Pacific Northwest NATIONAL LABORATORY

PNNL-10855, Rev 8

Determining Unabated Airborne Radionuclide Emissions Monitoring Requirements Using Inventory-Based Methods

November 2024

JM Barnett
SF Snyder
SA Swanson

U.S. DEPARTMENT OF ENERGY

Prepared for the U.S. Department of Energy
under Contract DE-AC05-76RL01830

DISCLAIMER

PACIFIC NORTHWEST NATIONAL LABORATORY
operated by
BATTELLE
for the
UNITED STATES DEPARTMENT OF ENERGY
under Contract DE-AC05-76RL01830

Printed in the United States of America

Available to DOE and DOE contractors from the
Office of Scientific and Technical Information,
P.O. Box 62, Oak Ridge, TN 37831-0062;
ph: (865) 576-8401
fax: (865) 576-5728
email: reports@adonis.osti.gov

Available to the public from the National Technical Information Service
5301 Shawnee Rd., Alexandria, VA 22312
ph: (800) 553-NTIS (6847)
email: orders@ntis.gov <https://www.ntis.gov/about>
Online ordering: http://www.ntis.gov

PNNL-10855, Rev 8

Determining Unabated Airborne Radionuclide Emissions Monitoring Requirements Using Inventory-Based Methods

November 2024

JM Barnett
SF Snyder
SA Swanson

Prepared for
the U.S. Department of Energy
under Contract DE-AC05-76RL01830

Pacific Northwest National Laboratory
Richland, Washington 99354

Abstract

Compliance with the airborne radionuclide emission monitoring requirements in the National Emission Standards for Hazardous Air Pollutants (NESHAP; Title 40 of the U.S. Code of Federal Regulations Part 61, Subpart H) and State requirements in Washington Administrative Code 246–247: Radiation Protection – Air Emissions and 173-480: Ambient Air Quality Standards and Emission Limits for Radionuclides were evaluated for Pacific Northwest National Laboratory (PNNL) operations. Additional guidance may be found in the U.S. Department of Energy Handbook, *Environmental Radiological Effluent Monitoring and Environmental Surveillance*. To meet regulatory requirements, reviews of planned or proposed projects and activities provide the basis for implementing necessary monitoring adjustments or for implementing changes to projects and activities in a timely manner. Potential unabated off-site doses were evaluated for emission locations managed by PNNL and licensed to the Department of Energy. These locations were at facilities in Richland, Washington (i.e., the Hanford Site and PNNL–Richland campus) and in Sequim, Washington, (PNNL–Sequim campus). This report describes the inventory-based methods and provides the results for the NESHAP assessment performed in January 2024 for calendar year ending 2023.

Summary

Compliance with the airborne radionuclide emission monitoring federal requirements in National Emission Standards for Hazardous Air Pollutants (NESHAP; 40 CFR Part 61, Subpart H); and State requirements in Washington Administrative Code (WAC) 246–247: Radiation Protection – Air Emissions, and WAC 173-480: Ambient Air Quality Standards and Emission Limits for Radionuclides were evaluated for Pacific Northwest National Laboratory (PNNL) operations. Potential unabated off-site doses were evaluated for emission locations at buildings that are located on the PNNL-Richland campus and the PNNL-Sequim campus operated by Battelle for the U.S. Department of Energy (DOE) and at Hanford Site buildings operated by PNNL. Five PNNL managed buildings have emission units that meet state and federal criteria for continuous sampling of airborne radionuclide emissions:

1. Hanford Site, 325 Building, Radiochemical Processing Laboratory
2. Hanford Site, 331 Building, Life Sciences Laboratory I
3. PNNL – Richland campus, 3410 Building, Materials Science and Technology Laboratory
4. PNNL – Richland campus, 3420 Building, Radiation Detection Laboratory
5. PNNL – Richland campus, 3430 Building, Ultratrace Laboratory.

The NESHAP assessments were performed using building radionuclide inventory data obtained in 2023. The buildings evaluated in 2024 included:

- Buildings with one or more emission points; filtered and unfiltered emission pathways are evaluated.
- Buildings that do not currently contain radioactive material but are in PNNL's Radioactive Material Tracking System because they have had or may have a managed radioactive material inventory.

Note that PNNL is not the sole occupant of some locations where PNNL tracks radioactive material; nevertheless, only the PNNL unabated emissions are evaluated against the PNNL compliance limits at such locations. Comprehensive results of these facility locations, noted below, may not be included in this document.

Emission units not associated with a building are not included in this report. For example, fugitive emissions released under the volumetrically release radioactive material permit may occur anywhere on the PNNL-Richland campus and are not restricted to a single building emission unit location.

- **Hanford Site Buildings**
  - 200E Prototype Surface Barrier Storage
  - 318 Radiological Calibrations Laboratory
  - 3220 300 Area Research Support Building
  - 325RPL Radiochemical Processing Laboratory
  - 331 Life Sciences Laboratory I. In addition to the building filtered emission point EP-331-01-V, potential unabated emissions were calculated separately for the minor emission unit EP-331-09-S.
  - 361 Modular Equipment Shelter (National Nuclear Security Administration)
- **PNNL-Richland Campus Buildings**
  - 2400 Stevens Office Building
  - 3410 Materials Science and Technology Laboratory
  - 3420 Radiation Detection Laboratory. In addition to the EP-3420-01-S filtered exhaust, there is also the EP-3420-02-S unfiltered exhaust.
  - 3425 Ultra Low Background Counting Laboratory.

- 3430 Ultratrace Laboratory. In addition to the EP-3430-01-S filtered exhaust, there is also the EP-3430-02-S unfiltered exhaust.
- 3020 Environmental Molecular Sciences Laboratory. Building had no radioactive material inventory at the time of the 2023 NESHAP assessment but is included here because it is listed in the RMT System and has had or may have a managed radioactive material inventory.
- 3310 BSF Biological Sciences Facility. Building had no radioactive material inventory at the time of the 2023 NESHAP assessment but is included here because it is listed in the RMT System and has had or may have a managed radioactive material inventory.
- 3440 Large Detector Laboratory. Building had no radioactive material inventory at the time of the 2023 NESHAP assessment but is included here because it is listed in the RMT System and has had or may have a managed radioactive material inventory.
- 3850 General Purpose Chemistry Laboratory
- AML Atmospheric Measurements Laboratory
- BSEL Biological Sciences and Engineering Laboratory. Building had no radioactive material inventory at the time of the 2023 NESHAP assessment but is included here because it is listed in the RMT System and has had or may have a managed radioactive material inventory.
- EDL Engineering Development Laboratory. Building had no radioactive material inventory at the time of the 2023 NESHAP assessment but is included here because it is listed in the RMT System and has had or may have a managed radioactive material inventory.
- LSL-II Life Sciences Laboratory II
- PSL Physical Sciences Laboratory. Building had no radioactive material inventory at the time of the 2023 NESHAP assessment but is included here because it is listed in the RMT System and has had or may have a managed radioactive material inventory.
- RSW Research Support Warehouse. Building had no radioactive material inventory at the time of the 2023 NESHAP assessment but is included here because it is listed in the RMT System and has had or may have a managed radioactive material inventory.

