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WHC-EP-0536

Quality Assurance Program Plan for Radionuclide Airborne Emissions Monitoring

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Prepared for the U.S. Department of Energy
Assistant Secretary for Defense Programs

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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Quality Assurance Program Plan for Radionuclide Airborne Emissions Monitoring

L. W. Vance

Date Published
December 1991

Prepared for the U.S. Department of Energy
Assistant Secretary for Defense Programs

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LIST OF TERMS

APA	Audit Program Administration
CFR	Code of Federal Regulations
DOE	U.S. Department of Energy
EA	Environmental Assurance
ECV	Environmental Compliance Verification
EP	Environmental Protection
ESQ	Environmental, Safety, Health, and Quality Assurance
ESQA	Environmental Services Quality Assurance
ESQD	Environment, Safety, Quality Data
JCS	job control system
NESHAP	"National Emission Standards for Hazardous Air Pollutants"
QA	quality assurance
QAPjP	Quality Assurance Project Plan
QAPP	Quality Assurance Program Plan
QC	quality control
QI	Quality Instruction
QR	Quality Requirement
Westinghouse Hanford	Westinghouse Hanford Company

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QUALITY ASSURANCE PROGRAM PLAN FOR RADIONUCLIDE AIR EMISSIONS MONITORING

1.0 INTRODUCTION

This Quality Assurance Program Plan (QAPP) describes how the Environmental, Safety, Health, and Quality Assurance Division verifies that radioactive airborne emission measurement activities from regulated stacks are controlled at the Hanford Site. As specified in the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1990, 1991), this QAPP is prepared in accordance with and to the requirements of QAMS-004/80, *Guidelines and Specifications for Preparing Quality Assurance Program Plans* (EPA 1983).

Radioactive airborne emission measurement requirements are defined in Subpart H of Title 40, *Code of Federal Regulations* (CFR), Part 61, "National Emission Standards for Hazardous Air Pollutants" (NESHAP) (EPA 1991). Detailed monitoring requirements apply to stacks exceeding 1% of the standard of 10 mrem annual effective dose equivalent to the maximally exposed individual from operations of the Hanford Site.

Title 40 CFR Part 61, Appendix B, Method 114, "Quality Assurance Methods," specifies the quality assurance (QA) requirements and that a QAPP should be prepared to meet the requirements of this regulation. This QAPP identifies how the ESQ Division will verify that the NESHAP QA methods are properly implemented.

2.0 QUALITY ASSURANCE POLICY STATEMENT

Westinghouse Hanford Company (Westinghouse Hanford) shall maintain and verify a prevention-oriented QA program to ensure that Westinghouse Hanford products and services meet requirements, are fit for use, and satisfy customer expectations. As part of prevention orientation, the QA program shall provide measurements of performance, establish criteria, and encourage changes that improve quality and productivity.

3.0 QUALITY ASSURANCE MANAGEMENT

Westinghouse Hanford independent oversight verification activities associated with the radioactive airborne emission measurement are controlled by the ESQ Division. The organizations within this Division that perform these oversight activities, and their interfaces, are noted on Figure 1.

The sections that follow describe the responsibilities of these organizations as they relate to radioactive air emissions measurements.

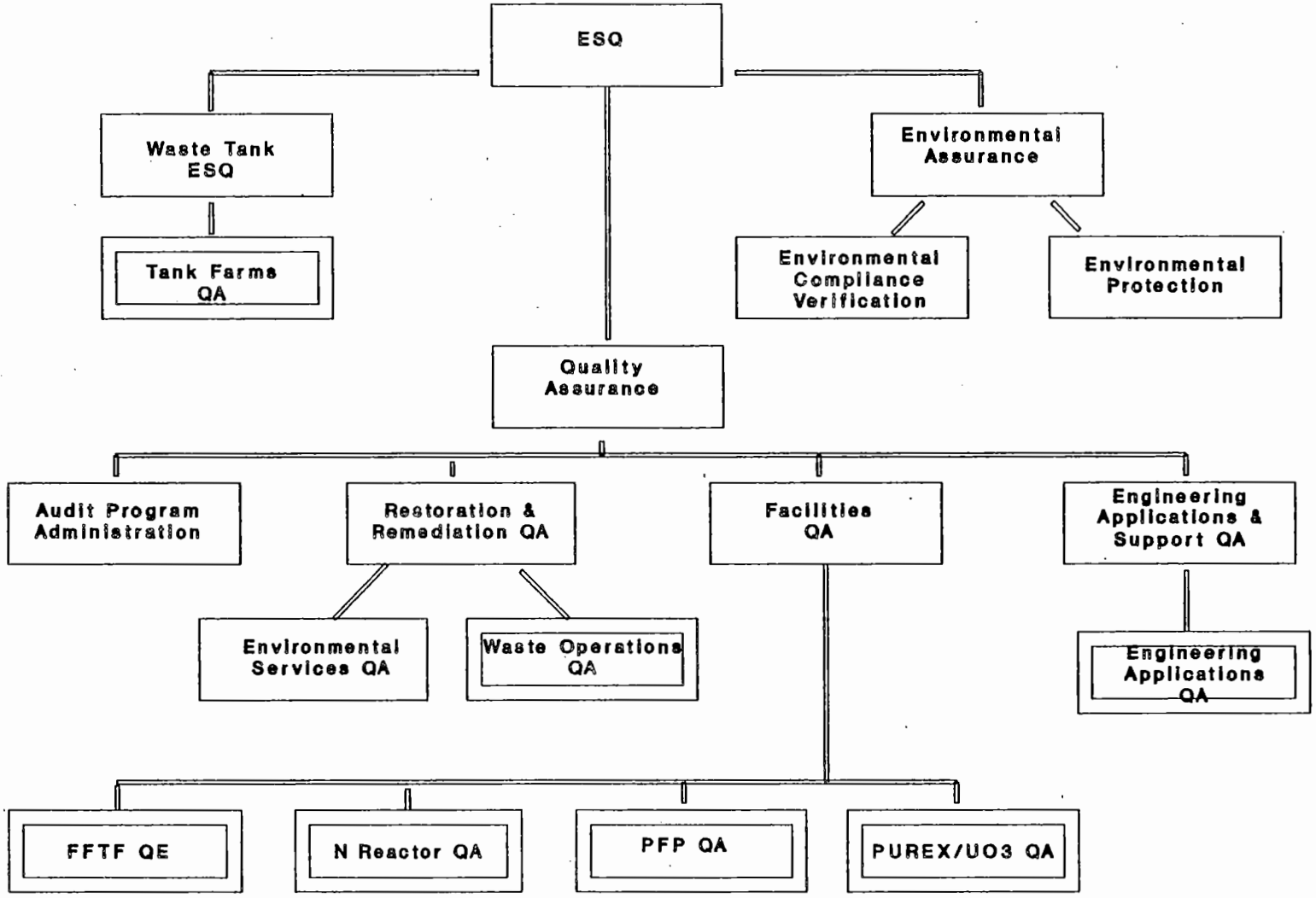

Figure 1. Radioactive Air Emissions Measurement Oversight.

3.1 ENVIRONMENTAL ASSURANCE

3.1.1 Environmental Protection

The Environmental Protection (EP) group, within the Environmental Assurance (EA) organization, has the following responsibilities:

- Provide technical direction for radioactive air emissions sampling and analysis
- Collect and compile radioactive air sampling and analytical data and combine with operational information to prepare regulatory reports.
- Maintain records of radioactive air emissions measurement release data
- Verify the analytical data received from the laboratory.

These responsibilities will be addressed in a future EP Quality Assurance Project Plan (QAPjP).

3.1.2 Environmental Compliance Verification

The Environmental Compliance Verification (ECV) group maintains and implements a comprehensive environmental oversight program to independently verify that Westinghouse Hanford operations are conducted in compliance with applicable environmental regulations, U.S. Department of Energy (DOE) orders, and Westinghouse Hanford management control systems.

The ECV group schedules and performs oversight activities (audits and appraisals) in accordance with requirements specified in WHC-CM-7-6, Sections 4.0, 5.0, 6.0, 7.0, 10.0, and 13.0 (WHC 1989a), and Quality Instruction (QI), 18.4 of WHC-CM-4-2, *Quality Assurance Manual* (WHC 1988).

The ECV group will schedule and perform at least one annual audit/appraisal of air emissions activities. Specific activities to be audited/appraised will be selected using a risk-based oversight schedule prioritization system. Annual ECV audit/appraisal activities will, to the extent possible, be integrated with those of the Westinghouse Hanford QA and Safety oversight organizations.

3.2 QUALITY ASSURANCE

3.2.1 Environmental Services Quality Assurance

The Environmental Services Quality Assurance (ESQA) group is responsible for administering this QAPP to meet the requirements for radionuclide air emissions. This effort includes verifying that regulatory QA requirements are included and interfacing with the regulatory analysis group to ensure that regulatory updates are incorporated into the document.

The ESQA group interfaces with the EP group, reviewing and approving quality-affecting controlled documents that define environmental measurement

activities prepared by the ESQA organization. This includes the upcoming EP QAPjP and quality-affecting documents prepared by the EP group to implement this plan.

The ESQA group is responsible for surveillance of activities associated with control of laboratory analysis activities. This includes the following:

- Reviewing and approving laboratory analytical procedures for QA/quality control(QC) requirements
- Surveillance of EP and laboratory activities associated with the radionuclide emissions stack monitoring
- Participating as a QA/QC specialist in laboratory reviews and audits.

Surveillances will be performed and controlled in accordance with WHC-CM-4-2, Quality Requirement (QR) 10.0, "Inspection," and QI 10.4, "Surveillance" (WHC 1988). Audit activities shall be accomplished in accordance with QR 18.0, "Audits," and QI 18.4, "Integrated Audits/ Appraisals."

3.2.2 Plant Quality Assurance Engineers

This is not a specific QA group, but consists of QA engineers from different QA groups performing the same function. These are noted by the double-lined areas of Figure 1.

The plant QA engineers are responsible for interfacing with plant personnel in reviewing and approving radioactive air monitoring documentation and verifying its implementation. The activities that the plant QA engineer reviews, approves, and verifies are described in Sections 6.2.2, 6.2.3, and 6.2.4 of this document. The activities are verified by surveillances that are performed and controlled in accordance with WHC-CM-4-2, QR 10.0, "Inspection," and QI 10.4, "Surveillance" (WHC 1988).

3.2.3 Audit Program Administration

The Audit Program Administration (APA) group schedules and performs the Westinghouse Hanford QA audit activities. Audits are performed in accordance with requirements specified in WHC-CM-4-2, QR 18.0, "Audits;" QI 18.1, "Audit Programming and Scheduling;" and QI 18.4, "Integrated Audits/Appraisals" (WHC 1988).

In accordance with QI 18.1, paragraph 4.2, QA group managers are responsible for determining internal audit needs. The ESQA group manager will interface with the other QA managers, EA, and other plant managers to decide on the effluent stack QA auditing needs. This will include at least one annual system audit of the stack sample collections and the analytical laboratory. It is permissible to do these as an integrated audit with the ECV group.

4.0 DOCUMENT CONTROL AND RECORDS

All records and data used in the generation and verification of regulatory reports are controlled in accordance WHC-CM-4-2, QR 4.0, "Document Control," and QR 17.0, "Quality Assurance Records" (WHC 1988).

4.1 ENVIRONMENTAL ASSURANCE

4.1.1 Environmental Protection

The records generated by the EP group will be controlled as specified in the upcoming EP QAPjP.

4.1.2 Environmental Compliance Verification

Section 13 of WHC-CM-7-6 (WHC 1989a), and QI 18.4 of WHC-CM-4-2 (WHC 1988) specify how ECV oversight documentation (in-process records and QA records) generated during oversight activities will be maintained and controlled.

4.2 QUALITY ASSURANCE

4.2.1 Environmental Services Quality Assurance

The ESQA group performs surveillances to verify the activities noted above, except for participation in system audits. The ESQA group will support audits under the direction of the Audits group.

The requirements for the control and documentation of surveillances is addressed in WHC-CM-4-2, QI 10.4, "Surveillance" (WHC 1988). This procedure specifies the surveillances preparation procedure, distribution list, schedule requirements, and control method. The ESQA organization prepares and performs the surveillances in accordance with this procedure.

All surveillances, with any noted deficiencies, are routed to the Environment, Safety, Quality Data (ESQD) organization, which tracks and verifies that deficiencies are addressed. The ESQD group interfaces with oversight organizations and controls their activities in accordance with WHC-CM-4-2, QI 16.6.

4.2.2 Plant Quality Assurance

Plant QA groups control their activities in the same manner as noted for ESQA.

4.2.3 Audit Program Administration

The requirements for the control and documentation of APA integrated audits are addressed in WHC-CM-4-2, QI 18.4, "Integrated Audits/Appraisals"

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(WHC 1988). This procedure specifies audit/appraisal preparation, schedule requirements, and control.

5.0 PERSONNEL QUALIFICATIONS

All organizations and their charters are included in WHC-CM-1-2, *Organization Charts and Charters* (WHC 1990a). All personnel working within an organization and their job titles are included in a divisional/departmental organization chart.

The job classification, training, and indoctrination requirements are specified in WHC-CM-1-3, MRP 4.22 (WHC 1990b). Each manager maintains employee records, documenting needed training completed for each job assignment, in accordance with this requirement.

6.0 RADIOACTIVE AIR EMISSIONS MEASUREMENT QUALITY ASSURANCE PROJECT PLANS IMPLEMENTATION

6.1 INTRODUCTION

There are two governing documents that specify the requirements for the QAPjPs associated with this effort: (1) The NESHAP (EPA 1991) suggests that a QAPjP be prepared to the requirements of 40 CFR 61, Appendix B, Method 114, for measuring radioactive air emissions, and (2) The *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1990, 1991) requires that a QAPjP be prepared in accordance with the requirements of QAMS-004/80 (EPA 1983).

It is appropriate that both of these regulatory requirements be addressed in this effort. These QAPjP requirements are addressed below.

- Each organization involved with the NESHAP program, and a description of its activities, is addressed in Section 6.2 of this document. Their responsibilities for the 40 CFR 61 Appendix B, Method 114, Section 4, "QA Methods," are specified on a point-by-point basis from this regulation.

- For those organizations that work with all stacks, the implementing information is included in this document. This includes the efforts of the Occupational Health and Safety and Central Support Services organizations (see Sections 6.2.3 and 6.2.4).

- Facility organizations that are responsible for specific stacks shall prepare a NESHAP, Appendix B, Method 114, "QA Method," point-by-point implementation document (see Section 6.2.2). These are appended to this document as they are completed.

- The laboratory point-by-point implementation is appended to this document (see Section 6.2.5).

- The EP organization will issue a separate QAPjP, to be prepared in accordance with the format of QAMS-004/80 (EPA 1983). This document

will address the appropriate NESHAP requirements (see Section 6.2.1) and provide guidance and technical assistance to the radioactive air emissions measurement program.

6.2 ORGANIZATION AND RESPONSIBILITIES

All organizational structure, functional responsibilities, levels of authority and lines of communication that could affect the sampling and analysis activities are addressed in this document or the upcoming EP QAPjP.

Figure 2 shows the organizational relationships involved in the radionuclide sampling, effluent flow measurement, and analysis activities. Figure 3 provides further definition for the stack effluent measurement activities.

The ESQ oversite interfaces and responsibilities are addressed in Section 3.0.

The organizational responsibilities for 40 CFR 61, Appendix B, Method 114, Section 4, "Quality Assurance Methods" (EPA 1991), as shown in Figures 2 and 3, are described below. These descriptions define the Method 114 point-by-point information that must be addressed by each organization.

6.2.1 Environmental Protection

The EP group, within the EA organization, has the responsibility to report radioactive air emissions from the facilities as specified in Section 3.1.1 of this QAPP.

The QAPjP that will be prepared by EP will address the following sections of 40 CFR 61, Appendix B, Method 114 (EPA 1991):

- Section 4.3.1, provide identification numbers for sample locations
- Section 4.3.5, specify the analysis that is to be performed for each stack
- Section 4.4, provide the data quality objectives for the sampling and analysis activities.

Other EP activities are addressed in Section 3.1.1 of this QAPP.

6.2.2 Facilities

The facility cognizant engineer is responsible for defining how the stack sampling, analysis, and effluent flow measurement requirements are implemented.

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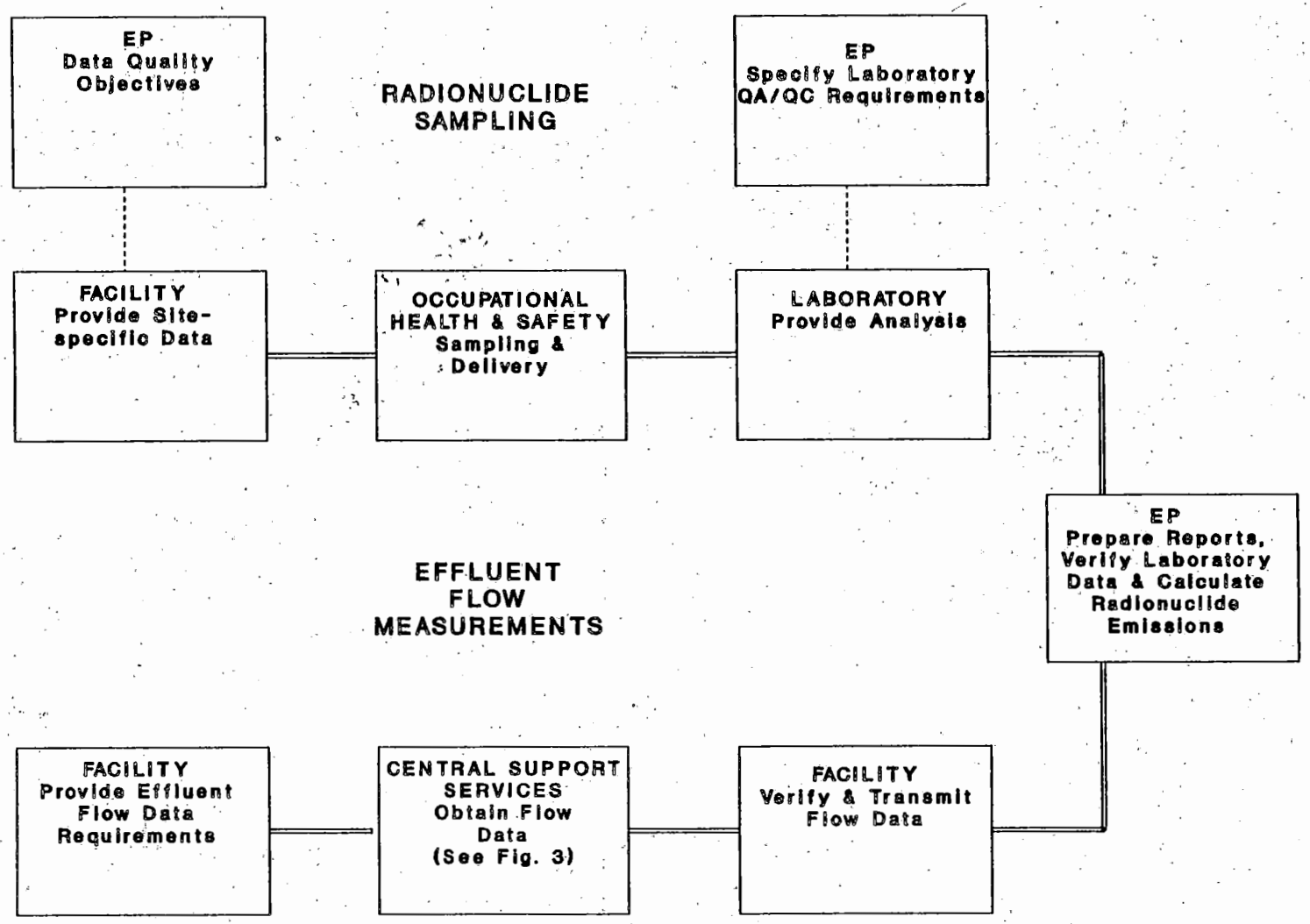
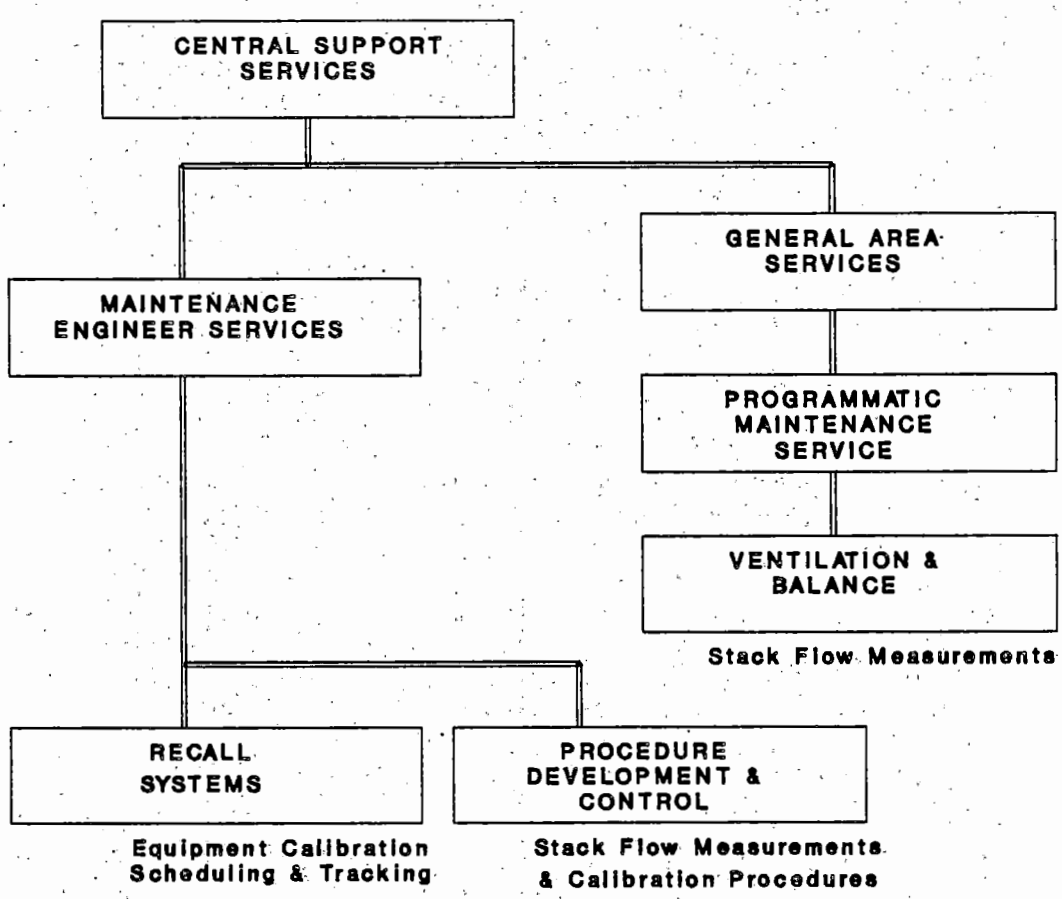


Figure 2. "National Emission Standards For Hazardous Air Pollutants" Implementation.

Figure 3. Effluent Flow Measurements.



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The facility cognizant engineer prepares the radionuclide stack point-by-point implementation that addresses the sections of 40 CFR 61, Appendix B, Method 114 (EPA 1991), described below.

- Section 4.2 describes the administrative controls that are used at the facility to ensure a prompt response in the event that emission levels increase because of unplanned operations.
- Section 4.3.1 specifies the number of sample points and the rationale for sample site selections.
- Section 4.3.2 describes sampling probes and representativeness of samples.
- Section 4.3.4 identifies the sampling procedure(s) to be used and sampling frequency.
- Section 4.3.6 describes the sample flow rate measurement systems or procedures, including calibration procedures and frequency of calibration.
- Section 4.3.7 describes the effluent flow rate measurement system, including frequency of measurements. The facility cognizant engineer is responsible for verifying these flow rates and transmitting the information to the EP organization.

6.2.3 Occupational Health and Safety

Occupational Health and Safety provides the sampling effort for the radionuclide air emissions under the technical direction of the facility cognizant engineer. The sampling activities should be done in accordance with the stack monitoring and sampling requirements of 40 CFR 61, Appendix B, Method 114 (EPA 1991).

The QA activities that are included in Method 114 and performed by this group are described below.

- Section 4.3.4 describes the sample collection procedures.
- Section 4.6 covers the sample tracking system for positive identification of samples from sample collection to delivery to the laboratory, as well as sample handling and preservation procedures to maintain the integrity of samples during collection and storage. NOTE: The sample tracking system must still be implemented.

The sampling collection, tracking, and handling procedures for all radionuclide effluents are contained in WHC-IP-0692 (WHC 1991a).

6.2.4 Central Support Services

The effluent flow measurement activities are performed by the Central Support Services group (see Figure 3) under the control of the facility cognizant engineer.

The QA activities from Method 114 (EPA 1991) that are performed by the organizations described below, through Central Support Services, are described in the paragraphs that follow.

6.2.4.1 Ventilation and Balance. In accordance with Section 4.3.7, the effluent flow measurements are performed by this group in accordance with procedures that are included in a Job Control System (JCS) (see WHC-CM-8-8 [WHC 1989b]) work package. The facility cognizant engineer is responsible for the preparation and transmittal of the JCS work package to the ventilation and balance organization.

The data collected from this activity are provided to the facility cognizant engineer who is responsible for verifying and transmitting this information to the EP group.

6.2.4.2 Procedure Development and Control. In accordance with Section 4.3.7, the procedures used for the effluent measurements and plant equipment calibrations are prepared by this group. Some of these procedures are generic, with the plant-specific information being included in the JCS prepared by the facility cognizant engineer.

The development and control of these procedures are addressed in WHC-CM-8-10, Section 06-03 (WHC 1990c).

6.2.4.3 Recall Systems. In accordance with Section 4.3.7, the scheduling of calibration for the continuous stack flow measurement equipment is controlled by this group. This scheduling information is forwarded to the facility planner/scheduler who prepares the JCS work package under the direction of the facility cognizant engineer. This work package is required for the maintenance forces to perform the calibration(s). The completed calibration information is returned to Recall Systems for tracking purposes.

The control of these calibration scheduling and tracking activities is addressed in WHC-CM-8-2, Section 202 (WHC 1991b).

6.2.5 Laboratories

The radionuclide air emissions samples will be analyzed in accordance with applicable regulations. The specific radionuclides to be analyzed for are determined jointly by EP and the facility cognizant engineer.

Laboratories shall have a QA plan and analytical procedures that meet the requirements of 40 CFR 61, Appendix B, Method 114 (EPA 1991). The QA activities identified in Method 114 that must be addressed in laboratory QA plans are as follows:

- Calibration activities specified by the Radionuclide Analysis Method in Method 114

- Section 4.3.5, the calibration procedures and frequency of calibration required for the analytical procedures used by the laboratory

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- Section 4.5, a quality control program to evaluate and track the quality of emissions measurement data

- Section 4.6, a sample tracking system to provide for positive identification of samples and data through all phases of sample receipt, analysis, and reporting

- Section 4.6, a sample control system to maintain the integrity of samples during storage and analysis.

6.2.6 Regulatory Analysis

Regulatory Analysis provides guidance on the interpretation of regulations and interfaces with the regulatory agencies to resolve regulatory issues.

6.2.7 Facility Compliance

The Facility Compliance group provides guidance to the facilities on the interpretation of regulations that pertain to the specific facility.

6.2.8 Other Support Contractors

Procurement of the services of other subcontractors to support radionuclide effluent activities addressed in this QAPP may be initiated by Westinghouse Hanford. Such services shall be in compliance with standard Westinghouse Hanford procurement procedures requirements. All work shall be performed in accordance with Westinghouse Hanford-approved QA plans and/or procedures, subject to the controls of WHC-CM-4-2, QI 7.3, "Source Surveillance and Inspection" (WHC 1988).

7.0 PERFORMANCE AND SYSTEM AUDITS

Audits shall be performed to verify the quality of operation of one or more elements of the total measurement system. Audits will be of the two types below.

- Performance audits, in which quantitative data are independently obtained for comparison with data routinely obtained by the measurement system.

- System audits, involving a qualitative onsite evaluation of laboratories (or other organizational elements of the measurement system) for compliance with established QA program and procedure requirements. This also includes audits of individual facility sampling programs against those requirements of this QAPP and facility QAPjPs.

A performance audit system needs to be established whereby performance evaluation samples are submitted to the laboratories.

System audits currently are being performed by the Audit Program Administration and Environmental Compliance Organizations. See Sections 3.1.2 and 3.2.3 above for implementation.

8.0 CORRECTIVE ACTION

Corrective action requests required as a result of surveillance or audit activity shall be documented and dispositioned as required by WHC-CM-4-2; QI 10.4, "Surveillance;" QR 15.0, "Control of Nonconforming Items;" QI 15.1, "Nonconforming Item Reporting;" and/or QR 16.0 "Corrective Action" (WHC 1988). Primary responsibilities for nonconformance resolution and corrective action tracking are assigned to EA and QA.

These actions will be performed as specified in Sections 4.0 and 7.0.

