinghouse Hanford that: (1) protect the environment from radioactive materials and other dangerous substances under Westinghouse Hanford jurisdiction; (2) protect people from radionuclides and other dangerous substances in the environment; and (3) provide a tool to be used in conjunction with applicable DOE Orders and other pertinent Federal, State, and local laws, rules, and regulations promulgated for Environmental Protection (EP) in accordance with the policy defined in *Management Policies* (WHC 1991d), MP 5.1, "Environmental Assurance."

3.5 FACILITY REQUIREMENTS FOR ORGANIC EMISSION STANDARDS

The EPA's Hazardous Waste Treatment, Storage, and Disposal Facility - Organic Air Emission Standards for process vents and equipment leaks (40 CFR 264, Subparts AA and BB) (EPA 1989c). These regulations, which require reductions in total organic emissions from affected systems, apply to distillation/ separation processes that manage hazardous waste containing 10 ppmw or greater total organics, and to facilities that manage hazardous wastes with greater than 10 percent organics. These are no distillation/separation process at PFP which manage hazardous wastes, and no hazardous wastes of greater than 10 percent organic are managed at PFP except in closed containers.

Operation of the Plutonium Reclamation Facility (PRF) is expected to generate carbon tetrachloride emissions in excess of the reportable quantity (RQ) value established by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). CERCLA requires that the National Response Center (NCR) be notified when such releases occur. Section 103(f)(2) of CERCLA modifies the notification requirement when the release is continuous and stable in both quantity and rate. If these criteria are met, a single initial verbal notification to the NRC is required when the continuous release of carbon tetrachloride resumes. An initial written notification is required to be submitted within 30 days of the verbal notifications and a one-time written follow-up report is required within 30 days of the first anniversary date of the initial written notification.

4.0 IDENTIFICATION AND CHARACTERIZATION OF EFFLUENT STREAMS

Both liquid and gaseous effluent streams exist at the PFP complex. Some of these streams are known to be contaminated, while others have a slight potential to be contaminated and still others have no potential to be contaminated. This section describes each effluent stream determined in the FEMP Determination Report to exceed the FEMP criteria. These descriptions include an identification of the actual or potential source terms contributing to each stream for both routine and upset operating conditions. Descriptions of the streams not exceeding the FEMP criteria are documented in the FEMP Determination Report (WHC 1991a).

The existing or potential liquid effluent streams from the PFP complex addressed in the FEMP Determination Report are:

- Effluents to the 216-Z-20 Crib
- Effluents to the 216-Z-21 Seepage Basin System (North Storm Drain)
- East Tile Field (Sanitary Sewer Line)
- West Tile Field (Sanitary Sewer Line)
- French drains
- 241-Z Treatment Tank.

Table 4-1 summarizes the constitution of each liquid effluent stream and provides a brief description of each stream and the associated facilities.

The existing or potential gaseous effluent streams from the PFP complex addressed in the FEMP Determination Report are:

- 234-5Z Building Zone 1 Exhaust
- 291-Z-1 Main Stack
- 296-Z-3 Stack for the 241-Z Building
- 296-Z-5 Stack for the 2736-ZB Building
- 296-Z-6 Stack for the 2736-Z Building
- 296-Z-10 and 296-Z-11 Stacks for the 231-Z Building
- 296-Z-14 Stack for the 232-Z Building.

Table 4-2 summarizes the constitution of each gaseous effluent stream and provides a brief description of each stream and the associated facilities.

4.1 IDENTIFICATION AND CHARACTERIZATION OF SOURCE TERMS CONTRIBUTING TO EACH EFFLUENT STREAM

This section describes the source terms that actually or potentially contribute to the PFP complex effluent streams during routine or upset operating conditions. Details are provided only for those streams for which the FEMP criteria were determined to be exceeded in the FEMP Determination Report (WHC 1991a). General information for all streams were provided in Tables 4-1 and 4-2.

Table 4-1. PFP Complex Liquid Effluent Streams.

Discharge Designation	Facilities Serviced	Liquid Waste Description	Hazardous Chemical Content	Radioactive Material Content	Comments[a]
216-Z-20 Crib	234-5Z, 291-Z, 236-Z, 2736-ZB, 231-Z	Process cooling water, condensates, building drains, air condition systems, storm drains, etc.	Normally Uncontaminated	Normally Uncontaminated (^{90}Sr, ^{137}Cs, ^{238}Pu, ^{239}Pu, ^{241}Pu, ^{241}Am)	Low probability of radioactive or hazardous release
216-Z-21 Basin	Primarily 234-5Z	Storm runoff, steam condensate, and cooling water	None	None	No hazardous potential
East Tile Field	234-5Z, 236-Z, 270-Z, 2704-Z MO-015, 016, 017, 031, 032, 939	Restroom sanitary waste Kitchen and restroom sanitary waste	None	None	No hazardous potential
West Tile Field	234-5Z Annex, 2736-ZB	Restroom sanitary waste	None	None	No hazardous potential
216-Z-13 French drains	291-Z	ET-8 Exhaust Fan, floor drainage	None	Normally Uncontaminated	Very low probability of radioactive release
216-Z-14 French drains	291-Z	ET-9 Exhaust Fan	None	Normally Uncontaminated	Very low probability of radioactive release
216-Z-15 French drains	291-Z	S-12 Evaporator Cooler drainage	None	Normally Uncontaminated	Very low probability of radioactive release
241-Z Treatment Tank	241-Z Treatment Tank and Facility	Contents of 241-Z Treatment Tank	Cr, Pb, Ag, CCl_4	TRU	Upset condition only. Subject to RCRA regulation

[a] Details are provided in the FEMP Determination Report (WHC 1991a).

Table 4-2. PFP Complex Gaseous Effluent Streams.

Discharge Designation	Facilities Serviced	Gaseous Effluent Description	Hazardous Chemical Content	Radioactive Material Content	Comments[a]
234-5Z Building Zone 1 Exhausts	234-5Z	Exhaust from building "clean" areas	None	None	No hazardous potential
291-Z-1 Main Stack	234-5Z, 236-Z, 242-Z	Main filtered effluent discharge	CCl_4, NO_x, HCl, Acetone	Pu and associated radionuclides	Hazardous potential
296-Z-3 Stack	241-Z	Building exhaust	CCl_4, NO_x	Pu and associated radionuclides	Extremely low hazardous potential
296-Z-5 Stack	2736-ZB	Building exhaust	None	Pu and associated radionuclides	Extremely low hazardous potential
296-Z-6 Stack	2736-Z	Storage vault exhaust	None	Pu and associated radionuclides	Extremely low hazardous potential
296-Z-10 and 296-Z-11 Stacks	231-Z	Building exhaust	None	Pu and associated radionuclides (^{241}Am)	Extremely low hazardous potential under upset conditions
296-Z-14 Stack	232-Z	Incinerator exhaust	None	^{239}Pu	Extremely low hazardous potential

[a] Details are provided in the FEMP Determination Report (WHC 1991a).

4.1.1 Routine Operating Conditions

4.1.1.1 216-Z-20 Crib. The 216-Z-20 Crib discharges aqueous waste from various PFP complex facilities to the ground. Operations and facilities serviced by this system include the PRF (236-Z), the RMC Line (234-5), the Engineering Laboratory (EL) (234-5), the Development Laboratory (DL) [234-5], and the 291-Z Exhaust Air Stack Building. The crib also receives cooling water and floor drain liquid from the 231-Z Building. HVAC condensate water is received from the 2736-ZB Building, and various building service waste liquids and storm drain effluent from the south side of 234-5Z Building is received. The waste collected by the transport system flows through a series of manholes to the 2904-Z Monitoring Facilities and then to the 216-Z-20 Crib, where it is discharged through perforated pipes to the ground.

The content of liquid effluents to the 216-Z-20 Crib is dependent on the liquid from its source. There are over 100 potential contributors to this liquid effluent stream; approximately two-thirds are nonroutine sources and one-third are routine sources. The latter includes heating, ventilation, and air conditioning condensate drains, and equipment cooling water streams.

Table 4-3 lists a summary of the sources, the facility origin, and the normal chemical makeup of the effluents to the 216-Z-20 Crib. A more detailed listing is presented in WHC-EP-0342, Addendum 8 (WHC 1990a).

There are no identifiable sources of routine effluent releases of hazardous or radioactive material to the 216-Z-20 Crib. Section 4.1.2.1 presents the potential effluent releases to this stream for upset conditions.

4.1.1.2 216-Z-13, 216-Z-14 and 216-Z-15 French Drains. The content of liquid effluents being discharged to the 216-Z-13, 216-Z-14, and 216-Z-15 French drains is not certain. The drains serve the 291-Z Building and are considered nonradioactive and nonhazardous. However, the drains are listed on the Inventory of Injection Wells with the EPA as having a very low probability of containing radioactive material. Any such releases would be significantly lower than the RQ values for both radioactive and nonradioactive materials. Although the FEMP Determination Report indicated that this stream exceeded the criteria for requiring a FEMP based on the uncertain releases, this stream has been reevaluated as not exceeding the criteria based on the potential releases being lower than RQ values.

4.1.1.3 291-Z-1 Main Stack. Seven major systems contribute to this effluent stream. These systems include exhaust from areas that have a slight potential for radioactive contamination (designated as "Zone 3" areas) or are potentially contaminated or known to be contaminated (designated as "Zone 4" areas). The systems are:

- The 234-5Z Building E-3 (Zone 3) Exhaust System
- The 234-5Z Building E-4 (Zone 4) Exhaust System
- The process solution transfer vacuum exhaust
- The PFP Air Sampling Vacuum Exhaust System
- The 236-Z Building E-3 Exhaust System
- The 236-Z Building E-4 Exhaust System
- The 236-Z Building Air Sampling Vacuum System.

Table 4-3. Effluent Sources to the 216-Z-20 Crib.

Building	Sources	Liquid
234-5Z	Drinking fountain drains Eye wash stations Sink drains Cooling water drains Storm drains (south side) Chiller drains Air conditioning drains Chemical preparation area	Drinking water Sanitary water Varied Cooling water Waste water Cooling water Condensate Varied
236-Z	Drinking fountain drains Condensate header Chemical preparation area Tank jacket cooling water Cooling water drains Exhaust duct sump jet	Drinking water Condensate Varied Varied Cooling water Condensate
2736-ZB	HVAC condensate drain	Condensate
231-Z	Cooling water Miscellaneous drains	Varied Varied
291-Z	Cooling water Floor drains	Varied Varied

Hazardous materials that may be released from the 291-Z-1 Stack in significant quantities include carbon tetrachloride (CCl_4), oxides of nitrogen (NO_x), and hydrogen chloride (HCl). Operation of the PRF has generated CCl_4 emissions in excess of reportable quantities. Operating data gathered from production campaigns conducted from 1983-1987 indicate CCl_4 releases averaged 75 lb/day. This amount is currently estimated to be less than 10 lb/day based on the non-operational status of the facility. NO_x produced by nitric acid, sodium nitrate, and other reactions results in the release of approximately 100 lb of NO_x per year. Also, approximately 20 lb of HCl gas has historically been released each year. Regarding radioactive materials, historical sampling data indicate that approximately 4.0 x 10^{-4} Ci of ^{239}Pu is released routinely each year.

4.1.1.4 2734-ZL Building HVAC Exhaust. The 2734-ZL Building formerly contained the hydrogen fluoride (HF) bottles and supply piping for the fluorinator in the RMC line. Based on the potential for an upset release, it was determined in the FEMP Determination Report that the FEMP criteria were exceeded for this effluent stream. Because HF has been permanently removed from this facility, this finding is now irrelevant.

4.1.2 Upset Operating Conditions

4.1.2.1 216-Z-20 Crib. One potential source of hazardous effluent to this stream is the C-4 Heat Exchanger in Glovebox 6. Tank C-4 in Glovebox 6 is vented to the atmosphere and is therefore at atmospheric pressure. When

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operating, the Protected Process Cooling Water (PPCW) coil within the tank is pressurized to above 30 lb/in^2 gauge, assuring that the flow would be into the C-4 Tank. When the PPCW is off, there would be no pressure. If there were a leak in the PPCW coil, this could result in hazardous or radioactive material migrating into the system where it would be transferred to the 216-Z-20 Crib when the system was used again. The only chemicals in the heat exchanger are those scrubbed from the vacuum exhaust, thus only trace amounts of hazardous materials would be released. Based on Unusual Occurrence Report (UOR) 86-05, a measurable amount of radioactive material could be released by this upset condition. This could result in a release of about 6.0 lb of nitric acid and 1.2×10^{-4} lbs (3.3×10^{-3} Ci) of Pu over a period of 24 h to the 216-Z-20 Crib. Nitric acid levels to 0.5 g/L, ANN to 0.01 g/L, and Pu to 0.1 mg/L are considered possible.

Another potential source is failure of the PRF cooling jackets, which could result in the release of Pu to the 216-Z-20 Crib. However, such a release would require the failure of multiple engineered and administrative barriers, including failure of the cooling jackets, alarms, and interlocks. Such an occurrence is outside the scope of this FEMP, because it involves the failure of more than one barrier and does not meet the definition of an upset condition.

A previous potential source of significant hazardous effluent to this stream, which was identified in the FEMP Determination Report (WHC 1991a), is a spill of nitric acid during feed transfer. The PFP bulk nitric acid storage tank holds up to 7000 g of liquid. The large liquid volume is more than sufficient to overwhelm tank sump barriers in either the RMC or PRF chemical preparation areas. Therefore, without additional controls in place, failure to follow operating procedures and turn the feed pump off promptly for a fill operation could result in an upset condition leading to contamination of the 216-Z-20 Crib. However, interlocks were installed in both the RMC and PRF to prevent this from occurring. During nitric acid transfer operations from the storage tank outside the 234-5Z Building to the product tanks inside 234-5Z (TK-C in Room 336) and 236-Z (TK-A-105 in Room 40), activation of the high liquid level detectors will disconnect power to the nitric acid feed pump and will close motor operated valves provided on the feed transfer pipelines. Therefore, a significant release could occur only after both a procedural violation and the failure of an engineered barrier.

4.1.2.2 216-Z-13, 216-Z-14 and 216-Z-15 French Drains. As stated in Section 4.1.1.2, the content of liquids discharged to these drains is uncertain. Therefore, it is possible that there are upset conditions that would lead to the release of hazardous or radioactive material, although both the probability and magnitude of such a release would be small.

4.1.2.3 291-Z-1 Main Stack. The only releases identified for upset conditions would be small amounts of various chemicals because of spillage of material or equipment failure. These releases include less than 10 lb in a 24 h period of NO_x. None of the postulated releases of either hazardous or radioactive material during upset conditions would exceed reportable quantities.

4.1.2.4 2734-ZL Building HVAC Exhaust. As described in Section 4.1.1.4, the source term (HF) has been permanently removed from this facility.

5.0 EFFLUENT POINT OF DISCHARGE DESCRIPTION

This section characterizes the effluent discharge points within the PFP complex for those effluent streams exceeding the criteria for requiring a FEMP. This characterization includes the identification of all contributing streams, physical dimensions, identification of any monitoring systems, flow rates, and other pertinent information. Information on the streams not exceeding the criteria was documented in the FEMP Determination Report (WHC 1991a).