* **PNNL-Sequim Campus DOE Operations**
  - MSL Sequim Campus / Marine Sciences Laboratory
* **Privately Owned/Other Buildings in the Richland, Washington, Area**. There were no radioactive material inventories in any of these buildings at the time of the 2023 NESHAP assessment. They are included here because they are listed in the RMT System and have had or may have a managed radioactive material inventory:
  - 3350 LSB Laboratory Support Building
  - AAF Atmospheric Research Monitoring Aerial Facility
  - APEL Applied Process Engineering Laboratory
  - CETSF Columbia Energy Test and Storage Facility
  - HAMMER Hazardous Materials Management and Emergency Response Training Center. PNNL tracks radioactive material in the Radioactive Material Tracking (RMT) System but is not the sole occupant of the building.
  - Outdoor RMAs
  - POP Port of Pasco/Pasco Airport
  - SALK Salk Building

Acronyms and Abbreviations

ANSI	American National Standards Institute
CAP88-PC	Clean Air Act Assessment Package – 1988 for Personal Computers
CFR	U.S. Code of Federal Regulations
Ci	curie
DOE	U.S. Department of Energy
EM	Effluent Management Group
EMSL	Environmental Molecular Sciences Laboratory
EPA	U.S. Environmental Protection Agency
HPS	Health Physics Society
LMF	location modification factor
LSL	Life Sciences Laboratory
MPR	maximum public receptor
mrem	millirem
MSL	Marine Sciences Laboratory
NESHAP	National Emission Standards for Hazardous Air Pollutants
PCM	periodic confirmatory measurement
PIC	potential impact category
PNNL	Pacific Northwest National Laboratory
PSL	Physical Sciences Laboratory
PTE	potential-to-emit
RMT	Radioactive Material Tracking (System)
WAC	Washington Administrative Code
WDOH	Washington Department of Health
yr	year

Contents

Tables

1.0 Introduction/Project Description

Radionuclide emission locations at the Pacific Northwest National Laboratory (PNNL)-Richland campus and the PNNL-Sequim campus[1] are licensed by the State of Washington Department of Health (WDOH) to the U.S. Department of Energy (DOE) Office of Science – Pacific Northwest Site Office. Radionuclide emission locations on the Hanford Site are licensed by WDOH to the DOE, Richland Operations Office.

Requirements for sampling airborne radionuclide emissions are contained in the following regulations and guidelines:

- U.S. Code of Federal Regulations, Title 40, Part 61 (40 CFR 61) Subpart H: National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities
- Washington Administrative Code (WAC) 246-247: Radiation Protection – Air Emissions
- WAC 173-480: Ambient Air Quality Standards and Emission Limits for Radionuclides
- DOE-HDBK-1216-2015, *Environmental Radiological Effluent Monitoring and Environmental Surveillance* (DOE 2015)

The first two regulations require the performance of continuous sampling at emission points that have a permitted potential-to-emit (PTE)[2] ≥0.1 mrem/yr off-site maximum public receptor (MPR) dose[3] if routine emissions were not mitigated by engineered pollution control systems. The third regulation requires a dose estimate at the off-site Maximum Air location, where the emissions of radionuclides are limited to a maximum dose of 10 mrem/yr to the whole body to any member of the public and presumes an individual is at that off-site location fulltime. The Maximum Air estimates are conducted for emissions at both PNNL[4] campuses. The fourth document provides guidance on monitoring and sampling radioactive airborne effluent streams.

In response to and in compliance with the listed requirements, the potential unmitigated off-site MPR dose from the PNNL-operated buildings that contain radioactive materials or sources is evaluated annually in a National Emission Standards for Hazardous Air Pollutants (NESHAP) Assessment. The Maximum Air dose is reported in the annual compliance reporting (e.g., Snyder et al. 2024a, 2024b) and generally is equal to or not much larger than the MPR dose.

The radionuclide NESHAP assessment is completed annually. The number and status of buildings evaluated may change as buildings are transitioned to other contractors, buildings are demolished, new buildings are added, or laboratory missions change. The NESHAP assessments include all PNNL buildings that house radioactive materials. This document describes the methodology used and reports summary results for those PNNL buildings. A listing of the most recent five assessments' references is provided in Table 1.

---

[1] Formerly identified as the PNNL Marine Sciences Laboratory (MSL). No change in operations have occurred.
[2] PTE is defined as the rate of release of radionuclides from an emission unit based on the actual or potential discharge of the effluent stream that would result if all abatement control equipment did not exist but operations are otherwise normal.
[3] Dose is reported in millirem (mrem), rather than millisieverts to be consistent with the reported NESHAP standard units.
[4] PNNL is operated by Battelle for DOE under Contract DE-AC05-76RL01830.

Table 1. References for Five Most Recent NESHAP Assessments

Radionuclide Inventory Year	Document
2019	Memo No. EHSS-EPRP-20-002 [a] Memo No. EHSS-EPRP-20-003
2020	AST# AST-02378
2021	Memo No. EHSS-EPRP-22-006 Memo No. EHSS-EPRP-22-007 [a]
2022	Memo No. EHSS-EPRP-23-014 [a] Memo No. EHSS-EPRP-23-015
2023	Memo No. EHSS-EPRP-24-017 Memo No. EHSS-EPRP-24-018 [a]

[a] Summary of areas not included in NESHAP assessment.

2.0 Assessment Methodology

This chapter describes the methods used by PNNL to determine the potential emissions of radioactive materials from building operations subcontracted to Battelle (see footnote 5 for contract information).

2.1 Projections of Annual Emission Quantities

Several methods for projecting potential unmitigated annual emission quantities are prescribed in WAC 246-247:

- Apply an annual release fraction to the radionuclide inventory in the building
- Multiply actual measured annual emissions by control system decontamination factors
- Add actual measured annual emission quantities to actual measured quantities retained by control systems
- Measure the annual discharge upstream from all control devices.

