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# Quality Assurance Program Plan for Radionuclide Airborne Emissions Monitoring

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

**Westinghouse Hanford Company** Richland, Washington

Management and Operations 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

R. J. Boom

Date Published
December 1995

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Assistant Secretary for Environmental Management

**Westinghouse Hanford Company** P.O Box 1970
Richland, Washington

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# QUALITY ASSURANCE PROGRAM PLAN FOR RADIONUCLIDE AIRBORNE EMISSIONS MONITORING

**R. J. Boom**

## ABSTRACT

*This Quality Assurance Program Plan identifies quality assurance program requirements and addresses the various Westinghouse Hanford Company organizations and their particular responsibilities in regards to sample and data handling of airborne emissions.*

*The Hanford Site radioactive airborne emissions requirements are defined in "National Emissions Standards for Hazardous Air Pollutants (NESHAP)," Code of Federal Regulations, Title 40, Part 61, Subpart H (EPA 1991a). Reporting of the emissions to the U.S. Department of Energy is performed in compliance with requirements of U.S. Department of Energy, Richland Operations Office Order 5400.1, General Environmental Protection Program (DOE-RL 1988).*

*This Quality Assurance Program Plan is prepared in accordance with and to the requirements of QAMS-004/80, Guidelines and Specifications for Preparing Quality Assurance Program Plans (EPA 1983).*

*Title 40 CFR Part 61, Appendix B, Method 114, "Quality Assurance Methods" (EPA 1991b) specifies the quality assurance requirements and that a program plan should be prepared to meet the requirements of this regulation.*

*This Quality Assurance Program Plan identifies NESHAP responsibilities and how the Westinghouse Hanford Company Environmental, Safety, Health, and Quality Assurance Division will verify that the methods are properly implemented.*

## TABLE OF CONTENTS

## TABLE OF CONTENTS (continued)

APPENDIXES

## LIST OF FIGURES

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# LIST OF TERMS

| | |
|---|---|
| ABCASH | Automated Bar Coding of Air Samples at Hanford |
| AEA | alpha energy analysis |
| AEQA | Analytical and Environmental Quality Assurance |
| ALARA | as low as reasonably achievable |
| AMS | analytical measurement system |
| CA | Compliance Assurance |
| CAM | continuous air monitor |
| CFR | Code of Federal Regulations |
| COC | chain of custody |
| CPRM | continuous particulate release monitor |
| DCRT | double contained receiving tank |
| DOE | U.S. Department of Energy |
| EM | Effluent Monitoring |
| EML | Environmental Monitoring Laboratory |
| EMSL | Environmental Monitoring Support Laboratory |
| EPA | Environmental Protection Agency |
| ES | Environmental Services |
| ESQ | Environmental, Safety and Quality |
| FPMCS | Facility Process Monitor Control System |
| GEA | gamma energy analysis |
| HEPA | high-efficiency particulate air [filter] |
| HPGe | high-purity germanium |
| JCS | Job Control System |
| LIMS | Laboratory Information Management System |
| MCA | multichannel analyzer |
| MPPP | Maintenance Programs/Plant Project |
| NESHAP | National Emission Standards for Hazardous Air Pollutants |
| NIST | National Institute of Standards and Technology |
| Northwest Laboratory | Pacific Northwest National Laboratory |
| PFP | Plutonium Finishing Plant |
| PNNL | Pacific Northwest National Laboratory |
| PSCP | Pisces System Calibration Procedures |
| PUREX | Plutonium-Uranium Extraction [Plant] |
| QA | quality assurance |
| QAPjP | quality assurance project plan |
| QAPP | quality assurance program plan |
| QC | quality control |
| QI | quality instruction |
| QR | quality requirement |
| RC | Radiological Control |
| RCT | radiological control technician |
| RPD | relative percent difference |
| RSD | relative standard deviation |
| SOW | statement of work |
| TFTP | Tank Farm Transition Project |
| TWRS | Tank Waste Remediation System |
| WHC | Westinghouse Hanford Company |
| WSCF | Waste Sampling and Characterization Facility |

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# QUALITY ASSURANCE PROGRAM PLAN FOR RADIONUCLIDE AIR EMISSIONS MONITORING

## 1.0 INTRODUCTION

This Quality Assurance Program Plan (QAPP) describes the quality assurance requirements and responsibilities for radioactive airborne emissions measurements activities for regulated stacks, and how these activities are controlled at the Hanford Site. 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 1991a). Detailed monitoring requirements apply to stacks whose potential emissions exceed 1% of the standard of 10 mrem annual effective dose equivalent to the maximally exposed individual from operations at the Hanford Site.

Title 40 CFR Part 61, Appendix B, Method 114, "Quality Assurance Methods" (EPA 1991b) specifies the quality assurance (QA) requirements and that a QAPP should be prepared to meet the requirements of this regulation.

Radiological Control, Effluent Monitoring, and facility personnel can then access this data soon after they are produced, usually the day after the filters are analyzed.

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## 2.0 QUALITY ASSURANCE POLICY STATEMENT

Westinghouse Hanford Company (WHC) shall maintain and verify a prevention-oriented QA program to ensure that WHC 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.

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# 3.0 EMERGENCY, SAFETY, AND QUALITY SERVICES MANAGEMENT

Independent oversight verification activities associated with the radioactive airborne emission measurements are controlled by the WHC Emergency, Safety, and Quality Services Division and Environmental Services (ES). The organizations that perform environmental oversight activities, and their interfaces, are noted in Figures 7-2 and 7-6.

The sections that follow describe the responsibilities of each involved organization as they relate to radioactive air emissions measurements.

## 3.1 Environmental Compliance Assessment

The organizational chart for ES is shown in Figure 7-2.

ES maintains and implements a comprehensive oversight program to independently verify that WHC operations and programs are conducted in compliance with applicable environmental regulations, U. S. Department of Energy (DOE) orders, and WHC management control systems.

ES schedules and performs oversight activities (compliance assessments) in accordance with requirements specified in WHC-CM-4-6, *Compliance Assurance*.

Radioactive airborne emission assessments will be conducted routinely on selected WHC facilities.

## 3.2 Quality Assurance

The organizational charts for Quality Assurance are shown in Figure 7-6 and Figure 7-7.

Surveillances will be performed and controlled in accordance with WHC-CM-4-2, Quality Requirement (QR) 10.0, "Inspection and Surveillance," and WHC-CM-4-5, Quality Assurance Instruction (QAI) 10.4, "Surveillance."

### 3.2.1 Analytical and Environmental Quality Assurance

The organizational chart for Analytical and Environmental Quality Assurance is shown on Figure 7-7.

The Analytical and Environmental Quality Assurance (AEQA) group is responsible to review and approve this QAPP to verify that regulatory QA requirements are included and implemented as specified. This includes interfacing with the Environmental Services Organization to ensure that regulatory updates are incorporated into the document.

AEQA interfaces with the Environmental Services Organization by reviewing and approving documents that define environmental regulatory quality requirements. AEQA also reviews and approves regulatory implementation documents and surveils the activities of the groups in this organization.

AEQA provides general direction and oversight of NESHAP's QA activities, provides training to other QA personnel, and conducts surveillances as needed to verify that activities are controlled.

AEQA is responsible for surveillance of activities associated with control of laboratory analysis activities, including:

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

### 3.2.2 Projects/Site Support Quality Assurance

The organizational chart for Projects/Site Support Quality Assurance is shown on Figure 7-7.

The Projects/Site Support Quality Assurance group interfaces with the Radiological Control and Maintenance Programs/Plant Project (MPPP) (vent and balance) groups by providing QA support of quality-affecting activities such as inspections, inspection planning, document review and approval, and participation in management self-assessments. They also provide the MPPP group with oversight of their quality-affecting activities through performance of assessments.

Reference: Sections 6.3.2 and 6.3.6 and Figures 7-5 and 7-8 of this document.

### 3.2.3 QA Personnel Associated with Facilities

The organizational chart for Facility Quality Assurance is shown on Figure 7-7.

QA personnel associated with WHC facilities are responsible for interfacing with responsible facility personnel in reviewing and approving facility radioactive air monitoring documentation and verifying its implementation. These QA personnel review, approve, and verify facility activities described in Section 6.3.1 of this document.

# 4.0 DOCUMENT CONTROL AND RECORDS

Records of effluent sample analyses performed by the laboratory and used to generate and verify regulatory reports shall be retained by the laboratory. Effluent flow measurements and record sampling data for each facility stack shall be validated by the facilities and then transmitted to the Effluent Monitoring Group. These records will be controlled in accordance with WHC-CM-4-2, QR 6.0, "Document Control," and QR 17.0, "Quality Assurance Records."

## 4.1 QUALITY ASSURANCE

The QA groups perform surveillances to verify the activities noted above. The requirements for control and documentation of surveillances is addressed in WHC-CM-4-2, QR 10, "Inspection and Surveillance" and WHC-CM-4-5, QAI 10.4, "Surveillance."

All surveillances, with any noted deficiencies, are routed to the Corrective Action System organization. They control their activities in accordance with WHC-CM-1-4, *Corrective Action Management Manual*.

## 4.2 COMPLIANCE ASSURANCE

WHC-CM-4-6, *Compliance Assurance Manual*, and WHC-CM-4-2, QR 18.0 "Audits" and Quality Instruction (QI) 18.1 "Audit Programming and Scheduling," specify how Compliance Assurance oversight documentation (in-process records and QA records) generated during oversight activities will be maintained and controlled.

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# 5.0 ORGANIZATION CHARTERS AND PERSONNEL QUALIFICATIONS

All organization charters are included in WHC-CM-1, *Company Policies and Charters*. Management structures at all levels are depicted in a divisional/departmental organization chart. Section 7.0 of this document identifies these organizations and their relationship to NESHAP activities.

The job classification, training, and indoctrination requirements are specified in WHC-CM-1-3, *Management Requirements and Procedures* and WHC-CM-4-33, *Security Manual*. Each manager maintains employee records, documenting needed training completed for each job assignment, in accordance with this requirement.

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# 6.0 RADIOACTIVE AIR EMISSIONS MEASUREMENT QUALITY ASSURANCE PROJECT PLANS IMPLEMENTATION

## 6.1 INTRODUCTION

The NESHAP (EPA 1991a) suggests that a Quality Assurance Project Plan (QAPjP) be prepared to the requirements of 40 CFR 61, Appendix B, Method 114 (EPA 1991b), for measuring radioactive air emissions. Section 6.0 of this QAPP, plus the attached appendixes, fulfill the QAPjP requirements for all regulated stacks. These QAPjP requirements are addressed below.

- Each organization involved with the NESHAP program, and a description of its activities, is addressed in Section 6.3 of this document. In addition, facilities required to perform a point-by-point comparison to 40 CFR 61 Appendix B, Method 114, Section 4.0, "QA Methods," (EPA 1991b) are appended to this document.
- The Effluent Monitoring (EM) organization has issued a separate QAPjP, WHC-EP-0528-1 (WHC 1994a), prepared in accordance with the format of QAMS-005/80 (EPA 1983). The QAPjP addresses the appropriate NESHAP requirements (see Section 6.3.5) and provides technical support to the radioactive air emissions measurement program.
- Facility organizations that are responsible for specific stacks shall prepare and maintain a NESHAP, Appendix B, Method 114, "QA Method," point-by-point implementation document for each stack (see Section 6.3.1). The point-by-point implementation documents are appended to this QAPP.
- For those organizations that work with all stacks, the implementing information is included in this QAPP. This includes the efforts of the Radiological Control and Maintenance Programs/Plant Project organizations (see Sections 6.3.2 and 6.3.6).
- The laboratories' point-by-point implementation is appended to this document (see Section 6.3.3).

## 6.2 SAMPLE TRACKING AND REPORTING SYSTEM

WHC has instituted the Automated Bar Coding Of Air Samples at Hanford (ABCASH) system to provide automated data acquisition, tracking, and analysis of air filter sample information. This comprehensive system controls tracking of this information from the time the sample is taken until the analytical information is provided to the report preparer. The ABCASH system provides information for the following users:

Sample Collection (Radiological Control Technician)
- automated collection of sample location, time, employee identification
- reader input of gas meter, rotameter, and vacuum values
- independent verification of above information

Analysis (Laboratory)
- tracking of samples from collection to compositing to analysis
- laboratory input of lab analysis information
- data tables to verify analyses

Facility Control (Responsible Facility Personnel)
- user input of stack flow values or flow integrator values
- user input of sampling and line efficiency data
- numerous data tables available to verify all sample and analysis activities

Radionuclide Reporting (Emissions Monitoring)
- calculation of radionuclide air emissions using laboratory analysis & responsible facility personnel stack-specific information

The ABCASH sample collection activities are described in WHC-IP-0718, Section 3.3.3, Automated Bar Coding of Air Samples at Hanford (WHC 1993a). Other responsibilities and system use are described in:

(1) WHC-SD-EN-UM-003, Revision 4, *User Manual for ABCASH Database and User Interface* (ADUI)(WHC 1993b)
(2) WHC-SD-EN-RD-003, Revision 2, *System Requirements Specification for Automated Bar Coding of Air Samples at Hanford System* (WHC 1993c)
(3) WHC-SD-EN-CSUD-002, *ABCASH Plotting Program - Users Guide* (WHC 1995a)
(4) WHC-EP-1165, *Training Manual for ABCASH Data Base and User Interface Overview* (WHC 1994b).
(5) WHC-SD-RE-ADP-003, *System Documentation for the Automatic Reduction of Radioactive Particulate Air Filter Sample Data* (WHC 1982)
(6) WHC-SD-EN-WP-003, *Work Plan for Automated Bar Coding of Air Samples at Hanford II System* (WHC 1991)

At the Pacific Northwest National Laboratory (Northwest Laboratory) 325 Laboratory, sampling data integrity and sample control are maintained from sample generation through the WHC/Operations - Northwest Laboratory/Analytical Laboratory interface by documentation employing Emission Monitoring Sample Change & Chain-of-Custody and Analytical Laboratory Services Request forms (Procedure J-W003 [WHC 1995d]). Upon receipt in the laboratory, sample data and analytical requirements are logged into the Northwest Laboratory/Analytical Laboratory Operations (ALO) Laboratory Information Management System (LIMS), a computer based system which provides sample tracking and monitors analytical status from sample receipt through analytical report production and sample disposal by means of input terminals located in the laboratory.

## 6.3 ORGANIZATION AND RESPONSIBILITIES

All organizational structure, levels of authority, and lines of communication that could affect the sampling and analysis activities are shown on the charts in Section 7.0 of this document. Figures 7-1 through 7-8 provide the organizational structure, and Figure 7-9 shows the organizational relationships involved in the radionuclide sampling, effluent flow measurement, and analysis activities.

Environmental Safety, Health and Quality Assurance oversight interfaces and responsibilities are addressed in Sections 3.0 and 4.0 of this document.

The organizational responsibilities for 40 CFR 61, Appendix B, Method 114, Section 4.0, "Quality Assurance Methods" (EPA 1991b) are described below.

### 6.3.1 Facilities

The responsible facility personnel (see Figures 7-3, 7-4, and 7-5) are responsible for defining how the stack sampling, analysis, effluent flow rate measurements, and instrument calibration requirements are implemented. He also prepares the radionuclide stack point-by-point implementation that addresses the sections of 40 CFR 61, Appendix B, Method 114 (EPA 1991b) described below.

- Administrative controls that are used at the facility to ensure a prompt response in the event that emission levels increase because of unplanned operations.

- Number of sample points and the rationale for sample site selections.

- Sampling probes and representativeness of samples.

- Sampling procedure(s) to be used and sampling frequency.

- Sample flow rate measurement systems procedures including sampling/monitoring instrument calibration scheduling and frequency. The scheduling of calibrations for the stack sampling and monitoring equipment is done in accordance with the requirements of 40 CFR 61, Appendix B, Method 114 (EPA 1991b). This scheduling information is prepared by the facility planner/scheduler who prepares the JCS work package under the direction of responsible facility personnel. Control of these calibration scheduling and tracking activities is addressed in WHC-CM-8-2, Section 2.2.

- Effluent flow rate measurement, including frequency of measurements. The responsible facility personnel are responsible for verifying flow rates and either entering the flow rate data directly into the ABCASH system or transmitting the information to the Effluent Monitoring (EM) organization.

- Routine verification of stack sample data by reviewing ABCASH data. The EM group will also provide quarterly anomaly reports to the facilities. These reports will be generated by the environmental release summary (ERS) program, a computer database, and the facilities will be expected to correct all reported anomalies.

### 6.3.2 Radiological Control

Radiological Control (see Figure 7-8) provides the sampling effort for the radionuclide air emissions under the technical direction of the responsible facility personnel. The sampling collection, tracking, and handling procedures for the effluent samples are contained in WHC-IP-0718 (WHC 1993a). The Radiological Engineering and ALARA group (see Figure 7-8) prepares the procedures for sample collection and for the sample tracking system that are used by the Radiological Control (RC) organization.

The sampling activities should be done in accordance with the stack monitoring and sampling requirements of 40 CFR 61, Appendix B, Method 114 (EPA 1991b). The QA activities that are included in Method 114 and performed by the RC group are described below.

- Sample collection requirements.

- 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.

### 6.3.3 Laboratories

The analytical laboratories analyze the radionuclide air emissions samples in accordance with applicable regulations. The specific radionuclides to be analyzed for are determined by EM with the assistance of the responsible facility personnel.

Laboratories shall have a QA plan and analytical procedures that meet the requirements of 40 CFR 61, Appendix B, Method 114 (EPA 1991b). 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

- The calibration procedures and frequency of calibration required for the analytical procedures used by the laboratory

- A quality control program to evaluate and track the quality of emissions measurement data

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

- A sample control system to maintain the integrity of samples during storage and analysis.

The QA plans that are used by the WHC Waste Sampling and Characterization Facility (WSCF) Laboratory and the Northwest Laboratory Analytical Chemistry Laboratory are *WHC-SD-CP-QAPP-0017, Rev. 0* (WHC 1995c) and *MCS-033* (PNL 1994), respectively.

### 6.3.4 Environmental Policy

Environmental Policy within the Environmental Services Division (see Figure 7-2) is responsible for WHC-CM-7-5, *Environmental Compliance Manual*, which establishes the environmental compliance requirements and guidelines for Westinghouse Hanford Company (WHC) in conjunction with applicable DOE orders and federal, state, and local laws and regulations. Environmental Policy also provides guidance on the interpretation of regulations, and interfaces with the regulatory agencies to resolve regulatory issues.

### 6.3.5 Effluent Monitoring

The Effluent Monitoring (EM) group (see Figure 7-2), within the Environmental Services organization, has the following responsibilities:

- Provide technical support for radioactive air emissions sampling and monitoring
- Provide technical requirements of radioactive air sample analysis: sampling schedule, list of specific radionuclides to be analyzed, and lower limits of detection
- Compile radioactive air sampling data and flow rates, which have been verified and transmitted by the facilities, to prepare regulatory reports
- Verify sample analysis parameters received from the laboratory
- Document records of radioactive air emissions in annual reports cleared for public access.
- Conduct routine radioactive airborne emission assessments on selected facilities.

The QAPjP WHC-EP-0528-1 (WHC 1994a), prepared by Effluent Monitoring, addresses the following within 40 CFR 61, Appendix B, Method 114 (EPA 1991b):

- Identification numbers for sample locations
- Analyses that are to be performed for each stack
- Data quality objectives for the sampling and analysis activities.

### 6.3.6 Maintenance Programs/Plant Project

The effluent stack flow measurements are performed by the Maintenance Programs/Plant Project (MPPP) group (see Figure 7-5) under the control of the responsible facility personnel. The QA activities from Method 114 (EPA 1991b), which are performed by MPPP are described in the paragraphs that follow.

The effluent stack flow measurements are performed in accordance with procedures included in the Job Control System (JCS). The procedures are prepared to meet the requirements of 40 CFR 61, Appendix B, Method 114, (EPA 1991b). Some of them are generic, with the plant-specific information being included in the JCS package. The responsible facility personnel are responsible for scheduling the preparation and transmittal of the JCS work package to the ventilation and balance organization.

After completion of the stack flow measurements, the data are provided to the responsible facility personnel, who are responsible for verifying and either entering the data directly into ABCASH or transmitting this information to the EM group.

### 6.3.7 Other Support Contractors

Procurement of the services of other subcontractors to support radionuclide effluent activities addressed in this QAPP may be initiated by WHC. Such services shall be in compliance with standard WHC procurement procedures requirements. All work shall be performed in accordance with approved QA plans and/or procedures, subject to the controls of WHC-CM-4-2, QR 4.0, "Procurement Document Control," and QR 7.0, "Control of Purchased Items and Services."