9.0 QUALITY ASSURANCE REPORTS

As stated in Sections 4.0, 7.0, and 8.0, radionuclide effluent monitoring shall be regularly assessed by surveillance and auditing processes. Surveillance, nonconformance, audit, and corrective action documentation shall be considered QA records and shall be documented and dispositioned as stated in Section 4.0. Records management requirements applicable to subcontractors or participant contractors shall be defined in applicable procurement documents or work orders as noted in Section 6.2.8.

10.0 REFERENCES

Ecology, EPA, and DOE, 1990, *Hanford Federal Facility Agreement and Consent Order*, Vol. 2, "Calendar Year 1990 Annual Update," Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

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WHC, 1990c, *Operations Support Services Standard Practices*, WHC-CM-8-10, Westinghouse Hanford Company, Richland, Washington.

WHC, 1991a, *Health Physics Procedures*, WHC-IP-0692, Westinghouse Hanford Company, Richland, Washington.

WHC, 1991b, *200 Area Support Services*, WHC-CM-8-2, Westinghouse Hanford Company, Richland, Washington.

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APPENDICES TO THE QUALITY ASSURANCE PROGRAM PLAN

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INTRODUCTION TO APPENDICES

These appendices supply information regarding a point-by-point comparison with Title 40, *Code of Federal Regulations* (CFR), Part 61*, Appendix B, Method 114, for the Hanford Site air emissions involving stacks known to have the potential to exceed 40 CFR 61, Subpart H, limits. Please note that Appendices A through F are intended to supply the information for which each facility has responsibility, and that Appendices G and H are intended to supply the information for which the analytical laboratories have responsibility. Specifically, Appendix G includes information for Hanford Site 200 Area stack analyses, and Appendix H includes information for Hanford Site 300 Area stack analyses.

*EPA, 1991, "National Emission Standards for Hazardous Air Pollutants," Title 40, *Code of Federal Regulations*, Part 61, U.S. Environmental Protection Agency, Washington, D.C.

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APPENDIX A

METHOD 114 COMPARISON FOR STACK 291-A-1

J. L. Geiger

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APPENDIX A

METHOD 114 COMPARISON FOR STACK 291-A-1

2.1 Radionuclides as Particulates. The extracted effluent stream is passed through a filter media to remove the particulates. The filter must have a high efficiency for removal of sub-micron particles. The guidance in ANSI N13.1-1969 shall be followed in using filter media to collect particulates (incorporated by reference-see § 61.18).

The sample is continuously removed from the effluent stream via the rake described in Section 4.3.2. The sample then flows through the sample line and the particulates are collected on a sample filter made of Gelman Versapor 3000*. According to the manufacturer, this filter medium has an efficiency of 95.8% for 3 μm particles. Section 4.3.6 describes the calibration of the sample flow rate measurement equipment.

2.2.1 The Radionuclide Tritium (H-3). Tritium in the form of water vapor is collected from the extracted effluent sample by sorption, condensation or dissolution techniques. Appropriate collectors may include silica gel, molecular sieves, and ethylene glycol or water bubblers.

Tritium in the gaseous form may be measured directly in the sample stream using Method B-1, collected as a gas sample or may be oxidized using a metal catalyst to tritiated water and collected as described above.

No irradiated fuel has been introduced into the Plutonium-Uranium Extraction (PUREX) Plant for several years. No dissolutions have been performed since late 1989. Gaseous sampling systems have shown that the levels of ^{3}H and ^{14}C have fallen to levels at or below the analytical detection limit, which were well below environmental release and monitoring limits. Consequently, sampling for these nuclides is no longer required or performed.

2.2.2 Radionuclides of iodine. Iodine is collected from an extracted sample by sorption or dissolution techniques. Appropriate collectors may include charcoal, impregnated charcoal, metal zeolite and caustic solutions.

No irradiated fuel has been introduced into the PUREX Plant for several years. No dissolutions have been performed since late 1989. Furthermore, concentrations of radioiodine in any fuel available for processing have decayed to such a low level that there is no longer any requirement to monitor for iodine. Nevertheless, sampling for iodine continues. Because it is not required, this sampling may be discontinued without notice.

After flowing through the Gelman Versapor 3000 filter, the gas sample flows through two silver zeolite cartridges to capture iodine.

2.2.3 Radionuclides of Argon, Krypton and Xenon. Radionuclides of these elements are either measured directly by an in-line or off-line monitor, or are collected from the extracted sample by low temperature sorption techniques, Appropriate sorbers may include charcoal or metal zeolite.

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*Trademark of Gelman Sciences, Inc.

No irradiated fuel has been introduced into the PUREX Plant for several years. No dissolutions have been performed since late 1989. Gaseous sampling systems had shown that the levels of ^{3}H and ^{14}C had fallen to levels at or below the analytical detection limit, which were well below environmental release and monitoring limits. Consequently, sampling for these nuclides is no longer required or performed. The release of other radioactive gases decreased more rapidly than for these nuclides. Consequently, there is no need for gaseous nuclide sampling.

2.2.4 Radionuclides of Oxygen, Carbon, Nitrogen and Radon. Radionuclides of these elements are measured directly using an in-line or off-line monitor. Radionuclides of carbon in the form of carbon dioxide may be collected by dissolution in caustic solutions.

No irradiated fuel has been introduced into the PUREX Plant for several years. No dissolutions have been performed since late 1989. Gaseous sampling systems had shown that the levels of ^{3}H and ^{14}C had fallen to levels at or below the analytical detection limit, which were well below environmental release and monitoring limits. Consequently, sampling for these nuclides is no longer required or performed. The release of other radioactive gases decreased more rapidly than for these nuclides. Consequently, there is no need for gaseous nuclide sampling.

4.0 Quality Assurance Methods

Each facility required to measure their radionuclide emissions shall conduct a quality assurance program in conjunction with the radionuclide emission measurements. This program shall assure that the emission measurements are representative, and are of known precision and accuracy and shall include administrative controls to assure prompt response when emission measurements indicate unexpectedly large emissions. The program shall consist of a system of policies, organizational responsibilities, written procedures, data quality specifications, audits, corrective actions and reports. This quality assurance program shall include the following program elements:

4.1 Documentation identifying the organizational structure, functional responsibilities, levels of authority and lines of communications for all activities related to the emissions measurement program.

See Section 6.2 of the main part of this document for the organizational structure.

4.2 Prescribed administrative controls to ensure prompt response in the event that emission levels increase due to unplanned operations.

WHC-CM-4-12 (WHC 1990a), Section 1.14, REV 0, ALARM RESPONSE AND MANAGEMENT. Provides guidance and sets requirements for managing the responses to alarms which are the responsibility of Occupational Health and Safety (OHS). This practice is applicable to all members of the Occupational Health and Safety organization. Area Health and Safety managers shall ensure that all members of their organizations are aware of and adhere to this practice.

WHC-CM-4-12, Section 2.1, REV 0, RADIOLOGICAL PROBLEM REPORTING PROGRAM. The purpose of the Radiological Problem Report (RPR) program is to provide a documented record of observed radiological problems, a mechanism for reporting these problems to management for action, a capability to track and monitor the progress of the planned corrective actions, and a database for assessing trends in radiological program performance and needed actions.

WHC-CM-4-12, Section 12.1, REV 1 EMERGENCY RESPONSE. An EMERGENCY is a sudden unexpected event requiring immediate response to mitigate impacts to people, property, or the environment. When radioactive material is involved, Health Physics (HP) plays a major role in evaluating, controlling, and recovering from the event. To be able to perform this function HP personnel receive training to respond to a variety of emergency situations. The HP procedures are written to provide guidelines to respond to emergencies. Together, the training and written procedure detail the HP Emergency Response Program.

Emergency Response. The HP personnel are, in many situations, the first to respond to a radiological emergency. The ability to assess and evaluate the situation and take immediate steps to minimize the effects of the event is crucial for controlling the emergency. The HP personnel must use their training and experience to make good decisions during the initial response to an emergency.

An emergency response may be initiated by personnel observing the event, alarms, the Patrol Operation Center, or the Emergency Control Center(s) once they are manned. For a planned response,

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HP personnel shall be in teams of at least two. Out of necessity (e.g., backshift response), one member could be an Operations person or other emergency service person such as fire or patrol. A rapid response is required; however, no undue risks should be taken nor should employee personnel safety be compromised. The type of emergency determines the level of planning for HP response. For example, a continuous air monitor (CAM) alarm or a small radioactive spill requires little planning for the initial response. However, when an emergency causes a facility evacuation, preplanning (e.g., stay time, entry route, etc.) and approval of the Building/Facility Emergency Director is necessary for a re-entry.

Although HP personnel respond to an emergency using basic guidelines, an area/facility may have specific procedures that have priority over these guidelines.

WHC-CM-4-13 (WHC 1991a), Section 12.1.2.3, REV 2, EFFLUENT EXHAUST CAM ALARM RESPONSE. This procedure establishes the standard method of handling samples from, and response to alarms at, Effluent Exhaust CAM systems.

WHC-CM-4-13, Section 12.1.2.4, REV 0, PUREX MAIN STACK (291-A-1) ALARM RESPONSE. This procedure establishes the method of response to alarms occurring on the Moving Filter Radioactive Aerosol Monitor (MFRAM), on the Continuous Particulate Release Monitor (CPRM), to alarms on the CPRM or MFRAM iodine monitors, or to high-activity levels detected on the Effluent Release Record Sample.

WHC-CM-4-13, Section 12.1.6, REV 2, STACK EFFLUENT RELEASE RESPONSE. This procedure establishes guidelines for responding to a potential or actual release of radioactive material through exhaust stacks.

WHC-CM-4-13, Section 12.2.1, REV 2, EMERGENCY RESPONSE AIR SAMPLING. This procedure establishes the instruction and guidelines for air sampling in an emergency situation.

WHC-CM-4-13, Section 12.2.3, REV 0, HEALTH PHYSICS EMERGENCY RESPONSE TEAM. This procedure provides the organizational structure of, the instructions for, and the responsibilities of the HP Emergency Response Team and the Radiation Protection Technologist (RPT) Field Survey Teams.

WHC-CM-4-13, Section 12.2.4, REV 2, EMERGENCY RADIOACTIVE PLUME TRACKING. This procedure establishes the instruction to track a plume created from a radioactive material release to the environment.

WHC-CM-4-13, Section 12.2.6, REV 0, GENERAL GUIDELINES FOR EMERGENCY RESPONSE. This procedure provides general guidelines to handle emergency situations.

WHC-IP-0263-202A (WHC 1990b), *Westinghouse Hanford Company Emergency Plan for PUREX Facility*. This document provides instructions for many types of emergencies, including excessive releases of radioactivity via the stacks.

WHC-CM-5-9 (WHC 1991b), Section 2.3, REV 1, PUREX/UO_3 Plant Occurrence Categorization, Notification, and Reporting. This procedure provides instructions for notification and reporting of specific events including environmental releases and related events.

4.3 A description of the sample collection and analysis procedures used in measuring the emission, including where applicable:

4.3.1 Identification of sampling sites and number of sampling points, including the rational for site selection.

The 291-A-1 stack is 7 feet in diameter. The record sampling site is a vertical section of the stack, at a height of 60 feet above-grade. There are a total of three sampling sites and six sampling probes.

The elevations of the sample ports are 60, 74, and 88 feet above-grade, which is the location of the last major flow disturbance in the stack. The sample ports are, therefore, approximately 8.6, 10.6, and 12.6 diameters downstream of the last major disturbance.

The stack is 200 feet, or 28.6 diameters, tall. The sample ports are, therefore, approximately 20, 18, and 16 diameters upstream of the next major flow disturbance.

The sites were chosen to provide representative sampling of the effluent and to comply with ANSI N13.1-1969 (ANSI 1969). The lowest sample port was chosen as the location of the record sample probe to minimize the length of sample line in accordance with ANSI N13.1-1969. These sample points also meet the criteria of 40 CFR 60, Appendix A, Method 1 (EPA 1991).

4.3.2 A description of the sampling probes and representativeness of the samples.

The sampling probes are "rakes," that is, multiport probes. The rakes are paired, i.e., there are two rakes at each sample location. With the exception of the particulate record sample, each rake has six inlet ports consisting of 3/8 in. OD by 0.035 in. wall 316 stainless steel tubing. At the inlet, each port is tapered to a knife edge with a 15-degree angle. At the 74-foot level, the inlet ports have a 2-in. vertical section followed by a 2-in. radius bend leading into the rake. (The backup record sample is collected from a rake at the 74-foot level.) At the 60-foot and 88-foot levels, the inlet ports have a 1-7/8-in. vertical section followed by a 1-7/8-in. radius bend.

The six-point sample rakes collect samples from the approximate centers of equal-area annuli in the stack, alternating between the near and far sides of the annuli. (For an annulus, the "center" is halfway between the inner and outer radii of an annulus.) The

table below compares the actual and ideal locations of the inlet ports, and also lists the difference in inches. The positions are measured from the center of the stack in the direction away from the liner penetration. The tolerance on the actual dimensions is ±0.1 in.

Actual (feet)	Ideal (feet)	Difference (inches)
-3.33333	-3.34752	0.170289
-2.66666	-2.66630	0.004329
-1.66666	-1.72479	0.697569
0	0	0
2.25	2.247799	0.026401
3	3.026393	0.316717

The rake that currently collects the particulate record sample has 16 inlets, consisting of 304 stainless steel tubing. At the inlet, each port is tapered to a knife edge with a 15-degree angle. The inlet ports have a 2-in. vertical section followed by a 2-in. radius bend leading into the rake at a 45-degree angle. The outer two ports are made of 3/8 in. OD, 0.065-in. wall tube. The next six ports are made of 1/4 in. OD, 0.028-in. wall tube. The inner eight ports are made of 1/4 in. OD, 0.035-in. wall tube. The inlet ports are arranged symmetrically and approximately centered over equal-area semi-annuli. The table compares the actual and ideal locations of the inlet ports, and also lists the difference. The positions are measured from the center of the stack. The tolerance on the actual dimensions is ±0.1 in.

Actual (feet)	Ideal (feet)	Difference (inches)
0.6167	0.618718	0.024621
1.5000	1.493718	0.075378
1.9500	1.946652	0.040178
2.3083	2.309088	0.009063
2.6250	2.620933	0.048799
2.9000	2.899040	0.011508
3.1500	3.152519	0.030234
3.3833	3.386975	0.043701

The use of an isokinetic 16-point probe located more than 8 duct diameters downstream of the last major flow disturbance ensures representative sampling.

4.3.3 A description of any continuous monitoring systems used to measure emissions, including the sensitivity of the system, calibration procedures and frequency of calibration.

Not applicable--emissions are not monitored continuously for compliance demonstration.

4.3.4 A description of the sample collection systems for each radionuclide measured, including frequency of collection, calibration procedures and frequency of calibration.

The sample is continuously removed from the effluent stream via the rake described in Section 4.3.2. The sample then flows through the sample line and the particulates are collected on a sample filter. The sample filters are replaced weekly, and sometimes more often. The filtered gas then flows through two silver zeolite cartridges to capture iodine and other volatile elements. Section 4.3.6 describes the calibration of the sample flow rate measurement equipment.

No irradiated fuel has been introduced into the PUREX Plant for several years. No dissolutions have been performed since late 1989. Gaseous sampling systems had shown that the levels of ^{3}H and ^{14}C had fallen to levels at or below the analytical detection limit, which were well below environmental release and monitoring limits. Consequently, sampling for these nuclides is no longer required or performed. The release of other radioactive gases decreased more rapidly than for these nuclides. Consequently, there is no need for gaseous nuclide sampling.

4.3.5 A description of the laboratory analysis procedures used for each radionuclide measured, including frequency of analysis, calibration procedures and frequency of calibration.

The *Facility Effluent Monitoring Plan Determination for the 200 Area Facilities* (WHC 1991c) lists the analytes of interest for the 291-A-1 Stack. These are: ^{238}Pu, $^{239,240}Pu$, ^{241}Am, $^{89,90}Sr$, Gamma Energy Analysis, Gross U, ^{147}Pm, ^{129}I, ^{131}I, ^{125}Sb, ^{113}Sn, ^{103}Ru, and ^{106}Ru.

4.3.6 A description of the sample flow rate measurement systems or procedures, including calibration procedures and frequency of calibration.

After exiting the record sample filter, the air flows through a flow measurement and control system. Currently a Kurz* Model 505 system measures the sample flow rate, a Kurz model 101-RM totalizes the sample flow, and a Kurz 710RMD(4200) adjusts a control valve to maintain a constant flow. At least once a day an employee adjusts the 710RMD to ensure isokinesis. The instruments are calibrated at least once per year (normally every 6 months). Currently the calibration procedures are PSCP-1-045, PSCP-4-167, and PSCP-4-197.

*Kurz is a trademark of Kurz Instruments, Inc.

After exiting the flow control valve, the air flows through a rotameter which provides backup indication. Approximately yearly calibration is accomplished by comparison with a standard rotameter, using procedure PSCP-7-001.

4.3.7 A description of effluent flow rate measurement procedures, including frequency of measurements, calibration procedures and frequency of calibration.

A six-point Kurz probe continuously measures the flow through the stack at the 74-foot level. A Kurz Model 195B transmitter sends the signal to a Kurz Model 142-RMD and a Kurz Model 132, which then drives a recorder, which continuously records the flow rate. The total flow is then summed from the recorder trace. The six flow elements on the six-point probe are pre-calibrated by the manufacturer. The remaining instruments are calibrated at least once per year (normally every 6 months). Currently the calibration procedures are PSCP-1-044, PSCP-4-001, and PSCP-4-167.

4.4 The objectives of the quality assurance program shall be documented and shall state the required precision, accuracy, and completeness of the emission measurement data including a description of the procedures used to assess these parameters.

The objectives will be documented in a future Environmental Protection Quality Assurance Project Plan.

4.5 The quality control program shall evaluate and track the quality of the emission measurement data against preset criteria. The program should include, where applicable, a system of replicates; spiked samples; split samples; blanks; and control charts. The number and frequency of such quality control checks shall be identified.

The program will be described in a future Environmental Protection Quality Assurance Project Plan.

4.6 A sample tracking system shall be established to provide for positive identification of samples and data through all phases of the sampling collection, analysis, and reporting system. Sample handling and preservation procedures shall be established to maintain integrity of the samples during collection, storage, and analysis.

Refer to Section 6.2.3 of the main part of this document.

4.7 Periodic internal and external audits shall be performed to monitor compliance with the quality assurance program. These audits shall be performed in accordance with written procedures and conducted by personnel who do not have responsibility for performing any of the operations being audited.

Refer to Section 7.0 of the main part of this document.

4.8 A corrective action program shall be established including criteria for when corrective actions will be taken and who is responsible for taking the corrective action.

Refer to Sections 4.0 and 7.0 of the main part of this document.

4.9 Periodic reports to responsible management shall be prepared on the performance of the emission measurements program. These reports should include assessment of the quality of the data, results of audits, and description of corrective actions.

Refer to Section 9.0 of the main part of this document.

4.10 Provide qualifications and training needed for Facility Cognizant Engineer.

WHC-CM-5-9, Section 2.19, REV 0, SELECTION OF PUREX/UO_3 COGNIZANT ENGINEERS AND COGNIZANT ENGINEER MANAGERS. This procedure establishes the requirements, qualifications, and process for the selection of PUREX/UO_3 Cognizant Engineers and Cognizant Engineer Managers.

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REFERENCES

ANSI, 1969, *Guide to Sampling Airborne Radioactive Materials in a Nuclear Facility*, ANSI N13.1, American National Standards Institute, Washington, D.C.

EPA, 1991, "Standards of Performance for New Stationary Sources," Title 40, *Code of Federal Regulations*, Part 60, U.S. Environmental Protection Agency, Washington, D.C.

PSCP-7-001, *AIR ROTAMETER, CALIBRATION PROCEDURE*

PSCP-4-197, *KURZ MODEL 710 RMD FLOW CONTROLLER, 4200 AND 7500 SYSTEMS*

PSCP-4-167, *KURZ SAMPLE LOW TOTALIZER, MODEL 101*

PSCP-4-001, *TAYLOR QUICK-SCAN RECORDER, SERIES 1300, CALIBRATION PROCEDURE*

PSCP-1-045, *KURZ LINEAR MASS FLOW METER, SERIES 505 AT PUREX*

PSCP-1-044, *KURZ 142/151 RM, CALIBRATION PROCEDURE*

WHC, 1990a, *Health Physics Practices Manual*, as amended, WHC-CM-4-12, Westinghouse Hanford Company, Richland, Washington.

WHC, 1990b, *Westinghouse Hanford Company Emergency Plan for PUREX Facility*, WHC-IP-0263-202A, Westinghouse Hanford Company, Richland, Washington.

WHC, 1991a, *Health Physics Procedures Manual*, as amended, WHC-CM-4-13, Westinghouse Hanford Company, Richland, Washington.

WHC, 1991b, *PUREX/UO_3 Plant Occurrence Categorization, Notification, and Reporting*, as amended, WHC-CM-5-9, Westinghouse Hanford Company, Richland, Washington.

WHC, 1991c, *Facility Effluent Monitoring Plan Determination for the 200 Area Facilities*, WHC-EP-0440, Westinghouse Hanford Company, Richland, Washington.

APPENDIX B

METHOD 114 COMPARISON FOR STACK 291-B-1

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APPENDIX C

METHOD 114 COMPARISON FOR STACK 291-Z-1

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APPENDIX C

METHOD 114 COMPARISON FOR STACK 291-Z-1

This section provides a line-by-line evaluation of quality assurance method requirements outlined in 40 CFR 61, Appendix B, Method 114, as they apply to the 291-Z-1 stack at the Plutonium Finishing Plant (PFP), Hanford Site.

METHOD 114-TEST METHODS FOR MEASURING RADIONUCLIDE EMISSIONS FROM STATIONARY SOURCES

1.0 Purpose and Background

This method provides the requirements for: (1) Stack monitoring and sample collection methods appropriate for radionuclides; (2) radiochemical methods which are used in determining the amounts of radionuclides collected by the stack sampling and; (3) quality assurance methods which are conducted in conjunction with these measurements. These methods are appropriate for emissions for stationary sources. A list of references is provided.

Many different types of facilities release radionuclides into air. These radionuclides differ in the chemical and physical forms, half-lives and type of radiation emitted. The appropriate combination of sample extraction, collection and analysis for an individual radionuclide is dependent upon many interrelated factors including the mixture of other radionuclides present. Because of this wide range of conditions, no single method for monitoring or sample collection and analysis of a radionuclide is applicable to all types of facilities. Therefore, a series of methods based on "principles of measurement" are described for monitoring and sample collection and analysis which are applicable to the measurement of radionuclides found in effluent streams at stationary sources. This approach provides the user with the flexibility to choose the most appropriate combination of monitoring and sample collection and analysis methods which are applicable to the effluent stream to be measured.

2.0 Stack Monitoring and Sample Collection Methods

Monitoring and sample collection methods are described based on "principles of monitoring and sample collection" which are applicable to the measurement of radionuclides from effluent streams at stationary sources. Radionuclides of most elements will be in the particulate form in these effluent streams and can be readily collected using a suitable filter media. Radionuclides of hydrogen, oxygen, carbon, nitrogen, the noble gases and in some circumstances iodine will be in the gaseous form. Radionuclides of these elements will require either the use of an in-line or off-line monitor to directly measure the radionuclides, or suitable sorbers, condensers or bubblers to collect the radionuclides.

2.1 Radionuclides as Particulates. The extracted effluent stream is passed through a filter media to remove the particulates. The filter must have a high efficiency for removal of sub-micron particles. The guidance in ANSI N13.1-1969 shall be followed in using filter media to collect particulates (incorporated by reference-see § 61.18).

The filter media used to remove the particulates is a 47-mm Versapor* 3000 or equivalent air sample filter as described by WHC-CM-4-13, Section 5.5.5.7, REV 2.

2.2 Radionuclides as Gases.

The 291-Z-1 stack does not exhaust radionuclide gases; therefore, this section is not applicable to this stack.

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2.3 Definition of Terms

No response required.

3.0 Radionuclide Analysis Methods

The analysis methods have been evaluated by the 222-S Laboratory cognizant personnel and are included as Appendix G.

4.0 Quality Assurance Methods

Each facility required to measure their radionuclide emissions shall conduct a quality assurance program in conjunction with the radionuclide emission measurements. This program shall assure that the emission measurements are representative, and are of known precision and accuracy and shall include administrative controls to assure prompt response when emission measurements indicate unexpectedly large emissions. The program shall consist of a system of policies, organizational responsibilities, written procedures, data quality specifications, audits, corrective actions and reports. This quality assurance program shall include the following program elements:

4.1 The organizational structure functional responsibilities, levels of authority and lines of communications for all activities related to the emissions measurement program shall be identified and documented.

4.2 Administrative controls shall be prescribed to ensure prompt response in the event that emission levels increase due to unplanned operations.

WHC-CM-4-1, REV 1, *Emergency Plan*. This manual contains an emergency preparedness plan to protect onsite personnel, public health and safety, and the environment in the event of operation, natural phenomena, and/or safeguards and security events at Westinghouse Hanford Company (Westinghouse Hanford) facilities. The requirements stated in the emergency preparedness plan are implemented through subtier plans and implementing procedures. These implementing plans and procedures established for response to emergencies by Westinghouse Hanford personnel and emergency management organizations are contained in WHC-CM-4-43, *Emergency Management Procedures*; WHC-CM-4-44, *Emergency Preparedness Administrative Manual*; various building emergency plans; and Westinghouse Hanford facility operating procedures (WHC-IP-0263-PFP).

WHC-CM-4-12, Section 1.14, REV 0, "Alarm Response and Management." This section provides guidance and sets requirements for managing the responses to alarms that are the responsibility of Occupational Health and Safety (OHS). This practice is applicable to all members of the OHS. Area OHS managers shall ensure that all members of their organizations are aware of and adhere to this practice.

WHC-CM-4-12, Section 2.1, REV 0, "Radiological Problem Reporting Program." The purpose of this section is to provide a documented record of observed radiological problems, a mechanism for reporting these problems to management for action, a capability to track and monitor the progress of the planned corrective actions, and a database for assessing trends in radiological program performance and needed actions.

WHC-CM-4-12, Section 12.1, REV 1, "Emergency Response." An emergency is a sudden unexpected event requiring immediate response to mitigate impacts to people, property, or the environment. When radioactive material is involved, Health Physics (HP) plays a major role in evaluating, controlling, and recovering from the event. To be able to perform this function, HP personnel receive training to respond to a variety of emergency situations. The HP procedures (WHC-IP-0692 and WHC-CM-4-12) are written to provide guidelines to respond to emergencies. Together, the training and the written procedure detail the HP emergency response program.

Emergency Response. The HP personnel, in many situations, are the first to respond to a radiological emergency. The ability to assess and evaluate the situation and take immediate steps to minimize the effects of the event is crucial for controlling the emergency. The HP personnel use their training and experience to make decisions during the initial response to an emergency.

An emergency response may be initiated by (1) personnel observing the event, (2) alarms, (3) the Patrol Operation Center, or (4) the Emergency Control Center(s) once they are manned. The type of emergency determines the level of planning for HP response. For a planned response, HP personnel shall be in teams of at least two. Out of necessity (e.g., backshift response), one member could be an Operations person or other emergency service person such as a firefighter or patrol. If a rapid response is required, no undue risks should be taken nor should personnel safety be compromised. When an emergency causes a facility evacuation, preplanning (e.g., stay time, entry route, etc.) and approval of the Building or Facility Emergency Director is necessary to re-enter.

Although HP personnel respond to an emergency using basic guidelines, an area or facility may have specific procedures that have priority over these guidelines.

WHC-IP-0692, Section 12.1.2.6, REV 0, "HP Response to Room 221A & Room 631 Annunciator Panel Alarms." This procedure provides the HP staff at PFP the information and required actions needed to respond to a radiation or contamination-related alarm.

WHC-IP-0692, Section 5.2.2.6, REV 2, "Gaseous Effluent Sampling and Monitoring System Operability Inspection." This procedure establishes the method of inspection, evaluation, and discrepancy reporting of the operational status of Gaseous Effluent Monitoring Systems (Stack Packs), in use in the 200 East and West Areas.

WHC-CM-4-13, Section 5.2.2.7, REV 2, "Operation of Gaseous Effluent Sampling and Monitoring Systems." This procedure establishes the standard method of operation of Gaseous Effluent Sampling and Monitoring Systems (Generic Stack Packs) in use in the 200 East and West Areas.

WHC-DI-33920-010, REV 0, *Operation and Inspection of PFP Stack Sampling and Monitoring Systems.* This desk instruction provides PFP

and stack-specific implementing procedures and references for the effluent sampling and monitoring systems including response to alarms.

WHC-CM-4-13, Procedure No. 12.1.2.3, REV 2, "Effluent Exhaust CAM Alarm Response." This procedure establishes the standard method of handling samples from, and response to alarms at, effluent exhaust continuous air monitor (CAM) systems in an expedited fashion.

WHC-IP-0263-PFP, Section 6.0, REV 2, "Emergency Response Plans." This procedure establishes guidelines for actions to be taken if the PFP discharges highly radioactive gaseous material.

WHC-CM-5-8, Procedure 1.5, REV 2, "Non-Routine Release Response." This procedure details the response actions to nonroutine releases as evidenced by high sample results from gaseous effluent samples at the PFP.