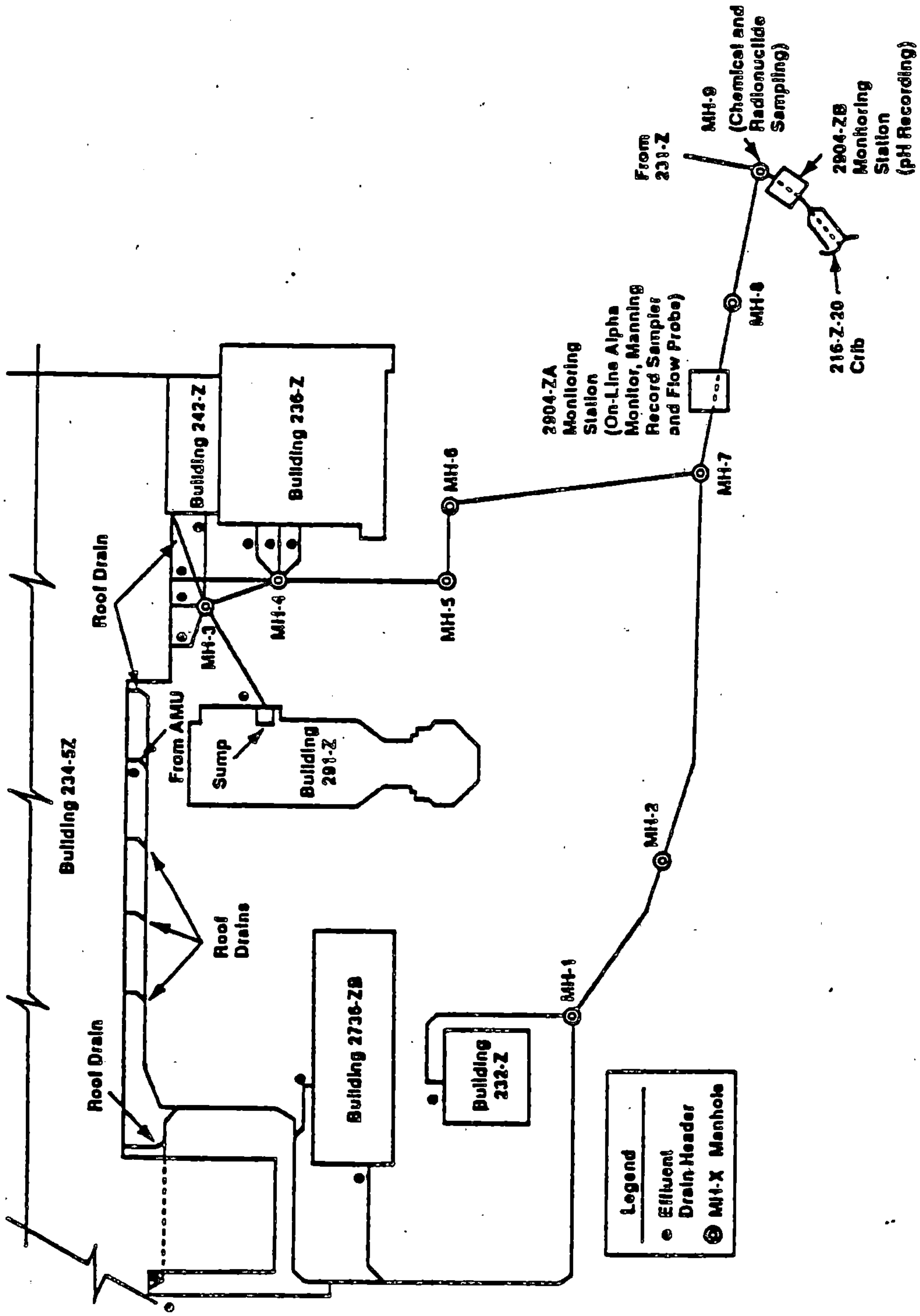
5.1 216-Z-20 CRIB

The 216-Z-20 Crib receives aqueous waste from various PFP complex facilities before the waste is discharged to the ground. Operations and facilities serviced by this system include the PRF (236-Z), the RMC Line (234-5), the EL (234-5), the DL (234-5), and the 291-Z Exhaust Air Stack Building. The crib also receives cooling water and floor drain liquid from various facilities including the 231-Z and 232-Z Buildings. HVAC condensate water is received from the 2736-ZB Building, and various building service waste liquids and storm drain effluent from the south side of 234-5Z Building is received. The waste collected by the transport system flows through a series of manholes to the 2904-Z Monitoring Facilities and then to the 216-Z-20 Crib, where it is discharged through perforated pipes to the ground.

The 216-Z-20 Crib was designed and constructed in 1981 and placed into service in 1982. The crib, designed for gravity-flow disposal of 275 gal/min liquid waste, consists of three parallel, perforated polyvinyl chloride (PVC) pipes., each 1500 ft long. Perforations are 0.5 in. in diameter, 30° below the horizontal pipe center. The central pipe is 10 in. in diameter with a 6-in.-diameter pipe located 3.5 ft to each side. The pipes are placed on a 1-ft-deep bed of 0.5-to-2.5-in.-diameter rock 7.5 ft below grade. The pipe is covered with rock to a depth of 1 ft, after which a 20-mil-thick PVC sheet is installed to provide a biological barrier and the excavation filled to grade level with uncontaminated backfill. Each distribution pipe is vented to the atmosphere by four equally spaced lines which extend 18 in. above grade. The distribution lines have a 0.2% slope from the crib inlet to the bottom end. After 5 to 6 yr of operation, percolation rates in the 216-Z-20 crib had decreased such that the stream flow sometimes exceeded crib disposal capacity. Increased production capacity has been provided by installation of seven 12-in.-diameter, 25-ft-deep drain wells.

There are nine manholes, numbered 1 through 9, located along the stream route to the 216-Z-20 Crib (Figure 5.1). The majority of the effluent streams flow directly into Manholes 3 and 4. The manholes serve as locations for obtaining grab samples of any stream flowing into Manholes 1, 2, 3, and 4. Grab samples can also be taken from Manholes 5, 6, 8, and 9 and from storm catch drain basin 2 at Manhole 2. Grab samples may be collected periodically as a backup to the record sampling system, to determine the source of accidental releases, or for special analysis of the stream constituents.

Figure 5-1. Plan and Overall Piping Schematic for the 216-Z-20 Crib Effluent Stream.



Instrumentation is installed in the 216-Z-20 Crib effluent stream downstream of the primary effluent sources to allow in-line monitoring. Monitoring stations and samplers are in place at 2904-ZA and 2904-ZB (Manhole 9) which monitor pH, flow rate, and alpha radiation in the liquid effluent. An automatic flow proportional composite grab sampler is used to sample the effluent. The 2904-ZA sampling and monitoring facility is located approximately 750 yd downstream of PFP atop Manhole 7 on the transport system. The 2904-ZB sampling and monitoring facility is located approximately 65 yd downstream of the 2904-ZA facility and is adjacent to Manhole 9 on the transport system.

5.2 291-Z-1 MAIN STACK

The PFP complex Main Stack exhausts filtered process and ventilation air from gloveboxes and hoods in the 234-5Z, 236-Z, and 242-Z Buildings, and those rooms which have a slight potential for contamination. Systems that contribute to this effluent stream include the 234-5Z Building E-3 and E-4 exhaust and process solution transfer vacuum exhaust; the PFP air sampling vacuum exhaust system; and the 236-Z Building E-3 and E-4 exhaust and air sampling vacuum exhaust systems. Depending on the source, the air is passed through from one to three testable stages of HEPA filtration before entering the stack. The stack is equipped with an air sampling probe located at the 50-ft level of the stack. The probe feeds a record sampler and an alpha continuous air monitor (CAM) with an alarm.

The flow rate from the stack averages approximately 225,000 ft^5/min as determined by Westinghouse Hanford Vent and Balance personnel. Four of seven exhaust fans operate at any one time, with the remaining three as standby plus two steam-driven turbines for power-loss emergency operation. The stack is 200 ft tall with inside and outside diameters at the base of 16 ft and 18 ft, respectively. It is constructed of 9-in. thick reinforced concrete and is stainless steel lined.

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6.0 EFFLUENT MONITORING/SAMPLING SYSTEM (EMS) DESIGN CRITERIA

This section presents design criteria for both liquid and gaseous effluent monitoring systems. These include criteria contained in Federal regulations including DOE Orders 5400.1 and 5400.5 (DOE 1988 and DOE 1990a), and design criteria used by the contractor to ensure compliance with the regulations. In some cases, contractor design criteria may not be compatible with existing regulations because of the age of the monitoring systems. Therefore, design criteria for actual or planned monitoring system upgrades are also described.

6.1 LIQUID EFFLUENTS

The DOE has maintained that the release of radioactive materials is governed by the Atomic Energy Act and that the release limits set by DOE correspond to Federally Permitted Releases and are thus exempt from other Federal and State Regulations. At the same time, DOE has committed to complying with all "applicable" limits of EPA and State regulations.

Radiation Protection of the Public and the Environment, DOE Order 5400.5 (DOE 1990a), provides guidance on the acceptable levels of radioactivity that are allowed in liquid waste and effluents. The purpose of the DOE standards is to both ensure that the dose to the public remains below 100 mrem/yr (Chapter I.3) and protect the environment.

Demonstration of compliance with 5400.5 (DOE 1990a) will generally be based on data from monitoring and surveillance programs (Chapter I, 8.a; Chapter II, 6). It is stated in the DOE Order (Chapter II, 4.d) that liquid effluents from DOE activities shall not cause private or public drinking water systems downstream of the facility discharge to exceed the drinking water limits in 40 CFR Part 141 (EPA 1989d), which are, in general, numerically equivalent to 4% of the DOE DCG values. There is no guidance given on how to achieve that goal with regard to allowable concentrations in the facility liquid effluent.

Some guidance is provided in Chapter II, Section 3, for surface discharges:

- Discharges greater than DCG values on an annual average would require the BAT to be applied
- Discharges at less than DCG do not require implementation of BAT
- The settleable solids in any liquid effluent stream may not exceed 5 pCi/g alpha or 50 pCi/g beta
- Interim dose limits for native aquatic animal organisms may not exceed 1 rad/d.

Guidance on discharges of liquid waste to aquifers and phase out of soil columns is found in DOE 5400.5, Chapter II, 3.b (DOE 1990a). The guidance is limited to a reaffirmation of DOE commitment to phase out soil column use (i.e., trenches, cribs, ponds, and drain fields) at the earliest practicable time and for those liquid discharges not first treated by BAT, DOE will develop (within 6 mo of the issuance date of order) a plan and schedule for implementing alternate acceptable disposal at the earliest practical time. In addition, new or increased discharges of radionuclides in liquid waste to soil columns is prohibited [Chapter II, 3.b(2)] unless the DOE activity cannot comply or the release is tritium [Chapter II, 3.e(1)].

Compliance with the dose limits of DOE Order 5400.5 (DOE 1990a)shall be demonstrated by documentation of an appropriate combination of measurements and calculation (Chapter II, 6.a). The ALARA concept in 5400.1 is to attain dose levels as low as technically and economically feasible. Compliance with these two objectives would seem to require monitoring any stream with the potential for containing measurable radioactivity.

For nonradioactive liquid effluents discharged to cribs, the basic criteria is that the facilities may not discharge any effluent that is a hazardous waste per WAC 173-303 (WAC 1989). The WAC 173-303 is the State's implementation of RCRA and incorporates by reference 40 CFR 261 (EPA 1989e) and 264 (EPA 1989c). The monitoring required is to demonstrate a continuing knowledge of the waste composition and to demonstrate compliance with the prohibition on discharging hazardous waste to the ground and is called for in DOE Order 5400.1 (DOE 1988), Sections 5 and 8 of Chapter IV.

A second area that impacts liquid releases to ponds, cribs, ditches, etc., is the "Land Ban" regulations embodied in 40 CFR 268 (EPA 1987a) and WAC 173-303-140 (WAC 1989). 40 CFR 268 is incorporated by reference into WAC 173-303. Again, monitoring will be to confirm the identity of the waste and demonstrate compliance.

While these regulations generally apply only to wastes designated as dangerous or expected to be dangerous, the applicable DOE Regulations (5400.1, 5a.1-4) require monitoring to demonstrate verification of compliance, evaluate effectiveness of effluent treatment and control, and determine if a waste is hazardous. In addition, DOE has committed to maintaining the ability to address environmental discharges before they pose a threat to the quality of the environment or the public welfare.

Westinghouse Hanford design and performance criteria for monitoring liquid effluent streams are established in the *Plutonium Finishing Plant Safety Analysis Report* (SAR) (WHC 1990b), Section 7.1.2. The following criteria are applicable to all radioactive liquid effluent streams at the PFP complex:

- Record sampling systems are in place for effluents that normally or potentially exceed 4% of the DCG values
- Continuous monitoring is performed on effluents that have the potential to exceed 1 DCG equivalent averaged over 1 yr
- Monitoring systems must have audible alarms.

The following criteria are applicable to all nonradioactive liquid effluent streams at the PFP complex:

- Sampling is performed when a regulated chemical exceeds 10% of the equivalent concentration
- Corrosive streams are monitored for pH.

The following criteria are applicable to both radioactive and nonradioactive liquid effluent streams at the PFP complex:

- Monitoring systems must maintain backup systems, be located downstream of the process but before the point of release, be calibrated in accordance with the manufacturer's recommendations, and have adequate written records
- Samples must provide representative measures of volume and concentration and calibrated flow rates must be recorded.

6.2 GASEOUS EFFLUENTS

Specific contractor design criteria for upgrading the 200 Area Stacks to meet recent regulations were documented by Cammann (1984). These criteria were intended to be used for upgrading selected 200 Area stack sampler-monitor systems. Although the 291-Z-1 Main Stack has not been upgraded to meet these criteria, the criteria are summarized here to document the criteria necessary to conform to applicable standards.

The design criteria for upgrading the stacks covered several categories, including stack flow totalizing, sample extraction probes, sample transport lines, record sampling, continuous air monitoring, alarm system, power coordination and backup, and reliability. The primary criteria that may be applicable to the 291-Z-1 Main Stack are summarized below; further details were documented by Cammann (1984).

<u>Stack Flow Totalizing</u>

- Stack flow totalizing is recommended, and shall be provided, whenever stack flowrates vary routinely by more than 20%.

<u>Sample Extraction Probes</u>

- Sample probe designs shall follow guidelines presented in ANSI 1969.
- Sample probes shall be designed for representative/isokinetic sample extraction based on the average stack velocity.
- Sample probes shall be located a minimum of 5-duct diameters downstream and 2-duct diameters upstream of major flow disturbance points, unless the suitability of an alternate location can be demonstrated through repeatable flow profile measurements.

- Independent sample extraction probes shall be provided for the record sample loop and the continuous air monitor loop.
- Sample extraction probes shall be flange mounted to the stack to facilitate periodic removal, inspection and cleaning activities.

Sample Transport Lines

- Sample transport lines shall be selected and installed to minimize particle loss attributed to gravity settling, turbulent impaction, and electrostatic effects.
- Sample transport line runs, bends, and tube transitions shall be minimized to the extent practical.
- Sample transport line bend radii shall be at least 10 times the inside diameter of the transport line.
- Provisions shall be made to inhibit condensation of moisture in sample transport lines.