# 7.0 ORGANIZATIONAL CHARTS AND FIGURES

The following eight charts show in more detail how the pertinent organizations fit together within the Westinghouse Hanford Company structure. Figure 7-9, Emission Sampling and Analytical Implementation, is a flow chart representing the different groups involved with the process of sample and data handling.

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Figure 7-1. Organizational Chart for WHC Senior Management.

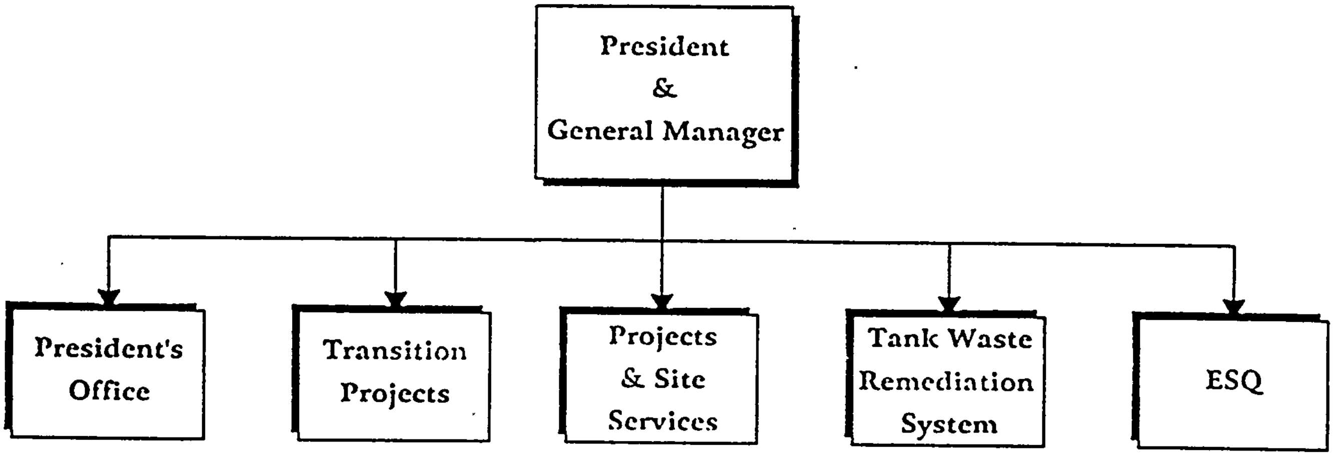

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Figure 7-2. Organizational Chart for Environmental Policy/Effluent Monitoring

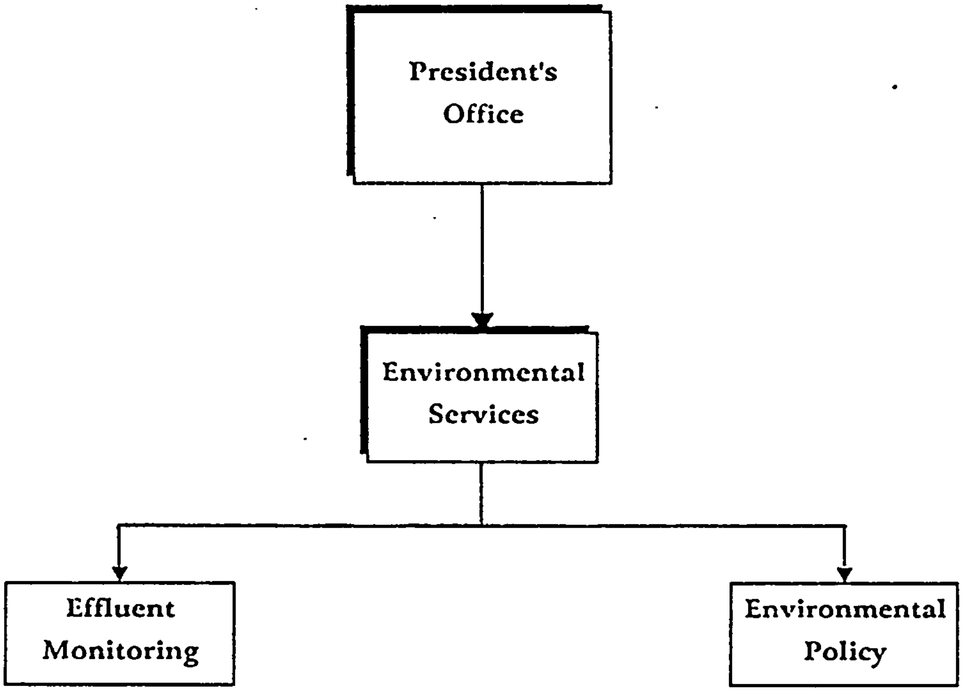

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Figure 7-3. Organizational Chart for Facilities - 1.

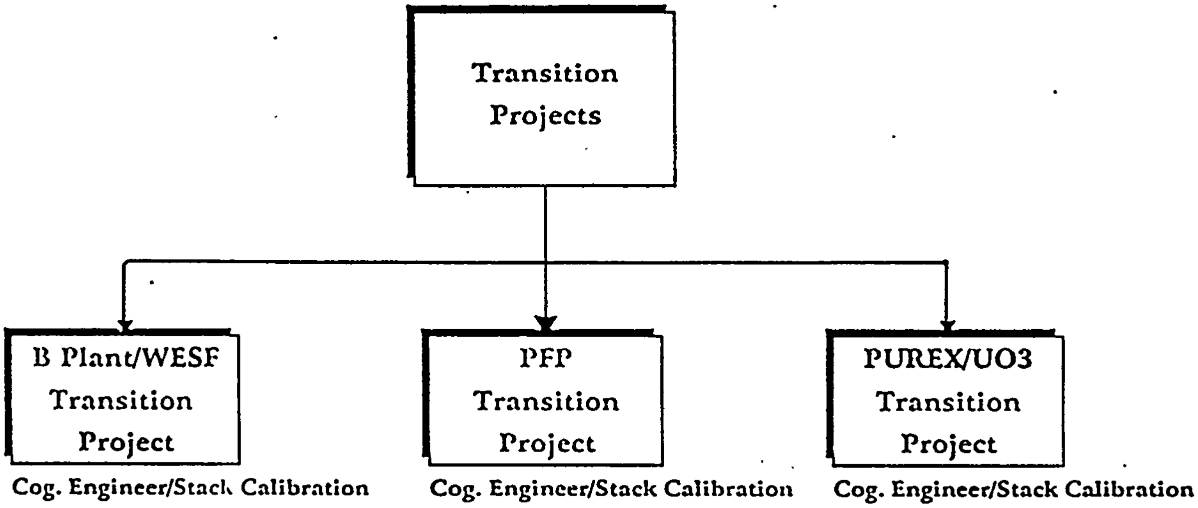

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Figure 7-4. Organizational Chart for Facilities - 2.

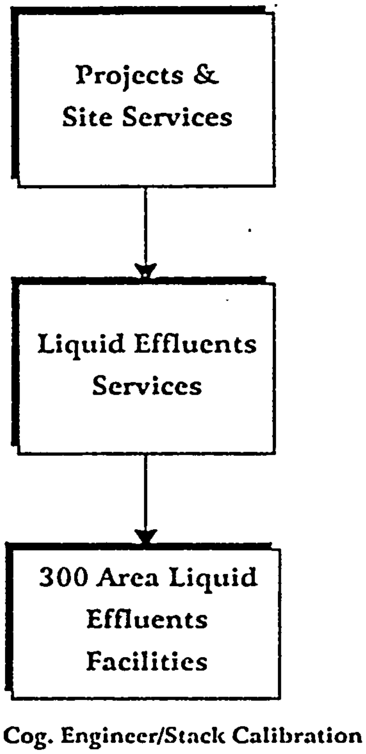

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Figure 7-5. Organizational Chart for Facilities - 3.

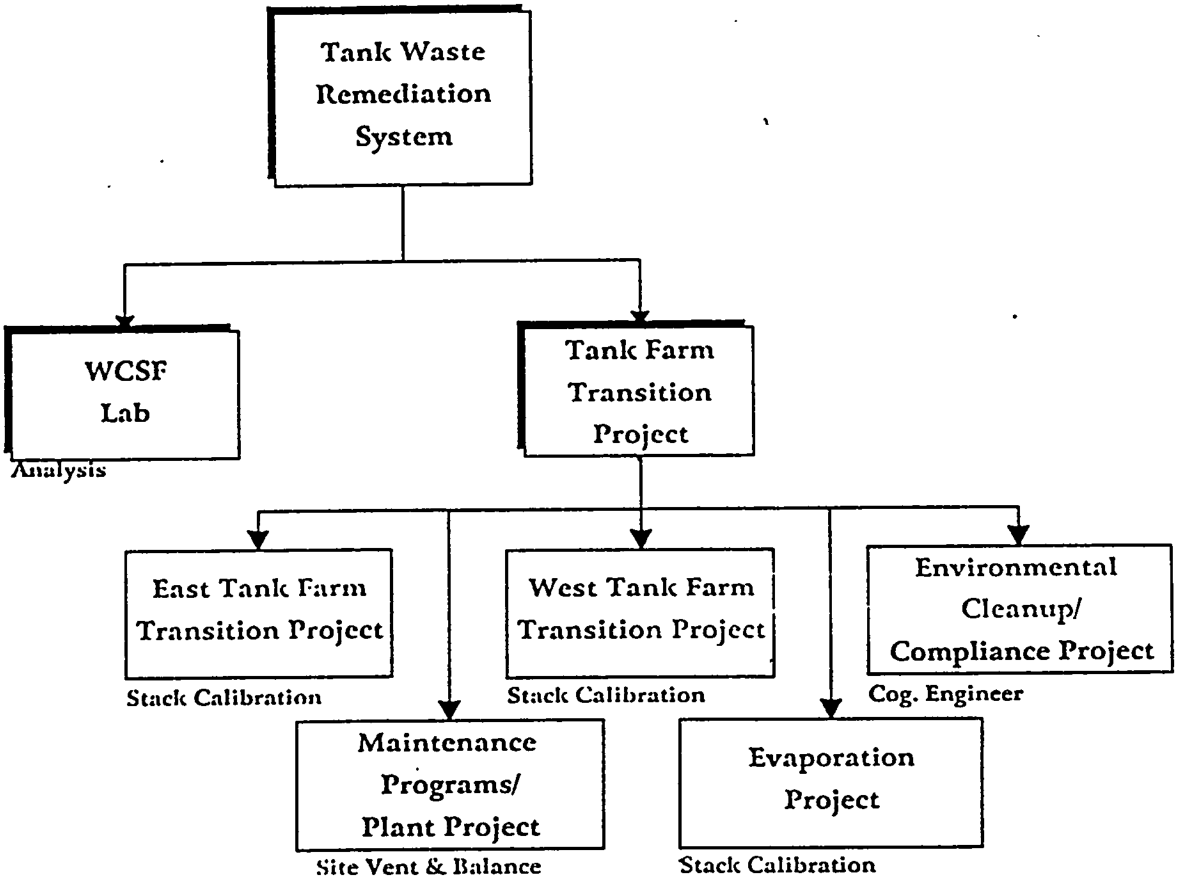

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Figure 7-6. Organizational Chart for Emergency, Safety, & Quality Services

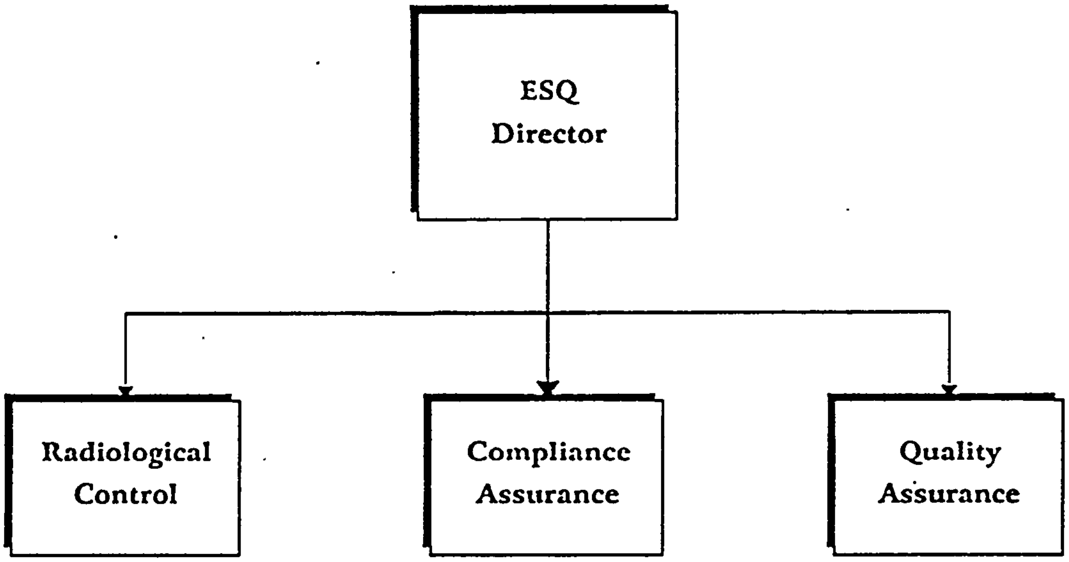

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Figure 7-7. Organizational Chart for Quality Assurance

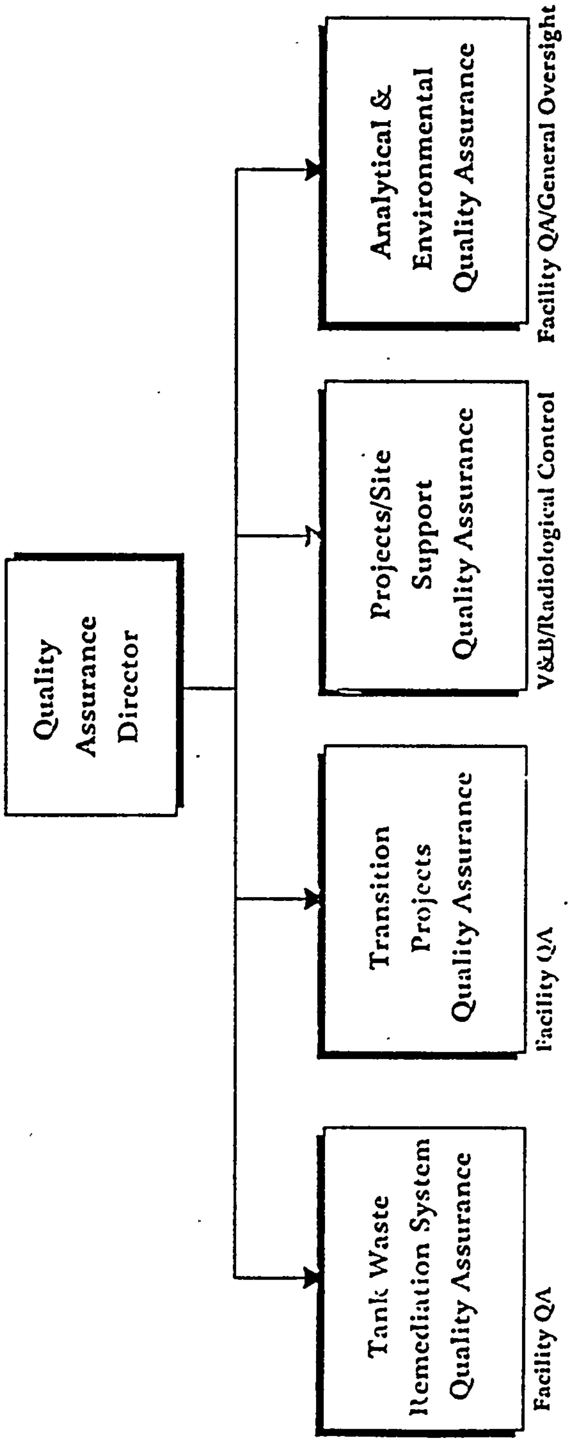

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Figure 7-8. Organizational Chart for Radiological Control

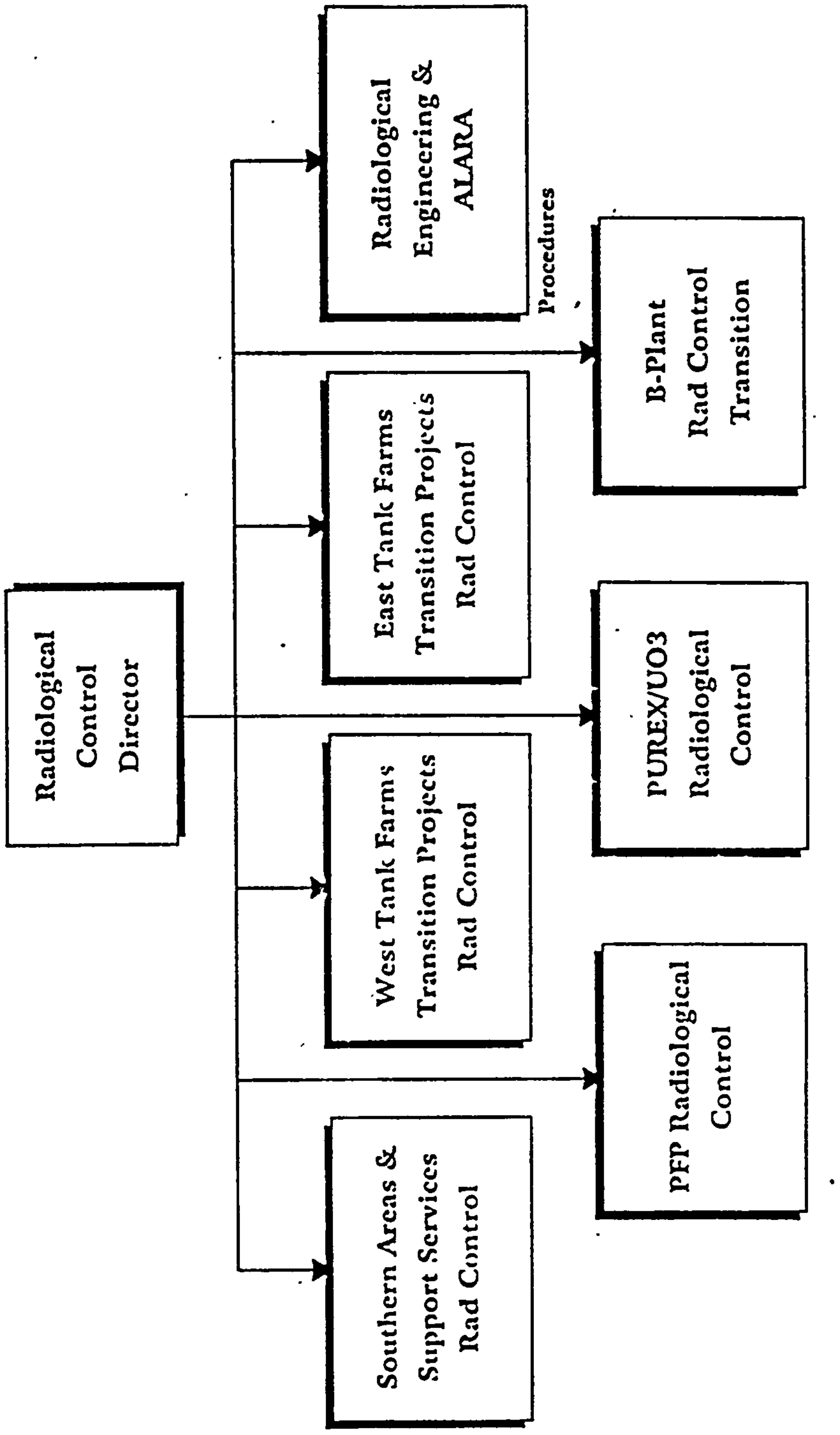

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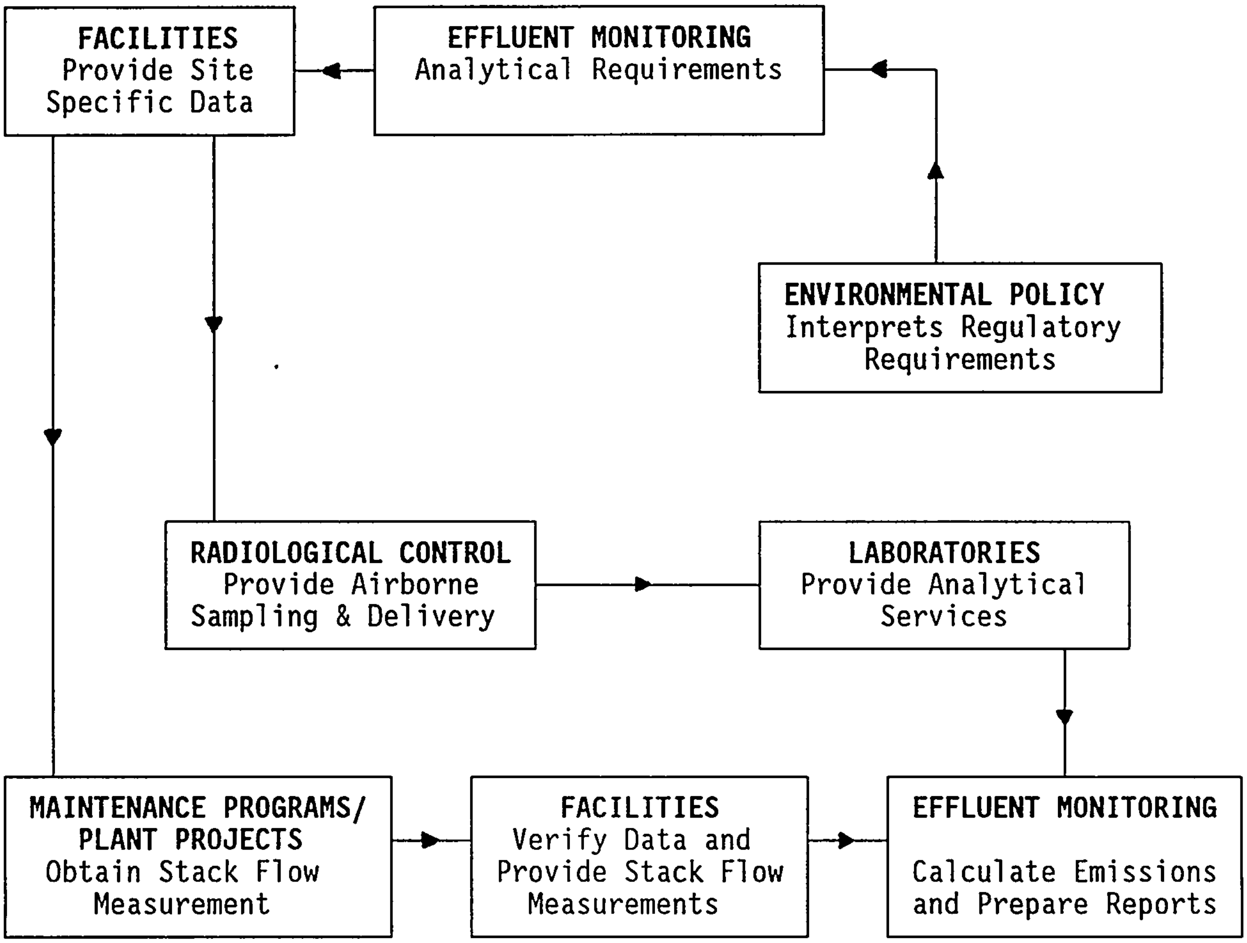
Figure 7-9. Emission Sampling and Analytical Implementation



