

Radiological and Toxic Air Emissions for the 224B Plutonium Concentration Facility

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

Contractor for the U.S. Department of Energy
under Contract DE-AC06-08RL14788

CH2MHILL
Plateau Remediation Company

**P.O. Box 1600
Richland, Washington 99352**

Radiological and Toxic Air Emissions for the 224B Plutonium Concentration Facility

Document Type: ECF

Program/Project: CPRM

P. Benjamin

Freestone Environmental, Inc.

Date Published

December 2019

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

Contractor for the U.S. Department of Energy
under Contract DE-AC06-08RL14788

CH2MHILL

Plateau Remediation Company

P.O. Box 1600

Richland, Washington 99352

APPROVED

By Janis D. Aardal at 10:14 am, Jan 09, 2020

Release Approval

Date

TRADEMARK DISCLAIMER

Reference herein to any specific commercial product, process, or service by tradename, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors.

This report has been reproduced from the best available copy.

Printed in the United States of America

ENVIRONMENTAL CALCULATION COVER PAGE

SECTION 1 - Completed by the Responsible Manager

Project:
CPRM

RELEASE / ISSUE

Date: 10/16/2019

Calculation Title and Description:
Radiological and Toxic Air Emission for 224B Plutonium Concentration Facility

DATE:
Jan 09, 2020



Qualifications Summary

Preparer(s):

Name: Piper Benjamin

Degree, Major, Institution, Year: Bachelor of Science, Biology, Eastern Wa. University, 2007

Professional Licenses: None

Brief Narrative of Experience: Five years as an environmental scientist working on documents related to the Hanford Site.

Checker(s):

Name: Carolyn Ervin

Degree, Major, Institution, Year: M.S., Materials Science & Engineering, Wa. State Univ., 1992

Professional Licenses: None

Brief Narrative of Experience: 27 years as an engineer for a wide variety of activities involving environmental cleanup, mechanical systems, and materials engineering.

Senior Reviewer(s):

Name: Frank Carleo

Degree, Major, Institution, Year: B.S., Environmental Science, Washington State University, 2015

Professional Licenses: None

Brief Narrative of Experience: Ten years of experience in the radiological and environmental field developing, implementing, and reviewing environmental calculations and associated documentation needed to permit and ensure compliance for clean-up activities at the Hanford Site. He is the CH2M Plateau Remediation Company authority in all matters related to the Clean Air Act as a Subject Matter Expert (SME).

SECTION 2 - Completed by Preparer

Calculation Number: ECF-HANFORD-17-0042

Revision Number: 1

Revision History

Revision No.	Description	Date	Affected Pages
1	Updated terminology used, added agreement for providing onsite MEI, no value change.	12/2019	All
0	Initial release.	10/25/2017	All

ENVIRONMENTAL CALCULATION COVER PAGE (Continued)

SECTION 3 - Completed by the Responsible Manager

Document Control:

Is the document intended to be controlled within the Document Management Control System (DMCS)? Yes No

Does document contain scientific and technical information intended for public use? Yes No

Does document contain controlled-use information? Yes No

SECTION 4 - Document Review and Approval

Preparer(s):

Piper Benjamin Environmental Scientist  10-16-19
Print First and Last Name Position Signature Date

Checker(s):

Carolyn Ervin Senior Env. Engineer  10/16/19
Print First and Last Name Position Signature Date

Senior Reviewer(s):

Frank Carleo CAA SME  10/17/19
Print First and Last Name Position Signature Date

Responsible Manager(s):

Deborah Singleton Environmental Manager  10/17/2019
Print First and Last Name Position Signature Date

SECTION 5 - Applicable if Calculation is a Risk Assessment or Uses an Environmental Model

Prior to Initiating Modeling:

Required training for modelers completed:

Integration Lead:

Print First and Last Name Signature Date

Safety Software Approved:

Integration Lead:

Print First and Last Name Signature Date

Calculation Approved:

Risk/Modeling Integration Manager:

Print First and Last Name Signature Date

Contents

1	Introduction.....	1
2	Background.....	2
3	Radiological Air Emission Calculations.....	4
	3.1 Assumptions and Inputs	5
	3.2 Methodology	6
	3.2.1 Annual Possession Quantity	7
	3.2.2 Potential-to-Emit.....	7
	3.2.3 Dose to the Maximally Exposed Individual.....	7
	3.3 Software Applications	8
	3.4 Calculations	8
	3.5 Radiological Air Emission Results.....	8
	3.5.1 Unabated Diffuse and Fugitive TEDE to the MEI.....	8
	3.5.2 Point Source Emissions Evaluation	10
4	Criteria/Toxic Air Determination.....	13
5	References	14

Figures

Figure 1.	224B Building Location within the B Plant Complex	1
Figure 2.	224B Building – Exploded View	3
Figure 3.	Near-Field Air Monitor Locations for the 224B Building	4

Tables

Table 1.	224B Building – Bounding Alpha Inventory.....	5
Table 2.	224B Building – Beta/Gamma Inventory	6
Table 3.	PTE and TEDE to the MEI Calculation for the 224B Building.....	9
Table 4.	Exhauster PTE Calculation for the 224B Building – Based on alpha DAC Activity	11
Table 5.	Exhauster PTE Calculation for the 224B Building – PTE and TEDE to the MEI.....	12
Table 6.	Chemical Contaminants of Concern	13
Table 7.	De Minimis Emission Values for 224B Building Chemicals	14

