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ENGINEERING CHANGE NOTICE

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Operating Specification	☐	Interface Control Drawing	☐	Spares Multiple Unit Listing	☐
Criticality Specification	☐	Calibration Procedure	☐	Test Procedures/Specification	☐
Conceptual Design Report	☐	Installation Procedure	☐	Component Index	☐
Equipment Spec.	☐	Maintenance Procedure	☐	ASME Coded Item	☐
Const. Spec.	☐	Engineering Procedure	☐	Human Factor Consideration	☐
Procurement Spec.	☐	Operating Instruction	☐	Computer Software	☐
Vendor Information	☐	Operating Procedure	☐	Electric Circuit Schedule	☐
OM Manual	☐	Operational Safety Requirement	☐	ICRS Procedure	☐
FSAR/SAR	☐	IEFD Drawing	☐	Process Control Manual/Plan	☐
Safety Equipment List	☐	Cell Arrangement Drawing	☐	Process Flow Chart	☐
Radiation Work Permit	☐	Essential Material Specification	☐	Purchase Requisition	☐
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HNF-3258, Rev. 1
January 2000

TECHNICAL BASIS FOR RADIOLOGICAL WORKPLACE AIR MONITORING/SAMPLING FOR THE RIVER CORRIDOR PROJECT 300 AREA

RL Hill

DS Mantooth

B&W Hanford Company, Richland, WA 99352

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Abstract: This report documents the technical basis by which the workplace air monitoring and sampling program is operated in the 324 and 327 Buildings.

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TECHNICAL BASIS FOR RADIOLOGICAL WORKPLACE AIR MONITORING/SAMPLING IN THE 324 AND 327 BUILDINGS

1.0 PURPOSE

This document serves to provide the technical basis by which the workplace air monitoring and sampling program is operated in the River Corridor Project 324 and 327 Buildings. Revision 1 addresses and incorporates changes in the air monitoring program drivers and implementation that have occurred after the previous revision's issue. These changes occurred in the following areas:

1. Changes in the language appearing in the applicable sections of 10CFR835.
2. Issue of new implementation guidance by the Department of Energy (DOE).
3. Modification of some air sampling/monitoring locations to better meet the needs of facility operations.

2.0 SCOPE

This document applies to monitoring and sampling of radioactive airborne particulates in the workplace of the following 300 Area RCP facilities during routine operations:

- Nuclear Facilities: 324 and 327.
- Fuel Supply Shutdown (FSS) and 300 Area Deactivation (300 ADP) Facilities: 309, 303A, 303B, 303E, 303G, 3712, 3716, 303F, 303K, 303K South, 303M, 304, 313 South, 333, 377, 3706, 3707G, and 321.
- 340 Project: 340, 340A, 340B (East and West), 3707F, MO-36, and MO-741.

This document does not apply to air monitoring/sampling of radioactive gases, effluent streams, or to environmental ambient air sampling or air sampling as a result of upset or off-normal conditions.

3.0 DEFINITIONS/ABBREVIATIONS/ACRONYMS

300 ADT: 300 Area Deactivation Projects.

airborne radioactive material: Radioactive material in any chemical or physical form that is dissolved, mixed, suspended, or otherwise entrained in air. [DOE G-10 CFR 835/E2]

airborne radioactivity area: Any area where the measured concentration of airborne radioactivity, above natural background, exceeds or is likely to exceed 10% of the derived air concentration (DAC) values listed in Appendix A or Appendix C of 10 CFR 835.

air inleakage: Leakage of air around a sample holder or into any fitting of a sample line that may affect the amount of deposition of radioactive material on the collector or the accuracy of sample volume measurements.

air monitoring: Actions to detect and quantify airborne radiological conditions by the collection of an air sample and the subsequent analysis, either in real-time or offline laboratory analysis, of the amount and type of radioactive material present in the workplace atmosphere.

air sampling: A form of air monitoring in which an air sample is collected and analyzed at a later time, sometimes referred to as retrospective air monitoring.

alarm set point (ASP): The count rate at which a continuous air monitor will alarm, usually set to correspond to a specific airborne radioactive material concentration by calculating the sample medium buildup rate.

annual limit on intake (ALI): The derived limit for the amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a year. ALI is the smaller value of either 1) intake of a given radionuclide in a year by the reference man (ICRP Publication 23) that would result in a committed effective dose equivalent of 5 rems (0.05 sievert) or 2) committed dose equivalent of 50 rems (0.5 sievert) to any individual organ or tissue. ALI values for intake by ingestion and inhalation of selected radionuclides are based on Table 1 of U.S. Environmental Protection Agency (EPA), EPA-520/1-88-020, "Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion, Federal Guidance Report No. 11," (EPA 1988).

ANSI: American National Standards Institute.

ARA: Airborne Radioactivity Area.

breathing zone air monitoring: Actions conducted to detect and quantify the radiological conditions of air from the general volume of air breathed by the worker, usually at a height of 1 to 2 meters. See "personal air monitoring."

BWHC: B&W Hanford Company.

CAM: Continuous Air Monitors.

CDMP: Completed Decision Making Package.

CFR: Code of Federal Regulations.

continuous air monitor (CAM): An instrument that continuously samples and measures

continuous air monitor (CAM): An instrument that continuously samples and measures the levels of airborne radioactive material on a "real-time" basis and has alarm capabilities at preset levels.

decision level (DL): The value of a net observation (result) at or above which a decision is made that a positive quantity of the analyte is present. The DL depends on the acceptable probability (alpha) of incorrectly concluding that there is analyte present (a Type 1 Error); usually taken as 0.05.

derived air concentration (DAC): For the radionuclides listed in Appendix A of 10 CFR 835, the airborne concentration that equals the annual limit for intake (ALI) divided by the volume of air breathed by an average worker for a working year of 2,000 hours (assuming a breathing volume of 2400 m³). For the radionuclides listed in Appendix C of 10 CFR 835, the air immersion DACs were calculated for a continuous, non-shielded exposure via immersion in a semi-infinite atmospheric cloud. The value is based upon the derived airborne concentration found in Table 1 of EPA-520/1-88-020 (EPA 1988).

derived air concentration hours (DAC-h): A quantity equivalent to the product of the concentration of airborne radioactive material (expressed as a fraction of a multiple of the derived air concentration for each radionuclide) and the time (in hours) of exposure to that radionuclide. A 2,000 DAC-h exposure will result in an intake of one ALI, which is equivalent to a committed effective dose equivalent (CEDE) of 5 rem (0.05 sievert).

fixed head air sampler: An air sampler located at a fixed location in the workplace.

FHI: Fluor Hanford Incorporated.

FSP: Facility Stabilization Project.

FSS: Fuel Supply Shutdown.

grab sampling: A single sample removed from the workplace air over a short time interval, typically less than one hour.

HCA: High Contamination Area.

HSRCM: Hanford Site Radiological Control Manual.

ICRP: International Commission on Radiation Protection.

IG: (DOE) Implementation Guide.

minimum detectable amount/activity (MDA): The smallest amount/activity of a radionuclide in a sample that will yield a result above the decision level with a beta probability of non-detection (Type II error) while accepting an alpha probability of

erroneously detecting that radionuclide in an appropriate blank sample (Type I error). The MDA is computed using the same value of alpha as used for the DL. The MDA depends on both alpha and beta. Measurement results are compared to the DL, not the MDA; the MDA is used to determine whether a program has adequate detection capability. The MDA will be greater than or equal to the DL. In this guide, the MDA is calculated assuming Type I and Type II errors of 0.05.

MDC: Minimum Detectable Concentration. [See NUREG-1400, Section 6.3.4]

monitor: To measure an airborne radioactive constituent or the gross content of radioactive material continuously or at a frequency, which permits an evaluation of the concentration over time. [ANSI N13.1-1969]

MSDS: Material Safety Data Sheet.

personal air monitoring: The monitoring of air for radioactive particles in the immediate vicinity of an individual worker's nose and mouth, usually by a portable sampling pump and collection tube (such as a lapel sampler) worn on the body. Personal air monitoring is a special case of breathing zone air monitoring.

PF: (Respiratory) Protection Factor.

PHC: Project Hanford Contractor.

PHMC: Project Hanford Management Contractor.

PHPP: Project Hanford Policy and Procedure System.

POG: Process Off Gas.

portable air sampler: An air sampler designed to be moved from area to area.

PTL: Postirradiation Testing Laboratory.

RCI: Radiological Control Instruction.

RCM: Radiological Control Manual.

RCP: Radiological Control Procedure

RCSO: Radiological Control Standing Order.

RCT: Radiological Control Technician.

real-time air monitor: Collection and real-time analysis of the workplace atmosphere using continuous air monitors (CAMs).

representative: Faithfully showing the quality and characteristics of the entire volume from which the sample is drawn.

representative air sampling: The sampling of airborne radioactive material in a manner such that the sample collected closely approximates both the amount of activity and the physical and chemical properties (e.g., particle size and solubility) of the aerosol to which the workers may be exposed.

RWP: Radiological Work Permit.

sample: A representative portion of an atmosphere of interest, or one or more separated constituents from a representative portion of an atmosphere.

SMF: Shielded Materials Facility.

source-specific air sampling: Collection of an air sample near an actual or likely release point in a work area using fixed-location samplers or portable air samplers.

trends: Changes or shifts in air sample data results (e.g., means or standard deviations) over time that may indicate a problem in the facility's radiation protection program.

trend chart: Plots of air sample data results over time (e.g., means and standard deviations) used to detect changes or shifts (trends) in data that may be indicative of a problem in the radiological control program.

WAM: Workplace Air Monitoring.

workplace monitoring: The measurement of radioactive material and/or direct radiation levels in areas that could be routinely occupied by workers.

4.0 REGULATORY REQUIREMENTS AND GUIDANCE

- The requirements for conducting workplace air monitoring and sampling at River Corridor Project facilities are contained in a hierarchal system of documents consisting of regulatory, as well as contractual requirements. Other documents, such as implementation guides and consensus standards provide methodologies and guidance acceptable for demonstrating compliance with the regulatory requirements. The following provides a brief "roadmap" of requirements and standards, which provide the basis for the 300 Area workplace air monitoring/sampling program. A matrix demonstrating how regulatory and contractual requirements are implemented for River Corridor Project is shown in Table 4-1.

4.1 Regulatory and Contractual Requirements

- 4.1.1 **10 CFR 835:** The radiation protection requirements associated with conduct of radiological work in DOE facilities are included in 10 CFR 835, Occupational Radiation Protection (DOE 1996a). Subpart E of 10 CFR 835 covers requirements for monitoring in the workplace, which includes individual monitoring, area monitoring, and radioactive contamination control and monitoring. Workplace air monitoring is a type of area monitoring and consists of air sampling and real-time air monitoring.
- 4.1.2 **HNF-SP-1145:** As required by 10 CFR 835, the Project Hanford Management Contractor (PHMC) has a Radiological Protection Program (RPP) in place as HNF-SP-1145, Revision 2, Fluor Daniel Hanford Radiation Protection Program, Implementation of Title 10, Code of Federal Regulations, Part 835.
- 4.1.3 **HSRCM-1:** The Hanford Site Radiological Control Manual (HSRCM-1) provides Hanford Site-wide radiological control policy and guidance consistent with the DOE Radiological Control Manual (DOE 1994a). By contractual agreement with DOE - Richland Office (RL), it is the standard by which radiological control programs at Hanford are conducted. Various articles throughout the HSRCM pertain to workplace air monitoring.
- 4.1.4 **PHMC Procedures:** The PHMC implements site-wide procedures either through the Project Hanford Policy and Procedure (PHPP) System or controlled manuals. The PHPP procedure specific to workplace air monitoring is HNF-PRO-331, *Work Place Air Monitoring* which is in the PHPP system. This procedure is based, in part, on the DOE Implementation Guide to Workplace Air Monitoring (DOE 1994), and to

the *Workplace Air Monitoring (WAM) Standards Completed Decision Making Package (CDMP)*, CDGH-9608-MCC-0079. In addition, there are other technical procedures that are directly or indirectly applicable to workplace air monitoring/sampling. They are below listed in Section 4.3.3, "Applicable Procedures".

- 4.1.5 300 Area Radiological Control Procedures:** All radiological control procedures that are applicable to the River Corridor Project facilities are contained in HNF-PRO-1277, 300 Area Radiological Control Procedures. This manual contains basically two types of procedures: "pointer" procedures (which state the conditions under which Hanford site radiological control procedures are implemented in the 300 Area), and 300 Area-specific procedures. In addition, procedural changes or additions that need immediate attention may be implemented through the use of Rad Con Standing Orders (for all radiological workers) or Rad Con Instructions (specifically for Radiological Control Technicians [RCT]).
- 4.1.6 Hanford Site Radiological Control Technical Basis Files:** The PHMC Radiological Control has developed a process (Completed Decision Making Packages or CDMP) by which solutions to identified Radiological Control problems are recommended and justified (i.e., a technical basis for decision making). In addition, technical position papers are developed where necessary to clarify PHMC's position on certain topics. Two documents in the PHMC technical basis files apply to workplace air monitoring/sampling:
- **(CDGH-9608-MCC-0079 1996):** This Project Hanford Management Contractor (PHMC) Radiological Control document, *Workplace Air Monitoring (WAM) Standards, Completed Decision Making Package (CDMP)*, provides a systematic approach for determining the need to initiate workplace air monitoring in Hanford facilities, and provides consistent standards for the workplace air monitoring programs at Hanford.
 - **(TPP-9704-INT-0174) :** This PHMC technical position paper provides justification for the interchangeability of Versapore-3000 and Versapore-3000T filters in CAMs, fixed head, and grab air samplers when alpha-emitting airborne particulate is a concern.

In addition to these requirements, guidance for performing various functions of the workplace air monitoring/sampling program is obtained from the following documents.

4.1.7 Applicable Mandatory Standards

DOE Order 5480.4, *Environmental Protection, Safety, and Health Protection Standards*, specifies the applicability of mandatory standards and provides a listing of reference ES&H standards.

-ANSI N13.6-1966 (R 1972): This ANSI standard, Practice for Occupational Radiati

-ANSI N317-1980: This ANSI standard, Performance Criteria for Instrumentation Used for Inplant Plutonium Monitoring, (ANSI 1980) includes guidance on calibration of CAMs.

4.1.8 Reference Standards and Guidance

The documents listed below are not mandatory but are a source of good practices and general information.

- **ANSI N13.1-1969:** This ANSI standard, Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities, (ANSI 1969) includes guidance for locating air monitors and samplers.
- **ANSI N42.17B-1989:** This ANSI standard, Performance Specifications for Health Physics Instrumentation - Occupational Airborne Radioactivity Monitoring Instrumentation, (ANSI 1989) includes guidance performance criteria and testing procedures for instruments and systems designed to continuously sample and quantify concentrations of radioactivity in ambient air in the workplace.
- **DOE WPAM Implementation Guide:** This implementation guide, Air Monitoring Guide for use with Title 10, Code of Federal Regulations, Part 835, Occupational Radiation Protection, DOE G 441.1-8, 3-17-99 (DOE 1999), provides a methodology considered acceptable to DOE for establishing and operating a workplace air monitoring program that will comply with 10 CFR835.
- **RCTP 95-01:** This position paper, DOE Radiological Control Technical Position, Monitoring of Airborne Radioactivity (DOE 1996b), provides technical positions of the DOE on several areas that have resulted from efforts to implement 10 CFR 835.403(a).
- **NUREG-1400:** The document, Air Sampling in the Workplace, developed for the U.S. Nuclear Regulatory Commission (NRC 1993), provides examples, methods, and techniques for air sampling that may be useful for implementing the requirements of 10 CFR Part 20 and may be adapted for use in complying with 10 CFR 835.

4.2 Specific Requirements

The requirements given below are excerpts from standards that are applicable to the workplace air monitoring/sampling program in the River Corridor Project:

4.2.1 10 CFR 835

Monitoring of airborne radioactivity is addressed, wholly or in part, in §835.403(a)(1-2) and §835.403(b). Other applicable sections are §835.209(b)(1-3), §835.401(a-b), §835.703(a), and §835.704(e).

- §835.403(a) & (b) (Air Monitoring)

(a) Monitoring of airborne radioactivity shall be performed:

- (1) Where an individual is likely to receive an exposure of 40 DAC-hours in a year; or*
- (2) As necessary to characterize the airborne radioactivity hazard where respiratory protective devices for protection against airborne radionuclides have been prescribed.*

(b) Real-time air monitoring shall be performed as necessary to detect and provide warning of airborne radioactivity concentrations that warrant immediate action to terminate inhalation of airborne radioactive material.

- §835.209(b)(1-3) (Concentrations of Radioactive Material in Air)

(b) The estimation of internal dose shall be based on bioassay data rather than air concentration values unless bioassay data are:

- (1) unavailable;*
- (2) inadequate; or*
- (3) internal dose estimates based on representative air concentration values are demonstrated to be as or more accurate.*

- §835.401(a) & (b) (General Requirements)

(a) Monitoring of individuals and areas shall be performed to:

- (1) Demonstrate compliance with the regulations in this part;*
- (2) Document radiological conditions;*
- (3) Detect changes in radiological conditions;*
- (4) Detect the gradual buildup of radioactive material;*
- (5) Verify the effectiveness of engineering and process controls in containing radioactive material and reducing radiation exposure; and*
- (6) Identify and control potential sources of individual exposure to*

radiation and/or radioactive material.

(b) Instruments and equipment used for monitoring shall be:

- (1) Periodically maintained and calibrated on an established frequency;*
- (2) Appropriate for the type(s), levels, and energies of the radiation(s) encountered;*
- (3) Appropriate for existing environmental conditions; and*
- (4) Routinely tested for operability.*

- **§835.703(a) (Other Monitoring Records)**

The following information shall be documented and maintained:

- (a) Results of monitoring for radiation and radioactive material in the workplace as required by Subparts E & L of this Part except for monitoring required by §835.1102*

- **§835.704(e) (Administrative Records)**

- (e) Changes in equipment, techniques, and procedures used for monitoring in the workplace shall be documented.*

4.2.2 HSRCM-1

Articles related, wholly or in part, to workplace air monitoring/sampling are 223.1-223.2, 235.1, 235.3, Table 2-4, 312.4.d, 316.1-316.6, 337.3-337.4, 346.2.a-c, 453, 521.2, 531.6, 543, 551.4, 555.1-555.9, 712.2, 751.1-751.2, and 753.1.

- **Article 223.1-223.2 (Airborne Radioactivity Control Levels)**

- 1. Personnel should not be exposed unnecessarily to airborne radioactivity. Use of engineering and administrative controls to reduce the potential for internal exposure should be evaluated before allowing personnel, with or without respiratory protection, to enter areas with airborne radioactivity.*
- 2. Occupied areas with airborne concentrations of radioactivity that are greater than or potentially greater than 10 percent of a Derived Air Concentration shall be posted as specified in Article 235. For most radionuclides, air containing 10 percent of a Derived Air Concentration results in a committed effective dose equivalent of approximately 10 mrem if inhaled continuously for one work week. Values of Derived Air Concentrations are provided in 10 CFR 835.*

- **Article 235.1 & 235.3 (Posting...Airborne Radioactivity Areas)**

1. Areas shall be posted to alert personnel to contamination in accordance with Table 2-4 and Article 231.
 3. Derived Air Concentration (DAC) values for use with Table 2-4 are found in 10 CFR 835.
- **Table 2-4 (Table 2-4: Criteria for Posting Contamination, High Contamination and Airborne Radioactivity Areas)**

AREA	CRITERIA	POSTING
Airborne Radioactivity	Concentrations ($\mu\text{Ci/cc}$) > 10% of any DAC value	"CAUTION, AIRBORNE RADIOACTIVITY AREA" "RWP Required for Entry"

- **Article 312.4.d (Planning for Maintenance, Operations and Modifications)**
4. Tasks with the potential to exceed the above trigger levels shall undergo a formal, documented radiological or ALARA review. At a minimum, this review should consider the following:
 - d. Use of engineered controls to minimize the spread of contamination and generation of airborne radioactivity.
- **Article 316.1-316.6 (Minimization of Internal Exposure)**

The minimization and control of internal exposure as discussed in Article 136 should be conducted in accordance with the following hierarchy of controls:

1. Engineering controls, including containment of radioactive material at the source wherever practicable, should be the primary method of minimizing airborne radioactivity and internal exposure to workers.
2. Administrative controls, including access restrictions and the use of specific work practices designed to minimize airborne contamination, should be used as the secondary method to minimize worker internal exposure.
3. When engineering and administrative controls have been applied and the potential for airborne radioactivity still exists, respiratory protection should be used to limit internal exposures. Use of respiratory protection should be considered under the following conditions:
 - a. Entry into posted Airborne Radioactivity Areas

- b. During breach of contaminated systems or components*
 - c. Work in areas or on equipment with removable contamination levels greater than 100 times the values in Table 2-2*
 - d. During work on contaminated or activated surfaces with the potential to generate airborne radioactivity.*
- 4. The selection of respiratory protection equipment should include consideration of worker safety, comfort and efficiency. The use of positive pressure respiratory protection devices is recommended wherever practicable to alleviate fatigue and increase comfort.*
- 5. In specific situations the use of respiratory protection may be contraindicated due to physical limitations or the potential for significantly increased external exposure. In such situations, written authorization should be obtained from the line organization manager and the Radiological Control Manager prior to incurring internal exposure. Specific justification of the need to accept the exposure, including a description of measures taken to mitigate the airborne radioactivity, should be documented as part of the authorization process.*
- 6. The following controls are applicable for activities authorized in accordance with the above:*
 - ...b. Evaluation of workplace airborne radioactivity levels should be provided through the use of continuous air monitors or air-samplers with expedited assessment and analysis of results.*

- **Article 346.2.a-c** (Response to Abnormal Situations)

- 2. Response to a Continuous Air Monitor alarm should include the following actions:*
 - a. Stop work activities*
 - b. Immediately exit the area*
 - c. Notify Radiological Control personnel.*

- **Article 453** (Control of Airborne Radioactivity)

- 2. The Radiological Control Organization shall be notified when engineering controls that prevent worker exposure to airborne radioactivity, such as barriers, gloveboxes and glovebags, are compromised. An evaluation should be made of continuing operations with compromised engineering controls. The use of respiratory protection to continue activities under these conditions is discouraged. Implementation of short-term engineering modifications that provide a commensurate level of worker protection is the preferred alternative.*
- 3. Preventive maintenance and surveillance procedures shall be*

established to ensure equipment controls are maintained in an operable condition for containment of airborne radioactivity.