Record Sampling

- The record sample airstream shall be routed through a 47-mm filter to obtain a buildup sample for laboratory analysis.
- The record sampling system shall have sample flowrate indicating and totalizing capabilities.
- A flowrate regulator shall be provided to maintain a constant flowrate to compensate for filter loading effects.
- Variable sample flow control may be required for exhaust streams having a flow that varies by more than 20%.
- The product of the sample flowrate and the sample collection time shall be at least 370 ft^3/min-hours.
- Sample flowrates shall not exceed 4 ft^3/min.

Continuous Air Monitoring

- The CAM system shall have flowrate indicating and regulating capabilities.
- The CAM system shall have local readout countrate meters with stripchart recording capability.
- Monitoring system alarm setpoints shall be adjusted to alarm at release concentrations as low as possible without resulting in excessive number of alarms because of normal fluctuations in either background radiation or release quantities.

Alarm System

- Separate remote instrument failure alarms, high airborne radiation alarms, and real time airborne radiation measurement indication shall be provided when feasible.

Power Coordination and Backup

- The stack sampler-monitor system shall operate continuously utilizing the same emergency electrical power backup capabilities as the stack blower fan(s).

Reliability

- CAM failure annunciation shall be provided and the CAM system will be checked periodically to verify system response.

- Independent vacuum pumps or house vacuum shall be provided for each leg of the record sampling system and the CAM system.

- Vacuum system failure annunciation shall be provided and checked periodically to demonstrate operability.

These criteria are generally consistent with, and in some cases more restrictive than, ANSI 1969, which continues to serve as the primary source of detailed requirements for effluent monitoring systems that is endorsed in the regulations. Therefore, comparison of the existing stack monitoring systems to these design criteria will help determine compliance with the applicable regulations. This comparison is made in Section 14.0 of this report.

Westinghouse Hanford design and performance criteria for monitoring gaseous effluent streams are established in the PFP SAR. In addition, various engineering documents and correspondence letters pertaining to the design of specific monitoring system components have been identified that document design criteria. In the discussion that follows, general contractor design and performance criteria for gaseous effluent sampling and monitoring as well as specific criteria for individual monitoring systems are presented.

The following criteria are applicable to all radioactive gaseous effluent streams at the PFP complex:

- Sampling is provided for all effluents that have the potential to exceed 10% (annual average) of any DCG-Public value

- Continuous monitoring and alarm systems are provided for all systems that have the potential at any time to exceed 10 times any DCG-Public value

- Audible and visible alarm indications are easily discernible to responsible personnel in continuously or frequently occupied (at least once every 0.5 h) areas

- Monitoring system alarms are set at release concentrations as low as possible without resulting in an excessive number of false alarms because of normal fluctuations in releases or background radiation levels

- Monitoring systems shall have the capability to alarm at the time-integrated equivalent concentration equal to a 4-h release at 5000 times the DCG-Public value

- Air monitoring systems are calibrated according to ANSI 1978 and ANSI 1974 when installed and anytime they are subject to maintenance or modification

- Air monitoring systems are powered from a source that has the same or equivalent back-up capability as the air mover for the effluent stream being monitored

- Air monitoring systems are inspected daily and source-checked monthly.

The following criterion is specific to the 291-Z-1 Stack for radioactive gaseous effluents:

- The annual average concentration of radionuclides released from the stack is not to exceed 100 times the DCG for alpha emitters and 10 times the DCG for beta emitters.

Although specific criteria for other stacks are also provided in the SAR, they pertain to stacks that were determined to not require a FEMP and, therefore, are not discussed here.

The following criteria are applicable to all nonradioactive gaseous effluent streams at the PFP complex:

- Continuous effluent monitoring systems with alarm capabilities are used for airborne effluents that have the credible potential to exceed 50% of any quantifiable release standard specified in the ECM, Table C-1.

- Analytical methods for continuous monitoring of effluents are in accordance with applicable EPA methods for the contaminants specified by EPA. Alternate methods are used where approved EPA methods are not specified.

The above criteria may be used to demonstrate compliance with applicable regulations provided that two conditions are met. First, it must be demonstrated that these criteria are consistent with the applicable regulations. Second, the actual operation of the systems must be consistent with the criteria. In Section 7.0, the effluent monitoring system instrumentation is described in detail. This information will be used to demonstrate compliance with both the criteria and applicable regulations in Section 14.0.

7.0 CHARACTERIZATION OF CURRENT EFFLUENT MONITORING SYSTEM

This section characterizes the existing effluent monitoring systems for those effluent streams exceeding the criteria requiring a FEMP. These characterizations include a description of the instrumentation and any applicable technical specifications or operational safety requirements (OSR).

7.1 INSTRUMENTATION DESCRIPTION

This section contains descriptions of the effluent monitoring instrumentation for each effluent discharge point. Detailed descriptions are provided for those effluent discharge points previously determined to require a FEMP (the 216-Z-20 Crib and the 291-Z-1 Main Stack). These detailed descriptions and the design criteria presented in Section 6.0 are used later in this report to determine compliance with applicable regulations. Only brief descriptions of the effluent monitoring instrumentation are provided for those discharge points not requiring a FEMP.

7.1.1 216-Z-20 Crib

Instrumentation is installed in the 216-Z-20 Crib effluent stream downstream of the primary effluent sources to allow in-line monitoring. Monitoring stations and samplers are in place at 2904-ZA and 2904-ZB (Manhole 9) which monitor pH, flow rate, and alpha radiation in the liquid effluent. An automatic flow proportional composite grab sampler is used to obtain representative samples of the effluent.

The 2904-ZA sampling and monitoring facility is located approximately 250 yd downstream of PFP atop Manhole 7 on the transport system. This facility contains a Manning Model S-500 sampler supplying a composite of flow-proportional grab samples and serves as the effluent record sampler. The sampler draws an aliquot approximately every 7 min from the effluent stream and deposits it into a 5-gal plastic carboy. An aliquot ranging from 1 to 4 L is removed from the carboy during each shift and sent to the 222-S Laboratory for analysis. Specific sampling and analysis procedures and analytes of interest are presented in Section 9.0.

The flow probe sends signals to a date- and time-stamped paper strip chart, which records the effluent flow rate. The flow probe is positioned directly below the 2904-ZA Building and is positioned parallel to the flow direction. The flow indicator is Analogic Model AN25M05 and the flow recorder is Texas Instrument Model 200.

The 2904-ZA facility also has a gross alpha monitor for determining the alpha radiation levels in the liquid effluent. The monitor is an Eberline Model OLAM-100 On-line Alpha Monitor System. This monitor is designed to detect the activity of alpha particles in aqueous solutions, including corrosive and/or organic solutions. The monitor consists of three main components: a sampling cell, an alpha particle sensor, and processing electronics. Detection of alpha emitters in the effluent stream is accomplished by diverting a sample of the process stream as a thin flow across the face of the sensor.

The liquid-sampling cell of the OLAM-100 has tubular ports for continuous inflow and outflow of the effluent sample. Inside the cell, a shaped deflector constricts and diverts the flow of liquid across the face of the alpha sensor in a thin sheet with a thickness of approximately 0.005 to 0.02 in.

The OLAM-100 sensor is a cerium-activated, high-silica glass which has been polished and optimized to maximize alpha sensitivity while minimizing beta sensitivity. It is held tightly against a silicon cushion under carefully adjusted tension.

The processing electronics include a photomultiplier tube (PMT) which is optically coupled to the sensor through a photocathode. Alpha particles striking the sensor produce light pulses, which are converted to electrons by the photocathode. The electrons are multiplied by the PMT which produces a measurable pulse, the voltage of which is proportional to the energy of the original alpha particle. The voltage pulse is transmitted over the signal cable to the processing electronics.

The primary considerations regarding the performance of the OLAM-100 system is (1) whether a representative, known fraction of the effluent stream is passed through the monitor, and (2) the minimum detectable activity concentration of the system. Manufacturer's tests indicate that the OLAM-100 system is capable of detecting alpha levels as low as 2.2 X 10^{-6} μCi/mL. The current alarm setpoint is 2.8 X 10^{-3} μCi/mL, which avoids an unacceptable false alarm frequency.

A date- and time-stamped paper strip chart of alpha counts is recorded for each month. In case of an OLAM alarm, sampling is performed by request at upstream manholes per procedure. If the OLAM is unavailable because of scheduled maintenance procedures or unforeseen operational difficulties, samples are collected every 2 h. An OLAM alarm signal is sent to at least one continuously manned location.

The 2904-ZB sampling and monitoring facility is located approximately 65 yd downstream of the 2904-ZA facility and is adjacent to Manhole 9 on the transport system. The facility houses two liquid samplers, a continuously recording pH monitor and a precision flowmeter. Only the pH monitor is presently operational.

The pH monitor is capable of monitoring a pH level from 1 to 14 and alarms at both the monitoring facility and 234-5Z (Rm. 104) if the pH level goes below 6 or above 9. The monitor has a recorder that is used to determine the duration and volume of any upset or unusual liquid discharge. The pH signal is sent to a date- and time-stamped paper strip chart.

Continued operation of the 216-Z-20 Crib effluent monitoring instrumentation is ensured through the use of Westinghouse Hanford-approved operating and calibration procedures. Procedure 7-GN-038, Rev. 4, provides a method to perform preventive maintenance, thorough cleaning, minor repairs, and inspection of various instrumentation. Procedure PSCP-5-004, Rev. 2, provides a method for standardizing and pH slope correction using either the grab-sample or buffered solution method for the Leeds and Northrup Model 7083 pH Analyzer/Controller. Procedure PSCP-4-179, Rev. 1, provides a method for calibrating the Analogic Model AN25M05 Measureometer II Digital Monitor. Procedure PSCP-4-101, Rev. 2, provides a method for calibrating the Texas Instrument Tigraph 200 Recorder.

7.1.2 291-Z-1 Main Stack

This stack is equipped with an air sampling probe system feeding a record sampler and an alpha CAM with an alarm. The stack flow rate is determined quarterly by Westinghouse Hanford Vent and Balance personnel and monthly using a portable measurement device for determining the monthly release of radioactivity. Daily monitoring of the amount of CCl_4 released is performed using a material balance during operation of the PRF process. Details on the stack monitoring equipment are provided below.

Air is extracted from the stack through a penetration at the 50-ft level. Six air sampling probes located at various locations along the 50-ft axis are used to extract the air. The flow rate through the sampling probes and line is approximately 4 ft^3/min.

The air is routed to effluent monitoring equipment located in an instrument cabinet outside the stack. This equipment includes:

- an incoming sampling line
- a flow splitter
- a record sample holder
- an Alpha 4 CAM
- two rotameters
- a flow totalizer
- two vacuum gauges
- two flow alarm switches
- vacuum lines
- two centrifugal type pumps
- two flow regulators
- an alarm relay panel
- an exhaust line routed back into the stack.

The instrument cabinet is heated, lit, and well ventilated. Therefore, the temperature and moisture content of the air in the sampling lines are unlikely to vary beyond acceptable levels. Details on the effluent monitoring equipment are provided below.

The cabinet is located outside of the stack at the 50-ft level. This arrangement facilitates the use of a straight and short sampling line (approximately 4-ft), thus minimizing potential losses in the sampling line. Upon entering the cabinet, the sample stream is split using a knife-edge "vee" type flow splitter. One line (designated 810) exiting the splitter goes to a record sampler, and the other line (designated 811) goes to an alpha CAM.

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The record sampler is a Hanford-type 47-mm fixed head sampler and is located approximately 8 in. after the splitter. The sampler is equipped with a Versapor 3000 type filter, which has a 0.3 μm pore size. The filter is removed weekly for analysis as described in Section 9.0. Air is drawn through the sampler at a flow rate of approximately 2 ft^3/min.

Air travels from the record sampler via a flexible line to a flow totalizer. The totalizer is a Rockwell Model MR-9 and measures total flow in increments of 0.1 m^3. The totalizer is calibrated quarterly by Westinghouse Hanford personnel. The air then travels through a vacuum gauge (Marsh Model Safecase PG73), an air rotameter, a pump (Marsh Model J7846), and then is routed back into the stack. The line also includes an adjustable flow switch (Chem-Tec Model 500-316-B-BP) which monitors the vacuum in the line and triggers an alarm when a pressure drop occurs indicating a loss of flow. Both the gauge and pressure switch are calibrated every 6 mo by Westinghouse Hanford personnel. Procedures in place for ensuring continued operation of the system components include PSCP-4-007, Rev. 1, which provides a method for calibrating the Rockwell flow totalizer; PSCP-4-091, Rev. 2, which provides a method for calibrating the pressure and vacuum gauges; PSCP-6-029, Rev. 1, which provides a method for calibrating the Chem-Tec Adjustable Flow Switch Model 500; and PSCP-7-001, Rev. 1, which provides a method for checking the calibration of the air rotameters.

The second line exiting the splitter leads to an Eberline Alpha 4 CAM. The CAM is calibrated annually by PNL per the PNL-MA-563 Eberline Alpha 4, 5, and 5A Air Monitors Calibration Procedure. The airflow through the CAM is maintained at approximately 2 ft^3/min. The CAM is equipped with alarms indicating high radiation levels or inoperability. Detailed information on the components of the CAM are available in the Eberline Technical Manual for the Alpha-4 CAM. The vacuum system serving the CAM is similar to that serving the record sampler except that there is no flow totalizer. Continued operation of the CAM is ensured through Westinghouse Hanford-approved test procedures. *Health Physics Procedures Manual* (WHC 1991e), Procedure 7.3.1, Rev. 3, describes the steps, material, and documentation necessary to perform an operational performance and efficiency test on Eberline Alpha CAMs Models Alpha-4, 5 and 5A. WHC-IP-0692, Procedure 5.2.6, Rev. 2, establishes standard methods for performing air in-leakage and air flow indicator calibration tests on CAMs.

On January 30, 1979, a final acceptance test was conducted on the 291-Z-1 effluent monitoring system. There have been no significant modifications to this system since that test was conducted. Continued operation of the system is ensured through Procedure 5.2.2.6, Rev. 2 (WHC 1991e), that describes the scheduling, steps required, and materials necessary to conduct a gaseous effluent sampling and monitoring operability inspection to ensure system reliability and accuracy of sample data, and Procedure 5.2.2.7, Rev. 2, which describes the steps necessary to start up and shut down the system and to perform routine sample exchanges.

7.2 TECHNICAL SPECIFICATIONS PERTAINING TO EFFLUENT MONITORING SYSTEM (EMS)

The technical specifications pertaining to the PFP complex effluent monitoring systems are established as OSRs. Several OSRs exist that pertain directly to the operation of the effluent monitoring system, and several OSRs also exist that pertain to effluent release limits, which indirectly impact the effluent monitoring systems because the systems must be capable of demonstrating compliance with the OSRs. The following OSRs pertain either directly or indirectly to the PFP complex effluent monitoring systems:

- For the 291-Z-1 Stack, the average gaseous effluent total alpha concentration is not to exceed 2×10^{-12} μCi/mL per yr or 8×10^{-12} μCi/mL per wk

- For the 216-Z-20 Crib, the combined liquid effluent total alpha concentration measured at 2901-ZA or 2904-ZA is not to exceed 5×10^{-6} μCi/mL per yr or 2×10^{-5} μCi/mL per wk

- Radiation monitoring equipment on the 291-Z-1 Stack shall operate continuously. Malfunctions or equipment failures shall be corrected promptly and backup samplers used as necessary

- Effluent monitoring systems for the 291-Z-1 Stack shall be operability tested monthly and calibrated annually

- The On-line Alpha Monitoring System in 2904-ZA shall be tested weekly and calibrated annually

- The On-line Alpha Monitoring System in 2904-ZA shall be tested monthly and calibrated annually

The capability of the effluent monitoring systems to comply with these OSRs is discussed in Section 14.0. Note that the last two OSRs listed above are contradictory. Therefore, the most restrictive of the two is used for compliance assessment.