Terms

APQ	annual possession quantity
COC	contaminant of concern
D&D	decontamination and demolition
DAC	derived air concentration
ECF	environmental calculation file
MEI	maximally exposed individual
NDA	nondestructive assay
NESHAP	National Emission Standards for Hazardous Air Pollutants
PTE	potential-to-emit
RAWP	removal action work plan
SD	standard deviation
TEDE	total effective dose equivalent

1 Introduction

This environmental calculation file (ECF) provides air emission estimates for the removal action at the 224B Plutonium Concentration Facility (224B Building), located south of the 221B Building (B Plant) in the 200 East Area (Figure 1) of the Hanford Site. The ECF summarizes the assumptions, inputs, and methodology used to calculate the potential-to-emit (PTE) radionuclide airborne emissions and the total effective dose equivalent (TEDE) to the maximally exposed individual (MEI). This ECF also documents the determination of criteria/toxic air emissions resulting from the removal action.



Figure 1. 224B Building Location within the B Plant Complex

This ECF supports DOE/RL-2017-33, *Removal Action Work Plan for the 224B Plutonium Concentration Facility* (hereinafter called the Removal Action Work Plan [RAWP]), which implements decontamination and demolition (D&D). The removal activities outlined in the RAWP will be performed in accordance with DOE/RL-2004-36, *Action Memorandum for the Non-Time Critical Removal Action for the 224-B Plutonium Concentration Facility*.

As described in the RAWP, the removal action for the 224B Building includes sampling for worker protection and waste characterization, removing radiological and nonradiological hazardous substances from the building, removing equipment and associated piping, decontaminating the structure and/or stabilizing the contamination, demolishing the structure to slab on grade, disposing of waste generated, and stabilizing the area. Soil sampling around and under the remaining slab is also included. Thus, a potential for radiological and/or chemical emissions exists at the 224B Building during the removal activities.

2 Background

Constructed in 1944, the 224B Building was used to purify and concentrate plutonium solution that was produced from the bismuth phosphate process in 221B (B Plant). The concentrated plutonium solution was shipped to the 231Z Isolation Building for final concentration. The resulting plutonium product was then sent offsite. Plutonium concentration operations at 224B were performed from approximately 1944 to 1952. Operations ceased in 1952 when the bismuth phosphate process was abandoned for a more efficient one.

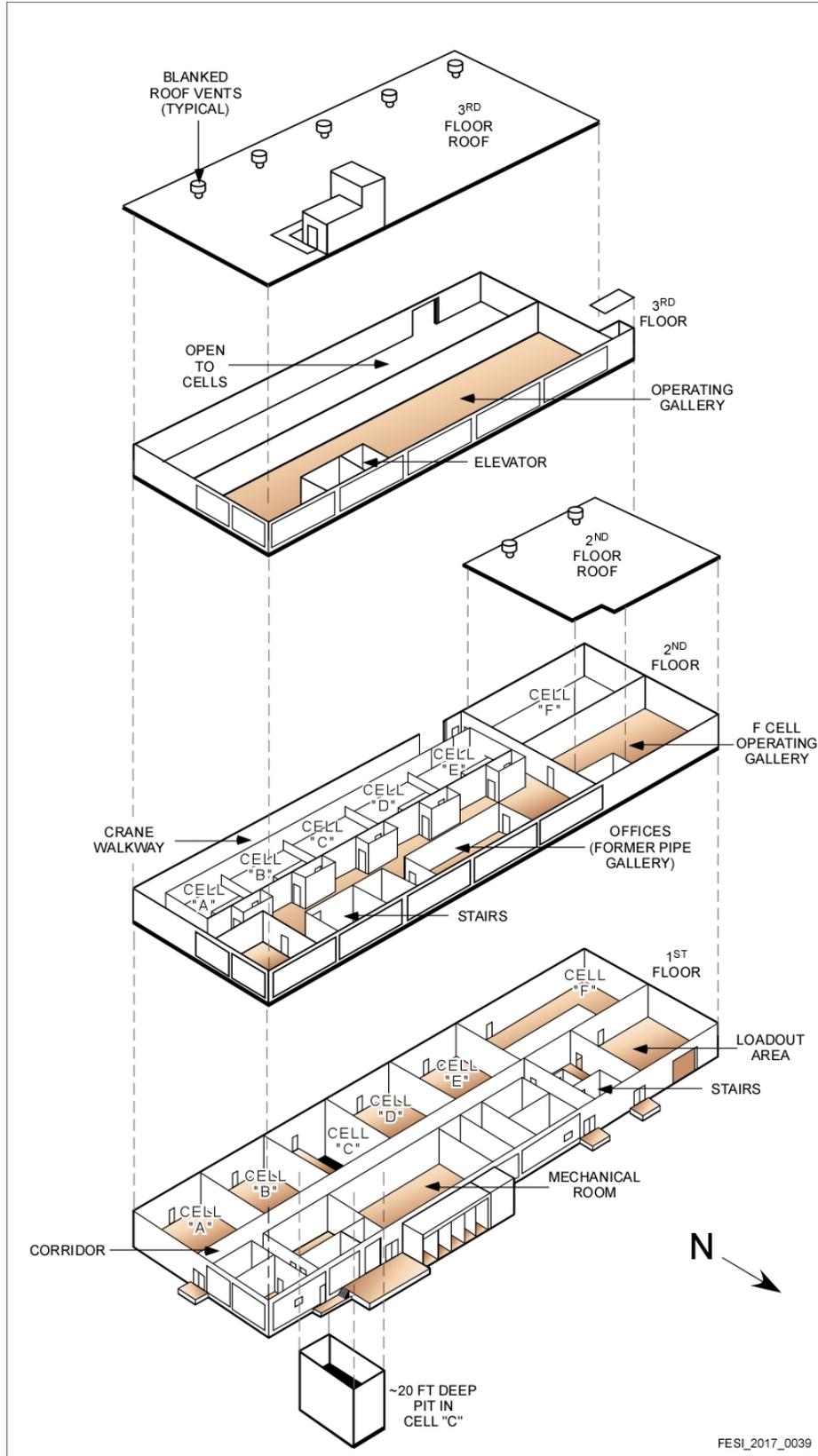
The three-story high 224B Building is constructed of reinforced concrete and concrete block and measures 60 m (197 ft) long and 18.3 m (60 ft) wide (Figure 2). The building is divided along its length by a concrete wall into two main sections: a cold side to the north (offices, loadout area, and pipe/operating galleries) and six process cells (A through F) to the south. Approximately half of C Cell is 5.2 m (17 ft) below the first-floor level, making a deep pit. A pipe tunnel extends 10.4 m (34 ft) from the deep cell beneath the first-floor cold side rooms to an underground pipe encasement that begins at the 224B Building boundary. The pipes within the tunnel and encasement were used for transferring solutions between 221B and 224B.