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# 8.0 AUDITS

Audits shall be performed to verify the quality of operation of one or more elements of the total measurement system. Currently 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, are being performed by the Quality Assurance and the Compliance Assurance Organizations. (See Sections 4.1 and 4.2 of this document). This also includes audits of individual facility sampling programs against the requirements of this QAPP.

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# 9.0 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 10.0, "Inspection and Surveillance;" QR 15.0, "Control of Nonconforming Items;" QI 15.1, "Nonconforming Item Reporting;" and/or QR 16.0 "Corrective Action."

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# 10.0 QUALITY ASSURANCE REPORTS

As stated in Sections 3.0 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 6.3.7.

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# 11.0 REFERENCES

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PNL, 1994, *Quality Assurance Plan for Activities Conducted by the Analytical Chemistry Laboratory*, QA Plan No. MCS-033, Pacific Northwest Laboratory, Analytical Chemistry Laboratory, Richland, Washington.

WHC, 1982, *System Documentation for the Automatic Reduction of Radioactive Particulate Air Filter Sample Data*, WHC-SD-RE-ADP-003, Westinghouse Hanford Company, Richland, Washington.

WHC, 1991, *Work Plan for Automated Bar Coding of Air Samples at Hanford II System*, WHC-SD-EN-WP-003, Westinghouse Hanford Company, Richland, Washington.

WHC, 1993a, *Health Physics Procedures Manual*, WHC-IP-0718, Westinghouse Hanford Company, Richland, Washington.

WHC, 1993b, *User Manual for ABCASH Database and User Interface (ADUI)*, WHC-SD-EN-UM-003, Westinghouse Hanford Company, Richland, Washington.

WHC, 1993c, *System Requirements Specification for Automated Bar Coding of Air Samples at Hanford System*, WHC-SD-EN-RD-003, Westinghouse Hanford Company, Richland, Washington.

WHC, 1994a, *Quality Assurance Project Plan for Radioactive Airborne Emissions Data Compilation and Reporting*, WHC-EP-0528-1, Westinghouse Hanford Company, Richland, Washington.

WHC, 1994b, *Training Manual for ABCASH Data Base and User Interface Overview*, WHC-EP-1165, Westinghouse Hanford Company, Richland, Washington.

WHC, 1995a, *ABCASH Plotting Program - User's Guide*, WHC-SD-EN-CSUD-002, Westinghouse Hanford Company, Richland, Washington.

WHC, 1995b, *Health Physics Scheduled Radiation Survey Task Description for Building 340, 300 Area, Task No. J-W005*, Westinghouse Hanford Company, Richland, Washington.

WHC, 1995c, Quality Assurance Program Plan for the Waste Sampling and Characterization Facility, WHC-SD-CP-QAPP-0017, Westinghouse Hanford Company, Richland, Washington.

WHC, 1995d, *Health Physics Scheduled Radiation Survey Task Description for Building 340, 300 Area, Task No. J-W003*, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-1, *Company Policies and Charters*, Westinghouse Hanford Company, Richland, Washington.

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

WHC-CM-1-4, *Corrective Action Management Manual*, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-4-2, *Quality Assurance Manual*, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-4-5, *Quality Assurance Qualifications and Instructions*, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-4-6, *Compliance Assurance*, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-4-33, *Security Manual*, Westinghouse Hanford Company, Richland, Washington.

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

WHC-CM-8-2, *Central Support Services*, Westinghouse Hanford Company, Richland, Washington.

# APPENDIXES TO THE
# QUALITY ASSURANCE PROGRAM PLAN

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# INTRODUCTION TO APPENDIXES

These appendixes supply information regarding a point-by-point comparison with Title 40, *Code of Federal Regulations* (CFR), Part 61, Appendix B, Method 114 (EPA 1991b), for the Hanford Site air emissions involving stacks known to have the potential to exceed 40 CFR 61, Subpart H (EPA 1991a) limits.

Appendixes A through F are intended to supply the information for which each facility has responsibility, and Appendixes 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.

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# APPENDIX A

# METHOD 114 COMPARISON FOR STACK 291-A-1

Jahan Lohrasbi

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# APPENDIX A

# METHOD 114 COMPARISON FOR STACK 291-A-1

## 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 combination of monitoring and sample collection and analysis methods most 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 Gelman Versapor[1] 3000 filter medium is an acrylic copolymer membrane supported by a non-woven nylon fabric. The manufacturer rates the efficiency of this medium at 91% for 0.3-µm aerosol. The manufacturer recently tested 24 samples with a 0.3-µm di-octyl phthalate aerosol. The measured average efficiency was 95.8% and the standard deviation was 1.6%, which supports the rated efficiency.**

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**

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[1] Trademark of Gelman Sciences, Inc., Ann Arbor, Michigan.

**that the levels of $^3H$ and $^{14}C$ have fallen to levels at or below the analytical detection limits, 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 a need to monitor for iodine. Nevertheless, sampling for iodine continues. Because it is low level, this sampling may be discontinued at any time.**

**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.

**No irradiated fuel has been introduced into the PUREX Plant for several years. No dissolutions have been performed since late 1989. Sampling for these nuclides is no longer required or performed. The release of other radioactive gases decreased even 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.

**There is no longer need for gaseous radionuclide sampling (see sections 2.2.1 through 2.2.3 above.**

## 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.

**Refer to Sections 6.3 and 7.0 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.

RC-090-001 (1995), *PUREX Main Stack (291-A-1) Effluent Record Sampling; Monitoring System*. This Plant Operating Procedure (PUREX/$UO_3$ Radiological Control) establishes the method of response to continuous particulate release monitor (CPRM) alarms or to high activity levels detected on the effluent release record sample.

WHC-IP-0718 (WHC 1993)

Section 4.9B, Rev. 0, "PUREX Main Stack (291-A-1) Effluent Record Sampling and Monitoring System" (WHC 1993). This procedure provides the information and instructions necessary to operate the PUREX Main Stack (291-A-1) Effluent Record Sampling and Monitoring Systems, for the continuous particulate release monitor (CPRM), and backup effluent monitoring continuous air monitors (CAMs).

Section ER-02, Rev. 1, "Air Sampling Checklist." This checklist establishes the instructions and guidelines for air sampling in an emergency situation.

Section ER-02, Rev. 1, "Plume Tracking Checklist." This checklist establishes the instructions for tracking a plume created from a radioactive material release to the environment.

Section ER-02, Rev. 1, "General Emergency Response Guidelines and Checklists." This procedure provides the Health Physics technician with checklists and instructions for responding to various radiological emergencies.

Section ER-05, Rev. 0, "Radiation Area Monitor Alarm Response." This procedure provides the instructions and checklists for response to alarms in radiation areas.

WHC-IP-0263-202A (WHC 1994a), *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, *PUREX/$UO_3$ Plant Administration*, 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 rationale for site selection.

The 291-A-1 stack is 2.1 m (7 ft) in diameter. The record sampling site is located at a height of 18.3 m (60 ft) above grade. There are a total of two sampling sites and three sampling probes in current use.

The elevations of the sample ports are 18.3 and 22.6 m (60 and 74 ft) above grade, which is the location of the last major flow disturbance in the stack. The sample ports are, therefore, approximately 8.6 and 10.6 diameters downstream of the last major disturbance.

The stack is 61 m (200 ft) from grade, or 28.6 diameters. The sample ports are, therefore, approximately 20 and 18 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). These sites also meet the criteria of 40 CFR 60, Appendix A, Method 1 (EPA 1992).

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

The sampling probe for the record sampler, the silver zeolite cartridge, and the CPRM is mounted in the horizontal plane at the 18.3-m (60-ft) level. The sampling probes for the backup record sampler and continuous air monitors (CAMs of alpha and beta) are located at 22.6 m (74 ft).

The sampling probe consists of "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. At the inlet, each port is tapered to a knife edge with a 15-degree angle. At the 22.6-m (74-ft) level, the backup record sample has six nozzles consisting of 0.64-cm (0.25-in.) outside diameter (OD) and 0.124-cm (0.049-in.)-wall 316 stainless steel tubing.

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 rake that currently collects the particulate record sample has 16 inlets, consisting of 304 stainless steel tubing at the 18.3-m (60-ft) level. At the inlet, each port is tapered to a knife edge with a 15-degree angle. The inlet ports have a 5.1-cm (2.0-in.) vertical section followed by a 5.1-cm (2.0-in.) radius bend leading into the rake at a 45-degree angle. The outer two ports are made of 0.95-cm (0.375-in.) OD, 0.165-cm (0.065-in.)-wall tube. The next six ports are made of 0.64-cm (0.25-in.) OD, 0.071-cm (0.028-in.)-wall tube. The inner eight ports are made of 0.64-cm (0.25-in.) OD, 0.089-cm (0.035 in.)-wall tube. The inlet ports are arranged symmetrically and approximately centered over equal-area semi-annuli.

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

This requirement is 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 removed continuously from the effluent stream via the rake described in Section 4.3.2 of this appendix. The sample then flows through the sample line and the particulates are collected on a sample filter. The sample filters are replaced monthly, and sometimes more often. The filter media is then composited for quarterly analysis of specific radionuclide concentrations.

The filtered gas at the 18.3-m (60-ft level) then flows through one silver zeolite cartridge to capture iodine and other volatile elements. Section 4.3.6 of this appendix describes the calibration of the sample flow rate measurement equipment.

The CPRM and CAM loops collect particulate matter in a similar fashion to that of the record sampler, but the CPRMs and CAMs monitor for elevated radioactivity on the filter. These instruments provide process control and backup capability for the record sampler. The CPRMs and CAMs are calibrated every six months and annually, respectively.

Currently, the calibration procedures for the CPRMs are PURX-9-006 and PSCP-3-087. Procedure PSCP-3-087 will be replaced by PURX-3-087. The procedures for the CAMs are PSCP-3-002 and PSCP-3-083. Procedure PSCP-3-083 will be replaced by PURX-3-083.

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 for the Plutonium Uranium Extraction Facility* (WHC 1994b) lists the analytes of interest for the 291-A-1 Stack. These are: $^{238}$Pu, $^{239,240}$Pu, $^{241}$Pu, $^{241}$Am, $^{89,90}$Sr, $^{147}$Pm, $^{220}$Rn, $^{129}$I, $^{134}$Cs, $^{137}$Cs, $^{125}$Sb, $^{113}$Sn, $^{103}$Ru, and $^{106}$Ru. For a description of the laboratory analysis procedures for these analytes, 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 collection and monitoring system consists of a record sampler, one silver zeolite cartridge, one CPRM (at the 18.3-m

[60-ft] level), one backup record sample and two backup CAMs (at the 22.6-m (74-ft) level). The record sampler and silver zeolite cartridge are considered the regulatory portion of the system for reporting the amount and concentration of radionuclides released to the environment. The generated reports are forwarded to all appropriate organizations and agencies. The CPRM and CAMs are considered the operational safety device and are set to alarm if emissions are detected above present levels.

The sample from the probe (18.3-m (60-ft) is split once and routed to the CPRM and to another splitter. This second splitter splits the flow again to the record sampler (the silver zeolite cartridge is installed just after the record sampler).

After exiting the silver zeolite cartridge, the air flows through a flow measurement and control system. Currently, a Kurz Model 505[2] system measures the sample flow rate, a Kurz model 101-RM[2] totalizes the sample flow, and a Kurz 710RMD[2] (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.

After exiting the flow control valve, the air flows through a rotameter that provides backup indication. Yearly calibration is accomplished by comparison with a standard rotameter, using procedure PSCP-7-001. Procedure PSCP-7-001 will be replaced by PURX-7-001.

The CPRM and CAMs system also have flow-rate-indicating and manual-flow-regulating capabilities. The audible and visible alarm signals that indicate low flow rates, high alpha, and high beta/gamma for the CPRM are provided remotely in the dispatcher's office. The alpha and beta/gamma count recorders for the CPRM are located in the central control room. The instruments are calibrated at least once per year (normally every 6 months). Currently the calibration procedures are PURX-9-006, and PSCP-3-087. Procedure PSCP-3-087 will be replaced by PURX-3-087. The CAMs are set to alarm (located in 292-AB building) if emissions are detected above present levels. Calibrations are accomplished on an annual basis using procedures PSCP-3-002 and PSCP-3-083. Procedure PSCP-3-083 will be replaced by PURX-3-083.

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

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[2] Trademark of Kurz Instruments, Inc., Monterey, California.

**A six-point Kurz probe continuously measures the flow through the stack at the 22.6-m (74-ft) level. The backup record sampler is also installed in this assembly. A Kurz Model 195B[3] transmitter sends the signal to a Kurz Model 142-RMD[3] and a Kurz Model 132[3], which then drives a recorder, which continuously records the flow rate. The total flow is recorded on a digital integrator, or can alternately be 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 procedure is PSCP-1-044.**

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.

**Refer to Appendix G. Also refer to WHC-EP-0528-1 (WHC 1994c) for the quality assurance requirements for compiling and reporting radioactive airborne emissions.**

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.

**Refer to 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 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 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 8.0 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 9.0 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 10.0 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.

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[3] Trademark of Kurz Instruments, Inc., Monterey, California.

**Section 6.0 of the main part of this document, plus the attached point-by-point comparisons to NESHAP quality assurance criteria, fulfill the QAPjP requirements for regulated stacks. Separate facility QAPjP's are not required.**

## APPENDIX A REFERENCES

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

EPA, 1992, "Standards of Performance for New Stationary Sources," Title 40, *Code of Federal Regulations*, Part 60, U.S. Environmental Protection Agency, Washington, D.C.

WHC, 1993, *Health Physics Procedures Manual*, WHC-IP-0718, Westinghouse Hanford Company, Richland, Washington.

WHC, 1994a, *Westinghouse Hanford Company Emergency Plan for PUREX Facility*, WHC-IP-0263-202A, Westinghouse Hanford Company, Richland, Washington.

WHC, 1994b, *Facility Effluent Monitoring Plan for the Plutonium Uranium Extraction Facility*, WHC-EP-0468-3, Westinghouse Hanford Company, Richland, Washington.

WHC, 1994c, *Quality Assurance Project Plan for Radioactive Airborne Emissions Data Compilation and Reporting*, WHC-EP-0528-1, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-5-9, *PUREX/$UO_3$ Plant Administration*, Westinghouse Hanford Company, Richland, Washington.

Procedures

Westinghouse Hanford Company, Richland, Washington:

PSCP-1-044, 1993, Rev. 2, *Kurz 142/151 RM, Calibration Procedure*

PSCP-1-045, 1993, Rev. 2, *Kurz Linear Mass Flow Meter, Series 505 at PUREX*

PSCP-3-002, 1994, Rev. 6, *Eberline Beta Air Monitor*

PSCP-3-083, 1989, Rev. 0, *PUREX Modified Effluent CAM Eberline Alpha-5a for Detection of Plutonium-239*

PSCP-3-087, 1992, Rev. 1, *Eberline Alpha-4, -5, and -5a CAM, for Detection of Plutonium in the Main Stack CPRM*

PSCP-4-167, 1989, Rev. 1, *Kurz Sample Low Totalizer, Model 101*

PSCP-4-197, 1989, Rev. 0, *Kurz Model 710 RMD Flow Controller, 4200 and 7500 Systems*

PSCP-7-001, 1993, Rev. 1C, *Air Rotameter, Calibration Procedure*

PURX-3-083, 1995, *PUREX Modified Effluent CAM Eberline Alpha-5a for Detection of Plutonium-239*

PURX-3-087, 1995, *Eberline Alpha-4, -5, and -5a CAM, for Detection of Plutonium in the Main Stack CPRM*

PURX-7-001, 1995, *Air Rotameter, Calibration Procedure*

PURX-9-006, 1995, *PUREX Main Stack Beta PING Calibration Procedure*

RC-090-001, 1995, *PUREX Main Stack (291-A-1) Effluent Record Sampling: Monitoring System*

# APPENDIX B

# METHOD 114 COMPARISON FOR STACKS 296-A-1

Jahan Lohrasbi

# APPENDIX B

# METHOD 114 COMPARISON FOR STACK 296-A-1

## 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 that 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" that 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 Gelman Versapor[1] 3000 filter medium is an acrylic copolymer membrane supported by a non-woven nylon fabric. The manufacturer rates the efficiency of this medium at 91% for 0.3-µm aerosol. The manufacturer recently tested 24 samples with a 0.3-µm di-octyl phthalate aerosol. The measured average efficiency was 95.8% and the standard deviation was 1.6%, which supports the rated efficiency.**

2.2 Radionuclides as Gases.

**Based on process knowledge, the 296-A-1 stack does not exhaust radionuclide gases; therefore, this section is not applicable to this stack.**

2.3 Definition of Terms

**No response is required.**

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[1] Trademark of Gelman Sciences, Inc., Ann Arbor, Michigan.

## 3.0 Radionuclide Analysis Methods

**The analysis methods have been evaluated by the WSCF 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.

**Refer to Sections 6.2 and 7.0 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-IP-0718 (WHC 1993)**

**Refer to Section ER-02, Rev. 1, "Air Sampling Checklist." This checklist establishes the instruction and guidelines for air sampling in an emergency situation.**

**Refer to Section ER-02, Rev. 1, "Plume Tracking Checklist." This checklist establishes the instruction to track a plume created from a radioactive material release to the environment.**

**Refer to Section ER-02, Rev. 1, "General Emergency Response Guidelines and Checklists." This procedure provides the Health Physics technician with checklists and instruction for response to various radiological emergencies.**

**Refer to Section ER-05, Rev. 0, "Radiation Area Monitor Alarm Response." This procedure provides the instructions and checklists for response to alarms in radiation areas.**

**WHC-IP-0263-202A (WHC 1994a), *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, *PUREX/UO3 Plant Administration*, Section 2.3, Rev. 3, "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 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 rational for site selection.