- **Article 521.2** *(Internal Dosimetry Requirements)*

2. *The estimation of internal dose shall be based on bioassay data rather than air concentration values unless bioassay data are:*

- a. *unavailable*
- b. *inadequate*
- c. *internal dose estimates based on representative air concentration values are demonstrated to be as or more accurate.*

- **Article 543** *(Exposures to Airborne Radioactivity)*

Potential intakes of radioactive material are indicated when personnel without respiratory protection are exposed to airborne radioactivity or when respiratory protection has been compromised. If intakes of radioactive material are indicated which could result in an individual receiving a committed effective dose equivalent greater than 100 mrem, the following actions should be taken:

- 1. *Identify personnel potentially exposed to airborne radioactivity*
- 2. *Obtain nasal smears for qualitative indication of intakes where appropriate*
- 3. *Analyze air samples to determine airborne concentrations where appropriate*
- 4. *Determine duration of potential exposure to airborne radioactivity*
- 5. *Perform bioassay appropriate for the type and quantity of radionuclides involved*
- 6. *Evaluate dose prior to permitting the worker to return to radiological work.*

- **Article 551.4** *(Radiological Monitoring and Surveys)*

4. *The Radiological Control Organization shall perform and document a review of the adequacy of sampling and monitoring systems as part of any facility or operational changes affecting radiological control. In the absence of such changes, a review should be conducted annually.*

- **Article 555.1-555.9** *(Airborne Radioactivity Monitoring)*

1. *In addition to the requirements of Article 551, air monitoring equipment should be used in situations where airborne radioactivity levels can fluctuate and early detection of airborne radioactivity could prevent or minimize inhalation of radioactivity by personnel. Selection of air monitoring equipment should be based on the specific job being monitored. Air monitoring equipment includes portable and fixed air sampling equipment and continuous air monitors.*
2. *Air sampling equipment shall be used in occupied areas where, under normal operating conditions, a person is likely to receive an annual intake of 2 percent or more of the specified Annual Limit of Intake (ALI) values (40 Derived Air Concentration (DAC) hours). An annual intake of 2 percent of a specified ALI generally represents a committed effective dose equivalent to a person of approximately 100 mrem.*
3. *Continuous air monitoring equipment shall be installed in occupied areas where a person without respiratory protection is likely to be exposed to a concentration of radioactivity in air exceeding 1 DAC or where there is a need to alert potentially exposed workers to unexpected increases in the airborne radioactivity levels. A person exposed continuously to a concentration of radioactivity in air of 1 DAC for 1 work week would generally receive a committed effective dose equivalent of approximately 100 mrem.*
4. *Air sampling equipment should be positioned to measure air concentrations to which persons are exposed. If this cannot be achieved, a program of personal breathing-zone air sampling should be initiated.*

NOTE: The PHMC has provided an interpretation (INTR-9710-WPA-0261) of HSRCM-1 Article 555.4 and has taken the position that this article "...only applies when using air sampling to measure the potential internal dose received by workers. The general placement of samplers and monitors depends on the purpose of the sampling or monitoring. Air sampling can provide many functions, only one of which is to estimate the worker's intake for calculating internal dose...Accordingly, the FDH Radiological Protection Organization has adopted NUREG-1400 guidance for air sampler/monitor placement. This guidance is consistent with HSRCM-1 (Article 555.4) when measuring the potential internal dose received by workers..."

5. *Air monitoring equipment shall be routinely calibrated and maintained at a frequency of at least once per year. Continuous air monitors should be capable of measuring 1 DAC when averaged over 8 hours (8 DAC-hours) under laboratory conditions.*
6. *Continuous air monitoring equipment required by Article 555.3 shall have alarm capability and sufficient sensitivity to alert*

personnel that immediate action is necessary in order to minimize or terminate inhalation exposures.

7. *The proper operation of continuous air monitoring equipment should be verified daily by performing an operational check. Operational checks should include positive air-flow indication, non-zero response to background activity, and internal check sources or 60 Hz electronic checks when available. Continuous air monitoring equipment should be verified weekly by checking for instrument response with a check source or with ambient levels of radon and thoron daughters.*
8. *Preliminary assessments of air samples utilizing field survey techniques should be performed promptly upon removal. In situations where background levels of radon and thoron daughters interfere with evaluation of alpha air samples, prompt field assessments may not be possible.*
9. *Air sample results should be evaluated as quickly as practicable for evaluation of the need for respiratory protection, area evacuation (if necessary), worker intake and worker relief from respirator use.*

- **Article 712.2 (Records Management Program)**

2. *Where radiological services (for example, dosimetry and laboratory analyses) are purchased, there should be a clear agreement regarding records responsibility during performance of the service. Records of results should reside in the custody of the originating contract organization.*

- **Article 751.1-751.2 (Radiological Surveys Requirements)**

1. *Radiological Control Programs require the performance of radiation, airborne radioactivity and contamination surveys to determine existing conditions in a given location. Maps with sufficient detail to permit identification of original survey and sampling locations should be maintained. Records shall contain sufficient detail to be meaningful even after the originator is no longer available. Radiological surveys should be recorded on appropriate standard forms and include the following common elements:*
 - a. *Date, time and purpose of the survey*
 - b. *General and specific location of the survey*
 - c. *Name and signature of the surveyor and analyst*
 - d. *Pertinent information needed to interpret the survey results*
 - e. *Reference to a specific Radiological Work Permit if the survey is performed to support the permit.*

2. *Records shall be maintained to document changes in monitoring equipment, techniques, and procedures.*

- **Article 753.1** *(Airborne Radioactivity)*

1. *In addition to the elements provided in Article 751, records of airborne radioactivity shall include, at a minimum, the following information:*
 - a. *Model and serial numbers of the sampler and laboratory counting instrument when available or unique identifier of each sampler and instrument.*
 - b. *Location of fixed air samplers*
 - c. *Location of portable air samplers used for a survey*
 - d. *Air concentrations in general airborne areas and breathing zones*
 - e. *Supporting parameters, including collection efficiency, flow rate, duration of sampling, correction factors and filter medium.*

4.2.3 Applicable Procedures

Monitoring of airborne radioactivity is specifically addressed, wholly or in part, in the 300 Area Radiological Control procedures listed in Table 4-1.

TABLE 4-1. Applicable 300 Area Radiological Control Procedures

Section	Title	Implements Sections in PHPP/PHMC Manuals		300 Area Facility Specific	Regulatory Drivers	
		HNF-PRO	IP-0718		835	HSRCM
3.4.7	CAM Alarms	—	Part 1, 1.4	—	1302(a)	346.2 543 555.6
5.5.5	Work Place Air Monitoring	331	—	X	209(a&c) 401(a-c) 403(a&b) 703(a) 704(e)	316.6.b 551.4 555
5.5.6	Radon	332	—	X	209(a&c) 401(a-c) 403(a&b) 703(a) 704(e)	316.6.b 551.4 555
5.5.7	Grab Air Sampling	—	Part 1, 3.1	—	209(a&c) 401(a-c) 403(a)(1) 403(b)	223.1, .2 316.6.b 555.1, .2, .4, .5, .8, .9 751.1, .2 753.1
5.5.8	Fixed Head Air Sampler Inspection and Exchange	—	Part 1, 3.2	X	209(a&c) 401(a-c) 403(a)(1) 403(b)	223.1, .2 316.6.b 555.1, .2, .4, .5, .8, .9 712.2 751.1, .2 753.1
5.5.9	Automated Bar Coding of Air Samplers at Hanford (ABCASH)	—	Part 1, 3.3	X	ABCASH system not Used in the River Corridor Project	
5.5.10	Estimation of Airborne Radioactivity Levels (TBD)	—	—		403(a)	555.3 555.6 555.7

5.7.1	Eberline SAC-4	641	—	—	—	562 563 712.1 761.3
5.7.2	Eberline BC-4	642	—	—	—	562 563 712.1 761.3
5.7.4	The Eberline Alpha-6A Family of Continuous Air Monitors	644	—	—	403	555 562 563 712.1.g 761.3
5.7.5	The Eberline AMS-3 Family of Continuous Air Monitors	645	—	—	403	555 562 563 712.1.g 761.3
5.7.6	Eberline ALPHA 4, 5, 5A, and 5AS Continuous Air Monitors	646	—	—	403	555 562 563 712.1.g 761.3
5.7.9	CAM Performance Testing	—	Part 1, 5.2	—	403 404(a)	555.7
5.7.10	Performance Testing Alpha and Beta Counting Instruments	—	Part 1, 5.3	—	403 404(a)	555.8
5.7.11	Analyzing Air and Smear Samples With Alpha and Beta Counting Instruments	—	Part 1, 5.4	—	403 404(a)	555.8

* TBD = To Be Done.

4.3 Specific Guidance

The following are excerpts from guidance documents that are applicable to workplace air monitoring/sampling that will be considered in the operation of the 300 Area workplace air monitoring/sampling program. These excerpts are not necessarily all inclusive. **NOTE:** When references are cited as coming from the *RCM*, *HSRCM* can be substituted for *RCM*.

4.3.1 DOE WPAM Implementation Guide (IG)

This implementation guide, *Air Monitoring Guide for use with Title 10*,

Code of Federal Regulations, Part 835, Occupational Radiation Protection, DOE G 441.1-8, 3-17-99 (DOE 1999), provides a methodology considered acceptable to DOE for establishing and operating a workplace air monitoring program that will comply with 10 CFR835. Pertinent sections are as follows:

Section 3:

The purposes for conducting an air monitoring program can be characterized as the need to assess individual exposures to airborne radioactive material, determine the need for and prescribe appropriate personnel protection from airborne radioactive material, and provide early warning of unexpected increases in airborne radioactivity levels. The type of air monitoring to be performed will depend on what the monitoring results are needed for. Under 10 CFR 835, air monitoring results are required to measure the concentrations of airborne radioactive material, determine posting requirements, determine the effectiveness of the engineered controls and barriers used to contain and confine radioactive material, determine appropriate protective equipment and measures, and provide warnings of significantly elevated levels of airborne radioactive materials. In addition, air monitoring results may be used to estimate individual intake. 10 CFR 835 establishes the basic elements of an air monitoring program: periodic air samples to assess actual and potential individual exposures and real-time air monitoring to provide immediate warning of increases in airborne radioactive material concentrations.

When implementing an air monitoring program, it is important to achieve a proper balance between the basic elements of the program -- air sampling and real-time air monitoring. The balance will depend on the characteristics of each facility and the justification for the approach taken should be included in program documentation.

The primary difficulty in meeting the air monitoring requirements in 10 CFR 835 is in collecting samples that can reliably reveal and estimate the magnitude of individual exposures. However, it should be possible to reliably detect increases in airborne radioactive material concentrations above baseline levels. This information can be used to initiate bioassay evaluations to verify whether an exposure has occurred and, if so, to estimate the magnitude of the exposure.

Real-time air monitoring is performed to provide warning of significantly elevated levels of airborne radioactive materials. The primary challenge in performing effective real-time air monitoring is placing the monitors where they will provide a rapid and reliable warning that an unexpected release has occurred. The number and placement of real-time air monitors should be

optimized. Proper strategy for the placement of real-time air monitors is critical to the effectiveness of the air monitoring program.

The air monitoring program is only one element of a comprehensive radiation protection program. Therefore, individuals involved with the air monitoring program should coordinate their efforts with other radiation protection program personnel, particularly with those involved in contamination control and internal dosimetry.

Section 4:

Monitoring of airborne radioactivity is required where an individual is likely to receive an exposure of 40 or more derived air concentration (DAC)-hours in a year or as necessary to characterize the airborne radioactivity hazard where respiratory protective devices for protection against airborne radionuclides have been prescribed (10 CFR 835.403(a)). Real-time air monitoring is required to be performed, as necessary, to detect and provide warning of airborne radioactivity concentrations that warrant immediate action to terminate inhalation of airborne radioactive material (10 CFR 835.403(b)).

- **Determining the Need**

Section 4.1:

The decision to perform air monitoring should be based on consideration of both actual and potential radiological conditions. Actual conditions are typically confirmed by air sampling results with detectable levels of activity. Potential conditions are identified through the use of professional judgement and experience regarding the likelihood that a radiological condition will exist. When evaluating potential conditions, both normal situations and unusual situations which can reasonably be expected to occur should be considered. NUREG-1400, (Section 1) provides an acceptable methodology for evaluating the need for air sampling by predicting likely intakes for some individuals who might receive a significant intake. This methodology provides an acceptable approach to justify and document decisions based on professional judgement and experience.

Section 4.1.2:

Air monitoring is performed to determine the need for Airborne Radioactivity Area posting and access controls, evaluate the effectiveness of engineering controls, and determine the proper respiratory protective device.

Section 4.1.2.1:

10 CFR 835.603(d) requires posting of airborne radioactivity areas. Air sampling may be used to determine whether an area should be posted as an airborne radioactivity area. Grab sampling is typically used to determine whether the criteria for posting airborne radioactivity areas have been exceeded. The sample volume should be sufficient to ensure the achievement of adequate counting system detection capabilities.

Section 4.1.2.2:

Physical design features for facilities and systems include measures to preclude and control releases of airborne radioactive material. Air monitoring should be performed in facilities and around systems with physical design features designed to prevent the release of airborne radioactivity and also following modifications which could affect air flow and ventilation balance. Fixed-location air sampling should be considered in the design and modification of facilities where uncontained radioactive material would be used or releases of airborne radioactive material would be anticipated. Results from fixed-location air sampling are particularly useful during the startup of a new facility or new operation within an existing facility to establish baseline airborne radioactive material concentrations and verify containment integrity.

Engineering controls are used to protect individuals when permanent physical design features cannot adequately contain radioactive material. When engineering controls, such as ventilation, vacuum cleaners, or containment devices, are used to reduce or maintain airborne radioactivity concentrations, air monitoring should be performed to determine the adequacy and effectiveness of the engineering controls. Generally, for installed physical design features, such as fume hoods, fixed-location air sampling is preferred, whereas for temporary controls, such as portable ventilation or use of vacuum cleaners, grab sampling is preferred. Real-time air monitoring for determining the adequacy of installed controls may also be appropriate or required.

Section 4.1.2.3:

Respiratory protective equipment is used to reduce an individual's intake of airborne radioactive materials. Each respiratory protective device is assigned a protection factor that indicates the degree of protection afforded by the respirator. Respiratory protective devices should be chosen based on the protection factor and actual or potential airborne radioactivity levels, taking

into account ALARA considerations, other industrial hazards, and worker safety.

An important step in selecting the proper respiratory protective equipment is determining the actual or potential concentration of airborne radioactivity in the area the individual is to enter. Air sampling shall be performed as necessary to characterize the airborne radioactivity hazard where respiratory protection against airborne radionuclides has been prescribed (10 CFR 835.403(a)(2)). Typically, grab sampling is used to determine the airborne radioactivity concentration. Real-time air monitoring may be useful in areas where substantial work is being performed and airborne radioactivity concentrations fluctuate. If the individual is entering an area where the airborne radioactivity concentration is routinely sampled and is not likely to have changed since air monitoring was last performed, previously obtained samples may be used to characterize the airborne radioactivity hazard. When the need for air monitoring is not clear, historical data from fixed-location air sampling and real-time air monitoring should be analyzed to determine whether respiratory protection is appropriate.

Section 4.1.3:

Real-time air monitoring shall be performed as necessary to detect and provide warning of airborne radioactivity concentrations that warrant immediate action to terminate exposure to airborne radioactive material (10 CFR 835.403(b)). Typically, real-time air monitoring should be used in areas where unexpected increases in airborne radioactivity levels could result in an exposure to an individual exceeding 40 DAC-hours in one week. This exposure is typically representative of a committed effective dose equivalent (CEDE) of approximately 100 millirem. To provide the necessary warning, real-time air monitors should have alarm capability and sufficient sensitivity to detect airborne radioactivity at these levels.

Unlike air sampling, the need for real-time air monitoring is based on the likelihood that an individual will be exposed to an unexpected increase of airborne radioactivity greater than a given level. The use of real-time air monitors is based upon the expectations of discrete events, rather than determination of ambient airborne radioactivity concentrations.

Real-time air monitors may not be appropriate or necessary in established airborne radioactivity areas where ambient airborne radioactivity levels are not expected to increase (i.e., unexpected releases are not likely). Grab samples are typically used to monitor airborne radioactivity levels and to detect trends. Historical workplace air monitoring records and knowledge of the type of work to be performed in the area can be used to justify the decision not to use a real-time air monitor.

- **Placement**

Section 4.2:

Once the need for air monitoring has been established, the monitor/sampler location(s) can be determined. Location is important because inappropriately placed equipment may not provide representative results. Concentrations of airborne radioactivity in an area can vary greatly from one location to another.

In general, air sampling equipment is most effective when located close to individuals to provide an indication of airborne radioactivity levels to which they are exposed. Real-time air monitoring equipment should be located to provide an early warning to individuals of a significant increase in levels of airborne radioactive material.

When selecting locations for air sampling and real-time air monitoring equipment, consideration should be given to the locations of possible release points and workers, the purpose of the sample, and room air flow patterns. The cost of real-time monitors and the time required to collect and analyze sample media limit the number used in a facility. This consideration, together with the need for a rapid response to an unplanned release, means that optimal placement is critical.

Section 4.2.1:

Actual and potential release points in an area should be identified. Actual release points can be determined from past operating experience. Potential release points can be determined from a review of safety analysis documentation for the facility. The location of individuals in relation to these release points should also be identified. Finally, occupancy times for individuals near the release locations should be estimated.

Section 4.2.2:

The air sampling equipment should be positioned in the vicinity of the individual, taking into consideration the air flow path from likely release points to the individual. Alternatively, if the purpose is to indicate containment or confinement control, then air sampling equipment should be positioned near the release point, or likely release point, in a downstream direction. The downstream direction can be determined by performing air flow studies.

Real-time air monitoring equipment, such as continuous air monitors (CAMs), should be positioned strategically in the affected area or at the affected area boundaries. If there is only one potential release point in an area, then placement of the real-time air monitor as close to the release point as possible in a downwind direction may be adequate. If there are multiple release points and a limited number of real-time air monitors, such that one cannot be placed near each release point, then the real-time air monitors should be

placed at locations expected to provide the most reliable indication of a release with the least delay from the onset of the release, should one occur. The general objective is to provide a rapid and reliable warning to the greatest number of individuals that a release has occurred.

Section 4.2.3:

Air flow studies should be used to determine the placement of air monitors and facilitate the interpretation of the results of air monitoring. The extent of air flow testing will depend on the type of air monitoring being performed. More extensive air flow testing should be performed when locating fixed-location air samplers and real-time air monitors than when locating air samplers being used as grab samplers for short duration jobs. Air flow studies may be useful in placement of grab samplers to ensure that samples are indeed representative. Air flow testing is not needed for personal air monitoring since proper placement of personal air samplers on the worker ensures collection of representative samples. Acceptable methods for determining air flow patterns are discussed, in detail, in NUREG-1400 (Section 2.3).

The radiation protection organization should be aware of facility characteristics, operations, and changes that may affect airflow patterns. The radiation protection organization should perform and document a review of the adequacy of sampling and monitoring systems periodically and as part of any facility or operational change affecting radiological control.

Placement of fixed-location air sampling and real-time air monitoring equipment should be reevaluated after changes to the ventilation system have been made or after equipment or structures have been added that may influence air flow. Air flow patterns in a given area should be reevaluated no less frequently than every 36 months.

- **Equipment**

Section 4.3:

Types of air sampling equipment include fixed-location air samplers, portable air samplers (high-volume and low-volume), and personal (lapel) air samplers. Selection of air sampling equipment should be based on the type of sample being collected (e.g., breathing zone air sample, source-specific air sample, or grab air sample). Detailed technical information regarding air sampling systems is provided in NUREG-1400 (Section 1.3).

Section 4.3.1:

Breathing zone air monitoring should be used when air monitoring results are

used to assign internal doses and when determining the effectiveness of respiratory protection equipment. Breathing zone air monitoring involves collecting an air sample from the individual's breathing environment, making allowances to eliminate interferences the samplers themselves may have on the individual's activities. Such air samples provide the most reliable indicator of the potential for inhalation of airborne radioactivity and can provide an estimate of the magnitude of possible exposures. Breathing zone air samples can be collected using fixed-location air samplers, portable air samplers, or personal air samplers. When fixed-location air sampling equipment will not provide a representative indication of the individual's breathing zone, then personal air sampling equipment should be used. When using personal air samplers, the radiation protection staff should ensure that the low flow rate will allow collection of enough radioactive material to meet the minimum sensitivity requirement for air monitoring.

Breathing zone air monitoring should also be used in areas where workers are likely to exceed an exposure of 40 DAC-hours in a year, and to identify possible worker internal exposures and the need for followup bioassay measurements. Breathing zone air monitoring data may be used to estimate intakes of radioactive material and subsequent internal dose in accordance with the requirements of 10 CFR 835.209(b).

Section 4.3.2:

Source-specific air sampling is the collection of an air sample near an actual, or likely, release point in a work area. Fixed-location and portable air samplers can be used for source-specific air sampling to verify containment or confinement integrity, document airborne radioactive material levels (can be used for determining the need for posting), and provide information relevant to determining when the use of respiratory protective devices is necessary.

Section 4.3.3:

Grab sampling should be used for temporary or non-routine situations and as a backup for other types of air sampling in the event of equipment failure. Grab sampling can be used to determine whether areas should be posted as airborne radioactivity areas and respiratory protective devices should be used for protection against airborne radioactive material. Portable air sampling equipment should be used for operations requiring grab sampling. Sample flow rates may vary depending upon the specific application, but should always allow collection of a sample volume adequate to ensure that the minimum detectable activity of the sampling and counting system corresponds to an intake of no greater than 2% of an annual limit on intake (ALI) ALI and 10% of the appropriate DAC.