The 1952 decontamination process for the 224B Building used nitric acid for product removal and a solution of sodium hydroxide and sodium citrate for special chemical flushing. The process tanks and lines were emptied and rinsed in 1977. A visual inspection of the facility prior to 1988 indicated that there was no liquid in any of the tanks or lines and minimal dried residues to be found.

During operations, the air balance in 224B was achieved by air supply and building exhaust. Air was supplied through ducting to the first and third floors of the cold side of the building, the F Cell operating gallery, and the loadout room. From the first and third floors, the air flowed into cells A through E; from the F Cell operating gallery and loadout room, it flowed into F Cell. Cell exhaust was provided by roof ventilators that were not filtered. The roof ventilators have been capped and are no longer running.

A portion of the current 296-B-1 stack emission includes contribution from 224B process vessels that were tied to the B Plant main exhaust system via the stainless-steel ventilation headers connected to a 61 cm (24 in.) underground clay ventilation line. This line runs along the south and west sides of 224B and leads to the B Plant main exhaust air tunnel. The flow from 224B through the clay ventilation line to B Plant is believed to be minimal, estimated at less than 14.2 m³/min (500 ft³/min).

Because of uncertainty in the supplemental ventilation effectiveness, for the purpose of the current analysis, flow is assumed to be zero, and the entire 224B source term is assumed to be diffuse and fugitive.



FESI_2017_0039

Figure 2. 224B Building – Exploded View

3 Radiological Air Emission Calculations

The potential for radiological release exists at the 224B Building. The state implementing regulations (WAC 246-247, “Radiation Protection—Air Emissions”) address potential radioactive airborne emissions from point, fugitive, or diffuse sources that require monitoring. Potential radiological releases from the 224B Building removal action would be considered diffuse and fugitive emissions. The Hanford Site Environmental Monitoring Program, which serves as the monitoring system for all site activities, is described in detail in DOE/RL-91-50, *Hanford Site Environmental Monitoring Plan*. Near-facility ambient air monitoring stations N019, N481, N969, and N972 surround the B Plant Complex area and will be used for monitoring during the removal action (Figure 3).



Figure 3. Near-Facility Air Monitoring Locations for the 224B Building

The methodology used to estimate the PTE is based on the guidance document DOE/RL-2006-29, *Calculating Potential-to-Emit Radiological Releases and Doses*. Airborne emissions control and monitoring requirements for radiological air emissions will be identified as needed based on the calculated value of the potential emissions and resultant public exposure.

A radiological characterization of the 224B process cells was performed in 1985 to support decontamination and decommissioning activities. The results of this effort are documented in SD-DD-TRP-002, *Radiological Characterization of the 224-B Hot Cells*, hereinafter called the Hot Cell Characterization. The characterization includes survey and sample results from dust (floors, walls, and equipment exteriors), gutters and sumps, process tanks and centrifuges, piping, loadout hood, and the C Cell pit. It was estimated that the contents of the process tanks and centrifuges accounts for about 95% of the total inventory (Tables 4.1 and 4.2 in Hot Cell Characterization [SD-DD-TRP-002]). CP-18179,

224-B Facility Documented Safety Analysis, hereinafter called the Safety Analysis, provided a calculated bounding inventory for americium-241 (Am-241) and five plutonium isotopes (238 through 242) in 2008 from the 1985 characterization results.