WHC-IP-0692, Procedure No. 12.2.1, REV 2, "Emergency Response Air Sampling." This procedure describes the guidelines and steps for emergency air sampling inside and outside facilities when a release of radioactive material is suspected.

WHC-IP-0692, Section 12.2.3, REV 0, "Health Physics Emergency Response Team." This procedure provides the organizational structure of, the instructions for, and the responsibilities of the HP Emergency Response Team and the HP Technicians Field Survey Teams. This procedure describes the steps for an initial emergency response by the HP Emergency Response Team and HP Technicians Field Survey Teams. The HP Emergency Response Team and the HP Technicians Field Survey Teams may be requested to respond to an emergency when an environmental release of radioactive material may extend beyond the control of a facility or outside the Hanford Site boundaries. These teams will have monitoring responsibilities only outside the boundaries of the event site.

WHC-IP-0692, Section 12.2.4, REV 2, "Emergency Radioactive Plume Tracking." This procedure establishes the instructions to track a beta-gamma plume created from a radioactive material release to the environment and determine if it is at ground level or at an elevated level.

Notifications and reporting of specific events related to environmental releases and/or events involving effluents and/or hazardous materials are reported via instruction given in WHC-CM-7-5, *Environmental Compliance Manual*, and WHC-IP-0263-PFP, *Building Emergency Plan for Plutonium Finishing Plant Complex Emergency Response Plans*, Section 6.6, "Radioactive Materials Response Plan." The purpose of these manuals and sections is to establish and implement specific criteria and requirements for the identification, categorization, notification, and reporting of occurrences at the PFP, as required by WHC-CM-1-3, MRP 5.14, "Occurrence Reporting and Processing of Operational Information."

4.3 The sample collection and analysis procedures used in measuring the emissions shall be described including where applicable:

4.3.1 Identification of sampling sites and number of sampling points, including the rationale for site selections.

A continuous effluent sample is extracted from the 291-Z-1 stack by a single probe located at the 15 m (50 ft) level of the stack. The stack diameter at this location is 15.75 ft. The nearest flow disturbances are at the inlet and outlet of the stack, approximately three stack diameters downstream and nine stack diameters upstream from the sampling location. The 15 m (50 ft) sampling location was selected after extensive studies were performed. The presence of an existing penetration in the stack at this level was an important factor in sample site location as this supplied Pacific Northwest Laboratory (PNL) an access point through which instrumentation could be inserted to study the effluent characteristics. The site was proven to be acceptable for sampling.

This sampling location meets the stack diameter requirements of 40 CFR 60, Method 1.

4.3.2 A description of sampling probes and representativeness of the samples.

The sampling probe consists of six nozzles branching from a single sample delivery line and is entirely of 300-series stainless steel (drawings H-2-28543 and H-2-28545). The collection probe spans the diameter of the stack with the nozzles centered in six equal annular areas. The bend radii of the collection tubes are 2.5 times the tube radius or 1.25 times the tube diameter. The sample delivery line increases in diameter as each branch line joins to keep the mass flow rate consistent with sample velocity. The probe delivers the sample to a 300-series stainless steel flow splitter for record and CAM samples.

The velocity distribution at the sampling site was measured before sampler construction. But as stated in ANSI N13.1-1969, "as the flow becomes more turbulent, the velocity becomes more nearly uniform across the duct." Therefore, velocity distribution is of lesser importance for the 291-Z-1 stack as the flow is highly turbulent (Reynolds Number = 2,000,000). The flow rate for the 291-Z-1 stack varies only a few percent. The variation in 1988 was determined to be only 3% and for 1991 a variation of 4.5% was observed. Given these facts, the sample probe provides the sample collection system with a representative, isokinetic sample.

4.3.3 A description of any continuous monitoring system used to measure emissions, including the sensitivity of the system, calibration procedures and frequency of calibration.

Not applicable--emissions are not monitored continuously.

4.3.4 A description of the sample collection systems for each radionuclide measured, including frequency of collection, calibration procedures and frequency of calibration.

The sample collection probe extracts effluent from the stack at a flow rate of 6 std. ft^3/min. The sampler probe uses six nozzles for sampling the stack flow (drawing H-2-28545). A sample transport line extends approximately 1 m, horizontally, from the stack surface connection flange to the monitoring instruments located within an adjacent, elevated sample shack. The sample transport line is heated by a baseboard heater immediately below the line within the building to inhibit condensation of moisture and resultant sample flow retardation by maintaining the temperature above the dewpoint. The sample transport line was selected and installed to minimize particle loss attributed to gravity settling and turbulent impaction. The transport line length and tube transition severity of the sample transport line were minimized. The bend radii are 1.25 times the inside diameter of the collection tube. Once the extracted sample is delivered to radiation monitoring system instrumentation, the sample stream passes through a flow splitter and is divided into two equal parts: the record sample loop and the CAM loop.

Particulate radionuclides are collected with a record sampler. The record sampler collects the particulates on a 47-mm-diameter filter (Gelman Sciences, Versapor 3000, 3 μm or equivalent). This filter is a membrane filter composed of acrylic copolymer cast on a non-woven nylon substrate good for collecting 0.3-μm size particles with a 91% collection efficiency in air applications. The record sampler provides a representation of the amount and concentrations of radioactive particulates being discharged. The record samples provide the basis for reporting the amount and concentration of radionuclides released to the environment. The filter media is exchanged weekly and evaluated for gross alpha and gross beta activities by laboratory analysis. The filter media is then composited for quarterly analysis of specific radionuclide concentrations.

The CAM loop collects particulate matter in a similar fashion to that of the record sampler, but the CAM monitors for elevated radioactivity on the filter. This instrument provides process control and backup capability for the record sampler. The CAM is calibrated annually.

4.3.5 A description of the laboratory analysis procedures used for each radionuclide measured. including frequency of analysis calibration procedures and frequency of calibration.

Refer to Appendix G.

4.3.6 A description of the sample flow rate measurement systems or procedures, including calibration procedures and frequency of calibration.

The sample flow rate is measured and regulated by instruments located downstream of the sample collection filter and CAM. The record sample loop passes in turn through an integrating flow meter

(totalizer), a sight flow indicator (rotameter), a vacuum pressure indicator, a vacuum switch, a flow regulator, and a vacuum pump. The flow rate regulator is provided to maintain a constant flow rate through the collection filter assembly to compensate for filter-loading effects. Audible and visible alarms signals indicating low vacuum pressure are provided remotely in the HP office and the power control room (both constantly manned locations). The calibration procedures and frequencies are summarized in Table C-1.

4.3.7 A description of the effluent flow rate measurement procedures, including frequency of measurements, calibration procedures and frequency of calibration.

The volumetric flow rate for the 291-Z-1 stack is determined by the summation of independent flow rates of five tributary effluent streams. The streams are independently measured in accordance with pre-approved procedure PFP-PAP-076, "Stack Flow Measurements," which references the vent and balance procedure 7-GN-56. The measurement locations and methods do not strictly conform to the criteria of 40 CFR 60, "Methods." The flow rate is directly measured with a standard pitot tube. The measurement locations are very close to flow disturbances both upstream and downstream. The building ductwork design does not allow for alternatives. The flow rates are determined quarterly as the flow rate does not widely vary.

4.4 The objectives of the quality assurance program shall be documented and shall state the required precision, accuracy and completeness of the emission measurement data including a description of the procedures used to assess these parameters. Accuracy is the degree of agreement of a measurement with a true or known value. Precision is a measure of the agreement among individual measurements of the same parameters under similar conditions. Completeness is a measure of the amount of data obtained compared to the amount expected under normal conditions.

See Appendix G. The objectives will be documented in a future Environmental Protection Quality Assurance Project Plan.

4.5 A quality control program shall be established to evaluate and track the quality of the emissions measurement data against preset criteria. The program should Include where applicable a system of replicates, spiked samples, split samples, blanks and control charts. The number and frequency of such quality control checks shall be identified.

See Appendix G.

4.6 A sample tracking system shall be established to provide for positive identification of samples and data through all phases of the sample collection, analysis and reporting system. Sample handling and preservation procedures shall be established to maintain the integrity of samples during collection, storage and analysis.

See Section 6.2.3 of the main body of this document.

4.7 Periodic internal and external audits shall be performed to monitor compliance with the quality assurance program. These audits shall be performed in accordance with written procedures and conducted by personnel who do not have responsibility for performing any of the operations being audited.

See Section 7.0 of the main body of this document.

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Table C-1. Calibration Procedures and Frequencies for Record Sampler (Sample Flow Measurement Devices).

Component	Procedures	PISCES*	Frequency
Vacuum gauge	PSCP-4-091 7-GN-038	E0004-2	6 month
Flow totalizer		E0005-1	3 month
	PSCP-4-007 7-GN-038		Install/annual
Rotameter	PSCP-7-001 7-GN-038	Y0016-C	6 month
Vacuum switch	PSCP-6-011 7-GN-038	E0005-2	6 month

*WHC-CM-8-2

The CAM loop differs only in that the sight flow indicator is an integral part of the CAM itself and that there is no flow totalizer. All other flow measurements, regulations, and monitoring is identical to that of the record sampler loop. The calibration procedures and frequencies are summarized in Table C-2.

Table C-2. Calibration Procedures and Frequencies for Continuous Air Monitor Sampler (Sample Flow Measurement Devices).

Component	Procedures	PISCES	Frequency
Vacuum gauge	PSCP-4-091 7-GN-038	E0004-1	6 month
Continuous air monitor/rotameter	PNL-MA-563		6 month
Vacuum switch	PSCP-6-011 7-GN-038	E0005-3	6 month

Independent vacuum pumps are provided for each loop of the system. Redundant vacuum systems are not furnished, but failure annunciation (low flow rates) is provided and checked periodically to demonstrate operability.

4.8 A corrective action program shall be established including criteria for when corrective action is needed, what corrective action will be taken and who is responsible for taking the corrective action.

See Section 8.0 of the main body of this document.

4.9 Periodic reports to responsible management shall be prepared on the performance of the emissions measurements program. These reports should include assessment of the quality of the data, results of audits and description of corrective actions.

See Section 9.0 of the main body of this document.

4.10 The quality assurance program should be documented in a quality assurance project plan which should address each of the above requirements.

The quality assurance program addressing stack 291-Z-1 will be documented in a future quality assurance project plan.

REFERENCES

40 CFR 60, "Standards of Performance of New Stationary Sources," Title 40, *Code for Federal Regulations*, Part 60, as amended, U.S. Environmental Protection Agency, Washington, D.C.

40 CFR 61, "National Emission Standards for Hazardous Air Pollutants," Title 40, *Code for Federal Regulations*, Part 61, as amended, U.S. Environmental Protection Agency, Washington, D.C.

ANSI, 1969, *Guide to Sampling Airborne Radioactive Materials in a Nuclear Facility*, ANSI N13.1-1969, American National Standards Institute, New York, New York.

Drawing H-2-28543, Sample Probe Installation Arrangement, Westinghouse Hanford Company, Richland, Washington.

Drawing H-2-28545, Sample Probe Assembly, Westinghouse Hanford Company, Richland, Washington.

Maintenance Engineering Services, Rockwell Type Gas Meter, PSCP-4-007, Westinghouse Hanford Company, Richland, Washington.

Maintenance Engineering Services, Pressure and Vacuum Gauges, PSCP-4-091, Westinghouse Hanford Company, Richland, Washington.

Maintenance Engineering Services, Diaphragm-Operated Pressure Switches, PSCP-6-011, Westinghouse Hanford Company, Richland, Washington.

Maintenance Engineering Services, 1989, *Calibration Procedure, Air Rotometer*, PSCP-7-001, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

PFP-PAP-076, Pre-approved Procedure, Vent & Balance Quarterly Stack Flow Measurements, Rev. 0, 1991, Westinghouse Hanford Company, Richland, Washington.

Procedure 7-GN-038, Pisces Recalled Instrumentation Maintenance Activities, Westinghouse Company, Richland, Washington.

Procedure 7-GN-56, Airflow Capacity and Distribution Tests, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-1-3, *Management Requirements and Procedures*, as amended, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-4-1, REV 1, *Emergency Plan*, as amended, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-4-12, *Health Physics Practices Manual*, as amended, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-4-13, *Health Physics Procedures Manual*, as amended, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-5-8, *Plutonium Finishing Plant Administration*, as amended, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-7-5, *Environmental Compliance Manual*, as amended, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-4-43, *Emergency Management Procedures*, as amended, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-4-44, *Emergency Preparedness Administrative Manual*, as amended, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-8-2, *200 Area Support Service*, as amended, Westinghouse Hanford Company, Richland, Washington.

WHC-DI-33920-010, REV 0, *Operation and Inspection of PFP Stack Sampling and Monitoring Systems*, Westinghouse Hanford Company, Richland, Washington.

WHC-IP-0263-PFP, *Building Emergency Plan for Plutonium Finishing Plant Complex Emergency Response Plan*, Westinghouse Hanford Company, Richland, Washington.

WHC-IP-0692, *Westinghouse Hanford Health Physics Procedures Manual-All Areas*, Westinghouse Hanford Company, Richland, Washington.

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APPENDIX D

METHOD 114 COMPARISON FOR STACK 296-A-22

G. M. Crummel

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APPENDIX D

METHOD 114 COMPARISON FOR STACK 296-A-22

1. Purpose and Background

This method provides the requirements for: (1) Stack monitoring and sample collection methods appropriate for radionuclides; (2) radiochemical methods which are used in determining the amounts of radionuclides collected by the stack sampling and; (3) quality assurance methods which are conducted in conjunction with these measurements. These methods are appropriate for emissions for stationary sources. A list of references is provided.

Many different types of facilities release radionuclides into air. These radionuclides differ in the chemical and physical forms, half-lives and type of radiation emitted. The appropriate combination of sample extraction, collection and analysis for an individual radionuclide is dependent upon many interrelated factors including the mixture of other radionuclides present. Because of this wide range of conditions, no single method for monitoring or sample collection and analysis of a radionuclide is applicable to all types of facilities. Therefore, a series of methods based on "principles of measurement" are described for monitoring and sample collection and analysis which are applicable to the measurement of radionuclides found in effluent streams at stationary sources. This approach provides the user with the flexibility to choose the most appropriate combination of monitoring and sample collection and analysis methods which are applicable to the effluent stream to be measured.

2. Stack Monitoring and Sample Collection Methods

Monitoring and sample collection methods are described based on "principles of monitoring and sample collection" which are applicable to the measurement of radionuclides from effluent streams at stationary sources. Radionuclides of most elements will be in the particulate form in these effluent streams and can be readily collected using a suitable filter media. Radionuclides of hydrogen, oxygen, carbon, nitrogen, the noble gases and in some circumstances iodine will be in the gaseous form. Radionuclides of these elements will require either the use of an in-line or off-line monitor to directly measure the radionuclides, or suitable sorbers, condensers or bubblers to collect the radionuclides.

2.1 Radionuclides as Particulates. The extracted effluent stream is passed through a filter media to remove the particulates. The filter must have a high efficiency for removal of sub-micron particles. The guidance in ANSI N13.1-1969 shall be followed in using filter media to collect particulates (incorporated by reference-see § 61.18).

Plant Documentation

Gelman Sciences, Inter-Office Memorandum to Karol Butcher, October 30, 1991, RE: Versapor 3000, DOP efficiency.

WHC, 1991, *Health Physics Procedure Manual*, WHC-IP-0692

"Operation of Gaseous Effluent Sampling and Monitoring Systems," Health Physics Procedure No. 5.2.2.7, Rev 2

Drawing H-2-92505, Sheet 1 of 4 - Vessel Vent Stack Monitor System Installation

Drawing H-2-92505, Sheet 2 of 4 - Vessel Vent Stack Monitor Details

Drawing H-2-92505, Sheet 4 of 4 - Vessel Vent Stack Monitor Flow Diagram

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Response. A 47-mm Versapor* 3000 or equivalent air sample filter is used for the record sampler. This filter is a membrane filter good for collecting 0.3-μm size particles with a collection efficiency of 95.8%.

2.2 Radionuclides as Gases.

Plant Documentation

WHC, 1991, *Health Physics Procedure Manual*, WHC-IP-0692

- "Silver Zeolite Monitor/Change-Out Program At 241-AW Tank Farm And The 242-A Evaporator," 200 Area Health Physics Procedure No. 5.2.2.5, Rev 1

Drawing H-2-92505, Sheet 1 of 4 - Vessel Vent Stack Monitor System Installation

Drawing H-2-92505, Sheet 2 of 4 - Vessel Vent Stack Monitor Details Drawing H-2-92505

Drawing H-2-92505, Sheet 4 of 4 - Vessel Vent Stack Monitor Flow Diagram

Response -- Silver zeolite cartridges are used and are designed to collect ^{129}I, ^{131}I, ^{125}Sb, ^{113}Sn, ^{103}Ru, and ^{106}Ru.

2.3 Definition of Terms

No response required.

3.0 Radionuclide Analysis Methods

The analysis methods have been evaluated by 222-S Laboratory cognizant personnel and are included as Appendix G.

4.0 Quality Assurance Methods

Each facility required to measure their radionuclide emissions shall conduct a quality assurance program in conjunction with the radionuclide emission measurements. This program shall assure that the emission measurements are representative, and are of known precision and accuracy and shall include administrative controls to assure prompt response when emission measurements indicate unexpectedly large emissions. The program shall consist of a system of policies, organizational responsibilities, written procedures, data quality specifications, audits, corrective actions and reports. This quality assurance program shall include the following program elements:

4.1 The organizational structure functional responsibilities, levels of authority and lines of communications for all activities related to the emissions measurement program shall be identified and documented.

The Organizational Structure

See Section 6.2 of the main part of this document for the organizational structure.

4.2 Administrative controls shall be prescribed to ensure prompt response in the event that emission levels increase due to unplanned operations.

WHC-CM-4-12, Section 1.14, REV 0, "Alarm Response and Management." Provides guidance and sets requirements for managing the responses to alarms that are the responsibility of Occupational Health and Safety (OHS). This practice is applicable to all members of OHS. Area OHS managers shall ensure that all members of their organizations are aware of and adhere to this practice.

WHC-CM-4-12, Section 2.1, REV 0, "Radiological Problem Reporting Program." The radiological problem reporting program provides a documented record of observed radiological problems, a mechanism for reporting these problems to management for action, a capability to track and monitor the progress of the planned corrective actions, and a database for assessing trends in radiological program performance and needed actions.

WHC-CM-4-12, Section 12.1, REV 1, "Emergency Response." An emergency is a sudden, unexpected event requiring immediate response to mitigate impacts to people, property, or the environment. When radioactive material is involved, Health Physics (HP) plays a major role in evaluating, controlling, and recovering from the event. To perform this function, HP personnel receive training to respond to a variety of emergency situations. The HP procedures are written to provide guidelines to respond to emergencies. Together, the training and the written procedure detail the HP Emergency Response Program.

Emergency Response. The HP personnel are, in many situations, the first to respond to a radiological emergency. The ability to assess and evaluate the situation and take immediate steps to minimize the effects of the event is crucial for controlling the emergency. The HP personnel must use their training and experience to make good decisions during the initial response to an emergency.

An emergency response may be initiated by personnel observing the event, alarms, the Patrol Operation Center or the Emergency Control Center(s) once they are manned. For a planned response, HP personnel shall be in teams of at least two. Out of necessity (e.g., backshift response), one member could be an Operations person, or other emergency service person such as fire or patrol. A rapid response is required; however, no undue risks should be taken nor should employee personnel safety be compromised. The type of emergency determines the level of planning for HP response. For example, a continuous air monitor (CAM) alarm or a small radioactive spill requires little planning for the initial response. However, when an emergency causes a facility evacuation, preplanning (e.g., stay time, entry route, etc.) and approval of the Building/Facility Emergency Director is necessary for a re-entry.

Although HP personnel respond to an emergency using basic guidelines, an area/facility may have specific procedures that have priority over these guidelines.

WHC-IP-0692, Section 12.1.2.3, REV 2, "Effluent Exhaust CAM Alarm Response." This procedure establishes the standard method of handling samples from, and response to alarms at, effluent exhaust CAM* systems. This procedure describes the steps and material necessary to exchange, perform field concentration calculations, and submit suspect samples for "rush" or "red envelope" analysis when responding to alarms on effluent exhaust CAM systems.

WHC-IP-0692, Section 12.1.6, REV 1, "Stack Effluent Release Response." This procedure establishes guidelines for responding to a potential or actual release of radioactive material through exhaust stacks. The procedure describes the immediate actions to respond to an exhaust CAM stack alarm (i.e., CAM monitoring downstream or upstream of the final filtration).

WHC-IP-0692, Procedure No. 12.2.1, REV 2, "Emergency Response Air Sampling." This procedure establishes the instruction and guidelines for air sampling in an emergency situation. The procedure describes the steps for sampling air both inside and outside facilities when a release of radioactive material is suspected.

WHC-IP-0692, Section 12.2.3, REV 0, "Health Physics Emergency Response Team." This procedure provides the organizational structure, responsibilities, and steps for an initial emergency response for the HP Emergency Response Team (ERT) and the HP Technician (HPT) Field Survey Teams. The HP ERT and the HPT Field Survey Teams may be requested to respond to an emergency when it is deemed that an environmental release of radioactive material may extend beyond the control of a facility or outside the boundaries of the Hanford Site. These teams will have monitoring responsibilities only outside the boundaries of the event site.

WHC-IP-0692, Section 12.2.4, REV 2, "Emergency Radioactive Plume Tracking." This procedure establishes the instructions to track a plume created from a radioactive material release to the environment. This procedure describes the steps to track and determine if a radioactive beta-gamma plume is at ground level or at an elevated level.

Notifications and reporting of specific events related to environmental releases and events involving effluents or hazardous materials are reported via instruction given in WHC-CM-5-7, *Tank Farms, Grout, and Solid Waste Management Administration Manual*, Section 1.22, "Tank Farms Occurrence Reporting and Processing of Operations Information." This procedure establishes and implements

*The CAM serves as a warning device to alert personnel to releases that exceed normal operating parameters. A CAM collects particulates on a filter monitored continuously by a radiation detector. The CAM filter may be used as a backup for the record sample.

specific criteria and requirements for the identification, categorization, notification, and reporting of occurrences at the tank farms, as required by WHC-CM-1-3, MRP 5.14, "Occurrence Reporting and Processing of Operational Information."

4.3 The sample collection and analysis procedures used in measuring the emissions shall be described including where applicable:

4.3.1 Identification of sampling sites and number of sampling points, including the rationale for site selections.

The vessel vent stack is 20.3 cm (8 in.) in diameter. The sample probe location within the vessel vent stack is located on the fourth floor of the condenser room. The closest flow disturbances are described below.

- Downstream--the sample return line enters the stack approximately 61 cm (2 ft) below the probe location. This equates to three stack diameters.

- Upstream--the elbow in the vessel vent which takes the stack outside the building is approximately 1.4 m (56 in.) above the probe. This equates to seven stack diameters.

This meets the criteria established in 40 CFR 60, Appendix A, Method 1A.

There are two nozzles on this probe. This is as recommended in American National Standards Institute (ANSI) N13.1-1969, Appendix A, Section A3.2 (ANSI 1969), for this size stack (8 in.).

4.3.2 A description of sampling probes and representativeness of the samples.

The sampling probe consists of two nozzles, sized as shown on drawing H-2-69316 (AEC 1974). The velocity distribution is not known. However, it is known that the stack flow is turbulent. As stated in ANSI N13.1-1969 (ANSI 1969), Appendix A, Section A3.3.2, "as the flow becomes more turbulent, the velocity becomes more nearly uniform across the duct." Based on this, it can be shown that the sampling probe is isokinetic.

See Section 4.3.6.

4.3.3 A description of any continuous monitoring systems used to measure emissions, including the sensitivity of the system, calibration procedures and frequency of calibration.

Not applicable; emissions are not monitored continuously.

4.3.4 A description of the sample collection systems for each radionuclide measured, including frequency of collection, calibration procedures and frequency of calibration.

The radionuclides are collected through the probe discussed in Section 4.3.1 above. Gaseous radionuclides are collected with silver zeolite cartridges that are designed to collect ^{129}I, ^{131}I, ^{125}Sb, ^{113}Sn, ^{103}Ru, and ^{106}Ru. The gross filter efficiency of a silver zeolite is based on the particular absorbed/adsorbed radionuclide being evaluated and the porosity of the filter. For uses at the Hanford Site (i.e., ruthenium, iodine), the efficiency is 99.2 to 99.98 (taken from Table 0-2 of *Air Sampling Instruments*, American Conference of Governmental Industrial Hygienists, seventh edition [ACGIH 1989]).

The silver zeolite cartridges are exchanged as follows:

- When the cartridges have been in the sample for 1 week
- When radiation readings indicate a buildup of greater than 16 mrem/hour within the last 8 hours
- When requested by operations management.

Particulate radionuclides are collected with a record sampler. The record sampler uses a 47-mm Versapor* 3000 or equivalent air sample filter for the record sampler. This membrane filter collects 0.3 μm size particles with a collection efficiency of 95.8%.

If at all possible, record air samples are left running for a full 168-hour (7-day) week to ensure a representative sample.

4.3.5 A description of the laboratory analysis procedures used for each radionuclide measured, including frequency of analysis calibration procedures and frequency of calibration.

See Appendix G.

4.3.6 A description of the sample flow rate measurement systems or procedures, including calibration procedures and frequency of calibration.

A sampler probe draws air from the vessel vent stack at a flow rate of 2.8 L/sec (6 std ft^3/min [scfm]). The sampler probe incorporates the use of two nozzles for sampling the stack flow (reference drawing H-2-69316 [AEC 1974]). A sample transport line extends from the probe connection flange to the monitoring instruments located on shelves near the stack. The sample transport line is heat traced (operating at 43 °C [110 °F]) to inhibit condensation of moisture and resultant sample flow retardation by maintaining the temperature above the dew point. The sample transport line was selected and installed in a manner designed to minimize particle loss attributed to gravity settling, turbulent impaction, and electrostatic effects. The run lengths, bend radii, and tube transition severity of the sample transport line are minimized to the extent practical. The bend radii are at least 10 times the inside diameter of the

*Trademark of Gelman Sciences Inc.

transport line. The sample air flows into the vessel vent radiation monitoring system instrumentation rack. Within the rack, the sample stream passes through a flow splitter and is divided into two parts.

1. One part passes through a record sample filter. The record sampler collects effluent particulates on a 47-mm-diameter filter. They are exchanged weekly and evaluated for gross alpha and beta activities by laboratory analysis. The record sampler provides an indication of the amount and concentrations of radioactive particulates being discharged. The record samples provide the basis for reporting the amount and concentration of radionuclides released to the environment. These reports are forwarded to all appropriate organizations and agencies.

   From there, the record sample loop passes through two silver zeolite cartridge filters. These filters collect volatile radionuclides. Silver zeolite filters are designed to collect ^{129}I, ^{131}I, ^{125}Sb, ^{113}Sn, ^{103}Ru, and ^{106}Ru. The cartridge filters are exchanged and sent to the laboratory weekly.

   Downstream of the filters the record sample loop passes in turn through a flow meter, a flow integrator indicator (totalizer), a pressure indicator, a flow regulator, and a vacuum return pump. The record sampling system has sample flow rate indicating (local and remote) and totalizing (2.2 scfm ± 10 %) capabilities. The flow rate regulator is provided to maintain a constant flow rate through the collection filter assembly to compensate for filter loading effects. Audible and visible alarm signals indicating low sample flow ($\leq$ 1.25 ft^3/min [cfm]) are provided locally (bell and beacon) and remotely on the monitor and control system (MCS) in the 242-A control room. The record sample flow rate (2.2 scfm ± 5%) is sized to provide optimum samples for laboratory analysis.

2. The second part of the sample stream is divided into two more streams by another flow splitter.

   a. One portion passes through a beta-gamma CAM equipped with remote (control room) and local alarms. The CAM (RM-VV-2) continuously monitors particulate matter buildup on a 47-mm-diameter filter paper for the detection and measurement of beta and gamma radiation. The filter paper is collected weekly and analyzed for gross beta and gamma readings.

   b. The second portion passes through an alpha CAM, which is similar to the beta-gamma CAM. It is equipped with remote (control room) and local alarms. This CAM (RM-VV-1) continuously monitors for alpha radionuclide buildup on 47-mm-diameter sample filter papers. Filter papers are collected weekly and analyzed for gross alpha concentration.

The CAM loops (beta/gamma and alpha) within the 296-A-22 stack effluent monitoring system have flow rate indicating and regulating capabilities. A flow rate regulator is provided on each loop to maintain a constant flow rate through the collection filter assembly to compensate for filter loading effects. The CAM systems have local readout count-rate meters and remote recording capability in the control room (on the MCS). Audible and visible alarms, including high airborne radiation, instrument malfunction, and low sample flow indications, are provided locally and on the MCS in the 242-A control room. In addition, high stack radiation and high stack alpha radiation alarms are annunciated on the computer automated surveillance system (CASS). An exhaust alpha monitor failure alarm is also tied to the CASS. An elapsed time meter is interlocked with the stack blower fan operation to provide a measure of exhaust stack operation times. The record sample vacuum pump is ganged to exhaust fan operation via a switched receptacle in the system cabinet. The CAM vacuum pumps operate continuously via the unswitched receptacle in the cabinet.