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8.0 HISTORICAL MONITORING/SAMPLING DATA FOR EFFLUENT STREAMS

This section presents recent monitoring and sampling data for the effluent streams determined to require a FEMP (the 216-Z-20 Crib and the 291-Z-1 Stack). Data for effluent streams determined to not require a FEMP are not included; pertinent information was provided in the FEMP Determination report.

8.1 NORMAL CONDITIONS

This section presents detailed monitoring and sampling data for the past several years for the 216-Z-20 Crib and the 291-Z-1 Stack (Brown et al. 1990; Coony and Thomas 1989; Coony et al. 1988). Because the operating characteristics of many of the PFP complex facilities and processes have changed during this period, some of the data may not reflect the current release quantities. Therefore, a comparison of the available data to both the current and future expected release quantities is provided based on the current status of operations and any future plans for the facilities.

8.1.1 216-Z-20 Crib

Four possible process configurations exist for the PFP complex: (1) PRF operating but not the RMC line; (2) RMC Line operating but not the PRF; (3) neither the PRF nor RMC line operating; (4) both the PRF and RMC Line operating (Jensen 1990). The first three configurations have existed in the past; the fourth has not. Consequently, historical monitoring and sampling data exist only for the first three cases.

During 1989, the total effluent volume released to the 216-Z-20 Crib was 2.89×10^{8} L. The monthly flow ranged from a low of 1.48×10^{7} L to 3.28×10^{7} L (Brown et al. 1990). Similar flows were reported for the first 3 mo of 1990 (Jensen 1990).

8.1.1.1 Radioactive Releases. Brown et al. 1990 reported the quantities of alpha-emitting and beta-emitting radionuclides released to the 216-Z-20 Crib during 1989. During that year, the PRF did not operate, but the RMC Line did operate for a period of approximately 2.5 mo. Less than 7.83×10^{-3} Ci of ^{239}Pu were released during 1989, with a maximum release of 3.16×10^{-3} Ci during any one month. The total activity of all alpha emitters released during 1989 was reported to be less than 7.18×10^{-2} Ci. The average and maximum monthly concentrations of ^{239}Pu were less than 2.71×10^{-8} μCi/mL and 1.55×10^{-7} μCi/mL, respectively. Note that the maximum concentration occurred during the approximately 2.5-mo period when the RMC Line was operating; the maximum monthly value when the RMC Line was not operating was reported to be approximately a factor of 10 less. However, the release concentrations during future RMC operations are anticipated to be much less than in the past because of the non-operational status of some processes. The average and maximum monthly concentrations of all alpha emitters released during 1989 were less than 2.49×10^{-7} μCi/mL and 1.49×10^{-6} μCi/mL, respectively (Brown et al. 1990). The values compare well with the data reported by Jensen (1990), where an average ^{239}Pu concentration (based on three samples) of 8.66 x 10^{-9} μCi/mL was reported. Table 8-1 provides historical radiological data based on annual summaries (WHC 1988a).

Table 8-1. Annual Average Alpha and Beta Concentrations Released to the 216-Z-20 Crib.

Year	Volume (L)	Alpha Concentration (μCi/mL)	Beta Concentration (μCi/mL)
1988	2.29 x 10^{8}	<1.75 x 10^{-8}	<2.41 x 10^{-8}
1987	2.04 x 10^{8}	4.03 x 10^{-8}	2.57 x 10^{-8}
1986	3.41 x 10^{8}	6.92 x 10^{-7}	9.30 x 10^{-8}
1985	4.57 x 10^{8}	1.32 x 10^{-6}	1.90 x 10^{-7}
1984	7.70 x 10^{8}	1.75 x 10^{-6}	2.15 x 10^{-7}

Jensen (1990) also reported historical sampling data for periods when either the PRF or the RMC Line was operating. Four samples analyzed during 1987 indicate that the average alpha activity concentration when the PRF was operating was 3.7 x 10^{-8} μCi/mL. Similarly, samples taken periodically from 1985 through 1988 indicated that the alpha activity ranged from a high of 2.4 x 10^{-6} μCi/mL (in 1985) to a low of 3.52 x 10^{-9} μCi/mL (in 1988) when the RMC Line was operating.

The total quantity of beta emitters reported to be released to the crib during 1989 was lower than the quantity of alpha emitters released. Brown et al. (1990) reported average and maximum monthly concentrations of beta emitters of less than 1.67 x 10^{-7} μCi/mL and 1.16 x 10^{-6} μCi/mL, respectively.

8.1.1.2 Nonradioactive Releases. Jensen (1990) provided a detailed analysis of four random samples taken at Manhole 9, which is downstream of all potential contributors. The samples were obtained during the period from November 30, 1989, to March 26, 1990. For chemical sampling, the procedure was to obtain representative samples by following the EPA's approved sampling and analysis protocol in accordance with SW-846 (EPA 1986). Details of the sampling and analysis procedures were described by Jensen (1990).

No significant quantities of hazardous chemicals were found in the four samples considering the sampling detection limits and the presence of the chemicals in the incoming water. These negative results were used to support a proposal that the stream is not a dangerous waste. Further details are provided in Jensen (1990), where additional sampling data from as early as 1985 are provided.

8.1.2 291-Z-1 Stack

During 1989, the total volume of air released from the 291-Z-1 Stack was approximately 3.5 x 10^{12} L. The monthly flow ranged from 2.5 x 10^{11} L to 3.6 x 10^{11} L (Brown et al. 1990).

8.1.2.1 Radioactive Releases. Brown et al. (1990) reported the quantities of various radionuclides released from the 291-Z-1 Stack during 1989. A total of 2.9 x 10^{-4} Ci of ^{239}Pu and 5.5 x 10^{-5} Ci of ^{241}Am were released. These radionuclides were the only ones specifically analyzed. Based on a total annual flow of 3.5 x 10^{12} L of air, the average concentrations of ^{239}Pu and ^{241}Am released were 8.3 x 10^{-14} μCi/mL and 1.6 x 10^{-15} μCi/mL, respectively. The 1989 releases are comparable to the 1988 releases, when approximately 2 x 10^{-4} Ci of ^{239}Pu and 2 x 10^{-5} Ci of ^{241}Am were released (DOE/RL 1990). Table 8-2 provides historical radiological data based on annual summaries (WHC 1988b).

Table 8-2. Annual Average Alpha and Beta Concentrations Released from the 291-Z-1 Stack.

Year	Alpha Concentration (μCi/mL)	Beta Concentration (μCi/mL)
1987	1.13 x 10^{-13}	1.31 x 10^{-14}
1986	1.08 x 10^{-12}	1.23 x 10^{-14}
1985	3.82 x 10^{-14}	4.52 x 10^{-14}
1984	3.79 x 10^{-14}	1.79 x 10^{-14}
1983	6.69 x 10^{-14}	2.92 x 10^{-14}
1982	4.00 x 10^{-14}	2.99 x 10^{-14}

Monthly releases of both alpha-emitting and beta-emitting radionuclides during 1989 were reported (Brown et al. 1990). The total monthly activity of alpha emitters released during 1989 ranged from 1.5 x 10^{-6} Ci to 6.0 x 10^{-5} Ci. The total monthly activity of beta emitters released ranged from less than 3.0 x 10^{-6} Ci to 6.3 x 10^{-6} Ci.

8.1.2.2 Nonradioactive Releases. The only nonradioactive substance released from the 291-Z-1 Stack that potentially exceeds reportable quantities is CCl_4, that is released during PRF operations. The quantities of this chemical are determined from material balance calculations. Approximately 18,300 lb were released during 1987, and no CCl_4 was released during 1988 or 1989. Future emissions are estimated to be much less than 75 lb/d when the facility becomes operational. Approximately 100 lb of NO_x were released during 1987, which is significantly less than reportable quantities. Small quantities of HF have been released routinely during past operations, but future operations will not involve the use of HF and none will be released.

8.2 UPSET CONDITIONS

There have been no recent upset conditions that have resulted in significant releases from the 216-Z-20 Crib. The most significant upset release from the 291-Z-1 Stack occurred in 1986, when an upset occurred in which HF damaged a HEPA filter bank. This release is irrelevant to this FEMP because HF is no longer used in PFP complex operations. No other significant upset releases have been identified that could affect the postulated release scenarios for upset conditions.

9.0 SAMPLE ANALYSIS

This section provides information on the analyses of the PFP facility effluent samples. Further discussion of Sample Analysis involving EPA Method 114 can be found in Section 16.2.5.

9.1 ANALYTICAL LABORATORY AND PROCEDURES

Analyses of gaseous effluent record sample filters for the 291-Z-1 Stack and liquid effluent samples for the 216-Z-20 Crib are performed by the Westinghouse Hanford 222-S Analytical Laboratory. The analyses of the stack CAM sample filters are performed by the PFP EL and are discussed in more detail later in this section.

The specific analytes of interest for the PFP complex are listed in Table 9-1. The gaseous effluent record samples are analyzed for gross alpha and beta activity as well as specific radionuclides in accordance with analytical procedure LA-943-123. The liquid effluent samples are analyzed for pH and plutonium content in accordance with procedures LA-212-102 and LA-943-123. The additional analytes listed for liquid effluents will be

Table 9-1. Analytes of Interest for the PFP Complex Effluents.

Effluent Category	Analyte Category	Analytes of Interest
Liquid	Ions/Anions	Chloride, Fluoride, Nitrate, Nitrite
	Inorganics	Aluminum, Antimony, Barium, Beryllium, Cadmium, Chromium, Cobalt, Copper, Mercury, Nickel, Silver, Vanadium, Zinc
	Volatile Organics	Acetone, Benzene, Carbon Tetrachloride, Chloroform, Methyl Ethyl Ketone, Toluene, Xylene
	Semivolatile Organics	Tributyl Phosphate
	Radionuclides	Alpha, Beta, ^{90}Sr, ^{137}Cs, ^{238}Pu, ^{239}Pu, ^{241}Pu
	Other	pH
Gaseous	Radionuclides	Alpha, Beta, ^{89}Sr, ^{90}Sr, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{241}Am

quantified periodically to verify that the regulatory status of the stream does not change during facility operations. These samples will be routed to an approved Westinghouse Hanford participant contractor or subcontractor laboratory for radiological and/or chemical analysis.

A computer-controlled Tennelec/Nucleus Alpha Energy Analysis System, located in Room 221-A of the 234-5Z Building, is used to analyze the CAM sample filters for plutonium content. This analysis is performed in accordance with laboratory procedure LA-508-305. Detection levels are established for radioisotope counting in accordance with procedure LA-508-002. The precision and accuracy of the analysis depends upon the matrix of the sample, the sample count rate, and the combined sample and background count rate (i.e., the amounts of plutonium and radon daughters present). The accuracy of the system is checked daily by counting a known standard bearing plutonium and calculating the percent recovery. Under normal sample collection circumstances the precision of the analysis at a level of 2.0×10^{-12} μCi/mL may approach ± 1.5%. At the detection limit of 1.0×10^{-16} μCi/mL, with high radon daughter content, the precision may be higher than ± 100%.

After the background activity and standard recovery have been determined, the CAM sample filters are removed from their transport envelopes and placed into individual sample holders. The sample holders are loaded into the counting system sample changer and the analyses are performed in batch (i.e., all stack CAM filters collected for the sample period). For each sample analyzed, the lab technician enters data specific to each sample into the computer. The information entered corresponds to dates and times the sample collection started and ended, sample location code, and sampling system flow rate, all of which is recorded on the sample envelope at the time the sample is collected. The computer performs automatic data reduction and the results are printed at the completion of the operations. All samples that are 2.0×10^{-12} μCi/mL and higher are set aside and counted again in 7 d. Samples below the 2.0×10^{-12} μCi/mL limit are normally disposed of the following day, the exceptions being those collected from the 291-Z-1 Stack. These filters are returned to the HPTs for delivery to the 222-S Laboratory along with the stack record samples.

9.2 SAMPLE AND DATA CHAIN OF CUSTODY

Health Physics Technicians (HPT) collect the PFP stack record sample and CAM sample filters weekly in accordance with the current sample schedule. When these samples are collected, appropriate sample data are also obtained and recorded on individual sample envelopes. The collection and data recording are done in accordance with Health Physics Procedure 5.2.2.7. The standard requirements for data entry on air sample envelopes are established in *Operational Health Physics Procedures Manual*, Procedure 2.1.6 (WHC 1989). The CAM sample filters are delivered to the PFP EL to be analyzed for plutonium content (see Section 9.1). The record sample filters are packaged and delivered to the 222-S laboratory where they are analyzed for gross alpha and beta activity, $^{239/240}$Pu, and ^{241}Am. All applicable chain of custody documentation required by the laboratory is completed by the HPT before the samples are transported. At the laboratory, the samples are "checked in" per the laboratory requirements and copies of the chain of custody documentation are returned to the Health Physics Field Office for reference.

The PFP Facility Operations personnel collect both routine and non-routine liquid effluent samples of the discharge to the 216-Z-20 Crib in accordance with the current sample schedule and PFP Plant Operating Procedure (POP) ZO-100-007. Once the samples have been packaged, they are transported to the Westinghouse Hanford 222-S analytical laboratory in accordance with POP ZO-100-024. Delivery of the samples is documented by signing an Analytical Laboratory Sample Log Sheet. Following verification that Item Transfer Forms are signed, the paperwork is returned to PFP Facility Operations.

Results from the laboratory analyses are reported to the Westinghouse Hanford Environmental Protection Group, which is responsible for evaluating the data against release limits and generating an annual effluents release report, and to the PFP EL and Facility Operations. Results from the CAM sample filters are reported to PFP Health Physics, PFP Engineering personnel, and Facility Services management in accordance with procedure LA-508-305.

A field sampling plan is being developed for the PFP complex that will direct additional sampling of the 216-Z-20 Crib in an effort to provide data to confirm that stream characteristics will not change over time or with process operations. Once initiated, this activity will be performed on a schedule to be identified in the plan.

Supporting procedures and documents for the PFP complex FEMP activities are presented in Table 9-2. These include PFP Plant Operating Manuals, Sample Schedules, Health Physics Manuals, and Analytical Procedures.

9.3 U.S. DEPARTMENT OF ENERGY ANALYTICAL AND LABORATORY GUIDELINES

The analytical and laboratory procedures for the FEMP activities are identified in the *Quality Assurance Project Plan for the Facility Effluent Monitoring Plan Activities* (WHC 1991f). General requirements for laboratory procedures, data analyses, and statistical treatment are addressed in the QAPP. Detailed descriptions of these requirements are given in each FEMP.

The following elements are identified in *Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance* (DOE 1991).

Table 9-2. Supporting Documents and Procedures for PFP Complex FEMP Activities.