The 296-A-1 stack is 0.61 m (2 ft) in diameter and tapers to 0.52 m (1.8 ft) at the top. The record sampling site is located at a height of 10.4 m (34 ft) above the base. There are a total of three sampling sites and three sampling probes.

The elevations of the sample ports are 10.4, 11.6, and 12.8 m (34, 38, and 42 ft) above base, which is the location of the last major flow disturbance in the stack. The sample ports are, therefore, approximately 17, 19, and 21 diameters downstream of the last major disturbance.

The stack is 18.9 m (62 ft) from base, or 31 diameters. The sample ports are, therefore, approximately 14, 12, and 10 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 1992).

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

The sampling probes for the record sampler and the alpha CAM are identical, and are mounted in the horizontal plane at the 14.0-m and 16.5-m (46-ft and 54-ft) levels, respectively. Note: For information purposes related to this study, the sampling ports have been numbered 1, 2, 3, and 4.

The sampling probe consists of four nozzles branching from a single delivery line and is made entirely of 304 stainless steel tubing (drawing H-2-75571, WHC 1991). At the inlet, each port is tapered to a knife edge with a 15-degree angle. The first port, located at the center of the stack, is made of 0.79-cm (5/16-in.) OD, 0.089-cm (0.035-in.)-wall tube. The inlet has a vertical section of 4.76 cm (1.875 in.), followed by a radius bend of 1.875 leading into the sample delivery line. The second port, located 18.4 cm (7.25 in.) from the center of the stack, is made of 1/8-in Schedule 40s pipe [0.68-cm (0.269-in.) ID]. The inlet has a vertical section of 6.4 cm (2.5 in.) followed by a radius bend of 2.5 leading into the sample delivery line. The third port, located 23.97 cm (9.438 in.) from the center of the stack, is made of 0.95-cm (3/8-in.) OD, 0.124-cm (0.049-in.)-wall tube. The inlet has a vertical section of 5.7 cm (2.25 in.) followed by a radius bend of 2.25, leading into the sample delivery line. The fourth port, located 28.42 cm (11.188 in.) from the center of the stack, is made of 1/4-in Schedule 80s pipe [.76 cm (0.302 in.)]. The inlet has a vertical section of 8.3 cm (3.25 in.), followed by a radius bend of 3.25, leading into the sample delivery line. The outer sampling line is made of 1.9-cm (3/4-in.) OD, .23-cm (0.109-in.)-wall tube. The inlet ports with different cross sectional areas are centered approximately in four equal annular areas. The use of an isokinetic 4-point probe located more than 15 duct diameters downstream of the last major flow disturbance is believed to achieve representative sampling (stack and sample flow rates are checked daily to ensure near isokinesis of ±10%).

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.

This requirement is 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 removed continuously from the effluent stream by the probe described in Section 4.3.2 of this appendix. The sample then flows through the sample line and the particulates are collected on a sample filter. The sample filters are replaced monthly, 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 every six months. The calibration procedures are PSCP-6-029 and PSCP-3-083. Procedure PSCP-3-083 will be replaced by PURX-3-083.

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 for the Plutonium Extraction Facility* (WHC 1994b) lists the analytes of interest for the 296-A-1 Stack. These are: $^{239,240}$Pu, and $^{241}$Am. For a description of the laboratory analysis procedures for these analytes, see 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 collection and monitoring system consists of a record sampler and one alpha CAM. The record sample is considered the regulatory portion of the system for reporting the amount and concentration of radionuclides released to the environment. The generated reports are forwarded to all appropriate organizations and agencies. The CAM is considered the operational safety device and is set to alarm (located in dispatcher's office) if emissions are detected above present levels. The sampling system is designed with two identical sampling probes mounted in the horizontal plane at the 14.0- and 16.5-m (46- and 54-ft) levels for the record sampler and alpha CAM respectively.

The sample flow rate is measured and regulated by instruments located downstream of the sample collection filter and CAM. The record sample loop passes through a flow transmitter, a flow regulator (flow control valve), a flow switch (flow alarm switch), a vacuum gauge, and a vacuum pump. The flow transmitter will send an electrical signal to the flow indicator control and the totalizer. The flow rate regulator is provided to maintain a constant flow rate through the collection filter assembly to compensate for filter-loading effects. At least once a day an employee adjusts the FIC-V28A-2-1 flow indicator controller to ensure near isokinesis (±10%). The audible and visible alarm signals that indicate low flow rates for record sampler are provided remotely in the dispatcher's office (refer to Drawing H-2-75568 [WHC 1991]). The instruments for the sample flow measurement are calibrated at least once per year (normally every 6 months). Currently the calibration procedures are PSCP-6-153, PSCP-6-029, PSCP-1-008, and PSCP-4-059. Procedures PSCP-6-153, PSCP-1-008 and PSCP-4-059 will be replaced by PURX-6-153, PURX-1-008 and PURX-4-059 respectively.

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 are identical to that of the record sampler loop. The audible and visible alarm signals that indicate low flow rates for the CAM are provided remotely in the dispatcher's office. The alpha count recorder is located in the central control room. The instruments are calibrated at least once per year (normally every 6 months). Currently the calibration procedures are PSCP-6-029, and PSCP-3-083. Procedure PSCP-3-083 will be replaced by PURX-3-083.

Alternative vacuum pumps are provided for the system. Failure annunciation (low flow rates) is provided and checked periodically in the dispatcher's office to demonstrate operability.

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

An Annubar[2] probe (multipoint probe) continuously measures the flow through the stack at the 15.2-m (50-ft) level. The annubar probe senses a total pressure through the velocity ports and a low pressure through the downstream ports. From their differential pressure, the flow transmitter sends the signal to the flow

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[2] Trademark of Dietrich Standard Corporation, Boulder, Colorado.

integrator and the totalizer. The total flow is recorded on a digital integrator in the central control room.

Flow measurements are accomplished quarterly following Procedure 7-GN-166 using a traverse pitot tube. There are two ports spaced 90° apart located 4.6 m (15 ft) above the sampling probe location on the stack. These locations are at 26.5 duct diameters downstream and 4.5 duct diameters upstream of any flow disturbances. These measurements are taken in each port at 10 equal annular traverse points (20 in all). The instruments for the stack flow measurement are calibrated at least once per year (normally every 6 months). Currently the calibration procedures are PSCP-6-032, PSCP-1-008, and PSCP-4-001. Procedures PSCP-6-032, PSCP-1-008, and PSCP-4-001 will be replaced by PURX-6-032, PURX-1-008, and PURX-4-001 respectively.

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.

Refer to Appendix G. Also refer to WHC-EP-0528-1 (WHC 1994c) for the quality assurance requirements for compiling and reporting radioactive airborne emissions.

4.5 The quality control program shall be established to 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 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 is made at the discretion of the scientist in charge.

As a type of process-control sample, stack filters are not subject to matrix effects and radionuclide spikes are not used. However, tracer elements $^{243}$Am and $^{236}$Pu or $^{242}$Pu support the analysis of $^{241}$Am, $^{238}$Pu, and $^{239,\,240}$Pu in the quarterly composite of monthly 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 assure that two representative portions are produced. Also, splitting the sample in effect dilutes the sample, which would adversely affect the method detection limits.

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

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

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 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 8.0 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 9.0 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 10.0 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.

**Section 6.0 of the main part of this document, plus the attached point-by-point comparisons to NESHAP quality assurance criteria, fulfill the QAPjP requirements for regulated stacks. Separate facility QAPjP's are not required.**

## APPENDIX B REFERENCES

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

EPA, 1992, "Standards of Performance for New Stationary Sources," Title 40, *Code of Federal Regulations*, Part 60, U.S. Environmental Protection Agency, Washington, D.C.

WHC, 1991, Drawings H-2-75568, *DWG List/Engineering Flow Diagram PR Room Stack MON*, and H-2-75571, *ELEC/INSTM Installation Details PR Room Stack Monitor*, Westinghouse Hanford Company, Richland, Washington.

WHC, 1993, *Health Physics Procedures Manual*, WHC-IP-0718, Westinghouse Hanford Company, Richland, Washington.

WHC, 1994a, *Westinghouse Hanford Company Emergency Plan for PUREX Facility*, WHC-IP-0263-202A, Westinghouse Hanford Company, Richland, Washington.

WHC, 1994b, *Facility Effluent Monitoring Plan for the Plutonium Uranium Extraction Facility*, WHC-EP-0468-3, Westinghouse Hanford Company, Richland, Washington.

WHC, 1994c, *Quality Assurance Project Plan for Radioactive Airborne Emissions Data Compilation and Reporting*, WHC-EP-0528-1, Westinghouse Hanford Company, Richland, Washington.

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

Procedures

Westinghouse Hanford Company, Richland, Washington:

PSCP-6-153, 1990, Rev. 0, *Generic D/P Transmitter*

PSCP-6-029, 1993, Rev. 1B, *Chem-Tec Adjustable Flow Switch Model 500*

PSCP-1-008, 1993, Rev. 2, *Taylor, Model 1311N, Integrator*

PSCP-4-059, 1992, Rev. 2, *Taylor Indicator and Indicating Controller, Series 1300*

PSCP-3-083, 1989, Rev. 0, *PUREX Modified Effluent CAM Eberline Alpha-5A for Detection of Plutonium 239*

PSCP-6-032, 1990, Rev. 1, *Dieterich Differential Pressure Transmitter Model 1151R*

PSCP-4-001, 1989, Rev. 1, *Taylor Quick-Scan Recorder, Series 1300, Calibration Procedure*

PURX-6-153, 1995, *Generic D/P Transmitter*

PURX-1-008, 1995, *Taylor Model 1311N Integrator*

PURX-4-059, 1995, *Taylor Indicator and Indicating Controller, Series 1300*

PURX-3-083, 1995, *PUREX Modified Effluent CAM Eberline Alpha-5A for Detection of Plutonium 239*

PURX-6-032, 1995, *Dieterich Differential Pressure Transmitter Model 1151R*

PURX-4-001, 1995, *Taylor Quick-Scan Recorder, Series 1300, Calibration Procedure*

7-GN-166, 1995, *Stack Airflow Test*

# APPENDIX C

# METHOD 114 COMPARISON FOR STACK 291-B-1

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# APPENDIX C

## METHOD 114 COMPARISON FOR STACK 291-B-1

This section provides a line-by-line evaluation of quality assurance method requirements outlined in 40 CFR 61, Appendix B, Method 114, Section 4.0 (EPA 1991b) as they apply to the 291-B-1 stack at the B-Plant Facility, 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.

No response is required.

### 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 section 61.18).

The Gelman Versapor[1] 3000 filter medium is an acrylic copolymer membrane supported by a non-woven nylon fabric. The manufacturer rates the efficiency of this medium at 91% for 0.3-μm aerosol. The manufacturer recently tested 24 samples with a 0.3-μm di-octyl phthalate aerosol. The measured average efficiency was 95.8% and the standard deviation was 1.6%, which supports the rated efficiency.

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[1] Trademark of Gelman Sciences, Inc., Ann Arbor, Michigan.

### 2.2 Radionuclides as Gases.

**The 291-B-1 Stack does not exhaust radionuclide gases; therefore, this section is not applicable to this stack (WHC 1991b).**

### 2.3 Definition of Terms

**No response is required.**

## 3.0 Radionuclide Analysis Methods

**The analysis methods have been evaluated by the WSCF 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 Sections 6.3 and 7.0 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.

**<u>DOE/RL-94-02</u>, *Hanford Emergency Response Plan* (DOE-RL 1994). This manual contains an emergency response 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 Hanford Site facilities. The requirements stated in the plan are implemented through subtier plans and implementing procedures. These implementing plans and procedures established for response to emergencies by Hanford Site 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 Hanford Site Facility operating procedures (WHC-IP-0263-BPC) (WHC 1992).**

**<u>WHC-CM-4-14</u>, Part 3, Section 5.0, *Applied Radiological Controls*.**

**The Radiological Control (RC) 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 RC 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 RC response. For a planned response, RC 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) and approval of the Building or Facility Emergency Director is necessary to re-enter.

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

WHC-IP-0718 (WHC 1993)

Section 3.3.2, Rev. 1, "Gaseous Effluent Monitoring System Inspection and Sample Exchange." This procedure provides the steps needed to perform inspections of the Gaseous Effluent Monitoring Systems (Stack Packs) and the exchange sequence for effluent air samples.

Section ER-04, Rev. 0, "CAM Alarms." This procedure establishes the standard method of handling samples from, and response to, alarms at effluent exhaust continuous air monitor systems in an expedited fashion.

Section ER-02, Rev. 1, "General Emergency Response Guidelines and Checklists." This procedure provides the instructions and checklists for response to various radiological emergencies.

WHC-IP-0263-BPC, Rev. 0, "Emergency Plan for the B-Plant Complex" (WHC 1992). This procedure establishes guidelines for actions to be taken if B-Plant discharges highly radioactive material.

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-BPC, *Building Emergency Plan for B Plant Complex* (WHC 1992). 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 B Plant, as required by WHC-CM-1-3, MRP 5.14, "Emergency Plan for the B-Plant Complex."

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 291-B-1 Stack has an inside diameter (ID) of 2 m (6.5 ft) at the probe location, approximately 11 meters (35 ft) from the base. The ID ranges from 2 m (7 ft) at that base of the stack, to 1.5 m (5 ft) at the top, 61 m (200 ft) above the base. There are twelve nozzles for sampling at the probe location; six nozzles supply the record sampler and six supply the beta-gamma monitor and the backup record sampler. ANSI N13.1-1969, Section A3.2 (ANSI 1969), recommends a minimum of six nozzles on a stack the diameter of the 291-B-1 Stack (WHC 1991b).

The procedure in 40 CFR 61, Appendix A, Method 1 (EPA 1991a) requires sampling to be performed at least eight stack diameters downstream and two diameters upstream of any flow disturbances. Eight stack diameters corresponds to 16 m (52 ft) and two stack diameters corresponds to 4 m (13 ft), based on the 2-m (6.5-ft)-diameter at the sampling location. As shown in the drawings and documentation listed in WHC 1991b, the 291-B-1 Stack complies with this procedure (WHC 1991b).

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

The sampling probe consists of twelve total nozzles, as shown on Drawing H-2-94159 (WHC 1991b). Six nozzle inlets are 0.348 ± 0.002 inches and the other six are 0.250 ± 0.002 inches in diameter. The stack flow is fully turbulent (Reynolds number approximately $6.8 \times 10^5$) and, as stated in Section A.3.3.2 of ANSI N13.1-1969, "... as the flow becomes more turbulent, the velocity becomes more nearly uniform across the duct." The combination of both turbulent flow and uniform velocity also causes the sample inlet velocity to nearly match the stack velocity. Therefore, the probe assembly is nearly isokinetic, as it was designed (see Note 4, Drawing H-2-94159 [WHC 1991b]).

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.

Emissions are not required to be 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.

Particulate radionuclides are collected with the record sampler, which uses 47-mm-diameter filter paper. This filter is a membrane filter which collects 0.3-$\mu$m particles with a collection efficiency of 95.8%. Record samplers are removed weekly and the sampler runs continuously to ensure a representative sample (WHC 1991a).

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 analytes of interest for the 291-B-1 Stack can be found in *Statement of Work for Services Provided by The Waste Sampling and Characterization Facility For Effluent Monitoring* (WHC 1995). For a description of the laboratory analysis procedures for these analytes, see Appendix G.

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

Three vacuum pumps draw air through the sample transport lines. The two pumps associated with the beta-gamma monitor and backup record sampler operate at 2.0 ± 0.2 $ft^3$/min while the record sampler operations at 2.0 ± 0.2 $ft^3$/min. A sample transport line extends from the probe mounting assembly to the monitoring instruments located in Building 292-B, approximately 12 m (40 ft) from the base of the stack. Four tubes are bound together between the probes and the monitoring instrumentation: one each for the record sampler and the beta and gamma monitor and two tubes comprising the pitot tube assembly (which is discussed in the following section). The sample transport lines are heat traced and insulated to inhibit condensation and the resultant sample flow retardation. The sample transport lines are installed with a minimum number of bends, using a minimum bend radius of ten times the tubing inside diameter. The sample air flows into the monitoring instrument assembly (WHC 1991b).

Record Sampler:

The record sampler sample passes through a record sample filter which collects effluent particulates on a 47-mm-diameter filter paper. The filter papers are exchanged weekly and evaluated for gross alpha and gross beta activities by laboratory analysis. The record samplers 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. Downstream of the filter, the record sampler passes through a flow meter, a flow totalizer, a flow regulator, and a vacuum pump. In the event of a low flow in the record sampler line, a local alarm and a remote alarm are activated. The local alarm indicates a low record flow (and is connected to the beacon outside Building 292-B) and the remote alarm in the 271-B dispatchers office indicates a monitor failure (WHC 1991b).

Beta-Gamma Sampler:

Within the monitoring instrumentation rack, the beta-gamma sample passes through a flow splitter and is divided into two parts: The first split passes through a beta-gamma continuous monitor equipped with both a local and a remote (271-B dispatcher's office) alarm. The monitor continuously monitors particulate matter buildup on filter paper for the detection and measurement of beta and gamma radiation. In the event the radiation buildup exceeds established parameters, a remote stack radiation indicator alarm is activated, as is a local high-beta radiation alarm. The local alarm is connected to both a bell and a beacon outside Building 292-B. After the monitor, the sample passes through a flow regulator and a vacuum pump. In the event of low flow in the beta-gamma sample line, a local alarm and a remote alarm are activated. The local alarm indicates a low beta flow (and is connected to the beacon outside the 292-B building) and the remote alarm in the 271-B dispatcher's office indicates a monitor failure.

The second split passes through a backup record sampler, which consists of a 47-mm-diameter filter that collects the effluent particulates. After the filter, the split passes through a rotameter (flow meter), a flow regulator, and a vacuum pump. In the event of a low flow in the backup sampler line, a local alarm and a remote alarm are activated. The local alarm indicates low back-up record flow (and is connected to the beacon outside Building 292-B) and the remote alarm in the 271-B dispatcher's office indicates a monitor failure (WHC 1991b).

Calibration and inspection of the system are accomplished at the following intervals:

| Procedure | Frequency |
|---|---|
| PROC 3.3.2 (Inspection) | Daily/Monthly |
| PSCP-3-002 (Source check) | Monthly |
| PSCP-4-007 (Calibration) | 6 Months |
| PSCP-4-091 " | 6 Months |
| PSCP-6-029 " | 6 Months |
| PSCP-7-001 " | 6 Months |

Titles of these procedures are:

Health Physics Procedure No. 3.3.2, Rev. 1, *Gaseous Effluent Monitoring System Inspection and Sample Exchange*.

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

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

Maintenance Engineering Services Calibration Procedure PSCP-4-091, *Pressure and Vacuum Gauges*

Maintenance Engineering Services Calibration Procedure PSCP-6-029, *Chem-Tec Adjustable Flow Switch Model 500*

**Maintenance Engineering Services Calibration Procedure PSCP-7-001, *Air Rotameter***

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

**The flow rate is measured continuously. The pitot tube assembly is comprised of two tubes that measure the static and total pressure in the stack air space, from which the flow rate can be determined and sent to the Facility Process Monitor Control System (FPMCS) by a flow transmitter. In the 271-B dispatchers office, stack flow rate is displayed and trended by the FPMCS (WHC 1991b).**

**The calibration and inspection is performed every 6 months using Maintenance Engineering Services Calibration Procedure PSCP-6-032, *Bailey Electronic DP Transmitter Type BCX Series*.**

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 of this document. Also refer to WHC-EP-0528-1 (WHC 1994) for the quality assurance requirements for compiling and reporting radioactive airborne emissions.**

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 of this document.**

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.

**Samples at B-Plant are tracked from collection to analysis in accordance with WHC-IP-0718, Section 3.3.2 (WHC 1993).**

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 8.0 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.

**See Section 9.0 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 10.0 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.

**Section 6.0 of the main part of this document, plus the attached point-by-point comparisons to NESHAP quality assurance criteria, fulfill the QAPjP requirements for regulated stacks. Separate facility QAPjP's are not required.**

## APPENDIX C REFERENCES

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

EPA, 1991a, "Quality Assurance Methods," 40 CFR 61, Appendix A, Method 1, *Code of Federal Regulations*, U.S. Environmental Protection Agency, Washington, D.C.