3.1 Assumptions and Inputs

This section provides the assumptions and inputs used to calculate PTE and the TEDE to the onsite and offsite MEI associated with the 224B Building removal action. The assumptions and inputs are derived from site features, physical parameters, and analytical data obtained from radiological survey reports.

1. Alpha inventory values in Table 1 for the plutonium isotopes (238 through 242) and Am-241 were obtained from the Safety Analysis (CP-18179).

Table 1. 224B Building – Bounding Alpha Inventory

Isotope	Total Inventory, 2008 Values (Ci)
Pu-238	2.69E+00
Pu-239/240	8.76E+01
Pu-241	2.89E+01
Pu-242	1.44E-03
Am-241	1.31E+01
Total	1.32E+02

Reference: Table B-8 in CP-18179, 224-B Facility Documented Safety Analysis.

The Safety Analysis (CP-18179) values were calculated from the measured Am-241 inventory values in Table 4.1 of the Hot Cell Characterization (SD-DD-TRP-002) by adding 1.96 times the standard deviation (SD), or $(1.96 \times SD)$, to the measured values to obtain an upper limit of the 95% confidence interval for the measurements (or a bounding Am-241 inventory). The plutonium inventory was calculated from the Am-241 values using an assumed isotopic weight distribution. All values were then decay corrected to 2008 values (using a maximum value for Am-241). Appendix B of the Safety Analysis (CP-18179) provides a more detailed description of this process.

2. Table 4.2 in the Hot Cell Characterization (SD-DD-TRP-002) estimates the total beta/gamma radiological inventory (cesium [Cs-137], strontium [Sr-90], and cobalt [Co-60]) in the process cells as 26.5 Ci. The total inventory summation is repeated in Table 2. Using the SD of 75%, the upper inventory limit is calculated by multiplying the total inventory by $(3 \times SD)$, as stated in the Table 4.2 footnote of SDD-DD-TRP-002. Table 2 shows a breakdown of the beta/gamma upper inventory limit by isotope. The calculated total inventory and upper inventory limit values in Table 2 are slightly higher than the values stated by Table 4.2 in the Hot Cell Characterization (SD-DD-TRP-002) (26.5 Ci and 59 Ci, respectively); the difference is attributed to rounding error.

Table 2. 224B Building – Beta/Gamma Inventory

Isotope	Estimated Cell Inventory (Ci) ^a						Total Inventory (Ci) ^b	Upper Inventory Limit (Ci) ^c
	A	B	C	D	E	F		
Cs-137	1.6E-02	8.2E-03	2.7E-01	1.0E-01	4.3E-02	6.6E-01	1.10E+00	2.47E+00
Sr-90	3.6E-02	6.0E-03	1.9E+01	1.2E+00	5.4E-02	1.3E+00	2.16E+01	4.86E+01
Co-60	6.0E-03	3.0E-03	3.7E+00	1.4E-01	6.0E-03	5.0E-03 ^d	3.86E+00	8.69E+00
Totals							2.66E+01	5.97E+01

Reference: SDD-DD-TRP-002, *Radiological Characterization of the 224B Hot Cells*.

a. Values from Table 4.2 of SD-DD-TRP-002.

b. Equals sum of estimated cell inventory.

c. Equals total inventory multiplied by (3×SD), where SD = 75% (Table 4.2 of SD-DD-TRP-002).

d. The estimated Co-60 value is less than 5.0E-03 Ci, but 5.0E-03 Ci is conservatively used here.

3. It is recognized that nondestructive assay (NDA) techniques and methods have evolved since those used in 1985, and it is anticipated that the values from the 1985 characterization effort will be revisited. To account for uncertainty that a new NDA may introduce as well as additional unexpected contamination in associated piping at the 224B Building, the annual possession quantity (APQ) used in the calculations will be the inventory values from Table 1 and Table 2, conservatively multiplied by 4.
4. The D&D activities described in the RAWP (DOE/RL-2017-33) may be conducted over several years. For conservatism, it is assumed that the entire APQ is available for release within a 1-year period.
5. The radionuclides of concern are particulate solids; therefore, a release fraction of 1.0E-03 is used in accordance with WAC 246-247-030(21)(a), “Definitions, Abbreviations, and Acronyms,” as amended, and Appendix D, “Methods for Estimating Radionuclide Emissions,” in 40 CFR 61, “National Emission Standards for Hazardous Air Pollutants” (NESHAP).
6. The dose factors were taken from Table 4.4 in DOE/RL-2006-29 with an effective release height of less than 40 m (131 ft) based on the proximity of the contaminated areas to ground surface and their location within the 200 East Area. The dose-per-unit-release factors include the parent isotope and its radioactive decay products (+D) in accordance with Section 3.2.3 of DOE/RL-2006-29. Section 3.4 provides the dose factor values.

3.2 Methodology

Potential radionuclide air emission estimates are determined using the “Method 1: Annual Possession Quantity” described in DOE/RL-2006-29.

Building radiological reports and process knowledge are used to estimate APQ, which is the assumed quantity of contamination present. The APQ is used to calculate the PTE, which is an estimate of the radionuclides that could potentially be emitted during the 224B Building removal action. The PTE and dose factors from DOE/RL-2006-29 are used to determine the TEDE to the offsite and onsite MEI. The process is outlined in the following steps:

1. Calculate the APQ (Section 3.2.1).
2. Determine PTE (Section 3.2.2).
3. Calculate the TEDE to the offsite and onsite MEI (Section 3.2.3).