Document or Procedure	Title or Subject
POP-Z0-100-007, Rev. D-7	Sample 2904-ZA
POP-Z0-100-008, Rev. D-2	Perform Drain/Manhole Sampling
POP-Z0-100-011, Rev. C-1	Sample Manhole 9 During Pump or Power Failure
POP-Z0-100-024, Rev. B-0	Transport Sample
POP-Z0-102-009, Rev. C-0	Operate/Decontaminate 2904-ZA Alpha Monitor
POP-Z0-102-010, Rev. A-3	Operate 2904-ZB Sampling Facility
FSS-Z-080-00003, Rev. C-1	291-Z Sump and Z-20 Crib Routine Sample Schedules
WHC-CM-4-12, Section 5.2, Rev. 2 (WHC 1989b)	Air Sampling
WHC-CM-4-12, Section 7.3, Rev. 1 (WHC 1989b)	Air Sampling and Monitoring Instruments
WHC-IP-0692, Section 5.2.2.6, Rev. 2 (WHC 1991e)	Gaseous Effluent Sampling and Monitoring System Operability Inspection
WHC-IP-0692, Section 5.2.2.7, Rev. 2 (WHC 1991e)	Operation of Gaseous Effluent Sampling and Monitoring Systems
WHC-IP-0692, Section 12.1.2.3, Rev. 2 (WHC 1991e)	Effluent Exhaust CAM Alarm Response
WHC-IP-0692, Section 12.1.6, Rev. 2 (WHC 1991e)	Stack Effluent Release Response
FSS-Z-080-00008, Rev. C-1	PFP Gaseous Sample Schedule
LA-508-002, Rev. A-2	Detection Levels for Radioisotopic Counting
LA-508-305, Rev. A-0	Air Filter Analyses by TENNELEC AEA
LA-508-105, Rev. A-1	Operation of the GAMMA PRODUCTS Alpha/Beta Counting Systems Located in the 222-S Counting Room
LA-212-102, Rev. C-3	Determination of Ph Direct Measurement
LA-943-123, Rev. E-0	Separation of Pu and Am by Ion Exchange

Table 9-3. Laboratory Procedures.

Element	Documentation
Sample identification system	To be provided when complete
Procedures preventing crosscontamination	Contained in 222-S Laboratory Analytical Procedures (identified in QAPP WHC-EP-0446 [WHC 1991f] Table 8-1)
Documentation of methods	Contained in 222-S Laboratory Analytical Procedures (identified in QAPP WHC-EP-0446 Table 8-1)
Gamma emitting radionuclides	See QAPP Table 8-1
Calibration	See QAPP Table B-1
Handling of samples	See QAPP Table 8-1
Analysis method and capabilities	See QAPP Table 8-1
Gross alpha, beta, and gamma measurements	See QAPP Table 8-1
Direct gamma-ray spectrometry	See QAPP Table 8-1
Beta counters	See QAPP Table 8-1
Alpha-energy analysis	See QAPP Table 8-1
Radiochemical separation procedures	To be provided when available
Reporting of results	To be provided when available
Counter calibration	See Table B-1, QAPP
Intercalibration of equipment and procedures	To be provided when available
Counter background	Contained in 222-S Laboratory Analytical Procedures (QAPP, Table 8-1)
Quality assurance	To be provided when available

Table 9-4. Data Analyses and Statistical Treatment.

Element	Documentation
Summary of data and statistical treatment requirements	To be provided when available
Variability of effluent and environmental data	To be provided when available
Summarization of data and testing for outliers	To be provided when available
Treatment of significant figures	To be provided when available
Parent-decay product relationships	To be provided when available
Comparisons to regulatory or administrative control standards and control data	To be provided when available
Quality assurance	To be provided when available

10.0 NOTIFICATION AND REPORTING REQUIREMENTS

Notifications and reporting of specific events related to environmental releases and/or events involving effluents and/or hazardous materials shall be made as per DOE Orders 5400.1 (DOE 1988) and 5000.3A (DOE 1990b). Implementation of the Orders is accomplished via *Management Requirements and Procedures Manual* (MRP) (WHC 1989c). Specific implementation, where required, is included in the appropriate Facility's "Occurrence Categorization, Notification and Reporting" procedure. Implementation of environmental limits and requirements is found in the Environmental Compliance Manual, WHC-CM-7-5.

10.1 REQUIREMENTS

10.1.1 Occurrence Identification and Immediate Response

Each employee shall identify events and conditions and shall promptly notify management of such occurrences:

a. Call 811 if immediate help such as fire, ambulance, or patrol is required.

b. Call 3-3800 (The Patrol Operations Center) if assistance other than fire, ambulance, or patrol is required.

c. After requesting necessary outside assistance, the employee shall notify his or her supervisor, who shall notify the facility manager, the building emergency director, and the Occurrence Notification Center (ONC) (6-2900).

Operations personnel shall take appropriate immediate action to stabilize or return the facility/operation to a safe condition. Actions taken in response to non-routine releases as evidenced by high sample results from liquid and gaseous effluent sampling are documented in *Plutonium Finishing Plant Administration Manual*, WHC-CM-5-8 (WHC 1988c), Section 1.5, Rev. 2, Non-Routine Release Response.

The oversight organizations shall notify their DOE Field Office, Richland, counterparts of the event after receiving notifications from, and discussing the event with, the facility manager.

10.1.2 Occurrence Categorization

Occurrences (environmental) shall be categorized as soon as practical using the specific criteria listed in Section 10.2 for radioactive and hazardous materials release. These categorizations should be made within 2 h of identification. Occurrences shall be categorized by their seriousness; if categorization is not clear, the occurrence shall be initially categorized at the higher level being considered. The occurrence categorization shall then be either evaluated, maintained, or lowered as information becomes available.

10.2 OCCURRENCE CATEGORIZATION

The following criteria for categorization of occurrences are established in WHC-CM-1-3 (WHC 1989c), which implements the requirements contained in DOE Order 5000.3A (DOE 1990b).

10.2.1 Radioactive Releases

10.2.1.1 Emergency

- Any release of radioactive material to controlled or uncontrolled areas in concentrations which, if averaged over a period of 24 hrs, would exceed 5000 times the DCG.

- Any release of radioactive material off-site that is not a normal monitored release and could reasonably be expected to result in an annual dose or dose commitment to any member of the general population greater than 500 mrem.

10.2.1.2 Unusual Occurrence

- Release of radionuclide material that violates environmental requirements in permits, regulations, or DOE standards as determined by Westinghouse Hanford EP.

- Other release below emergency levels that require immediate reporting to regulatory agencies or trigger outside agency specific action levels as determined by Westinghouse Hanford EP.

10.2.1.3 Off-Normal

- Any release of radionuclides that is not a normally monitored release.

- Any discovery of radionuclides where they are not expected (e.g., storm sewers, sanitary sewers, etc.) and for which no immediate explanation is available.

- Any statistically significant increase in normally monitored releases of radionuclides to an uncontrolled area.

- Any release of radionuclides which will be reported to an outside agency (excluding normal reporting) but is not classified as an unusual occurrence.

- Any controlled and monitored gaseous radionuclide release exceeding a Westinghouse Hanford-established ACV on an annual basis or exceeding 10 times the Administrative Control Value (ACV) on a weekly basis.

- Any controlled and monitored (instantaneous) gaseous radionuclide release exceeding 5000 times the DCG over any 4-h period.

- Any controlled and monitored liquid radionuclide releases exceeding Westinghouse Hanford established ACV on an annual basis or exceeding 2 times ACV on a monthly or weekly basis.

- Any controlled and monitored liquid radionuclide release exceeding 5000 times DCG instantaneously.

10.2.2 Hazardous Substances Releases

10.2.2.1 Emergency

- Any actual or potential release of material to the environment that results in or could result in significant off-site consequences; i.e., need to relocate people, major wildlife kills, woodland degradation, and aquifer contamination, the need to secure downstream water supply intakes, etc.

10.2.2.2 Unusual Occurrence

- Release of a hazardous substance, regulated pollutant, or oil that exceeds a reportable quantity, federal permits, DOE standards, or levels requiring immediate reporting to outside agencies as determined by Westinghouse Hanford EP.

10.2.2.3 Off-Normal

- Any unmonitored release of hazardous substance or regulated pollutant as determined by Westinghouse Hanford EP.

- Any statistically significant increase of hazardous substance in normally monitored released.

- Any discovery of toxic or hazardous substance where it is not expected.

- Any release of hazardous substance or oil which is not classified as an unusual occurrence but will be reported to outside agencies (excluding normal reporting) as determined by Westinghouse Hanford EP.

10.2.3 Discovery of Radioactive or Hazardous Material Contamination Because of DOE Operations

10.2.3.1 Emergency

- Discovery of contamination that results of could result in significant consequences; i.e., exceeding safe exposure limits to workers or public.

10.2.3.2 Unusual Occurrence

- Discovery of off-site contamination due to DOE operations which does not represent an immediate threat to the public.

- Any discovery of groundwater contamination not previously known or suspected.

10.2.3.3 Off-Normal

- Discovery of any on-site contamination attributable to DOE operations not previously known or expected.

10.2.4 Agreement/Compliance Activities

10.2.4.1 Unusual Occurrence

- Any agreement, compliance, remediation, or permit-mandated activity for which 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.

- Any occurrence under any agreement or compliance area that requires notification of an outside agency within 4 h or less, or triggers an outside regulatory agency action level, or otherwise indicates specific interest/concern from such agencies.

10.2.4.2 Off-Normal

- Any occurrence under any agreement of compliance area that will be reported to outside agencies in a format other than routine monthly or quarterly reports.

- Any changes to existing agreements or permit-mandated activities.

- Development of news agreements or permit-mandated activities.

11.0 INTERFACE WITH THE OPERATIONAL ENVIRONMENTAL SURVEILLANCE PROGRAM

11.1 DESCRIPTION

The sitewide Environmental Monitoring Plan (EMP), as described in the FEMP Management Plan (WHC 1991g), consists of two distinct but related components: environmental surveillance conducted by PNL and effluent monitoring conducted by Westinghouse Hanford. The responsibilities for these two portions of the EMP are delineated in a Memorandum of Understanding (MOU 1989). Environmental surveillance, conducted by PNL, consists of surveillance of all environmental parameters to demonstrate compliance with regulations. Effluent monitoring includes both in-line and facility effluent monitoring as well as near-field (near-facility) operational environmental monitoring. Projected EDEs, reported in this FEMP, are the products of in-line effluent monitoring. Near-field monitoring is required by Part O, "Environmental Monitoring," *Environmental Compliance Manual* (WHC 1991c), and procedures are described in *Operational Environmental Monitoring* (WHC 1988d).

11.2 PURPOSE

The purpose of near-field (operational environmental) monitoring is to determine the effectiveness of environmental controls in preventing unplanned spread of contamination from facilities and sites managed by Westinghouse Hanford under the approval of DOE. Effluent monitoring and reporting, monitoring of surplus and waste management units, and monitoring near-field environmental media are, therefore, conducted by Westinghouse Hanford for the purposes of: controlling operations, determining the effectiveness of facility effluent controls, measuring the adequacy of containment at waste transportation and disposal units, detecting and monitoring upset conditions, and evaluating and upgrading effluent monitoring capabilities.

11.3 BASIS

Near-field environmental surveillance is conducted to (1) monitor employee protection; (2) monitor environmental protection; and (3) ensure compliance with local, state, and federal regulations. Compliance with parts of DOE Orders 5400.1, *General Environmental Protection Program*; 5400.5, *Radiation Protection of the Public and the Environment*; 5484.1, *Protection, Safety, and Health Protection Information Reporting System*; 5820.2A, *Radioactive Waste Management*; and, *Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance* (DOE 1991), are addressed through this activity.

11.4 MEDIA SAMPLED AND ANALYSES PERFORMED

Procedure protocols for sampling, analysis, data handling, and reporting are specified in WHC 1988d. Media include ambient air, surface water, groundwater, external radiation dose, soil, sediment, vegetation, and animals at or near active and inactive facilities and/or waste sites. Parameters monitored include the following, as needed: pH, water temperature, radionuclides, radiation exposure, and hazardous constituents. Animals that are not contaminated, as determined by a field instrument survey, are released at the capture location.

11.5 LOCATIONS

Samples are collected from known or suspected effluent pathways (e.g., downwind of potential releases, liquid streams, or proximal to release points). To avoid duplication, Westinghouse Hanford relies upon existing sample locations where PNL has previously established sample sites (e.g., air samplers in the 300 Area). There are 38 air samplers (4 in the 100 Area and 34 in the 200/600 Areas), 35 surface water sample sites (22 in the 100 Area and 13 in the 200/600 Areas), 110 groundwater monitoring wells (20 in the 100 Area, 89 in the 200/600 Areas, and 1 in the 300/400 Areas), 299 external radiation monitor points (182 survey points and 41 thermoluminescent dosimeter (TLD) sites in the 100 Area, 61 TLD sites in the 200/600 Areas, and 15 TLD sites in the 300/400 Areas), 157 soil sample sites (32 in the 100 Area, 110 in the 200/600 Areas, and 15 in the 300/400 Areas), and 95 vegetation sample sites (40 in the 100 Area, 40 in the 200/600 Areas, and 15 in the 300/400 Areas). Animal samples are collected at or near facilities and/or waste sites. Specific locations of sample sites are found in WHC-CM-7-4.

Additionally, surveys to detect surface radiological contamination, scheduled in WHC-CM-7-4, are conducted near and on liquid waste disposal sites (e.g., cribs, trenches, drains, retention basin perimeters, pond perimeters, and ditch banks), solid waste disposal sites (e.g., burial grounds and trenches), unplanned release sites, tank farm perimeters, stabilized waste disposal sites, roads, and firebreaks in the Operations Areas. There are 391 sites in the Operations Areas (100 in the 100 Area, 273 in the 200/600 Areas, and 18 in the 300/400 Areas) where radiological surveys are conducted.

11.6 PROGRAM REVIEW

The near-field (operational environmental) monitoring program will be reviewed at least annually to determine that the appropriate effluents are being monitored and that the monitor locations are in position to best determine potential releases.

11.7 SAMPLER DESIGN

Sampler design (e.g., air monitors) will be reviewed at least biannually to determine equipment efficiency and compliance with current EPA and industry [e.g., ANSI and American Society for Testing and Materials (ASTM)] standards.

11.8 COMMUNICATION

The Operations and Engineering Contractor and the Research and Development Contractor will compare and communicate results of their respective monitoring programs at least quarterly and as soon as possible under upset conditions.

11.9 REPORTS

Results of the near-field environmental monitoring program are published in the document series *Westinghouse Hanford Company Environmental Surveillance Annual Report*, WHC-EP-0145 (WHC 1991h). Results of routine radiological surveys are published in the document series WHC-SP-0595, *Quarterly Environmental Radiological Survey Summary*. The radionuclide values in these reports are expressed in curies, or portions thereof, for each radionuclide per unit weight of sample (e.g., picocuries per gram) or in field instrument values (e.g., counts per minute) rather than EDE, which is calculated as the summation of the products of the dose equivalent received by specified tissues of the body and a tissue-specific weighting factor.