Section 4.3.4:

Operability checks of air monitoring equipment are used to ensure that the equipment is functioning properly prior to and during use. Operability checks shall be performed routinely on flow rate meters (10 CFR 835.401(b)(4)). In addition, because excessive dust loading interferes with alpha particle detection and reductions in flow rate result in uncertainties in the total air volume sampled, periodic verification of flow rates should be performed. At a minimum, the flow rates should be verified when sample media are exchanged. Rapid or significant changes in flow rate should be investigated immediately. These instances may indicate the need for more frequent changes of sample media or loss of integrity of filter or sampling equipment. The sample flow rate used for estimating air concentration should be the average of the flow rate when the sample was started and the flow rate when the sample medium was removed.

Section 4.4.1:

Instruments used for real-time air monitoring shall be appropriate for the type(s), levels, and energies of radiation(s) encountered in the workplace (10 CFR 835.401(b)(2)) and for existing environmental conditions (10 CFR 835.401(b)(3)). The selection of real-time air monitors should be based on the characteristics of the airborne radioactive material, the anticipated range of airborne radioactive material concentrations and the possible variations of the concentrations over time. The type of real-time air monitor used depends on the type of facility in which it is used, the radioisotopes being monitored, and the physical and chemical forms of the radioactive material. Commonly used monitors at DOE facilities are: particulate-radioactive material continuous air monitors (e.g., alpha CAMs and beta CAMs); impactor air monitors; and gaseous radioactive material monitors. Monitors that use background-reduction methods (e.g., activity-fractioning monitors and pseudo-coincidence monitors) may also be used. CAMs should not be used when high levels of contamination or other factors would prevent them from providing reliable results. Use of CAMs for particulates and noble gases is acceptable; however, detection of radon requires a different monitoring methodology that provides real-time information and alarm capabilities. In these cases, the use of working level monitors may be acceptable.

If a real-time air monitor is likely to become highly contaminated or if unreasonably high flow rates are needed, then one of the following techniques can be used: (1) periodic direct reading of fixed air sample media by using portable survey instruments; or (2) periodic grab samples with rapid analysis.

Section 4.4.2:

Real-time air monitors should be capable of measuring 1 DAC when averaged over 8 hours (8 DAC-hours) under laboratory conditions. Alarm set points for real-time air monitors used for routine monitoring should be set at the lowest practical level so as to accurately indicate loss of containment or the need for corrective action without causing a significant number of false alarms. When monitoring for alpha emitters shows high radon and thoron concentrations, an alarm set point of up to 24 DAC-hours may be acceptable. In all cases, the actual alarm set point established for each unit and the technical basis for the alarm set points should be documented. If real-time monitors are used during work requiring the use of respiratory protective devices, the alarm set point can be adjusted to provide an early warning that the applicable respiratory protection factor may be exceeded.

Section 4.4.3:

Real-time air monitors shall have alarm capability and sufficient sensitivity to alert potentially exposed individuals that immediate action is necessary to minimize or terminate inhalation exposure (10 CFR 835.403(b)). The alarm should be audible and have a distinctive tone or sound so that it is not confused with other work area alarms, such as those for criticality. The audible alarm intensity should be a minimum sound level of 75 dB at 15 cm. In areas that have a high ambient noise level (>95 dB), a visual alarm should activate with the audible alarm. The visual alarm should be distinctive so that it cannot be mistaken for other types of alarms. If the monitor is installed outside the work area, there should be additional audible and visible alarm indicators inside the area to ensure that individuals are promptly notified. ANSI N42.17B, Performance Specifications for Health Physics Instrumentation - Occupational Airborne Radioactivity Monitoring Instrumentation (ANSI 1989), provides additional guidance regarding alarm capabilities.

Section 4.4.4:

Operability checks shall be routinely performed on real-time air monitoring equipment (10 CFR 835.401(b)(4)). The following periodic operability checks should be performed at the frequency indicated:

- Daily operability checks should include positive airflow indication, presence of a typical non-zero response to background activity, and internal check sources or 60 Hz electronic checks when available. In addition, daily checks should verify the control settings and the operability of strip chart recorders, if used.*
- Weekly operability checks should verify instrument response with a check*

source or with ambient levels of radon or thoron daughters. If an instrument response falls outside established response limits, it should be taken out of service.

- *Once each month, every real-time air monitor in active service should be tested to ensure proper operation of the alarm. Alarm testing should also verify alarm response when the detector fails.*

The adequacy of battery power should be tested monthly for real-time air monitors that rely on battery backup power in an emergency. Similarly, for those monitors using emergency power supplies, the adequacy of the emergency power for monitor operation should be verified as a part of the emergency power checks.

- **Samples and Data**

Section 4.5:

Provisions for detecting changes in radiological conditions, detecting the gradual buildup of radioactive material, verifying the effectiveness of engineering and process controls in containing radioactive material, and identifying and controlling potential sources of individual exposure to radioactive material require that certain evaluations of air monitoring results be performed (10 CFR 835.401(a)(3-6)). Additional technical information regarding evaluation of sampling results is provided in NUREG-1400 (Section 6).

Air sample results should be evaluated as quickly as practical for special situations, such as the evaluation of the need for respiratory protection, area evacuation (if necessary), individual intake, and relief from use of respiratory protective devices. Preliminary assessments of air samples using field survey techniques should be performed promptly upon removing the sample from its holder. When background levels of radon and thoron daughters interfere with evaluation of alpha air samples, prompt field assessments may not be possible. Procedures should define the methods for counting samples in the field (i.e., detection equipment to use, configuration of the detector and the sample, and conversion factors). Prompt field assessments are not required for fixed-location, portable, or personal air samplers used to routinely sample the individual's breathing environment unless upset conditions have been identified.

- **Q. C.**

Section 4.6:

Records of the results of air monitoring shall be documented and maintained (10 CFR 835.703(a)). To meet this requirement, quality control should be applied to all phases of the air monitoring program to include sample identification, handling, and

storage, air sampling and real-time air monitoring equipment, counting room equipment, and record-keeping.

Section 4.6.1:

All samples collected should be assigned an identification number that cannot be confused with samples taken at another location. Sample designators should be placed on all collection envelopes or containers to reduce the possibility of mislabeling a sample. Other information on the envelope should include the date and time of sample collection and the sample flow rates.

Samples should be handled carefully to prevent cross-contamination between samples and should be placed in appropriately labeled containers to reduce the potential for loss. Arrangements should be made for sample storage prior to counting and between counts if multiple counts are required.

Each organization should develop a tracking system for its air samples that permits positive identification of any individual sample, while indicating the results of the sample analysis, the flow rate, the dates and times of sample collection, the individual performing the collection, and pertinent information about the sample collection system. A sample log book or a computerized database should be maintained. This should contain the necessary entries to provide a complete history of the sample and its analysis.

Section 4.6.2:

Components of air sampling and real-time air monitoring systems (i.e., air mover, CAM detector, portable air sampler, fixed sampling head, sampling line) should be uniquely identified. Labeling of equipment and maintaining a log of equipment locations will allow the radiation protection staff to locate a sampling or monitoring unit should there be a questionable sample result.

Equipment used for air monitoring shall be periodically maintained and calibrated on an established frequency (10 CFR 835.401(b)(1)). ANSI N42.17B indicates that air flow meters, differential pressure indicators, and other devices used to determine volumetric flow rates of air samplers and monitors should be calibrated to within $\pm 15\%$ of the true reading. Calibrations should be performed annually at the atmospheric pressure and temperature conditions that are expected during sampling conditions, or the appropriate correction factor should be applied during the calculation of the flow rate.

Detectors in real-time air monitors should be calibrated with a calibration source(s) typical of the radionuclide(s) present in the work environment. The calibration should also be performed after failure of an operability test.

Calibration sources should be traceable to the National Institute of Standards and Technology (NIST). At a minimum, air leakage tests should be performed on real-time air monitors when they are calibrated, whenever a monitor is replaced, and whenever a monitor's rubber O-rings or other seals are replaced. Ideally, tests for leakage should also be performed during monthly or quarterly performance tests.

Procedures should be established to address the appropriate review and use of data when a critical component of an air monitoring system (e.g., detector or airflow meter) is determined to be out of calibration. Procedures should be established to review the accuracy of any data generated by that particular equipment since it was last calibrated.

Section 4.6.3:

Counting room equipment shall be routinely tested for operability (10 CFR 835.401(b)(4)). Daily performance checks of background count rate and radiation response (source checks) should be performed on the counting system.

- **Audits**

Section 4.6.4:

The radiation protection organization should perform and document a review of the adequacy of air monitoring systems as part of any facility or operational changes affecting radiological control. In the absence of such changes, a review should be conducted annually. The air monitoring program should be reviewed as a functional element in the internal audit program required under 10 CFR 835.102.

- **Administrative Controls**

Section 4.7.1:

A document should be developed that provides the technical basis for selecting, placing, and operating air sampling and real-time air monitoring equipment. This document should include information such as:

- *performance and acceptance testing of new equipment;*
- *filter media characteristics;*
- *sample transport line losses (if applicable);*
- *flow rate and duration of sample collection;*

- *identification of relevant supplies and equipment by manufacturer, make, and model;*
- *performance of air flow studies;*
- *rationale for the use and placement of air samplers and real-time air monitors;*
- *rationale for demonstrating that air samples are representative of air breathed by workers;*
- *list of, and a facility map showing, actual locations of air sampling and real-time air monitoring equipment;*
- *calculation of the decision level, minimum detectable activity, and minimum detectable concentration for sampling/counting configurations;*
- *procedures for sample analysis;*
- *procedures for sample accountability; and*
- *routine maintenance and calibration of equipment.*

This information should be readily available to radiation protection staff and should be reviewed periodically and revised as necessary.

Section 4.7.2:

Written procedures should be available for:

- *collecting air samples;*
- *performing operability checks of air sampling and real-time air monitoring equipment;*
- *calibrating flow rate meters;*
- *calibrating any radiation detectors that are part of the air monitoring equipment;*
- *conducting air flow studies to aid in the placement of air sampling and real-time air monitoring equipment; and*
- *interpreting the air monitoring results.*

Other written procedures should be established for the following:

- *counting room staff, on the operation and routine maintenance of air sample counting equipment, including the development and continued use of source count statistical control charts.*
- *radiochemistry staff, on the performance of special analyses.*

Any changes in procedures used for monitoring in the workplace shall be documented (10 CFR 835.704(e)).

4.3.2 NUREG-1400

The document, NUREG-1400, Air Sampling in the Workplace, (NRC 1993), was written for the U.S. Nuclear Regulatory Commission as a technical source for NRC licensees using NRC Regulatory Guide 8.25, Revision 1, Air Sampling in the Workplace, and addresses air sampling to meet the requirements in NRC's regulations on radiation protection, 10 CFR Part 20.

- **Evaluation of the Need for Air Sampling**

- **Section 1.1:**

***WHEN TO EVALUATE THE NEED FOR AIR SAMPLING** - The need to perform surveys and monitoring is based on the need to limit dose to workers.*

...The first step is to estimate the quantity, Q , of unencapsulated radioactive material that is available to be inhaled by a worker during 1 year in a room or work location.

...This step of the process addresses only the total estimated amount of material handled in the room or area, without considering how many workers may be exposed.

...The second step in the method is to estimate the potential for the intake of material by a worker. Based on observations and experience with a wide range of facilities, equipment, and processes, Brodsky has concluded that the fractional amount of radioactive material inhaled by a worker is generally less than on millionth (10^{-6}) of the amount of radioactive material processed (Brodsky 1980)

...Regulatory Guide 8.25 recommends that the need for air sampling be considered if:

$$Q > 10^4 \text{ ALI}$$

where Q is the total quantity of unencapsulated material processed in a year for a given work location.

- **Section 1.2:**

***AIR SAMPLING BASED ON POTENTIAL INTAKES AND CONCENTRATIONS** - ...several additional factors are involved in determining the amount of material that may actually be inhaled by a*

worker, the potential intake, I_p . These factors include the release fraction, R , for the radioactive material based on its physical form and use, the type of containment, C , for the material, and dispersibility, D , of the material. Using the rule of thumb that, when normal precautions are taken, a worker is not likely to have an intake, I_p , exceeding 10^6 of the material being handled, the modified potential intake, I_p , will be:

- **Section 1.2.1:**

RELEASE FRACTION R - ...The NRC has published suitable release fractions in 10 CFR 30.72... (which) were developed specifically for emergency planning... The technical basis for the release fractions, and the experiments from which they are derived, are described by McGuire (1988)... A simplified list of release fractions adapted from 10 CFR 30.72 is presented in Table 1-1...

PHYSICAL FORM	RELEASE FRACTION (R)
<i>Gases or volatile material</i>	<i>1</i>
<i>Nonvolatile powders</i>	<i>0.01</i>
<i>Solids (e.g., uranium fuel pellets, cobalt, or iridium metal)</i>	<i>0.001</i>
<i>Liquids</i>	<i>0.01</i>
<i>Encapsulated material</i>	<i>0</i>

- **Section 1.2.2:**

CONFINEMENT FACTOR C - The confinement factor takes into consideration whether the material is separated and confined while a worker is present or whether it is actually handled in the open. Suggested values for the confinement factor would be one hundredth of the material handled in a glovebox ($Q \times 0.01$), one tenth of the material handled in a well-ventilated hood ($Q \times 0.1$), and one for of the material handled in an open work area ($Q \times 1$).

- **Section 1.2.3:**

DISPERSIBILITY D - ...A dispersibility factor D of 10 can be applied to the calculation if cutting, grinding, heating, or chemical reactions of material are performed; (where no energy added through actions or reactions, $D = 1$).

- **Section 1.3.3:**

TYPES OF SAMPLERS - There are four basic types of air-sampling systems. The first consists of a lapel sampler, which is worn by the worker and can be

used to determine intake. The second and third types are the portable air samplers and fixed-location air samplers, which are usually used to determine airborne radioactive concentrations in the workplace and to ensure that confinement control is maintained. The fourth sampling system is air monitoring, which samples and measures airborne concentrations for use as an early warning of higher-than-expected airborne radioactive concentrations.

- **Location of Air Samplers**

- **Section 2:**

...To locate fixed air samplers, continuous air monitors, and portable samplers in areas to ensure adequate air sampling, health physicists need a clear understanding of the flow of air in a work area...

- **Section 2.1:**

PURPOSE OF AIRFLOW STUDIES - Health physicists can use systematic airflow studies, such as the release of smoke aerosols, to determine the airflow in a work area....Table 2.1 lists the purposes and general placement of air samplers and monitors to best achieve the desired measurements.

PURPOSE OF SAMPLING/MONITORING	GENERAL PLACEMENT OF SAMPLERS/MONITORS
<i>Estimate worker's intake for calculating internal dose</i>	<i>Sampler located in worker's breathing zone, near nose and mouth</i>
<i>Identify area needing confinement control</i>	<i>Sampler in airflow pathway near actual or potential release point</i>
<i>Provide early warning of elevated airborne release</i>	<i>Continuous air monitors placed between workers and release point(s)</i>
<i>Test for leakage of radioactive materials from sealed confinement system</i>	<i>Samplers located downstream of confinement control area</i>
<i>Determine total concentration from many potential release points</i>	<i>Downstream at exhaust point</i>
<i>Determine if airborne radioactivity area exists</i>	<i>Samplers at workers' locations</i>
<i>Special purposes, e.g., determining particle size</i>	<i>Case by case, depending on airflow patterns.</i>

- **Section 2.2:**

DETERMINATION OF AIRFLOW PATTERNS - ...suggests that an airflow study be conducted after any work-area changes, including changes in the setup of work areas, ventilation system changes, or seasonal variations that might change airflow patterns...

...also recommends a routine evaluation of fixed-location samplers—10% evaluated once a year - to determine if their locations are still appropriate.

- **Section 2.2.1:**

PREPARATION FOR AIRFLOW STUDIES - Certain preparations provide a good starting point for making an airflow pattern study. First, review the significant features of the work area, the area's air-sampling history, and any facility changes that may have affected airflow patterns since the last study to determine which areas to test.

...In areas of high external dose rate or high concentrations of airborne radioactive materials, it is desirable to keep airflow testing to a minimum.

- **Section 2.2.2:**

METHODS OF AIRFLOW STUDIES - The two types of airflow pattern studies are qualitative studies, which use an aerosol that can be visually observed and recorded, and quantitative methods, which actually provide measurements of dilution effects in the work area.

...Qualitative methods are the primary means of determining airflow patterns to assist in the placement of air samplers.

- **Section 2.2.3:**

PERFORMING QUALITATIVE AIRFLOW PATTERN STUDIES - To begin a qualitative airflow pattern test, the smoke candle (or whatever is used for visual confirmation of airflow patterns) is (released) near the points at which radioactive materials are potentially or actually released.

...it is recommended that at least two persons observe the dissipation of the smoke (or whatever is used)...

...Both observers record 1) the pattern of smoke flow and 2) the time it takes for the smoke to be dissipated.

...The results are then documented on drawings of the work area.

- **Section 2.3:**

***SELECTING SAMPLER LOCATIONS** - The steps taken to determine air sampler locations include identifying the purpose of the sample, identifying release points, and determining airflow patterns around these release points...*

- **Section 2.3.1:**

***FACTORS IN LOCATING SAMPLERS** - ...Fixed location air samplers on hoods are typically placed at a height of 1.8 m (6 ft) or less from the floor on the front face of the hood.*

...Air samplers are generally placed so as to avoid the influence of supply airflow.

...Some other rules-of-thumb for locating samplers include the following:

- *Samplers are placed so that they are easily accessible for changing filters and servicing.*
- *High-volume samplers are positioned so that their exhaust is directed downstream from the sample collector to avoid sampling their own clean exhaust air.*
- *If a sampler is operated on a horizontal surface, as a convenient means of support, the air discharged from the sampler is not directed at the surface, where it could cause localized excessive air concentration from resuspended surface contamination.*

- **Measurement of Volume of Air Sampled**

- **Section 5:**

***MEASUREMENT OF THE VOLUME OF AIR SAMPLED** - Determining the concentration of radioactive materials in the air involves accurate measurements of both the sample activity collected and the volume of air collected during the sampling interval. (NRC) Regulatory Guide 8.25 (NRC 1992) recommends that an air-sampling program provide for an annual calibration of all flow-rate measurement instruments (airflow or volume meters).*

- **Section 5.4:**

***METHOD FOR determining AIR IN-LEAKAGE** - (NRC) Regulatory Guide 8.25 recommends that continuous air monitors be checked for in-leakage when they are calibrated for volume of air sampled. In-leakage upstream of the flow-measuring device is limited to a maximum of 5% by ANSI N42.18 (ANSI 1985).*

- **Evaluation of Sampling Results**

- **Section 6.1:**

DETECTING CHANGES IN AIR CONCENTRATION OVER TIME - (NRC)

Regulatory Guide 8.25 recommends that the results fixed-location sampling, whose purpose is to confirm radioactive material confinement during routine or repeated operations, be either 1) analyzed for trends or 2) compared with administrative action levels.

...Administrative action levels can be used as a basis for determining when confinement is satisfactory.

- **Section 6.3.1:**

DETERMINING THE ACTIVITY CONCENTRATION - *An integral part of an air-sampling program is the measurement of radioactivity and the subsequent interpretation of the data. Counts in a radioactivity measurement system come from both the background and samples.*

...Under the assumption of constant concentration of radioactivity in the air during the time the sample is collected, and if sampling, decay, and counting times are short with respect to the half-life, the activity concentration is given by:

$$C = \frac{R_n}{EFKT_s}$$

where

C = concentration of radioactive material in the air in $\mu\text{Ci}/\text{cm}^3$ (or Bq m^{-3})

R_n = net count rate in cpm (or cps)

E = fractional filter efficiency (% efficiency/100)

F = airflow rate through the sampler in cm^3/min (or $\text{m}^3 \text{s}^{-1}$)

K = counting efficiency in cpm/ μCi (or cps Bq^{-1})

T_s = duration of sample collection in min (or s).

- **Section 6.3.2:**

DECIDING WHETHER AN AIR SAMPLE IS ABOVE BACKGROUND: THE DECISION LEVEL - *Any net count rate greater than the decision level represents the presence of activity in the sample. The decision level for the net count rate is as follows (Strom and Stansbury 1992, Lochamy 1976):*

where the 1.645 value corresponds to a 5% false alarm rate...

R_b = background count rate (cpm or s^{-1})

T_b = background count time (min)

$$DL(R_n) = 1.645 \sqrt{R_b \left(\frac{1}{T_b} + \frac{1}{T_s} \right)}$$

T_s = gross count time (min).

...Licensees may assume that no activity is present in air if the net count rate is less than the decision level; however, it is a good practice to record all air-sampling results, whether above the decision level or not.

- **Section 6.3.3:**

MEASURING DETECTION CAPABILITY FOR A COUNTING SYSTEM:

MINIMUM DETECTABLE ACTIVITY - A counting system may be characterized by a minimum detectable activity for a specified choice of parameters such as counting times. Once a decision level has been specified by the choice of count times and the false alarm rate (this document uses a 5% false alarm rate), it is possible to determine a value of activity that would yield a count rate less than the decision level a certain fraction of the time. This value of activity is called the minimum detectable activity... Under these assumptions, the minimum detectable activity (MDA) for the activity on the filter becomes

$$MDA = \frac{2.71 + 3.29 \sqrt{R_b T_b \left(1 + \frac{T_s}{T_b} \right)}}{K T_s}$$

...The minimum detectable activity is a performance indicator for a counting system

...The minimum detectable activity is an amount of activity that yields a result above the decision level most of the time (95% of the time for this document).

...Normally, measurement results (in terms of count rates) are compared with the decision level or other action levels. The minimum detectable activity, on the other hand, is normally compared with performance goals.

- **Section 6.3.4:**

MEASURING DETECTION CAPABILITY FOR AN AIR-SAMPLING

PROGRAM: MINIMUM DETECTABLE CONCENTRATION - The minimum detectable concentration (MDC) (of the equipment and procedures) for any single measurement is

$$MDC = \frac{2.71 + 3.29 \sqrt{R_b T_b (1 + \frac{T_g}{T_b})}}{E F K T_g T_b}$$

4.3.3 ANSI Standards

4.3.3.1 ANSI N13.1-1969, Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities, (ANSI 1969), provides principles for obtaining valid samples of airborne radioactive materials and prescribes acceptable methods and materials for gas and particulate sampling. Pertinent sections are as follows:

- Section 4.2.1.1 (Sampling in a Zone Occupied by Workers)

The samples should ideally be drawn from a point or series of points within the breathing zone of the worker. Ideally the actual sampling point would be closely adjacent to the worker's nostrils and mouth throughout all his activities. This has been found to be impractical, and some compromises have been necessary.