The following sections provide detailed descriptions of each step. Section 3.4 provides the air emissions calculations.

3.2.1 Annual Possession Quantity

The APQ is measured as total activity in curies. As specified in Section 3.1 Items 1 and 2, the building activity (bounding inventory) is used to calculate the APQ, as shown in Equation 1. For the purposes of this calculation, the APQ is the activity derived from the 1985 report conservatively multiplied by 4 to account for changes in NDA methods and any additional unexpected contamination (as specified in Section 3.1, Item 3). Equation 1 shows this process:

$$APQ (Ci) = \text{Activity} (Ci) \times 4 \quad (\text{Eq. 1})$$

where:

- APQ = annual possession quantity
- Activity = building activity
- 4 = conservatism multiplier.

3.2.2 Potential-to-Emit

The maximum PTE in a calendar year is calculated using the APQ and a release fraction, in accordance with NESHAP (Appendix D in 40 CFR 61). Since it is assumed that the entire APQ is available for release within a 1-year period (as described in Section 3.1, Item 4), Ci/yr is used for APQ units in PTE and MEI dose calculations. APQ is multiplied by a unitless release fraction of 1.0E-03, as described in Section 3.1, Item 5. Equation 2 shows this process:

$$PTE \left(\frac{Ci}{yr} \right) = APQ \left(\frac{Ci}{yr} \right) \times 1.0E-03 \quad (\text{Eq. 2})$$

where PTE is potential-to-emit.

3.2.3 Dose to the Maximally Exposed Individual

The TEDE to the onsite and offsite MEI is determined by multiplying the PTE, as determined using Equation 2, by the dose-per-unit-release factors, as described in Section 3.1, Item 6. The TEDE to the onsite MEI for a single isotope is performed using Equation 3:

$$\text{Onsite TEDE} \left(\frac{mrem}{yr} \right) = PTE \left(\frac{Ci}{yr} \right) \times \text{Onsite Dose Factor} \left(\frac{mrem/yr}{Ci/yr} \right) \quad (\text{Eq. 3})$$

Similarly, the TEDE to the offsite MEI for a single isotope is performed using Equation 4:

$$\text{Offsite TEDE} \left(\frac{mrem}{yr} \right) = PTE \left(\frac{Ci}{yr} \right) \times \text{Offsite Dose Factor} \left(\frac{mrem/yr}{Ci/yr} \right) \quad (\text{Eq. 4})$$

3.3 Software Applications

Microsoft® Excel® 2016 was used to perform the calculations in Section 3.4. Excel is a site-licensed client software.

3.4 Calculations

Table 3 provides the potential air emission calculations for the 224B Building radiological contaminants of concern (COCs). These calculations follow the methodology described in Section 3.2, using the assumptions and inputs stated in Section 3.1. Table 3 also provides the TEDE for onsite and offsite MEIs by using the sum of potential air emission for all radiological COCs.

3.5 Radiological Air Emission Results

Potential radionuclide air emission estimates were calculated for the 224B Building removal action described in the RAWP (DOE/RL-2017-33).

3.5.1 Unabated Diffuse and Fugitive TEDE to the MEI

The resulting unabated TEDE to the MEI are as follows:

- The TEDE to the onsite MEI is 1.35 mrem/yr. The onsite MEI is located at Energy Northwest. The distance from the 200 East Area emission zone to Energy Northwest is 16.7 km (10.4 mi) east-southeast.

TEDE to the onsite MEI is provided in accordance with the agreement reached between U.S. Department of Energy, Richland Operations Office; the Environmental Protection Agency; and the Washington State Department of Health (AIR 00-1012, "New Onsite MEI").

- The TEDE to the offsite MEI is 1.17 mrem/yr. The offsite MEI is located at the Hanford Site boundary. The distance from the 200 East Area emission zone to the Hanford Site boundary is 19.4 km (12.1 mi) east-southeast.

As determined by the above calculations, the TEDE to the MEIs for the 224B Building are above the 0.1 mrem/yr limit in WAC 246-247-075, "Monitoring, Testing, and Quality Assurance," that requires continuous monitoring of radionuclide emissions but below the 10 mrem/yr ambient air requirement in the NESHAP (40 CFR 61, Subpart H, "National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities"). The calculations are also in compliance with WAC 246-221-060, "Radiation Protection Standards," "Dose Limits for Individual Members of the Public," which requires that Hanford Site operations not result in a dose to an individual member of the public in excess of 10 mrem/yr.

® Microsoft and Excel are registered trademarks of Microsoft Corporation, Redmond, Washington.