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12.0 QUALITY ASSURANCE (QA)

12.1 PURPOSE

This Quality Assurance (QA) Plan describes the quality assurance requirements associated with implementing FEMPs. The plan identifies the FEMP activities and assigns the appropriate quality assurance requirements defined by the Westinghouse Hanford *Quality Assurance Manual* (WHC 1988). This QA Plan shall be consistent with the requirements in *Quality Assurance*, DOE 5700.6B (DOE 1986). In addition, QA requirements in 40 CFR 60, Appendix A (EPA 1990), "Reference Methodologies" shall be considered when performing monitoring calculations and establishing monitoring systems.

12.2 OBJECTIVE

The objective of this plan is to provide a documented QA plan describing QA requirements for facilities implementing the FEMPs.

12.3 REQUIREMENTS

A Quality Assurance Project Plan (QAPP) (WHC 1991f) has been developed to implement the overall QA program requirements defined by WHC-CM-4-2 (WHC 1988). The QAPP applies specifically to the field activities, laboratory analyses, and continuous monitoring performed for all FEMPs conducted by Westinghouse Hanford. Plans and procedures referenced in the QAPP are available for regulatory review upon request by the direction of the Westinghouse Hanford Environmental Assurance Manager. The EPA Method 114 is discussed in detail in Section 16.2.6 of this document.

12.4 FACILITY SPECIFIC REQUIREMENTS

The QAPP includes a list of analytes of interest and analytical methods for RCRA groundwater monitoring at the Hanford Site. This list includes detection limits and precision and accuracy requirements for each analyte. The analytes of interest applicable to the PFP complex have been identified from this table and are listed in Table 12-1. Procedural controls specific to the PFP complex were presented in Section 9.0.

Table 12-1. Analytes of Interest and Analytical Methods for Liquid Effluent Monitoring and Sampling at the PFP Complex.

Analytical Category	Analyte of Interest	Standard Reference Method[a]	Analytical Method	Contractual Quantitation Limit (Target)[c]
Volatile Organics	Acetone	8240	b	100
	Benzene	8240	b	5
	Carbon Tetrachloride	8240	b	5
Semi-Volatile Organics	Chloroform	8240	b	5
	Methyl Ethyl Ketone	8240	b	5
	Toluene	8240/8250	b	5
	Xylene	8240	b	5
	Tributyl Phosphate	8240	b	5
Inorganics	Aluminum	6010	b	45
	Antimony	6010	b	10
	Barium	6010	b	20
	Beryllium	6010	b	3
	Cadmium	6010	b	40
	Chromium	6010	b	70
	Cobalt	6010	b	70
	Copper	6010	b	60
	Mercury	7470/7741	b	2
	Nickel	6010	b	50
	Silver	6010	b	70
	Vanadium	6010	b	80
	Zinc	6010	b	20
Ions/Anions	Chloride	325.3[d]	b	1000
	Fluoride	340.2[d]	b	10
	Nitrate	352.1[d]	b	100
	Nitrite	354.1[d]	b	10
Radionuclides[e]	alpha	9310	b	30 pCi/L
	beta	9310	b	1000 pCi/L

Table 12-1. Analytes of Interest and Analytical Methods for Liquid Effluent Monitoring and Sampling at the PFP Complex.

Analytical Category	Analyte of Interest	Standard Reference Method[a]	Analytical Method	Contractual Quantitation Limit (Target)[c]
Radionuclides[e] (cont.)	^{90}Sr	SR-05[f]	b	1000 pCi/L
	^{239}Pu	00-07[g]	b	30 pCi/L
Other	pH	9045	b	Not Applicable

[a] Standard methods are from Test Methods for Evaluating Solid Waste (SW 846) (EPA 1986).

[b] Analytical methods shall be Westinghouse Hanford or Westinghouse-approved participant contractor or subcontractor procedures based on the reference methods cited in column 3 of this table. All procedure reviews and approvals shall be in compliance with applicable Westinghouse Hanford procedure control or procurement procedures. Once laboratory methods are approved, this table shall be updated to provide contractual method references as applicable.

[c] Target Contractual Quantitation Limits (CQLs) are to be considered only as target values for initial procurement negotiations with the analytical laboratory. Values are expressed as µg/L unless otherwise specified. This table shall be updated to reflect negotiated contractual values as specified in the final procurement documents or work orders.

[d] Standard methods are from Methods for Chemical Analysis of Water and Waste (EPA 1983b).

[e] Standard methods are from Eastern Environmental Radiation Facility, Radiochemistry Procedures Manual (EPA 1984).

[f] Standard methods are from Prescribed Procedures for the Measurement of Radioactivity in Drinking Water (EPA 1982).

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13.0 INTERNAL AND EXTERNAL PLAN REVIEW

The *General Environmental Protection Program*, DOE Order 5400.1, Chapter IV.4 (DOE 1988), requires the FEMP be reviewed annually and updated every 3 yr. The FEMP should be reviewed and updated as necessary after each major change or modification in the facility processes, facility structure, ventilation and liquid collection systems, monitoring equipment, waste treatment, or a significant change to the Safety Analysis Reports. In addition, EPA regulations require that records on the results of radioactive airborne emissions monitoring be maintained on site for 5 yr. Operations management shall maintain records of reports on measurements of stack particulates or other nonradioactive hazardous pollutant emissions for three years. Facility operators will have to certify on a semiannual basis that no changes in operations that would require additional measurements have occurred.

Westinghouse Hanford EP prepares an annual effluent discharges report for each area on the Hanford Site to cover both airborne and liquid release pathways. Although the report is based on the calendar year, the emission limits apply to any period of 12 consecutive months. In addition, a report on the air emissions and compliance to the Clean Air Act is prepared by EP and submitted to EPA as well as DOE-HQ.

Facility management is to obtain the EP function's approval for all changes to the FEMPs, including those generated in the annual review and update. In addition, the FEMP shall be reviewed by QA.

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14.0 COMPLIANCE ASSESSMENT

This section provides a detailed comparison of the effluent monitoring systems described in Section 7.0 with the applicable regulations presented in Section 3.0. Based on the information presented previously, there are no PFP complex effluent streams out of compliance with the requirement to provide monitoring. Furthermore, all radioactive and nonradioactive hazardous materials that are potentially released through these streams are currently being monitored if required.

Many effluent streams at the PFP complex that do not require a detailed monitoring plan according to either the FEMP Determination report or the reassessment of the FEMP Determination data as described previously are monitored. For these effluent streams and associated monitoring systems, the descriptions provided in the FEMP Determination Report (WHC 1991) are considered sufficient and it is outside the scope of this FEMP to evaluate the compliance of these monitoring systems with the regulations. Consequently, this assessment focuses only on the two effluent streams and associated monitoring systems that were determined to exceed the FEMP criteria: the 216-Z-20 Crib and the 291-Z-1 Stack.

14.1 216-Z-20 CRIB

The effluent monitoring and sampling system for the 216-Z-20 Crib is designed to detect the presence of reportable quantities of hazardous and radioactive material and to detect an abnormal pH level. The monitoring system includes a flow proportional grab sampler, continuous in-line pH monitor, continuous in-line alpha radiation monitor, and numerous sampling access points for periodic grab samples. Grab samples are used appropriately as a backup to the automatic systems and can also be used to determine the source of an accidental release and to obtain samples for nonroutine analysis. These uses do not conflict with applicable regulations.

A primary consideration regarding the required monitoring capabilities for this effluent stream is whether or not the stream is considered a dangerous waste pursuant to *Dangerous Waste Regulations*, WAC 173-303 (WAC 1989). Jensen (1990) evaluated the stream based on process knowledge and analysis of several samples and compared the results to the WAC 173-303 criteria for dangerous waste. It was concluded that the stream not be designated a dangerous waste. Given this analysis, the monitoring system must be capable of demonstrating that the waste does not meet the criteria. The type or frequency of monitoring for specific chemicals, radionuclides, or physical properties depends on the potential for exceeding the relevant criteria. The primary requirement that representative samples are obtained is met through the use of the flow proportional grab sampler.

One criterion that has the potential to be exceeded is corrosivity. WAC 173-303-090 (WAC 1989) states that waste is considered corrosive, and therefore a dangerous waste, if it has a pH less than or equal to 2 or greater than or equal to 12.5. A specific method for determining pH is prescribed, which gives laboratory procedures for pH measurement. The presence of a continuously recording in-line pH monitor at the 2904-ZB Building exceeds this requirement. The 216-Z-20 Crib pH monitor is set to alarm at a pH below 6 or above 9, which would alert operators in advance of the possibility of exceeding the pH criterion for corrosivity.

For discharges of radioactive liquids, the basic requirement for the 216-Z-20 Crib is that the RQ values contained in 40 CFR 302 (EPA 1985a) CERCLA are not exceeded. The RQ values are given in units of radioactivity and pertain to daily releases. As described previously, the only radioactive material having the potential to be released in significant quantities to the 216-Z-20 Crib are plutonium isotopes and associated radionuclides such as ^{241}Am, ^{90}Sr and ^{137}Cs. Because significant quantities of these radionuclides are not normally released, it is sufficient to monitor for gross alpha radioactivity, which would confirm that none of the above radionuclides had been released in unacceptable quantities. Isotopic analysis for specific radionuclides can be accomplished if necessary based on the gross alpha analysis.

Plutonium-239 has an RQ value of 0.01 Ci, or 10,000 μCi. Given a daily volume of effluent released to the Crib of approximately 770,000 L, a ^{239}Pu concentration of 1.3 x 10^{-5} μCi/mL released over a 24-hr period would be reportable under 40 CFR 302. Therefore, the monitoring and sampling system must be capable of detecting this concentration of ^{239}Pu. Based on data from Cammann (1990) and ICRP Publication 38 (ICRP 1983), approximately 70% of the alpha emissions from weapons grade Pu is attributable to ^{239}Pu. Therefore, measurement of gross alpha emissions from the 216-Z-20 Crib effluent must be able to detect 1.3 x 10^{-5} μCi/mL/0.70, or approximately 2 x 10^{-5} μCi/mL gross alpha, in order to detect the required ^{239}Pu concentration.

The OLAM-100 system described previously in Section 7.0 is capable of detecting approximately 5 x 10^{-4} μCi/mL of gross alpha, and the operating alarm setpoint is set slightly higher at 2.8 x 10^{-3} μCi/mL in order to avoid frequent false alarms. This setpoint is approximately two orders of magnitude too insensitive to ensure compliance with the 40 CFR 302 reporting requirements. **Consequently, the OLAM-100 is used primarily as a process monitor to alert plant operators of abnormal operating conditions. Therefore, sampling and laboratory analysis having sufficient sensitivity for quantifying concentrations of alpha emitters is necessary for compliance.**

14.2 291-Z-1 MAIN STACK

The only hazardous chemical potentially released from the 291-Z-1 Main Stack in quantities greater than RQ values is CCl_4. The quantities released are determined from material balance calculations in lieu of monitoring. Although monitoring may be provided for some chemicals that are not released in quantities greater than RQ values, the monitoring systems are outside the scope of this FEMP and are not described. Therefore, this section focuses on the compliance of the stack monitoring system with regulations governing the release of radioactive materials.

The primary intent of regulations governing this system is to ensure that (1) the appropriate radioactive materials are being monitored, (2) the system can detect and quantify the levels of concern, and (3) the quantification is accurate. The basic requirements for monitoring the release of radionuclides to air are contained in 40 CFR 61 (EPA 1989a), the National Emission Standards for Hazardous Air Pollutants; Radionuclides; Final Rule and Notice of Reconsideration (NESHAP). The requirements of Subpart H of the NESHAP, "National Emission Standards for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities," were summarized in Section 3.0 of this document, and are described in detail in Attachment 16.2. The following is an assessment of the compliance of the 291-Z-1 Stack monitoring system against these requirements and the criteria described in Section 6.0.

The NESHAP specifies parameters that must be sampled or measured and specific implementation methods. The methods are contained in 40 CFR 60 (EPA 1990), Appendix A and 40 CFR 61, Appendix B (EPA 1989a). The following six elements are the essential requirements for design and operation of an airborne effluent release monitoring system mandated by the NESHAP (Section 61.93) for DOE facilities.

- The placement of the sampling/monitoring probe or sensor must be derived using EPA Method 1.
- Effluent flow rate must be measured using EPA Method 2 in large stacks and vents or EPA Method 2A in pipes and small vents.
- Radionuclides shall be directly monitored or extracted, collected and measured.
- If measurement is not performed in situ, the guidance presented in ANSI N13.1-1969 must be followed for sample extraction.
- Radionuclides must be measured according to 40 CFR 61, Appendix B, Method 114.
- A quality assurance program must be conducted that meets the performance requirements described in 40 CFR 61, Appendix B, Method 114.

As documented in the NESHAP (Section 61.93) (EPA 1989a) one of the primary conditions that must be met to ensure accurate measurement is that the monitoring be performed in an acceptable location in the stack. 40 CFR 60, App. A (EPA 1990), Method 1, requires that sampling be performed "at a site located at least eight stack diameters downstream and two diameters upstream from any flow disturbance..." This condition is not met for the 291-Z-1 Stack sampling probes, which are located at the 50 ft level of the stack, or approximately three duct diameters from the base of the 16-ft diameter stack where major flow transitions occur. However, Method 1 also states that "if necessary, an alternative location may be necessary, at a position at least two stack diameters downstream and a half diameter upstream from any flow disturbance." Therefore, compliance with the sampling probe placement requirement depends in part on the reasons for selecting the 50-ft level for sampling. An insight into these reasons are documented in a letter dated June 1, 1977 (from J. A. Glissmeyer, PNL, to Don J. Carrell, Atlantic Richfield Hanford Company). In part, the letter acknowledges that the location was not in compliance with the existing recommendations (ANSI 1969), which stipulated a sampling location at least five duct diameters downstream of any flow disturbance. The letter further stated that "the compromise was

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that a penetration was available at the 50-ft level." Apparently, it was considered unreasonable at the time to create a new penetration for the sampling lines. In addition, the stack flow is highly turbulent, having a Reynolds (Re) number of over 2,000,000. Consequently, the 5 or 8 stack diameter is less important than it would be if the flow were laminar. However, as is discussed below, selection of this sampling location necessitates careful studies of flow and particle size distributions to ensure that representative samples are obtained.

Another critical consideration is proper placement and operation of the sampler probes within the stack. One concern is that the probes exist in proper locations and sufficient quantities to ensure that the particles being sampled are representative of those being released from the stack. In cases where mixing is complete and particle size distribution is uniform over the stack cross section, a single probe may be sufficient. A second concern is that the velocity of flow through the sampling probe(s) be approximately the same as the flow velocity surrounding the probe (i.e., isokinetic), thus assuring that particles of certain sizes are neither preferentially sampled nor excluded.

Specific criteria for a point or points from which a sample is to be taken are listed in ANSI 1969, which is specifically referenced in the NESHAP (Section 61.93) (EPA 1989a). The two primary criteria are (1) the particle and gaseous composition is representative at the point in the cross section selected, or enough points in the cross section are sampled essentially simultaneously or sequentially to provide an average, representative sample, and (2) the velocity and flow distribution in the duct at this cross section should be known so that the rate of sampling can be chosen to provide near-isokinetic sampling for particles larger than about 2 to 5 μm. For very large stacks such as 291-Z-1, ANSI 1969 specifies a minimum of six sampling points. Each sampling point should be centered in an equal annular area of size equal to the cross sectional area divided by the number of probes. Fewer withdrawal points may be used if careful studies demonstrate that uniformity of composition exists throughout the cross section of the duct.