The inventory-based assessment method[5] has been used by PNNL since the initial building assessment in 1991. The inventory method yields an assessment based on the current building status (or even the future status if projected future inventory quantities are used in the assessment), while the other prescribed methods yield an assessment based on past building measurements. The inventory method may be more appropriate for use at research and development facilities where types and quantities of radionuclides may change and where historical sampling data may not be a reliable predictor of future emissions.

Since 2006, PNNL has maintained radioactive inventory information using the Radioactive Material Tracking System (RMT), a web-based software tool that supports real-time tracking of radioactive materials. RMT has been updated since Revision 6 of this document to include the PNNL-Sequim campus. RMT provides a process that is used to achieve compliance with numerous regulatory requirements pertaining to radioactive material management. Appendix A provides a summary of the database features that apply to radioactive air emissions. RMT is updated by radioactive material custodians as well as other users with authorized access to radioactive material. The software allows the approved user to add, move, modify, and ship radioactive materials in and out of PNNL buildings and verifies that building radioactive material inventory limits have not been exceeded with any inventory update. RMT also has extensive search and report capabilities. For buildings with multiple emission points, the system can verify compliance with sub-building zones.

Radioactive inventory as well as throughput and proposed radioactive additions in the upcoming year are evaluated annually (DI-AIR-001). The evaluation includes the RMT Administrator contacting RMT custodians, contacting Environmental Compliance Representatives, reviewing outstanding radioactive material requests, and proposing nuclear material additions for updates and inputs. The RMT custodians verify the RMT inventory for material under their scope of responsibility.

---

[5] This method is described in WAC 246-247-030 (21)(a) as follows: "Multiply the annual possession quantity of each radionuclide by the release fraction for that radionuclide, depending on its physical state. Use the following release fractions: 1) 1 for gases, 2) 10^{-3} for liquids or particulate solids, and 3) 10^{-6} for solids. Determine the physical state for each radionuclide by considering its chemical form and the highest temperature to which it is subjected. Use a release fraction of 1 if the radionuclide is subjected to temperatures at or above its boiling point; use a release fraction of 10^{-3} if the radionuclide is subjected to temperatures at or above its melting point, but below its boiling point. If the chemical form is not known, use a release fraction of 1 for any radionuclide that is heated to a temperature of 100°C or more, boils at a temperature of 100°C or less, or is intentionally dispersed into the environment."

The custodians enter and manage inventory that represents current materials in the building and items on order or expected to be used in a future year (e.g., throughput items). Environmental Compliance Representatives provide information from Electronic Prep and Risk reviews about new projects involving radioactive materials. The RMT Administrator enters and maintains data representing additional radioactive materials that may be processed in the coming year, throughput for normal operations,[6] anticipated new work, and emission of gases.

Radioactive gas emissions (e.g., Kr-85) are managed separately in the Radioactive Air Gas Emissions database except for tritium from the 325RPL which is sampled monthly. Data from the database are used as a resource to populate expected gas emissions for the coming year. The RMT Administrator assigns a radioactive material custodian as appropriate for the additional information, and the custodian reviews and verifies the complete set of data under his/her name. The RMT Administrator generates NESHAP reports for each building that list RMT inventory items, summarizes the total PTE, and identifies the percent of each isotope in the inventory contributing to the PTE.

Radionuclides meeting either of the following criteria are excluded from the assessments:

- Radionuclides present in commercially available building/construction materials
- Radionuclides that can be purchased or possessed without a special radioactive materials license.

Data are reviewed and revised as needed to eliminate duplicate information and to obtain additional information as necessary. The review process is then documented and filed in e-records under CASE1830.08-10.

Potential release fractions for radionuclides are based on the physical form of the radionuclide as shown in Table 2. Radionuclides present as sealed sources or in sealed, unvented U.S. Department of Transportation-compliant shipping containers are assumed to be unavailable for release under normal conditions.

Table 2. Physical Forms and Potential Annual Release Fractions for Radionuclides

Form	Description	Potential Release Fraction
Gas[(a)]	Radioactive material in a gaseous or vapor form. This includes solids or liquids heated to a high enough temperature to be in a volatized state or are intentionally dispersed into the environment.	1
Liquid[(a)]	Radioactive material is a liquid, solution, or slurry, and its primary container will be opened at some point during the calendar year.	10^{-3}
Particulate solid[(a)]	Radioactive material will be present in powder form.	10^{-3}
Non-particulate Solid[(a)]	Radioactive material is a monolithic solid or consists of relatively large chunks.	10^{-6}

[6] The RMT System calculates throughput for the previous year and provides a field for custodians to record items on order and any expected changes in throughput for the future year.

Form	Description	Potential Release Fraction
Non-dispersible Radioactive Material	Radioactive material in a leak-proof rigid container (including waste drums and boxes) that is not opened or is not planned to be opened through the calendar year. Also includes radioactive material determined to be non-dispersible in accordance with Radiation Control Program Procedure 3.1.01.	0
Sealed source: any type	Radioactive source manufactured, obtained, or retained for the purpose of using the emitted radiation. The sealed radioactive source consists of a known or estimated quantity of radioactive material contained within a sealed capsule, sealed between layer(s) of non-radioactive material, or firmly fixed to a non-radioactive surface by electroplating or other means intended to prevent leakage or escape of the radioactive material.	0

(a) Based on Table 1 of American National Standards Institute/Health Physics Society N13.1-1999 (HPS 1999); and on WAC 246-247-030(21)(a).

2.2 Unit Dose Calculation

For unit dose calculations, the off-site MPR is defined as an individual whose residence location or work location maximize the potential dose from airborne pathways. Models assume the receptor continuously occupies the location and acquires food grown at the location. All potential environmental transport pathways associated with an airborne radionuclide release were included (i.e., air inhalation, air submersion, exposure to deposited radionuclides, and food ingestion). This is a prospective dose based on estimated potential emissions from emission units and is used in determining emission monitoring requirements as part of the permitting process.

Unit dose factors for the Richland area MPR were calculated for specific radionuclides using the U.S. Environmental Protection Agency (EPA) compliance code (Clean Air Act Assessment Package – 1988 for Personal Computers [CAP88-PC]; EPA 2015). Unit dose factors for the Sequim area MPR were calculated using the EPA COMPLY code (EPA 2017).