Independent vacuum pumps are provided for each loop of the system. Redundant vacuum systems are not furnished, but failure annunciation (low flow rates) is provided and checked periodically to demonstrate operability.

Each loop of the sample stream, after passing through its particular sampler/monitor, and flow control system is pumped by individual vacuum pumps through a line which discharges back into the vessel vent stack.

The record sample holder is described as follows:

- Large outside diameter with knurled outer ring for ease of opening
- Rubber "O" ring gaskets used to seal the sample holder
- Fine mesh screen behind the sample filter to keep the sample a constant distance from the inlet
- Sample vacuum side is connected by a flexible line for ease of access.

The record sample vacuum system consists of the equipment described below.

- Rotameter: Reads out in std ft^3/hour (SCFH) or cfm of air flow through the sample paper. Certified accurate to ±10% at 2.2 scfm. Operating range: 0.0 to 3.0 scfm ± 5%.
- Gas meter totalizer: Industry standard gas meter. Reads out in cubic meters. Measures the total volume of air pulled

through the sample filter. Certified accurate to ±5% at 2.2 scfm.

- Flow alarm switch: Trips an alarm at the loss of flow (at 1.25 cfm) due to vacuum pump failure and/or sample filter clogging. Accurate to within ±10%.

- Vacuum line to the vacuum pump: Equipped with a standard quick disconnect for connection to alternate pumps and for sample filter retrieval.

- Stack flow switch: Controls a "switched" power outlet providing power to the record sample vacuum pump. Automatically shuts down the record sample vacuum when the stack fans cease operation.

- Record sample timer: Provides integrated timing of power supplied to the "switched" power outlet. Resettable 5-digit to 99999. Normally reset to zero when the record sample is exchanged. Certified accurate to ±1%.

Calibration and inspection of the system are accomplished using the following schedule:

Procedure	Frequency
PROC 5.2.2.6	Weekly
PSCP-3-002	Monthly
PSCP-3-003	Monthly
PSCP-4-007	6 Months
PSCP-4-091	6 Months
PSCP-6-029	6 Months
PSCP-7-0016	Months

The titles of these procedures are as follows:

- "Gaseous Effluent Sampling and Monitoring System Operability Inspection," Health Physics Procedure 5.2.2.6, REV 2

- Maintenance Engineering Services Calibration Procedure, "Eberline Beta Air Monitor, Models AMS-3, AMS-3A, And 700300," Calibration Procedure PSCP-3-002

- Maintenance Engineering Services Calibration Procedure, "Eberline Alpha-4, -5, and 5A," Calibration Procedure PSCP-3-003

- Maintenance Engineering Services Calibration Procedure, "Rockwell Type Gas Meter," Calibration Procedure PSCP-4-007

- Maintenance Engineering Services Calibration Procedure, "Pressure and Vacuum Gauges," Calibration Procedure PSCP-4-091
- Maintenance Engineering Services Calibration Procedure, "Chem-Tec Adjustable Flow Switch Model 500," Calibration Procedure PSCP-6-029
- Maintenance Engineering Services Calibration Procedure, "Air Rotometer," Calibration Procedure PSCP-7-001.

4.3.7 A description of the effluent flow rate measurement procedures, including frequency of measurements, calibration procedures and frequency of calibration.

For the vessel vent, flow measurements are accomplished quarterly via Procedure 7-GN-56. The port available for use is located on the fourth floor of the condenser room, 1 foot above the sampler probe. This location is 44 in. below the flow disturbance presented by the elbow that directs the flow outside the building. In equivalent stack diameters, these distances place this location at 1.5 downstream and 5.5 upstream.

4.4 The objectives of the quality assurance program shall be documented and shall state the required precision, accuracy and completeness of the emission measurement data including a description of the procedures used to assess these parameters. Accuracy is the degree of agreement of a measurement with a true or known value. Precision is a measure of the agreement among individual measurements of the same parameters under similar conditions. Completeness is a measure of the amount of data obtained compared to the amount expected under normal conditions.

See Appendix G. The objectives will be documented in a future Environmental Protection Quality Assurance Project Plan.

4.5 A quality control program shall be established to evaluate and track the quality of the emissions measurement data against preset criteria. The program should include where applicable a system of replicates, spiked samples, split samples, blanks and control charts. The number and frequency of such quality control checks shall be identified.

See Appendix G.

4.6 A sample tracking system shall be established to provide for positive identification of samples and data through all phases of the sample collection, analysis and reporting system. Sample handling and preservation procedures shall be established to maintain the integrity of samples during collection, storage and analysis.

Refer to Section 6.2.3 of the main part of this document.

4.7 Periodic internal and external audits shall be performed to monitor compliance with the quality assurance program. These audits shall be performed in accordance with written procedures and conducted by personnel who do not have responsibility for performing any of the operations being audited.

Refer to Section 7.0 of the main part of this document.

4.8 A corrective action program shall be established including criteria for when corrective action is needed, what corrective action will be taken and who is responsible for taking the corrective action.

Refer to Section 8.0 of the main part of this document.

4.9 Periodic reports to responsible management shall be prepared on the performance of the emissions measurements program. These reports should include assessment of the quality of the data, results of audits and description of corrective actions.

Refer to Section 9.0 of the main part of this document.

4.10 The quality assurance program should be documented in a quality assurance project plan which should address each of the above requirements.

The quality assurance program addressing stack 296-A-22 will be documented in a future quality assurance project plan.

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REFERENCES

40 CFR 60, "Standards of Performance of New Stationary Sources," Title 40, *Code of Federal Regulations*, Part 60, as amended, U.S. Environmental Protection Agency, Washington, D.C.

40 CFR 61, "National Emission Standards for Hazardous Air Pollutants," Title 40, *Code of Federal Regulations*, Part 61, as amended, U.S. Environmental Protection Agency, Washington, D.C.

ACGIH, 1989, *Air Sampling Instruments*, American Conference of Governmental Industrial Hygienists, 7th Edition, Cincinatti, Ohio.

AEC, 1974, *Vessel Vent System Arrangement*, Drawing No. H-2-69361, Atomic Energy Commission, Richland Operations Office, Richland, Washington.

ANSI, 1969, *Guide to Sampling Airborne Radioactive Materials in a Nuclear Facility*, ANSI N13.1-1969, American National Standards Institute, New York, New York.

Health Physics Procedure 5.2.2.6.

Procedure 7-GN-56.

"Gaseous Effluent Sampling and Monitoring System Operability Inspection," Health Physics Procedure 5.2.2.6, REV 2, Westinghouse Hanford Company, Richland, Washington.

Maintenance Engineering Services Calibration Procedure, "Eberline Beta Air Monitor, Models AMS-3, AMS-3A, And 700300," Calibration Procedure PSCP-3-002, Westinghouse Hanford Company, Richland, Washington.

Maintenance Engineering Services Calibration Procedure, "Eberline Alpha-4, -5, and 5A," Calibration Procedure PSCP-3-003, Westinghouse Hanford Company, Richland, Washington.

Maintenance Engineering Services Calibration Procedure, "Rockwell Type Gas Meter," Calibration Procedure PSCP-4-007, Westinghouse Hanford Company, Richland, Washington.

Maintenance Engineering Services Calibration Procedure, "Pressure and Vacuum Gauges," Calibration Procedure PSCP-4-091, Westinghouse Hanford Company, Richland, Washington.

Maintenance Engineering Services Calibration Procedure, "Chem-Tec Adjustable Flow Switch Model 500," Calibration Procedure PSCP-6-029, Westinghouse Hanford Company, Richland, Washington.

Maintenance Engineering Services Calibration Procedure, "Air Rotometer," Calibration Procedure PSCP-7-001, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-1-3, *Management Requirements and Procedures*, as amended, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-4-12, *Health Physics Practices Manual*, as amended, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-5-7, *Tank Farms, Grout, and Solid Waste Management Administration Manual*, Westinghouse Hanford Company, Richland, Washington.

WHC-IP-0692, *Westinghouse Hanford Health Physics Procedures Manual-All Areas*, Westinghouse Hanford Company, Richland, Washington.

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APPENDIX E

METHOD 114 COMPARISON FOR STACK 296-A-40

G. M. Crummel

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APPENDIX E

METHOD 114 COMPARISON FOR STACK 296-A-40

1. Purpose and Background

This method provides the requirements for: (1) Stack monitoring and sample collection methods appropriate for radionuclides; (2) radiochemical methods which are used in determining the amounts of radionuclides collected by the stack sampling and; (3) quality assurance methods which are conducted in conjunction with these measurements. These methods are appropriate for emissions for stationary sources. A list of references is provided.

Many different types of facilities release radionuclides into air. These radionuclides differ in the chemical and physical forms, half-lives and type of radiation emitted. The appropriate combination of sample extraction, collection and analysis for an individual radionuclide is dependent upon many interrelated factors including the mixture of other radionuclides present. Because of this wide range of conditions, no single method for monitoring or sample collection and analysis of a radionuclide is applicable to all types of facilities. Therefore, a series of methods based on "principles of measurement" are described for monitoring and sample collection and analysis which are applicable to the measurement of radionuclides found in effluent streams at stationary sources. This approach provides the user with the flexibility to choose the most appropriate combination of monitoring and sample collection and analysis methods which are applicable to the effluent stream to be measured.

2. Stack Monitoring and Sample Collection Methods

Monitoring and sample collection methods are described based on "principles of monitoring and sample collection" which are applicable to the measurement of radionuclides from effluent streams at stationary sources. Radionuclides of most elements will be in the particulate form in these effluent streams and can be readily collected using a suitable filter media. Radionuclides of hydrogen, oxygen, carbon, nitrogen, the noble gases and in some circumstances iodine will be in the gaseous form. Radionuclides of these elements will require either the use of an in-line or off-line monitor to directly measure the radionuclides, or suitable sorbers, condensers or bubblers to collect the radionuclides.

2.1 Radionuclides as Particulates. The extracted effluent stream is passed through a filter media to remove the particulates. The filter must have a high efficiency for removal of sub-micron particles. The guidance in ANSI N13.1-1969 shall be followed in using filter media to collect particulates (incorporated by reference-see § 61.18).

Plant Documentation

Gelman Sciences, Inter-Office Memorandum to Karol Butcher, October 30, 1991, RE: Versapor 3000, DOP efficiency.

WHC, 1991, *Health Physics Procedure Manual*, WHC-IP-0692

- **"Operation of Gaseous Effluent Sampling and Monitoring Systems," Health Physics Procedure No. 5.2.2.7, Rev 2**

Response. A 47-mm Versapor* 3000 or equivalent air sample filter is used for the record sampler. This filter is a membrane filter good for collecting 0.3-μm size particles with a collection efficiency of 95.8%.

2.2 Radionuclides as Gases.

Plant Documentation:

WHC, 1991, *Health Physics Procedure Manual*, WHC-IP-0692

*Trademark of Gelman Sciences, Inc.

- "Silver Zeolite Monitor/Change-Out Program At 241-AP Tank Farm," 200 Area Health Physics Procedure No. 5.2.2.4, Rev 0

Response: Silver Zeolite Cartridges are used and are designed to collect ^{129}I, ^{131}I, ^{125}Sb, ^{113}Sn, ^{103}Ru, and ^{106}Ru.

2.3 Definition of Terms

No response required.

3.0 Radionuclide Analysis Methods

The analysis methods have been evaluated by 222-S Laboratory cognizant personnel and are included as Appendix G.

4.0 Quality Assurance Methods

Each facility required to measure their radionuclide emissions shall conduct a quality assurance program in conjunction with the radionuclide emission measurements. This program shall assure that the emission measurements are representative, and are of known precision and accuracy and shall include administrative controls to assure prompt response when emission measurements indicate unexpectedly large emissions. The program shall consist of a system of policies, organizational responsibilities, written procedures, data quality specifications, audits, corrective actions and reports. This quality assurance program shall include the following program elements:

4.1 The organizational structure functional responsibilities, levels of authority and lines of communications for all activities related to the emissions measurement program shall be identified and documented.

For the organizational structure, refer to Section 6.2 of the main part of this document.

4.2 Administrative controls shall be prescribed to ensure prompt response in the event that emission levels increase due to unplanned operations.

WHC-CM-4-12, Section 1.14, REV 0, "Alarm Response and Management." Provides guidance and sets requirements for managing the responses to alarms that are the responsibility of Occupational Health and Safety (OHS). This practice is applicable to all members of the OHS organization. Area OHS managers shall ensure that all members of their organizations are aware of and adhere to this practice.

WHC-CM-4-12, Section 2.1, REV 0, "Radiological Problem Reporting Program." The purpose of the radiological problem report program is to provide a documented record of observed radiological problems, a mechanism for reporting these problems to management for action, a capability to track and monitor the progress of the planned corrective actions, and a database for assessing trends in radiological program performance and needed actions.

WHC-CM-4-12, Section 12.1, REV 1, "Emergency Response." An emergency is a sudden unexpected event requiring immediate response to mitigate impacts to people, property, or the environment. When radioactive material is involved, Health Physics (HP) plays a major role in evaluating, controlling, and recovering from the event. To

be able to perform this function, HP personnel receive training to respond to a variety of emergency situations. Procedures for HPs (WHC-CM-4-12 and WHC-IP-0692) are written to provide guidelines to respond to emergencies. Together, the training and the written procedures detail the HP emergency response program.

Emergency Response. The HP personnel are, in many situations, the first to respond to a radiological emergency. The ability to assess and evaluate the situation and take immediate steps to minimize the effects of the event is crucial for controlling the emergency. The HP personnel must use their training and experience to make good decisions during the initial response to an emergency.

An emergency response may be initiated by (1) personnel observing the event, (2) alarms, (3) the Patrol Operation Center, or (4) the Emergency Control Center(s) once they are manned. For a planned response, HP personnel shall be in teams of at least two. Out of necessity (e.g., backshift response), one member could be an Operations person or other emergency service person, such as a firefighter or patrol officer. A rapid response is required; however, no undue risks should be taken nor should employee safety be compromised. The type of emergency determines the level of planning for HP response. For example, a continuous air monitor (CAM) alarm or a small radioactive spill requires little planning for the initial response. However, when an emergency causes a facility evacuation, preplanning (e.g., stay time, entry route, etc.) and approval of the Building or Facility Emergency Director is necessary to re-enter.

Although HP personnel respond to an emergency using basic guidelines, an area or facility may have specific procedures that have priority over these guidelines.

WHC-IP-0692, Section 12.1.2.1, REV 0, "OHP Response to Double-Shell/Aging Waste Tank Pressurization Alarm." This procedure establishes the method of Operational Health Physics (OHP) response to tank pressurization alarms on double-shell or aging waste tanks. This procedure describes the steps and material necessary to respond to, and perform investigative surveys after, tank pressurization alarms.

WHC-IP-0692, Section 12.1.2.3, REV 2, "Effluent Exhaust CAM Alarm Response." This procedure establishes the standard method of handling samples from, and response to alarms at, effluent exhaust CAM systems. This procedure describes the steps and material necessary to exchange, perform field concentration calculations, and submit suspect samples for "rush" or "Red Envelope" analysis, when responding to alarms on effluent exhaust CAM systems.

WHC-IP-0692, Section 12.1.6, REV 1, "Stack Effluent Release Response." This procedure establishes guidelines for responding to a potential or actual release of radioactive material through exhaust stacks. This procedure describes the immediate actions to

respond to an exhaust (CAM) stack alarm (i.e., CAM monitoring downstream or upstream of the final filtration).

WHC-IP-0692, Procedure No. 12.2.1, REV 2, "Emergency Response Air Sampling." This procedure establishes the instruction and guidelines for air sampling in an emergency situation. This procedure describes the steps for air sampling both inside and outside facilities when a release of radioactive material is suspected.

WHC-IP-0692, Section 12.2.3, REV 0, "Health Physics Emergency Response Team." This procedure provides the organizational structure of, the instructions for, and the responsibilities of the HP Emergency Response Team and the HP Technicians Field Survey Teams. This procedure describes the steps for an initial emergency response by the HP Emergency Response Team (ERT) and HP Technicians Field Survey Teams. The HP ERT and the HP Technicians Field Survey Teams may be requested to respond to an emergency when it is deemed that an environmental release of radioactive material may extend beyond the control of a facility or outside the boundaries of the Hanford Site. These teams will have monitoring responsibilities only outside the boundaries of the event site.

WHC-IP-0692, Section 12.2.4, REV 2, "Emergency Radioactive Plume Tracking." This procedure establishes the instructions to track a radioactive beta-gamma plume created from a radioactive material release to the environment and determine if it is at ground level or at an elevated level.

Notifications and reporting of specific events related to environmental releases and/or events involving effluents and/or hazardous materials are reported via instruction given in WHC-CM-5-7, *Tank Farms, Grout, and Solid Waste Management Administration Manual*, Section 1.22, "Tank Farms Occurrence Reporting and Processing of Operations Information." The purpose of this procedure is to establish and implement specific criteria and requirements for the identification, categorization, notification, and reporting of occurrences at the tank farms, as required by WHC-CM-1-3, MRP 5.14, "Occurrence Reporting and Processing of Operational Information."

4.3 A description of the sample collection and analysis procedures used in measuring the emission, including where applicable:

4.3.1 -- Identification of sampling sites and number of sampling points, including the rational for site selection.

The 241-A-40 stack measures 25.4 cm (10 in.) in diameter. The sample probe assembly is located 2.4 m (8 ft) above the fan discharge point into the stack and 50.8 cm (20 in.) below the top of the stack. The closest flow disturbances are approximately 9.6 stack diameters downstream (the fan discharge point) and two stack diameters upstream (the top of stack).

There are two nozzles on this probe. This is as recommended in ANSI N13.1-1969, Appendix A, Section A3.2 (ANSI 1969), for this size stack, 25.4 cm (10 in.).

4.3.2 -- A description of the sampling probes and representativeness of the samples.

The sample probe consists of two inlets that point down into the upflowing gas. A 95-mm (3/8-in.) diameter probe inlet is on the stack centerline and a second 95-mm (3/8-in.) diameter probe inlet is 10.8 cm (4 1/4 in.) from the centerline. This is shown on drawing H-2-91245. The inner nozzle on the probe (center of stack) represents approximately 70% of the stack cross-sectional area sampled and the outer nozzle represents approximately 30% of the area. It is easily shown (from Table A1, ANSI N13.1-1969, and from information on the stack flow rate) that the flow within the stack is highly turbulent resulting in a uniform velocity distribution across the cross-sectional area of the stack. As stated in ANSI N13.1-1969, Appendix A, Section A3.3.2, "as the flow becomes more turbulent, the velocity becomes more nearly uniform across the duct." Based on this it can be shown that the sampling probe is isokinetic.

4.3.3 -- A description of any continuous monitoring systems used to measure emissions, including the sensitivity of the system, calibration procedures and frequency of calibration.

Not applicable; emissions are not monitored continuously.

4.3.4 -- A description of the sample collection systems for each radionuclide measured, including frequency of collection, calibration procedures and frequency of calibration.

The radionuclides are collected through the probe discussed in Section 4.3.1. Gaseous radionuclides are collected with silver zeolite cartridges, designed to collect ^{129}I, ^{131}I, ^{125}Sb, ^{113}Sn, ^{103}Ru, and ^{106}Ru. The gross filter efficiency of a silver zeolite is based on the particular absorbed/adsorbed radionuclide being evaluated and the porosity of the filter. For uses at the Hanford Site (i.e., ruthenium, iodine), the efficiency is 99.2 to 99.98 (taken from Table 0-2 of *Air Sampling Instruments*, ACGIH, 1989, 7th edition).

The silver zeolite cartridges are exchanged as follows:

- When the cartridges have been in the sample for 1 week
- When radiation readings indicate a buildup of greater than 16 mrem/hour within the last 8 hours
- When requested by operations management.

Particulate radionuclides are collected with a record sampler. The record sampler uses a 47-mm Versapor 3000* or equivalent air sample filter. This filter is a membrane filter good for collecting 0.3 μm size particles with a collection efficiency of 95.8%.

If at all possible, record air samples are left running for a full 168 hours (7 days) to ensure a representative sample.

4.3.5 -- A description of the laboratory analysis procedures used for each radionuclide measured, including frequency of analysis, calibration procedures and frequency of calibration.

Methods used for analysis of radionuclides must be based on principles of measurements described in 40 CFR 61, Appendix B, Method 114. Use of methods based on principles of measurement other than those described in Method 114, Section 3, must be approved before use by the U.S. Environmental Protection Agency Administrator.

Refer to the main part of this document for laboratory implementing procedures.

4.3.6 -- A description of the sample flow rate measurement systems or procedures, including calibration procedures and frequency of calibration.

A representative airborne sample is extracted from the exhaust stack (296-A-40) via two separate sampling probes (each sampling probe is identical; see Section 4.3.2) and sample lines. The sample transport lines are 1.9-cm (3/4-in.) outside diameter (OD) stainless steel tubing approximately 4.3-m (14-ft) long. These lines are heat treated and kept at a nominal temperature of 43.3 °C (110 °F). This is assumed to be above dewpoint (i.e., the temperature at which condensation of water vapor in air takes place).

One line directs the sample through a record sampler and two silver zeolite cartridges. The record sampler and silver zeolite cartridges operate at 62.3 L/min (2.2 ft^3/min). The record sampler collects particulates on a 47-mm filter. This filter is exchanged weekly and analyzed by the 222-S Laboratory for the presence and quantity of alpha and beta radiation and is isotopically analyzed quarterly to quantify the amount of specific radionuclides. The results become the record of stack emissions. The record sampler flow (2.2 std ft^3/min ±5%) is indicated on a gauge and the flow is totalized (2.2 std ft^3/min ±10%). A timer records the duration of the sample interval. The flow, total flow, and time are indicated on local instruments. A low record sample gas flow rate activates a local alarm.

The record sample gas train for tank exhausts includes two silver zeolite cartridges in series that measure the ^{106}Ru and ^{129}I released during the period of record. The normal procedure is to exchange the silver cartridges weekly or when radiation readings rise at a

*Trademark of Gelman Sciences Inc.

rate of greater than 16 mrem/hour within the last 8 hours. The sample is replaced with a new cartridge, and the spent cartridge is packaged and transported to the 222-S Laboratory. The second cartridge is also checked at this time. This silver zeolite cartridge is removed from the holder and the radiation is measured with a hand-held instrument. If the radiation reading is low, the sample cartridge is reinstalled. A system leak check is required during changeout of the silver zeolite cartridge. The air flow through the record sample head is blocked and the sample line rotameter checked for any indication of flow.

The second line directs the sample through a beta continuous air monitor (CAM)*. This independent sample extraction probe continuously withdraws a sample from the tank farm stack exhaust at a rate of 2.0 std ft^3/min (56.6 L/min) ±10%. Radioactive effluent particulates are collected on a filter and the radioactivity measured by an Eberline** Model AMS-3 beta-gamma monitor with a count rate meter output accuracy of ±1%. The instrument has a range of 10 to 100,000 cpm on a four-decade scale. The strip chart recorder in the enclosure has been replaced with an ammeter and the strip chart is remotely located in a control room or instrument building.

Independent vacuum pumps are provided for each loop of the system. Redundant vacuum systems are not furnished, but failure annunciation (low flow rates) is provided and checked periodically to demonstrate operability.

The record sample holder is described as follows:

- Large outside diameter with knurled outer ring for ease of opening
- Rubber "O" ring gaskets used to seal the sample holder
- Fine mesh screen behind the sample filter to keep the sample a constant distance from the inlet
- Sample vacuum side is connected by a flexible line for ease of access.

The record sample vacuum system consists of the equipment described below.

- Rotameter (FI): Reads out in std ft^3/min (SCFH) or ft^3/min (CFM) of air flow through the sample paper. Certified accurate to ±10% @ 2.2 SCFM. Operating range: 0.0 to 3.0 SCFM ± 5%.

*The CAMs serve as warning devices to alert personnel to releases that exceed normal operating parameters. The CAMs collect particulates on a filter monitored continuously by a radiation detector. The CAM filter may be used as a backup for the record sample.

**Trademark of Eberline Instrument Corporation.

- Gas meter totalizer (FIQ): Industry standard gas meter. Reads out in cubic meters. Measures the total volume of air pulled through the sample filter. Certified accurate to ±5% @ 2.2 SCFM.

- Flow alarm switch (FAS): Trips an alarm at the loss of flow (@ 1.25 CFM [ft^3/min]) due to vacuum pump failure and/or sample filter clogging. Accurate to within ±10%.

- Vacuum line to the vacuum pump: Equipped with a standard quick disconnect for connection to alternate pumps and for sample filter retrieval.

- Stack flow switch: Controls a "switched" power outlet providing power to the record sample vacuum pump. Automatically shuts down the record sample vacuum when the stack fans cease operation.

- Record sample timer: Provides integrated timing of power supplied to the "switched" power outlet. Resettable 5-digit to 99999. Normally reset to zero when the record sample is exchanged. Certified accurate to ±1%.

Calibration and inspection of the system are accomplished as follows:

Procedure	Frequency
PROC 5.2.2.6	Weekly
PSCP-3-002	Monthly
PSCP-3-003	Monthly
PSCP-4-007	6 Months
PSCP-4-091	6 Months
PSCP-6-029	6 Months
PSCP-7-001	6 Months

The titles of these procedures are as follows:

- "Gaseous Effluent Sampling and Monitoring System Operability Inspection," Health Physics Procedure 5.2.2.6, REV 2

- Maintenance Engineering Services Calibration Procedure, "Eberline Beta Air Monitor, Models AMS-3, AMS-3A, And 700300," Calibration Procedure PSCP-3-002

- Maintenance Engineering Services Calibration Procedure, "Eberline Alpha-4, -5, and 5A," Calibration Procedure PSCP-3-003

- Maintenance Engineering Services Calibration Procedure, "Rockwell Type Gas Meter," Calibration Procedure PSCP-4-007
- Maintenance Engineering Services Calibration Procedure, "Pressure and Vacuum Gauges," Calibration Procedure PSCP-4-091
- Maintenance Engineering Services Calibration Procedure, "Chem-Tec Adjustable Flow Switch Model 500," Calibration Procedure PSCP-6-029
- Maintenance Engineering Services Calibration Procedure, "Air Rotometer," Calibration Procedure PSCP-7-001.

4.3.7 A description of effluent flow rate measurement procedures, including frequency of measurements, calibration procedures and frequency of calibration.

For the 241-AP Tank Farm primary exhaust stack, flow measurements are accomplished via Procedure 7-GN-56 on a quarterly basis. The location chosen for velocity measurements is at the top of the stack, which is nearly 3.0 m (10 ft) above the fan discharge into the stack. This is two stack diameters downstream from the nearest flow disturbance (the sample probe) and zero stack diameters upstream from the nearest flow disturbance (top of stack).

4.4 The objectives of the quality assurance program shall be documented and shall state the required precision, accuracy, and completeness of the emission measurement data including a description of the procedures used to assess these parameters.

The objectives will be documented in a future Environmental Protection Quality Assurance Project Plan.

4.5 The quality control program shall evaluate and track the quality of the emission measurement data against preset criteria. The program should include, where applicable, a system of replicates; spiked samples; split samples; blanks; and control charts. The number and frequency of such quality control checks shall be identified.

The quality control program will be documented in a future Environmental Protection Quality Assurance Project Plan.

4.6 A sample tracking system shall be established to provide for positive identification of samples and data through all phases of the sampling collection, analysis, and reporting system. Sample handling and preservation procedures shall be established to maintain integrity of the samples during collection, storage, and analysis.

Refer to Section 6.2.3 of the main part of this document.

4.7 Periodic internal and external audits shall be performed to monitor compliance with the quality assurance program. These audits shall be performed in accordance with written procedures and conducted by personnel who do not have responsibility for performing any of the operations being audited.

Refer to Section 7.0 of the main part of this document.

4.8 A corrective action program shall be established including criteria for when corrective actions will be taken and who is responsible for taking the corrective action.

Refer to Section 8.0 of the main part of this document.

4.9 Periodic reports to responsible management shall be prepared on the performance of the emission measurements program. These reports should include assessment of the quality of the data, results of audits, and description of corrective actions.

Refer to Section 9.0 of the main part of this document.

REFERENCES

Procedure 7-GN-56

40 CFR 61, "National Emission Standards for Hazardous Air Pollutants," Title 40, *Code of Federal Regulations*, Part 61, as amended, U.S. Environmental Protection Agency, Washington, D.C.

ACGIH, 1989, *Air Sampling Instruments*, American Conference of Governmental Industrial Hygienists, Cincinnati, Ohio.

ANSI, 1969, *Guide to Sampling Airborne Radioactive Materials in a Nuclear Facility*, ANSI N13.1-1969, American National Standards Institute, New York, New York.

"Gaseous Effluent Sampling and Monitoring System Operability Inspection," Health Physics Procedure 5.2.2.6, REV 2, Westinghouse Hanford Company, Richland, Washington.

Maintenance Engineering Services Calibration Procedure, "Eberline Beta Air Monitor, Models AMS-3, AMS-3A, And 700300," Calibration Procedure PSCP-3-002, Westinghouse Hanford Company, Richland, Washington.

Maintenance Engineering Services Calibration Procedure, "Eberline Alpha-4, -5, and 5A," Calibration Procedure PSCP-3-003, Westinghouse Hanford Company, Richland, Washington.