EPA, 1991b, "Quality Assurance Methods," 40 CFR 61, Appendix B, Method 114, *Code of Federal Regulations*, U.S. Environmental Protection Agency, Washington, D.C.

DOE-RL, 1994, *Hanford Emergency Response Plan*, DOE/RL-94-02, U. S. Department of Energy, Richland Operations Office, Richland, Washington

WHC, 1991a, *Facility Effluent Monitoring Plan for the B Plant*, WHC-EP-0467, Westinghouse Hanford Company, Richland, Washington.

WHC, 1991b, *Drawings*, Westinghouse Hanford Company, Richland, Washington.

- H-2-91208, *Generic Stack Beta Record Rack Assembly*
- H-2-92488, *Generic Stack Sampler/Monitor modified Monitor Assembly*
- H-2-92489, *Generic Stack Sampler/Monitor Record Sample Loop Assembly*
- H-2-92490, *Generic Stack Sampler/Monitor Sample Extraction Assembly*
- H-2-92514, *Differential Pressure Transmitter and Manifold Assembly*
- H-2-94158, *Elect/Instm/Dwg List Site Plan and Details, 291-B-1 Sampler/Monitor*
- H-2-94159, *Probe Assembly 291-B-1 Stack Sampler/Monitor*
- H-2-96550, *IEFD B Plant Area Stack Monitors 291-B-1*
- W-69512, *291-B-T-U Concrete Stack Foundation Details*
- W-73544, *221 T-U-B Concrete Ducts and Pits, Plans and Details*
- HW-72051, *Building No. 291 T, U, B Ventilation Exhaust Units Arrangement*
- W-72438, *Building No. 291 T-U-B Ventilation Exhaust Stack Breeching Arrangement*
- ES-BPF-70174, *Reinforced Concrete Chimney Lined Process Stack Eq Pc 291-B-C-T-U-901*

  (Note: This drawing represents a condensed recreation of the original Rust Engineering blue print file 70174 of July 10, 1943. The original contract called for four tapered reinforced concrete stacks, circular in section, with acid-proof brick lining. Stacks to be 61 m (200 ft) above foundations - inside diameter at top 1.5 m (5 ft). Hole drilled in concrete column adjacent to ladder at a point 15.2 m (50 ft) above top of foundation.)

WHC, 1992, *Building Emergency Plan for B Plant Complex*, WHC-IP-0263-BCP, Westinghouse Hanford Company, Richland, Washington.

WHC, 1993, *Health Physics Procedure Manual*, WHC-IP-0718, Westinghouse Hanford Company, Richland, Washington.

WHC, 1994, *Quality Assurance Project Plan for Radioactive Airborne Emissions Data Compilation and Reporting*, WHC-EP-0528-1, Westinghouse Hanford Company, Richland, Washington.

WHC, 1995, *Statement of Work for Services Provided by The Waste Sampling and Characterization Facility For Effluent Monitoring*, WHC-EP-0835, Westinghouse Hanford Company, Richland, Washington.

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

WHC-CM-4-14, *Applied Radiological Controls*, Westinghouse Hanford Company, Richland, Washington.

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

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

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

## Procedures

Westinghouse Hanford Company, Richland, Washington:

Maintenance Engineering Services Calibration Procedure PSCP-3-002, 1994, Rev. 6, *Eberline Beta Air Monitor, Models AMS-3, AMS-3A and 700300*

Maintenance Engineering Services Calibration Procedure PSCP-4-007, 1995, Rev. 2, *Rockwell Type Gas Meter*

Maintenance Engineering Services Calibration Procedure PSCP-4-091, 1992, Rev. 3, *Pressure and Vacuum Gauges*

Maintenance Engineering Services Calibration Procedure PSCP-6-029, 1993, *Chem-Tec Adjustable Flow Switch Model 500*

Maintenance Engineering Services Calibration Procedure PSCP-7-001, 1993, Rev. 1C, *Air Rotameter*

Maintenance Engineering Services Calibration Procedure PSCP-6-032, 1990, Rev. 1, *Bailey Electronic DP Transmitter Type BCX Series*

# APPENDIX D

# METHOD 114 COMPARISON FOR STACK 291-Z-1

P. J. Sullivan

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# APPENDIX D

# 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.

**No response is required.**

### 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 Gelman Versapor[1] 3000 filter medium is an acrylic copolymer membrane supported by a non-woven nylon fabric. The manufacturer rates the efficiency of this medium at 91% for 0.3-μm aerosol. The manufacturer recently tested 24 samples with a 0.3-μm di-octyl phthalate aerosol. The measured average efficiency was 95.8% and the standard deviation was 1.6%, which supports the rated efficiency.**

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[1] Trademark of Gelman Sciences, Inc., Ann Arbor, Michigan.

2.2 Radionuclides as Gases.

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

2.3 Definition of Terms

**No response is required.**

## 3.0 Radionuclide Analysis Methods

**The analysis methods have been evaluated by the Waste Sampling and Characterization Facility (WSCF) 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 Sections 6.3 and 7.0 of WHC-EP-0536 (WHC 1991).**

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

**<u>DOE/RL-94-02</u>, *Hanford Emergency Response Plan* (DOE-RL 1994). This document contains an emergency response 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 Hanford Site facilities. The requirements stated in the plan are implemented through subtier plans and implementing procedures. These implementing plans and procedures established for response to emergencies by Hanford Site 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 Hanford Site Facility operating procedures.**

**<u>WHC-CM-4-14</u>, Part 3, Section 5.0, *Applied Radiological Controls***

**The RC 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 RC 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 RC response. For a planned response, RC 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) and approval of the Building or Facility Emergency Director is necessary to re-enter.

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

WHC-IP-0718, Section 3.3.2, Rev. 1, "Gaseous Effluent Monitoring System Inspection and Sample Exchange" (WHC 1993). This procedure provides the steps needed to perform inspections of the Gaseous Effluent Monitoring Systems (Stack Packs) and the exchange sequence for effluent air samples.

ZH-100-101, "PFP Shiftly 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 at PFP.

ZH-100-102, "PFP Biweekly Gaseous Effluent Sampling and Monitoring System Inspection and Sample Exchange." This procedure provides RC personnel with instruction necessary to perform routine weekly sample collection and sampler inspection for all PFP Stack Monitors.

WHC-IP-0718, Section ER-04, Rev. 0, "CAM Alarms". This procedure establishes the standard method of handling samples from, and response to, alarms at effluent exhaust continuous air monitor systems in an expedited fashion.

ZH-100-104, "Radiological Control Response to Room 221A & Room 631 Annunciator Panel Alarms." This procedure provides the RC staff at PFP the information and required actions needed to respond to a radiation or contamination-related alarm.

WHC-IP-0718, Section ER-02, Rev. 1, "General Emergency Response Guidelines and Checklists." This procedure provides the instructions and checklists for response to various radiological emergencies.

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. 4, "Non-Routine Release Response." This procedure details the response actions to non-routine releases as evidenced by high sample results from gaseous effluent samples at the PFP.

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 4.8 m (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 National Laboratory (Northwest Laboratory) 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 alternative site location requirements of 40 CFR 60, Appendix A, 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 [WHC 1977a and 1977b]). 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 (ANSI 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 4 $ft^3$/min. The sampler probe uses six nozzles for sampling the stack flow (drawing H-2-28545 [WHC 1977b]). 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. 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 bi-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.

The analytes of interest for the 291-Z-1 Stack can be found in WHC-EP-0835, *Statement of Work for Services Provided by The Waste Sampling and Characterization Facility For Effluent Monitoring* (WHC 1995). For a description of the laboratory analysis procedures for these analytes, see 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 radiological control technician (RCT) office, Room 221A and the Power Control Room, Room 321A, which is manned 24 hours per day. The annual calibration procedures and monthly functional tests for the 291-Z-1 Stack CAM and record sampler system components are ZSE-24B-001 (monthly) and ZSE-24B-002 (annual). Components include vacuum gauges, flow totalizers, rotameters, vacuum or flow switches, and Continuous Air Monitors (CAMs).

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.

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

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

To comply with the 40 CFR, Part 61, Subpart H standards, volumetric flow rate for the 291-Z-1 stack is conservatively assumed to be 290,000 cubic feet per minute. On May 11, 1995, the U.S. Environmental Protection Agency (EPA) granted approval to the

**U.S. Department of Energy, Richland Operations Office (DOE-RL) for the use of this value in calculations involving this stack.**

**On June 26, 1995, DOE-RL satisfied the only EPA approval condition by providing direction (to use 290,000 cubic feet per minute) to WHC. Finally, in a memorandum dated September 18, 1995, EPA, Region 10 declared the 291-Z-1 stack compliant with the requirements of 40 CFR, Part 61, Subpart H (EPA 1995).**

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. Also refer to WHC-EP-0528-1 (WHC 1994) for the quality assurance requirements for compiling and reporting radioactive airborne emissions.**

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 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 8.0 of the main body 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.

**See Section 9.0 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 10.0 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.

**Section 6.0 of the main part of this document, plus the attached point-by-point comparisons to NESHAP quality assurance criteria, fulfill the QAPjP requirements for regulated stacks. Separate facility QAPjP's are not required.**

# APPENDIX D 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.

EPA, 1991, "Quality Assurance Methods," Title 40, *Code of Federal Regulations*, Part 61, Appendix B, Method 114, U.S. Environmental Protection Agency, Washington, D.C.

EPA, 1995, *Notice of Approval to Use the 291-Z-1 Stack Volumetric Flow Rate*, (memorandum 95-PCA-914, R. W. Poeton to J. E. Rasmussen, DOE-RL, September 18), U.S. Environmental Protection Agency, Region 10, Seattle, Washington.

DOE-RL, 1994, *Hanford Emergency Response Plan*, DOE/RL-94-02, U. S. Department of Energy, Richland Operations Office, Richland, Washington

WHC, 1977a, *Sample Probe Installation Arrangement*, Drawing H-2-28543, Westinghouse Hanford Company, Richland, Washington.

WHC, 1977b, *Sample Probe Assembly*, Westinghouse Hanford Company, Drawing H-2-28545, Richland, Washington.

WHC, 1991, *Quality Assurance Program Plan for Radionuclide Airborne Emissions Monitoring*, WHC-EP-0536, Westinghouse Hanford Company, Richland, Washington.

WHC, 1992, *Building Emergency Plan for Plutonium Finishing Plant Complex Emergency Response Plan*, WHC-IP-0263-PFP, Westinghouse Hanford Company, Richland, Washington.

WHC, 1993, *Westinghouse Hanford Health Physics Procedures Manual*, WHC-IP-0718, Westinghouse Hanford Company, Richland, Washington.

WHC, 1994, *Quality Assurance Project Plan for Radioactive Airborne Emissions Data Compilation and Reporting*, WHC-EP-0528-1, Westinghouse Hanford Company, Richland, Washington.

WHC, 1995, *Statement of Work for Services Provided by the Waste Sampling and Characterization Facility for Effluent Monitoring*, WHC-EP-0835, Westinghouse Hanford Company, Richland, Washington.

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

WHC-CM-4-14, *Applied Radiological Controls*, Westinghouse Hanford Company, Richland, Washington.

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

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

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

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

## Procedures

Westinghouse Hanford Company, Richland, Washington:

PFP Engineering Administration, 1994, *Monthly 291-Z-1 Stack Effluent Monitor Functional Test*, ZSE-24B-001

PFP Engineering Administration, 1994, *Annual 291-Z-1 Stack Effluent Systems Calibration and Replacement*, ZSE-24B-002

PFP Engineering Administration, 1995, *Perform Shiftly Gaseous Effluent Sampling and Monitoring System Operability Inspection*, ZH-100-101

PFP Engineering Administration, 1995, *Perform Bi-Weekly Gaseous Effluent Sampling and Monitoring System Inspection and Sample Exchange*, ZH-100-102

PFP Engineering Administration, 1994, *Perform Radiological Control Response to Room 221-A and Room 631 Annunciator Panel Alarms*, ZH-100-104

# APPENDIX E

# TANK FARMS TRANSITION PROJECT

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# APPENDIX E

# TANK FARMS TRANSITION PROJECT

| | |
|---|---|
| 296-A-17 | 241-AY/AZ Tank Farm Exhauster |
| 296-P-26 | 241-AY/AZ Tank Farm Backup Exhauster |
| 296-A-22 | 242-A Evaporator Vessel Vent Exhauster |
| 296-A-40 | 241-AP Tank Farm Exhauster |
| 296-B-28 | 244-BX Double Contained Receiver Tank Exhauster |
| 296-C-05 | 244-CR Vault Exhauster |
| 296-P-16 | 241-C-105/106 Tank Exhauster |
| 296-A-12 | 244-AR Vessel Vent Exhauster |
| 296-S-15 | 241-SX Tank Farm Exhauster |
| 296-S-22 | 244-S Double Contained Receiver Tank Exhauster |
| 296-T-18 | 244-TX Double Contained Receiver Tank Exhauster |
| 296-U-11 | 244-U Double Contained Receiver Tank Exhauster |

## INTRODUCTION

This appendix contains the point-by-point comparison with Method 114 (EPA 1991) for all of the NESHAP Designated Stacks belonging to the Tank Farm Transition Project (TFTP). The point-by-point sections common to all TFTP stacks are contained in Section I of this appendix, and the information that is specific to the individual stacks is contained in the sections that follow.

# SECTION I: METHOD 114 COMPARISON FOR TANK WASTE REMEDIATION SYSTEM (TWRS) STACKS

## 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.

**No response required.**

## 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).

**Documentation:**

Wagemaker, Wendy, 1991, *Versapor 3000, DOP Efficiency*, (interoffice memorandum to Karol Butcher, October 30), Gelman Sciences, Inc., Ann Arbor, Michigan.

**Discussion:**

The Gelman Versapor[1] 3000 filter medium is an acrylic copolymer membrane supported by a non-woven nylon fabric. The manufacturer rates the efficiency of this medium at 91% for 0.3-μm aerosol. The manufacturer recently tested 24 samples with a 0.3-μm di-octyl phthalate aerosol. The measured average efficiency was 95.8% and the standard deviation was 1.6%, which supports the rated efficiency.

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[1] Trademark of Gelman Sciences, Inc., Ann Arbor, Michigan.

### 2.2 Radionuclides as Gases.

Documentation:

*Gaseous Effluent Sampling*, Health Physics Desk Instruction #DI33300-18-0, March 31, 1994, Westinghouse Hanford Company, Richland, Washington.

Discussion: Silver Zeolite Cartridges are used to collect $^{129}$I, $^{103}$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 O-2 of *Air Sampling Instruments*, American Conference of Governmental Industrial Hygienists, seventh edition [ACGIH 1989]).

## 3.0 Radionuclide Analysis Methods

The analysis methods are included in 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 6.3 and Section 7.0 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.

DOE/RL-94-02, *Hanford Emergency Response Plan* (DOE-RL 1994). This document contains an emergency response plan to protect on-site personnel, public health and safety, and the environment in the event of operation, natural phenomena, and/or safeguards and security events at Hanford Site Facilities. The requirements stated in the plan are implemented through subtier plans and implementing procedures. These implementing plans and procedures established for response to emergencies by Hanford Site 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 Hanford Site facility operating procedures.

WHC-CM-4-14, *Applied Radiological Controls*, Part 3, Section 5.0

The RC 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 RC 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 an RC response. For a planned response, RC 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) and approval of the Building or Facility Emergency Director is necessary to re-enter.

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

WHC-IP-0718 (WHC 1993a), Section 3.3.2, "Gaseous Effluent Monitoring System Inspection and Sample Exchange." This procedure provides the steps needed to perform inspections of the Gaseous Effluent Monitoring Systems (Stack Packs) and the exchange sequence for effluent air samples.

WHC-IP-0718, Section ER-02, "General Emergency Response Guidelines and Checklists." This procedure provides the instructions and checklists for response to various radiological emergencies.

WHC-IP-0718, Section ER-04, "CAM Alarms". This procedure establishes the standard method of handling samples from, and response to, alarms at effluent exhaust continuous air monitor systems in an expedited fashion.

WHC-IP-0718, Section ER-05, "Radiation Area Monitor Alarm Response." This procedure provides the instructions and checklists for response to alarms in radiation areas.

Notifications and reporting of specific events related to environmental releases and/or events involving effluents and/or hazardous materials are reported via instructions given in WHC-CM-7-5, *Environmental Compliance Manual*, and WHC-IP-0839, *Tank Farms Emergency Response Guides* (WHC 1993b): Tab L, Waste Tank Fire or Explosion; Tab O, Waste Tank Overpressurization; Tab P, High Area Radiation. 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 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.

This information is provided in each of the specific stack sections of this appendix.

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

This section discusses compliance of the sample probes with ANSI N13.1, Section A3.4 (ANSI 1969), and the conditions that are necessary for collecting a representative sample from an airborne effluent stream that contains particulates. The specific stack sections of this appendix address the sampling conditions at each stack and the sample representativeness.

The sample probes are described in WHC-SD-WM-ES-291-1 (WHC 1994a) with the exception of 296-S-25 and 296-U-11. The specific stack sections of this appendix state whether or not the sample probe is designed in accordance with ANSI N13.1, Section A3.4. The specific stack sections of this appendix also address the impact that a deviation from A3.4 recommendations may have on sample representativeness.

In general, the samples are representative if the following conditions are met:

- SINGLE-NOZZLE PROBES

- The effluent stream at the sampling location is well mixed.

- The sampling system collection efficiency for small particles (3.5 micron) is roughly equal to the collection efficiency for relatively large particles (10 micron); OR

the particle sizes at the sampling location are less than 5 micron and are normally distributed (ie., the particle size distribution is not bi-modal).

- MULTI-NOZZLE PROBES

- The effluent stream at the sampling location is well mixed.

- The sampling system collection efficiency for small particles (3.5 micron) is roughly equal to the collection efficiency for relatively large particles (10 micron); OR

The particle sizes at the sampling location are less than 5 micron and have a normal distribution.

- The velocity profile at the sampling location is uniform.

- The sampling probe nozzles represent equal annular areas.

The flow at the sampling location in all of the stacks is turbulent, and assumed to be well mixed.

The particle penetration fractions (which are proportional to collection efficiencies) presented in this appendix account for an-isokinetic sampling conditions as well as particle losses which occur due to turbulent impaction with the sample system walls. A large difference between the small and the large particle penetration fractions does not mean that the sample representativeness is poor, it just indicates that the sampling system is biased with respect to large or small particles.

During normal operating conditions (HEPA [high-efficiency particulate air filter] efficiency >99.95% for 0.3 micron), the number of large particles (>5 micron) that pass through the HEPA filters is insignificant in comparison to the number of small particles (0.1 micron). This is because HEPA filter efficiency increases sharply as particle size increases from 0.1 micron (HEPA filters are least efficient around 0.1 micron. Isokinetic sampling conditions are not necessary for collecting a representative sample from airstreams with particle sizes less than 5 micron (ANSI 1969). Downstream from the HEPA filters, the particle sizes are assumed to have a normal distribution. Provided all of the other conditions are met, the samples are representative.

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; CAMs are not used to measure emissions for reporting 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 type and number of equipment that make up the sample collection and monitoring systems vary from stack to stack. WHC-SD-WM-ES-291-1 (WHC 1994a) includes a list of sampling/monitoring equipment located on each stack. In general, the sample collection and monitoring system consists of the following elements:

- Sampling probe, which withdraws the sample from the stack.
- Sample transport line, which transports the sample from the probe to the sample collection and/or detection devices.
- Sample collection and/or detection devices.

- Rotameter, which measures the flowrate through the sampling system.
- Gas meter (or totalizer), which measures the volume of air that passed through the sampling system.
- Pressure or vacuum gauge, which measures the vacuum in the sampling system.
- Flow switch (exception: the A-29, B-28, S-22, and T-18 systems contain a pressure switch instead), which indicates when the sample flowrate falls below a preset limit.
- Flow regulator, which maintains an established flow rate through the sampling/monitoring system.
- Vacuum pump, which pulls the air sample through the sampling/monitoring system.
- Timer, which indicates the length of time that the sampling system has been operating.

The two types of sample collection devices used in Tank Farms are record samplers and Silver Zeolite samplers.

RECORD SAMPLER: Particulate radionuclides are collected with the record sampler. The record sampler holds the 47-mm sample filter paper (described in the response to paragraph 2.1 of this appendix).

Record air samples are routinely changed on a weekly or biweekly (every two weeks) basis. Record samplers are collection devices that do not require calibration.