...In the interest of simplicity, air samples are frequently taken with fixed-position samplers.

...The location should be selected to be as close to the breathing zone as is practical without interfering with the work and the worker.

...With judicious placing of the sampling point and correlation with true breathing zone samplers, the fixed-position samplers can be useful. Routinely obtained samples from fixed locations will signal changes in general air concentrations and help in determining the source of the contamination.

...Samplers placed at the ventilation duct exits may provide a better integrated average of the air concentration. However, they can be unrepresentative of actual air breathed...

...Air samples may be installed slightly above head height and in front of the worker, or they may be installed at the front face of the hood, glove box, or other enclosure used to contain radioactive material processed. The collection filter is most frequently oriented in a vertical plane to reduce the potential for the collection of larger particles by gravity settling.

- Section 4.2.3 (Sample Programming)

Many factors enter into the design of a sampling program. The sampling

program includes the frequency, duration, and volume rate of sampling. In most cases the selection of these three elements in programming will be a compromise between ideal values and those which provide safety and yet are technically, economically, and conveniently achieved.

- **Section 4.3.1** (Sensitivity of Detection and Measurement)

The sensitivity and accuracy of the analytical or counting method will determine the minimum volume of air which must be sampled to obtain the requisite accuracy and precision of results.

- **Section 4.3.2** (Permissible Levels at Points of Sampling)

The permissible concentration of the radioisotopes of interest will also determine the minimum volume to be sample. If possible, the samples should be large enough to permit one-tenth the permissible level to be determined with reliability.

- **Section 4.3.4** (Natural Radioactive Materials)

The presence of natural radioactive materials of short half-life may mask the presence of significant quantities of longer-lived materials, necessitating delays between collection and counting, or repeated counting at subsequent times, or requiring special methods; for example, energy discrimination, pseudo-coincidence counting, or particle size discrimination sampling methods such as annular impactor and particle size selective filter technique. Such methods must be employed, or rapid radiochemical separations performed, when natural radioactive emitters mask shorter-lived radioisotopes of interest.

- **Section 4.3.2** (Specific Nature of the Operation or Process)

The nature of the operation which creates the potential for airborne radioactive materials may influence the sampling program. An operation or process being instituted for the first time may require more frequent and extensive sampling than one well-established and proven. The potential for release of radioactive material and the consequences of accidental air contamination must be considered in establishing frequency and duration of sampling.

- **Section 5.2.2.1.7** (Related Equipment for Filter Sampling)

(3) **Flow Measuring Devices.** *The flow rate must be measured to determine the airborne radioactive material concentration and to insure*

that the collector is being operated at its design flow rate.

- **Section 6 (Validation of Sampling Effectiveness)**

...The ultimate demonstration of effectiveness (of air sampling) is obtained through showing that workers in the areas sampled continue to have insignificant body burdens of the isotopes of concern.

- **Appendix B (Particle Deposition in Sample Lines)**

- **B1. Introduction** - *...it is noted that samples may be distorted as to composition when the sample is obtained by drawing the particle-containing air through sampling lines. It is recommended that sampling lines be avoided whenever possible and always kept to a minimum length when the line cannot be avoided.*

- **B2. Gravity Deposition** - *Particles carried by an airstream moving in a horizontal tube will tend to settle to the bottom of the tube due to the influence of gravity.*

- **B3. Brownian Diffusion** - *Very small particles can diffuse to the wall of a conduit by Brownian motion.
...Very small particles are lost to the wall rapidly when gas flow is very low. Velocities must be kept high enough to avoid appreciable losses by Brownian diffusion.*

- **B4. Turbulent Deposition** - *Particles carried in turbulent flow will be deposited on the walls of a conduit to a greater or lesser degree, depending upon particle size and density, the average velocity of the air, and the diameter and length of the conduit.
...Prediction of deposition losses is subject to uncertainties, since rather small changes in air velocity or particle quality may markedly affect the deposition constant.
...Deposition does not continue to increase indefinitely as the velocity and particle size increases. A velocity will be reached above which particles will be re-entrained.*

4.3.3.2 **ANSI N13.6-1966 (R 1972), Practice for Occupational Radiation Exposure Records Systems**, (ANSI 1972), provides guidance to the employer for the systematic generation and retention of records relating to occupational radiation exposure. The sections pertinent to a workplace air monitoring/sampling program are as follows:

- **Section 4.8.4 (Internal Exposure Estimates from Special Programs)**

On occasion, internal exposure may be determined by estimating the amount of airborne radioactive material inhaled, based on airborne radioactive material measurements and exposure times, rather than through bioassay analysis or whole-body counter examination. When procedures of this type are used, the record of the individual should include:

- (1) Identification of the individual*
- (2) The period(s) covered*
- (3) The basis for the exposure estimate*
- (4) The concentration of airborne radioactive material, time exposed, and estimated breathing rate*
- (5) The estimated internal exposure*
- (6) Identification of the investigator*
- (7) A reference to any documentation of the studies which established the factors in (4).*

Section 5.6 (Airborne Radioactive Material Monitoring Records)

The records of analyses of airborne radioactive material should include:

- (1) Period (date and time) of sampling*
- (2) General location of the air-sampling station, i.e., building and room*
- (3) Specific location where the air sample was collected*
- (4) Purpose of sample collected, e.g., routine air sampling or air sample for special evaluation*
- (5) Type of sample collection equipment used, e.g., filter, impactor, or evacuated ionization chamber*
- (6) Collection efficiency of sampling system*
- (7) Flow rate, duration of sampling, and total volume of air sampled*
- (8) Identification of sample analysis equipment used*
- (9) Counting data; background, source count, gross count, net count, counting time*
- (10) Reference to calculated correction factors, e.g., backscatter, self absorption and efficiency of analytical equipment*
- (11) Calculated airborne radioactive material concentration*
- (12) Identity of the air contaminant, if determined*
- (13) Identification of the individual performing the analysis*

When continuous air monitors are used with chart recorders, the following additional information should be recorded on the chart:

- (14) Type of instrument, e.g., fixed filter or moving tape*
- (15) Tape and chart speed*
- (16) Identity of scale or range of operation*
- (17) Specific calibration and relationship between the chart divisions*

and the concentration of the airborne radioactive material depending on the tape speed and flow rate of a moving filter unit, or the flow rate of a fixed filter unit.

- 4.3.3.3 **ANSI N317-1980, Performance Criteria for Instrumentation Used for Inplant Plutonium Monitoring**, (ANSI 1980), provides criteria for radiation protection instrumentation essential to implant plutonium monitoring. The sections pertinent to a workplace air monitoring/sampling program are as follows:

- **Section 5.3.1 (Fixed Monitoring Instruments)**

Airborne contamination monitors are normally of the continuous type commonly referred to as continuous air monitors (CAMs). The following criteria apply to those instruments. More information on air monitoring is contained in ANSI N13.10-1974 (Specification and Performance of On-Site Instrumentation for Continuously Monitoring Radioactivity in Effluents).

- 4.3.3.4 **ANSI N42.17B-1989**, This ANSI standard, **Performance Specifications for Health Physics Instrumentation - Occupational Airborne Radioactivity Monitoring Instrumentation**, (ANSI 1989), provides criteria and testing procedures for instruments and instrument systems designed to continuously sample and quantify concentrations of radioactivity in ambient air in the workplace. The sections pertinent to a workplace air monitoring/sampling program are as follows:

- **Section 4.2.5 (Air In-Leakage Requirements)**

The design of the sampler shall be such that in-leakage of air that would allow air flow to bypass the collection medium or that allows air from other than the desired sampling of the sample head shall be eliminated.

- **Section 4.5.1 (Alarm Threshold Requirements)**

Instrument may be equipped with audible or visible alarms or both. For instruments equipped with an alarm, the alarm threshold shall be capable of adjustment to any point within the specified range of the instrument. This threshold shall be stated or indicated as either a percentage of the range in use or in absolute values of the units of measurement.

- **Section 5.1.1.1 (Electronic Criteria of Alarm Reset)**

Instruments may be provided with various audible or visual alarms or both

that operate in one of the following modes:

- (1) *Latching, in which the alarm remains activated until manually reset (i.e., acknowledged)*
- (2) *Nonlatching, in which the alarm deactivates or clears automatically on reduction of exposure rate below the alarm level.*

Alarms shall normally continue to operate in radiation fields greater than the selected alarm points. However, it should be possible to interrupt or deactivate the audible alarm manually without interrupting the visual alarm.

- **Section 5.1.1.5 (Visual Alarms)**

Visual alarms may be flashing or steady state.

- **Section 6.1.1 (Radiation Response - Minimum Detectable Activity)**

The MDA for specific radionuclides or radiation types over a given energy range shall be stated by the manufacturer. Radionuclide and background conditions that are to be used in testing shall be agreed upon between the instrument manufacturer and the user.

- **Section 6.1.2 (Minimum Detectable Activity Test)**

The minimum detectable activity for specific radionuclides under different radiation background conditions shall be determined using the following equation:

$$MDA = \frac{4.65 S_b}{K}$$

where

S_b = the standard deviation of the count rate

K = a conversion factor, typically in units of c/min/μCi.

- **Section 6.4.1 (Radiation Type and Energy Requirements)**

...Instruments for the measurement of gross beta activity shall be responsive to betas with energies from 0.08 to 3 MeV.

...The source-to-detector distance shall not exceed 10 cm.

...Instruments for gross alpha activity shall respond to alpha particles with energies greater than 3.5 MeV.

- **Section 9.1.1** (*Flow or Flowrate Meter Accuracy Requirements*)

Air flowrate meters shall be accurate to within $\pm 15\%$ of the conventionally true flowrate values.

- **Section 9.2.1** (*Air In-Leakage Requirements*)

The leakage of air into the monitoring unit upstream of the flowrate meter shall be less than 10% of the nominal flowrate.

- **Section 9.4.1** (*Filter Pressure Drop Requirements*)

The minimum pressure drop that causes a 10% decrease from the nominal airflow under standard conditions shall be stated by the manufacturer, and the pressure drop measured during testing shall not be below that stated by the manufacturer.

4.3.4 DOE Radiological Control Technical Position, RCTP 95-01

This position paper, **DOE Radiological Control Technical Position, Monitoring of Airborne Radioactivity**, RCTP 95-01 (DOE 1996b), provides technical positions of the DOE on several areas that have resulted from efforts to implement 10 CFR 835.403(a).

- ***DISCUSSION** - As specified in 10 CFR 835.403(a)(1), air sampling requirements are based upon exposure potential, rather than airborne radioactivity concentrations, in order to allow consideration of occupancy times, respiratory protection, and other site-specific factors. Due to the flexibility available with modern air sampling systems (including advantages such as high sample rates, flexibility of sampler location, correspondence with working times, and sturdy construction), performance of discrete air sampling (using grab or lapel samplers) is generally more consistent with the requirements for sampling for exposure assessment purposes. Positioning options and sample rates of CAMs are generally more limited. In light of these limitations, 10 CFR 835 does not prescribe CAMs for situations in which air monitoring results are to be used for exposure assessment. This does not preclude the use of CAMs (see 58 Federal Register (FR) 65474), particularly where the airborne concentrations are known to be relatively homogeneous and stable. Ultimately, the operating entity must be able to demonstrate that the sampling technique in use is capable of detecting and evaluating the level or concentration of airborne radioactive material at work locations, as required by 10 CFR 835.403(a)(1). ...Continuous air monitors are most often used to provide early warning of*

fluctuations in airborne radioactivity concentrations that may result in unplanned exposures. This condition may occur when airborne radioactivity is unexpectedly transferred beyond the boundaries of a posted area or containment device or structure or where individuals are working in a contaminated area without respiratory protection, thus creating the potential for exposure of unmonitored and unprotected individuals. As specified in 10 CFR 835, CAMs must have alarm capability and sufficient sensitivity to provide this warning function.

...The Department recognizes that use of CAMs to monitor momentary changes is generally not effective and has, therefore, left the prescription of averaging periods and alarm setpoints up to the contractors' determination, dependent upon site-specific conditions (see 58 FR 65474).

...The presence of radon in concentrations that have been heightened due to previous or current activities may cause particular concern due to difficulties in discerning "background" levels of radon as opposed to "occupational" levels. Note that 10 CFR 835.209(c) specifically allows for determination of internal dose using air monitoring results when bioassay data are inadequate or less accurate than air monitoring results. The use of air monitoring data to determine occupational exposures to radon may require performance of statistical studies, using on- and off-site monitoring data, to establish reasonable bases for assigning doses based upon the occupational fraction of the total exposure.

- **TECHNICAL POSITION** - Based on the information cited above...
- *Site-specific temporal and spatial averaging techniques may be used in determining the requirements for air monitoring. Justification for these techniques should be documented and retained and the results of these analyses used in documentation of the RPP.*
- *Approved respirator protection factors may be considered in specifying application of CAMs if all individuals in the affected area will be wearing respiratory protection devices. This provision supplements the Department's reliance upon engineering and administrative controls for airborne radioactivity control (see the RadCon Manual article 316) and does not diminish the need to perform workplace monitoring as required by 10 CFR 835.401(a). In addition, the accompanying provision regarding the need to alert individuals to unexpected transients remains in effect and must be considered. Criteria requiring the use of CAMs should be fully described in the RPP.*
- *Any of the various available air sampling methods (high or low flow rate grab samples, CAMs, lapel samples, etc.) may be used to demonstrate compliance with 10 CFR 835.403(a)(1). Specific guidance should be developed and provided to individuals performing the sampling (such as in site procedures) to ensure proper application of the specified method.*

- *Air monitoring results may be used for determination of internal doses but only under the conditions specified in 10 CFR 835.209(c). Efforts should be made to acquire and analyze air samples using the most representative and accurate techniques that are available, considering site-specific factors such as available resources and potential for missed dose.*
- *When performing air monitoring to demonstrate compliance with either 10 CFR 835.403(a)(1) or (2), the method used must be appropriate for the existing environmental conditions, consistent with 10 CFR 835.401(c)(3). Any conflicts between this requirement and the specific monitoring requirements of 10 CFR 835.403(a) should be considered in development of the RPP.*

4.3.5 PHMC Workplace Air Monitoring Standards Completed Decision Making Package

This Project Hanford Management Contractor (PHMC) Radiological Control document, *Workplace Air Monitoring (WAM) Standards, Completed Decision Making Package* (CDGH-9608-MCC-0079 1996), provides a systematic approach for determining the need to initiate workplace air monitoring in Hanford facilities, and provides consistent standards for the workplace air monitoring programs at Hanford.

- *...Facilities will use centrally developed definitions as standards when developing their WAM programs. The definitions below represent the requested clarifications for evaluating the need for workplace air sampling at the facility level.*

Occupied/Normally Occupied Area: 96 minutes, or greater, per day (work shift) or equivalent (i.e., 8 hours per week, 104 hours per quarter, etc.)

Infrequently Occupied: Any Occupied/Normally Occupied Area that is not continuously occupied (2000 hours per year)

Suspension Factor: 1E-6/m generally, 1E-7/m limited work scope and 1E-5/m aggressive work scope

LDAC: Westinghouse Hanford Company evaluates the potential to exceed 1 DAC as the potential to exceed 8 DAC-Hours in a single working shift (8 hours). These standards allow quantitative assessment of facility WAM needs and are consistent with the principles of ALARA and the regulatory basis (protecting the worker).

OCCUPIED AREA/NORMALLY OCCUPIED AREA - Any area in which

personnel are present for 96 minutes (90 min for simplicity), or more, per day is an occupied area. Facilities may adjust this value based on the averaging period used to evaluate occupancy. For example, 8 hours per week and 104 hours per quarter are equivalent. These definitions are determined as follows (with dimensional conversion as necessary):

$$x \text{ hr/wk} = \frac{100 \text{ mrem/yr}}{(0.10 \text{ DAC}) * (2.5 \text{ mrem/DAC} - \text{hr}) * (50 \text{ wk/yr})}$$

The technical basis for this definition is 2 percent of an ALI (100 mrem CEDE) and ten-percent DAC. These provide a meaningful decision point because exposing workers to either action level results in the collection of an air sample.

Using these guidelines to define occupancy assures that no worker will exceed 100 mrem when present in a location for less than the calculated time. Therefore, regulations require no periodic air sampling in an area whose occupancy is less than 90 minutes per day (or equivalent). This definition is not applicable when conditions exceed respiratory protection factors and/or the worker's breathing air is above 10% of the DAC. In this situation, facilities should initiate air sampling to provide data identifying the potential intake.

Any area with an occupancy rate greater than 96 min/day (8 h/wk, 104 h/qtr, 416 h/yr, etc.) but less than 2000 h/yr is infrequently occupied. 2000 h/yr represents continuous occupancy. Usually, portable CAMs and grab air samples are preferred when workers infrequently occupy areas. Portable CAMs include instruments that remain in a general location but do not operate continuously (i.e., turned on and off when work begins and ends respectively).

These definitions require quantitative assessment of occupancy rates. If this assessment is impractical, facility-specific definitions are advised.

SUSPENSION (RESUSPENSION) FACTOR - Suspension factors allow estimating potential airborne radioactivity resulting from removable surface contamination. Radiological Control will use three general suspension factors for different work evolutions. Each value applies to an enclosed air space lacking ventilation and assumes uniformly distributed contamination across the horizontal floor surface. For minimal activities such as general inspection/surveillance, a suspension factor of 1E-06/m is appropriate. In instances of non-heat generating aggressive work such as sweeping, 1E-5/m is an acceptable suspension factor. Finally, a suspension factor of 1E-07/m is appropriate under stationary working conditions. These suspension

factors are typical values. Because suspension factors span at least ten decades (10^{-3} /m to 10^{13} /m), specific nuclides, material forms and work scope may require using more precise values including suspension rates. Facility WAM documents must provide justification for deviating from the values above.

- *1 DAC - Westinghouse Hanford Company (now PHMC) evaluates the potential to exceed 1 DAC as the potential to exceed 8 DAC-Hours in a single working shift (8 hours).*

This is a straightforward application of (DOE Implementation Guide) G-10 CFR 835/E2 guidelines. This approach is consistent with the DOE's position as identified in RCTP 95-01.

Time averaging allows the facility to protect the worker from relevant exposures. Without time averaging, the regulations place undue restriction on the facility by mandating CAMs in areas where brief increases in the airborne concentration exceed 1 DAC. An air concentration of 100 DAC for one minute does not require a CAM when applying time averaging techniques because the exposure is less than 8 DAC-h (1.7 DAC-h) and represents a small CEDE (~4.3 mrem). However, if four of these releases are possible within a single shift, the potential to exceed 8 DAC-h is present and a CAM is required.

4.3.6 PHMC Technical Position Paper - Versapore-3000/3000T

This PHMC technical position paper, Comparison of Versapore-3000 and Versapore-3000T Membrane Filter Media for Radiation Protection and Environmental Sampling Applications, (TPP-9704-INT-0174), provides justification for the interchangeability of Versapore-3000 and Versapore-3000T filters in CAMs.

(Fluor Daniel Hanford) FDH Radiation Protection, in cooperation with Environmental Protection (FDH), has determined that the Versapore-3000 and the Versapore-3000T membrane filters are interchangeable for Radiation Protection and Environmental (FDH-9756066, ED Adair) sampling applications.

...(Project Hanford Major Subcontractors) Radiation Protection organizations used the Versapore-3000 membrane filter in alpha CAMs, fixed head, and grab air samplers when alpha-emitting airborne particulate is a concern.

...Although not specifically required, we have, as a good practice, corrected Versapore-3000 data for the 0.3 μ m DOP efficiency. FDH Radiation Protection communicates this good practice through procedures governing

air sample analysis.

...The Versapore-3000 was originally selected for its high collection efficiency, fair spectral resolution, physical durability, reasonable pressure drop...

...The Versapore-3000T uses the same 3 μm acrylic copolymer membrane as the Versapore-3000. However, the 3000T uses a nonwoven polyester support that is less than one-half as thick as the nylon backing of the 3000. Gelman Sciences has no data on the collection efficiency of this filter and refused to document an official position regarding the effects of their change on the collection efficiency and pressure drop of the filter.

...(Project Hanford Major Subcontractors) Radiation Protection (organizations) have adopted the good practice of limiting filter use to those filters providing a pressure drop that is equivalent (< 5% difference) to the pressure drop of the calibration filter or pressure correcting flow rate data (PBGH-9705-INT-0183).

...Empirical data show that the rotameter calibrations performed with Versapore-3000 filters are accurate to within 5%, on average, when 3000T filters are used in an air sampler or CAM. This variation is less than the action level (greater than 5% difference) at which the DOE suggests correcting data for pressure differences (G-10 CFR 835/E2).

...Having measured a filter collection efficiency that is greater than 95%, industry references allow us to omit correcting data for filter efficiency (i.e., we may assume the collection efficiency equals unity) when calculating airborne material concentration (Regulatory Guide 8.25). Rather than omit filter collection efficiency from air sample calculations, FDH Radiation Protection directs (Project Hanford Major Subcontractors) Radiation Protection organizations, through procedures, to continue applying the Versapore-3000 0.3 μm DOP collection efficiency to air sample data when using Versapore filters (3000 or 3000T)... (This) introduces a conservative bias to air sample data when the actual airborne particulate size is different from 0.3 μm while simultaneously enhancing data accuracy when airborne particulate size is 0.3 μm .

...CONCLUSION - Based on testing described in this paper, the Versapore-3000 and the Versapore-3000T membrane filters are interchangeable for Radiation Protection applications.

5.0 BACKGROUND INFORMATION ON 324 and 327 Buildings

5.1 324 Facility

The 324 Building has a partial basement, a first, second, and partial third floors surrounding the Engineering Hot Cell Complex. Figures 1 through 4 provide a diagram of each floor.