Table 3. PTE and TEDE to the MEI Calculation for the 224B Building

A	B	C	D	E	F	G	H
Isotope	Inventory ^{a,b} (Ci)	APQ ^c (Ci)	Unabated PTE ^d (Ci/yr)	Dose Factor ^e (mrem/yr per Ci/yr)		Unabated TEDE (mrem/yr)	
				Onsite MEI	Offsite MEI	Onsite MEI ^f	Offsite MEI ^g
Pu-238	2.69E+00	1.08E+01	1.08E-02	3.01E+00	2.55E+00	3.24E-02	2.74E-02
Pu-239/240	8.76E+01	3.50E+02	3.50E-01	3.28E+00	2.78E+00	1.15E+00	9.74E-01
Pu-241	2.89E+01	1.16E+02	1.16E-01	6.00E-02	5.19E-02	6.94E-03	6.00E-03
Pu-242	1.44E-03	5.76E-03	5.76E-06	3.11E+00	2.64E+00	1.79E-05	1.52E-05
Am-241	1.31E+01	5.24E+01	5.24E-02	2.71E+00	2.30E+00	1.42E-01	1.21E-01
Cs-137	2.47E+00	9.87E+00	9.87E-03	1.46E-01	2.40E-01	1.44E-03	2.37E-03
Sr-90	4.86E+01	1.94E+02	1.94E-01	3.96E-02	1.93E-01	7.70E-03	3.75E-02
Co-60	8.69E+00	3.47E+01	3.47E-02	1.88E-01	1.68E-01	6.53E-03	5.84E-03
Totals						1.35E+00	1.17E+00

References: AIR 00-1012, "New Onsite MEI."

CP-18179, 224-B Facility Documented Safety Analysis.

DOE/RL-2006-29, Calculating Potential-to-Emit Radiological Releases and Doses.

a. Bounding inventory values for plutonium isotopes and Am-241 were obtained from Table B-8 in CP-18179 (specified in Section 3.1, Item 1).

b. Upper inventory limit values for Cs-137, Sr-90, and Co-60 (specified in Section 3.1, Item 2).

c. APQ is calculated as follows: **Column C (APQ) = Column B (Inventory) × Conservatism Multiplier** (Section 3.2.1, Eq. 1) with Conservatism Multiplier = 4 (specified in Section 3.1, Item 3).

d. PTE is calculated as follows: **Column D (PTE) = Column C (APQ) × Release Fraction** (see Section 3.2.2, Equation 2) with Release Fraction = 1.0E-03 (specified in Section 3.1, Item 5).

e. Dose factors were obtained from Table 4.4 in DOE/RL-2006-29, with an effective release height of less than 40 m (131 ft) (specified in Section 3.1, Item 6).

f. TEDE to the onsite MEI is calculated as follows: **Column G (Onsite TEDE) = Column D (PTE) × Column E (Onsite Dose Factor)** (Section 3.2.3, Eq. 3). TEDE to the onsite MEI is provided in accordance with the agreement reached between DOE-RL, EPA, and WDOH (AIR 00-1012).

g. TEDE to the offsite MEI is calculated as follows: **Column H (Offsite TEDE) = Column D (PTE) × Column F (Offsite Dose Factor)** (Section 3.2.3, Eq. 4).

3.5.2 Point Source Emissions Evaluation

To facilitate working in the building, an exhauster may be used to provide building ventilation for worker comfort as well as to control radon buildup. As a point source, controls to reduce (abate) radiological emissions utilizing high-efficiency particulate air filtration would be implemented. To estimate the portion of the overall PTE an exhauster would address, a supplemental calculation was performed. The calculation in Table 4 and Table 5 follows the Method 4: Measurement Upstream of Control Device described in Section 2.1.4 of DOE/RL-2006-29 and assumes that an upstream value of 10 derived air concentration (DAC) alpha or less would be maintained on average for worker safety with an exhauster flow rate of 10,000 ft³/min.

Using these inputs, the onsite TEDE to the MEI associated with the operation of the exhauster is 1.50E-02 mrem/yr, while the offsite TEDE to the MEI is 1.31E-02 mrem/yr. Both values are only 1% of the total values in Table 3. As the DAC and exhauster flow rate are directly proportional to the TEDE values to the MEI; the following are examples of outputs based on input variations:

- 1 DAC at 10,000 ft³/min is 1/10 of the calculated TEDE to the MEI
- 10 DAC at 20,000 ft³/min is twice the calculated TEDE to the MEI

TEDE to the onsite MEI is provided in accordance with the agreement reached between DOE-RL, EPA, and WDOH (AIR 00-1012, "New Onsite MEI").
--

Table 4. Exhauster PTE Calculation for the 224B Building – Based on alpha DAC Activity

A	B	C	D	E	F	G
Isotope (Ray Type)	Inventory ^a (Ci)	Percent of Inventory ^b	Percent of Inventory ^c		Activity at 3E-12 μCi/mL (α or β/γ) ^d (μCi/mL)	Activity at 10DAC Alpha ^e (μCi/ft ³)
			α	β/γ		
Pu-238 (β/γ)	2.69E+00	1.4	--	2.95	8.84E-14	2.50E-08
Pu-239/240 (α)	8.76E+01	45.6	87.0	--	2.61E-12	7.39E-07
Pu-241 (β/γ)	2.89E+01	15.0	--	31.6	9.49E-13	2.69E-07
Pu-242 (β/γ)	1.44E-03	0.001	--	0.0016	4.73E-17	1.34E-11
Am-241 (α)	1.31E+01	6.8	13.0	--	3.90E-13	1.11E-07
Cs-137 (β/γ)	2.47E+00	1.3	--	2.7	8.11E-14	2.30E-08
Sr-90 (β/γ)	4.86E+01	25.3	--	53.2	1.60E-12	4.52E-07
Co-60 (β/γ)	8.69E+00	4.5	--	9.5	2.85E-13	8.08E-08
Totals	1.92E+02	100	100	100	--	--