Radionuclides that were not represented in COMPLY were conservatively assigned default values, usually equal to that of Am-241 for alpha emitters; or the greater of either Cs-137 or Sr-90 for non-alpha emitters or as indicated in the unit dose factor documentation. Daughter product decay also was considered in assigning default values for short half-life radionuclides. The most recently published unit release dose factors were calculated using CAP88-PC Version 4.0 for the Hanford Site (Snyder and Rokkan 2016) and for the PNNL-Richland campus (Snyder and Barnett 2016). Older references for the Hanford Site and PNNL-Richland campus dose factors include Rhoads et al. (2010) and Rhoads and Barnett (2009), respectively. These documents describe the methods and assumptions used and provide unit dose factors for the PNNL emission units in the Hanford Site 300 Area and PNNL-Richland campus. Unit dose release factors for the PNNL-Sequim campus are indicated in Appendix B of the annual air emissions reports (Snyder et al. 2024b).

For the Physical Sciences Facility, dose assessments were performed using unit dose factors for the PNNL-Richland campus. For emission units where the documented MPRs of Snyder and Rokkan (2016) or Snyder and Barnett 2016 are not applicable, dose assessment can be performed by applying a location modification factor (LMF) to the unit dose factor to correct for varying source-receptor distances and directions. The LMF was calculated by dividing the atmospheric dispersion value (Chi/Q) for the building by the atmospheric dispersion value for the assumed MPR location when the same meteorology and receptor assumptions are applied (Snyder and Barnett 2017). The compliance code CAP88-PC was used to calculate these dispersion values.

2.3 Potential Emission Dose Assessment

Potential unabated doses are assessed for the MPR for each PNNL registered emission unit. Desk instruction DI-AIR-001, Conducting and Documenting the Annual NESHAP Assessment, describes the process for generating several tables of data (see Section 3.0) used for operational planning for the coming year and annual NESHAP assessment reporting. While there are several, two important and relevant operational planning results generated from dose information from the desk instruction output are indicated here.

1. *Verification that WDOH permit emission unit potential dose limits are not expected to be exceeded*. RMT System output includes an unabated emissions dose estimation that is facility, stack, and radionuclide specific. The NESHAP assessment provides a means to alert staff to the possible need for permitting action for projects anticipated in the coming year. It also verifies that the major/minor status for emissions units is correctly identified, based on the emission unit total PTE dose.
2. *Confirm the list of radionuclides that require analysis in the composited stack particulate samples of continuously monitored stacks*. The desk instruction results are used to establish the isotope-specific analysis that should be done for the major emission units (i.e., identify isotopes that contribute ≥10% to the PTE, or >0.1 mrem/yr to the PTE, or >25% of the PTE after controls). The PNNL-Sequim campus has no continuously monitored emission units, so this second item does not apply to their emissions.

3.0 Reports

RMT provides the PNNL facility radioactive material inventory used to generate a high-quality annual NESHAP assessment. The annual NESHAP assessment from DI-AIR-001 is based on two reports created by and exported from RMT.

1. The first export report is the Dose Contribution Report (Cumulative). It provides the PTE dose for each radionuclide that has been in each PNNL building during the current reporting year and the contribution of each radionuclide to the annual PTE calculated by the RMT System for that emission unit.
2. The second export report is the FEMP Data Evaluation Report (Cumulative). It provides a listing of RMT items that have been in each building throughout the year and the data used to calculate the PTE for the item (including each item's activity by radionuclide, physical form, release fraction, radionuclide- and location-specific PTE dose conversion factor, and PTE value for each item by radionuclide).

Annual NESHAP assessment reports are maintained as records in the e-records under CASE1830.08-10 (see Table 1). The annual NESHAP assessment formal reporting is considered a pair of memos or a single assessment report (see Table 1). For example, the pair: *2023 National Emissions Standards for Hazardous Air Pollutants Assessment for PNNL-DOE Facilities* and the memo *Buildings/Areas Not Included in the Calendar Year 2023 National Emissions Standards for Hazardous Air Pollutants Assessment*.

Facilities with only sealed sources in 2023 are listed in Table 3. Facilities having no specific WDOH-permitted emissions may house sealed sources or, for PNNL-Richland campus locations only, use Potential Impact Category (PIC)-5 (Barnett 2018 and Barnett and Snyder 2021) authorized materials.

As indicated previously, potential unabated doses are assessed in the annual NESHAP assessment for the MPR for each PNNL registered emission unit. Table 4 shows calendar year 2023 assessment results for facilities with potential radionuclide emissions to air.

A review of the annual NESHAP assessment report can also prove informative when staff are documenting the actual and estimated emissions estimates used for the annual NESHAP compliance reporting.

Table 3. Exempt[(a)] Facilities with Sealed Sources Only, 2023

Required Emission Monitoring Method	Building	System Description	2023 Potential Offsite Dose mrem/yr	Comment
Systems Located on the Hanford Site				
None	200E Storage	Prototype Surface Barrier Storage	0	Sealed sources
None	3220	300 Area Research Support Building	0	Sealed sources
Systems Located on the PNNL-Richland Campus				
None	EMSL (3020)	Environmental Molecular Sciences Laboratory	0	Sealed sources, VRRM, and non-dispersible
None	3850	General Purpose Chemistry Laboratory	0	Sealed sources
None	3440	Large Detector Laboratory	0	Sealed sources
Systems Located Elsewhere in Richland, Washington Area				
None	2400 Stevens	2400 Stevens Office Building	0	Sealed sources
None	AAF	Atmospheric Research Monitoring Aerial Facility	0	No radioactive inventory
None	AML	Atmospheric Measurements Laboratory	0	Sealed sources
None	APEL	Applied Process and Engineering Laboratory	0	Sealed sources; no radioactive inventory at time of 2023 assessment
None	BSEL	Bioproduct Sciences and Engineering Laboratory	0	Sealed sources
None	BSF	Biological Sciences Facility	0	Sealed sources
None	EDL	Engineering Development Laboratory	0	Sealed sources
None	HAMMER	Hazardous Materials Management and Emergency Response Federal Training Center	0	No radioactive inventory
None	LSB	Laboratory Support Building	0	No radioactive inventory
None	Outdoor RMAs	Outdoor radioactive material areas	0	No radioactive inventory
None	PSL	Physical Sciences Laboratory	0	No radioactive inventory
None	SALK	Salk Building	0	Sealed sources; no radioactive inventory at time of 2023 assessment

Required Emission Monitoring Method	Building	System Description	2023 Potential Offsite Dose mrem/yr	Comment
None	RSW	Research Support Warehouse/Radiation Portal Monitoring Project Warehouse	0	No radioactive inventory
None	LSL-II	Life Sciences Laboratory II	0	Sealed sources
None	CETSF	Columbia Energy Test and Storage Facility	0	No radioactive inventory
None	POP	Port of Pasco/Pasco Airport	0	No radioactive inventory
Systems Located at the PNNL-Sequim Campus in Sequim, Washington				
		N/A		

[a] Exempt as a registered emission unit because the facility contains only sealed sources; however, for the PNNL-Richland campus PIC-5 authorized sources (e.g., volumetrically released radioactive material, non-dispersible radioactive material) may be present in these facilities.