As described in Section 7.0, the sampler arrangement for the 291-Z-1 stack consists of six probes extending at various locations from a single sampling line. The probe orifice diameters are identical, although the sampling line becomes progressively thinner as the distance from the stack penetration increases, apparently to ensure that the outer probes draw the sample at a sufficient flow rate. However, documentation was not available demonstrating this to be the case. These probes are not exactly centered in an equal annular area of size equal to the cross sectional area divided by the number of probes as recommended by ANSI 1969. The placement of the probes within the cross-section of the stack becomes less critical when consideration is given to data provided by the standard that as flow becomes more turbulent, the velocity becomes more nearly uniform across the duct. Air flow through the stack is highly turbulent as noted previously (Re = 2.2 million).

The requirement to draw samples isokinetically is important for ensuring representative sampling, although it is less important for turbulent flow conditions (as exists) compared to laminar flow conditions. Under turbulent flow conditions, the flow velocity is roughly the same across the majority of the stack cross-section. Therefore, in general, each probe can draw air at approximately the same velocity and meet isokinetic conditions provided that the sample velocity is approximately the same as the stack velocity. However, this is not true for sampling locations near the stack wall, where the stack flow velocity decreases dramatically. Because one of the 291-Z-1 sampling probes is located near a stack wall, it may be necessary that the flow rate through this probe be less than that through other probes. Although it appears that sample flow velocity was considered in the design of the sampling system, as suggested by the decreasing sample line diameter, no documentation was available that provides measurements or calculations of both stack flow velocity profiles and sampling probe velocities to demonstrate isokinetic sampling. Calculations using the available information would be insufficient to draw defensible conclusions.

Based on historical stack flow rate sampling data obtained monthly using a portable system (DOE/RL 1991), the stack flow rate may be highly variable. For example, during 1989, the total monthly flow varied by approximately 20% on either side of the mean monthly flow (Brown et al. 1990). The flow averaged over a shorter period, such as a week or a day, varies by much more than 20%. Not accounting for this variation in the effluent monitoring system leads to two problems. First, the average weekly release concentration determined from the sample analysis is highly uncertain because the weekly flow is highly uncertain. This error could be highly significant in the case of an accidental, short-term release. Second, it is not possible to ensure isokinetic flow if the flow varies significantly by an unknown amount. For example, if required, it would be possible to draw samples isokinetically using a feedback system that adjusts the sample flow rate to correspond with changes in the stack flow rate provided that the stack flow rate is continuously monitored.

Another important consideration regarding representative sampling is particle size distribution. Because the sampling probes are located much less than 8 stack diameters downstream of the stack base, uniform mixing of the particles may not be present at the sampling points. Consequently, careful studies of the particle size distributions across the 50-ft level are necessary to demonstrate that the samplers are not preferentially sampling certain particle sizes. The Westinghouse Hanford Compliance Plan 89-016 references a study by PNL that indicated that the mean particle diameters in the 291-Z-1 Stack ranged from 3.3 to 9.0 μm; however, no documentation was available that addresses the particle size distributions across the 50-ft level where the probes are located. This information is necessary to demonstrate that the current sampling probe locations and configuration draw representative samples.

To summarize the analysis of the stack sampling probe design, a sufficient number of probes are used to sample the stack effluent to ensure that the sample composition is representative of the composition of the effluent. However, the documentation was not identified that demonstrates that the probes are located properly. Isokinetic sampling is difficult in this stack because of the highly variable flow rate. However, no documentation was available that demonstrates, preferably through measurements, that isokinetic sampling conditions exist even for average stack flow rates. These measurements should include both stack velocity profile measurements and measurements of the velocity through the sampling probe orifices. Also, characterization of the particle size distributions across the 50-ft axis is necessary to ensure that mixing is complete at this level because the sampling probes are close to a major flow transition. Such measurements are required even though the air is passed through several stages of HEPA filtration because of the possibility of HEPA filter inoperability or conglomeration of particles downstream of the filters. In general, it appears that the overall system may be sufficient given the effluent stream conditions, although documentation is lacking.

Specific requirements on the number and location of points used to characterize particle size distributions are provided in 40 CFR 60, App. A, Method 1. In cases in which the eight- and two-diameter criterion can not be met, the minimum number of traverse points is dependent on the specific number of duct diameters both downstream and upstream of the closest flow disturbances.

Details on the effluent monitoring equipment and sampling lines were provided in Section 7.1.2. The equipment and lines appear adequate, except that an adequate method for regulating the flow rate through the sample lines is not present (the flow regulators serve only to maintain a constant flow rate). Adjustment of flow rate may be necessary at times when the stack flow rate is known to increase or decrease significantly. Another area that has not been addressed is line losses. Significant loss of radioactive material in sampling lines is possible, especially if the lines are bent dramatically or frequently. Although the organization of the sampling lines and equipment for the 291-Z-1 Stack appear to be reasonable, a formal evaluation of line losses is specifically required in ANSI 1969. Although no documentation of line loss studies for the 291-Z-1 monitoring system is available, a site-wide study of sampling line losses is currently underway.

The performance of the 291-Z-1 gaseous effluent monitoring system must be adequate to detect the maximum releasable quantity of radioactivity in order to demonstrate that the limits have not been exceeded. Considering applicable regulations, the maximum allowable release of alpha emitters is 2×10^{-12} μCi/mL averaged over one year or 8×10^{-12} μCi/mL averaged over one week as mandated by the OSRs. Because both the CAM and record sampler filters are changed and evaluated weekly, the units must have minimum detection limits at least as good as 8×10^{-12} μCi/mL averaged over one week. According to the manufacturer's technical manual for the Alpha-4 CAM, an air concentration of 8×10^{-12} μCi/mL can be detected over a 20-h period. This capability also complies with the WHC-CM-7-5 requirement that an alarm go off if a release of 5000 times the DCG-Public value (2×10^{-14} μCi/mL for ^{239}Pu) over a 4-h period occurs. For the record sampler, a minimum detection level of 2×10^{-15} μCi/mL over a one week period must be detected to comply with WHC-CM-7-5 policy. The current detection level is 1×10^{-14} μCi/mL, which is inconsistent with the policy but is adequate for regulatory purposes.

As described in Section 7.0, procedures for obtaining and evaluating air samples and calibrating, testing and inspecting air sampling equipment are in place. The primary procedure addressing operability of the Gaseous Effluent Monitoring systems in the 200 Areas is Procedure 5.2.2.6, "Gaseous Effluent Sampling and Monitoring System Operability Inspection." This procedure provides Radiation Protection Technologists with specific instructions for inspecting various components on either a daily, weekly, or monthly basis. Tasks required to be performed daily include checks of the operability of the

CAMs and proper air flow rates. Weekly tasks, which are performed concurrently with the weekly changeout of the record sampler filter, include alarm function tests. Monthly tasks include performance of the monthly routine CAM operational performance tests. Procedure 5.2.2.7 provides instructions for operation of the systems including exchanging the filters for the record samplers and CAMs. Procedures exist for counting air samples (2.1.11), recording readings of air sampling equipment (2.1.6), testing air sampler and CAM in-leakage and airflow (5.2.6), and performing monthly alpha CAM operational performance tests (7.3.1, Rev. 3).

These procedures appear to be adequate, in general, for complying with the applicable regulations. However, it appears that procedures for inspecting and cleaning the sampling probes are not available. This is an important part of the air sampling process because probes can become partially plugged resulting in inaccurate measurements. Implementing such a procedure for the 291-Z-1 Stack would be difficult because the probes were not designed to be removed for these purposes. The requirement to perform these tasks is contained in ANSI 1969.

To summarize the evaluation of the 291-Z-1 Main Stack effluent monitoring system, the basic areas of possible noncompliance with applicable regulations and standards are as follows:

- ANSI 1969 -- A strict characterization of the effluent stream does not exist. However, the range of particles captured by the sampling system is believed to be representative for the stream based on knowledge of the particles which would be able to penetrate the HEPAs upstream.

- ANSI 1969 -- A velocity profile was undoubtedly a part of the design documentation, but has not been found.

- ANSI 1969 -- The sample withdrawal point is not far enough downstream for current standard recommendations for a stack of this size. However, this recommendation is less important for highly turbulent flow conditions, as exists in the 291-Z-1 Stack, than for laminar flow conditions.

- ANSI 1969 -- Procedures for inspecting and cleaning the air sampling probes do not exist.

In lieu of immediate corrective actions, a two-year waiver from the NESHAP requirements was recently granted through December 15, 1991, by the EPA (letter from G. O'Neal, EPA, to E. A. Bracken, DOE-RL, dated June 3, 1991). This waiver will provide time for EPA to review and act on Hanford's request for approval of existing stack monitoring systems (letter from E. A. Bracken, DOE-RL, to G. O'Neal, EPA, dated May 7, 1991). The 291-Z-1 Stack was included in this request. No corrective actions will be taken before disposition of this request.

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15.0 SUMMARY AND CONCLUSIONS

This FEMP assessed the magnitude of routine and potential liquid and airborne effluent releases from the PFP complex to determine the compliance of effluent monitoring systems and sampling programs with applicable Federal, State, and local regulations. Based on the data reviewed, two effluent streams were determined to require a monitoring plan according to the regulations. These streams are the 291-Z-1 Main Stack and the 216-Z-20 Crib. The adequacy and compliance of the monitoring systems or sampling programs are documented in this Plan. Compliance was determined by comparing the existing systems and procedures to applicable regulations and accepted guidance. Specifics of the monitoring/sampling programs that were determined not to be in compliance were identified.

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16.2 SUMMARY OF NESHAP REQUIREMENTS

This section provides a detailed description of the criteria established in the NESHAP and associated documents. This information expands on the information provided in Sections 3.0 and 6.0 of this report and supports the findings stated in Section 14.0, "Compliance Assessment."

The NESHAP establishes requirements and procedures for measuring radionuclide emissions from point sources (e.g., stacks and vents). The requirements and procedures are contained in 40 CFR 61.93. Alternative procedures are allowed if EPA has granted prior approval. The following sections present methods that the NESHAP mandates for an airborne radionuclide effluent monitoring system. Alternative methods are allowed but they must have received prior EPA approval.

16.2.1 Measurement of Effluent Flow Rate

The NESHAP requires that flow rate measurements be made. The flow rate (volumetric) needs to be accurately quantified so that concentrations or activity levels, measured in the samples that are extracted, can be used to derive total emission rates. The volumetric flow rate is the product of the cross-sectional area of the stack and the effluent velocity. The measurement of velocity is complicated by its variation across the diameter of the stack. For stacks with a circular cross-section, the maximum velocity occurs at the center of the stack and the velocity approaches zero at the stack wall.

The NESHAP specifies EPA Reference Method 2 to determine velocity and volumetric flow rate for stacks and large vents. Reference Method 2A is specified for flow rates through pipes and small vents. Both methods are contained in 40 CFR 60, Appendix A.

Method 2 specifies the measurement of average gas velocity with a Type S pitot tube. It is applicable to any gas stream where a measurement site that meet the criteria of Method 1 is available. It cannot be used in cyclonic or swirling gas streams.

Method 2A specifies the measurement of average gas velocity directly with a gas volume meter. Temperature and pressure measurements are made to correct the volume to standard conditions. It is applicable to pipes and small ducts, either in-line or at exhaust positions, within the temperature range of 0°C to 50°C.

The NESHAP does not define a specific frequency for conducting flow rate measurements. The rule states that the frequency of flow rate measurements should be dependent upon the variability of the effluent flow rate. If the flow is highly variable, continuous or frequent flow rate measurements must be made. For consistent flow rates, only periodic measurements are necessary.

16.2.2 Measurement of Radionuclides

The NESHAP mandates that radionuclides be monitored in situ or extracted, collected, and measured. The effluent stream must be monitored continuously with an in-line (in situ) detector, or representative samples must be extracted continuously. Periodic sampling may be used only with EPA's prior approval, and the frequency must be sufficient to provide representative sampling.

The NESHAP requires that radionuclides be measured at the point of release so that dispersion modeling can then be used to estimate the ambient impact (dose) at critical receptors. Measurements are made on samples of the effluent. The samples must be representative of the entire effluent stream to minimize over- or underestimation of the characteristics of the effluent and the estimated ambient impacts. The characteristics of the effluent stream can vary temporally and spatially. The procedures specified by the NESHAP are designed to ensure that samples are representative. 40 CFR 61.93(b)(2)(ii) mandates that monitoring or sample extraction be performed continuously. This eliminates or at least mitigates the impact of temporal variation on the representativeness of the sample. The NESHAP also mitigates the impact of spatial variation on representativeness of the sample by mandating a method for identifying an acceptable sampling site. This method is presented in the next section.

16.2.3 Sampling or Monitoring Site Location (EPA Method 1)

In order to obtain a representative sample that considers the impact of spatial variation the NESHAP [40 CFR 61.93(b)(2)(i)] mandates that EPA Method 1 be employed to select a monitoring or sampling site. EPA Method 1 can be found in 40 CFR 60, Appendix A. The purpose of the method is to aid in the representative measurement of contaminants and volumetric flow rate by identifying a measurement site where the effluent stream is flowing in a known direction. The method also divides the stack into cross-sections of equal areas. The method is applicable to flowing gas streams in ducts, stacks or vents. It cannot be used when (1) flow is cyclonic or swirling, (2) a stack is smaller than 12 in. in diameter, or (3) the measurement site is less than 2 stack diameters downstream or less than 0.5 diameter upstream from a flow disturbance.

16.2.4 Sample Extraction (ANSI 1969)

If the sample must be extracted from the effluent stream and transported to a collection device or analyzer, precautions must be taken to ensure that the representativeness of the sample is not affected by the extraction process.

If it is necessary to extract the sample from the effluent for collection or measurement, the NESHAP [40 CFR 61.93(b)(2)(i)] mandates that ANSI 1969 be followed to mitigate changes in the characteristics of the sample because of extraction and transport of the sample to the collection or measurement device.

ANSI 1969, "Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities," provides the guideline for design of an effluent monitoring system. The standard encompasses the design of the probe and the transport system for moving the sample from the probe's orifice to the sample collection device or analyzer.

The guidelines in ANSI 1969 are designed to ensure that the sample that is collected and/or measured represents the effluent slip stream at the point of extraction. Factors that affect the representativeness of the sample during collection and transport are inertial separation, deposition, impaction, sample loss/dilution, physical changes, and/or chemical activity. ANSI 1969 provides guidance for mitigating the impact of each of these factors.

16.2.4.1 Inertial Separation. Radioactive particulate matter is frequently a contaminant of concern in airborne effluents. Particulate matter consists of small solid and liquid particles. These particles when entrained in an airstream tend to continue to move in a straight line, resulting from momentum, when the air stream flow is redirected because of a bend, tee, change in diameter, or other flow disturbance. The greater the mass of the particle, the greater the tendency to continue to move in a straight line. This is the principal mechanism of inertial separation. It is employed in cyclonic separators to remove particles from an effluent stream, or at the inlet of an air sampling device to obtain a sample that is differentiated by size. The location of a sample probe should avoid regions where a change in the direction of the airstream flow may result in an unrepresentative particle size distribution.

ANSI 1969 recommends that a sampling point should be a minimum of 5 diameters (or five times the major dimension for rectangular ducts) downstream from abrupt changes in flow direction or prominent transitions.