The 324 Building operations covered by this document currently consist of stabilization and waste reduction activities to prepare the building for eventual deactivation, and building engineering and maintenance. The building engineering and maintenance activities are required to allow conduct of stabilization waste handling activities with minimum risk to workers, public, and environment, and include the following tasks:

- required preventive maintenance and calibrations
- repair of failed and malfunctioning equipment
- walkdown of safety systems, equipment, and building grounds (operational surveillance)
- required radiological surveys
- entry control, source checks, and dosimetry
- building utilities and assessments
- waste management assessments

The facility is comprised of both nonradiological areas (Table 5-1) and radiological areas (Table 5-2). It can be assumed that radioactive material has not been introduced into nonradiological areas and workplace air monitoring/sampling is not required. A workplace air monitoring /sampling needs assessment is done on these areas will be conducted for radiological areas.

TABLE 5-1. Nonradiological Areas in 324 Facility

AREA	NONRADIOLOGICAL AREAS IN 324 FACILITY
Basement	Nonradiological laboratories, administrative and operational support areas (Rooms 20, 21, 22, 22A, and 22B)
First Floor	Entry and lobby (Rooms 103 and 104), offices (Rooms 105-107, 118-120, 125, 126A, 151-193), lunchroom (Room 117), conference rooms (117A and 173), laboratories (Rooms 109-115), Corridor 10, craft shop (Rooms 701-706), EDL laboratories (EDL-101, EDL-102, and the High Bay) excluding the FCAs present in EDL-101 and EDL-102, and restrooms (Rooms 123 and 123A).
Second Floor	Offices and nonradiological laboratories (Rooms 202-212, 214-241, 251-293), upper portions of EDL-101, EDL-102, and the High Bay, and Corridor 20
Third Floor	Offices and control room (Rooms 301-304, 307-310), and Corridor 30

TABLE 5-2. Radiological Areas in 324 Facility

AREA	RADIOLOGICAL AREAS IN 324 FACILITY
Basement	Storage vault and associated laboratories (Rooms 3A-3M and the Storage Vault), Rooms 4, 4A, and the Tank Pit excluding FCAs present (Room 1), Tank Pit (Room 1), sump in Room 4, Room 18 ^(a) , and the HLV and LLV tanks
First Floor	RE hot cells A-Cell, B-Cell, C-Cell, D-Cell, REC Airlock, REC operating galleries for A-Cell, B-Cell ^(b,c) and C-Cell (Room 131), B-Cell Sample Room and hood, Corridor 13 (south of the C-Cell gallery and entrance point to the radiological areas), SMF Airlock, South Cell, East Cell, SMF operating galleries (Rooms 139, 139A-139D), CHA (Room 137), Loadout Station sampler hood (Room 145), Trucklock (Room 138), Load Out Stall (LOS) in the Trucklock, Room 146, Manipulator Repair Shop (Room 147), Radiological Support Areas (Rooms 122, 123A, Change Room and donning/doffing protective clothing, and Room 126), the Decontamination Room (Room 122), and Room 11 POG/HEPA system
Second Floor	REC operating galleries for A-Cell, B-Cell (Room 244) and D-Cell (Room 245), mezzanine levels in Rooms 146 and 147)
Third Floor	Operating gallery for A-Cell (Room 311), the mezzanine level of the D-Cell gallery, and Stairwell #7 and #8.

- (a) The slab floor in Room 18 was contaminated in the past from wash water that leaked out of B-Cell. Previously, a portion of the top of the slab was removed to try to lower the contamination levels. As more of the slab was removed the contamination levels kept increasing. A concrete "cap" was then poured back on the floor to cover and contain the contamination.
- (b) Under the south B-Cell viewing window, liquid (in-cell wash water) has migrated out of the cell along the side of the window frame. This area has routinely been found to have smearable contamination and elevated dose rates.
- (c) On the west B-Cell wall, the concrete has been chipped next to a shield plug. This area has routinely been found to have smearable contamination.

5.1.1 Stabilization/Waste Reduction Activities

324 Building B-Cell Cleanout Activity

The B-Cell Cleanout activity is a multi-year effort to eliminate legacy equipment and disposable nuclear material from the B-Cell in the 324 Building. B-Cell was designed to handle high-activity radioactive materials in a research setting, with remote-handling capabilities and appropriate shielding under unique space considerations. During more than 30 years of research and development activities, B-Cell accumulated a significant amount of radioactive and mixed waste, of which a large portion is in a potentially dispersible form. The B-Cell Cleanout activity is the most significant stabilization activity being conducted.

324 Building A-Cell Cleanout Activity

The A-Cell Cleanout activity is a multi-year effort to eliminate legacy equipment

and removable residual contamination from A-Cell in the 324 Building. The most recent mission for A-Cell (and primary contributor to its current condition) was to support B-Cell activities to electropolish and store high-activity, vitrified, sealed isotopic heat source containers (i.e., stainless steel) of high-level radioactive material in a glass matrix.

5.1.2 324 Building D-Cell Cleanout Activity

The D-Cell Cleanout activity is a multi-year effort to eliminate legacy equipment and disposable nuclear material from the D-Cell area which was used for engineering development work involving highly radioactive materials and waste. The current baseline includes disconnecting the electrical system, removing unattached material/equipment and unattached combustible material, removing filters and associated tanks and filtration unit, decontaminating D-Cell, sealing HVAC access, removing manipulators and split plug penetrations, removing liner, remediating concrete, and locking out the shield door.

Hazards anticipated with the D-Cell Cleanout activity are localized. The worker radiological exposure hazards typically are those associated with hot cell and waste handling activities. Provisions to protect workers from radiological hazards are addressed in Chapter 5.0 of the 324 Safety Analysis Report, Organization and Safety Management Programs.

5.1.3 Noncompliant Legacy Waste Container Repackaging Activity

The Noncompliant Legacy Waste Container Repackaging activity includes the transportation, verification (examination and assay), and repackaging of the remaining waste containers inherited in the transfer of the 324 Building by the Project Hanford Management Contract (PHMC) Team's operating contractor, B&W Hanford Company, now FHI. The waste containers were designated as low-level waste by the waste generator. However, because of the presence of prohibited articles (such as batteries and light bulbs), suspect containers are required to be managed as mixed waste.

5.1.4 Stabilization/Deactivation Preparation Activities

The following activities are needed before conducting specific deactivation scope, and in the case of the 324 Building B-Cell Cleanout activity, allowing completion of the stabilization milestone. The activities must be accomplished so that waste stream paths for solid and liquid waste are in place before waste is generated during deactivation.

Special Case Waste Handling Options

The 324 Building SCW (B-Cell dispersibles, tank heels, REC pipe-trench sludge, etc.) contains significant quantities of high dose rate nuclear material and waste requiring storage or disposal outside the 300 Area.

Liquid Waste Handling System Options

The Liquid Waste Handling System (LWHS) Options will include the collection, treatment, and load -out of liquid waste generated during deactivation and stabilization of the 324 Building. The liquid waste will be transferred to a tanker truck for disposal at an appropriate TSD facility. The proposed system will use existing piping, tanks, instrumentation, controls and other features, where reasonable, to minimize cost and physical changes to the building.

5.1.5 324 Building Deactivation Activities

The initial building deactivation activities in FY 2000 include activities to identify, isolate, stabilize, and remove building hazards (i.e., chemical, radiological, industrial) from the 324 Building hot cells. The activities include the 324 Building B-Cell Cleanout activity, LWHS Options activities, 324 Building Laboratories and Experimental Areas activity, 324 Building REC Area activity, and 324 Building Support Areas activity. These, and all future 324 Building deactivation activities, will be the primary contributors to overall reductions in the building risk.

5.1.6 324 Building Exterior and Yard Activity

Deactivation of the 324 Building exterior and yard includes the asphalt area, areas used for storage, areas where piping and ventilation systems penetrate exterior walls, access doors and stairs, and unloading/loading docks. The activity also includes the 324A Building and 324D Building (exhaust stack and monitoring buildings), the 3718E Building (general storage building), and the 3718G Building (chemical storage building).

5.1.7 324 Building Basement Area Activity

The Basement Area activity covers deactivation of the 324 Building basement. The objective of the activity is to remove, affix, or safely contain all hazards associated with the basement areas, to allow for minimal S&M. The 324 Building

basement includes rooms 3A, 3B, 3C, 3E, 3F, 3G, 3H, 3J, 3K, 3L, 3M, 4, 4A, the service tunnel, and vault. Major hazardous and radiological concerns associated with these areas are the radiological contamination areas, the chemical fume hoods, and the lead used for shielding.

5.1.8 324 Building Heating, Ventilation, and Air Conditioning Activity

The HVAC activity will isolate the HVAC to the 324 Building. The HVAC is divided into three major areas: the cold side, hot side, and POG-vessel ventilation systems.

The major activities associated with the cold side are removing refrigerant (Freon¹) and sealing the inlets and outlets. The hot side is divided into zones. These zones have considerable radioactive material holdup, increasing near the REC and SMF cells. Waste generated from the activity is anticipated to include remote-handled low-level and TRU waste (Category 3). The POG ventilation system activities will include removal of all filters and isolation of the electrical connections. Some of the system will require removal because of residual contamination levels inside the ductwork. However, where appropriate, the equipment will be abandoned in place. On completion of this activity, all HVAC will be isolated and de-energized.

Hazards anticipated with the HVAC activity include worker industrial hazards, as well as radiological exposure hazards typically associated with construction/demolition activities involving radiologically and chemically contaminated systems.

5.1.9 324 Building Laboratories and Experimental Areas

The 324 Building Laboratories and Experimental Areas activity will remove all hazards associated with the following: Laboratory Rooms 22, 22A, and 22B; EDL 101; Room 108 and the 324C Building Addition; EDL 102; the high-bay addition; Laboratory Room 308; Laboratory Rooms 207 through 212; low level canyon (Room 146); and tank pit (Room 1).

The major tasks associated with this activity are as follows:

- Removal of material and combustibles in the chemical storage area;
- Flushing of chemical tanks;
- Decontamination and isolation of fume hoods;

¹ Freon is a trademark of E. I. du Pont de Nemours and Company.

- Disconnection of electrical power from equipment; and
- Sealing of penetrations.

The laboratories have minimal radiological contamination, but contain visible chemical residue and potential industrial hazards.

On completion of the activity, the laboratories and experimental areas will be free of chemical hazards, all penetrations to the outside will be sealed, and all remaining contamination will be fixed. Hazards anticipated with the Laboratories and Experimental activity include worker industrial hazards, as well as radiological and chemical exposure hazards typically associated with construction/demolition activities involving radiologically and chemically contaminated systems.

5.1.10 324 Building Office Area

The 324 Building Office Area activity provides for the removal of equipment and transient combustible material, isolation of utilities and services, and removal or excess of mobile offices. The office areas are Administrative Rooms 103 through 107, 109 through 129, 151 through 195, and 202 through 206; Maintenance Rooms 701 through 706; and four mobile office trailers. In addition, equipment in the maintenance rooms will be drained and disconnected from their power source.

Hazards anticipated with the Office Area activity include worker industrial hazards, as well as toxic material exposure hazards, typically associated with construction/demolition activities.

5.1.11 324 Building Radiochemical Engineering Complex Cell Area

The REC consists of the A-Cell, B-Cell, C-Cell, D-Cell, the airlock, the pipe trench, and the cell cubicles and pass-through ports. Closure of B-Cell, D-Cell, and potentially the pipe trench will entail cleaning to a clean debris surface standard as defined by the "debris rule," 40 CFR 268.45, "Treatment Standards for Hazardous Debris." The airlock, cell cubicles, and pass-through ports will be closed by removing and/or isolating dangerous waste pipes from the HLV. A-Cell and C-Cell were not used for TSD activities and therefore, no closure activities are identified for these areas.

Components requiring closure in the piping system include all piping runs that were used to carry dangerous waste constituents between the REC and the Vault tanks. Piping that might have carried dangerous waste constituents will undergo

closure activities (i.e., decontamination, integrity tests, and removal).

The HLV and LLV tanks and associated piping will be decontaminated and removed. Removal of the vault tanks is consistent with the closure plan. Major efforts will include introduction of a decontamination solution to remove residual heels, high-pressure water rinse, removal of piping using crimp cutters, and removal of all accessible equipment.

Hazards anticipated with the Radiochemical Engineering Cell (REC) Area activity include those worker radiological and chemical exposure hazards typically associated with hot cell activities, processing, and waste transfers from cells.

5.1.12 324 Building Shielded Material Facility Area

The 324 Building SMF Area activity will include removal of radiological hazards associated with the SMF. The SMF cells, located in the southeast portion of the 324 Building, consist of the airlock cell (Room 141), South Cell (Room 140) and the East cell (Room 142). The south, east, and airlock cells are joined, forming an "L," and are surrounded by an operating gallery (Room 139). The first 2.3 meters (from the floor upward) of the cell shielding wall, is constructed of 1.2-meters-thick, high-density concrete. The rest of the cell shielding is constructed of 1.2-meter-thick normal-density concrete. All cells have stainless steel floors and mild-steel walls.

The South Cell, East Cell, and the airlock will require the same steps as the REC area. The steps will include sealing all penetrations to prevent leakage of material and deactivation fluids, chemical treatment (e.g., applying dry alkaline foam) to all surfaces, and rinsing with water until the desired decontamination factor is achieved.

Hazards anticipated with the (SMF) area activity include those worker radiological and chemical exposure hazards typically associated with hot cell activities, processing, and waste transfers from cells.

5.1.13 324 Building Stand-Alone Mothballed Equipment

The 324 Building Stand-Alone Mothballed Equipment activity will allow for mothballing the bridge crane in Rooms 137 and 138, the monorail hoist in Room 317, the high-bay elevator, and the main elevator. These activities will allow for the elimination of potential industrial hazards and the isolation of building

electrical systems.

Activities associated with mothballing equipment include draining all fluids from the cranes and elevators. After the fluids have been drained, the cables and counterweight associated with the elevators will be adjusted to remove tension.

Hazards anticipated with the Stand-Alone Mothballed Equipment activity primarily include worker industrial hazards typically associated with maintenance activities.

5.1.14 324 Building Stand-Alone Operational Equipment

The 324 Building Stand-Alone Operational Equipment activity provides for the installation of a motor control center and electrical utilities to allow for long-term S&M. On completion of this activity, the 324 Building will have one control panel on the outside door that can be energized to allow for surveillance of the areas identified as needing access. This activity will reduce the control point for electricity to one control box.

5.2 327 Facility

The 327 Facility one-story structure with a basement. Figures 5 and 6 provide a diagram of each of these floors, with indications of the radiological contamination area postings as of March 1998. The 327 Facility houses the Postirradiation Testing Laboratory (PTL). The laboratory consists of specially equipped, shielded, and ventilated Hot Cells and laboratories designed for physical and metallurgical examination and testing of irradiated fuels, concentrated fission products, and irradiated structural materials. The dimensions of the building are 215 ft x 140 ft x 32 ft. There are three major areas inside the building: 1) the Canyon, 2) the Storage and Transfer area, 3) the Basement.

The Canyon is the main work area of the facility, containing 12 shielded hot cells, a dry storage system, and a wet storage/transfer basin. Accessed from the Canyon are rooms housing support operations, such as a photo lab, machine shop, manipulator decontamination/repair area, a Low Level Metallography Lab, and a laboratory storage area. Examinations and testing of irradiated materials are carried out in the 12 shielded cells. There are 10 cells constructed of cast iron or steel, and two small cells constructed of lead bricks.

The West End of the Canyon is the Transfer and Storage Area or Trucklock. This area is used for receiving and shipping casks containing irradiated materials, for storage of

irradiated materials in the large water basin, and for compaction of Low Level Waste trash generated in the facility. A penthouse area is located on the Southwest end of the transfer and storage area; this penthouse area is accessible from outside or from a wall-mounted ladder in the transfer and storage area.

The transfer and storage area also contains a decontamination chamber that is positioned over the West end of the large wet storage basin, and a water filtration system designed to remove radionuclides from the basin water. A large roll-up door at the West End of the building opens to the outside. This door provides access to the outside cask storage pad and allows vehicle entry into the transfer area. Metal doors at the East End of the water storage basin can be closed while the outside roll-up door is open. This serves to isolate the transfer area from the remainder of the Canyon, and helps maintain air balance in the building when the outside roll-up door is open.

The Facility basement is separated into 3 distinct areas. The north third of the basement is used for storage of supplies, idle equipment, and specially constructed cell plugs not in use. The middle of the basement houses the hot cell ventilation ductwork, HEPA filters for the hot cells, and the activated charcoal filtration system. An access hatch to a crawl space containing building steam pipes is also in this area. The south third of the basement is physically separated from the rest of the basement by a wall. The (nonradiological area) cold side equipment room is located in this area.

The 327 Building operations covered by this document currently consist of stabilization and waste reduction activities to prepare the building for eventual deactivation, and building engineering and maintenance. The building engineering and maintenance activities are required to allow conduct of stabilization waste handling activities with minimum risk to workers, public, and environment, and include the following tasks:

- required preventive maintenance and calibrations
- repair of failed and malfunctioning equipment
- walkdown of safety systems, equipment, and building grounds (operational surveillance)
- required radiological surveys
- entry control, source checks, and dosimetry
- building utilities and assessments
- waste management assessments

The facility is comprised of both nonradiological areas (Table 5-3) and radiological

areas (Table 5-4). It can be assumed that radioactive material has not been introduced into nonradiological areas and workplace air monitoring/sampling is not required. A workplace air monitoring /sampling needs assessment is done on these areas will be conducted for radiological areas.

TABLE 5-3. Nonradiological Areas in 327 Facility

AREA	NONRADIOLOGICAL AREAS IN 327 FACILITY
Basement	South third - cold side equipment room
First Floor	Administrative and operational support offices (Rooms 1, 1A, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, men & women change rooms, adjacent hallways and building main entrance foyer).

TABLE 5-4. Radiological Areas in 327 Facility

AREA	RADIOLOGICAL AREAS IN 327 FACILITY
Basement	Hot side basement, all areas.
First Floor	A, B, C, D, E, F, G, H, I, and SERF hot cells, general canyon, Trucklock, Rooms 15, 16, 17, 18, 20, Equipment Room, and dress-out area.

5.2.1 Stabilization/Waste and Risk Reduction Activities

327 Building Legacy Waste/Fuel Removal Activity

The legacy waste/fuel removal activity is a multi-year effort to be completed in accordance with the PMP. The fuel characterization activities in the 327 Building resulted in the accumulation of a significant quantity of radioactive material. The activity includes consolidation and disposal of legacy fuel and materials currently located at the 327 Building. The activity will include packaging fuel, fuel segments, fuel pins, and residue material; characterization of existing and resultant waste material; and preparation of containers for transport to the 200 Area Central Waste Complex (CWC). Some of the legacy fuel is packaged in stainless steel containers and has been stored in 327 Building basin.

Legacy Waste Container Repackaging Activities

The legacy waste container repackaging activities include the transportation, verification (examination and assay), and repackaging of the remaining waste containers inherited in the transfer of the 327 Building to the Project Hanford Management Contractor's operating contractor, BWHC. Some containers contained prohibited articles, and were managed as suspect low-level mixed waste (LLMW) until they were either repackaged or sent to T-Plant for repackaging. The containers require verification (examination). A large percentage of the containers may be undergoing waste segregation and repackaging which may be conducted at the Hanford Site T-Plant.

5.2.2 Deactivation Preparation Activities

The following activities are needed before conducting specific deactivation scope of work. These activities must be accomplished so that waste management routes for solid and liquid wastes are in place before waste is generated during deactivation.

Special Case Waste Handling Options

Several 300 Area buildings, operated by BWHC and PNNL, contain significant quantities of high-dose-rate nuclear material and waste requiring storage or disposal outside the 300 Area. Due to the high activity levels of the wastes and difficulties in characterizing, classifying, and packaging them to meet the Hanford Site Solid Waste Acceptance Criteria, they were listed as Special Case Waste (SCW) under Tri-Party Agreement major milestone M-33-00, and subsequently under major milestone M-92-00.

327 Building Liquid Waste Handling Options

The 327 Building liquid waste handling options activity will include engineering analysis, design, and physical modifications to the 327 Building RLWS. This activity will involve modifications to the building. Several modification options are being considered. One option includes adding piping systems to allow for collection of the RLWS, interim storage until treatment, treatment with a vendor treatment skid, and final load out in casks and/or drums. Final cleanout of the 327 Building RLWS will be completed in various other activities, including the 327 Building basement activities and 327 Building Utilities heating, ventilating, and air conditioning (HVAC) activities.

Building Basement Activity

The 327 Building basement activity includes tasks necessary to deactivate the 327 Building cell filter room, mechanical room, storage room, and elevator. The 327 Building basement contains significant quantities of abandoned material and equipment associated with laboratory experiments in the canyon cells. The basement also contains piping related to the RLWS and highly contaminated ductwork (see Section 4.3.5). Major activities associated with the 327 Building basement cleanout include removal of loose material and contaminated equipment.

5.2.3 327 Building Canyon

The 327 Building canyon activities include the necessary activities to deactivate Cells A-I, the decontamination cell, density cell, dry storage carousel, east and west canyon cranes, evaporator cell, Special Environmental Radiometallurgy Facility (SERF) cell, the SERF storage cell, transfer and storage basins, waste compactor, and truck lock. Deactivation will consist of removing material from the cells. Equipment located in F-Cell, G-Cell, and SERF cell will be size reduced prior to removal. In the remaining cells, equipment will be removed via shielded casks through ports in the side of the cells. Cell decontamination will include applying dry alkaline foam (or other suitable methods) to all surfaces followed by rinsing with water.

The transfer and storage basin will be drained and the storage racks size-reduced, packaged, and removed. The concrete will be decontaminated using wipes, scabbling or other means depending on the extent of residual contamination.

5.2.4 327 Building Support Areas Activities

The 327 Building support areas activities include activities necessary to deactivate the following areas in and around the 327 Building: exterior and yard, 3723 Building, cask storage pad, decontamination room and hallway, low-level laboratory, machine shop, manipulator shop, radiological control technician (RCT) office, Number 3 equipment room, Number 4 equipment room, offices area (kitchen, hallways, and restrooms), change room area, Plutonium Recycle Test Reactor (PRTR) room (commonly known as the 'Burst' Room), storage room, and the waste compactor and truck lock..

5.2.5 327 Building Utilities and Heating, Ventilating, and Air Conditioning

The 327 Building utilities and HVAC activities include activities necessary to deactivate the water, steam, air, vacuum, sanitary sewer, process sewer, fire suppression and detection, telecommunications, RPS, RLWS, and compressed gas portions of the piped utilities. By completing these activities, all liquid generation and exit points will be isolated.