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Maintenance Engineering Services Calibration Procedure, "Pressure and Vacuum Gauges," Calibration Procedure PSCP-4-091, Westinghouse Hanford Company, Richland, Washington.

Maintenance Engineering Services Calibration Procedure, "Chem-Tec Adjustable Flow Switch Model 500," Calibration Procedure PSCP-6-029, Westinghouse Hanford Company, Richland, Washington.

Maintenance Engineering Services Calibration Procedure, "Air Rotometer," Calibration Procedure PSCP-7-001, Westinghouse Hanford Company, Richland, Washington.

RL and RHO, 1984, *Quality Assurance Level I, KI Primary Tank 10 Exhaust Stack Probe Assembly*, Drawing No. H-2-91245, U.S. Department of Energy-Richland Operations Office and Rockwell Hanford Operations, Richland, Washington.

WHC-CM-1-3, *Management Requirements and Procedures*, as amended, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-4-12, *Health Physics Practices Manual*, as amended, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-5-7, *Tank Farms, Grout, and Solid Waste Management Administration Manual*, as amended, Westinghouse Hanford Company, Richland, Washington.

WHC-IP-0692, *Westinghouse Hanford Health Physics Procedures Manual-All Areas*, Westinghouse Hanford Company, Richland, Washington.

APPENDIX F

METHOD 114 COMPARISON FOR STACK 340-NT-EX

L. D. Schwartz

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APPENDIX F

METHOD 114 COMPARISON FOR STACK 340-NT-EX

METHOD 114-TEST METHODS FOR MEASURING
RADIONUCLIDE EMISSIONS FROM STATIONARY SOURCES

1. Purpose and Background

This method provides the requirements for: (1) Stack monitoring and sample collection methods appropriate for radionuclides; (2) radiochemical methods which are used in determining the amounts of radionuclides collected by the stack sampling and; (3) quality assurance methods which are conducted in conjunction with these measurements. These methods are appropriate for emissions for stationary sources. A list of references is provided.

Many different types of facilities release radionuclides into air. These radionuclides differ in the chemical and physical forms, half-lives and type of radiation emitted. The appropriate combination of sample extraction, collection and analysis for an individual radionuclide is dependent upon many interrelated factors including the mixture of other radionuclides present. Because of this wide range of conditions, no single method for monitoring or sample collection and analysis of a radionuclide is applicable to all types of facilities. Therefore, a series of methods based on "principles of measurement" are described for monitoring and sample collection and analysis which are applicable to the measurement of radionuclides found in effluent streams at stationary sources. This approach provides the user with the flexibility to choose the most appropriate combination of monitoring and sample collection and analysis methods which are applicable to the effluent stream to be measured.

2. Stack Monitoring and Sample Collection Methods

Monitoring and sample collection methods are described based on "principles of monitoring and sample collection" which are applicable to the measurement of radionuclides from effluent streams at stationary sources. Radionuclides of most elements will be in the particulate form in these effluent streams and can be readily collected using a suitable filter media. Radionuclides of hydrogen, oxygen, carbon, nitrogen, the noble gases and in some circumstances iodine will be in the gaseous form. Radionuclides of these elements will require either the use of an in-line or off-line monitor to directly measure the radionuclides, or suitable sorbers, condensers or bubblers to collect the radionuclides.

2.1 Radionuclides as Particulates. The extracted effluent stream is passed through a filter media to remove the particulates. The filter must have a high efficiency for removal of sub-micron particles. The guidance in ANSI N13.1-1969 shall be followed in using filter media to collect particulates (incorporated by reference-see § 61.18).

The facility uses WHC-IP-0692, *Health Physics Procedures Manual*, Section 5.2.3.1, "Air Sample Exchange," for direction in choosing filter media (WHC 1991a). This procedure requires use of a 3-μm particle rated LB5211 or equivalent fiberglass filter. The 340 Facility currently uses Gelman Sciences, Inc., 3 μm Versapor 3000* size 47-mm filters. Although listed as 3 μm filters, in a letter provided by Gelman Sciences, these filters have shown a 95% efficiency rating for particles of size 0.3 μm using ASTM D 2986-71 Method (Gelman Sciences).

2.2 Radionuclides as Gases.

Samples are exchanged weekly as required by Health Physics Scheduled Radiation Survey Task Description for Building 340, Task No. J-W005, Survey No. 911562 (WHC 1991b). Procedure 5.2.3.1, "Air Sample Exchange," found in WHC-IP-0692, *Health Physics Procedures Manual*, provides the detailed instruction of how to accomplish a changeout (WHC 1991a). This procedure discusses the

*Trademark of Gelman Sciences, Inc.

use of charcoal cartridges used at the 340 Facility to sample radioactive iodine.

2.2.1 The Radionuclide Tritium (H-3). Tritium in the form of water vapor is collected from the extracted effluent sample by sorption, condensation or dissolution techniques. Appropriate collectors may include silica gel, molecular sieves, and ethylene glycol or water bubblers.

Tritium in the gaseous form may be measured directly in the sample stream using Method B-1, collected as a gas sample or may be oxidized using a metal catalyst to tritiated water and collected as described above.

Vault storage tanks get their radioactivity from the waste sent to the facility by Pacific Northwest Laboratory (PNL). Work in the laboratories is not routine, instead varying with each project. Constituent type and volume received at the 340 Facility also varies with each project. Recently, PNL has been working with tritium. To date, the 340 Facility has not evaluated the need to implement monitoring of tritium in the stack effluent.

2.2.2 Radionuclides of iodine. Iodine is collected from an extracted sample by sorption or dissolution techniques. Appropriate collectors may include charcoal, impregnated charcoal, metal zeolite and caustic solutions.

Vault storage tanks get their radioactivity from the waste sent to the facility by PNL. Work in the laboratories is not routine, instead varying with each project. Constituent type and volume received at the 340 Facility also varies with each project. In the past, PNL worked with large quantities of radioactive iodine. Although this is no longer the case, the 340 Facility continues to monitor for radioactive iodine using HI-Q Environmental Products, TEDA-Impregnated Carbon Cartridge for Adsorption of Radioactive Iodine.

2.2.3 Radionuclides of Argon, Krypton and Xenon. Radionuclides of these elements are either measured directly by an in-line or off-line monitor, or are collected from the extracted sample by low temperature sorption techniques, Appropriate sorbers may include charcoal or metal zeolite.

Vault storage tanks get their radioactivity from the waste sent to the facility by PNL. Work in the laboratories is not routine, instead varying with each project. Constituent type and volume received at the 340 Facility also varies with each project. Currently, PNL does not use radioactive argon, krypton, or xenon in any projects.

2.2.4 Radionuclides of Oxygen, Carbon, Nitrogen and Radon. Radionuclides of these elements are measured directly using an in-line or off-line monitor. Radionuclides of carbon in the form of carbon dioxide may be collected by dissolution in caustic solutions.

Vault storage tanks get their radioactivity from the waste sent to the facility by PNL. Work in the laboratories is not routine, instead varying with each project. Constituent type and volume received at the 340 Facility also varies with each project. Currently, PNL does not use radioactive oxygen, nitrogen, or radon in any projects.

2.3 Definition of Terms

In-line monitor means a continuous measurement system in which the detector is placed directly in or adjacent to the effluent stream. This may involve either gross radioactivity measurements or specific radionuclide measurements. Gross measurements shall be made in conformance with the conditions specified in Methods A-4, B-2 and G-4.

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Off-line monitor means a measurement system in which the detector is used to continuously measure an extracted sample of the effluent stream. This may involve either gross radioactivity measurements or specific radionuclide measurements. Gross measurements shall be made in conformance with the conditions specified in Methods A-4, B-2 and G-4.

Sample collection means a procedure in which the radionuclides are removed from an extracted sample of the effluent using a collection media. These collection media include filters, absorbers, bubblers and condensers. The collected sample is analyzed using the methods described in Section 3.

3. Radionuclide Analysis Methods

A series of methods based on "principles of measurement" are described 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 which would interfere with the measurement.

Also identified (Table 1) are methods for a selected list of radionuclides. The listed radionuclides are those which are most commonly used and which have the greatest potential for causing dose to members of the public. Use of methods based on principles of measurement other than those described in this section must be approved in advance of use by the Administrator. For radionuclides not listed in Table 1, any of the described methods may be used provided the user can demonstrate that the applicability conditions of the method have been met.

The type of method applicable to the analysis of a radionuclide is dependent upon the type of radiation emitted, i.e., alpha, beta or gamma. Therefore, the methods described below are grouped according to principles of measurements for the analysis of alpha, beta and gamma emitting radionuclides.

3.1 Methods for Alpha Emitting Radionuclides

3.1.1 Method A-1, Radiochemistry-Alpha Spectrometry.

Principle: The element of interest is separated from other elements, and from the sample matrix using radiochemical techniques. The procedure may involve precipitation, ion exchange, or solvent extraction. Carriers (elements chemically similar to the element of interest) may be used. The element is deposited on a planchet in a very thin film by electrodeposition or by coprecipitation on a very small amount of carrier, such as lanthanum fluoride. The deposited element is then counted with an alpha spectrometer. The activity of the nuclide of interest is measured by the number of alpha counts in the appropriate energy region. A correction for chemical yield and counting efficiency is made using a standardized radioactive nuclide (tracer) of the same element. If a radioactive tracer is not available for the element of interest, a predetermined chemical yield factor may be used.

Applicability: This method is applicable for determining 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 which could interfere in the spectral region of interest. APHA-605(2), ASTM-D-3972(13).

3.1.2 Method A-2, Radiochemistry-Alpha Counting.

Principle: The element of interest is separated from other elements, and from the sample matrix using radiochemistry. The procedure may involve precipitation, ion exchange, or solvent extraction. Carriers (elements chemically similar to the element of interest) may be used. The element is deposited on a planchet in a thin film and counted with a alpha counter. A correction for chemical yield (if necessary) is made. The alpha count rate measures the total activity of all emitting radionuclides of the separated element.

Applicability: This method is applicable for the measurement of any alpha-emitting radionuclide, provided no other alpha emitting radionuclide is present in the separated sample. It 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 which could be present in the sample that has the highest dose conversion factor. IDO-12096(18).

3.1.3 Method A-3, Direct Alpha Spectrometry.

Principle: The sample, collected on a suitable filter, is counted directly on an alpha spectrometer. The sample must be thin enough and collected on the surface of the filter so that any absorption of alpha particle energy in the sample or the filter, which would degrade the spectrum, is minimal.

Applicability: This method is applicable to simple mixtures of alpha emitting radionuclides and only when the amount of particulates collected on the filter paper are relatively small and the alpha spectra is adequately resolved. Resolutions should be 50 keV (FWHM) or better, ASTM-D-3084(16).

3.1.4 Method A-4, Direct Alpha Counting (Gross alpha determination).

Principle: The sample, collected on a suitable filter, is counted with an alpha counter. The sample must be thin enough so that self-absorption is not significant and the filter must be of such a nature that the particles are retained on the surface.

Applicability: Gross alpha determination 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 for the purposes and under the conditions described in section 3.7. APHA-601(3), ASTM-D-1943(10).

3.1.5 Method A-5, Chemical Determination of Uranium.

Uranium: Uranium may be measured chemically by either colorimetry or fluorometry. In both procedures, the sample is dissolved, the uranium is oxidized to the hexavalent form and extracted into a suitable solvent. Impurities are removed from the solvent layer. For colorimetry, dibenzoylmethane is added, and the uranium is measured by the absorbance in a colorimeter. For fluorometry, a portion of the solution is fused with a sodium fluoride-lithium fluoride flux and the uranium is determined by the ultraviolet activated fluorescence of the fused disk in a fluorometer.

Applicability: This method is applicable to the measurements of emission rates of uranium when the isotopic ratio of the uranium radionuclides is well known. ASTM-E318(15), ASTM-D-2907(14).

3.1.6 Method A-6, Radon-222-Continuous Gas Monitor.

Principle: Radon-222 is measured directly in a continuously extracted sample stream by passing the air stream through a calibrated scintillation cell. Prior to the scintillation cell, the air stream is treated to remove particulates and excess moisture. The alpha particles from radon-222 and its decay products strike a zinc sulfide coating on the inside of the scintillation cell producing light pulses. The light pulses are detected by a photomultiplier tube which generates electrical pulses. These pulses are processed by the system electronics and the read out is in pCi/l of radon-222.

Applicability: This method is applicable to the measurement of radon-222 in effluent streams which do not contain significant quantities of radon-220. Users of this method should calibrate the monitor in a radon calibration chamber at least twice per year. The background of the monitor should also be checked periodically by operating the instrument in a low radon environment. EPA 520/1-89-009(24).

3.1.7 Method A-7, Radon-222-Alpha Track Detectors

Principle: Radon-222 is measured directly in the effluent stream using alpha track detectors (ATD). The alpha particles emitted by radon-222 and its decay products strike a small plastic strip and produce submicron damage tracks. The plastic strip is placed in a caustic solution that accentuates the damage tracks which are counted using a microscope or automatic counting system. The number of tracks per unit area is corrected to the radon concentration in air using a conversion factor derived from data generated in a radon calibration facility.

Applicability: Prior approval from EPA is required for use of this method. This method is only applicable to effluent streams which do not contain significant quantities of radon-220, unless special detectors are used to discriminate against radon 220. This method may be used only when ATDs have been demonstrated to produce data comparable to data obtained with Method A-6. Such data should be submitted to EPA when requesting approval for the use of this method. EPA 520/1-89-009(24).

3.2 Methods for Gaseous Beta Emitting Radionuclides.

3.2.1 Method B-1, Direct Counting in Flow-Through Ionization Chambers.

Principle: An ionization chamber containing a specific volume of gas which flows at a given flow rate through the chamber is used. The sample (effluent stream sample) acts as the counting gas for the chamber. The activity of the radionuclide is determined from the current measured in the ionization chamber.

Applicability: This method is applicable for 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. DOE/EP-0096(1 7), NCRP-58(23).

3.2.2 Method B-2, Direct Counting With In-line or Off-line Beta Detectors.

Principle: The beta detector is placed directly in the effluent stream (in-line) or an extracted sample of the effluent stream is passed through a chamber containing a beta detector (off-line). The activities of the radionuclides present in the effluent stream are determined from the beta count rate, and a knowledge of the radionuclides present and the relationship of the gross beta count rate and the specific radionuclide concentration.

Applicability: This method is applicable only to radionuclides with maximum beta particle energies greater then 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. Specific radionuclide analysis of periodic grab samples may be used to identify the types and quantities of radionuclides present and to establish the relationship between specific radionuclide analyses and gross beta count rates.

This method is applicable to unidentified mixtures of gaseous radionuclides only for the purposes and under the conditions described in section 3.7.

3.3 Methods for Non-Gaseous Beta Emitting Radionuclides.

3.3.1 Method B-3, Radiochemistry-Beta Counting.

Principle: The element of interest is separated from other elements, and from the sample matrix by radiochemistry. This may involve precipitation, distillation, ion exchange, or solvent extraction. Carriers (elements chemically similar to the element of interest) may be used. The element is deposited on a planchet, and counted with a beta counter. Corrections for chemical yield and decay (if necessary) are made. The beta count rate determines the total activity of all radionuclides of the separated element. This method may also involve the radiochemical separation and counting of a daughter element, after a suitable period of ingrowth, in which case it is specific for the parent nuclide.

Applicability: This method is applicable for 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. APHA-608(5).

3.3.2 Method B-4, Direct Beta Counting (Gross beta determination).

Principle: The sample, collected on a suitable filter, is counted with a beta counter. The sample must be thin enough so that self-absorption corrections can be made.

Applicability: 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 the purposes and under the conditions described in section 3.7. APHA-602(4), ASTM-D-1890(11).

3.3.3 Method B-5, Liquid Scintillation Spectrometry.

Principle: An aliquot of a collected sample or the result of some other chemical separation or processing technique is added to a liquid scintillation "cocktail" which is viewed by photomultiplier tubes in a liquid scintillation spectrometer. The spectrometer is adjusted to establish a channel or "window" for the pulse energy appropriate to the nuclide of interest. The activity of the nuclide of interest is measured by the counting rate in the appropriate energy channel. Corrections are made for chemical yield where separations are made.

Applicability: This method is applicable to 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 which 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. APHA.609(6), EML LV-539-17(19).

3.4 Gamma Emitting Radionuclides

3.4.1 Method G-1. High Resolution Gamma Spectrometry.

Principle: The sample is counted with a high resolution gamma detector, usually either a Ge(Li) or a high purity Ge detector, connected to a multichannel analyzer or computer. The gamma emitting radionuclides in the sample are measured from the gamma count rates in the energy regions characteristic of the individual radionuclide. Corrections are made for counts contributed by other radionuclides to the spectral regions of the radionuclides of interest. Radiochemical separations may be made prior to counting but are usually not necessary.

Applicability: This method is applicable to the measurement of any gamma emitting radionuclide with gamma energies greater than 20 keV. It 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. ASTM-3649(9), IDO-12096(18).

3.4.2 Method G-2, Low Resolution Gamma Spectrometry.

Principle: The sample is counted with a low resolution gamma detector, a thallium activated sodium iodide crystal. The detector is coupled to a photomultiplier tube and connected to a multichannel analyzer. The gamma emitting radionuclides in the sample are measured from the gamma count rates in the energy regions

characteristic of the individual radionuclides. Corrections are made for counts contributed by other radionuclides to the spectral regions of the radionuclides of interest. Radiochemical separation may be used prior to counting to obtain less complex gamma spectra if needed.

Applicability: This method is applicable to the measurement of gamma emitting radionuclides with energies greater than 100 keV. It 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 by passing the gas stream through a chamber or cell containing the detector. ASTM-D-2459(12), EMSL-LV-0539-17(19).

3.4.3 Method G-3, Single Channel Gamma Spectrometry.

Principle: The sample is counted with a thallium activated sodium iodide crystal. The detector is coupled to a photomultiplier tube connected to a single channel analyzer. The activity of a gamma emitting radionuclide is determined from the gamma counts in the energy range for which the counter is set.

Applicability: This method is applicable to the measurement of a single gamma emitting radionuclide. It 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 by passing the gas stream through a chamber or cell containing the detector.

3.4.4 Method G-4, Gross Gamma Counting.

Principle: The sample is counted with a gamma detector usually a thallium activated sodium iodine crystal. The detector is coupled to a photomultiplier tube and gamma rays above a specific threshold energy level are counted.

Applicability: 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 stream are well known. When gross gamma measurements are used to determine emissions of specific radionuclides periodic measurements using Methods G-1 or G-2 should be made to demonstrate that the gross gamma measurements provide reliable emission data. This 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 passing an extracted sample of the effluent stream through a chamber or cell containing the detector.

3.5 Counting Methods. All of the methods with the exception of Method A-5 involve counting the radiation emitted by the radionuclide. Counting methods applicable to the measurement of alpha, beta and gamma radiations are listed below. The equipment needed and the counting principles involved are described in detail in ASTM-3648(8).

3.5.1 Alpha Counting:

▪ Gas Flow Proportional Counters. The alpha particles cause ionization in the counting gas and the resulting electrical pulses are counted. These counters may be windowless or have very thin windows.

▪Scintillation Counters. The alpha particles transfer energy to a scintillator resulting in a production of light photons which strike a photomultiplier tube converting the light photons to electrical pulses which are counted. The counters may involve the use of solid scintillation materials such as zinc sulfide or liquid scintillation solutions.

▪Solid-State Counters. Semiconductor materials, such as silicon surface-barrier p-n junctions, act as solid ionization chambers. The alpha particles interact which the detector producing electron hole pairs. The charged pair is collected by an applied electrical field and the resulting electrical pulses are counted.

▪Alpha Spectrometers. Semiconductor detectors used in conjunction with multichannel analyzers for energy discrimination.

3.5.2 Beta Counting:

▪Ionization Chambers. These chambers contain the beta-emitting nuclide in gaseous form. The ionization current produced is measured.

▪Geiger-Muller (GM) Counters-or Gas Flow Proportional Counters. The beta particles cause ionization in the counting gas and the resulting electrical pulses are counted. Proportional gas flow counters which are heavily shielded by lead or other metal, and provided with an anti-coincidence shield to reject cosmic rays, are called low background beta counters.

▪Scintillation Counters. The beta particles transfer energy to a scintillator resulting in a production of light photons, which strike a photomultiplier tube converting the light photon to electrical pulses which are counted. This may involve the use of anthracene crystals, plastic scintillator, or liquid scintillation solutions with organic phosphors.

▪Liquid Scintillation Spectrometers. Liquid scintillation counters which use two photomultiplier tubes in coincidence to reduce background counts. This counter may also electronically discriminate among pulses of a given range of energy.

3.5.3 Gamma Counting:

▪Low-Resolution Gamma Spectrometers. The gamma rays interact with thallium activated sodium iodide or cesium iodide crystal resulting in the release of light photons which strike a photomultiplier tube converting the light pulses to electrical pulses proportional to the energy of the gamma ray. Multi-channel analyzers are used to separate and store the pulses according to the energy absorbed in the crystal.

▪High-Resolution gamma Spectrometers. Gamma rays interact with a lithium-drifted (Ge(Li)) or high-purity germanium (HPGe) semiconductor detectors resulting in a production of electron-hole pairs. The charged pair is collected by an applied electrical field. A very stable low noise preamplifier amplifies the pulses of electrical charge resulting from the gamma photon interactions. Multichannel analyzers or computers are used to separate and store the pulses according to the energy absorbed in the crystal.

▪Single Channel Analyzers. Thallium activated sodium iodide crystals used with a single window analyzer. Pulses from the photomultiplier tubes are separated in a single predetermined energy range.

3.5.4 Calibration of Counters. Counters are calibrated for specific radionuclide measurements using a standard of the radionuclide under either identical or very similar conditions as the sample to be counted. For gamma spectrometers a series of standards covering the energy range of interest may be used to construct a calibration curve relating gamma energy to counting efficiency.

In those cases where a standard is not available for a radionuclide, counters may be calibrated using a standard with energy characteristics as similar as possible to the radionuclide to be measured. For gross alpha and beta measurements of the unidentified mixtures of radionuclides, alpha counters are calibrated with a natural uranium standard and beta counters with a cesium-137 standard. The standard must contain the same weight and distribution of solids as the samples, and be mounted in an identical manner. If the samples contain variable amounts of solids, calibration curves relating weight of solids present to counting efficiency are prepared. Standards other than those prescribed may be used provided it can be shown that such standards are more applicable to the radionuclide mixture measured.

3.6 Radiochemical Methods for Selected Radionuclides. Methods for a selected list of radionuclides are listed in Table 1. The radionuclides listed are those which are most commonly used and which hove the greatest potential for causing doses to members of the public. For radionuclides not listed in Table 1, methods based on any of the applicable "principles of measurement" described in section 3.1 through 3.4 may be used.

3.7 Applicability of Gross Alpha and Beta Measurements to Unidentified Mixtures of Radionuclides. Gross alpha and beta measurements may be used as a screening measurement as a part of an emission measurement program to identify the need to do specific radionuclide analyses or to confirm or verify that unexpected radionuclides are not being released in significant quantities.

Gross alpha (Method A-4) or gross beta (Methods B-2 or B-4) measurements may also be used for the purpose of comparing the measured concentrations in the effluent stream with the limiting "Concentration Levels for Environmental Compliance" in Table 2 of Appendix E. For unidentified mixtures, the measured concentration value shall be compared with the lowest environmental concentration limit for any radionuclide which is not known to be absent from the effluent stream.

See Appendix H.

4.0 Quality Assurance Methods

Each facility required to measure their radionuclide emissions shall conduct a quality assurance program in conjunction with the radionuclide emission measurements. This program shall assure that the emission measurements are representative, and are of known precision and accuracy and shall include administrative controls to assure prompt response when emission measurements indicate unexpectedly large emissions. The program shall consist of a system of policies, organizational responsibilities, written procedures, data quality specifications, audits, corrective actions and reports. This quality assurance program shall include the following program elements:

4.1 The organizational structure functional responsibilities, levels of authority and lines of communications for all activities related to the emissions measurement program shall be identified and documented.

4.2 Administrative controls shall be prescribed to ensure prompt response in the event that emission levels increase due to unplanned operations.

WHC-CM-4-12 (WHC 1990a), Section 1.14, REV 0, "Alarm Response and Management." Provides guidance and sets requirements for managing the responses to alarms that are the responsibility of Occupational Health and Safety (OHS). This practice is applicable to all members of the OHS organization. Area Health and Safety

managers shall ensure that all members of their organizations are aware of and adhere to this practice.

WHC-CM-4-12 (WHC 1990a), Section 2.1, REV 0, "Radiological Problem Reporting Program." The purpose of the Radiological Problem Report (RPR) program is to provide a documented record of observed radiological problems, a mechanism for reporting these problems to management for action, a capability to track and monitor the progress of the planned corrective actions, and a database for assessing trends in radiological program performance and needed actions.

WHC-CM-4-12, Section 12.1, REV 1, "Emergency Response." An Emergency is a sudden unexpected event requiring immediate response to mitigate impacts to people, property, or the environment. When radioactive material is involved, Health Physics (HP) plays a major role in evaluating, controlling, and recovering from the event. To perform this function, HP personnel receive training to respond to a variety of emergency situations. All HP procedures provide emergency response guidelines. Together, the training and the written procedure detail the HP Emergency Response Program.

Emergency Response. In many situations HP personnel are the first to respond to a radiological emergency. The ability to assess and evaluate the situation and take immediate steps to minimize the effects of the event is crucial for controlling the emergency. The HP personnel must use their training and experience to make good decisions during the initial response to an emergency.

An emergency response may be initiated by personnel observing the event, alarms, the Patrol Operation Center, or the Emergency Control Center(s) once they are manned. For a planned response, HP personnel shall be in teams of at least two. Out of necessity (e.g., backshift response), one member could be an Operations person or other emergency service person such as fire or patrol. A rapid response is required; however, no undue risks should be taken nor should employee personnel safety be compromised. The type of emergency determines the level of planning for HP response. For example, a continuous air monitor (CAM) alarm or a small radioactive spill requires little planning for the initial response. However, when an emergency causes a facility evacuation, preplanning (e.g., stay time, entry route) by and approval of the Building/Facility Emergency Director are necessary for re-entry.

Although HP personnel respond to an emergency using basic guidelines, an area/facility may have specific procedures that have priority over these guidelines.

WHC-IP-0692 (WHC 1991a), 12.1.2.3, Rev 2, "Effluent Exhaust CAM Alarm Response." This procedure establishes the standard method of handling samples from, and response to alarms at, Effluent Exhaust CAM systems. This procedure describes the steps and material necessary to exchange, perform field concentration calcula-

tions, and submit suspect samples for "rush" or "Red Envelope" analysis when responding to alarms on Effluent Exhaust CAM systems.

WHC-IP-0692, 12.1.6, REV 1, "Stack Effluent Release Response." This procedure establishes guidelines for responding to a potential or actual release of radioactive material through exhaust stacks. This procedure describes the immediate actions to respond to an exhaust (CAM) stack alarm (i.e., CAM monitoring downstream or upstream of the final filtration).

WHC-IP-0692, Procedure No. 12.2.1, Rev. 2, "Emergency Response Air Sampling." This procedure establishes the instruction and guidelines for air sampling in an emergency situation. This procedure describes the steps for air sampling both inside and outside facilities when a release of radioactive material is suspected.

WHC-IP-0692, Section 12.2.3, REV 0, "Health Physics Emergency Response Team." This procedure provides the organizational structure of, the instructions for, and the responsibilities of the HP Emergency Response Team and the Radiation Protection Technologist (RPT) Field Survey Teams. This procedure describes the steps for an initial emergency response by the HP Emergency Response Team (ERT) and RPT Field Survey Teams. The HP ERT and the RPT Field Survey Teams may be requested to respond to an emergency when it is deemed that an environmental release of radioactive material may extend beyond the control of a facility or outside the boundaries of the Hanford Site. These teams will have monitoring responsibilities only outside the boundaries of the event site.

WHC-IP-0692, Section 12.2.4, Rev. 2, "Emergency Radioactive Plume Tracking." This procedure establishes the instructions to track a plume created from a radioactive material release to the environment. This procedure describes the steps to track and to determine if a radioactive beta-gamma plume is at ground level or at an elevated level.

Notifications and reporting of specific events related to environmental releases and/or events involving effluents and/or hazardous materials are reported via instruction given in WHC-CM-5-34 (WHC 1991c), *Solid/Liquid Waste Remediation Operations Administration*, Section 1.18, "Occurrence Reporting and Processing of Operations Information." The purpose of this procedure is to establish and implement specific criteria and requirements for the identification, categorization, notification, and reporting of occurrences within the Solid/Liquid Waste Division, including the 340 Facility, as required by WHC-CM-1-3 (WHC 1990b), MRP 5.14, "Occurrence Reporting and Processing of Operational Information."

4.3 The sample collection and analysis procedures used in measuring the emissions shall be described including where applicable:

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4.3.1 Identification of sampling sites and number of sampling points, including the rationale for site selections.