Table 4. Registered Emission Unit Potential Dose Assessment for Unabated Emissions, 2023.

Required Emission Monitoring Method per WDOH License[(a)]	Emission Unit	Emission Type[(b)]	System Description	2023 Assessment Dose, mrem/yr	Comment
Systems Located on the Hanford Site					
Inventory	J-318	Fugitive	Radiological Calibration Laboratory	1.29E-04	Primarily sealed and check sources
Cont. Monitoring	EP-325-01-S	Major Point	325-Radiochemical Processing Laboratory	3.57E+00	Also known as 325RPL
Cont. Monitoring	EP-331-01-V	Major Point	Life Sciences Laboratory I	4.71E-03	
Inventory	EP-331-09-S	Minor Point	Life Sciences Laboratory I	1.21E-05	
Inventory	J-361	Fugitive	Modular Equipment Shelter	1.72E-09	Radioactive gases, trace
Systems Located on the PNNL-Richland Campus					
Cont. Monitoring	EP-3410-01-S	Major Point	Material Science and Technology Laboratory	6.76E-05	
Cont. Monitoring	EP-3420-01-S	Major Point	Radiation Detection Laboratory	2.95E-03	
Inventory	EP-3420-02-S	Minor Point	Radiation Detection Laboratory	1.07E-06	
Inventory	J-3425	Fugitive	Ultra-Low Background Counting Laboratory	1.59E-06	
Cont. Monitoring	EP-3430-01-S	Major Point	Ultratrace Laboratory	5.70E-03	
Inventory	EP-3430-02-S	Minor Point	Ultratrace Laboratory	5.12E-08	
Systems Located Elsewhere in Richland, Washington					
	N/A	N/A	N/A	N/A	

Required Emission Monitoring Method per WDOH License[a]	Emission Unit	Emission Type[b]	System Description	2023 Assessment Dose, mrem/yr	Comment
Systems Located at the PNNL-Sequim Campus in Sequim, Washington					
Inventory	J-MSL	Fugitive	Entire PNNL-Sequim campus	4.55E-10	

(a) Monitoring Measurement Required: "*Inventory*" means 40 CFR 61 Appendix D Methods based on radionuclide inventory and includes input from the Radioactive Air Gas Emissions database. *Cont. Monitoring* means continuous measurement (sampling) of stack emissions. "*Periodic*" means periodic (non-continuous) measurement of emissions. "*Survey*" means in field radiological surveys conducted during demolition and excavation.

(b) Emission Types: "*Fugitive* emissions" are radioactive air emissions that do not and could not reasonably pass through a stack, vent, or other functionally equivalent structure, and that are not feasible to directly measure and quantify. "*Major Point* source" is a discrete, well-defined location from which radioactive air emissions originate, such as a stack, vent, or other functionally equivalent structure with a PTE equal to or greater than 0.1 mrem/yr and requires continuous sampling and in some cases also continuous monitoring. "*Minor Point* source" is a discrete, well-defined location from which radioactive air emissions originate, such as a stack, vent, or other functionally equivalent structure with a PTE less than 0.1 mrem/yr.

4.0 References

40 CFR 61, Subpart H. "National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities." U.S. Environmental Protection Agency. Washington, D.C.

Alexander RE. 1974. Applications of Bioassay of Uranium. WASH 1251, U.S. Nuclear Regulatory Commission, Washington, D.C.

American National Standards Institute – ANSI N317-1980 (Reaffirmed 1991). 1991. Performance Criteria for Instrumentation Used for Inplant Plutonium Monitoring. Institute of Electrical and Electronics Engineers, Inc., New York, New York.

Ballinger MY and RB Hall. 1991. A History of Major Hanford Facilities and Processes Involving Radioactive Material. PNL-6964 HEDR, Pacific Northwest Laboratory, Richland, Washington.

Barnett JM. 2024. Pacific Northwest National Laboratory Effluent Management Quality Assurance Plan. EM-QA-01, Rev. 12, Pacific Northwest National Laboratory, Richland, Washington.

Barnett JM. 2018. Pacific Northwest National Laboratory Potential Impact Categories for Radiological Air Emission Monitoring. PNNL-19904, Rev. 5, Pacific Northwest National Laboratory, Richland, Washington.

Barnett JM and SF Snyder. 2021. Pacific Northwest National Laboratory Facility Radionuclide Emission Points and Sampling Systems. PNNL-15992, Revision 5, Pacific Northwest National Laboratory, Richland, Washington

Daling, PM. Radioactive Material Tracking (RMT) System Quality Assurance Plan. EPRP-RMT-017, Revision 8. Pacific Northwest National Laboratory, Richland, Washington.

DOE – U.S. Department of Energy. 2015. Environmental Radiological Effluent Monitoring and Environmental Surveillance. DOE-HDBK-1216-2015. Washington, D.C.

Dyekman DL, JE Cranna, SF Snyder. 2024. Radionuclide Air Emissions Report for the Hanford Site, Calendar Year 2023. DOE/RL-2024-08, Rev 0, U.S. Department of Energy, Richland Operations Office, Richland Washington.

EPA – U.S. Environmental Protection Agency. 2007. Recommendations for a Uniform Protocol for Periodic Confirmatory Measurements of "Minor" Air Emissions Sources Subject to 40 CFR Part 61, Subpart H. Office of Radiation and Indoor Air, Washington, D.C.

EPA – U.S. Environmental Protection Agency. 2015. CAP88-PC Version 4.0 User Guide. Office of Radiation and Indoor Air, Washington, D.C. Last accessed June 27, 2018: https://www.epa.gov/radiation/cap-88-pc

EPA – U.S. Environmental Protection Agency. 2017. COMPLY Version 1.7. Office of Radiation and Indoor Air, Washington, D.C. Last accessed June 27, 2018: https://www.epa.gov/radiation/comply

HPS – American National Standards Institute/Health Physics Society. 1999. Sampling and Monitoring Releases of Airborne Radioactive Substances from the Stacks and Ducts of Nuclear Facilities. ANSI/HPS N13.1–1999, McLean, VA. (Re-affirmed in 2011 and reissued in 2021.)