5.3 Fuel Supply Shutdown (FSS) and 300 Area Deactivation Projects (300 ADP)

The current radiological status and operations performed in the FSS and 300 ADP Facilities are summarized in Table 5-5.

TABLE 5-5 FSS AND 300 ADP FACILITY OPERATIONS

BUILDING	RAD. POSTING	OPERATIONS
309	CA/RBA/FCA/RMA	Not routinely occupied. Facility shut down.
303A	RA/RMA	Not routinely occupied. Facility shut down.
303B	RA/RMA	Not routinely occupied. Facility shut down.
303E	RA/RMA	Not routinely occupied. Facility shut down.
303G	RA/RMA	Not routinely occupied. Facility shut down.
3712	RA/RMA	Not routinely occupied. Facility shut down.
3716	RA/RMA/RCA	Not routinely occupied. Facility shut down.
303F	FCA/RMA	Not routinely occupied. Transition activities.
303K	CA	Not routinely occupied. Used for storage.
303K South	RA/RMA	Not routinely occupied. Used for storage.
303M	FCA	Not routinely occupied. Shutdown activities.
304	FCA	Not routinely occupied. Shutdown activities.
313 South	CA/RBA/FCA/RMA	Not routinely occupied. Shutdown activities.
333	CA/RBA/FCA/RMA/HCA	Not routinely occupied. Shutdown activities.
377	CA/RBA/FCA	Not routinely occupied. Facility shut down.
3706	FCA/CA	Not routinely occupied. Facility shut down.
3707G	RBA/FCA	Not routinely occupied. Facility shut down.
321	CA/FCA/RBA	Not routinely occupied. Facility shut down.

5.4 340 Project

The 340 Project includes the following buildings: 340, 340-A, 340-B (East and

West), 3707-F, and two trailers (M0-036 and M0-741).

The 340 Waste Handling Facility received and processed radioactive liquid waste from operations in the 300 Area of Hanford, Washington. The 340 Waste Handling Facility was also used for temporary storage of packaged solid radioactive waste, as a staging area for hazardous waste, and for decontamination of equipment with low-level contamination. Current activities consist of deactivation/shutdown operations.

The 340 Building houses the truck lock, equipment room, an equipment decontamination room, a control room, and a mechanical equipment room in an above ground structure. It also contains two radioactive liquid waste system (RLWS) neutralization tanks in an underground vault, and the associated underground valve pit, which are not routinely occupied.

The 340-A Building houses six stainless steel tanks that provide reserve capacity for the RLWS waste which have been fully sparged.

340-B East and 340-B West are located in the same building, but are completely separated by a concrete wall. 340-B East houses the railroad car receiving and loadout station, which is no longer in active use. 340-B West is a dry storage area which may contain radioactive waste and non-waste items.

The 3707-F Building is the sampling station for retention process sewer water. The M0-036 Trailer contains work offices and a lunchroom.

6.0 TECHNICAL BASIS FOR WORKPLACE AIR MONITORING/SAMPLING

The following sections contain a description of the technical bases for the workplace air monitoring/sampling program in the 324 and 327 Facilities. Where the 324 and 327 Facilities program is implementing PHMC site procedures, the associated technical basis files for those procedures will apply, unless stated otherwise.

6.1 Determining the Need for Workplace Air Monitoring/Sampling

The 324 and 327 facilities subscribe to the DOE technical position (DOE 1996b) that any of the various air sampling methods (fixed head air samplers, CAMs, high or low flow rate grab samplers, lapel air samplers, etc.) may be used to demonstrate

compliance with §835.403(a)(1). The recommendations given in NUREG-1400 (NRC 1993) on selection and placement of air samplers/monitors (Table 6-1) will be considered in workplace air monitoring/sampling needs assessments done in the 324 and 327 Facilities.

In 324 and 327 facilities, there are three different workplace monitoring/sampling regimens considered at this time. These are:

- Monitoring using fixed head (location) air samplers
- Monitoring using CAMs (real-time or continuous air monitors)
- Grab air sampling.

6.1.1 Criteria for Use of Fixed Head Air Samplers

The basis that determine the need for fixed head air samplers contain two criteria: (1) the potential to exceed 2% ALI; and (2) routine occupancy of the area.

Potential to exceed 2% ALI

Fixed head air sampling is needed if there is a potential for exceeding 2% of an ALI. The value 2% ALI is generally equivalent to 100 mrem, i.e., $5,000 \text{ mrem/ALI} \times 0.02 = 100 \text{ mrem}$; also, $2000 \text{ DAC-hr/yr/ALI} \times 0.02 = 40 \text{ DAC-hr}$ (10CFR835.403). The most conservative DACs and ALIs are used for the radionuclide mix found in the 324 and 327 facilities (Berk et al, 1998; Landsman et al. 1998), i.e., ^{239}Pu for alpha and ^{90}Sr for beta. Table 6-2 provides the DACs and ALIs applicable to these 300 Area facilities.

TABLE 6-2. Applicable DAC and ALI Values

	ALI (μCi)	DAC (μCi/ml)	2% ALI (μCi)	DAC Equivalent to 2% ALI
Alpha (²³⁹ Pu)	4.8E-3	2E-12	9.6E-5	4E-14
Beta (⁹⁰ Sr)	4.8E0	2E-9	9.6E-2	4E-11

Removable contamination levels on surfaces of a given area can be used to see if the 2% ALI value will be exceeded in that area. To obtain estimates of airborne radioactivity levels from removable contamination levels, the following equation is used:

$$R \text{ dpm}/100 \text{ cm}^2 = \frac{(C \text{ } \mu\text{Ci}/\text{ml})}{\left(\frac{100 \text{ cm}^2}{0.01 \text{ m}^2}\right)(1\text{E}-6/\text{m})\left(\frac{1 \text{ } \mu\text{Ci}}{2.22\text{E}6 \text{ dpm}}\right)\left(\frac{1 \text{ m}^3}{1\text{E}6 \text{ ml}}\right)}$$

where

R = Removable contamination level (dpm/100 cm²)
C = Calculated air concentration (μCi/ml).

The (10⁻⁶/m) value is a resuspension factor used to represent that a worker is unlikely to have an intake resulting in 10⁻⁶ of the total amount of the material present when work activities do not readily disrupt the radioactive contamination, assuming uniformly distributed contamination across the horizontal floor surface and does not account for ventilation (CDGH-9608-MCC-0079; NRC 1993). The other three parameters in the above equation are conversion factors.

Using the DAC values representing 2% ALI as given in Table 6-2, the resulting removable contamination levels calculated are 888 dpm/100 cm² for alpha and 888,000 dpm/100 cm² for beta.

→ Thus, the first criteria for needing fixed head air samplers is met if > 880 dpm/100 cm² alpha or > 880,000 dpm/100 cm² beta is present.

Occupancy Factor

The second criteria for determining the need for fixed head air samples is that if the 2% ALI level has a potential to be exceeded (i.e., removable contamination levels > 880 dpm/100 cm² alpha or > 880,000 dpm/100 cm² beta), then the area having contaminated air must be **routinely occupied** by a worker who is in this location as part of a normal or routine work assignment and has the potential to breath the contaminated air. For the River Corridor Project, time averaging is used in determining occupancy values. As described in the PHMC WAM technical basis guidance (CDGH-9608-MCC-0079), any area in which personnel are present or traverse for more than 96 min/d (or 416 hr/yr) is considered **routinely occupied**. The 96 min/d value is based on 2% ALI and 10% DAC using a derivation of the equation presented in the PHMC WAM technical basis guidance (CDGH-9608-MCC-0079):

$$OCC \text{ min /d} = \frac{2\% \text{ ALI}}{(10\% \text{ DAC})(2.5 \text{ mrem/DAC} \cdot \text{h})(50 \text{ wk/yr})(5 \text{ d/wk})(1 \text{ h}/60 \text{ min})}$$

where

OCC	=	Calculated occupancy (96 min/d)
2% ALI	=	100 mrem/yr
10% DAC	=	Air concentration that requires Airborne Radiation Area (ARA) posting.

The 2.5 mrem/DAC-h parameter is derived from the definition of DAC (see Section 3.0) where

$$\frac{5,000 \frac{\text{mrem}}{\text{DAC}}}{2,000 \text{ h}} = 2.5 \frac{\text{mrem}}{\text{DAC} \cdot \text{h}}$$

Occupancy for 8 hr/d for the entire work year, or 2000 hr/yr, is considered **continuous occupancy**, which is a subset of routine occupancy (i.e., > 96 min/d). Areas having less than 96 min/d occupancy are considered to have **low occupancy**. If the area has a low occupancy, then the potential for 2% ALI will not be reached before the area air concentration is at 10% DAC (i.e., area posted as a ARA).

Thus, workplace air monitoring/sampling is not required in areas of low occupancy (CDGH-9608-MCC-0079). Note, however, that for respiratory protection purposes, air monitoring/sampling of any job where there is a potential to exceed 10% DAC is required regardless of the time the job takes. See Section 6.1.3 on the use of grab air sampling for more detail.

Other Considerations

In addition to these criteria, NUREG-1400 allows consideration of containment or confinement barriers such as hot cells, gloveboxes/glovebags, or ventilated hoods. The NUREG-1400 calculation methodology employs factors that reduce the magnitude of potential releases when these controls are employed.

The decision to use fixed-head air sampling can also be based on historical workplace air monitoring and an assessment of the types of work to be performed. A history of airborne levels less than those required to achieve 2% of an ALI associated with routine, well-characterized operations can serve as a basis to discontinue fixed-head monitoring.

See Table 6-3 for a summary on when fixed head air samplers are needed. Additionally, fixed head air samplers may be used downstream of a sealed confinement system to monitor confinement.

TABLE 6-3. Needs Assessment for Fixed Head Air Samplers *

2% ALI - ALPHA (> 880 dpm/100 cm ² alpha)	2% ALI - BETA (> 880,000 dpm/ 100 cm ² alpha)	Low Occupancy (< 96 min/d)	Routine or Continuous Occupancy (> 96 min/d)	FIXED HEAD AIR SAMPLER NEEDED?
X		X		NO
X			X	YES
	X	X		NO
	X		X	YES

- Based solely on regulatory requirements.

6.1.2 Criteria for Use of CAMs

The regulatory basis (10CFR835.403(b)) specifies when CAMs are needed:

Real time air monitoring shall be performed as necessary to detect and provide warning of airborne radioactivity concentrations that warrant immediate action to terminate inhalation of airborne radioactive material.

Air Concentrations Exceeding 1 DAC Criteria

As described in the PHMC WAM technical basis guidance (CDGH-9608-MCC-0079), DOE's technical position (DOE 1996b) on workplace air monitoring, time averaging will be used to determine if CAMs are needed with respect to the 1 DAC criteria. The DOE has recognized that the use of CAMs to monitor momentary changes in airborne radioactivity levels is not effective (DOE 1994b; DOE 1996b). Thus, in the River Corridor Project, the potential to exceed 1 DAC is taken as the potential to exceed 1 DAC in an 8-hr work shift (i.e., 8 DAC-h). In addition, the occupancy factor described above for fixed head air samplers also applies here.

Using the general methodology presented in NUREG-1400 (NRC 1993), it is first necessary to estimate the quantity of unencapsulated radioactive material that is available in the area to be inhaled by an individual. The removable contamination levels obtained from Radiological Survey Reports, or, as a conservative measure, limits on applicable Radiological Work Permits (RWPs) can be used as an estimate of unencapsulated radioactive material. Rearranging the equation presented above, airborne radioactivity concentrations can be estimated from removable contamination, as follows:

$$C \text{ } \mu\text{Ci/ml} = (R \text{ dpm}/100 \text{ cm}^2) \left(\frac{100 \text{ cm}^2}{0.01 \text{ m}^2} \right) (1\text{E}-6/\text{m}) \left(\frac{1 \text{ } \mu\text{Ci}}{2.22\text{E}6 \text{ dpm}} \right) \left(\frac{1 \text{ m}^3}{1\text{E}6 \text{ ml}} \right)$$

Tables 6-4 and 6-5 provide a listing of alpha and beta removable contamination levels, respectively, and the estimated air concentrations resulting from such levels. Also, included are associated DACs, DAC-h values (assuming 8 hr exposure per work shift), and a determination on whether a CAM would be required (i.e., > 8 DAC-h). Some of the removable contamination levels represent various RWP void limits given in current 324 and 327 facility RWPs.

Thus, the criteria for needing CAMs in place is met when removable contamination levels above 4.4E4 dpm/100 cm² (alpha) and 4.4E7 dpm/100 cm² (beta) are present. Both of these values are significantly above the level for posting as a High Contamination Area (HCA), 2,000 and 100,000 dpm/100

cm², respectively. Even if the resuspension factor was increased to 10⁻⁵/m, to indicate aggressive work being conducted in the area, such as sweeping, the calculated removable contamination levels needed to reach 8 DAC-h would be 4.4E3 dpm/100 cm² for alpha or 4.4E6 dpm/100 cm² for beta, both of which are also above the levels signifying HCAs.

TABLE 6-4. Alpha Removable Contamination Levels Having the Potential to Exceed 1 DAC (or 8 DAC-h)

R (dpm/100 cm ²)	C (μCi/ml)	# DAC	# DAC-h for 8-h Shift	Is CAM required?
50,000	2.3E-12	1.1	9.0	YES
44,400	2.0E-12	1.0	8.0	YES
20,000	9.0E-13	0.45	3.6	NO
2,000 (HCA Limit)	9.0E-14	0.045	0.36	NO
200	9.0E-15	0.0045	0.036	NO
20	9.0E-16	4.5E-4	0.0036	NO

TABLE 6-5. Beta Removable Contamination Levels Having the Potential to Exceed 1 DAC (or 8 DAC-h)

R (dpm/100 cm ²)	C (μCi/ml)	# DAC	# DAC-h for 8-h Shift	Is CAM required?
100,000,000	4.5E-9	2.3	18	YES
50,000,000	2.3E-9	1.1	9	YES
44,400,000	2.0E-9	1.0	8.0	YES
1,000,000	4.5E-11	0.02	0.18	NO
100,000 (HCA Limit)	4.5E-12	0.0023	0.018	NO

10,000	4.5E-13	2.3E-4	0.0018	NO
1,000	4.5E-14	2.3E-5	1.8E-4	NO

Other Considerations

As indicated in Table 6-1, CAMS may also be used to provide early warning of an elevated airborne release or to monitor a gradual buildup of airborne radioactive material. Such a use may be to monitor and provide early warning of as loss of integrity of a hot cell sealed confinement. CAMs should not normally be used in lieu of fixed head air samplers. Examples of where CAMs may be used (either long-term or short-term) are (DOE 1999):

- Either within or at boundaries of areas where work is performed that creates or has the potential to create airborne radioactivity.
- Either within or at boundaries of areas where a power failure or other disruption of engineering controls could result in the release of airborne radioactivity.
- Either within or at boundaries of established ARAs when work is being performed that has the potential to significantly increase the ambient airborne radioactivity levels.

CAMs may not be appropriate or necessary in established ARAs where ambient airborne radioactivity levels are not expected to increase (i.e., unexpected releases are not likely) (DOE 1999). The decision not to use CAMs can be based on historical workplace air monitoring/sampling records and the type of work to be performed in an area.

6.1.3 Criteria for Use of Grab Air Samplers

In the River Corridor Project, the DOE guidance (DOE 1999) will be considered when determining the need for grab air sampling. Cases in which grab air sampling will be considered are:

- in low occupancy areas where the worker's annual exposure may exceed 2% ALI

- for a new operation, to develop baseline and to verify containment integrity
- to establish the need for posting of ARAs
- to determine if respiratory protection should be worn, removed or upgraded
- to assess unknown airborne radioactive material concentrations when special maintenance work is required on systems contaminated with radioactive material or when there is a loss of process controls (§835.401(a) and HSRCM-1 Article 555.1)
- to provide an estimate of worker exposures for situations where bioassay measurements may not be available or their validity is questionable (§835.209(b) and HSRCM-1 Article 521.2)
- on any job where there is a potential to exceed 10% DAC, or the respiratory PF, regardless of the time the job takes
- as a backup for other types of air sampling in the event of equipment failure.

The procedure in Section 3.1, *Grab Air Sampling*, in HNF-IP-0718, as implemented through RCP 5.5.7, HNF-IP-1277, will be used for grab air sampling in the 324 and 327 Facilities. The following equations from the appendices of Section 3.1 will be used.

- **Approximation for Airborne Radioactivity Concentration**

$$Activity (\mu Ci/ml) = \frac{N * k}{V * E}$$

where

A	=	Airborne Radioactivity Concentration ($\mu Ci/ml$)
N	=	Net Count Rate (cpm)
k	=	$1.6E-11$ Conversion Factor ($\mu Ci-ft^3/dpm-ml$)

V = Air Sample Volume (ft³)
E = Instrument Detection Efficiency (fractional dpm/cpm).

- **Minimum Sample Collection Time to Estimate Respiratory Protection Effectiveness or Need for Continued ARA Posting (PF=1)**

The sample flow rates used for grab air sampling will depend on the specific application. However, in most cases sample collection should be undertaken to allow adequate sample volume to ensure that the MDA of the sampling and counting system is no greater than 10% ALI. That is:

$$t = \frac{k * MDA}{0.1 * DAC * PF * F}$$

where

k = 1.6E-11 Conversion Factor (μCi-ft³/dpm-ml)
MDA = Instrument MDA (dpm)
DAC = DAC (for radionuclide of concern)
PF = Protection factor of respirator
F = Flow rate (cfm) [usually use maximum sampler flow rate).

- **Derivation of "k" Conversion Factor**

$$k = \left(\frac{1 \mu\text{Ci}}{2.22\text{E}6 \text{ dpm}} \right) * \left(\frac{1 \text{ ft}^3}{28,316.9 \text{ ml}} \right) = 1.6\text{E}-11 \frac{\mu\text{Ci} * \text{ft}^3}{\text{dpm} * \text{ml}}$$

6.2 Placement of Air Sampling and Real-Time Air Monitoring Equipment

Once it is determined that air monitoring or sampling is needed, it is important to carefully determine the location of the air monitors/samplers. In general, CAMs should be placed in a location to provide an early warning of a significant increase in airborne radioactivity levels, and air samplers should be located in the worker's vicinity to provide an indication of airborne radioactivity levels to which the individual may be

exposed. Consideration will be given to potential release points, worker locations(s), the purpose of the sample, and room air flow patterns. Another consideration is that the air sampler placement is such that it will not interfere with normal conduct of work (NRC 1993). Some other rules-of-thumb recommended by the NRC (NRC 1993) are:

- place air samplers so as to avoid the influence of supply airflow
- place air samplers so that they are readily accessible for changing filters and servicing
- If an air sampler is operated on a horizontal surface, as a convenient means of support, the air discharged from the sampler is not directed at the surface, where it could cause localized excessive air concentration from resuspended surface contamination.

6.2.1 Locations of Release Points and Workers

(NRC) Regulatory Guide 8.25 states that early warning samplers should be located close to release points, preferably between workers and release points, and should be capable of detecting a release (NRC 1993).

Placement of air sampling and monitoring equipment should be reevaluated after changes to the ventilation system or after equipment or structures have been added to the work area that may influence air flow.

6.2.2 Purpose of Sample

As mentioned in Section 6.1, the recommendations given in NUREG-1400 (NRC 1993) on selection and placement of air samplers/monitors will be considered in workplace air monitoring/sampling needs assessments done in the River Corridor Project. See Table 6-1 or Table 1 in site procedure, HNF-PRO-331, *Work Place Air Monitoring*.

Air sampling equipment should be positioned in the vicinity of the worker, taking into consideration the air flow path from likely release points to the worker. Position air sampling equipment near the release point or likely release point in a downstream direction if the sample's purpose is to provide an indication of containment or confinement control. The downstream direction can

be determined by performing air flow studies in the workplace (DOE 1999).

CAMs should be positioned strategically in the work area. For areas having only one potential release point in a work area, the CAM should be placed as close to the release point as possible in a downstream direction. For areas having multiple release points and a limited number of real-time air monitors, such that one can not be placed near each release point, then the CAMs should be placed at those locations expected to provide the most reliable indication of a release, should one occur. The general approach for CAMs is to provide a rapid and reliable warning that a release has occurred (DOE 1999).

6.2.3 Room Air Flow Patterns

Airflow studies were performed in 1995 and 1996 for 327 and 324 Buildings, respectively. Since neither facility operations or ventilation systems have been modified since that time, these results are still considered valid. In the event system operation or configuration is changed, or, substantially different operations are initiated, the air flow patterns will be re-evaluated.

Copies of air flow studies for areas having existing air samplers and CAMS can be obtained from the FTA for Workplace Air Monitoring.

6.2.4 Respiratory Protection Factors

In the River Corridor Project, the respiratory protection factors (PF) given in Attachment 5, "Required Respiratory Protection Factors", of site procedure HNF-PRO-423, *Radiological Work Permits*, will be used (Table 6-6).

TABLE 6-6. Required Respiratory Protection Factors

RESPIRATORY TYPE	PROTECTION FACTOR (PF)	CONCENTRATION RANGE FOR USE ($\mu\text{Ci}/\text{ml}$)		DAC RANGE FOR USE (DAC)	
		^{239}Pu	^{90}Sr ^(a)	^{239}Pu	^{90}Sr ^(a)
No respiratory needed ^(b)	—	<2E-13	<2E-10	<0.1	<0.1
Full-Face Negative	100	2E-13 to 2E-11	2E-10 to 2E-8	0.1 to <10	0.1 to <10

Pressure					
Duo Flow, Air-Purifying	100	2E-13 to 2E-11	2E-10 to 2E-8	0.1 to < 10	0.1 to < 10
Fresh Air Supply					
Duo Flow, Supplied Air	1,000	2E-12 to 2E-10	2E-9 to 2E-7	1 to < 100	1 to < 100
Constant Flow without Escape Provision	1,000	2E-12 to 2E-10	2E-9 to 2E-7	1 to < 100	1 to < 100
Pressure Demand Mask	1,000	2E-12 to 2E-10	2E-9 to 2E-7	1 to < 100	1 to < 100
Air-Supplied Hood	1,000	2E-12 to 2E-10	2E-9 to 2E-7	1 to < 100	1 to < 100
Full-Face Pressure Demand with Escape Provision	10,000 ^(a)	4E-11 to 2E-9	2E-9 to 2E-7	20 to < 1,000	20 to < 1,000
Self-Contained Breathing Apparatus	10,000 ^(a)	4E-11 to 2E-9	2E-9 to 2E-7	20 to < 1,000	20 to < 1,000
<p>(a) The values for 90Sr are used for aerosols containing particles of mixed fission products.</p> <p>(b) Personnel should receive less than 40 DAC-h intake. This generally represents a committed (effective) dose equivalent of 100 mrem internal exposure. Adjust stay times accordingly.</p> <p>(c) Caution is recommended if the need for respiratory protection is such that the full protection factor of 10,000 is to be utilized (approaching the 2E-9 or 2E-6 upper limit). Respiratory protection factors of these high values may prove unreliable.</p>					

6.3 Air Sampling Equipment

Air sampling equipment to be used in the River Corridor Project include fixed head air samplers and portable air samplers. At the current time, breathing zone air monitoring is not used in 324 and 327 Facilities (INTR-9710-WPA-0261).