Drawing H-3-34406 (DOE-RL 1978), "HVAC Elevations, Sections and Details," shows stack dimensions and sampling site location. As shown, the stack is 18 in. in diameter. The sample site is located 10 ft downstream (or 6.6 duct diameters) from the last disturbance and 2 ft (or 1.3 duct diameter) from the point of release. This location meets the criteria specified in 40 CFR 60, Appendix A, Method 1A (EPA 1991).

The sample probe was designed and installed by Air Monitor Corporation (AMC). The Certified Vendor Information, CVI-30256, Operating and Maintenance Manual for the 300 Area Radioactive Liquid Waste System (Air Monitor Corporation), contains the probe design drawings and a detailed explanation of how American National Standards Institute (ANSI) standards are applied. To summarize here, the stack has one sample probe with eight sample nozzles. The AMC sampling unit uses an air profiling station to produce a flat velocity profile of non-rotating, straight air. This allows for isokinetic sampling and measuring the stack velocity and volume under almost any condition of airflow.

4.3.2 A description of sampling probes and representativeness of the samples

The sample probe was designed and installed by AMC. The CVI-30256 contains the probe design drawings and a detailed explanation of how ANSI standards are applied. To summarize here, the stack has one sample probe. It has 20 total pressure sensors, 4 static pressure sensors, and 8 sample nozzles. The inside diameter of each nozzle is 0.58 in. and each covers 0.224 ft^2 of area. The AMC sampling unit uses an air profiling station to produce a flat velocity profile of non-rotating, straight air. This allows for isokinetic sampling and measuring the stack velocity and volume under almost any condition of airflow.

4.3.3 A description of any continuous monitoring system used to measure emissions, including the sensitivity of the system, calibration procedures and frequency of calibration.

Not applicable; emissions are not monitored continuously for compliance purposes.

4.3.4 A description of the sample collection systems for each radionuclide measured, including frequency of collection, calibration procedures and frequency of calibration.

The sampler runs continuously to ensure a representative sample. Radioactive particulates are captured on a high-efficiency particulate air filter as described in Section 2.1 of this document. Radioactive iodine is captured on a charcoal cartridge as described in Section 2.2.2 of this document. Samples are collected weekly, in accordance with procedures WHC-IP-0692, *Health Physics Procedures Manual*, Section 5.2.3.1, "Air Sample Exchange" (WHC 1991a), and Health Physics Scheduled Radiation Survey Task Description for Building 340, Task No. J-W005, Survey No. 911562 (WHC 1991b). There are no calibrations required for the particulate filter or the charcoal cartridge.

4.3.5 A description of the laboratory analysis procedures used for each radionuclide measured, including frequency of analysis calibration procedures and frequency of calibration.

Laboratory analysis procedures used for Stack 340-NT-EX record samples are described by the information in Appendix H.

4.3.6 A description of the sample flow rate measurement systems or procedures, including calibration procedures and frequency of calibration.

The sample flow rate is regulated using a rotameter provided by Dwyer Instruments. These rotameters are described in Certified Vendor Information CVI-30268, "Flowmeters," model number RMA-9-TMV (Dwyer Instruments). The visual float is verified weekly during sample collection in accordance with WHC-IP-0692, *Health Physics Procedures Manual*, Section 5.2.3.1, "Air Sample Exchange." Rotameters are scheduled for calibration annually. The calibration is completed in accordance with Calibration Procedure 1148, "Calibrate Rotameter" (Becken 1990).

4.3.7 A description of the effluent flow rate measurement procedures, including frequency of measurements, calibration procedures and frequency of calibration.

The flow measurements for Stack 340-NT-EX are required annually at a minimum in accordance with the 300 Area Maintenance Engineer Services procedure #1135. A pitot tube is inserted into a test port to measure the velocity pressure, which is then converted to flow using a table and equation from the data sheet for the procedure. Control of measuring and test equipment is addressed in WHC-CM-8-3, which requires annual calibration frequency.

4.4 The objectives of the quality assurance program shall be documented and shall state the required precision, accuracy and completeness of the emission measurement data including a description of the procedures used to assess these parameters. Accuracy is the degree of agreement of a measurement with a true or known value. Precision is a measure of the agreement among individual measurements of the same parameters under similar conditions. Completeness is a measure of the amount of data obtained compared to the amount expected under normal conditions.

The objectives of the quality assurance program will be described in a future Environmental Protection Quality Assurance Project Plan.

4.5 A quality control program shall be established to evaluate and track the quality of the emissions measurement data against preset criteria. The program should Include where applicable a system of replicates, spiked samples, split samples, blanks and control charts. The number and frequency of such quality control checks shall be identified.

Laboratory requirements are presented in Appendix H.

4.6 A sample tracking system shall be established to provide for positive identification of samples and data through all phases of the sample collection, analysis and reporting system. Sample handling and preservation procedures shall be established to maintain the integrity of samples during collection, storage and analysis.

See Section 6.2.3 of the main body of this report.

4.7 Periodic internal and external audits shall be performed to monitor compliance with the quality assurance program. These audits shall be performed in accordance with written procedures and conducted by personnel who do not have responsibility for performing any of the operations being audited.

See Section 7.0 of the main body of this report.

4.8 A corrective action program shall be established including criteria for when corrective action is needed, what corrective action will be taken and who is responsible for taking the corrective action.

See Section 8.0 of the main body of this report.

4.9 Periodic reports to responsible management shall be prepared on the performance of the emissions measurements program. These reports should include assessment of the quality of the data, results of audits and description of corrective actions.

See Section 9.0 of the main body of this report.

4.10 The quality assurance program should be documented in a quality assurance project plan which should address each of the above requirements.

The quality assurance program for stack 340-NT-EX will be described in a future Quality Assurance Project Plan.

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WHC, 1990b, *Management Requirements and Procedures*, as amended, WHC-CM-1-3, Westinghouse Hanford Company, Richland, Washington.

WHC, 1991a, *Health Physics Procedures Manual*, WHC-IP-0692, Westinghouse Hanford Company, Richland, Washington.

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APPENDIX G

METHOD 114 COMPARISON FOR THE 222-S LABORATORY

A. K. Dasgupta

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APPENDIX G

METHOD 114 COMPARISON FOR THE 222-S LABORATORY

Emissions monitoring practices for the following Hanford Site main stacks are evaluated for compliance with the radionuclide emission requirements defined in Title 40 Code of Federal Regulations (CFR) Part 61, Subpart H, "National Emission Standards for Hazardous Air Pollutants" (NESHAP) (EPA 1991):

a. 291-A-1--Plutonium-Uranium Extraction (PUREX) Plant Main Exhaust Stack
b. 291-B-1--B Plant Main Stack
c. 291-Z-1--Plutonium Finishing Plant Main Stack
d. 296-A-22--242-A Evaporator
e. 296-A-40--241-AP Tank Exhaust, Tank Farm
f. 340-NT-EX--Waste Handling Facility.

The effluents from each of these stacks are well characterized. The characterizations of radionuclide composition in emissions are in complete agreement with the operations carried out in respective facilities generating radioactive emissions. Samples of emissions are collected from the stacks having the potential to contain the radionuclides given in Table G-1 in concentrations at the stack exits that may exceed 10% of any of the Derived Concentration Guides values provided in DOE Order 5400.5 (DOE 1990). Samples of emissions are collected periodically from various stacks by personnel in other organizations. The samples from stacks a through e above are delivered to the 222-S Laboratory and analyzed for each of the radionuclides listed in Table G-1.

The laboratory receives weekly or daily main stack air filter samples from the facilities. They are usually 47-mm filters (acrylic copolymer on nylon), except from PUREX where 5-in. (127-mm) filters are used. Before analysis is performed, samples are held for 7 days so that radon/daughters, if present in the filters, can decay away.

The emissions collection media, sodium hydroxide bubbler and silica gel, are used only at the PUREX main stack for collecting ^{14}C and ^{3}H, respectively, and are sent biweekly to the laboratory for analysis.

The radionuclides ^{131}I, ^{129}I, ^{103}Ru, ^{106}Rh, ^{113}Sn, and ^{125}Sb are monitored at the PUREX, 242-A Evaporator, and AP Tank Farm main stacks. Samples are collected using silver zeolite cartridges that are sent weekly to the laboratory for identification of radionuclides and determination of their activity.

After a 7-day decay period, the total alpha/total beta activity concentrations in the weekly and daily air particulate samples are determined (procedure LA-508-110). This screening process is performed to make a quick evaluation of activity levels in the main stack air streams. If the activity level for a specific main stack is found to be significantly increased, as

Table G-1. Radionuclides

Nuclides requested for analysis	PUREX 291-A-1	B Plant 291-B-1	Z-Plant 291-Z-1	242-A Evaport. 296-A-22	241-AP tank 296-A-40	T Plant 291-T-1
Alpha Emitter	Am-241, Pu-238, Pu-239 & Pu-240	Am-241, Pu-238, Pu-239 & Pu-240	Am-241, Pu-238, Pu-239 & Pu-240			Am-241, Pu-238, Pu-239 & Pu-240
Beta Emitter	Sr-89, Sr-90/ Y-90, Pm-147, C-14 & H-3 (gas)	Sr-89, Sr-90/ Y-90		Sr-89, Sr-90/Y-90	Sr-89, Sr-90/Y-90	
Gamma emitter[a]	Nb-95, Zr-95, Cs-134, Cs-137 & Ce-144 I-129[b] I-131[b] Rh/Ru-106[b] Ru-103[b] Sn-113[b] Sb-125[b]	Cs-134 & Cs-137		Cs-134 & Cs-137 I-129[b] I-131[b] Rh/Ru-106[b] Ru-103[b] Sn-113[b] Sb-125[b]	Cs-134 & Cs-137 I-129[b] I-131[b] Rh/Ru-106[b] Ru-103[b] Sn-113[b] Sb-125[b]	
Gross Activity	TA/TB[c]	TA/TB	TA/TB	TA/TB	TA/TB	TA/TB

(a) The gamma spectroscopic technique is used for analyses of these radionuclides because they emit gamma rays of high intensity.
(b) These radionuclides are collected on silver zeolite sampling media.
(c) Total alpha and total beta analysis.

indicated by its total alpha/total beta data, then facility personnel are contacted to alert them of a change in emissions. It is important to note here that continuous air monitoring systems with alarms are installed at each main stack for near real-time response to elevated releases. These alarms will allow rapid response from facility personnel if the situation warrants. For compliance, the screening of weekly total alpha/total beta measurements is made assuming the most limiting alpha particulate ($^{239,240}Pu$) and the most limiting beta-emitting radionuclide (^{90}Sr) in the Hanford Site stack effluents. To ensure conservatism, the 222-S Laboratory performs specific radionuclide analyses on a composite of all filters collected during a calendar quarter. Gamma energy analysis (GEA) is performed (LA-508-052) on the composite to determine the activities of the gamma emitters, particularly ^{95}Nb, ^{95}Zr, ^{134}Cs, ^{137}Cs, and ^{144}Ce.

After GEA is complete, the quarterly composite of air filters is ashed, dissolved/leached, then appropriately treated and mounted for analysis of individual alpha emitters (LA-549-112 [dissolution], LA-943-123 [chemical separation], LA-542-101 [electrodeposition], LA-508-051 [alpha spectrometry] for ^{241}Am, ^{238}Pu, $^{239,240}Pu$) and beta emitters (LA-549-112 [dissolution], LA-220-103 [chemical separation], LA-508-111 [total beta counting] for $^{89,90}Sr/^{90}Y$; LA-549-112 [dissolution], LA-613-111 [chemical separation], LA-548-111 [mounting in scintillation cocktail], LA-508-121 [scintillation counting] for ^{147}Pm), depending on the type of analyses requested by the facility and 200 Areas Environmental Protection group.

Biweekly gas samples from the PUREX main stack, collected in sodium hydroxide bubblers and silica gel are analyzed for ^{14}C (LA-348-101 [chemical separation], LA-548-111 [mounting in cocktail], LA-508-121 [scintillation counting]) and for ^{3}H (LA-218-112 [processing], LA-548-111 [mounting in cocktail], LA-508-121 [liquid scintillation counting]), respectively. The weekly samples for ^{129}I, ^{131}I, ^{125}Sb, ^{113}Sn, ^{106}Rh, and ^{103}Ru from each of the PUREX, 242-A Evaporator, and AP Tank Farm main stacks, collected on silver zeolite cartridges, are analyzed by the GEA (LA-288-101 in conjunction with LA-508-052).

A point-by-point comparison of analyses performed with the regulatory requirements of 40 CFR 61, Subpart H, Method 114 (particularly Sections 3 and 4 as applicable to 222-S Laboratory operations) (EPA 1991) is provided in the attachment.

METHOD 114-TEST METHODS FOR MEASURING
RADIONUCLIDE EMISSIONS FROM STATIONARY SOURCES

1. Purpose and Background

This method provides the requirements for: (1) Stack monitoring and sample collection methods appropriate for radionuclides; (2) radiochemical methods which are used in determining the amounts of radionuclides collected by the stack sampling and; (3) quality assurance methods which are conducted in conjunction with these measurements. These methods are appropriate for emissions for stationary sources. A list of references is provided.

Many different types of facilities release radionuclides into air. These radionuclides differ in the chemical and physical forms, half-lives and type of radiation emitted. The appropriate combination of sample extraction, collection and analysis for an individual radionuclide is dependent upon many interrelated factors including the mixture of other radionuclides present. Because of this wide range of conditions, no single method for monitoring or sample collection and analysis of a radionuclide is applicable to all types of facilities. Therefore, a series of methods based on "principles of measurement" are described for monitoring and sample collection and analysis which are applicable to the measurement of radionuclides found in effluent streams at stationary sources. This approach provides the user with the flexibility to choose the most appropriate combination of monitoring and sample collection and analysis methods which are applicable to the effluent stream to be measured.

Response: **Our answers to U.S. Environmental Protection Agency (EPA) requirements (regulatory criteria 40 CFR 61, Subpart H, Appendix B, Method 114) (EPA 1991) regarding Hanford site air emissions are provided here.**

2. Stack Monitoring and Sample Collection Methods

Monitoring and sample collection methods are described based on "principles of monitoring and sample collection" which are applicable to the measurement of radionuclides from effluent streams at stationary sources. Radionuclides of most elements will be in the particulate form in these effluent streams and can be readily collected using a suitable filter media. Radionuclides of hydrogen, oxygen, carbon, nitrogen, the noble gases and in some circumstances iodine will be in the gaseous form. Radionuclides of these elements will require either the use of an in-line or off-line monitor to directly measure the radionuclides, or suitable sorbers, condensers or bubblers to collect the radionuclides.

Response: **No answer is required of radioanalytical chemistry.**

2.1 Radionuclides as Particulates. The extracted effluent stream is passed through a filter media to remove the particulates. The filter must have a high efficiency for removal of sub-micron particles. The guidance in ANSI N13.1-1969 shall be followed in using filter media to collect particulates (incorporated by reference-see § 61.18).

See Appendices A, B, C, D, and E.

2.2 Radionuclides as Gases.

2.2.1 The Radionuclide Tritium (H-3). Tritium in the form of water vapor is collected from the extracted effluent sample by sorption, condensation or dissolution techniques. Appropriate collectors may include silica gel, molecular sieves, and ethylene glycol or water bubblers.

Tritium in the gaseous form may be measured directly in the sample stream using Method B-1, collected as a gas sample or may be oxidized using a metal catalyst to tritiated water and collected as described above.

2.2.2 Radionuclides of iodine. Iodine is collected from an extracted sample by sorption or dissolution techniques. Appropriate collectors may include charcoal, impregnated charcoal, metal zeolite and caustic solutions.

2.2.3 Radionuclides of Argon, Krypton and Xenon. Radionuclides of these elements are either measured directly by an in-line or off-line monitor, or are collected from the extracted sample by low temperature sorption techniques, Appropriate sorbers may include charcoal or metal zeolite.

2.2.4 Radionuclides of Oxygen, Carbon, Nitrogen and Radon. Radionuclides of these elements are measured directly using an in-line or off-line monitor. Radionuclides of carbon in the form of carbon dioxide may be collected by dissolution in caustic solutions.

See Appendices A, D, and E.

2.3 Definition of Terms

In-line monitor means a continuous measurement system in which the detector is placed directly in or adjacent to the effluent stream. This may involve either gross radioactivity measurements or specific radionuclide measurements. Gross measurements shall be made in conformance with the conditions specified in Methods A-4, B-2, and G-4.

Off-line monitor means a measurement system in which the detector is used to continuously measure an extracted sample of the effluent stream. This may involve either gross radioactivity measurements or specific radionuclide measurements. Gross measurements shall be made in conformance with the conditions specified in Methods A-4, B-2 and G-4.

Sample collection means a procedure in which the radionuclides are removed from an extracted sample of the effluent using a collection media. These collection media include filters, absorbers, bubblers and condensers. The collected sample is analyzed using the methods described in Section 3.

Response: **No answer is required.**

3. Radionuclide Analysis Methods

A series of methods based on "principles of measurement" are described 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 which would interfere with the measurement.

Also identified (Table 1) are methods for a selected list of radionuclides. The listed radionuclides are those which are most commonly used and which have the greatest potential for causing dose to members of the public. Use of methods based on principles of measurement other than those described in this section must be approved in advance of use by the Administrator. For radionuclides not listed in Table 1, any of the described methods may be used provided the user can demonstrate that the applicability conditions of the method have been met.

The type of method applicable to the analysis of a radionuclide is dependent upon the type of radiation emitted, i.e., alpha, beta or gamma. Therefore, the methods described below are grouped according to principles of measurements for the analysis of alpha, beta and gamma emitting radionuclides.

3.1 Methods for Alpha Emitting Radionuclides

3.1.1 Method A-1, Radiochemistry-Alpha Spectrometry.

Principle: The element of interest is separated from other elements, and from the sample matrix using radiochemical techniques. The procedure may involve precipitation, ion exchange, or solvent extraction. Carriers (elements chemically similar to the element of interest) may be used. The element is deposited on a planchet in a very thin film by electrodeposition or by coprecipitation on a very small amount of carrier, such as lanthanum fluoride. The deposited element is then counted with an alpha spectrometer. The activity of the nuclide of interest is measured by the number of alpha counts in the appropriate energy region. A correction for chemical yield and counting efficiency is made using a standardized radioactive nuclide (tracer) of the same element. If a radioactive tracer is not available for the element of interest, a predetermined chemical yield factor may be used.

Applicability: This method is applicable for determining 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 which could interfere in the spectral region of interest. APHA-605(2), ASTM-D-3972(13).

Response: **Our method involves dissolution (LA-549-112), chemical separation (LA-943-123), electrodeposition (LA-542-101), followed by alpha spectrometry (LA-508-051). It meets all the requirements of the EPA-suggested method. This is used for analyzing ^{241}Am, ^{238}Pu, and ^{239,240}Pu in the air filter samples. The activities of these nuclides are determined by direct comparison with the recoveries of (National Institute of Standards and Technology ([NIST] traceable) ^{243}Am and ^{236}Pu tracers.**

3.1.2 Method A-2, Radiochemistry-Alpha Counting.

Principle: The element of interest is separated from other elements, and from the sample matrix using radiochemistry. The procedure may involve precipitation, ion exchange, or solvent extraction. Carriers (elements chemically similar to the element of interest) may be used. The element is deposited on

a planchet in a thin film and counted with a alpha counter. A correction for chemical yield (if necessary) is made. The alpha count rate measures the total activity of all emitting radionuclides of the separated element.

Applicability: This method is applicable for the measurement of any alpha-emitting radionuclide, provided no other alpha emitting radionuclide is present in the separated sample. It 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 which could be present in the sample that has the highest dose conversion factor. IDO-12096(18).

Response: **Because the tracer technique is used in the separation process, this method is not used for air filter analysis.**

3.1.3 Method A-3, Direct Alpha Spectrometry.

Principle: The sample, collected on a suitable filter, is counted directly on an alpha spectrometer. The sample must be thin enough and collected on the surface of the filter so that any absorption of alpha particle energy in the sample or the filter, which would degrade the spectrum, is minimal.

Applicability: This method is applicable to simple mixtures of alpha emitting radionuclides and only when the amount of particulates collected on the filter paper are relatively small and the alpha spectra is adequately resolved. Resolutions should be 50 keV (FWHM) or better, ASTM-D-3084(16).

Response: **Our method follows the procedure LO-150-133, then LA-508-110 for total alpha counts, and finally LA-508-051 for alpha spectrometry. It partially meets the requirements of the EPA method. This method is usually used for emergency air samples. The sample is counted on the alpha counter of known efficiency to obtain the total alpha counts. In the alpha energy analysis (AEA), the relative peak fractions of different alpha emitters identified in the sample are determined. The peak fractions are then used to correct the total alpha counts and thus determine the activities of individual alpha nuclides present in the sample.**

3.1.4 Method A-4, Direct Alpha Counting (Gross alpha determination).

Principle: The sample, collected on a suitable filter, is counted with an alpha counter. The sample must be thin enough so that self-absorption is not significant and the filter must be of such a nature that the particles are retained on the surface.

Applicability: Gross alpha determination 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 for the purposes and under the conditions described in section 3.7. APHA-601(3), ASTM-D-1943(10).

Response: **Our method follows the procedure LA-508-110 or LA-508-114. It meets all of the requirements stated in the EPA-suggested method.**

3.1.5 Method A-5, Chemical Determination of Uranium.

Uranium: Uranium may be measured chemically by either colorimetry or fluorometry. In both procedures, the sample is dissolved, the uranium is oxidized to the hexavalent form and extracted into a suitable solvent. Impurities are removed from the solvent layer. For colorimetry, dibenzoylmethane is added, and the uranium is measured by the absorbance in a colorimeter. For fluorometry, a portion of the solution is fused with a sodium fluoride-lithium fluoride flux and the uranium is determined by the ultraviolet activated fluorescence of the fused disk in a fluorometer.

Applicability: This method is applicable to the measurements of emission rates of uranium when the isotopic ratio of the uranium radionuclides is well known. ASTM-E318(15), ASTM-D-2907(14).

Response: **Total uranium is determined by procedure LA-925-107. The laser-induced kinetic phosphorescence analyzer is an improvement over the old fluorometric method for uranium determination. It is highly sensitive (lower detection level of 50 ppt is quite possible) because the laser frequency is used specifically for excitation of uranium atoms. It**

is faster and produces quality numbers. Quality can also be monitored during analysis. It exceeds the requirements mentioned in the EPA method.

3.1.6 Method A-6, Radon-222-Continuous Gas Monitor.

Principle: Radon-222 is measured directly in a continuously extracted sample stream by passing the air stream through a calibrated scintillation cell. Prior to the scintillation cell, the air stream is treated to remove particulates and excess moisture. The alpha particles from radon-222 and its decay products strike a zinc sulfide coating on the inside of the scintillation cell producing light pulses. The light pulses are detected by a photomultiplier tube which generates electrical pulses. These pulses are processed by the system electronics and the read out is in pCi/l of radon-222.

Applicability: This method is applicable to the measurement of radon-222 in effluent streams which do not contain significant quantities of radon-220. Users of this method should calibrate the monitor in a radon calibration chamber at least twice per year. The background of the monitor should also be checked periodically by operating the instrument in a low radon environment. EPA 520/1-89-009(24).

Response: **Not applicable at the 222-S Laboratory.**

3.1.7 Method A-7, Radon-222-Alpha Track Detectors

Principle: Radon-222 is measured directly in the effluent stream using alpha track detectors (ATD). The alpha particles emitted by radon-222 and its decay products strike a small plastic strip and produce submicron damage tracks. The plastic strip is placed in a caustic solution that accentuates the damage tracks which are counted using a microscope or automatic counting system. The number of tracks per unit area is corrected to the radon concentration in air using a conversion factor derived from data generated in a radon calibration facility.

Applicability: Prior approval from EPA is required for use of this method. This method is only applicable to effluent streams which do not contain significant quantities of radon-220, unless special detectors are used to discriminate against radon 220. This method may be used only when ATDs have been demonstrated to produce data comparable to data obtained with Method A-6. Such data should be submitted to EPA when requesting approval for the use of this method. EPA 520/1-89-009(24).

Response: **Not applicable; direct monitoring of ^{222}Rn is not performed at the 222-S Laboratory.**

3.2 Methods for Gaseous Beta Emitting Radionuclides.

3.2.1 Method B-1, Direct Counting in Flow-Through Ionization Chambers.

Principle: An ionization chamber containing a specific volume of gas which flows at a given flow rate through the chamber is used. The sample (effluent stream sample) acts as the counting gas for the chamber. The activity of the radionuclide is determined from the current measured in the ionization chamber.

Applicability: This method is applicable for 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. DOE/EP-0096(17), NCRP-58(23).

Response: **Not applicable; not performed.**

3.2.2 Method B-2, Direct Counting With In-line or Off-line Beta Detectors.

Principle: The beta detector is placed directly in the effluent stream (in-line) or an extracted sample of the effluent stream is passed through a chamber containing a beta detector (off-line). The activities of the radionuclides present in the effluent stream are determined from the beta count rate, and a knowledge of the radionuclides present and the relationship of the gross beta count rate and the specific radionuclide concentration.

Applicability: This method is applicable only to radionuclides with maximum beta particle energies greater then 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. Specific radionuclide analysis of periodic grab samples may be used to identify the types and quantities of radionuclides present and to establish the relationship between specific radionuclide analyses and gross beta count rates.

This method is applicable to unidentified mixtures of gaseous radionuclides only for the purposes and under the conditions described in section 3.7.

Response: **Not applicable; not performed.**

3.3 Methods for Non-Gaseous Beta Emitting Radionuclides.

3.3.1 Method B-3, Radiochemistry-Beta Counting.

Principle: The element of interest is separated from other elements, and from the sample matrix by radiochemistry. This may involve precipitation, distillation, ion exchange, or solvent extraction. Carriers (elements chemically similar to the element of interest) may be used. The element is deposited on a planchet, and counted with a beta counter. Corrections for chemical yield and decay (if necessary) are made. The beta count rate determines the total activity of all radionuclides of the separated element. This method may also involve the radiochemical separation and counting of a daughter element, after a suitable period of ingrowth, in which case it is specific for the parent nuclide.

Applicability: This method is applicable for 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. APHA-608(5).

Response: **Our method for determining ^{89}Sr, $^{90}Sr/^{90}Y$ in air filter samples is carried out using procedures LA-549-112 (dissolution) and LA-220-103 (for chemical separation), followed by procedure LA-508-111 (total beta counting). The laboratory method certainly meets the requirements stated above.**

3.3.2 Method B-4, Direct Beta Counting (Gross beta determination).

Principle: The sample, collected on a suitable filter, is counted with a beta counter. The sample must be thin enough so that self-absorption corrections can be made.

Applicability: 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 the purposes and under the conditions described in section 3.7. APHA-602(4), ASTM-D-1890(11).

Response: **For gross beta determination, procedure LA-508-110 or LA-508-114 is followed. It satisfies the method requirements.**

3.3.3 Method B-5, Liquid Scintillation Spectrometry.

Principle: An aliquot of a collected sample or the result of some other chemical separation or processing technique is added to a liquid scintillation "cocktail" which is viewed by photomultiplier tubes in a liquid scintillation spectrometer. The spectrometer is adjusted to establish a channel or "window" for the pulse energy appropriate to the nuclide of interest. The activity of the nuclide of interest is measured by the counting rate in the appropriate energy channel. Corrections are made for chemical yield where separations are made.

Applicability: This method is applicable to 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 which 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. APHA.609(6), EML LV-539-17(19).

Response: **It is used for determining ^{147}Pm in air filter samples (LA-549-112 for dissolution, LA-613-111 for chemical separation, LA-548-111 for incorporating into scintillation cocktail, and LA-508-121 for liquid scintillation counting). This is also used for determination of ^{14}C (LA-348-101, LA-548-111, and LA-508-121, sequentially) and ^{3}H (LA-218-112, LA-548-111, and LA-508-121, sequentially) in gas samples. This method satisfies all of the requirements.**

3.4 Gamma Emitting Radionuclides

3.4.1 Method G-1. High Resolution Gamma Spectrometry.

Principle: The sample is counted with a high resolution gamma detector, usually either a Ge(Li) or a high purity Ge detector, connected to a multichannel analyzer or computer. The gamma emitting radionuclides in the sample are measured from the gamma count rates in the energy regions characteristic of the individual radionuclide. Corrections are made for counts contributed by other radionuclides to the spectral regions of the radionuclides of interest. Radiochemical separations may be made prior to counting but are usually not necessary.

Applicability: This method is applicable to the measurement of any gamma emitting radionuclide with gamma energies greater than 20 keV. It 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. ASTM-3649(9), IDO-12096(18).

Response: **Our method uses gamma ray spectroscopy with high resolution germanium detectors and follows procedure LA-508-052. It meets all the requirements explained in the EPA method.**

3.4.2 Method G-2, Low Resolution Gamma Spectrometry.

Principle: The sample is counted with a low resolution gamma detector, a thallium activated sodium iodide crystal. The detector is coupled to a photomultiplier tube and connected to a multichannel analyzer. The gamma emitting radionuclides in the sample are measured from the gamma count rates in the energy regions characteristic of the individual radionuclides. Corrections are made for counts contributed by other radionuclides to the spectral regions of the radionuclides of interest. Radiochemical separation may be used prior to counting to obtain less complex gamma spectra if needed.