PNNL – Pacific Northwest National Laboratory. Conducting and Documenting the Annual NESHAP Assessment. Desk Instruction: DI-AIR-001, current revision, Environmental Protection and Regulatory Programs, Richland, Washington. Last accessed October 8, 2024: https://eprp.pnl.gov/Procedure.aspx?Document=DI-AIR-001&topic=Procedures_and_Documentation.

Rhoads K and JM Barnett. 2009. Pacific Northwest National Laboratory Site Dose-per-Unit-Release Factors for Use in Calculating Radionuclide Air Emissions Potential-to-Emit Radiological Releases and Doses. PNNL-17847, Revision 1, Pacific Northwest National Laboratory, Richland, Washington.

Rhoads K, SF Snyder, RL Aaberg, and DJ Rokkan. 2010. Calculating Potential-to-Emit Radiological Releases and Doses. DOE/RL-2006-29, Revision 1, U.S. Department of Energy, Richland, Washington.

Shleien B, LA Slaback Jr, and BK Birky. 1998. Handbook of Health Physics and Radiological Health, Third Edition, Lippincott Williams & Wilkins, New York, New York.

Snyder SF and JM Barnett. 2016. PNNL Campus Dose-per-Unit-Release Factors for Calculating Radionuclide Emissions Potential-to-Emit Doses. PNNL-17847, Rev. 4. Pacific Northwest National Laboratory, Richland, Washington.

Snyder SF and DJ Rokkan. 2016. Calculating Potential-to-Emit Radiological Releases and Doses. DOE/RL-2006-29, Revision 2, U.S. Department of Energy, Richland, Washington.

Snyder SF, and JM Barnett. 2017. Location Modification Factors for Potential Dose Estimation. Health Physics/Operational Radiation Safety 113(1):73-77. DOI: 10.1097/HP.0000000000000684.

Snyder SF, LE Bisping, SG Ramos, LN Dinh, and JM Barnett. 2024a. PNNL-Richland Campus Radionuclide Air Emissions Report for Calendar Year 2023, PNNL-20436-14, Pacific Northwest National Laboratory, Richland, Washington.

Snyder SF, LN Dinh, and JM Barnett. 2024b. PNNL-Sequim Campus Radionuclide Air Emissions Report for Calendar Year 2023. PNNL-22342-12, Pacific Northwest National Laboratory, Richland, Washington.

Sula MJ, EH Carbaugh, and DE Bihl. 1991. Technical Basis for Internal Dosimetry at Hanford. PNL-6866, Rev 1, Pacific Northwest Laboratory, Richland, Washington.

Washington Administrative Code—WAC. Ambient Air Quality Standards and Emission Limits for Radionuclides. WAC 173-480, Olympia, Washington.

Washington Administrative Code—WAC. Radiation Protection - Air Emissions. WAC 246-247, Olympia, Washington.

Appendix A – Radioactive Material Tracking Database Features

The Radioactive Material Tracking System (RMT) is a web-based, real-time-tracking software system. RMT users add, move, modify, or ship out radioactive materials in the system to maintain inventory management and to verify that emissions are below regulatory permitted quantities. The calculated potential-to-emit (PTE) information obtained from the RMT System provides the basis to verify that each building is operating within set threshold limits. The annual Radiation National Emission Standards for Hazardous Air Pollutants assessment process includes verification of this information and compiling it into a final report. The inventory information obtained and reported is described in Section 2.1.

A.1 Database Population

New or updated inventory information is obtained from individual research personnel who act as custodians or users of the material. The PNNL HDI work control Radiological – General, Exhibit – Radioactive Material Tracking (RMT), contains requirements for entering and maintaining inventory data. RMT users have been granted access to the RMT System and are trained by an RMT Technical Contact. Training is documented and maintained through the PNNL Laboratory Training Database.

Information entered into the RMT System that is pertinent to radiological air emissions includes:

- Name of the staff member acting as custodian of the material
- Material physical form—gas, liquid, particulate solid, non-particulate solid, non-dispersible, or sealed source
- Radionuclides[7]
- Inventory in activity, mass, or concentration for each nuclide
- Building and room in which material is stored or used
- Specific item description and any additional comments related to the material (e.g., reference numbers on the material, whether the material is considered throughput, and a description of the material)
- RMT ID number is assigned by the database for each entry.

Additional information may be entered to assist staff in identification or management of the material.

A.2 RMT Reference Table Information

Potential dose calculations are made possible through reference table data that are run in a software stored procedure. These software stored procedures and reference tables are developed and maintained as safety software under the RMT System Quality Assurance Plan (EPRP-RMT-017). Any changes to these reference tables or processes require rigorous testing, peer review, and documentation before implementation.

[7] Appendix B provides support data for radionuclides in uranium and plutonium enrichments.

Dose-per-Unit Release Factors Table – Current factors for the mrem dose per curie released to ambient air (mrem/Ci) for different isotopes are listed in:

- Hanford Site emission facilities: DOE/RL-2006-29 (Revision 2) (Snyder and Rokkan 2016)
- PNNL-Richland campus emission facilities: PNNL-17847 (Revision 4) (Snyder and Barnett 2016)
- PNNL-Sequim campus emission facilities: PNNL-22342-12, Appendix B (Snyder, Dinh, and Barnett 2024)

Release Fraction Table – The release fractions for material forms (such as gases, liquids, or particulate solids).

Location Modification Factors (LMF) Table – The LMF for the building from which the potential emission occurs. Unit dose factors are calculated for the worst-case, off-site unit dose factor in the 300 Area (off-site MPR <40 m release height, east). LMFs modify these doses for facilities in Richland based on a ratio of dispersion factors.

A.3 Calculations

The database uses queries and macros that are applied to the inventory data to calculate the potential dose for the different PNNL buildings or for the Sequim campus, as appropriate.

Normalizing Inventory Data – The database is designed to convert the reported mass and activity inventory units (such as g, mCi, µCi, mg, µg) to Ci units for use in subsequent calculations.

Potential Dose Calculations – Potential dose calculations are determined on a building-specific basis. The reported inventory is first converted to Ci and then is multiplied by release fraction (based on the physical form of the item), the dose-per-unit release factor (mrem/Ci) for the specific nuclide, and the LMF.