6.3.1 Selection

In the 324 and 327 facilities, the SAIC Model Number H-810 air sampler is currently used. It has maximum air flows of 5 to 6 cfm. The LB-5211 A-O filter is used with this air sampler. As recommended in site procedure, HNF-PRO-331, *Work Place Air Monitoring*, this filter is recommended for analysis of beta emissions.

Note that in the 324 Facility, this type of air sampler is routinely used during manned entries into the HCA environment of the REC airlock. Since it is

virtually impossible to perform a release survey on this equipment to allow it to be removed for scheduled calibrations, portable air samplers used in the REC airlock are used up to the first scheduled calibration date, then discarded. Thus, a rotating supply of portable air samplers are needed in this facility to support work involving REC airlock entry.

6.3.2 Components

For the 324 and 327 facilities, the sample holders currently in place for fixed heads are 2 inches in diameter. The LB-5211 A-O and Versapore 3000 (TPP-9704-INT-0174) filters, nominal 2 inch in diameter, are used for beta and alpha air sampling/monitoring, respectively (HNF-PRO-331). HD-2061 filters may be used in high volume air samplers (RCI-5).

6.3.3 Sample Change Frequency and Sample Duration

The potential for release of radioactive material and the consequences of accidental air contamination must be considered in establishing frequency and duration of sampling (DOE 1999). Most of the fixed head air samplers and CAMs used in the 324 and 327 facilities are in place on a continuous basis. In some cases, CAMs may be put into place temporarily on a as needed basis for certain jobs.

The air sample filter exchanges is generally weekly. However, daily may be used, if warranted. Section 3.2, "Fixed Head Air Sampler Inspection and Exchange", of HNF-IP-0718, and as implemented by RCP 5.5.8 of HNF-IP-1277, provides the procedure under which fixed head air filters are exchanged.

See Section 6.1.3 above for guidance on sample duration for grab air sampling.

6.3.4 Calibration and Operability Checks

Fixed head air sampler inspections are performed annually using the procedure Section 3.2 in HNF-IP-0718. In addition, in the River Corridor Project, the rotameter flow rate verification is performed according to HNF-IP-1277, Procedure 5.5.8. It has been determined that this verification process meets the calibration requirements outlined in Section 4.

6.4 Real-Time Air Monitoring Equipment

6.4.1 Selection

In the 324 and 327 facilities, the types of CAMS that may be used include Eberline CAMS types, such as AMS-3, the Alpha 4, 5, 5A, 5AS or 6A. A description of the instruments and the operability tests for each type are given in the following procedures:

TITLE	HNF-PRO	IP-1277
The Eberline Alpha-6A Family of Continuous Air Monitors	644	5.7.4
The Eberline AMS-3 Family of Continuous Air Monitors	645	5.7.5
Eberline ALPHA 4, 5, 5A, and 5AS Continuous Air Monitors	646	5.7.6

6.4.2 Components

Similar filters as that used in fixed head air samplers are used in CAMs. Each CAM used shall have an audible alarm. Visible alarms may also be used.

To avoid deposition of airborne radioactive material in sampling lines, sampling lines should be avoided whenever possible. When a sampling line is deemed necessary, the guidelines used for designing the sampling line are those given in the DOE WAM Implementation Guide (DOE 1999) and ANSI N13.1.

6.4.3 Alarm Requirements

The equation used to determine alarm setpoints for CAMs in the 324 and 327 Facilities is the following (from Section 5.2, HNF-IP-0178 implemented through RCP 5.7.9):

$$ASP = \frac{DAC \, t \, F \, E \, PF}{1.6E-11}$$

where

ASP = Alarm Set Point (cpm)

DAC = Applicable DAC value (i.e., 2E-12 μ Ci/ml for alpha, 2E-9 μ Ci/ml for beta)

t = Applicable timeframe (ideally 8 hr or less; no greater than 24 hr unless prevented by presence of radon progeny interference)*

F = Flow (cfm)

E = Counting Efficiency (cpm/dpm)

PF = Respiratory Protection Factor (1 if not wearing respirators)

and,

$$1.6E-11 \frac{\mu\text{Ci} \cdot \text{ft}^3}{\text{dpm} \cdot \text{cc}} = (60 \frac{\text{min}}{\text{hr}}) (2.22E6 \frac{\text{dpm}}{\mu} \text{Ci}) (12 \frac{\text{inch}}{\text{ft}})^3 (2.54 \frac{\text{cm}}{\text{inch}})^3$$

* In accordance with Section 5.2, HNF-IP-0178 (implemented through RCP 5.7.9), at no time should the CAM ASP exceed 40 DAC-h, after accounting for any applicable respiratory protection factor (PF), i.e., $t < 40 \text{ h}$. This is assuming that 1 DAC-h is equivalent to 2.5 mrem, and 40 DAC-h is equivalent to 100 mrem. That is (see DAC definition in Section 3 above),

$$\frac{5,000 \frac{\text{mrem}}{\text{DAC}}}{2,000 \text{ h}} = 2.5 \frac{\text{mrem}}{\text{DAC} \cdot \text{h}}$$

6.4.4 Response to CAM Alarm and CAM Failure

Response to CAM alarms or CAM failure will be performed according to Section 1.4, *CAM Alarms*, in HNF-IP-0178.

6.4.5 Calibration and Operability Checks

CAM calibration is performed in accordance with HNF-PRO-644, -646 (alpha CAMs), and HNF-PRO-645 (beta CAMs). CAM performance testing will be performed according to Section 5.2, *CAM Performance Testing*, in HNF-IP-0178, as well as other requirements given in the CAM procedures listed in Section 6.4.1 above.

6.5 Sample Analysis and Data Review

Air sample results should be evaluated as quickly as practicable for special situations, such as the evaluation of the need for respiratory protection, area evacuation (if necessary), worker intake, and worker relief from respirator use. Prompt field assessments are not required for fixed-location, portable, or personal air samplers used to routinely sample the worker's breathing environment unless upset conditions have been identified.

6.5.1 Detailed Sample Analysis

Air samples may be analyzed by RCTs or be sent out to an analytical laboratory for analysis. When RCTs analyze an air sample, the procedures, Section 5.4, *Analyzing Air and Smear Samples With Alpha and Beta Counting Instruments*, and Section 5.3, *Performance Testing Alpha and Beta Counting Instruments*, in HNF-IP-0718 are used. When air samples are sent to analytical laboratories, the specifications equivalent to those from Section 5.4 of HNF-IP-0718 required for the air sample analysis and reporting are specified in a statement of work. In either case, the influence of air samples by radon and its associated progeny are reduced by counting the sample after allowing a sufficient time for decay of the radon progeny.

6.5.2 Adjustments to Derived Air Concentration

If adjustments to DAC values are deemed necessary for specific cases (i.e., to better represent the physical and biochemical characteristics of the radionuclides), the adjustments will be done using either particle sizing, a measurement of the respirable fraction of airborne particles, or the compound lung solubility, according to the guidance presented in Chapter 4, *Adjustments to Derived Air Concentration*, in NUREG-1400 (NRC 1993).

6.5.3 Review of Sample Results (Tracking and Trending)

In accordance with HNF-PRO-331, as implemented through RCP 5.5.5, the air sample analytical data are tracked in a MicroSoft Excel® spreadsheet, then trended and analyzed to identify any samples that are greater than 2% DAC. This analysis is done two ways: (1) the data values and the respective 2% DAC comparison lines are plotted graphically over time (see Figure 13 for an example), and (2) the data value is compared to the applicable 2% DAC value using the following formulae for alpha and beta (see Figure 14 for an example, where the data corresponds to the plot in Figure 13). For the later case, the formula used for this evaluation are as follows:

$$= IF(DAT\alpha VALUE > 2\% DAC_{\alpha}, "YES", "NO")$$

$$= IF(DAT\beta VALUE > 2\% DAC_{\beta}, "YES", "NO")$$

Currently, the FTA-Workplace Air Monitoring performs the tracking and trending for the 300 Area facilities air sample data. The analyses, in the form of spreadsheets and trending plots, are sent to the appropriate Radiological Control First -Line Supervisor for review and filing. The FTA keeps a copy of the analyses.

6.6 Quality Control and Quality Assurance

6.6.1 Sample Identification, Handling, and Storage

As implemented through RCP 5.5.9 of HNF-IP-1277, the site procedure, "Automated Bar Coding of Air Samplers at Hanford (ABCASH)", Section 3.3, HNF-IP-0718, Health Physics Procedures, is not used in the River Corridor Project. Instead, unique identifiers that are specific to each individual facility are used to identify air samples in a manner similar to that given in Section 4.6.1 of the Air Monitoring Guide, DOE G 441.1-8 (DOE 1999).

6.6.2 Air Sampling and Real-Time Air Monitoring Equipment

An inventory is kept of the components air sampling and monitoring systems within the 324 and 327 Facilities.

6.6.3 Counting Room Equipment

For previous years (including Fiscal Year 1998) the air samples were sent to a non-BWHC laboratory for analysis. The statement of work for this analytical service includes the requirement that the laboratory provide the minimum detectable concentration (MDC) of alpha and beta for the counting system used in the analysis (see section 4.3.2 above for a definition of MDC) . The reported MDC values are then compared with 2% DAC as part of the tracking and trending of air sample data. For this, the most conservative DAC values are used:

	ALPHA	BETA
RADIONUCLIDE	^{239}Pu	^{90}Sr
DAC	2E-12 $\mu\text{Ci/ml}$	2E-9 $\mu\text{Ci/ml}$
2% DAC	4E-14 $\mu\text{Ci/ml}$	4E-11 $\mu\text{Ci/ml}$

Using a spreadsheet, the reported MDCs were compared to see if they are less than the applicable 2% DAC value. The formulae used for this comparison for alpha and beta, respectively, are:

$$= \text{IF}(\text{MDC}_{\alpha} \text{ VALUE} < 2\% \text{ DAC}_{\alpha}, "YES", "NO")$$

$$= \text{IF}(\text{MDC}_{\beta} \text{ VALUE} < 2\% \text{ DAC}_{\beta}, "YES", "NO")$$

6.6.4 Audits

In accordance with HNF-PRO-331, *Work Place Air Monitoring*, as implemented through RCP 5.5.5, an annual review of the adequacy of the workplace air monitoring systems will be conducted. Partial reviews will be conducted when changes to the facility, operations, or air monitoring program are made that may influence air flow or the effectiveness of air monitoring equipment (i.e., CAM line-loss), (in RCP 5.5.5, and RCP 3.1.1, *300 Area Enhanced Radiological Work Planning*).

In addition, self assessments of the workplace air monitoring/sampling program will be conducted in accordance with RCP 1.3.1, *Radiological Protection Self-Assessments*, which implements site procedure, HNF-PRO-319, of the same title.

6.6.5 Recordkeeping

Radiological records in the River Corridor Project, will be managed according to RCP 7.1.1, *Radiological Records Management*, in HNF-IP-1277. In addition, RCI-8, *Documentation of Radiological Surveys*, which will be incorporated into RCP 5.8.1, provides instruction on entering air sample data on the radiological survey report form.

6.7 Administrative Controls

6.7.1 300 Area Radiological Control Procedures

As mentioned above, all radiological control procedures that are applicable to the 324 and 327 Facilities are contained in HNF-PRO-1277, 300 Area Radiological Control Procedures. These procedures are listed in Table 4-1.

Procedural changes or additions that need immediate attention may be implemented through the use of Rad Con Standing Orders (RCSOs) or Rad Con Instructions (RCIs). The RCSOs/RCIs currently active which pertain to workplace air monitoring/sampling are:

- *Clarifications on Workplace Air Monitoring*, RCI-5, Rev 2, March 2, 1998.
- *Clarifications on Rotameter Flow Verification*, RCI-6, Rev 2, March 2, 1998.
- *Radon Determinations for Downposting*, RCI-10, Rev 0, August 6, 1998.

6.7.2 Operational Procedures

River Corridor Project operational groups shall notify the facility Radiological Control group when engineering controls that prevent worker exposure to airborne radioactivity, such as barriers, gloveboxes and glovebags, are compromised. An evaluation should be made of continuing operations with compromised engineering controls. The use of respiratory protection to continue activities under these conditions is discouraged. Implementation of short-term engineering modifications that provide a commensurate level of worker protection is the preferred alternative. [HSRCM-1 453.2]

6.7.3 DAC-Hour Tracking

River Corridor Project has opted to utilize its bioassay program in lieu of DAC-hr tracking to assess intakes of radioactive material. However, in the event air sampling indicates any exposure to an individual in excess of 1 DAC-hr, additional internal exposure will be tracked in accordance with HNF-PRO-380.

7.0 300 AREA WORKPLACE AIR MONITORING/SAMPLING PROGRAM

The 324 and 327 facilities were transitioned from PNNL direction to B&W Hanford Company, River Corridor Project direction in November of 1996. The fixed head air sampler and CAM locations currently used in these two facilities were put into place using PNNL-developed workplace air monitoring criteria. Here, the criteria developed in Section 6.0 above for determining the need for fixed head air samplers and for CAMs are used for determining which of the existing samplers/monitors are needed. Also, historical data available from radioactive contamination characterization of the two facilities are used in these determinations.

7.1 324 Facility

The results of the needs assessment for 324 Facility workplace air monitoring is presented in Table 7.1. No location was identified that has the potential for exceeding 2% of an ALI. However, an assessment of building operations did indicate 23 locations that should remain active in the interest of trending airborne radioactivity that might result from gradual loss of containment.

Similarly, the needs assessment did not indicate any locations that would require real time monitoring due to a potential of exceeding 1 DAC (averaged over 8 hours). A total of seven locations will be continuously monitored for beta activity

to assess confinement integrity. The specific locations of active sampling locations are shown in Table 7.1.

7.2 327 Facility

The needs assessment for 327 Facility workplace air monitoring is presented in Table 7.2. No location was identified that has the potential for exceeding 2% of an ALI or 1 DAC (averaged over an 8 hours). A review of historical air sampling results and contamination surveys within the context of present and future operations also failed to indicate the need for any location where routine or continuous air monitoring is justified. These results lead to the recommendation that the six fixed-head air samplers currently operating should be deactivated. In addition, the alpha and beta CAMs currently located at B-Cell, E-Cell, G-Cell, and the SERF Cell are not required. There are two locations, the Truck Lock (at the waste compactor) and the Decontamination Room (Room 20) that should be operated on a job specific basis when compacting or decontamination activities are occurring.

It is well known that high levels of both alpha and beta emitting contaminants exist within the 327 hot cells. Upset conditions during cell intrusive tasks, or any other unexpected event that might cause a containment breach, may result in elevated airborne activity levels. For this reason, in addition to the CAM monitors mentioned above, the air sampling/monitoring program will consist of the following activities:

1. Cell intrusive activities will be evaluated on a case by case basis. Those deemed to possess the potential for releasing airborne radioactivity will, at a minimum, be monitored by one set of CAMs (beta and alpha) to detect unexpected transients in airborne contamination levels.
2. One set of CAMs (beta and alpha) will run continuously in the canyon area and will be located on the north wall adjacent to the SERF Cell (See Figure 6). Additional CAMs may be activated in response to specific jobs or conditions.
3. One set of CAMs (beta and alpha) will run continuously in the 327 Basement (Figure 5) to provide warning to personnel entering this area of unexpected airborne radioactivity releases.
4. Grab sampling or other techniques will be employed as determined by the radiological work planning process. Each task will be carefully evaluated for air sampling needs with respect to types, location, and duration of air sampling equipment to ensure workers are adequately protected from airborne contaminants.

7.3 Fuel Supply Shutdown (FSS) and 300 Area Deactivation Project (300 ADP).

The work place air sampling/monitoring needs assessment (Ekstrom 1997) resulted in the conclusion that no FSS or 300 AD facility requires routine air sampling or monitoring. This result is largely due to the low occupancy and/or the nature of the current shutdown/transition activities. These activities are evaluated on a case-by-case basis and job-specific air sampling is implemented when warranted.

7.4 340 Project

The work place air sampling/monitoring needs assessment (Medley 1999) resulted in the conclusion that the facilities comprising the 340 Project do not require routine air sampling or monitoring. This result is due to the low occupancy status and/or radiological conditions that do not meet the criteria for workplace air sampling/monitoring. Ongoing activities in these facilities are evaluated on a case-by-case basis and job-specific air sampling is implemented when warranted.

TABLE 7-1. 324 FACILITY WORKPLACE AIR MONITORING/SAMPLING NEEDS ASSESSMENT

324 AIR SAMPLE LOCATION INFORMATION				FIXED HEAD REQUIREMENTS						CAM REQUIREMENTS			
				>880 dpm/100 cm ² Alpha	>8.8E5 dpm/100 cm ² Beta	Occupancy > 96 min/d	Other	Needed?	> 4.4E4 dpm/100 cm ² Alpha	> 4.4E7 dpm/100 cm ² Beta	Other	Active?	
1	3A	BASEMENT	By vault door	NO	NO	NO	—	NO	—	—	—	—	
2	3A VAULT ALPHA CAM	BASEMENT	CAM by vault door; sample line into vault	—	—	—	—	—	—	NO	Keep to monitor vault	—	
3	3B-1	BASEMENT	On north wall	NO	NO	NO	—	NO	—	—	—	—	
4	3B-2	BASEMENT	On pillar just inside the door	NO	NO	NO	—	NO	—	—	—	—	
5	3C	BASEMENT	Inactivated 7/29/97	—	—	—	—	—	—	—	—	—	
6	3D	BASEMENT	Inactivated 7/29/97	—	—	—	—	—	—	—	—	—	
7	3	BASEMENT	Just inside door	NO	NO	NO	—	NO	—	—	—	—	
8	3F-3	BASEMENT	On 3rd pillar	NO	NO	NO	—	NO	—	—	—	—	
9	3G-1	BASEMENT	On south wall	NO	NO	NO	—	NO	—	—	—	—	
10	3G-2	BASEMENT	By inert glovebox	NO	NO	NO	Keep-trending; glovebox unknowns	YES	—	—	—	—	

324 AIR SAMPLE LOCATION INFORMATION			FIXED HEAD REQUIREMENTS							CAM REQUIREMENTS			
			>880 dpm/100 cm ² Alpha	>8.8E5 dpm/100 cm ² Beta	Occupancy > 96 min/d	Other	Needed?	> 4.4E4 dpm/100 cm ² Alpha	> 4.4E7 dpm/100 cm ² Beta	Other	Active?		
11	3H	Just inside door	NO	NO	NO	—	NO	—	—	—	—		
12	3K	In front of fume hood	NO	NO	NO	Keep - trending; fume hood unknowns	YES	—	—	—	—		
13	ROOM 4-1	Behind large pump	NO	NO	YES	Keep-monitor for gradual buildup around bldg. vacuum pump	YES	—	—	—	—		
14	ROOM 5	Just inside door	NO	NO	NO	—	NO	—	—	—	—		
15	ROOM 8	Just inside door	NO	NO	NO	—	NO	—	—	—	—		
16	ROOM 11	On Rm 147 north wall; in-line sampling	NO	NO	NO	Keep - Trending	YES	—	—	—	—		
17	TANK PIT	South wall	NO	NO	YES	—	NO	—	—	—	—		
18	ROOM 18-1	On west wall	NO	NO	NO	—	NO	—	—	—	—		
19	ROOM 18-2	On south wall of B-Cell	NO	NO	NO	—	NO	—	—	—	—		
20	ROOM 18-3	At southwest corner of B-Cell wall	NO	NO	NO	—	NO	—	—	—	—		

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324 AIR SAMPLE LOCATION INFORMATION				FIXED HEAD REQUIREMENTS							CAM REQUIREMENTS		
				>880 dpm/100 cm ² Alpha	>8.8E5 dpm/100 cm ² Beta	Occupancy > 96 min/d	Other	Needed?	> 4.4E4 dpm/100 cm ² Alpha	> 4.4E7 dpm/100 cm ² Beta	Other	Active?	
21	ROOM 18-4	BASEMENT	By entrance near exhauster	NO	NO	NO	—	NO	—	—	—	—	
22	123-1	1st FLOOR, SOP	Change room by PCMs on controlled area side	NO	NO	YES	—	NO	—	—	—	—	
23	131-1	1st FLOOR, B-CELL GALLERY	At southwest corner of B-Cell wall	NO	NO	YES	—	NO	—	—	—	—	
24	131-2	1st FLOOR, B-CELL GALLERY	On B-Cell north wall	NO	NO	YES	—	NO	—	—	—	—	
25	131-3	1st FLOOR, B- CELL GALLERY	On B-Cell west wall	NO	NO	YES	—	NO	—	—	—	—	
26	131-4	1st FLOOR, B-CELL GALLERY	In B-Cell Sample Rm on west wall	NO	NO	YES	Keep- trending, monitor for gradual buildup around transfer port in sample hood	YES	—	—	—	—	
27	131-5	1st FLOOR, B- CELL GALLERY	At southeast corner of B-Cell wall by exhauster	NO	NO	YES	—	NO	—	—	—	—	