Reference: 10 CFR 20, “Standards for Protection Against Radiation,” Appendix B, “Annual Limits on Intake (ALIs) and Derived Air Concentrations (DACs) of Radionuclides for Occupational Exposure; Effluent Concentrations; Concentrations for Release to Sewerage.”

a. Inventory values as described in items 1 and 2 in Section 3.1.

b. Percent of Inventory is calculated as follows: **Column C = Column B ÷ Sum of Column B**

c. Percent of α or β/γ inventory is calculated as follows: Percent of α inventory = **Column C(α) ÷ Sum of Column C(α = 52.44%)**; Percent of β/γ inventory = **Column C(β/γ) ÷ Sum of Column C(β/γ = 47.56%)**.

d. Activity at 3E-12 μCi/mL total activity is calculated for both α and β/γ isotopes as follows: **Column F = Column D or E × 3E-12 μCi/mL**

The value of **3E-12 μCi/mL** is the DAC for **Pu-239, Pu-240, and Am-241** from Appendix B in 10 CFR 20. α DAC (3E-12 μCi/mL) assumed a mixture of Pu-239/240 (45.6%) and Am-241 (6.8%). Assumes that β/γ airborne will be approximately the same as the airborne concentration because β/γ isotopes are 47.6% of the total inventory.

e. It is assumed that working spaces to be ventilated would be ≤10 DAC alpha. Activity at 10 DAC alpha is calculated and units converted as follows: **Column G = Column F × 10 × CF1**, where CF1: 1 ft³ = 28,316.85 mL.

Table 5. Exhauster PTE Calculation for the 224B Building – PTE and TEDE to the MEI

A	B	C	D	E	F	G	H
Isotopes (ray type)	Activity at 10DAC alpha ^a (μCi/ft ³)	Exhauster Flow Rate ^b (ft ³ /min)	Release PTE ^c (Ci/yr)	Dose Factor ^d (mrem/yr per Ci/yr)		Exhauster TEDE (mrem/yr)	
				Onsite MEI	Offsite MEI	Onsite MEI ^e	Offsite MEI ^f
Pu-238 (β/γ)	2.50E-08	1.00E+04	1.32E-04	3.01E+00	2.55E+00	3.96E-04	3.35E-04
Pu-239/240 (α)	7.39E-07	1.00E+04	3.88E-03	3.28E+00	2.78E+00	1.27E-02	1.08E-02
Pu-241 (β/γ)	2.69E-07	1.00E+04	1.41E-03	6.00E-02	5.19E-02	8.48E-05	7.33E-05
Pu-242 (β/γ)	1.34E-11	1.00E+04	7.04E-08	3.11E+00	2.64E+00	2.19E-07	1.86E-07
Am-241 (α)	1.11E-07	1.00E+04	5.81E-04	2.71E+00	2.30E+00	1.57E-03	1.34E-03
Cs-137 (β/γ)	2.30E-08	1.00E+04	1.21E-04	1.46E-01	2.40E-01	1.76E-05	2.90E-05
Sr-90 (β/γ)	4.52E-07	1.00E+04	2.38E-03	3.96E-02	1.93E-01	9.41E-05	4.58E-04
Co-60 (β/γ)	8.08E-08	1.00E+04	4.25E-04	1.88E-01	1.68E-01	7.98E-05	7.13E-05
Totals						1.50E-02	1.31E-02

References: AIR 00-1012, “New Onsite MEI.”

DOE/RL-2006-29, *Calculating Potential-to-Emit Radiological Releases and Doses*.

a. Values repeated from column G in Table 4.

b. Assumed flow rate of exhauster.

c. Release PTE is calculated: **Column D = Column B × Column C × CF2 × CF3**, where CF2: 1 year = 525,600 min and CF3: 1 Ci = 1E+06 μCi.

d. Dose factors were obtained from Table 4.4 in DOE/RL-2006-29, , with an effective release height of less than 40 m (131 ft).

e. TEDE to the onsite MEI is calculated: **Column G = Column D × Column E**. TEDE to the onsite MEI is provided in accordance with the agreement reached between DOE-RL, EPA, and WDOH (AIR 00-1012).

f. TEDE to the Offsite MEI is calculated: **Column H = Column D × Column F**

DOE-RL = U.S. Department of Energy, Richland Operations Office

EPA = U.S. Environmental Protection Agency

MEI = maximally exposed individual

PTE = potential-to-emit

TEDE = total effective dose equivalent

WDOH = Washington State Department of Health

4 Criteria/Toxic Air Determination

This chapter documents the determination of criteria/toxic air emissions resulting from the removal action at the 224B Building. This determination supports DOE/RL-2017-33 and subsequent field work packages. The nonradioactive emissions resulting from this removal action will be fugitive particulate matter. Under WAC 173-400, “General Regulations for Air Pollution Sources,” and WAC 173-460, “Controls for New Sources of Toxic Air Pollutants,” requirements are established for the regulation of emissions of criteria and toxic air pollutants. In accordance with WAC 173-400-040, “General Standards for Maximum Emissions,” reasonable precautions must be taken to prevent the release of air contaminants associated with fugitive emissions resulting from materials handling, demolition, or other operations if criteria/toxic emissions are expected.