Example: Calculate the PTE to the off-site MPR for 20 g of U-238 powder in the 325RPL Building

$$20 \text{ g} \times 3.36\text{E-7 Ci/g U-238} \times 1\text{E-03} \times 1.07 \text{ mrem/Ci/yr} \times 1.0 = 7.2\text{E-09 mrem/yr}$$

where:

20 g	=	quantity of material
3.36E-7 Ci/g	=	specific activity of U-238
1E-03	=	release fraction for particulate solids or liquids
1.07 mrem/Ci/yr	=	dose-per-unit release factor of U-238 for the off-site receptor in the east sector of the 300 Area with a ≥40 m release height
1.0	=	LMF (with relation to 300 Area).

The cumulative PTE for the building is determined by summing the potential doses of each inventory entry.

A.4 Radioactive Material Tracking Reports

Reports generated by the RMT System for the radioactive air National Emission Standards for Hazardous Air Pollutants assessment include the "Throughput Report," the "FEMP Data Evaluation Report," and the "FEMP Dose Contribution Report." Together these reports provide the itemized inventory data provided by the RMT System, including current inventory plus additional inventory anticipated to be processed in the coming year or brought in for new projects. The reports provide the cumulative inventory that has been in the building during the calendar year, physical forms, release fractions, dose-per-unit-release factor, and PTE values. The reports also provide a complete listing of each radioisotope present in the building, associated dose contribution (mrem), and the percent of the total dose for the building.

Other methods not available in the RMT System also are used during the assessment process. These include the Volumetric Released Radioactive Material approvals for the calendar year; and the Radioactive Air Gas Emissions database authorizations for gas emissions during the calendar year. Finally, the Electronic Prep and Risk System is evaluated for upcoming projects in which radioactive material will be used.

Appendix B – Common Radionuclide Mixtures

For uranium and plutonium inventory items for which enrichment is known but data on specific isotopic breakdown are not available, a method was devised to conservatively estimate isotopic composition. Uranium and plutonium blends can be grouped under the categories shown in Table B.1. Each of these categories represents an isotopic blend of uranium or plutonium that may be commonly found on the Hanford Site. The percentages shown are weight percent, and other components that make up the blend are other isotopes of uranium or plutonium. For aged plutonium blends, Am-241 also makes up a significant fraction.

Table B.1. Uranium and Plutonium Blend Information

Material in Inventory	Blend Information	Bin
Depleted Uranium or Uranium ≤0.25% U-235	Depleted Uranium	U(dep)
Natural Uranium or Uranium ≤0.72% U-235	Natural Uranium	U(nat)
Uranium ≤0.83% U-235 (commonly found at Hanford)	Hanford Uranium	U(Hanf)
Uranium Enriched ≤20% U-235	Uranium Enriched <20%	U(20%)
Uranium Enriched ≤90% U-235	Uranium Enriched <90%	U(90%)
Uranium ≥90% U-235	U-235	U-235
Plutonium with ≤6% Pu-240	Pu Blend with 6% Pu-240	Pu(6%)
Plutonium with ≤12% Pu-240	Pu Blend with 12% Pu-240	Pu(12%)
Plutonium with ≥12% Pu-240	Pu Blend with 24% Pu-240	Pu(24%)

Data and calculations for each of the blends are described here. Uranium blend information was obtained from Sula, Carbaugh, and Bihl (1991) and is shown in Table B.2.

Table B.2. Uranium Blend Specific Activities

Uranium Blend	Specific Activity, Ci/g
U(dep)	3.64E-07
U(nat)	6.87E-07
U(Hanf)	9.00E-07
U(20%)	9.36E-06
U(90%)	6.21E-05

Data for depleted uranium, natural uranium, and uranium commonly found at the Hanford Site are from Tables 8.2 and 8.3 of the referenced report. For the 20% and 90% U-235 blends, an equation was used to calculate specific activity. The equation was obtained from Figure 8.1 of Sula, Carbaugh, and Bihl (1991) and is back-referenced to WASH-1251 (Alexander 1974).

$$SA = (0.4 + 0.38E + 0.0034E^2) \times 10^{-6}$$

where: SA = specific activity, Ci/g and

E = weight percent of U-235

For E = 20 (i.e., 20 wt% U-235), SA = 9.36E-6 Ci/g
For E = 90 (i.e., 90 wt% U-235), SA = 6.21E-5 Ci/g

The uranium isotopes that contribute significantly to the activity are alpha emitters and have approximately the same dose potential per curie. Therefore, the specific activity is used in converting a known mass of uranium blend to activity, and the activity is all attributed to U-235.

The radionuclide and isotopic composition of 6% and 12% plutonium blends were also obtained from Sula, Carbaugh, and Bihl (1991). Data for these Pu mixtures prior to any decay of Pu-241 to Am-241 are shown in Table B.3 and were obtained from Tables 9.1 and 9.2 of the referenced report.

Table B.3. Isotopic Composition and Specific Activity of Pu Blends

		6% Pu mix			12% Pu mix		
Isotope	**Specific Activity Ci/g**	No Decay wt%	40-yr Decay wt%	Spec Act Mix Ci alpha/g	No Decay wt%	40-yr Decay wt%	Spec Act Mix Ci alpha/g
Pu-238	17.1	0.05	0.05	8.6E-03	0.1	0.1	1.7E-02
Pu-239	0.0621	93.0	93.0	5.8E-02	84.4	84.4	5.2E-02
Pu-240	0.227	6.1	6.1	1.4E-02	12.4	12.4	2.8E-02
Pu-241	103	0.8	0.1	(a)	3.0	0.45	(a)
Pu-242	3.92E-03	0.05	0.05	2.0E-06	0.1	0.1	3.9E-06
Am-241	3.43	0.0	0.7	2.3E-02	0.0	2.55	8.7E-02
			Total mix	1.0E-01		**Total mix**	1.9E-01

(a) Pu-241 is excluded from the total mix calculation because it is a beta-emitter, and the dose is insignificant compared to the dose from the other alpha-emitting radioactive materials.

Plutonium inventory items at the Hanford Site have most likely aged for many years and contain significant amounts of Am-241.[8] A 40-year age is assumed for plutonium blend calculations and the amount of Pu-241 decayed to Am-241 is calculated using the following equation (Shleien, Slaback, and Birky 1998):

$$N/N0 = e^{(-0.693\, t/T)}$$

where: N/N0 = the fraction of parent material left,
t = Time
T = half-life of the parent material.