324 AIR SAMPLE LOCATION INFORMATION				FIXED HEAD REQUIREMENTS						CAM REQUIREMENTS		
				>880 dpm/100 cm ² Alpha	>8.8E5 dpm/100 cm ² Beta	Occupancy > 96 min/d	Other	Needed?	> 4.4E4 dpm/100 cm ² Alpha	> 4.4E7 dpm/100 cm ² Beta	Other	Active?
28	131-6	1st FLOOR, B-CELL GALLERY	On B-Cell south wall by cell window	NO	NO	YES	Keep- trending, monitor for gradual buildup from old cell window leak	YES	—	—	—	
29	131-7	1st FLOOR, B-CELL GALLERY	On B-Cell west wall by cell window	NO	NO	YES	Keep- trending, monitor for gradual buildup from chipped concrete	YES	—	—	—	
30	131-8	1st FLOOR, B-CELL GALLERY	At northwest corner of B-Cell wall	NO	NO	YES	—	NO	—	—	—	
31	131-9	1st FLOOR, B- CELL GALLERY	On B-Cell north wall by cell window	NO	NO	YES	—	NO	—	—	—	
32	131 CAM NORTH	1st FLOOR, B- CELL GALLERY	CAM at northwest corner of B-Cell wall	—	—	—	—	—	NO	NO	Keep to monitor confinement integrity YES	
33	131 CAM SOUTH	1st FLOOR, B- CELL GALLERY	CAM at southwest corner of B-Cell wall	—	—	—	—	—	NO	NO	Keep to monitor confinement integrity YES	
		1st FLOOR,	On C-Cell south									

324 AIR SAMPLE LOCATION INFORMATION				FIXED HEAD REQUIREMENTS						CAM REQUIREMENTS			
				>880 dpm/100 cm ² Alpha	>8.8E5 dpm/100 cm ² Beta	Occupancy > 96 min/d	Other	Needed?	> 4.4E4 dpm/100 cm ² Alpha	> 4.4E7 dpm/100 cm ² Beta	Other	Active?	
34	132-1	C-CELL GALLERY	wall west end	NO	NO	YES	—	NO	—	—	—	—	
35	132-2	1st FLOOR, C-CELL GALLERY	On C-Cell south wall at east cell window	NO	NO	YES	—	NO	—	—	—	—	
36	132-3	1st FLOOR, C-CELL GALLERY	On west wall of gallery	NO	NO	YES	—	NO	—	—	—	—	
37	137-1	1st FLOOR, CHA	On south wall	NO	NO	YES	—	NO	—	—	—	—	
38	137-2	1st FLOOR, CHA	On west wall by A-Frame filter monitors	NO	NO	YES	Keep- trending; monitor for gradual buildup from A-Frame filters under CHA	YES	—	—	—	—	
39	137-3	1st FLOOR, CHA	On west wall by REC airlock door	NO	NO	YES	Keep- trending; monitor for gradual buildup from opening REC Airlock door	YES	—	—	—	—	
40	137	1st FLOOR,	CAM by west	—	—	—	—	—	NO	YES	Keep to	YES	

324 AIR SAMPLE LOCATION INFORMATION		FIXED HEAD REQUIREMENTS						CAM REQUIREMENTS		
		>880 dpm/100 cm ² Alpha	>8.8E5 dpm/100 cm ² Beta	Occupancy > 96 min/d	Other	Needed?	> 4.4E4 dpm/100 cm ² Alpha	> 4.4E7 dpm/100 cm ² Beta	Other	Active?
	CAM	CHA	wall at REC airlock door						monitor REC Airlock	
41	138-1	1st FLOOR, TRUCKLOC K	On south wall just inside of door	YES	—	NO	—	—	—	—
42	138-2	1st FLOOR, TRUCKLOC K	North end of Load-Out Stall	YES	Keep- treading; Load-out stall unknowns	YES	—	—	—	—
43	139-1	1st FLOOR, SMF GALLERY	At SMF window station #17	YES	—	NO	—	—	—	—
44	139-2	1st FLOOR, SMF GALLERY	On northeast wall behind parts cabinet	YES	—	NO	—	—	—	—
45	139-3	1st FLOOR, SMF GALLERY	On center of east wall	YES	—	NO	—	—	—	—
46	139-4	1st FLOOR, SMF 139C	In Rm 139C, south east corner	YES	—	NO	—	—	—	—
47	139-5	1st FLOOR, SMF GALLERY	On west wall just inside of door	YES	—	NO	—	—	—	—
		1st FLOOR,	On north wall in							

324 AIR SAMPLE LOCATION INFORMATION			FIXED HEAD REQUIREMENTS							CAM REQUIREMENTS			
			>880 dpm/100 cm ² Alpha	>8.8E5 dpm/100 cm ² Beta	Occupancy > 96 min/d	Other	Needed?	> 4.4E4 dpm/100 cm ² Alpha	> 4.4E7 dpm/100 cm ² Beta	Other	Active?		
48	139-6	SMF GALLERY	northwest corner	NO	NO	YES	—	NO	—	—	—	—	
49	139-7	1st FLOOR, SMF 139C	In Rm 139C, over workbench	NO	NO	YES	—	NO	—	—	—	—	
50	139-8	1st FLOOR, SMF GALLERY	At SMF window station #9	NO	NO	YES	—	NO	—	—	—	—	
51	139-9	1st FLOOR, SMF GALLERY	At SMF window station #10	NO	NO	YES	—	NO	—	—	—	—	
52	139-10	1st FLOOR, SMF GALLERY	Between SMF window stations # 12 and #13	NO	NO	YES	—	NO	—	—	—	—	
53	139-11	1st FLOOR, SMF GALLERY	At SMF window station #14	NO	NO	YES	Keep-trending gallery for East Cell- south & South Cell-east	YES	—	—	—	—	
54	139-12	1st FLOOR, SMF GALLERY	At SMF window station #15	NO	NO	YES	—	NO	—	—	—	—	
55	139-13	1st FLOOR, SMF GALLERY	Near airlock door	NO	NO	YES	Keep- trending; monitor for gradual	YES	—	—	—	—	

324 AIR SAMPLE LOCATION INFORMATION			FIXED HEAD REQUIREMENTS						CAM REQUIREMENTS		
			>880 dpm/100 cm ² Alpha	>8.8E5 dpm/100 cm ² Beta	Occupancy > 96 min/d	Other	Needed?	> 4.4E4 dpm/100 cm ² Alpha	> 4.4E7 dpm/100 cm ² Beta	Other	Active?
						buildup from opening SMF Airlock door					
56	139-14	1st FLOOR, SMF GALLERY	At SMF window station #1	NO	YES	YES	Keep-trending at airlock workstation	YES	—	—	—
57	139-15	1st FLOOR, SMF GALLERY	At SMF window station #3	NO	NO	YES	—	NO	—	—	—
58	139-16	1st FLOOR, SMF GALLERY	At SMF window station #4	NO	NO	YES	—	NO	—	—	—
59	139-17	1st FLOOR, SMF GALLERY	At SMF window station #7	NO	NO	YES	—	NO	—	—	—
60	139-18	1st FLOOR, SMF GALLERY	At SMF window station #8	NO	NO	YES	—	NO	—	—	—
61	SMF SE CAM	1st FLOOR, SMF GALLERY	CAM at south wall by exhaust	NO	NO	YES	—	NO	NO	Keep to monitor SMF airlock	YES
62	141 BETA CAM	1st FLOOR, SMF AIRLOCK	CAM outside of SMF airlock	NO	NO	YES	—	NO	NO	Keep to monitor SMF confinement integrity	YES

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		FIXED HEAD REQUIREMENTS							CAM REQUIREMENTS			
		324 AIR SAMPLE LOCATION INFORMATION		>880 dpm/100 cm ² Alpha	>8.8E5 dpm/100 cm ² Beta	Occupancy > 96 min/d	Other	Needed?	> 4.4E4 dpm/100 cm ² Alpha	> 4.4E7 dpm/100 cm ² Beta	Other	Active?
63	145	1st FLOOR, HLV/LLV LOADOUT	On west wall just inside of door	NO	NO	NO	Keep- trending; monitor for gradual buildup from HLV/LLV	YES	—	—	—	—
64	146-1	1st FLOOR, PNNL FURNANCE	At fume hood	NO	NO	YES	Keep-trending at alpha fume hood	YES	—	—	—	—
65	146-2	1st FLOOR, PNNL FURNANCE	On east wall of 146 Mezzanine	NO	NO	NO	—	NO	—	—	—	—
66	146-3	1st FLOOR, PNNL FURNANCE	At ICP fume hood	NO	NO	YES	—	NO	—	—	—	—
67	146-4	1st FLOOR, PNNL FURNANCE	NEW (4/98) -- At walk-in hood	NO	NO	YES	Keep-trending at alpha fume hood	YES	—	—	—	—
68	146 ALPHA CAM	1st FLOOR, PNNL FURNANCE	CAM in southeast corner of room by fume hood	—	—	—	—	—	NO	NO	Keep to monitor alpha control zone	—
69	147-1	1st FLOOR, MANIP REPAIR	On west wall just inside of door	NO	NO	YES	Keep- trending; monitor for gradual	YES	—	—	—	—

324 AIR SAMPLE LOCATION INFORMATION		FIXED HEAD REQUIREMENTS						CAM REQUIREMENTS		
		>880 dpm/100 cm ² Alpha	>8.8E5 dpm/100 cm ² Beta	Occupancy > 96 min/d	Other	Needed?	> 4.4E4 dpm/100 cm ² Alpha	> 4.4E7 dpm/100 cm ² Beta	Other	Active?
70	147-2	1st FLOOR, MANIP REPAIR	On south wall by main power panel	NO	YES	Keep- trending; monitor for gradual buildup from decon glovebox	YES	—	—	—
71	147-3	1st FLOOR, MANIP REPAIR	On east wall behind waste compactor	NO	YES	—	NO	—	—	—
72	147-4	1st FLOOR, MANIP REPAIR	In northwest corner of room in manipulator storage area	NO	YES	Keep- trending; monitor for gradual buildup from potentially contam'd manipulators	YES	—	—	—
73	147 BETA CAM	1st FLOOR, MANIP REPAIR	CAM at south wall by main power panel	—	—	—	NO	NO	Keep to monitor integrity of decon glovebox & fume hood confinements	YES

324 AIR SAMPLE LOCATION INFORMATION			FIXED HEAD REQUIREMENTS						CAM REQUIREMENTS			
			>880 dpm/100 cm ² Alpha	>8.8E5 dpm/100 cm ² Beta	Occupancy > 96 min/d	Other	Needed?	> 4.4E4 dpm/100 cm ² Alpha	> 4.4E7 dpm/100 cm ² Beta	Use only on as needed basis	Other	Active?
74	147 COMPA CT BETA CAM	1st FLOOR, MANIP	CAM at waste compactor	—	—	—	—	NO	NO	Use only on as needed basis	—	NO
75	244-1	2nd FLOOR, B-CELL GALLERY	On B-Cell south wall	NO	YES	Keep-trending	YES	NO	—	—	—	—
76	244-2	2nd FLOOR, B-CELL GALLERY	On B-Cell west wall	NO	YES	—	NO	—	—	—	—	—
77	244-3	2nd FLOOR, B-CELL GALLERY	On A-Cell north wall	NO	YES	—	NO	—	—	—	—	—
78	244-4	2nd FLOOR, B-CELL GALLERY	On A-Cell north wall by A22 cubicle	NO	YES	—	NO	—	—	—	—	—
79	244-5	2nd FLOOR, B-CELL GALLERY	On A-Cell north wall by diagonal penetrations	NO	YES	Keep- trending, monitor for gradual buildup from hot cell penetrations	YES	NO	—	—	—	—
80	244-6	2nd FLOOR, B-CELL GALLERY	At northwest corner of B-Cell wall	NO	YES	—	NO	—	—	—	—	—

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324 AIR SAMPLE LOCATION INFORMATION			FIXED HEAD REQUIREMENTS							CAM REQUIREMENTS			
			>880 dpm/100 cm ² Alpha	>8.8E5 dpm/100 cm ² Beta	Occupancy > 96 min/d	Other	Needed?	> 4.4E4 dpm/100 cm ² Alpha	> 4.4E7 dpm/100 cm ² Beta	Other	Active?		
81	244-7	2nd FLOOR, B-CELL GALLERY	On B-Cell west wall center	NO	NO	YES	—	NO	—	—	—	—	
82	244-8	2nd FLOOR, B-CELL GALLERY	On south gallery wall by D-Cell gallery door	NO	NO	YES	—	NO	—	—	—	—	
83	245-1	2nd FLOOR, D-CELL GALLERY	In gallery hallway by double doors	NO	NO	YES	—	NO	—	—	—	—	
84	245-2	2nd FLOOR, D-CELL GALLERY	On D-Cell south wall east end	NO	NO	YES	Keep-trending	YES	—	—	—	—	
85	245 D- CELL BETA CAM	2nd FLOOR, D-CELL GALLERY	CAM at D-Cell south wall	—	—	—	—	—	NO	NO	Keep to monitor hot cell confinement integrity	YES	
86	311-1	3rd FLOOR, A-CELL GALLERY	On A-Cell south wall	NO	NO	NO	—	NO	—	—	—	—	
87	311-2	3rd FLOOR, A-CELL GALLERY	At southeast corner of A-Cell	NO	NO	NO	Keep-trending	YES	—	—	—	—	

TABLE 7-2. 327 FACILITY WORKPLACE AIR MONITORING/SAMPLING NEEDS ASSESSMENT

327 AIR SAMPLE LOCATION INFORMATION	FIXED HEAD REQUIREMENTS					CAM REQUIREMENTS			
	>880 dpm/100 cm ² Alpha	>8.8E5 dpm/100 cm ² Beta	Occupancy > 96 min/d	Other	Needed?	> 4.4E4 dpm/100 cm ² Alpha	> 4.4E7 dpm/100 cm ² Beta	Other	Active?
1 Waste Compactor	NO	NO	NO	—	NO	—	—	—	—
2 Trucklock Alpha CAM	—	—	—	—	NO	NO	NO	Job Specific Monitor Waste Operations	NO
3 Trucklock Beta CAM	—	—	—	—	—	NO	NO	Job Specific Monitor Waste Operations	NO
4 Basin	NO	NO	YES	—	NO	—	—	—	—
5 Dry Storage	NO	NO	YES	—	NO	—	—	—	—
6 A-Cell West	NO	NO	YES	—	NO	—	—	—	—
7 B-Cell North	NO	NO	YES	—	NO	—	—	—	—
8 B-Cell South	NO	NO	YES	—	NO	—	—	—	—
9 B-Cell Alpha CAM	—	—	—	—	—	NO	NO	—	NO
10 B-Cell Beta CAM	—	—	—	—	—	NO	NO	—	NO
11 C-Cell East	NO	NO	YES	—	NO	—	—	—	—
12 C-Cell North	NO	NO	YES	—	NO	—	—	—	—
13 D-Cell	NO	NO	YES	—	NO	—	—	—	—
14 E-Cell	NO	NO	YES	—	NO	—	—	—	—

327 AIR SAMPLE LOCATION INFORMATION		FIXED HEAD REQUIREMENTS					CAM REQUIREMENTS			
		>880 dpm/100 cm ² Alpha	>8.8E5 dpm/100 cm ² Beta	Occupancy > 96 min/d	Other	Needed?	> 4.4E4 dpm/100 cm ² Alpha	> 4.4E7 dpm/100 cm ² Beta	Other	Active?
15	E-Cell Alpha CAM	—	—	—	—	—	NO	NO	—	NO
16	E-Cell Beta CAM	—	—	—	—	—	NO	NO	—	NO
17	F-Cell	NO	NO	YES	—	NO	—	—	—	—
18	G-Cell East	NO	NO	YES	—	NO	—	—	—	—
19	G-Cell West	NO	NO	YES	—	NO	—	—	—	—
20	G-Cell Alpha CAM	—	—	—	—	—	NO	NO	—	—
21	G-Cell Beta CAM	—	—	—	—	—	NO	NO	—	NO
22	H-Cell	NO	NO	YES	—	NO	—	—	—	—
23	I-Cell	NO	NO	YES	—	NO	—	—	—	—
24	SERF Cell	NO	NO	YES	—	NO	—	—	—	—
25	Rm 16 Manip Storage	NO	NO	NO	—	NO	—	—	—	—
26	Rm 18 Manip Repair	NO	NO	YES	—	NO	—	—	—	—
27	Rm 20 Decon Hood	NO	NO	YES	—	NO	—	—	—	—
28	Rm 20 Alpha CAM (Job Specific)	—	—	—	—	—	NO	NO	Job specific Monitor Decon Activities	NO
29	Rm 20 Beta CAM (Job Specific)	—	—	—	—	—	NO	NO	Job Specific Monitor Decon	NO

327 AIR SAMPLE LOCATION INFORMATION		FIXED HEAD REQUIREMENTS					CAM REQUIREMENTS			
		>880 dpm/100 cm ² Alpha	>8.8E5 dpm/100 cm ² Beta	Occupancy > 96 min/d	Other	Needed?	> 4.4E4 dpm/100 cm ² Alpha	> 4.4E7 dpm/100 cm ² Beta	Other Activities	Active?
30	Low-Level Lab	NO	NO	YES	—	NO	—	—	—	—
31	Machine Shop	NO	NO	YES	—	NO	—	—	—	—
32	Change Room 1	NO	NO	YES	—	NO	—	—	—	—
33	Change Room 2	NO	NO	YES	—	NO	—	—	—	—
34	SERF Storage - Basement	NO	NO	YES	—	NO	—	—	—	—
35	SERF Storage Alpha CAM	—	—	—	—	—	NO	NO	—	NO
36	SERF Storage Beta CAM	—	—	—	—	—	NO	NO	—	NO
37	SW Basement	NO	NO	YES	—	NO	—	—	—	—
38	East Basement	NO	NO	YES	—	NO	—	—	—	—

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9.0 FIGURES

The following figures are diagrams of the 324 and 327 facilities. For Figures 1-6, posted Contamination Areas (as of March 1988) have been designated on each diagram. For Figures 7-12, the locations of fixed head air samplers and CAMs are designated on each diagram. Figures 12 and 13 are examples of the air sample trending data and plots.

Figure 1: 324 Facility Air Sampling Location Basement

Figure 2: 324 Facility Air Sampling Locations - First Floor

ND

Legend

β - Beta CAM
● - Fixed Head

Figure 5: 327 Facility Air Sampling Locations - Basement

The floor plan of the Environmental Sciences Building is a complex layout with various rooms and facilities. The plan is oriented with North at the top. Key areas include:

- North Loading Dock** and **Canopy** at the top left.
- Liquid Nitrogen Storage** (circular room) and **Manipulator Repair** room.
- Access for PRTR** and **Burst Test Facility** (large room with a central area).
- Acid Storage** and **Cask Storage Pad** at the bottom left.
- Transformer Pad** and **Elev** (elevator) near the top center.
- Decom Cell** and **Wet Storage Basin** (labeled **WET STORAGE BASIN**).
- Dry Storage** and **Machine Shop** (large room with multiple work areas).
- Vent Equip Rm** and **Lunch Rm** (large room with multiple tables).
- Cells** (A through Z) arranged in a row along the right side.
- EP-327-01-S**, **EP-327-02-V**, and **EP-327-03-S** (series of rooms or storage areas).

Figure 7: Example of Air Sample Trending Plot

Figure 8: Example of Air Sample Trending Data Analysis

SAMPLE LOCATION	DATE ON	TIME ON	DATE SAMPLE OFF	TIME OFF	ALPHA BKG	BETA BKG	ALPHA EFF	BETA EFF	ALPHA MDC (uCi/ml)	BETA MDC (uCi/ml)	SAMPLE VOL (ml)	ALPHA CONC (uCi/ml)	BETA CONC (uCi/ml)	ALPHA (Greater than 10% DAC)	BETA (Greater than 10% DAC)
ROOM 18-3	9/27/97	16:00	10/3/97	15:00	0.1	8.2	0.3348	0.1674	-	-	4.86E+08	6.92E-16	1.36E-14	NO	NO
ROOM 18-3	10/3/97	15:00	10/10/97	9:00	0.2	8.2	0.3348	0.1674	-	-	5.50E+08	3.00E-16	5.62E-14	NO	NO
ROOM 18-3	10/10/97	9:00	10/17/97	13:00	0.0	8.0	0.3348	0.1674	-	-	5.71E+08	8.84E-16	3.59E-14	NO	NO
ROOM 18-3	10/17/97	13:00	10/24/97	13:00	0.4	9.8	0.3042	0.1555	-	-	5.71E+08	1.82E-15	2.35E-14	NO	NO
ROOM 18-3	10/24/97	13:00	10/31/97	14:00	0.1	9.9	0.3042	0.1555	-	-	5.74E+08	2.50E-15	5.67E-15	NO	NO
ROOM 18-3	10/31/97	14:00	11/7/97	8:30	0.0	10.5	0.3042	0.1555	-	-	5.52E+08	5.03E-15	9.84E-15	NO	NO
ROOM 18-3	11/7/97	-	11/14/97	-	-	-	-	-	6.26E-15	5.73E-14	5.70E+08	2.25E-15	1.07E-14	NO	NO
ROOM 18-3	11/14/97	10:00	11/21/97	-	-	-	-	-	5.25E-15	5.28E-14	5.71E+08	2.50E-15	5.14E-14	NO	NO
ROOM 18-3	11/21/97	-	11/28/97	11:00	-	-	-	-	5.22E-15	5.57E-14	5.74E+08	6.45E-16	1.32E-14	NO	NO
ROOM 18-3	11/28/97	11:00	12/5/97	13:00	-	-	-	-	6.93E-15	5.41E-14	5.78E+08	1.82E-15	4.84E-14	NO	NO
ROOM 18-3	12/5/97	9:00	12/12/97	9:00	-	-	-	-	5.25E-15	5.83E-14	5.71E+08	1.82E-15	4.19E-14	NO	NO
ROOM 18-3	12/12/97	9:00	12/19/97	14:00	-	-	-	-	6.13E-15	5.74E-14	5.90E+08	1.20E-15	3.07E-15	NO	NO
ROOM 18-3	12/19/97	17:00	12/26/97	8:30	-	-	-	-	6.67E-15	6.22E-14	5.42E+08	2.30E-15	3.41E-14	NO	NO
ROOM 18-3	12/26/97	8:30	1/2/98	10:00	-	-	-	-	2.81E-15	5.70E-14	5.70E+08	3.80E-15	1.88E-14	NO	NO