SILVER ZEOLITE SAMPLER: Gaseous radionuclides are collected with a Silver Zeolite cartridge that is used to collect $^{129}$I, $^{103}$Ru, and $^{106}$Ru (described in response to paragraph 2.2 of this appendix).

The Silver Zeolite cartridges are exchanged weekly.

The Silver Zeolite cartridges are collection devices that do not require calibration.

All of the stack sampling/monitoring systems have record samplers.

Not all of the stacks sampling/monitoring systems have Silver Zeolite cartridges. The specific stack sections of this appendix (Sections II through XIII) identify the stacks that have Silver Zeolite samplers.

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.

**Radionuclides that should be measured are identified annually by Effluent Monitoring. The analytes of interest can be found in *Statement of Work for Services Provided by the Waste Sampling and Characterization Facility for Effluent Monitoring* (WHC 1995). For a description of the laboratory analysis procedures for these analytes, see Appendix G.**

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

**The sampling/monitoring system is calibrated annually by Maintenance Procedure 6-TF-077; Stack Sampling and Monitoring System Maintenance.**

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

**Effluent flow rates are measured quarterly by Ventilation Business Unit personnel using Maintenance Procedure 6-TF-155; "Air Flow Tests for Tank Farm Stacks and Ducts".**

**The micromanometer used to quantify the stack flow rate (Neotronics Model #MP-20) is calibrated annually by Westinghouse Standards Laboratory, Richland, Washington.**

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 valid data obtained compared to the amount expected under normal conditions.

**See Appendix G. Also refer to WHC-EP-0528-1 (WHC 1994b) for the quality assurance requirements for compiling and reporting radioactive airborne emissions.**

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 the 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 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 8.0 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 9.0 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 10.0 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.

**Section 6.0 of the main part of this document, plus the attached point-by-point comparisons to NESHAP quality assurance criteria, fulfill the QAPjP requirements for regulated stacks. Separate facility QAPjP's are not required.**

# SECTION II: 296-A-17 STACK SPECIFICS

This section contains information that is specific to the 296-A-17 Stack (AY/AZ Tank Farm Exhaust Stack).

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.

This stack is 44.5 cm (17.5 in.) in diameter. The sampling site is located 2.2 diameters downstream from the exhaust recirculation duct outlet and 5.3 diameters upstream from the flow measurement port above roof.

The sample probe has three nozzles, as recommended by ANSI N13.1, Section A3.2 (ANSI 1969).

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

The sample probe is described in WHC-SD-WM-ES-291-1 (WHC 1994a), and meets the guidance presented in ANSI N13.1, Section A3.4 (ANSI 1969).

One of the dimensions needed to determine how the sample probe is centered in the stack could not be located on the drawings for this stack, and is relatively difficult to field verify due to the sampling probe mount being located 4.6 m (15 ft) above the ground in the 702 Filter Building. Because the sample probe has three nozzles and the span from the first to the third nozzle is 36.5 cm (14 3/8 in.) (the stack ID being 44.5 cm [17.5 in.]), it was assumed that the second nozzle is positioned on the centerline of the stack. To be located at the midpoints of three equal areas in the stack, the nozzles should be located at the following distances from the center of the stack: 0, 15.49 and 20.19 cm (0, 6.098, and 7.947 in.). The nozzles are located at the following distances from the center of the stack: 0, 15.88, and 20.64 cm (0, 6.25, and 8.125 in.). Therefore, the withdrawal points represent equal annular areas.

The velocity profile at the flow measurement location is uniform (see WHC-EP-0784, Appendix A). The flow measurement location is 5.3 duct diameters downstream from the sampling location, which is 2.2 duct diameters downstream from the nearest flow disturbance (exhaust recirculation outlet). Because the flow is turbulent, and there are no obstructions between the sampling location and flow measurement location, the velocity distribution at the sampling location is assumed to be uniform.

Theoretical calculations of sample line losses indicate that the sampling system is very biased with respect to large particles (WHC 1994a). The predicted particle penetration fractions are 85% for 3.5-micron-sized particles and 10% for 10 micron. The majority of particles are less than 5 micron in size and assumed to have a normal distribution at the sampling location.

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 296-A-17 Stack has a Silver Zeolite sampler and the cartridges are exchanged weekly. The collection devices do not require calibration.

# SECTION III: 296-P-26 STACK SPECIFICS

This section contains information that is specific to the 296-P-26 Stack (AY/AZ Tank Farm Backup Exhaust Stack).

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.

This stack is 40.6 cm (16 in.) in diameter. The sampling site is located 5 diameters downstream from the nearest flow disturbance (diffuser plate just above fan) and 2 diameters upstream from the nearest flow disturbance (top of stack).

The sample probe has three nozzles, as is recommended by ANSI N13.1, Section 3.2 (ANSI 1969).

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

The sample probe is described in WHC-SD-WM-ES-291-1 (WHC 1994a), and meets the guidance presented in ANSI N13.1, Section A3.4 (ANSI 1969).

To be located at the midpoints of three equal areas in the stack, the nozzles should be located at the following distances from the center of the stack: 0, 14.2, 18.5 cm (0, 5.58, and 7.27 in.). The nozzles are located at the following distances from the center of the stack: 0, 14.0, 18.1 cm (0, 5.50, and 7.125 in.), and represent equal annular areas.

The velocity profile at the flow measurement location indicates a non-uniform flow distribution (see WHC-EP-0784, Appendix B [WHC 1984]). The disturbance is believed to be from the fan diffuser plate. The flow measurement location is just upstream from the sampling location and 5 duct diameters downstream from the fan diffuser plate. The flow disturbance is not expected to adversely affect the sample representativeness because the effluent stream at the sampling location is turbulent and assumed to be well mixed. Therefore, the sampling system may not be representative, however, the samples are believed to be representative.

Theoretical calculations of sample line losses indicate that the sampling system is somewhat biased with respect to large particles (WHC 1994a). The predicted sampling system particle penetration fractions are 99% for 3.5-micron-sized particles and 77% for 10 micron. The majority of particles are less than 5 micron in size and assumed to have a normal distribution at the sampling location.

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 296-P-26 Stack has a Silver Zeolite sampler and the cartridges are exchanged weekly. The collection devices do not require calibration.**

# SECTION IV: 296-A-22 STACK SPECIFICS

This section contains information that is specific to the 296-A-22 Stack (242-A Evaporator Vessel Vent Stack).

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 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 nearest flow disturbances are 3 duct diameters upstream (sample return line), and 7 duct diameters downstream (elbow in the vessel vent which routes the stack outside the building).

The sample probe has two nozzles as is recommended by ANSI N13.1, Section A3.2 (ANSI 1969).

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

The sample probe is described in WHC-SD-WM-ES-291-1 (WHC 1994a), and meets the guidance presented in ANSI N13.1, Section A3.4 (ANSI 1969).

Each of the two sample probe nozzles are centered in equal annular areas.

A velocity profile has not been plotted for this stack; however, because the flow within the stack is highly turbulent, the velocity profile is assumed to be uniform.

Theoretical calculations of sample line losses indicate that the sampling system is biased with respect to large particles (WHC 1994a). The predicted sampling system particle penetration fractions are 90% for 3.5-micron-sized particles and 40.8% for 10 micron. The majority of particles are less than 5 micron in size and assumed to have a normal distribution at the sampling location.

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 296-A-22 Stack has a Silver Zeolite sampler and the cartridges are exchanged weekly. The collection devices do not require calibration.

# SECTION V: 296-A-40 STACK SPECIFICS

**This section contains information that is specific to the 296-A-40 Stack (AP Tank Farm Exhaust Stack).**

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 sampling site is located 10 duct diameters downstream of the fan discharge point into the stack and 2 duct diameters upstream of the top of the stack.

The sample probe has two nozzles, as recommended in ANSI N13.1, Section A3.2 (ANSI 1969).

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

The sample probe is described in WHC-SD-WM-ES-291-1 (WHC 1994a), and meets the guidance presented in ANSI N13.1, Section A3.4 (ANSI 1969).

The two nozzles are centered in each of the two equal annular areas.

The velocity profile has not been plotted for this stack. However, since the flow is turbulent, and the sampling location is 9.6 duct diameters downstream from the nearest flow disturbance, the velocity profile is assumed to be uniform.

Theoretical calculations of sample line losses indicate that the sampling system is biased with respect to large particles (WHC 1994a). The predicted sampling system particle penetration fractions are 90.4% for 3.5-micron-sized particles and 49.9% for 10 micron. The majority of particles are less than 5 micron in size and assumed to have a normal distribution at the sampling location.

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 296-A-40 Stack has a Silver Zeolite sampler and the cartridges are exchanged weekly. The collection devices do not require calibration.

# SECTION VI: 296-B-28 STACK SPECIFICS

This section contains information that is specific to the 296-B-28 Stack (244-BX Double Contained Receiving Tank (DCRT) Exhaust Stack).

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 sampling site is located 10 duct diameters downstream of the fan discharge into the stack, and 4 duct diameters upstream of the CAM sample probe.

The sample probe has one nozzle, as recommended by ANSI N13.1, Section A3.2 (ANSI 1969).

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

The sample probe is described in WHC-SD-WM-ES-291-1 (WHC 1994a), and meets the guidance presented in ANSI N13.1, Section A3.4 (ANSI 1969).

Theoretical calculations of sample line losses indicate that the sampling system is very biased with respect to large particles (WHC 1994a). The predicted sampling system particle penetration fractions are 86.4% for 3.5-micron-sized particles and 16.8% for 10 micron. The majority of particles are less than 5 micron in size and assumed to have a normal distribution.

# SECTION VII: 296-C-5 STACK SPECIFICS

This section contains information that is specific to the 296-C-5 Stack (244-CR Vault Exhaust Stack).

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 sampling site is located 7 duct diameters downstream of the fan discharge into the stack and 22 duct diameters upstream of the top of the stack.

The sample probe has one nozzle, however, three are recommended by ANSI N13.1, Section A3.2 (ANSI 1969).

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

The sample probe is described in WHC-SD-WM-ES-291-1 (WHC 1994a), and meets the guidance presented in ANSI N13.1, Section A3.4 (ANSI 1969).

The sample probe nozzle is located approximately 13 cm (5 in.) off from the center line of the stack. The fact that the sampling system only has one nozzle (instead of three) and the nozzle is located off the center line of the stack, is not expected to have an adverse effect on sample representativeness.

Theoretical calculations of sample line losses indicate that the sampling system is somewhat biased with respect to large particles (WHC 1994a). The predicted sampling system particle penetration fractions are 95.2% for 3.5-micron-sized particles and 69.2% for 10 micron. The majority of particles are less than 5 micron in size and assumed to have a normal distribution at the sampling location.

# SECTION VIII: 296-P-16 STACK SPECIFICS

**This section contains information that is specific to the 296-P-16 Stack (C-105/106 Tank Exhaust Stack).**

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 sampling site is located 2 duct diameters upstream of the top of the stack and 5 duct diameters downstream of the stack extension (closest upstream flow disturbance).**

**The sample probe has three nozzles, as recommended by ANSI N13.1, Section A3.2 (ANSI 1969).**

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

**The sample probe is described in WHC-SD-WM-ES-291-1 (WHC 1994a), and meets the guidance presented in ANSI N13.1, Section A3.4 (ANSI 1969).**

**The sample probe nozzles are centered in equal annular areas.**

**The velocity profile at the flow measurement location indicates a uniform flow distribution (see WHC-EP-0784, Appendix H [WHC 1984]). The flow measurement location is just upstream from the sampling location and 4.9 duct diameters downstream from the fan inlet to the stack.**

**Theoretical calculations of sample line losses indicate that the sampling system is biased with respect to large particles (WHC 1994a). The predicted sampling system particle penetration fractions are 90.6% for 3.5-micron-sized particles and 54.4% for 10 micron. The majority of particles are less than 5 micron in size and assumed to have a normal distribution at the sampling location.**

# SECTION IX: 296-A-12 STACK SPECIFICS

**This section contains information that is specific to the 296-A-12 Stack (244-AR Vessel Vent Exhaust Stack).**

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 sampling site is located 210 duct diameters upstream of the top of the stack and 12 duct diameters downstream of the elbow on the inlet to the stack (closest upstream flow disturbance).

The sample probe has two nozzles, as recommended by ANSI N13.1, Section A3.2 (ANSI 1969).

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

The sample probe is described in WHC-SD-WM-ES-291-1 (WHC 1994a), but does not meet the guidance presented in ANSI N13.1, Section A3.4 (ANSI 1969). Specifically, the bend radius and nozzle length do not meet the guidance. This is not expected to significantly affect the sample representativeness because the majority of particles should be less than 5 micron in diameter.

The sample probe nozzles are centered in equal annular areas.

The velocity profile at the flow measurement location is unknown, but assumed to be uniform because the flow is turbulent and the sampling location is 12 duct diameters downstream from the nearest flow disturbance. The flow measurement location is just upstream from the sampling location and approximately 8 duct diameters downstream from the inlet to the stack.

Theoretical calculations of sample line losses indicate that the existing sampling system is very biased with respect to large particles (WHC 1994a). However, the existing 0.75 inch diameter sample lines are being replaced by 1 inch diameter sample lines, which should significantly reduce the bias of the sampling system. The predicted sampling system particle penetration fractions for the existing 0.75 inch diameter sample lines are 86.4% for 3.5-micron-sized particles and 8.6% for 10 micron. The majority of particles are less than 5 micron in size and assumed to have a normally distribution at the sampling location.

# SECTION X: 296-S-15 STACK SPECIFICS

This section contains information that is specific to the 296-S-15 Stack (SX Tank Farm Exhaust Stack).

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 sampling site is located 1.3 duct diameters upstream from the top of the stack and 0.8 duct diameters downstream from the fan discharge into the stack.

The sample probe has five nozzles, as recommended by ANSI N13.1, Section A3.2 (ANSI 1969).

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

The sample probe, which is described in WHC-SD-WM-ES-291-1 (WHC 1994a), does not meet the guidance presented in ANSI N13.1, Section A3.4 (ANSI 1969). Specifically, the nozzle length does not meet the recommended minimum. This deficiency may contribute to the sampling system bias with respect to particle sizes, but is not expected to adversely affect the representativeness of the samples.

The sample probe nozzles are centered in equal annular areas.

The velocity profile at the sampling location is unknown. The sampling location is less than one duct diameter downstream from the fan inlet to the stack. This is not expected to have a significant effect on sample representativeness because the effluent stream at the sampling location is turbulent and assumed to be well mixed.

Theoretical calculations of sample line losses indicate that the sampling system is biased with respect to large particles (WHC 1994a). The predicted sampling system particle penetration fractions are 93.7% for 3.5-micron sized particles and 57.8% for 10 micron. The majority of particles are less than 5 micron in size and assumed to have a normal distribution at the sampling location.

# SECTION XI: 296-S-22 STACK SPECIFICS

This section contains information that is specific to the 296-S-22 Stack (244-S DCRT Exhaust Stack).

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.

This stack is 15 cm (6 in.) in diameter. The sample probe is located 2 duct diameters upstream from the nozzle opening of the CAM sample probe, and 9.75 duct diameters downstream from the fan discharge into the stack.

The sample probe has one nozzle, as is recommended by ANSI N13.1, Section A3.2 (ANSI 1969).

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

The sample probe, which is described in WHC-SD-WM-ES-291-1 (WHC 1994a), does not meet the guidance presented in ANSI N13.1, Section A3.4 (ANSI 1969). Specifically, the nozzle bend radius and nozzle length do not meet the recommended minimums. This deficiency may contribute to the sampling system bias with respect to particle sizes, but is not expected to adversely affect the representativeness of the samples.

Theoretical calculations of sample line losses indicate that the sampling system is very biased with respect to large particles (WHC 1994a). The predicted sampling system particle penetration fractions are 84.5% for 3.5-micron-sized particles and 17.3% for 10 micron. The majority of particles are less than 5 micron in size and assumed to have a normal distribution at the sampling location.

# SECTION XII: 296-T-18 STACK SPECIFICS

This section contains information that is specific to the 296-T-18 Stack (244-TX DCRT Exhaust Stack).

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.

This stack is 15 cm (6 in.) in diameter. The sample probe is located 2 duct diameters upstream of the nozzle opening of the CAM sample probe, and 9.5 duct diameters downstream from the fan discharge into the stack.

The sample probe has one nozzle, as is recommended by ANSI N13.1, Section A3.2 (ANSI 1969).

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

The sample probe is described in WHC-SD-WM-ES-291-1 (WHC 1994a), and meets the guidance presented in ANSI N13.1, Section A3.4 (ANSI 1969).

Theoretical calculations of sample line losses indicate that the sampling system is very biased with respect to large particles (WHC 1994a). The predicted sampling system particle penetration fractions are 82.3% for 3.5-micron-sized particles and 16.1% for 10 micron. The majority of particles are less than 5 micron in size and assumed to have a normal distribution at the sampling location.

# SECTION XIII: 296-U-11 STACK SPECIFICS

This section contains information that is specific to the 296-U-11 Stack (244-U DCRT Exhaust Stack).

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.

This stack is 15.4 cm (6.07 in.) in diameter. The sample probe is located 6 duct diameters upstream of the nozzle opening of the CAM sample probe, and 11 duct diameters downstream from the fan discharge into the stack.

The sample probe has one nozzle, as is recommended by ANSI N13.1, Section A3.2 (ANSI 1969).

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

The sample probe meets the guidance presented in ANSI N13.1, Section A3.4 (ANSI 1969).

Theoretical calculations of sample line losses indicate that the sampling system is not significantly biased with respect to large particles. The predicted sampling system particle penetration fraction is 82% for 10-micron-sized particles. The majority of particles are less than 5 micron in size and assumed to have a normal distribution at the sampling location.

## APPENDIX E REFERENCES

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

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

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

Procedures

Westinghouse Hanford Company, Richland, Washington:

Maintenance Engineering Services Calibration Procedure, *"Stack Sampling and Monitoring System Maintenance"*, Rev. 0, 1994, Maintenance Procedure 6-TF-077.

Maintenance Technical Services Maintenance Procedure; *"Air Flow Tests for Tank Farm Stacks and Ducts"*, Maintenance Procedure 6-TF-155, Rev. 0A, 1995.

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# APPENDIX F

# METHOD 114 COMPARISON FOR STACK 340-NT-EX

K. J. Hagerty

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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

### 1.0 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 facility uses WHC-IP-0718, *Health Physics Procedures*, Section 3.3.2, "Gaseous Effluent Monitoring System Inspection and Sample Exchange" (WHC 1993), for direction in choosing filter media. The 340 Facility currently uses Gelman Sciences, Inc., 3 μm Versapor 3000[1] size 47-mm filters. Although listed as 3 μm filters, in a letter provided by Gelman Sciences, these filters have shown a 91% efficiency rating for particles of size 0.3 μm (Butcher 1991). The manufacturer recently tested 24 samples with a 0.3-μm di-octyl phthalate aerosol. The measured average efficiency was 95.8% and the standard deviation was 1.6%, which supports the rated efficiency.**

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[1] Trademark of Gelman Sciences, Inc., Ann Arbor, Michigan.

2.2 Radionuclides as Gases

**Samples are exchanged bi-weekly as required by Health Physics Scheduled Radiation Survey Task Description for Building 340, Task No. J-W005, (WHC 1995). Procedure 3.3.2, "Gaseous Effluent Monitoring System Inspection and Sample Exchange," found in WHC-IP-0718, *Health Physics Procedures Manual*, provides the detailed instructions of how to accomplish a changeout (WHC 1993).**

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 National Laboratory (Northwest Laboratory). Work in the laboratories is not routine, but varies with each project. Constituent type and volume received at the 340 Facility also varies with each project. For Tritium (H-3) discharges from the 340-NT-EX stack, the dose to the maximally exposed individual, located in the Ringold area, was calculated. The effective dose equivalent from Tritium discharges was shown to be 2.9E-5 mrem per year. Periodic sampling for Tritium will be done at the 340 Facility to confirm low emissions.**

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.

**The 340 Facility is not required to monitor for radioactive iodine, but samples are taken on a quarterly interval.**

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 Northwest Laboratory. 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, Northwest Laboratory 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 Northwest Laboratory. 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, Northwest Laboratory does not use radioactive oxygen, nitrogen, or radon in any projects.**

### 2.3 Definition of Terms

**No response required.**

## 3.0 Radionuclide Analysis Methods

**The analysis methods have been evaluated by 325 Laboratory cognizant personnel and are included as 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.