Applicability: This method is applicable to the measurement of gamma emitting radionuclides with energies greater than 100 keV. It 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 by passing the gas stream through a chamber or cell containing the detector. ASTM-D-2459(12), EMSL-LV-0539-17(19).

Response: **Not applicable because this method is not used in air filter analysis.**

3.4.3 Method G-3, Single Channel Gamma Spectrometry.

Principle: The sample is counted with a thallium activated sodium iodide crystal. The detector is coupled to a photomultiplier tube connected to a single channel analyzer. The activity of a gamma emitting radionuclide is determined from the gamma counts in the energy range for which the counter is set.

Applicability: This method is applicable to the measurement of a single gamma emitting radionuclide. It 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 by passing the gas stream through a chamber or cell containing the detector.

Response: **Not applicable because this technique is not used in air filter analysis.**

3.4.4 Method G-4, Gross Gamma Counting.

Principle: The sample is counted with a gamma detector usually a thallium activated sodium iodine crystal. The detector is coupled to a photomultiplier tube and gamma rays above a specific threshold energy level are counted.

Applicability: 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 stream are well known. When gross gamma measurements are used to determine emissions of specific radionuclides periodic measurements using Methods G-1 or G-2 should be made to demonstrate that the gross gamma measurements provide reliable emission data. This 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 passing an extracted sample of the effluent stream through a chamber or cell containing the detector.

Response: **Not applicable.**

3.5 Counting Methods. All of the methods with the exception of Method A-5 involve counting the radiation emitted by the radionuclide. Counting methods applicable to the measurement of alpha, beta and gamma radiations are listed below. The equipment needed and the counting principles involved are described in detail in ASTM-3648(8).

3.5.1 Alpha Counting:

▪Gas Flow Proportional Counters. The alpha particles cause ionization in the counting gas and the resulting electrical pulses are counted. These counters may be windowless or have very thin windows.

▪Scintillation Counters. The alpha particles transfer energy to a scintillator resulting in a production of light photons which strike a photomultiplier tube converting the light photons to electrical pulses which are counted. The counters may involve the use of solid scintillation materials such as zinc sulfide or liquid scintillation solutions.

▪Solid-State Counters. Semiconductor materials, such as silicon surface-barrier p-n junctions, act as solid ionization chambers. The alpha particles interact which the detector producing electron hole pairs. The charged pair is collected by an applied electrical field and the resulting electrical pulses are counted.

▪Alpha Spectrometers. Semiconductor detectors used in conjunction with multichannel analyzers for energy discrimination.

Response: **Alpha proportional counters (home-built chambers with EG&G ORTEC electronics), window-type gas flow proportional counters (some having automatic sample changer), surface-barrier solid-state detectors connected to a multichannel analyzer (MCA) (Canberra's Jupiter™ system) are used for air filter analysis in our laboratory. Our equipment meets the EPA specifications.**

3.5.2 Beta Counting:

▪Ionization Chambers. These chambers contain the beta-emitting nuclide in gaseous form. The ionization current produced is measured.

▪Geiger-Muller (GM) Counters-or Gas Flow Proportional Counters. The beta particles cause ionization in the counting gas and the resulting electrical pulses are counted. Proportional gas flow counters which are heavily shielded by lead or other metal, and provided with an anti-coincidence shield to reject cosmic rays, are called low background beta counters.

▪Scintillation Counters. The beta particles transfer energy to a scintillator resulting in a production of light photons, which strike a photomultiplier tube converting the light photon to electrical pulses which are counted. This may involve the use of anthracene crystals, plastic scintillator, or liquid scintillation solutions with organic phosphors.

▪Liquid Scintillation Spectrometers. Liquid scintillation counters which use two photomultiplier tubes in coincidence to reduce background counts. This counter may also electronically discriminate among pulses of a given range of energy.

Response: **Window-type gas flow proportional counter (some having an automatic sample changer) liquid scintillation spectrometers manufactured by Beckman Instruments, Inc., are used for analysis. Our counting equipment meets the requirements.**

3.5.3 Gamma Counting:

▪Low-Resolution Gamma Spectrometers. The gamma rays interact with thallium activated sodium iodide or cesium iodide crystal resulting in the release of light photons which strike a photomultiplier tube converting the light pulses to electrical pulses proportional to the energy of the gamma ray. Multi-channel analyzers are used to separate and store the pulses according to the energy absorbed in the crystal.

▪High-Resolution gamma Spectrometers. Gamma rays interact with a lithium-drifted (Ge(Li)) or high-purity germanium (HPGe) semiconductor detectors resulting in a production of electron-hole pairs. The charged pair is collected by an applied electrical field. A very stable low noise preamplifier amplifies the pulses of electrical charge resulting from the gamma photon interactions. Multichannel analyzers or computers are used to separate and store the pulses according to the energy absorbed in the crystal.

™Jupiter is a trademark of Canberra Industries, Inc.

▪Single Channel Analyzers. Thallium activated sodium iodide crystals used with a single window analyzer. Pulses from the photomultiplier tubes are separated in a single predetermined energy range.

Response: **High-resolution gamma detectors (high purity Ge detectors for both low and high energies) from EG&G ORTEC and Princeton Gamma Tech, well-type pure Ge detectors connected to MCA (Canberra's Jupiter system) are available and used for air filter analysis. Our equipment exceeds the EPA requirements.**

3.5.4 Calibration of Counters. Counters are calibrated for specific radionuclide measurements using a standard of the radionuclide under either identical or very similar conditions as the sample to be counted. For gamma spectrometers a series of standards covering the energy range of interest may be used to construct a calibration curve relating gamma energy to counting efficiency.

In those cases where a standard is not available for a radionuclide, counters may be calibrated using a standard with energy characteristics as similar as possible to the radionuclide to be measured. For gross alpha and beta measurements of the unidentified mixtures of radionuclides, alpha counters are calibrated with a natural uranium standard and beta counters with a cesium-137 standard. The standard must contain the same weight and distribution of solids as the samples, and be mounted in an identical manner. If the samples contain variable amounts of solids, calibration curves relating weight of solids present to counting efficiency are prepared. Standards other than those prescribed may be used provided it can be shown that such standards are more applicable to the radionuclide mixture measured.

Response: **A mixed gamma standard (NIST traceable) emitting various gamma-rays ranging from 59 to 1850 keV is used, using vendor-supplied calibration software, for constructing efficiency versus energy calibration curves for different geometrical configurations used in gamma analysis. The calibration procedure for gamma ray spectrometer is documented in LQ-508-003. Our calibration procedure meets the EPA criteria for gamma ray spectroscopic analysis.**

For calibration of beta detectors for $^{90}Sr/^{90}Y$ analysis, procedure LQ-508-002 is used in conjunction with LQ-508-005. It meets the requirements of the EPA-suggested method. A method standard also is used to check the performance and calibration of the detector.

For calibration of alpha/beta proportional counters, procedure LQ-508-002 is carried out. It partially deviates from the EPA requirements. For gross alpha and gross beta measurements, our instruments are calibrated with ^{241}Am and ^{60}Co standards, respectively. The reasons for choosing the ^{241}Am standard for calibration follow.

- **It is commonly found in the main stack air samples.**
- **Alpha counting efficiency usually is the same for other alpha emitters that also are found in the air stack samples**
- **The ^{241}Am standard also can be checked independently by gamma analysis. The reason for using the ^{60}Co standard in calibration is the lower counting efficiency with ^{60}Co (beta max = 317 keV) compared to those with ^{137}Cs (beta max = 511 keV) and ^{90}Sr (beta max = 546 keV). Consequently, it will generate conservative numbers in our analysis. The calibration curves relating weight of solids present to counting efficiencies are not done in alpha/beta analysis, but currently are being evaluated.**

3.6 Radiochemical Methods for Selected Radionuclides. Methods for a selected list of radionuclides are listed in Table 1. The radionuclides listed are those which are most commonly used and which hove the

greatest potential for causing doses to members of the public. For radionuclides not listed in Table 1, methods based on any of the applicable "principles of measurement" described in section 3.1 through 3.4 may be used.

Response: The air samples from the main stacks are well characterized. Some of the radionuclides identified (^{241}Am, ^{238}Pu, $^{239,240}Pu$, ^{90}Sr, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{147}Pm, ^{14}C, ^{3}H, and ^{131}I) are listed in Table 1 of Method 114 (EPA 1991) and are analyzed according to the approved methods given in the table. Other radionuclides (^{95}Nb, ^{95}Zr, ^{129}I, $^{106}Rh/^{106}Ru$, ^{113}Sn, ^{125}Sb, and ^{103}Ru) not listed in the table are analyzed by the methods outlined in Method 114, depending on the type of emitted radiations. It is important to note here that the nuclides ^{95}Zr, ^{95}Nb, and ^{103}Ru have nearly decayed to nondetectable levels because no product is being produced.

3.7 Applicability of Gross Alpha and Beta Measurements to Unidentified Mixtures of Radionuclides. Gross alpha and beta measurements may be used as a screening measurement as a part of an emission measurement program to identify the need to do specific radionuclide analyses or to confirm or verify that unexpected radionuclides are not being released in significant quantities.

Gross alpha (Method A-4) or gross beta (Methods B-2 or B-4) measurements may also be used for the purpose of comparing the measured concentrations in the effluent stream with the limiting "Concentration Levels for Environmental Compliance" in Table 2 of Appendix E. For unidentified mixtures, the measured concentration value shall be compared with the lowest environmental concentration limit for any radionuclide which is not known to be absent from the effluent stream.

Response: This is not applicable because the air effluents from the Hanford Site main stacks are well characterized. However, gross alpha and beta analyses for weekly and daily air samples are routinely performed in the 222-S Laboratory before starting specific radionuclide analyses. Following this practice, the facility can verify a significant release of a radionuclide into the air so corrective actions to minimize radionuclide emission into the environment can be taken promptly by facility personnel. The gross alpha and beta results from analysis are compared to those listed in the appendix of DOE Order 5400.5 (DOE 1990) for compliance.

4.0 Quality Assurance Methods

Each facility required to measure their radionuclide emissions shall conduct a quality assurance program in conjunction with the radionuclide emission measurements. This program shall assure that the emission measurements are representative, and are of known precision and accuracy and shall include administrative controls to assure prompt response when emission measurements indicate unexpectedly large emissions. The program shall consist of a system of policies, organizational responsibilities, written procedures, data quality specifications, audits, corrective actions and reports. This quality assurance program shall include the following program elements:

4.1 The organizational structure functional responsibilities, levels of authority and lines of communications for all activities related to the emissions measurement program shall be identified and documented.

The company manual WHC-CM-1-2, *Organizational Charts and Charters*, exhibits the current company organizational structure and titles. This manual includes the organization's upper level management charters. Responsibilities for radioactive airborne emissions sampling activities are described in the main pat of this document.

4.2 Administrative controls shall be prescribed to ensure prompt response in the event that emission levels increase due to unplanned operations.

See Appendices A, B, C, D, and E.

4.3 The sample collection and analysis procedures used in measuring the emissions shall be described including where applicable:

4.3 The sample collection and analysis procedures used in measuring the emissions shall be described including where applicable:

4.3.1 Identification of sampling sites and number of sampling points, including the rationale for site selections.

See Appendices A, B, C, D, and E.

4.3.2 A description of sampling probes and representativeness of the samples.

See Appendices A, B, C, D, and E.

4.3.3 A description of any continuous monitoring system used to measure emissions, including the sensitivity of the system, calibration procedures and frequency of calibration.

See Appendices A, B, C, D, and E.

4.3.4 A description of the sample collection systems for each radionuclide measured, including frequency of collection, calibration procedures and frequency of calibration.

See Appendices A, B, C, D, and E.

4.3.5 A description of the laboratory analysis procedures used for each radionuclide measured. including frequency of analysis calibration procedures and frequency of calibration.

Response:

- Total alpha/total beta activity is determined by procedure LA-508-110 or LA-508-114 on weekly samples, and occasionally on daily air samples, per collection point. The calibration procedure is documented in LQ-508-002. It is done only when deemed necessary by a responsible scientist. The counting system is recalibrated only in case of (1) major repairs or adjustments to the power supply or detector or (2) calibration shift as indicated by the instrument control standards. The performance of the counting systems is checked by running the instrument control standards (^{147}Pm for low-energy beta, ^{60}Co for mid-energy beta, ^{137}Cs for high-energy beta, and ^{241}Am for alpha activity) separately. When a batch of air filter samples is run, all the performance standards and the background (for counting frequency refer to LO-150-115) also are run with it. To verify that the counting system is working properly, the standard values from analysis should fall within the administrative limits set according to appropriate quality assurance program plans (QAPP) to be prepared in the future.

- Our laboratory method for analysis of alpha emitters (^{241}Am, ^{238}Pu, and ^{239,240}Pu) involves various steps (LA-549-112 for dissolution, LA-943-123 for chemical separation, LA-542-101 for electrodeposition, and LA-508-051 for final alpha spectrometry). The analysis of alpha emitters is done quarterly on weekly/daily air filter samples. The energy resolution and calibration of the AEA system over the energy range of 4 to 6 MeV are checked once a month by the preventive maintenance (PM) procedure 2S18006. Efficiency calibration of the AEA is not needed in our analysis method because direct comparison of the sample with recoveries of the tracers (^{243}Am and ^{236}Pu) is made to determine the activities of the

radionuclides present in the sample. To carry out the sample analysis, AEA system performance is checked once every 24 hours for alpha energy shift with a certified mixed alpha source standard. Each alpha energy peak identified in the standard must fall within administratively assigned certain channels (±10) on the MCA. For counting frequency of performance check standards, procedure LO-150-115 is referred to. The recovery of the radionuclides and the calibration of the system are checked on a batch basis by running a method standard under the identical conditions as the sample.

- The lab method for determining beta activity (^{89}Sr, $^{90}Sr/^{90}Y$) consists of a dissolution step (LA-549-112), chemical separation (LA-220-103), and total beta counting (LA-508-111). Analysis is done quarterly on weekly/daily air filter samples per collection point. The calibration procedure LQ-508-002 (for window-type gas flow proportional counter) is used in conjunction with LQ-508-005 (mother/daughter case, i.e., $^{90}Sr/^{90}Y$ in growth calibration). It is performed only when the responsible scientist finds it necessary. The reasons are the same as stated for total alpha/total beta. The performance of the counting system is checked once per shift by running instrument control standards (^{60}Co, ^{137}Cs, and ^{147}Pm for beta activity). The complete procedure for the $^{90}Sr/^{90}Y$ analysis in the sample is carried out with a method standard (several filter papers spiked with ^{90}Sr, ^{147}Pm, ^{60}Co, ^{241}Am, ^{239}Pu, and U) provided by the 222-SA Standard Laboratory) on a batch basis. This checks the overall performance of our method. The chemical yield is determined by using appropriate carrier.

- Determination of beta activity (^{147}Pm, ^{14}C, and ^{3}H) involves processing (LA-549-112 and LA-613-111 for ^{147}Pm, LA-348-101 for ^{14}C, and LA-218-112 for ^{3}H), mounting in scintillation cocktail (LA-508-111), and finally, liquid scintillation counting (LA-508-121). The ^{147}Pm analysis is done quarterly on weekly/daily air filter samples. The ^{14}C and ^{3}H analyses are done on a composite of biweekly gas samples. For calibration, the quality assurance (QA) section of procedure LA-508-121 is referenced. The calibration of the instrument is checked by the manufacturer's supplied sources (^{14}C and ^{3}H) and its software.

  For ^{147}Pm analysis, the method standard is run once per quarter. The method standard is always run with a batch of samples for ^{3}H and ^{14}C analysis. The results of the method standard checks the overall performance, including the calibration of the counting system. The instrument calibration check is done a minimum of once a week (refer to LO-150-115).

- For analysis of gamma emitters ^{95}Nb, ^{95}Zr, ^{134}Cs, ^{137}Cs, and ^{144}Ce the procedure LA-508-052 is followed. Analysis is done quarterly on weekly/daily air filter samples. For analysis of volatile radionuclides (^{129}I, ^{131}I, $^{106}Rh/^{106}Ru$, ^{113}Sn, ^{125}Sb, and ^{103}Ru) collected weekly on silver zeolite cartridge, the procedure LA-288-101 is used in conjunction with procedure

LA-508-052. Calibration of the gamma ray spectrometer is done with the procedure documented in LQ-508-003 using a (NIST traceable) certified mixed gamma ray standard. It is carried out only when it is deemed necessary by a responsible scientist. To check efficiency and energy calibration daily, the performance of each detector of the GEA system over the whole energy range is done once every shift by running a mixed gamma standard consisting of ^{241}Am for low energy, ^{137}Cs for mid energy, and ^{60}Co for high energy. The results of each of these radionuclides should fall within the administrative limits set according to the appropriate QAPP to continue analysis of samples. The daily performance results are documented. Minor adjustments of the electronics (i.e., fine gain, pole zero of the amplifiers, lower level of discriminator of analog-to-digital converter, etc.) are done from time to time when necessary for proper energy calibration. Whenever a minor electronic adjustment is done on a detector, it is followed by analysis of a performance standard. For a major shift in the calibration, the system is then thoroughly calibrated using LQ-508-003.

- The content of the 222-S Laboratory's procedures, test plans, supporting documents, and drawings provide a sufficient level of detail to allow trained personnel to produce quality results safely. Laboratory procedures are controlled as required by WHC-CM-5-4, Section 5.4, "Analytical Laboratory Procedures." The specific content of laboratory procedures is defined by its author, based on accepted methods such as 40 CFR 61, Appendix B, Method 114 (EPA 1991). The content must be agreed to by the peer and technical reviewers. While authors are responsible for the specific content of their procedures, they address the topics below.

<u>Summary</u> - MANDATORY - A short description or abstract of the procedure containing enough information to distinguish it from other procedures.

<u>Applications</u> - MANDATORY - Defines the scope and purpose of the specific procedure. This section may be combined with the following element under the title "Applications and Limitations."

<u>Limitations</u> - MANDATORY - Briefly describes those areas in which the procedure is not applicable. A statement of accuracy and precision will be given where appropriate.

<u>Quality Control Protocol</u> - Procedures used to support environmental projects that have specific quality control requirements. For these procedures, the source of the quality control requirements will be identified. The samples or project that this element applies to will be identified. The following information is typical of quality control requirements: frequency and type of calibration, reagent blank analysis, spike sample analysis, and duplicate sample analysis.

Impact Level Identifier - MANDATORY - An impact level will be identified for each procedure following WHC-CM-1-3, MRP 5.43, with a brief basis of determination statement. This MRP lists several descriptive paragraphs delineating what constitutes an Impact Level 1, 2, 3, or 4 activity. The following parts of MRP 5.43 cover most analytical laboratory procedures.

1. Section 5, paragraph 6, part c., Impact Level 3 - work authorization documentation associated with work involving occupational hazards not covered by approved procedure, such as Operational Safety Assessments, Radiation Work Permits, or Industrial Safety Standards.

2. Section 5, paragraph 6, part c., Impact Level 4 - Documentation for any activity not classed as Impact Level 1, 2, or 3.

The laboratories' procedures are usually specific to one activity. These activities are well defined using common scientific instrumentation and equipment operated in an acceptable manner. The chemicals and materials used are normally small quantities with limited potential for environmental or personnel safety impact. In general, the equipment used in the laboratory is not classified as Safety Class 3 or higher.

Safety - MANDATORY - The procedure must identify applicable safety hazards.

The following documents identify Westinghouse Hanford Company (Westinghouse Hanford) safety requirements:

- WHC-CM-4-3, Volume 1-3, Industrial Safety
- WHC-CM-4-10, Radiation Protection
- WHC-CM-4-15, Radiation Work Requirements and Work Permits Manual
- WHC-CM-4-29, Nuclear Criticality Safety.

Supporting document WHC-SD-CP-LB-003, *Safety in the Analytical Laboratory*, is the laboratory general safety document. The authors must review safety requirements and include safety warnings appropriate to the actions directed by the procedure.

Reagents - If the procedure requires analytical reagents, a list of reagents will be provided. The MSDS number will be placed in brackets by each chemical name. Reagent makeup, storage container requirements, unique storage needs, shelf-life requirements, special labeling, and special preparation steps will be included. Special notations for any known or suspected carcinogen as listed on WHC-CM-4-3, Volume 2, Table 1, "WHC Master Carcinogen List," will be made on the reagent list.

Reagent preparation described fully in other current Westinghouse Hanford documentation may be included by reference.

Equipment - Special equipment needs will be listed. Standard hood or glovebox equipment is assumed to be available at the work station

and does not need to be listed. The fabrication of off-standard equipment will be referenced or described in this section.

Procedure Steps - MANDATORY - A step-by-step description of operations necessary to perform the task will be presented in a logical and sequentially numbered order or an assignment of responsibilities. CAUTIONS and WARNINGS notations will be included for the applicable safety hazard before the action is described. Steps with potential for criticality specification violation will be identified. Explanatory "Notes" may be included for clarification of process.

Calculations - Calculations required to complete the work will be described in this section. Examples with sample values may be included. All combined factors will be fully described and units noted.

Calibrations - When calibrations are required, a description of how to carry out required calibrations will be given.

Discussion - A discussion of the theoretical aspects of the procedure. Brief identification of unique characteristics and interfaces to aid in troubleshooting may be included.

References - A reference list of published information to provide technical basis for the procedure may be included.

The mandatory topics are addressed in both procedures. However, the laboratories have technical, analytical, and administrative procedures. Non-mandatory topics are included if appropriate to the activity covered by the procedure.

The calibrations of all laboratory instruments are controlled by the Laboratory Instrument Calibration Control System (LICCS). The LICCS documents the requirements for and the performance of calibration activities for each analytical instrument or measurement device.

4.3.6 A description of the sample flow rate measurement systems or procedures, including calibration procedures and frequency of calibration.

See Appendices A, B, C, D, and E.

4.3.7 A description of the effluent flow rate measurement procedures, including frequency of measurements, calibration procedures and frequency of calibration.

See Appendices A, B, C, D, and E.

4.4 The objectives of the quality assurance program shall be documented and shall state the required precision, accuracy and completeness of the emission measurement data including a description of the procedures used to assess these parameters. Accuracy is the degree of agreement of a measurement with a true or known value. Precision is a measure of the agreement among individual measurements of the same parameters under similar conditions. Completeness is a measure of the amount of data obtained compared to the amount expected under normal conditions.

The accuracy of analyses is checked using percent recovery. The evaluation of blind or known check standards provides the percent recovery.

9 2 1 2 4 9 3 0 5 0 7

For both blind and known check standards, percent recovery is calculated by the following equation:

$$P = 100 \cdot \frac{R}{S_t}$$

Where:

P = Percent recovery
R = Measured or recovered analyte concentration in the check standard
S_t = Concentration of analyte in the check standard.

The laboratories do not use manual W. A. Shewhart control charts (Shewhart 1931). The Laboratory Measurement Control System (LMCS) is a software package designed for support of management quality control decisions. Each analytical measurement system has different control parameter requirements based on the use of specific standards. The LMCS program provide a performance versus limits control chart for each standard. The average percent recovery ($\bar{P}$) or 100%, depending on the method, marks the center of the limit. The upper and lower boundaries of the limits are multiples of the standard deviation (s) of the average percent recovery. The laboratory manager approves the LMCS limits, defined as $\bar{P} \pm ns$, where n is a positive number. The values for $\bar{P}$ and s are either performance based. In general, management sets the warning limits at 2s and the control limits at 3s or their equivalent.

When the LMCS identifies an out-of-control method, it automatically initiates corrective action. The system issues an Off Standard Condition Report (OSCR). The scientist in charge of the method must discover and resolve the problem to close out the OSCR. Until the OSCR has been clear, personnel can not perform any analyses by this method. After the scientist has resolved the problem, personnel evaluate all analyses performed since the last in-control point.

The laboratories assess precision by examining the results from split samples or laboratory duplicates. Percent relative difference measures the precision of analyses. Percent relative difference is computed by the following equation:

$$RD = 100 \cdot \frac{S_d}{\bar{X}}$$

Where:

RD = Percent relative difference
S_d = The standard deviation estimate of the duplicate data set
$\bar{X}$ = The arithmetic mean (average) of the duplicate data set.

9 2 1 2 4 9 3 0 5 0 8

The initial QA objective for completeness of analyses in the laboratories is 90%. This means that the goal is to produce usable analytical data for a minimum of 90% of the analyses requested on all samples submitted to the laboratory. The laboratory evaluates actual performance against the 90% objective. If the laboratory performance drops below this limit, management initiates corrective action. This action shall identify and correct those activities within the laboratory that have caused the drop in performance.

4.5 A quality control program shall be established to evaluate and track the quality of the emissions measurement data against preset criteria. The program should Include where applicable a system of replicates, spiked samples, split samples, blanks and control charts. The number and frequency of such quality control checks shall be identified.

The samples analyzed under this program consist of mounts made from preparation of stack filters. Each sample collection point produces only one sample which is sent to the laboratory for analysis. No replicate samples are available. Repeat measurement of individual samples are made at the discretion of the scientist in charge.

As a type of process control samples, stack filters are not subject to matrix effects and radionuclide spikes are not used. However, tracer elements ^{243}Am and ^{236}Pu support the analysis of ^{241}Am, ^{238}Pu, and ^{239,240}Pu in the quarterly composite of weekly filter samples.

The laboratory does not split samples. There is no guarantee that the distribution of material on the filter will be homogenous. Because of this, no subsampling procedure, such as splitting, can be assured of producing two representative portions. Also, splitting the sample in effect dilutes the sample, which would adversely effects the method detection limits.

Formal blanks are not available for these analysis. However, prior to the analysis of a batch of samples, the background of the counting instrument is checked. This background check as made on each planchet and planchet holder.

Control charts and standards used in support of these analysis are described in Section 4.4.

4.6 A sample tracking system shall be established to provide for positive identification of samples and data through all phases of the sample collection, analysis and reporting system. Sample handling and preservation procedures shall be established to maintain the integrity of samples during collection, storage and analysis.

These samples come from fixed sample points and are analyzed according to established sample schedules. When requesting an analysis, the customer accesses the laboratory's sample and information management system which connects to the database, where the customer enters the request for analysis following LC-608-001, "LCCS User." The system generates the next available sample identification number and transmits it to the customer. The customer's activities, except for use of the laboratory's sample and information systems, are not covered by the laboratory's QAPP.

Sample traceability begins with the database issuance of a unique sample identification number to the requesting customer. With this

number the database references the date and time of the request, the customer's identification, the sample point, and type of analysis. Other information required to maintain the traceability of samples, such as date and time of sampling, is controlled by the customer and is not covered by this QAPP.

For each requested analysis, the database generates an analytical card. The card lists the sample, customer, and analysis requested. When the sample arrives at the laboratory, it is matched to its analytical card. The sample is then carried through the analysis listed on the card. Due to the turnaround time required on these samples, they are not normally stored. If it should become necessary, the 222-S Laboratory has secure laboratory storage available.

4.7 Periodic internal and external audits shall be performed to monitor compliance with the quality assurance program. These audits shall be performed in accordance with written procedures and conducted by personnel who do not have responsibility for performing any of the operations being audited.

Personnel within the laboratory and data quality perform internal audits on laboratory analytical activities. These internal audits do not supplant the activities of the organizations directed by policy to perform company-wide audits and surveillances, nor does the laboratory QAPP cover them.

4.8 A corrective action program shall be established including criteria for when corrective action is needed, what corrective action will be taken and who is responsible for taking the corrective action.

The laboratories follow the corrective action system defined in WHC-CM-1-3, MRP 5.1, "Corrective Action Management System." In addition, for analytical work the laboratories have an internal quality control system based on the analyses of chemical standards that can initiate a corrective action request.

4.9 Periodic reports to responsible management shall be prepared on the performance of the emissions measurements program. These reports should include assessment of the quality of the data, results of audits and description of corrective actions.

See Section 9.0 of the main body of this report.

4.10 The quality assurance program should be documented in a quality assurance project plan which should address each of the above requirements.

The future Environmental Protection Project Plan and Laboratory Quality Assurance Program Plan will address quality assurance for radioactive airborne emissions sampling and reporting.

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REFERENCES

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

EPA, 1991, "National Emission Standards for Hazardous Air Pollutants," Title 40, *Code of Federal Regulations*, Part 61, U.S. Environmental Protection Agency, Washington, D.C.

LA-218-112
LA-220-103
LA-288-101
LA-348-101
LA-508-051
LA-508-052
LA-508-110
LA-508-111
LA-508-114
LA-508-121
LA-542-101
LA-548-111
LA-549-112
LA-613-111
LA-925-107
LA-943-123
LO-150-115
LQ-508-002
LQ-508-003
LQ-508-005
PM# 2S18006
WHC-CM-4-15
WHC-CM-5-4
WHC-CM-1-3
WHC-CM-4-3
WHC-CM-4-10
WHC-CM-4-29
WHC-SD-CP-LB-003

Shewhart, 1931, *Economic Control of Quality of Manufactured Product*, Van Nostrand, New York City, New York.

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APPENDIX H

METHOD 114 COMPARISON FOR 325 LABORATORY

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APPENDIX H

METHOD 114 COMPARISON FOR 325 LABORATORY

3. Radionuclide Analysis Methods

A series of methods based on "principles of measurement" are described 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 which would interfere with the measurement.