However, the NESHAP requires that Method 1 be used to select sampling sides. Method 1 requires that the probe is 8 diameters upstream and 2 diameters downstream from a flow disturbance. The more restrictive requirements of Method 1 should be applied.

Inertial separation can be induced in particles entrained in an airstream by suddenly changing the velocity of the airstream. In airborne effluent monitoring systems, distortion in particle size distributions may occur when the velocity of the sampled air entering the sample probe (or collector, when supported directly in the stream to be sampled) is significantly different from the velocity of the air in the stream sampled. When the air drawn through the sampler or collector in the stream is at a much lower velocity than the stream velocity, larger particles will be preferentially collected. When the air velocity through the sample probe and collector is greater than the stream velocity smaller particles will be preferentially collected. The degree that the fractionation occurs is a function of particle size, density, the particle size distribution, and the difference between the isokinetic velocity and the an isokinetic velocity employed. Except in very unusual situations, particles smaller than an aerodynamic diameter of about 5 μm are able to follow the streamlines of the air, and the fractionation error is not great.

ANSI 1969 recommends that in applications in which particle sizes may be expected to vary, particularly when particles larger than 5 μm are anticipated, the sampler arrangement be designed to permit near isokinetic flow into the sampler entry probe or through the collector when the collector is facing into the stream sampled.

16.2.4.2 Deposition Losses. The principal mechanisms by which particles are deposited are gravity settling and Brownian diffusion when the flow is laminar. Particles carried by an airstream moving in a horizontal tube will tend to settle to the bottom of the tube due to the influence of gravity. Any delivery line carrying the sample to the collection or measurement device will preferentially remove large particles through gravitational settling when the flow is too low. Very small particles can diffuse to the wall of a conduit by Brownian motion. Particle size is of extreme significance. Very small particles are lost to the wall rapidly when gas flow is very low.

ANSI 1969, Appendix B recommends that sampling lines be avoided whenever possible and always kept at a minimum length. In every case where sampling delivery lines are required, a deposition evaluation should be made in the lines. Appendix B also provides a table that allows a determination to be made of the significance of distortion because of deposition.

16.2.4.3 Impaction Losses. Particles carried in turbulent flow will be deposited on the walls of a conduit because of the adhesive properties of the particle and the wall. The degree of deposition depends upon particle size and density, the average velocity of the air, and the diameter and length of the conduit. Deposition does not continue to increase indefinitely as the velocity and particle size increases. A velocity will be reached above which particles will be re-entrained. The onset of re-entrainment is a function of particle size, the particle density, tube diameter, and the adhesive properties of the particle and wall.

16.2.4.4 Physical Changes. A change in the physical state (e.g., liquid, gas, solid) of an airstream constituent can result in sample distortions. Such changes can be precipitated by a temperature and/or pressure change. Moisture in the sample can result in condensate on the inner surfaces of sampling lines that may form pockets and act as traps, or provide wetted surfaces to which the contaminant of interest may adhere. In extreme situations traps and pockets may act as effective scrubbers for the radioactive material transported. Excessive moisture may also destroy filter media usefulness either by blocking the air passageways through the pores, or by weakening it to a point that it tears or breaks easily. The ANSI 1969 recommends heated sampling lines when heavy moisture loadings are anticipated, to prevent condensation in the lines and to raise the collector temperature well above dewpoint.

16.2.4.5 Chemical Activity. Chemically reactive contaminants in the extracted sample can be largely absorbed on or react with materials of construction resulting in under-representation in the analysis. In addition the corrosion, clogging, and uneven surfaces that can result from chemically active constituents can result in distortion of the measurement of non-reactive contaminants. The ANSI 1969 recommends extreme care when extracting a sample from an airstream when the air contains chemically reactive forms of radioactive isotopes. Precautions would include having a thorough understanding of the chemical composition of the airstream and the materials of construction of the effluent monitoring/sampling system. For example, when radioiodine is a constituent, materials to be avoided in sampling systems are rubber, copper, and some plastics.

16.2.4.6 Sample Loss/Dilution. There are many mechanisms that can result in sample loss. An isokinetic sample extraction can cause the loss of larger or smaller particles. Deposition or impaction in sample transport lines can cause losses of particulate matter. Chemical reaction of the sample with the material of construction can cause sample loss due to absorption or it can become fixed because it reacted with a system component. The reactions can also cause physical obstructions that interfere with the transfer of nonreactive contaminants resulting in losses at the collection or measurement device.

Since sample transfer lines operate at below atmospheric pressure, system leaks will generally introduce ambient air into the sampling lines that will dilute the constituents in the sample.

ANSI 1969 recommends that sampling lines be avoided whenever possible and always kept at a minimum length. Guidelines to mitigate the various types of line losses were presented in the previous five sections. In addition, good operating practice would mandate identification of effluent monitoring system leakage and expedient corrective action to preclude sample dilution from this type of problem.

16.2.5 Sample Analysis (EPA Method 114)

The requirements for determining the amounts of radionuclides collected by the effluent sampling system are provided in EPA Method 114, which is codified in 40 CFR 61, Appendix B. The appropriate sample analysis for a radionuclide is dependent upon a number of interrelated factors including the mixture of other radionuclides present. Therefore, a series of methods based on "principles of measurement" are described for monitoring and sample collection and analysis; these methods are applicable to the measurement of radionuclides found in effluent streams at stationary sources. The approach provides flexibility to choose the most appropriate combination of monitoring and sample collection and analysis methods.

16.2.5.1 Stack Monitoring and Sample Collection Methods. EPA Method 114 presents monitoring and sample collection methods based on "principles of monitoring and sample collection" which are applicable to the measurement of radionuclides from effluent streams at stationary sources. The collection media (i.e., filters) for particulate radionuclides are incorporated by reference to ANSI 1969. Collection methods for other radionuclide physical states are presented in Table 16-1.

16.2.5.2 Radionuclide Analysis Methods. EPA Method 114 presents a series of methods based on "principles of measurement," which are applicable to the analysis of radionuclides collected from airborne effluent streams at stationary sources. These methods are applicable only under the conditions stated and within the limitations described. Some methods specify that only a single radionuclide be present in the sample or the chemically separated sample. This condition should be interpreted to mean that no other radionuclides are present in quantities that would interfere with the measurement. The methods that are applicable are dependent upon the type of radiation emitted. Table 16-2 summarizes the mandated analysis methods by radiation type and applicability.

16.2.6 Quality Assurance Program for Effluent Monitoring

EPA Method 114 presents minimum requirements for a QA program. The QA program must be documented in a project plan that addresses all the QA elements prescribed in Method 114. The QA Project Plan must contain the following critical elements:

- A description of the organizational structure that includes functional responsibilities, authority, and lines of communication for all emission measurement activities
- A description of administrative controls
- A description of sample collection and analysis procedures that includes (1) identification of sampling sites, the number of sampling points, and the rationale for their selection; (2) a description of probes and sample representativeness; (3) a description of the continuous emission monitoring system, its sensitivity, calibration procedures, and frequency of calibration; (4) a description of the collection system for each radionuclide measured, including frequency of collection, calibration procedures, and frequency of calibration; (5) a description of the laboratory analysis procedures used for each radionuclide measured, the frequency of analysis, calibration procedures, and the frequency of calibration; (6) a description of the sample flow rate measurement

Table 16-1. Collection Methods (Contained Within EPA Method 114).

Radionuclide of Concern	Direct Measurement Method	Collection Principles	Appropriate Collectors
Particulate		Refers to ANSI 1969	Refers to ANSI 1969
Tritium (water vapor)		Sorption, condensation, or dissolution	Silica gel, molecular sieves, ethylene glycol or water bubblers
Tritium (gas)	B-1	Measured directly	Not applicable
		Metal catalyst oxidation to water, then same as tritium water vapor	Same as tritium water vapor
		Gas sample	Cylinder or flexible bag
Iodine		Sorption or dissolution techniques	Charcoal, impregnated charcoal, metal zeolite and caustic solutions
Argon Krypton and Xenon	A-4 B-2 G-4	Measured directly	Not applicable
		Low temperature sorption technique	Charcoal or metal zeolite
Oxygen, Carbon, Nitrogen and Radon. Radionuclide Gases	A-4 B-2 G-4	Measured directly	Not applicable
Carbon (as carbon dioxide)		Sorption	Caustic scrubber

Table 16-2. Analysis Methods (Contained Within EPA Method 114).

Radioactivity Type	Method	Techniques	Applicability
Alpha Emitting	A-1	Radiochemistry-Alpha Spectrometry	Determine the activity of any alpha-emitting radionuclide, regardless of what other radionuclides are present in the sample provided the chemical separation step produces a very thin sample and removes all other radionuclides that could interfere with the spectral region of interest.
Alpha Emitting	A-2	Radiochemistry-Alpha Counting	The measurement of any alpha-emitting radionuclide, provided no other alpha emitting radionuclide is present in the separated sample. Method A-2 may also be applicable for determining compliance when other radionuclides of the separated element are present, provided that the calculated emission rate is assigned to the radionuclide that has the highest dose conversion factor that could be present in the sample.
Alpha Emitting	A-3	Direct Alpha Spectrometry	Simple mixtures of alpha-emitting radionuclides and only when the amount of particulates collected on the filter paper are relatively small and the alpha spectrum is adequately resolved. Resolutions should be 500 keV or better.

Table 16-2. Analysis Methods (Contained Within EPA Method 114).

Radioactivity Type	Method	Techniques	Applicability
Alpha Emitting	A-4	Direct Alpha Counting (Gross Alpha Determination)	Gross alpha determinations may be used to measure emissions of specific radionuclides only (1) when it is known that the sample contains only a single radionuclide, or the identity and isotopic ratio of the radionuclides in the sample are well-known, and (2) measurements using either Method A-1, A-2, or A-5 have shown that this method provides a reasonably accurate measurement of the emission rate. Gross alpha measurements are applicable to unidentified mixtures of radionuclides only under certain conditions.
Alpha Emitting	A-5	Chemical Determination of Uranium	Emissions of uranium when the isotopic ratio of the uranium radionuclides is well- known.
Alpha Emitting	A-6	Radon-222 Continuous Gas Monitor	Emissions of radon in effluent streams that do not contain significant quantities of ^{220}Rn.
Alpha Emitting	A-7	Radon-222 Alpha Track Detectors (ATDs)	Effluent streams that do not contain significant quantities of ^{220}Rn, unless special detectors are used to discriminate against ^{220}Rn. ATDs must have been demonstrated to produce data comparable to data obtained with Method A-6. Prior approval from EPA is required for use of this method.
Gaseous Beta Emitting	B-1	Direct Counting in Flow-Through Ionization Chambers	Measuring the activity of a gaseous beta-emitting radionuclide in an effluent stream that is suitable as a counting gas, when no other beta-emitting nuclides are present.

Table 16-2. Analysis Methods (Contained Within EPA Method 114).

Radioactivity Type	Method	Techniques	Applicability
Gaseous Beta Emitting	B-2	Direct Counting with In-Line or Off-Line Beta Detectors	Radionuclides with maximum beta particle energies greater than 0.2 MeV. This method may be used to measure emissions of specific radionuclides only when it is known that the sample contains only a single radionuclide or the identity and isotopic ratio of the radionuclides in the effluent stream are well known. Also applicable to unidentified mixtures of gaseous radionuclides for specific purposes and certain conditions.
Gaseous Beta Emitting	B-3	Radiochemistry-Beta Counting	Measuring the activity of any beta-emitting radionuclide with a maximum energy greater than 0.2 MeV, provided no other radionuclide is present in the separated sample.
Gaseous Beta Emitting	B-4	Direct Beta Counting (Gross Beta Determination)	Gross beta measurements are applicable only to radionuclides with maximum beta particle energies greater than 0.2 MeV. Gross beta measurements may be used to measure emissions of specific radionuclides only (1) when it is known that the sample contains only a single radionuclide, and (2) measurements made using Method B-3 show reasonable agreement with the gross beta measurement. Gross beta measurements are applicable to mixtures of radionuclides only for specific purposes and certain conditions.

Table 16-2. Analysis Methods (Contained Within EPA Method 114).

Radioactivity Type	Method	Techniques	Applicability
Gaseous Beta Emitting	B-5	Liquid Scintillation Spectrometry	Any beta-emitting nuclide when no other radionuclide is present in the sample or the separated sample provided that it can be incorporated in the scintillation cocktail. This method is also applicable for samples that contain more than one radionuclide but only when the energies of the beta particles are sufficiently separated so that they can be resolved by the spectrometer. This method is most applicable to the measurement of low-energy beta emitters such as tritium and carbon-14.
Gamma Emitting	G-1	High Resolution Gamma Spectrometry	The measurement of any gamma-emitting radionuclide with gamma energies greater than 20 keV. Method G-1 can be applied to complex mixtures of radionuclides. The samples counted may be in the form of particulate filters, absorbers, liquids, or gases. The method may also be applied to the analysis of gaseous gamma-emitting radionuclides directly in an effluent stream by passing the stream through a chamber or cell containing the detector.

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Table 16-2. Analysis Methods (Contained Within EPA Method 114).

Radioactivity Type	Method	Techniques	Applicability
Gamma Emitting	G-2	Low Resolution Gamma Spectrometry	The measurement of gamma-emitting radionuclides with energies greater than 100 keV. Method G-2 can be applied only to relatively simple mixtures of gamma-emitting radionuclides. The samples counted may be in the form of particulate filters, absorbers, liquids, or gas. The method can be applied to the analysis of gaseous radionuclides directly in an effluent stream (see previous).
Gamma Emitting	G-3	Single Channel Gamma Spectrometry	The measurement of a single gamma- emitting radionuclide. Method G-3 is not applicable to mixtures of radionuclides. The samples counted may be in the form of particulate filters, absorbers, liquids, or gas. The method can be applied to the analysis of gaseous radionuclides directly in an effluent stream (see previous).

Table 16-2. Analysis Methods (Contained Within EPA Method 114).

Radioactivity Type	Method	Techniques	Applicability
Gamma Emitting	G-4	Gross Gamma Counting	Gross gamma measurements may be used to measure emissions of specific radionuclides only when it is known that the sample contains a single radionuclide or the identity and isotopic ratio of the radionuclides in the effluent steam are well known. When gross gamma measurements are used to determine emissions of specific radionuclides, periodic measurement using Methods G-1 or G-2 should be made to demonstrate that the gross gamma measurements provide reliable emission data. The method may be applied to analysis of gaseous radionuclides directly in an effluent stream by placing the detector directly in or adjacent to the effluent stream or by passing an extracted sample of the effluent stream through a chamber or cell containing the detector.

systems or procedures, the frequency of measurements, calibration procedures, and frequency of calibration; (7) a description of the effluent flow rate measurement procedures, the frequency of measurements, calibration procedures, and frequency of calibration

- The objectives of the QA program, which must include the required precision, accuracy, and completeness of the emission measurement data and a description of the procedures used to assess these parameters
- A quality control program must be presented to evaluate and track emissions measurement data against predetermined criteria
- A sample tracking system must be established to maintain the integrity of samples during collection, storage, and analysis
- An audit program that provides for periodic internal and external verification of compliance with the QA program
- Establish corrective actions and assign responsibility for those actions
- Periodic reports must be submitted to management on the performance of the emissions measurements program that assesses (1) quality of the data, (2) results of audits, and (3) corrective actions.

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