Pu-241 has a half-life of 14.4 years (Shleien, Slaback, and Birky 1998, Table 8.13) and decays to about 15% of its original mass after 40 years, according to the above equation.
Am-241 has a much longer half-life (432 years), so all of the Pu-241 that is converted to Am-241 is present. Table B.3 shows the resulting weight percent of each isotope after a 40-year decay for each of the plutonium blends.

[8] Fuel reprocessing at the Hanford Site took place from the mid-1940s to the mid-1980s (Ballinger and Hall 1991).

All of the isotopes in Table B.3 are alpha emitters except for Pu-241 which decays by beta emission and is much less damaging per curie than the other isotopes. The dose effect from the Pu-241 contribution is negligible compared to the rest. Thus, Pu-241 is excluded from further calculations, and the specific activity for the mix is calculated in terms of curies of alpha emitter per gram. The specific activity of the mix is determined by summing the contributions from the alpha-emitting nuclides.

The isotopic composition for a 24% Pu blend was obtained from ANSI N317-1980 (R1991), Performance Criteria for Instrumentation Used for Inplant Plutonium Monitoring. That document provides isotopic compositions of plutonium for different reactor types and burnup. The composition that results in the most conservative unit dose is shown in Table B.4 and corresponds to the data for boiling water reactor with 28,000 MWD/T burnup with 40 years decay for Pu-241. Data in Table B.4 were taken directly from ANSI N317-1980 (R1991) and do not quite add up to 100%, most likely because of the number of significant digits used in the data.

Table B.4. Isotopic Composition and Specific Activity of 24% Pu Blend

Isotope	Specific Activity Ci/g	No Decay wt%	24% Pu mix 40-yr Decay wt%	Spec Act Mix Ci alpha/g
Pu-238	17.1	1.80	1.8	3.1E-01
Pu-239	0.0621	54.20	54.2	3.4E-02
Pu-240	0.227	23.80	23.8	5.4E-02
Pu-241	103	13.50	2.0	(a)
Pu-242	3.92E-03	6.40	6.4	2.5E-04
Am-241	3.43	0.00	11.5	3.9E-01
			Total mix:	7.9E-01

(a) Pu-241 is excluded from the total mix calculation because it is a beta-emitter and the dose is insignificant compared to the dose from the other alpha-emitting radioactive materials.

Appendix C – Comparison of EPA Recommendations with PNNL Radiological Air Task Documents

Table C.1 provides a comparison of U.S. Environmental Protection Agency (EPA) recommendations for a uniform protocol for periodic confirmatory measurements of "Minor" air emissions sources subject to 40 CFR Part 61, Subpart H (EPA 2007) with Pacific Northwest National Laboratory (PNNL) radioactive air task documents.

Table C.1. PNNL Crosswalk for EPA Recommendation with Periodic Confirmatory Measurements

Recommendations for Periodic Confirmatory Measurements (PCMs)	• PNNL-10855, *Determining Unabated Airborne Radionuclide Emissions Monitoring Requirements Using Inventory-Based Methods* • PNNL-19904, *PNNL Potential Impact Categories* • EM-QA-01, *Effluent Management Quality Assurance Plan* • PNNL-15992, *Pacific Northwest National Laboratory Facility Radionuclide Emission Points and Sampling Systems*
(1) GRADED APPROACH TO CLASSIFICATION SYSTEM: Describe how minor sources are subdivided and the basis for each classification.	PNNL-19904, the PNNL potential impact categories (PICs) document, specifies the basis for minor source categories, identifies a PIC for each PNNL minor source, and the use of PIC-5 for campus-wide radionuclide emissions applications.
(2) METHODS FOR PCM: Methods used to confirm that minor sources are correctly categorized (e.g., emissions measurement, radionuclide inventory).	PNNL-10855 describes the methodology for completing the annual National Emission Standards Hazardous Air Pollutant assessment. The annual assessments use current radionuclide inventory for each building.
(3) SUPPORTIVE DATA: • Meteorological • Release fractions • Materials volatilization temperatures • Maximally exposed individual selection method	• The Hanford Site Meteorological Station provides meteorological measurements for the Hanford Site and PNNL-Richland campus. Dose modeling meteorological data are published in the appendix of the annual radionuclide air emission report for the Hanford Site (i.e., DOE/RL-2024-08). Meteorological data for the Sequim facility is acquired from a publicly available Washington State University resource in Sequim, WA, as indicated in the appendix of the annual air emissions report (e.g., PNNL-22342-12). • PNNL-10855 describes release fractions. • PNNL-10855 describes materials volatilization temperatures considered in potential release-fraction determinations. • Maximally exposed individual selection for: – Hanford Site emissions: Described in DOE/RL-2006-29, Calculating Potential-to-Emit Radiological Release and Doses. – PNNL-Richland campus emissions: Described in PNNL-17847, PNNL Campus Dose-per-Unit-Release Factors for Calculating Radionuclide Emissions Potential-to-Emit Doses. – PNNL Sequim campus emissions: Described in annual air emissions reports (i.e., PNNL-22342-12).
(4) DISPERSION/DOSE MODEL USED: The reason for using any code other than CAP-88 version 3 (or newer version) should be explained.	CAP88-PC used for Hanford Site and PNNL-Richland campus dispersion modeling as described in PNNL-10855. COMPLY used for PNNL-Sequim campus dispersion modeling due to small emissions and limited meteorological data availability.
(5) QUALITY CONTROL ASPECTS: Quality assurance activities performed on a minor source should be consistent with a graded approach.	EM-QA-01 details quality assurance methods in place to validate the data gathering and reporting process. Standard operating procedures are implemented for related work (e.g., sampling activities) and updated biennially.
(6) FREQUENCY OF CONFIRMATION: The frequency that source emissions will be confirmed by sampling or other means.	PNNL-10855 describes the annual National Emission Standards Hazardous Air Pollutant assessment methodology. The Washington Department of Health permits specify monitoring requirements and sampling frequencies. Current sampling frequencies are maintained in a database (e.g., Gaseous Effluent Database) and documented in PNNL-15992. Note: Although the potential-to-emit (PTE) for each emission unit is calculated annually using actual radionuclide inventory, the PTE used for assigning PICs should be the permitted PTE, which is based on maximum estimated inventory and throughput for permitted activities.

Pacific Northwest National Laboratory

902 Battelle Boulevard
P.O. Box 999
Richland, WA 99354
1-888-375-PNNL (7665)

www.pnnl.gov