Also identified (Table 1) are methods for a selected list of radionuclides. The listed radionuclides are those which are most commonly used and which have the greatest potential for causing dose to members of the public. Use of methods based on principles of measurement other than those described in this section must be approved in advance of use by the Administrator. For radionuclides not listed in Table 1, any of the described methods may be used provided the user can demonstrate that the applicability conditions of the method have been met.

The type of method applicable to the analysis of a radionuclide is dependent upon the type of radiation emitted, i.e., alpha, beta or gamma. Therefore, the methods described below are grouped according to principles of measurements for the analysis of alpha, beta and gamma emitting radionuclides.

3.1 Methods for Alpha Emitting Radionuclides

3.1.1 Method A-1, Radiochemistry-Alpha Spectrometry.

Principle: The element of interest is separated from other elements, and from the sample matrix using radiochemical techniques. The procedure may involve precipitation, ion exchange, or solvent extraction. Carriers (elements chemically similar to the element of interest) may be used. The element is deposited on a planchet in a very thin film by electrodeposition or by coprecipitation on a very small amount of carrier, such as lanthanum fluoride. The deposited element is then counted with an alpha spectrometer. The activity of the nuclide of interest is measured by the number of alpha counts in the appropriate energy region. A correction for chemical yield and counting efficiency is made using a standardized radioactive nuclide (tracer) of the same element. If a radioactive tracer is not available for the element of interest, a predetermined chemical yield factor may be used.

Applicability: This method is applicable for determining 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 which could interfere in the spectral region of interest. APHA-605(2), ASTM-D-3972(13).

The sample filter is destroyed by digestion with nitric acid. Activity ratios for any alpha emitters present are determined by alpha spectral analysis of a thin-film deposit prepared by electrodeposition of an aliquot from the digestion from a dimethyl sulfoxide matrix. The alpha spectrometry system consists of alpha spectrometry modules connected to a pulse height analyzer. Activity of individual alpha-emitting nuclides is calculated using the measured alpha activity ratios and a total alpha measurement performed on an aliquot of the digestion solution.

3.1.2 Method A-2, Radiochemistry-Alpha Counting.

Principle: The element of interest is separated from other elements, and from the sample matrix using radiochemistry. The procedure may involve precipitation, ion exchange, or solvent extraction. Carriers (elements chemically similar to the element of interest) may be used. The element is deposited on a planchet in a thin film and counted with a alpha counter. A correction for chemical yield (if necessary) is made. The alpha count rate measures the total activity of all emitting radionuclides of the separated element.

Applicability: This method is applicable for the measurement of any alpha-emitting radionuclide, provided no other alpha emitting radionuclide is present in the separated sample. It 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 which could be present in the sample that has the highest dose conversion factor. IDO-12096(18).

The technique of chemically separating and individually determining alpha emitting nuclides is employed only when filter sample dissolution produces a solution unsuitable for alpha spectrometry (Method 3.1.1). Counting systems described for Methods 3.1.1, 3.1.3, and 3.1.5 are employed in alpha counting operations relating to separated nuclides. Where isotopic measurements of a single element are required and the respective alpha energies do not permit satisfactory differentiation, mass spectrometry is employed.

3.1.3 Method A-3, Direct Alpha Spectrometry.

Principle: The sample, collected on a suitable filter, is counted directly on an alpha spectrometer. The sample must be thin enough and collected on the surface of the filter so that any absorption of alpha particle energy in the sample or the filter, which would degrade the spectrum, is minimal.

Applicability: This method is applicable to simple mixtures of alpha emitting radionuclides and only when the amount of particulates collected on the filter paper are relatively small and the alpha spectra is adequately resolved. Resolutions should be 50 keV (FWHM) or better, ASTM-D-3084(16).

This method is not used to produce quantitative alpha data. Direct alpha spectral analysis does not provide spectra of satisfactory resolution with currently used filter media. This method may be used to identify the chemical separations, if any, required when Methods 3.1.1 and 3.1.2 are performed.

3.1.4 Method A-4, Direct Alpha Counting (Gross alpha determination).

Principle: The sample, collected on a suitable filter, is counted with an alpha counter. The sample must be thin enough so that self-absorption is not significant and the filter must be of such a nature that the particles are retained on the surface.

Applicability: Gross alpha determination 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 for the purposes and under the conditions described in section 3.7. APHA-601(3), ASTM-D-1943(10).

Filter samples are counted directly in a low background counting system. The system consists of a thin-window gas-flow proportional detector and a gas-flow proportional guard detector operated in anti-coincidence, a high voltage supply, a low/wide beta amp/discriminator, a low/wide beta amp/single channel analyzer, a timer, and two scalers. The system employs pulse height discrimination to differentiate alpha and beta activity. This method is used to screen filter samples for those exhibiting alpha activity levels sufficiently above detection limits to allow application of Method 3.1.1. An alpha scintillation counter employing a zinc sulfide detector is employed to perform alpha measurements on filter samples exhibiting beta/alpha activity ratios high enough to introduce significant uncertainty into alpha results.

3.1.5 Method A-5, Chemical Determination of Uranium.

Uranium: Uranium may be measured chemically by either colorimetry or fluorometry. In both procedures, the sample is dissolved, the uranium is oxidized to the hexavalent form and extracted into a suitable solvent. Impurities are removed from the solvent layer. For colorimetry, dibenzoylmethane is added, and the uranium is measured by the absorbance in a colorimeter. For fluorometry, a portion of the solution is fused with a sodium fluoride-lithium fluoride flux and the uranium is determined by the ultraviolet activated fluorescence of the fused disk in a fluorometer.

Applicability: This method is applicable to the measurements of emission rates of uranium when the isotopic ratio of the uranium radionuclides is well known. ASTM-E318(15), ASTM-D-2907(14).

The sample filter is destroyed by digestion with nitric acid and the resulting solution is analyzed directly in aqueous solution using a pulsed laser fluorimeter.

3.1.6 Method A-6, Radon-222-Continuous Gas Monitor.

Principle: Radon-222 is measured directly in a continuously extracted sample stream by passing the air stream through a calibrated scintillation cell. Prior to the scintillation cell, the air stream is treated to remove particulates and excess moisture. The alpha particles from radon-222 and its decay products strike a zinc sulfide coating on the inside of the scintillation cell producing light pulses. The light pulses are detected by a photomultiplier tube which generates electrical pulses. These pulses are processed by the system electronics and the read out is in pCi/l of radon-222.

Applicability: This method is applicable to the measurement of radon-222 in effluent streams which do not contain significant quantities of radon-220. Users of this method should calibrate the monitor in a radon calibration chamber at least twice per year. The background of the monitor should also be checked periodically by operating the instrument in a low radon environment. EPA 520/1-89-009(24).

In-line monitoring of effluent air streams is not included in the analytical plan for the segment of the emission monitoring program performed by the Analytical Chemistry Laboratory.

3.1.7 Method A-7, Radon-222-Alpha Track Detectors

Principle: Radon-222 is measured directly in the effluent stream using alpha track detectors (ATD). The alpha particles emitted by radon-222 and its decay products strike a small plastic strip and produce submicron damage tracks. The plastic strip is placed in a caustic solution that accentuates the damage tracks which are counted using a microscope or automatic counting system. The number of tracks per unit area is corrected to the radon concentration in air using a conversion factor derived from data generated in a radon calibration facility.

Applicability: Prior approval from EPA is required for use of this method. This method is only applicable to effluent streams which do not contain significant quantities of radon-220, unless special detectors are used to discriminate against radon 220. This method may be used only when ATDs have been demonstrated to produce data comparable to data obtained with Method A-6. Such data should be submitted to EPA when requesting approval for the use of this method. EPA 520/1-89-009(24).

In-line monitoring of effluent air streams is not included in the analytical plan for the segment of the emission monitoring program performed by the Analytical Chemistry Laboratory.

3.2 Methods for Gaseous Beta Emitting Radionuclides.

3.2.1 Method B-1, Direct Counting in Flow-Through Ionization Chambers.

Principle: An ionization chamber containing a specific volume of gas which flows at a given flow rate through the chamber is used. The sample (effluent stream sample) acts as the counting gas for the chamber. The activity of the radionuclide is determined from the current measured in the ionization chamber.

Applicability: This method is applicable for 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. DOE/EP-0096(17), NCRP-58(23).

In-line monitoring of effluent air streams is not included in the analytical plan for the segment of the emission monitoring program performed by the Analytical Chemistry Laboratory.

3.2.2 Method B-2, Direct Counting With In-line or Off-line Beta Detectors.

Principle: The beta detector is placed directly in the effluent stream (in-line) or an extracted sample of the effluent stream is passed through a chamber containing a beta detector (off-line). The activities of the radionuclides present in the effluent stream are determined from the beta count rate, and a knowledge of the radionuclides present and the relationship of the gross beta count rate and the specific radionuclide concentration.

Applicability: This method is applicable only to radionuclides with maximum beta particle energies greater then 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. Specific radionuclide analysis of periodic grab samples

may be used to identify the types and quantities of radionuclides present and to establish the relationship between specific radionuclide analyses and gross beta count rates.

This method is applicable to unidentified mixtures of gaseous radionuclides only for the purposes and under the conditions described in section 3.7.

In-line air stream samples are not included in the analytical plan for the segment of the emission monitoring program performed by the Analytical Chemistry Laboratory.

3.3 Methods for Non-Gaseous Beta Emitting Radionuclides.

3.3.1 Method B-3, Radiochemistry-Beta Counting.

Principle: The element of interest is separated from other elements, and from the sample matrix by radiochemistry. This may involve precipitation, distillation, ion exchange, or solvent extraction. Carriers (elements chemically similar to the element of interest) may be used. The element is deposited on a planchet, and counted with a beta counter. Corrections for chemical yield and decay (if necessary) are made. The beta count rate determines the total activity of all radionuclides of the separated element. This method may also involve the radiochemical separation and counting of a daughter element, after a suitable period of ingrowth, in which case it is specific for the parent nuclide.

Applicability: This method is applicable for 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. APHA-608(5).

The sample filter is destroyed by digestion with nitric acid. Beta-emitting nuclides are determined by one or more of the following methods:

- **Gamma spectral analysis of a digestion solution aliquot for determination of those nuclides with associated gamma activity**
- **Beta absorption measurement of a digestion solution aliquot by absorber counting in a gas-flow proportional counter**
- **Chemical separation of pure beta-emitting nuclides, followed by counting in a gas-flow proportional counter or liquid scintillation counter (Method 3.3.3).**

3.3.2 Method B-4, Direct Beta Counting (Gross beta determination).

Principle: The sample, collected on a suitable filter, is counted with a beta counter. The sample must be thin enough so that self-absorption corrections can be made.

Applicability: 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 the purposes and under the conditions described in section 3.7. APHA-602(4), ASTM-D-1890(11).

Filter samples are counted directly in a low background counting system. The system consists of a thin-window gas-flow proportional detector and a gas-flow proportional guard detector operated in anti-coincidence, a high voltage supply, a low/wide beta amp/discriminator, a low/wide beta amp/single channel analyzer, a timer, and two scalers. The system employs pulse height discrimination to differentiate alpha and beta activity. This method is used to screen filter samples for those exhibiting beta activity levels sufficiently above detection limits to allow application of Method 3.2.3. Absorption techniques using a thin absorber are employed to perform beta measurement on filter samplers exhibiting alpha/beta activity ratios high enough to introduce significant uncertainty into beta results.

3.3.3 Method B-5, Liquid Scintillation Spectrometry.

Principle: An aliquot of a collected sample or the result of some other chemical separation or processing technique is added to a liquid scintillation "cocktail" which is viewed by photomultiplier tubes in a liquid scintillation spectrometer. The spectrometer is adjusted to establish a channel or "window" for the pulse energy appropriate to the nuclide of interest. The activity of the nuclide of interest is measured by the counting rate in the appropriate energy channel. Corrections are made for chemical yield where separations are made.

Applicability: This method is applicable to 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 which 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. APHA.609(6), EML LV-539-17(19).

The sample filter is destroyed by digestion with nitric acid. When a single beta emitter is present, only two low energy beta emitters sufficiently separated in energy for spectral resolution are present, or a chemical separation isolates a single beta-emitting nuclide, the digestion solution is analyzed in a liquid scintillation spectrometer.

3.4 Gamma Emitting Radionuclides

3.4.1 Method G-1. High Resolution Gamma Spectrometry.

Principle: The sample is counted with a high resolution gamma detector, usually either a Ge(Li) or a high purity Ge detector, connected to a multichannel analyzer or computer. The gamma emitting radionuclides in the sample are measured from the gamma count rates in the energy regions characteristic of the individual radionuclide. Corrections are made for counts contributed by other radionuclides to the spectral regions of the radionuclides of interest. Radiochemical separations may be made prior to counting but are usually not necessary.

Applicability: This method is applicable to the measurement of any gamma emitting radionuclide with gamma energies greater than 20 keV. It 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. ASTM-3649(9), IDO-12096(18).

Filter and charcoal cartridge samples are counted directly on a high-resolution intrinsic germanium detector. The system consists of the detector, a bias supply, a spectrometry amplifier, an analog-to-digital converter, and a pulse height analyzer linked to a multiuser system.

3.4.2 Method G-2, Low Resolution Gamma Spectrometry.

Principle: The sample is counted with a low resolution gamma detector, a thallium activated sodium iodide crystal. The detector is coupled to a photomultiplier tube and connected to a multichannel analyzer. The gamma emitting radionuclides in the sample are measured from the gamma count rates in the energy regions characteristic of the individual radionuclides. Corrections are made for counts contributed by other radionuclides to the spectral regions of the radionuclides of interest. Radiochemical separation may be used prior to counting to obtain less complex gamma spectra if needed.

Applicability: This method is applicable to the measurement of gamma emitting radionuclides with energies greater than 100 keV. It 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 by passing the gas stream through a chamber or cell containing the detector. ASTM-D-2459(12), EMSL-LV-0539-17(19).

Charcoal cartridge samples are counted directly on a 4-in. by 5-in thallium-activated sodium iodide detector. The system consists of the detector, a high voltage supply, a preamplifier, a linear amplifier, an analog-to-digital converter, and a pulse height analyzer linked to a multiuser system. This method is used to screen charcoal cartridge samples for those samples exhibiting gamma activity levels sufficiently above detection limits to permit gamma component identification by high-resolution gamma spectrometry.

3.4.3 Method G-3, Single Channel Gamma Spectrometry.

Principle: The sample is counted with a thallium activated sodium iodide crystal. The detector is coupled to a photomultiplier tube connected to a single channel analyzer. The activity of a gamma emitting radionuclide is determined from the gamma counts in the energy range for which the counter is set.

Applicability: This method is applicable to the measurement of a single gamma emitting radionuclide. It 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 by passing the gas stream through a chamber or cell containing the detector.

Single channel gamma spectrometry is not employed at the Analytical Chemistry Laboratory.

3.4.4 Method G-4, Gross Gamma Counting.

Principle: The sample is counted with a gamma detector usually a thallium activated sodium iodine crystal. The detector is coupled to a photomultiplier tube and gamma rays above a specific threshold energy level are counted.

Applicability: 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 stream are well known. When gross gamma measurements are used to determine emissions of specific radionuclides periodic measurements using Methods G-1 or G-2 should be made to demonstrate that the gross gamma measurements provide reliable emission data. This 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 passing an extracted sample of the effluent stream through a chamber or cell containing the detector.

Gross gamma counting techniques are not included in the analytical plan for the segment of the emissions monitoring program performed by the Analytical Chemistry Laboratory.

3.5 Counting Methods. All of the methods with the exception of Method A-5 involve counting the radiation emitted by the radionuclide. Counting methods applicable to the measurement of alpha, beta and gamma radiations are listed below. The equipment needed and the counting principles involved are described in detail in ASTM-3648(8).

3.5.1 Alpha Counting:

▪ Gas Flow Proportional Counters. The alpha particles cause ionization in the counting gas and the resulting electrical pulses are counted. These counters may be windowless or have very thin windows.

▪Scintillation Counters. The alpha particles transfer energy to a scintillator resulting in a production of light photons which strike a photomultiplier tube converting the light photons to electrical pulses which are counted. The counters may involve the use of solid scintillation materials such as zinc sulfide or liquid scintillation solutions.

▪Solid-State Counters. Semiconductor materials, such as silicon surface-barrier p-n junctions, act as solid ionization chambers. The alpha particles interact which the detector producing electron hole pairs. The charged pair is collected by an applied electrical field and the resulting electrical pulses are counted.

▪Alpha Spectrometers. Semiconductor detectors used in conjunction with multichannel analyzers for energy discrimination.

- **Gas-Flow Proportional Counters. A thin-window gas-flow proportional counting system is employed to perform Methods 3.1.2 and 3.1.4.**
- **Scintillation Counters. An alpha scintillation counter equipped with a zinc sulfide detector may be employed to perform Method 3.1.4.**
- **Solid State Counters. Solid state semiconductor detectors are employed in alpha spectrometry Methods 3.1.1 and 3.1.3 and in gross alpha measurements associated with Methods 3.1.2 and 3.1.4.**

- **Alpha Spectrometers. Solid state semiconductor detector equipped pulse height analyzers are employed to perform Methods 3.1.1 and 3.1.3.**

- **Liquid Scintillation Spectrometers. Liquid scintillation spectrometer systems designed to discriminate between alpha, beta, and gamma activity on a pulse shape basis are not currently operational at the Analytical Chemistry Laboratory. Scintillation techniques that discriminate between alpha and beta activity on a pulse height basis are not included in the analytical plan for the emissions monitoring program performed at the Analytical Chemistry Laboratory.**

3.5.2 Beta Counting:

▪Ionization Chambers. These chambers contain the beta-emitting nuclide in gaseous form. The ionization current produced is measured.

▪Geiger-Muller (GM) Counters-or Gas Flow Proportional Counters. The beta particles cause ionization in the counting gas and the resulting electrical pulses are counted. Proportional gas flow counters which are heavily shielded by lead or other metal, and provided with an anti-coincidence shield to reject cosmic rays, are called low background beta counters.

▪Scintillation Counters. The beta particles transfer energy to a scintillator resulting in a production of light photons, which strike a photomultiplier tube converting the light photon to electrical pulses which are counted. This may involve the use of anthracene crystals, plastic scintillator, or liquid scintillation solutions with organic phosphors.

▪Liquid Scintillation Spectrometers. Liquid scintillation counters which use two photomultiplier tubes in coincidence to reduce background counts. This counter may also electronically discriminate among pulses of a given range of energy.

- **Ionization Chambers. The analytical plan for the segment of the emissions monitoring program performed by the Analytical Chemistry Laboratory does not include samples suited to this counting technique.**

- **Gas-Flow Proportional Counters. A thin window gas-flow proportional counting system is employed to perform Methods 3.3.1 and 3.3.2.**

- **Scintillation Counters. Solid state beta scintillation detectors are not currently included in the analytical plan for the segment of the emissions monitoring program performed by the Analytical Chemistry Laboratory.**

- **Liquid Scintillation Spectrometer. Liquid scintillation spectrometer systems designed to discriminate between alpha, beta, and gamma activity on a pulse shape basis are not currently operational at the Analytical Chemistry Laboratory. Scintillation techniques that discriminate between alpha and beta activity on a pulse height basis are not included in the analytical plan for the emissions monitoring program performed at the Analytical Chemistry Laboratory.**

3.5.3 Gamma Counting:

▪Low-Resolution Gamma Spectrometers. The gamma rays interact with thallium activated sodium iodide or cesium iodide crystal resulting in the release of light photons which strike a photomultiplier tube converting the light pulses to electrical pulses proportional to the energy of the gamma ray. Multi-channel analyzers are used to separate and store the pulses according to the energy absorbed in the crystal.

▪High-Resolution gamma Spectrometers. Gamma rays interact with a lithium-drifted (Ge(Li)) or high-purity germanium (HPGe) semiconductor detectors resulting in a production of electron-hole pairs. The

charged pair is collected by an applied electrical field. A very stable low noise preamplifier amplifies the pulses of electrical charge resulting from the gamma photon interactions. Multichannel analyzers or computers are used to separate and store the pulses according to the energy absorbed in the crystal.

▪Single Channel Analyzers. Thallium activated sodium iodide crystals used with a single window analyzer. Pulses from the photomultiplier tubes are separated in a single predetermined energy range.

- **Low Resolution Gamma Spectrometers. A 4-in. by 5-in. thallium-activated sodium iodide detector is employed to perform Method 3.4.2.**

- **High Resolution Gamma Spectrometer. A high-resolution intrinsic germanium detector is employed to perform Method 3.4.1.**

- **Single Channel Analyzers - Single channel gamma spectrometry is not included in the analytical plan for the emissions monitoring program performed at the Analytical Chemistry Laboratory.**

3.5.4 Calibration of Counters. Counters are calibrated for specific radionuclide measurements using a standard of the radionuclide under either identical or very similar conditions as the sample to be counted. For gamma spectrometers a series of standards covering the energy range of interest may be used to construct a calibration curve relating gamma energy to counting efficiency.

In those cases where a standard is not available for a radionuclide, counters may be calibrated using a standard with energy characteristics as similar as possible to the radionuclide to be measured. For gross alpha and beta measurements of the unidentified mixtures of radionuclides, alpha counters are calibrated with a natural uranium standard and beta counters with a cesium-137 standard. The standard must contain the same weight and distribution of solids as the samples, and be mounted in an identical manner. If the samples contain variable amounts of solids, calibration curves relating weight of solids present to counting efficiency are prepared. Standards other than those prescribed may be used provided it can be shown that such standards are more applicable to the radionuclide mixture measured.

The thin-window gas-flow proportional counter that is used for filter sample screening for positive amounts of alpha and beta activity using Methods 3.1.4 and 3.3.2 is calibrated for the alpha-emitting nuclide ^{239}Pu and beta-emitting nuclides ^{90}SrY, ^{99}Tc, and ^{137}Cs using National Institute of Standards and Technology (NIST) traceable standard reference materials fabricated into the filter sample counting geometry configuration. Efficiency data measured for ^{239}Pu have been demonstrated to be applicable to all alpha energies greater than 4.0 MeV. The analytical program specifies that all net beta measurement amounting to less than the 2 sigma uncertainty in the measured beta counting background will be reported as less than a detection limit based on that 2 sigma quantity and calculated as ^{90}SrY. Gross beta results for filter samples exhibiting positive beta activity are calculated using an efficiency that is weighted according to components identified in the sample using Method 3.3.1.

The high-resolution gamma ray spectrometry system that is used for quantitative gamma spectral analysis of filter and charcoal cartridge samples, Method 3.4.1, is efficiency calibrated using a mixed nuclide certified standard and individual NIST traceable standard reference solutions of ^{60}Co, ^{131}I, ^{133}Ba, ^{137}Cs, and ^{152}Eu fabricated into the charcoal cartridge counting geometry configuration. The emissions monitoring program plan (PNL 1990) specifies that charcoal cartridge samples exhibiting no ^{131}I activity at the 364 KeV principal gamma energy shall be reported as containing less than an ^{131}I detection limit calculated using the 2 sigma uncertainty in the measured spectrum background at that energy.

3.6 Radiochemical Methods for Selected Radionuclides. Methods for a selected list of radionuclides are listed in Table 1. The radionuclides listed are those which are most commonly used and which hove the greatest potential for causing doses to members of the public. For radionuclides not listed in Table 1, methods based on any of the applicable "principles of measurement" described in section 3.1 through 3.4 may be used.

Filter and charcoal cartridge samples found to contain significant alpha, beta, or gamma activity components during screening under Methods 3.1.4, 3.3.2, and 3.4.2 that cannot be quantitatively determined by gamma spectral analysis using Method 3.4.1 are analyzed using counting Methods 3.1.1, 3.1.2, and 3.3.1. Volume 7 of the Analytical Chemistry Laboratory Manual (PNL 1990) contains established procedures for separation and measurement of selected radionuclides not specific to the emissions monitoring program plan that can be applied to filter and charcoal sample analysis.

3.7 Applicability of Gross Alpha and Beta Measurements to Unidentified Mixtures of Radionuclides. Gross alpha and beta measurements may be used as a screening measurement as a part of an emission measurement program to identify the need to do specific radionuclide analyses or to confirm or verify that unexpected radionuclides are not being released in significant quantities.

Gross alpha (Method A-4) or gross beta (Methods B-2 or B-4) measurements may also be used for the purpose of comparing the measured concentrations in the effluent stream with the limiting "Concentration Levels for Environmental Compliance" in Table 2 of Appendix E. For unidentified mixtures, the measured concentration value shall be compared with the lowest environmental concentration limit for any radionuclide which is not known to be absent from the effluent stream.

Methods 3.1.4 and 3.3.2 gross activity measurements are used only as a screening procedure to identify those filter samples containing significant amounts of alpha and beta activity, respectively. Detection limit values calculated using the 2 sigma uncertainty in the respective measured backgrounds are reported for samples exhibiting net activities less than these uncertainties.

4.0 Quality Assurance Methods

Each facility required to measure their radionuclide emissions shall conduct a quality assurance program in conjunction with the radionuclide emission measurements. This program shall assure that the emission measurements are representative, and are of known precision and accuracy and shall include administrative controls to assure prompt response when emission measurements indicate unexpectedly large emissions. The program shall consist of a system of policies, organizational responsibilities, written procedures, data quality specifications, audits, corrective actions and reports. This quality assurance program shall include the following program elements:

4.3.5 A description of the laboratory analysis procedures used for each radionuclide measured. including frequency of analysis calibration procedures and frequency of calibration.

Particulate matter filter samples and gaseous material charcoal absorption samples are collected from the various sampling sites on a scheduled, usually weekly, basis by Westinghouse Hanford personnel. These samples are delivered to the Analytical Chemistry Laboratory, 325 Building, 300 Area.

Calibration procedures for all counting instruments employed in the performance of analytical measurements described for emission monitoring program samples in Volume 6 of the Analytical Chemistry Laboratory Manual are documented in that manual (PNL 1990).

The filter and charcoal cartridge samples that constitute the Analytical Chemistry Laboratory emissions monitoring program rarely exhibit positive gross alpha, gross beta, or gamma activity, excepting naturally occurring

radon daughter activity when certain atmospheric conditions exist. For samples exhibiting net activities less than the 2 sigma uncertainty of the applicable counting instrument measured background, these 2 sigma uncertainties are used to calculate maximum possible limits for possible alpha, beta, and gamma emissions. Calculation conventions for gross count data are described in Table II, Section 3.5.4, Calibration of Counters (PNL 1990).

Filter samples exhibiting net alpha activity greater than the 2 sigma uncertainty in the measured beta counting system background are quantitatively analyzed by chemical destruction of the filter medium followed by direct total alpha and alpha spectral measurement of the resulting solution.

Filter samples exhibiting net beta activity greater than the 2 sigma uncertainty in the measured alpha counting system background are quantitatively analyzed by direct high-resolution gamma ray spectrometry. When data indicate possible presence of pure beta-emitting radionuclides in a filter sample, quantitative analytical methods for ^{90}SrY, ^{99}Tc, and ^{147}Pm, documented in Volume 7 of the Analytical Chemistry Laboratory Manual (PNL 1990) are performed.

4.5 A quality control program shall be established to evaluate and track the quality of the emissions measurement data against preset criteria. The program should Include where applicable a system of replicates, spiked samples, split samples, blanks and control charts. The number and frequency of such quality control checks shall be identified.

Quality control procedures governing calibration and control of counting instruments employed in the emissions monitoring program are documented in Volume 6 of the Analytical Chemistry Laboratory Manual (PNL 1990). Counting instrument performance is monitored by the use of "control" sources consisting of selected radionuclides exhibiting energy range extremes which are established simultaneously with instrument calibration. Control sources are remeasured daily; so long as a control measurement result falls within 3 sigma limits established for the original control data, instrument calibration is assumed to remain valid. Should a control count exceed a 2 sigma limit, a remeasurement is performed; should both measurements fall outside a 3 sigma limit, the instrument is referred to a cognizant scientist for further testing and referral to instrument repair services. When an instrument is returned to service, it is recalibrated and new controls are established. Alpha proportional counting systems are controlled using ^{239}Pu sources, alpha spectral analyzers with a mixed ^{237}Np + ^{239}Pu + ^{241}Am source, and beta proportional counting systems with individual ^{99}Tc, ^{147}Pm, and ^{90}SrY sources. High resolution gamma spectral analyzers are controlled with either a mixed ^{241}Am + ^{137}Cs + ^{60}Co source or a ^{152}Eu + ^{137}Cs + ^{60}Co source, while low resolution gamma spectral analyzers are controlled with individual ^{57}Co and ^{60}Co sources.

Counting system backgrounds are measured at least once each working day; long background measurements are performed over weekends.

A control chart is used to evaluate current performance of each counting instrument and to identify trends in performance. Control of each instrument is determined at least once each working day before the instrument is used. All calibration data, control data, and background

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data are recorded directly into a laboratory record book dedicated to that specific instrument. Control charts and instrument maintenance and repair records are included in the same volume.

The individual procedures for quantitative determination of specific nuclides documented in Volume 7 of PNL (1990) specify replicate analysis, internal standards, and other quality-related operations in performance of radiochemical analysis where applicable.

REFERENCE

PNL, 1990, *Analytical Chemistry Laboratory Manual*, Volumes 6 and 7, PNL-MA-597, Pacific Northwest Laboratory, Richland, Washington.

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