**See Sections 6.3 and 7.0 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.

**DOE/RL-94-02, *Hanford Emergency Response Plan* (DOE-RL 1994). This document contains an emergency response 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 Hanford Site Facilities. The requirements stated in the plan are implemented through subtier plans and implementing procedures. These implementing plans and procedures, established for response to emergencies by Hanford Site 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 Hanford Site Facility operating procedures.**

**WHC-CM-4-14, Part 3, Section 5.0, *Applied Radiological Controls***

**The radiological control technician (RCT) 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 RCT 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 RC response. For a planned response, RC 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) and approval of the Building or Facility Emergency Director is necessary to re-enter.

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

WHC-IP-0718, Section 3.3.2, Rev. 1, "Gaseous Effluent Monitoring System Inspection and Sample Exchange" (WHC 1993). This procedure provides the steps needed to perform inspections of the Gaseous Effluent Monitoring Systems (Stack Packs) and the exchange sequence for effluent air samples.

WHC-IP-0718, Section ER-04, Rev. 0, "CAM Alarms." This procedure establishes the standard method of handling samples from, and response to, alarms at effluent exhaust continuous air monitor systems in an expedited fashion.

WHC-IP-0718, Section ER-02, Rev. 1, "General Emergency Response Guidelines and Checklists." This procedure provides the instructions and checklists for response to various radiological emergencies.

Notifications and reporting of specific events related to environmental releases and/or events involving effluents and/or hazardous materials are reported via instructions given in WHC-CM-7-5, *Environmental Compliance Manual*. 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 340 Facility, 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.

Drawing H-3-34406 (DOE-RL 1978), "HVAC Elevations, Sections and Details," shows stack dimensions and sampling site location. As shown, the stack is 46 cm (18 in.) in diameter. The sample site is located 3.6 cm (12 ft) downstream (or 8 duct diameters) from the last disturbance and 0.9 m (3 ft) (or 2 duct diameters) 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 vendor. The vendor information contains the probe design drawings. To summarize here, the stack has one sample probe with three 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 a vendor. The sampler consists of a single sample probe with 3 sample nozzles. The inside diameter of each nozzle is 0.427 in. Each nozzle represents an equal annular area of 0.597 $ft^2$. The vendor information contains the probe design drawings. Sample withdrawal velocity is maintained at or near as possible to the stack velocity to obtain representative samples. 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.

Radioactive particulates are captured on a high-efficiency particulate air filter as described in Section 2.1 of this appendix. Radioactive iodine is captured on a charcoal cartridge as described in Section 2.2.2 of this appendix. Particulate samples are collected bi-weekly and radioiodine quarterly, in accordance with procedures WHC-IP-0718, *Health Physics Procedures*, Section 3.3.2, "Gaseous Effluent Monitoring System Inspection and Sample Exchange" (WHC 1993), and Health Physics Scheduled Radiation Survey Task Description for Building 340, Task No. J-W003, (WHC 1995). The J-W003 procedure includes sample chain-of-custody requirements. No calibrations are required for the particulate filter.

System calibration is performed annually using procedure 340-18-013, "Mass-Tron[2] Flow Transmitter Calibration"

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[2] *Trademark of Air Monitor Corporation, Santa Rosa, California.*

(1995). The stack and sample flows are measured using an Air Monitor Corp. Mass-Tron air flow indicating transmitter. Based on stack flow, the sample flow is changed with a manual needle valve to maintain the same velocity in the sample line as in the stack.

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 basis by Hanford Site 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 (PNNL 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. 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 (PNNL 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 (PNNL 1990) are performed.

Laboratory analysis procedures used for Stack 340-NT-EX record samples are described by the information in Section 3.0 of 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 manually controlled needle valve. Sample flow is indicated locally with an Air Monitor Corporation flow indicating transmitter. Daily checks of the flow are used to ensure isokinetic sample flows. The flow indicating transmitter is calibrated annually in accordance with procedure 340-18-013. (1995).**

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 number 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, *300 Area Support Services*, 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.

**Laboratory requirements are presented in Appendix H. Also refer to WHC-EP-0528-1 (WHC 1994) for the quality assurance requirements for compiling and reporting radioactive airborne emissions.**

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.

**Sampling data integrity and sample control are maintained from sample generation through the WHC/Operations - PNNL Analytical Laboratory interface by documentation employing Emission Monitoring Sample Chain-of-Custody and Analytical Laboratory Services Request forms (Procedure J-W003 [WHC 1995]). The PNNL/ALO Laboratory Information Management System (LIMS), a computer-based system, provides sample tracking from sample receipt through analytical report production.**

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 8.0 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 9.0 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 10.0 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.

**Section 6.0 of the main part of this document, plus the attached point-by-point comparisons to NESHAP quality assurance criteria, fulfill the QAPjP requirements for regulated stacks. Separate facility QAPjP's are not required.**

## APPENDIX F REFERENCES

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PNNL, 1990, *Analytical Chemistry Laboratory Manual, Volume 6*, Pacific Northwest National Laboratory, Richland, Washington.

WHC, 1993, *Health Physics Procedures Manual*, WHC-IP-0718, Westinghouse Hanford Company, Richland, Washington.

WHC, 1994, *Quality Assurance Project Plan for Radioactive Airborne Emissions Data Compilation and Reporting*, WHC-EP-0528-1, Westinghouse Hanford Company, Richland, Washington.

WHC, 1995, *Health Physics Scheduled Radiation Survey Task Description for Building 340, 300 Area, Task No. J-W003*, Westinghouse Hanford Company, Richland, Washington.

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

WHC-CM-4-14, *Applied Radiological Controls*, Westinghouse Hanford Company, Richland, Washington.

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

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

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

WHC-CM-8-3, *300 Area Support Services*, Westinghouse Hanford Company, Richland Washington

## Procedures

Westinghouse Hanford Company, Richland, Washington:

340-18-013, 1995, *Mass-Tron Flow Transmitter Calibration*

J-W003, 1995, *Scheduled Radiation Survey Task Description for the 340 Facility*

# APPENDIX G

# METHOD 114 COMPARISON FOR WSCF LABORATORY

A. K. Dasgupta

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# APPENDIX G

## METHOD 114 COMPARISON FOR WSCF LABORATORY

Emissions monitoring practices are evaluated in this appendix 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):

The effluents from emission points 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 exceed 10% of any of the Derived Concentration Guides values provided in DOE Order 5400.5 (DOE 1990). The laboratory receives bi-weekly or quarterly main stack air filter samples depending on the NESHAP category. They are usually 47-mm filters (acrylic copolymer on nylon). Before analysis is performed, samples are held for 7 days so that radon/daughters, if present in the filters, can decay away.

The radionuclides $^{129}$I, $^{106}$Ru, $^{113}$Sn, and $^{125}$Sb are sampled at the AW, AY/AZ, and AP Tank Farm main stacks, and also at the 242-A Evaporator Vessel Vent and PUREX main stacks. Samples are collected using silver zeolite cartridges that are sent 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 air particulate samples are determined using procedure LA-508-415. 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 major stack is found to be significantly increased, as indicated by its total alpha/total beta data, then facility personnel must be aware of the change in emissions. The results of the total alpha/total beta are downloaded from the computer that does the data analysis to a personal computer on the local area network. Facility Radiological Control personnel, Effluent Monitoring personnel and effluent cognizant engineers can then access this data soon after they are produced--usually the day after the filters are analyzed. Interested parties can also request a copy of the data report.

It is important to note here that continuous process control air monitoring systems with alarms are installed at each major 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 compliance, the WSCF Laboratory can, upon request, perform specific radionuclide analyses on a composite of all filters collected during a calendar quarter. These analyses include gamma energy analysis (GEA), specific analysis for Pu and Am isotopes, and specific analysis for Sr isotopes. Environmental Effluent Monitoring usually determines which analyses are performed for each particular composite.

Any requested GEA would be the first analysis performed (LA-508-481) on the composite (LA-548-442 for making a composite). The GEA determines the activities of the gamma emitters, particularly Cs-137, Ru-106, Sn-113 and any other positive gamma peaks except radon and thoron daughters. After a 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-549-412 [dissolution], LA-943-424 [chemical separation], LA-508-472 [alpha spectrometry] for $^{241}$Am, $^{238}$Pu, $^{239,240}$Pu) and beta emitters (LA-549-412 [dissolution], or LA-220-406 [separation by Sr-spec ion exchange], LA-508-415 [total beta counting] for $^{89,90}$Sr/$^{90}$Y; LA-549-412 [dissolution], LA-613-411 [chemical separation for $^{147}$ Pm, if needed], LA-548-411 [mounting in scintillation cocktail], LA-508-421 [scintillation counting], depending on the type of analyses requested.

The weekly samples for $^{129}$I, $^{125}$Sb, $^{113}$Sn, and $^{106}$Ru from each of the PUREX, 242-A Evaporator, and AW, AY/AZ, and AP Tank Farm stacks are collected on silver zeolite cartridges and are analyzed by the GEA (LA-508-481 in conjunction with LA-548-421).

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 below.

## 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.

*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.**

### 2.0 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.

*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 Appendixes A, B, C, D, E and F.**

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 Appendixes A 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 response required.**

## 3.0 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-549-412), chemical separation (LA-943-424), followed by alpha spectrometry (LA-508-472). 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) or certified $^{243}$Am and $^{236}$Pu or Pu-242 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*: **The method (A-2) of determining total alpha emitter activity of the separated element is not used because more than one alpha may be present.**

### 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 is not done at the WSCF Lab. This method is used, however, by the 222-S counting room for emergency air samples (red bordered samples).

*Response*: **The WSCF counting room uses 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. 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*: **The filter samples are counted in a low background thin-window gas-flow proportional counter with a guard detector operated in coincidence mode. It uses pulse height discriminator to separate alpha & beta activity. Our method follows the procedure LA-508-415. 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*: **Not applicable. Uranium analyses are not performed on record samples.**

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 WSCF 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 WSCF 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 at the WSCF 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.

*Response*: **Not applicable; not performed at the WSCF 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).

**Response: Our method for determining $^{90}Sr/^{90}Y$ in air filter samples is carried out using procedures LA-549-412 (dissolution of the filter sample by nitric acid) and or LA-220-406 (chemical separation by Sr-spec ion exchange), followed by procedure LA-508-415 (total beta counting). The laboratory method 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: The filter samples are counted in a low background thin-window gas-flow proportional counter with a guard detector in coincidence mode. It uses pulse height discriminator to separate alpha & beta activity.For gross beta determination, procedure LA-508-415 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: Not applicable. 200 Area record samples are not analyzed for $^{147}Pm$ or $^{3}H$.**

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*: **An air filter or a composite of air filters collected over one quarter of a year is counted on a high purity Ge (HPGe) detector connected to a computer-controlled multichannel analyzer. Samples collected in silver zeolite cartridges (mounts prepared by LA-548-421) are counted on a n-type high purity Ge detector (very useful for low gamma & x-rays). Our method uses gamma ray spectroscopy with high resolution germanium detectors and follows procedure LA-508-481. 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*: **Thin-window-type gas flow proportional counters with automatic sample changers, and ion implanted solid state detectors connected to a multichannel analyzer (MCA) are used for alpha counting of air filters in the WSCF laboratory. The laboratory 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*: **Thin-Window-type gas flow proportional counters with automatic sample changers and liquid scintillation spectrometers are used for beta counting. WSCF 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.

- 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 (closed-end HPGe coaxial) and well-type pure Ge detectors connected to computer controlled MCAs are used for air filter analysis. WSCF 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-508-405. 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, the procedure LQ-508-002 is carried out. It partially deviates from the EPA requirements. For gross alpha and gross beta measurements, WSCF**

instruments are calibrated with vendor supplied and certified filter standards made with NIST traceable alpha emitting $^{241}$Am and beta emitting $^{137}$Cs standards respectively, fabricated into the filter sample counting geometry. The efficiency based on $^{137}$Cs is slightly higher than that based on $^{90}$Sr/$^{90}$Y equilibrium mixture. To convert the gross beta results based on $^{137}$Cs efficiency, the gross beta data should be divided by a factor of 0.95. The 5% would be considered a conservative estimate.

The gross alpha result, based on $^{241}$Am efficiency, is essentially the same as that based on $^{239/240}$Pu efficiency because the alpha energies of both are high and very similar.

The reasons for choosing the $^{241}$Am standard for alpha calibration are as follows:

- $^{241}$Am is commonly found in the main stack air samples.
- Alpha counting efficiency for $^{241}$Am is 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.

Due to technical difficulties, the calibration curves relating weight of solids present to counting efficiencies were not established in direct alpha/beta counting of air filter samples. However, the self-absorption factor (LA-220-407) is applied to Sr-90 analysis of quarterly air filter composite samples.

### 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, $^{137}$Cs, $^{147}$Pm, and $^{3}$H are listed in Table 1 of Method 114 (EPA 1991) and are analyzed according to the approved methods given in the table. Other radionuclides ( $^{129}$I, $^{106}$Ru, $^{113}$Sn, $^{125}$Sb) not listed in the table are analyzed by the methods outlined in Method 114, depending on the type of radiation.

### 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 air samples are routinely performed in the WSCF laboratory before starting specific radionuclide analyses. Prompt and careful review of screening results would let facility personnel verify a significant release of a radionuclide into the air and quickly initiate corrective actions to minimize radionuclide emission into the environment. 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, *Company Policies 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 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.

**See Appendixes A, B, C, D, E and F.**

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 Appendixes A, B, C, D, E and F.**

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

**See Appendixes A, B, C, D, E and F.**

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 Appendixes A, B, C, D, E and F.**

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 Appendixes A, B, C, D, E and F.

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-508-415 on weekly samples, and occasionally on daily air samples, per collection point. The calibration procedure is documented in LQ-508-002. The counting system is calibrated only in the 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 (for counting frequency refer to LO-150-415) are also 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 the appropriate quality assurance project plan (QAPjP) or statement of work (SOW) (WHC 1995b).

- Our laboratory method for analysis of alpha emitters ($^{241}$Am, $^{238}$Pu, and $^{239,240}$Pu) involves various steps (LA-549-412 for dissolution, LA-943-424 for chemical separation, LA-542-401 and LA-508-472 for final alpha spectrometry). The analysis of specific alpha emitters is done only on quarterly composites of weekly/daily air filters. The energy resolution and calibration of the AEA (alpha energy analysis) system over the energy range of 4 to 6 MeV are checked once a day by the procedure LA-508-471. 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 or Pu-242) is made to determine the activities of the radionuclides $^{241}$ Am and $^{238,239/240}$Pu present in the sample. For routine operation, 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) or energy window of 30 keV on the MCA. For counting frequency of performance check standards, procedure LO-150-415 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 ($^{90}$Sr/$^{90}$Y) consists of a dissolution step (LA-549-412), chemical separation (LA-220-406), and total beta counting (LA-508-415). Analysis is done only on quarterly composites of weekly/daily air filters per collection point. The calibration procedure LQ-508-002 (for window-type gas flow proportional counter) is used in conjunction with LQ-508-005 (for mother/daughter case, i.e., $^{90}$Sr/$^{90}$Y in-growth calibration). It is performed only when the responsible scientist finds it necessary. The performance of the beta counting system is checked once per shift by running instrument control standards ($^{60}$Co, $^{137}$Cs, and $^{147}$Pm for beta activity) with each batch of samples. 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) on a batch basis. This checks the overall performance of our method. The chemical yield is determined by using the appropriate, stable Sr carrier or tracer ($^{85}$ Sr).

- For analysis of gamma emitters $^{134}$Cs, $^{137}$Cs, $^{113}$Sn, $^{106}$Ru and any other positive gamma peak except radon and thoron daughters, the procedure LA-508-481 is followed. Analysis is done on quarterly composites of weekly/daily air filter samples. For analysis of volatile radionuclides ($^{129}$I, $^{106}$Ru, $^{113}$Sn, $^{125}$Sb) collected weekly on silver zeolite cartridge, the procedure LA-548-421 is used in conjunction with procedure LA-508-481. Calibration of the gamma ray spectrometer is done with the procedure documented in LQ-508-405 using a (NIST traceable) certified mixed gamma ray standard. Recalibration is carried out only when it is deemed necessary by a responsible scientist. The performance of each detector of the GEA system over the whole energy range is checked for energy efficiency calibration once a day 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 QAPjP 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 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-508-405.

- The content of the WSCF 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 3.9, "Laboratory Procedures--Preparation, Review and Approval", and Section 3.10, "Laboratory Procedure Changes and Procedure Change Authorization". 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.

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

  Applications - 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."

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

  Quality Control Protocol - 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.

  Approval Designator - MANDATORY - An approval designator will be identified for each procedure following WHC-CM-3-5, Section 12.7 with a brief basis of determination statement.

  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-4-29, Nuclear Criticality Safety
- HSRCM-1, Hanford Site Radiological Control Manual

Supporting document WHC-SD-CP-LB-003, *Safety in the Analytical Laboratory* (WHC 1989), 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 material safety data sheet (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 a 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.

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

See Appendixes A, B, C, D, E and F.

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

See Appendixes A, B, C, D, E and F.

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 is documented in the Quality Assurance Program Plan for the Waste Sampling and Characterization Facility (WHC-SD-CP-QAPP-017)(WHC 1995a).

Precision is a measure of the agreement among individual measurements of the same parameter under similar conditions, and is estimated by means of duplicate/replicate analyses. Analytical method precision is estimated using laboratory control standards (method) over time and does not reflect the measure of precision in sample matrices.

Precision can be determined by the relative standard deviation or relative percent difference. The relative standard deviation (RSD) is used when at least three replicate measurements are performed on a given technique. The RSD is computed using the following equation:

$RSD = 100*s/x$ where $s$ is standard deviation with $n-1$ degrees of freedom, $n$ total number of observed values, and $x$ mean of observed values.

The relative percent difference (RPD) is used when two measurements exist. The RPD is computed using the following equation:

$RPD = (x1 - x2)*100/x$ where x1, x2 are observed values and x mean of observed values.

Accuracy is defined as the closeness of agreement between an observed value and an accepted reference value. The accuracy of analytical methods is determined using percent recovery. As a basic QC protocol, the evaluation of blind, laboratory control (method standards) appropriate performance evaluation samples (DOE's Environmental Monitoring Laboratory [EML] or EPA's Environmental Monitoring Support Laboratory [EMSL]) may be used to provide the percent recovery (P). However, this can be superseded by the customer's requirements as stated in a statement of work (SOW).

$P = 100 * R/K$ where R is the measured activity of the standard and K is the known value of the standard.

Completeness is a measure of the amount of usable/valid data obtained from a measurement system compared to the amount of data that was expected to be obtained under correct normal conditions. The objectives for completeness of analyses is 90%. 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.

Quality performance within each Analytical Measurement System (AMS) is maintained by the ability to detect when an AMS is not performing to specifications and to document the deviation as well as the corrective action. The following Quality Control options are used to evaluate the listed components that will affect the quality of the AMS. Where possible the quality control options presented in the table below will be used. Each analytical batch will have at least a blank, laboratory control standard (method) and samples.

| Option | Component |
|---|---|
| Laboratory Control Sample or QC Standard (method standard) | Accuracy, and gross operation of instrument, reagents, dilution and technique |
| Replicate Analysis ( for composite only) * | Precision |
| Tracer | Matrix interference and yield |
| Preparation Blank | Contamination |
| Instrument Control Standards | Instrument stability |

Each sample collection point produces only one filter sample which is sent to the laboratory for analysis. No replicate samples are available. Repeat counting of the sample mounts, if needed, can be performed using other detectors at the discretion of the scientist in charge.

Radionuclide spikes are not used. However, tracer elements $^{243}$Am, and $^{236}$Pu, or $^{242}$Pu, are used in the analysis of $^{241}$Am, $^{238}$Pu, and $^{239,240}$Pu in the quarterly composites of weekly filter samples in order to determine matrix interference and the yield.

The laboratory does not split samples. There is no guarantee that the distribution of material on the filter will be homogeneous. 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 effect the method detection limits.

Blank filters from the same manufacturer and type are used in analysis of a batch of dissolved composite air samples. Blank filter holder (planchets) are used to check of the background of the counting instrument.

The parameters used in quality control program to monitor and evaluate AMS performance on standards are warning and control limits. These are usually obtained by the statistical evaluation of the laboratory control standard data over time and set to 2 sigma (warning) and 3 sigma (control limit). However, the customer and the chemist may require setting the limit for accepting the accuracy or the recovery of a laboratory standard, such as ± 25% at the 95% confidence interval as stated in the SOW (WHC-EP-0835)(WHC 1995b).

The counting room instruments software can generate instrument control charts based on instrument control charts based on instrument control standard, background, efficiency, etc. The method control chart can be generated either manually or from the

Multi-LIMS. Both of these charts are updated and evaluated on a regular basis.

The WSCF Radiochemistry Laboratory Quality Control Program also includes participation in the following performance evaluation programs:

- USEPA National Exposure Research Laboratory, Characterization Research Division, Las Vegas
- DOE Environmental Measurements Laboratory, Quality Assessment Program, New York

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 an established statement of work (SOW) that is reviewed and revised annually.

For those samples on the system traceability begins with the Automated Barcoding of Air Samples at Hanford (ABCASH) database issuance of a unique sample identifier (Sxxxxxx) for the customer. With this number the database references the sample point, date and time the sample was in service, the date and time the sample was removed, and the total flow. ABCASH also generates chain of custody (COC) paperwork from the moment of sampling, to transportation, and receipt at the laboratory.

When the samples are brought to the laboratory, the sample custodian uses ABCASH to generate a laboratory receipt COC by scanning the sample barcodes. The samples are then entered into the laboratory database (Multi-LIMS) where another unique identifier is issued (WYYFxxxxxxx). For each sample covered by the SOW, the MLIMS has the associated required analysis protocols and analytes. The database then generates a worklist which lists each sample by both laboratory and customer ID, and the required analysis. The results of the initial analyses are electronically transferred from the instrument to the MLIMS database. After validation, the results are electronically uploaded to ABCASH. The samples are then archived in a storage file for quarterly compositing and eventual non-destructive and subsequent destructive analyses. The results of these analyses are input to MLIMS and again, after validation, the results are sent directly to the customer.

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 the Quality Assurance Plan for the Waste Sampling and Characterization Facility, WHC-SD-CP-QAPP-0017, Rev 0, section 15 (WHC 1995a).**

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 10.0 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.

**Section 6.0 of the main part of this document, plus the attached point-by-point comparisons to NESHAP quality assurance criteria, fulfill the QAPjP requirements for regulated stacks. Separate facility QAPjP's are not required.**

## APPENDIX G 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.

HSRCM-1, 1994, *Hanford Site Radiological Control Manual*, Site Contractors, Richland, Washington.

WHC, 1989, *Safety in the Analytical Laboratory*, WHC-SD-CP-LB-003, Rev. 2.0, Westinghouse Hanford Company, Richland, Washington.

WHC, 1995a, *Quality Assurance Program Plan for the Waste Sampling and Characterization Facility*, WHC-SD-CP-QAPP-0017, Westinghouse Hanford Company, Richland, Washington.

WHC, 1995b, *Statement of Work for Services Provided by the Waste Sampling and Characterization Facility for Effluent Monitoring*, WHC-EP-0835, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-1, *Company Policies and Charters*, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-3-5, *Document Control and Record Management*, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-4-3, *Industrial Safety Manual*, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-4-29, *Nuclear Criticality Safety*, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-5-4, *Laboratories Administration*, Westinghouse Hanford Company, Richland, Washington.

### Procedures

LA-220-406, 1994, *Strontium-89 and 90 in Aqueous Samples by SR-Spec Separation*

LA-220-407, 1994, *Measurement of Self-Absorption of Beta Radiation for 90 SR Determinations*

LA-508-051, 1990, *Alpha Energy Analysis Using the Canberra Jupiter Systems*

LA-508-110, 1994, *Operation of the Tennelec L/B 5500 Alpha/Beta Counting System*

LA-508-472, 1995, *Alpha Energy Sample Processing Using Alpha Management Software on the Genie System*

LA-508-471, 1995, *Alpha Energy Data Acquisition and System Checkout Using Alpha Management Software on the Genie System*

LA-508-481, 1995, *Gamma Energy Analysis Using PROcount Software*

LA-508-415, 1995, *Operation of the Protean 2-Inch Alpha/Beta Counting System*

LA-508-421, 1995, *Operation of the Tri-Carb Model 2500 TR Liquid Scintillation Analyzer*

LA-542-401, 1993, *Electrodeposition of Actinides - WSCF*

LA-548-411, 1993, *Preparation of Mounts for Liquid Scintillation Counting - WSCF*

LA-548-421, 1995, *Preparation of Sample Mounts for Gamma Energy Analysis*

LA-548-442, 1993, *Preparation of Quarterly Filter Composites for Gamma Analyses*

LA-549-412, 1994, *Dissolution of Versapor Type Filters - WSCF*

LA-613-411, 1994, *Determination of Promethium 147 in Effluent Water Samples by Solvent Extraction and LSC - WSCF*

LA-943-424, 1994, *Americium and Plutonium TRU-SPEC Separation and Neodymium Fluoride Precipitation Plating*

LO-150-133, 1994, *Processing Record Stack and Red-Bordered (Emergency) Air Samples*

LO-150-415, 1994, *Instrument Standards Counting Schedule - WSCF Nuclear Spectroscopy and Air Sample Laboratories*

LQ-508-405, 1995, *Gamma Energy Analyzer System Calibration Using Procount Software*

LQ-508-002, 1994, *Calibration Guidelines for Window-Type Gas Flow Alpha/Beta Proportional Counters*

LQ-508-005, 1990, *Calibration of Beta Detectors for SR 90*

# APPENDIX H

## METHOD 114 COMPARISON FOR 325 LABORATORY

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# APPENDIX H

# METHOD 114 COMPARISON FOR THE 325 BUILDING ANALYTICAL CHEMISTRY LABORATORY

## 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.

*Response*: **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 below.**

### 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.

*Response*: **Not required**

#### 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).

*Response*: **See Appendix F.**

#### 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.

*Response*: **See Appendixes A and E.**

### 2.3 Definition of Terms

*Response*: **Not required.**

## 3.0 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_: 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).

**_Response_: 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).

**_Response_: 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).

*Response*: 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. Filter samples are counted directly in a low background, gas-flow counting system; activity limits are calculated for filter samples exhibiting no detectable alpha activity by assigning calculated detection limit emission rates to the radionuclide which could be in the sample that has the highest dose conversion factor.

The counting system consists of a thin-window gas-flow proportional detector and a gas-flow proportional guard detector operated in anti-coincidence. Sample changing, detector high voltage, discriminator settings, count timing, count data accumulation, and database maintenance are managed by a computer-controlled operating system. Pulse height discrimination is employed to differentiate system noise, alpha activity, and beta activity. An alpha scintillation counting system equipped with a zinc sulfide detector is employed to perform direct alpha measurements upon filter samples exhibiting beta/alpha activity ratios high enough to introduce significant uncertainty into the alpha measurement. Filter samples may also be screened for detectable alpha activity by immersing them directly into scintillation "cocktail" and liquid scintillation counting [Method 3.3.3].

### 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_: 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).

**_Response_: 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).

**_Response_: 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(1 7), NCRP-58(23).

*Response*: **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.

*Response*: **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).

*Response*: **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).

*Response*: This method is used to screen filter samples for those samples exhibiting beta activity levels sufficiently above detection limits to allow application of chemical separation or processing techniques followed by beta proportion counting, Method 3.3.3, or Method 3.4.1. Filter samples are counted directly in a low background, gas-flow proportional counting system; activity limits are calculated for filter samples exhibiting no detectable alpha activity by assigning calculated detection limit emission rates to the radionuclide which could be in the sample that has the highest conversion factor.

The counting system consists of a thin-window gas-flow proportional detector and a gas-flow proportional guard detector operated in anti-coincidence. Sample changing, detector high voltage, discriminator settings, count timing, count data accumulation, and database maintenance are managed by a computer-controlled operating system. Pulse height discrimination is employed to differentiate system noise, alpha activity, and beta activity. Should a filter sample exhibit an alpha/beta activity ratio high enough to introduce significant uncertainty into the proportional counter beta measurement, absorption proportional counting or direct liquid scintillation counting [Method 3.3.3] techniques are employed.

### 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*: The sample filter is destroyed by digestion with nitric acid. When a single beta emitter is present or isolated by chemical separation, or multiple beta components are sufficiently separated in energy for spectral resolution, measurements are

**performed upon the resulting solution by liquid scintillation counting. Sample changing, photomultiplier operation voltages, discriminator settings, count timing, count data accumulation, and database maintenance are managed by a computer-controlled operating system. Pulse shape discrimination is employed to differentiate alpha, beta, and gamma activity; measurements are accumulated in energy spectrum form. Filter samples may be screened for detectable alpha and beta activity by immersing them directly into scintillation "cocktail" and counting.**

## 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*: **Gamma measurements are performed upon filter and charcoal cartridge samples by direct counting, employing a high-resolution intrinsic germanium detector. Count timing, count data accumulation, data processing, analytical report production, and database maintenance are managed by a computer-controlled multi-user system. Pulse height discrimination is employed to determine photon energies; measurements are accumulated in energy spectrum form. Recently acquired, high-efficiency, high-resolution detectors are supplanting high efficiency, low-resolution detectors [Method 3.4.2] in screening samples for detectable gamma activity.**

### 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*: **This method is used to screen filter and charcoal cartridge samples for the presence of gamma activity levels sufficiently above detection limits to justify the longer counting necessitated by lower-efficiency, high-resolution gamma counting systems. Gamma measurements are performed directly on a 4-in. by 5-in. thallium-activated sodium iodide well detector. Count timing, count data accumulation, and database maintenance are managed by a computer-controlled multi-user system. Pulse height discrimination is employed to discriminate photon energies; measurements are accumulated in energy spectrum form at a resolution approximately one order of magnitude poorer than that of a high resolution intrinsic germanium detector equipped system. Recently acquired high-efficiency, high-resolution detectors [Method 3.4.1] are supplanting the sodium iodide detector.**

### 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*: **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.

*Response*: **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.

*Response*:

- Gas-Flow Proportional Counters. A thin-window gas-flow proportional counting system is employed to perform Methods 3.1.2 and 3.1.4. [PNL-MA-599, Analytical Chemistry Laboratory Compendium, Volume 5: Radiochemical Analysis, Method PNL-ALO-434] (PNL 1994b)

- Scintillation Counters. An alpha scintillation counter equipped with a zinc sulfide detector and a liquid scintillation counter may be non-routinely employed to perform Method 3.1.4. [PNL-MA-599, Analytical Chemistry Laboratory Compendium, Volume 5: Radiochemical Analysis, Method PNL-ALO-434 and PNL-ALO-474] (PNL 1994b)

- 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 [PNL-MA-599, Analytical Chemistry Laboratory Compendium, Volume 5: Radiochemical Analysis, Methods PNL-ALO-422 and PNL-ALO-469] (PNL 1994b).

- Alpha Spectrometers. Solid state semiconductor detector equipped pulse height analyzers are employed to perform Methods 3.1.1 and 3.1.3 [PNL-MA-599, Analytical Chemistry Laboratory Compendium, Volume 5: Radiochemical Analysis, Methods PNL-ALO-422 and PNL-ALO-469].

- Liquid Scintillation Spectrometers. Liquid scintillation spectrometer systems which employ pulse shape discrimination to differentiate between alpha, beta, and gamma activity are operational at the Analytical Chemistry Laboratory [PNL-MA-599, Analytical Chemistry Laboratory Compendium, Volume 5: Radiochemical Analysis, Method PNL-ALO-474], though not included for routine use in the environmental monitoring program analytical plan.

### 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*:

- **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. [PNL-MA-599, Analytical Chemistry Laboratory Compendium, Volume 5: Radiochemical Analysis, Method PNL-ALO-434].**
- **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 which employ pulse shape discrimination to differentiate between alpha, beta, and gamma activity are operational at the Analytical Chemistry Laboratory [PNL-MA-599, Analytical Chemistry Laboratory Compendium, Volume 5: Radiochemical Analysis, Method PNL-ALO-474], though not included for routine use in the environmental monitoring program analytical plan].**

### 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.

*Response*:

- **Low Resolution Gamma Spectrometers. A 4-in. by 5-in. thallium-activated sodium iodide detector is employed to perform Method 3.4.2 [PNL-MA-599, Analytical Chemistry Laboratory Compendium, Volume 5: Radiochemical Analysis, Method PNL-ALO-446]. Recently acquired high-efficiency, high resolution detectors [Method 3.4.1] are supplanting the sodium iodide detector.**
- **High Resolution Gamma Spectrometer. A high-resolution intrinsic germanium detector is employed to perform Method 3.4.1 [PNL-MA-599, Analytical Chemistry Laboratory Compendium, Volume 5: Radiochemical Analysis, Method PNL-ALO-450].**
- **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.

*Response*: **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 [PNL-MA-599, Analytical Chemistry Laboratory Compendium, Volume 5: Radiochemical Analysis, Methods PNL-ALO-434 and PNL-ALO-447].

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 both individual nuclide and mixed nuclide National Institute of Standards and Technology [NIST] traceable standard reference materials fabricated into filter and charcoal cartridge counting geometry configurations. $^{60}$Co, $^{131}$I, $^{133}$Ba, $^{137}$Cs, and $^{152}$Eu comprise the individual nuclide list; the mixed nuclide standards are $^{125}$Sb + $^{154}$Eu + $^{155}$Eu + $^{57}$Co + $^{60}$Co + $^{85}$Sr + $^{88}$Y + $^{109}$Cd + $^{113}$Tn + $^{137}$Cs + $^{139}$Ce + $^{203}$Hg + $^{241}$Am. The emissions monitoring program plan 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. [PNL-MA-599, Analytical Chemistry Laboratory Compendium, Volume 5: Radiochemical Analysis, Methods PNL-ALO-450 and PNL-ALO-447].

### 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*: 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 5 of the Analytical Chemistry Laboratory Compendium (PNL 1994b) 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.

*Response*: **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.
>
> *Response*: **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 Sample Receiving Operation, 325 Building, 300 Area, together with applicable sampling data, chain of custody, and analytical request documentation.**
>
> **Calibration procedures for all counting instruments employed in the performance of analytical measurements are documented in PNL-MA-599, Analytical Chemistry Laboratory Compendium, Volume 5: Radiochemical Analysis under respective PNL-ALO procedure numbers. Calibration procedures relevant to emission monitoring program samples are included in PNL-MA-599, Analytical Chemistry Laboratory Compendium, Volume 5: Radiochemical Analysis, procedures PNL-ALO-434 and PNL-ALO-446.**
>
> **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 stagnant atmospheric conditions prevail during the sampling interval. 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 activity limits for possible alpha, beta, and gamma emissions. Calculation conventions for gross count data are described in PNL-MA-599, Analytical Chemistry Laboratory Compendium, Volume 5: Radiochemical Analysis, procedure PNL-ALO-447.**

Filter samples exhibiting net alpha activity significantly greater than the 2 sigma uncertainty in the measured beta counting system alpha 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 significantly 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 PNL-MA-599, Analytical Chemistry Laboratory Compendium, Volume 5: Radiochemical Analysis.

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.

*Response*: Sample collection points produce a single filter sample that is submitted to the laboratory for analysis: replicate and formal blank samples are not available. The laboratory does not employ sub sampling procedures such as sample splitting because distribution of activity upon samples is not uniform. Radionuclide spiking is not applicable because samples rarely exhibit gross activity that is statistically significant relative to analytical minimum detection limits.

Accuracy and precision of laboratory measurements are maintained by quality control procedures discussed in Section 4.5 below. The laboratory participates in the Air Filter Performance Evaluation Study conducted by the Environmental Protection Agency's Environmental Monitoring System's laboratory.

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.

*Response*: Quality control procedures governing analytical operations within the Analytical Chemistry Laboratory are documented in PNL-MA-70, Quality Assurance Manual, Part 2: Good Practices Standard and Part 3: Procedures for the Quality Assurance Program (PNL 1994a). Implementation of these instructions for the Analytical Chemistry Laboratory is contained in QA Plan No. MCS-033: Quality Assurance Plan For Activities Conducted By the Analytical Chemistry Laboratory (PNL 1994c), and for the emissions program in particular in PNL-MA-599, Analytical Chemistry Laboratory Compendium, Volume 5: Radiochemical Analysis, procedures PNL-ALO-434, PNL-ALO-446, and PNL-ALO-447.

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. As a minimum requirement, control sources are remeasured prior to instrument use each working day; so long as a control measurement result falls within 3 sigma limits established from the original control data at the time of instrument calibration, the original control data are assumed to remain valid. Should a control count exceed the 3 sigma limit, two remeasurements are performed; should either remeasurement fall outside the 3 sigma limit, the instrument is referred to a cognizant scientist for further testing and referral to instrument repair services. Two sigma control limits are maintained as an instrument performance warning device. 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 analysis systems with mixed $^{237}$Np + $^{239}$Pu + $^{241}$Am sources, and beta proportional counting systems with separate $^{99}$Tc and $^{90}$SrY sources. High-resolution gamma spectral analysis systems are controlled with either mixed $^{241}$Am + $^{137}$Cs + $^{60}$Co or mixed $^{152}$Eu + $^{137}$Cs + $^{60}$Co sources, while low-resolution gamma spectral analysis systems 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. Computer based operating systems record all control count data directly into a control chart database for the respective instrument and plot the result on the corresponding control chart.

The individual procedures for quantitative determination of specific nuclides documented in PNL-MA-599, Analytical Chemistry Laboratory Compendium, Volume 5: Radiochemical Analysis specify replicate analysis, internal standards, and other quality-related operations in performance of that analysis where applicable.

The Analytical Chemistry Laboratory (ACL) participates in a variety of performance evaluation (PE) programs in support of the Quality Control Program. These programs are conducted throughout the year and provide continuing evidence of the laboratory performance. The following is a list and brief summary of the radioisotopic PE programs in which the ACL currently participates.

- USEPA EMSL-Las Vegas Nuclear Radiation Assessment (NRA) Program: This program provides approximately one to two PE's /month with each consisting of a different series of isotopes for testing.

- DOE Environmental Monitoring Laboratory Quality Assessment Program (EML-QAP): This program operates semiannually and concentrates on many of the commonly tested radioisotopes in various matrices.

- National Energy Institute-National Institute of Standards and Technology (NEI-NIST) Radioactivity Measurements Assurance Program: This program consists of approximately one radioisotopic PE every other month. Reports of traceability to NIST are issued.

- Sample Exchange/Evaluation Program: A cooperative program developed by the PNL-ACL and WHC. This generally annual program is designed to test the comparability of data between the ACL and WHC-222S on Hanford Site Materials. Testing typically includes inorganics, radionuclides, and limited organics.

- DOE Mixed Analyte Performance Evaluation Program (MAPEP): This a pilot program being developed to evaluate Inorganic, Organic, and Radiochemical constituents in various liquid and solid matrices. The planned schedule for this program is semiannually.

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.

*Response*: Sampling data integrity and sample control are maintained from sample generation through the WHC/Operations - PNL/Analytical Laboratory interface by documentation employing Emission Monitoring Sample Change & Chain-of-Custody and Analytical Laboratory Services Request forms. Upon receipt in the laboratory, sample data and analytical requirements are logged into the PNL/ALO Laboratory Information Management System (LIMS), a computer based system which provides sample tracking and monitors analytical status from sample receipt through analytical report production and sample disposal by means of input terminals located in the several laboratory operations.

## APPENDIX H REFERENCES

EPA, 1991, "Quality Assurance Methods," 40 CFR 61, Appendix B, Method 114, *Code of Federal Regulations*, U.S. Environmental Protection Agency, Washington, D.C.

PNL, 1994a, *Quality Assurance Manual*, PNL-MA-70, Part 2, "Good Practices," and Part 3, "Procedure for Quality Assurance Programs," Pacific Northwest Laboratory, Richland, Washington, 1994.

PNL, 1994b, *Analytical Chemistry Laboratory Compendium, Volume 5: Radiochemistry Analysis*, PNL-MA-599, Pacific Northwest Laboratory, Richland, Washington.

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|---|---|
| Procedure PNL-ALO-422: | Solutions Analysis: Alpha Spectrometry |
| Procedure PNL-ALO-434: | Beta and Alpha Proportional Counting: Particle Filter Analysis |
| Procedure PNL-ALO-446: | 4x5 NaI Well Crystal Detector and Intrinsic Germanium Detector Gamma Spectrometry: Charcoal Cartridge and Particle Filter Counting |
| Procedure PNL-ALO-447: | Data Processing, Analytical Report Production and Records Management |
| Procedure PNL-ALO-450: | Gamma Energy Analysis and Low-Energy Photo Spectrometry |
| Procedure PNL-ALO-469: | Counting Procedure for Alpha Spectrometry |
| Procedure PNL-ALO-474: | Measurement of Alpha and Beta Activity |

PNL, 1994c, *Quality Assurance Plan for Activities Conducted by the Analytical Chemistry Laboratory*, QA Plan No. MCS-033, Pacific Northwest Laboratory, Analytical Chemistry Laboratory, Richland, Washington.

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