The chemical COCs for the 224B Building (Table 6) are based on process knowledge, historical analytical data, and agreement by the original data quality objectives team as documented in HNF-19589, *Data Quality Objectives Summary Report for D&D of the 224-B Facility*. The chemical contaminants identified in Table 6 were compared to WAC 173-460-150, “Table of ASIL, SQER and de Minimis Emission Values,” to identify regulated contaminants. Table 7 includes those chemicals from Table 6 that are regulated and their de minimis emission values. It is recognized that several process chemicals such as arsenic, cadmium, chromium, and beryllium have low de minimis values. As stated in Chapter 2, the process tanks, chemical scale tanks, and piping in 224B were rinsed, flushed, and drained during past decontamination and deactivation activities. Only minimal dried residuals remain in the process equipment, and because this equipment will not be handled in a manner to create emissions, no emissions in excess of the de minimis emission values are anticipated. The WAC provisions are applicable or relevant and appropriate requirements for this action.

Anions (bromide, fluoride, nitrate, nitrite, phosphate, and sulfate) ^a	Corrosives (acids and caustics), including:	
Asbestos fibers	• Ammonium sulfate, (NH ₄) ₂ SO ₄	• Oxalic acid, C ₂ H ₂ O ₄
Beryllium ^a	• Ammonium nitrate, NH ₄ NO ₃	• Phosphoric acid, H ₃ PO ₄
Lubricants/oils ^a	• Bismuth phosphate, BiPO ₄	• Potassium fluoride, KF
Metals (arsenic, barium, cadmium, chromium, hexavalent chromium ^a , lead, mercury, niobium, nickel, and silver)	• Chromium nitrate, Cr(NO ₃) ₃	• Potassium hydroxide, KOH
Polychlorinated biphenyls	• Hydrofluoric acid, HF	• Potassium nitrate, KNO ₃
Total inorganic carbon ^b	• Hydrogen peroxide, H ₂ O ₂	• Potassium permanganate, KMnO ₄
Total organic carbon ^{a,b}	• Lanthanum salts, La(NO ₃) ₃ •2NH ₄ NO ₃ •4H ₂ O	• Sodium bismuthate, NaBiO ₃
Total organic halides ^a	• Lanthanum fluoride, LaF ₃	• Sodium citrate, Na ₂ C ₆ H ₅ O ₇ •2H ₂ O
	• Lanthanum hydroxide, La(OH) ₃	• Sodium dichromate, Na ₂ Cr ₂ O ₇
	• Magnesium oxide, MgO	• Sodium hydroxide, NaOH
	• Magnesium nitrate, Mg(NO ₃) ₂	• Sodium nitrate, NaNO ₃
	• Manganese nitrate, Mn(NO ₃) ₂	• Sodium tartrate, Na ₂ C ₄ H ₄ O ₆ •2H ₂ O
	• Nitric acid, HNO ₃	• Sulfuric acid, H ₂ SO ₄

Reference: Tables 1-8, 1-17, and 1-18 in HNF-19589, *Data Quality Objectives Summary Report for D&D of the 224-B Facility*.

a. Constituents added to list in HNF-19589 based on additional document reviews.

b. Replaces carbon as a constituent.

Table 7. De Minimis Emission Values for 224B Building Chemicals

Name	CAS Number	De Minimis Emission*
Ammonium sulfate	7783-20-2	1.31E-02 lb/hr
Arsenic and inorganic arsenic compounds	--	2.91E-03 lb/yr
Asbestos	1332-21-4	1.53E-04 lb/yr
Beryllium and compounds, NOS	--	4.00E-03 lb/yr
Cadmium and compounds	7440-43-9	2.28E-03 lb/yr
Chromium (VI)	18540-29-9	6.40E-05 lb/yr
Fluoride-containing chemicals, NOS	--	8.54E-02 lb/day
Hydrogen fluoride	7664-39-3	9.20E-02 lb/day
Lead and compounds, NOS	--	1.00E+01 lb/yr
Manganese and compounds	--	2.63E-04 lb/day
Mercury, elemental	7439-97-6	5.91E-04 lb/day
Nitric acid	7697-37-2	9.42E-03 lb/hr
Phosphoric acid	7664-38-2	4.60E-02 lb/day
Polychlorinated biphenyls, NOS	1336-36-3	1.68E-02 lb/yr
Sodium hydroxide	1310-73-2	8.76E-04 lb/hr
Sulfuric acid	7664-93-9	6.57E-03 lb/day

*Values from WAC 173-460-150, "Table of ASIL, SQER and de Minimis Emission Values."

CAS = Chemical Abstracts Service

NOS = not otherwise specified

Polychlorinated biphenyls are associated with painted surfaces and electrical equipment (light ballasts) and are unlikely to become airborne due to the techniques employed during D&D. Toxic air requirements associated with asbestos-containing materials at the 224B Building will be addressed in accordance with applicable NESHAP requirements. An asbestos inspection will be performed by an *Asbestos Hazard Emergency Response Act of 1986*-certified building inspector and necessary abatement performed.

5 References

10 CFR 20, "Standards for Protection Against Radiation," Appendix B, "Annual Limits on Intake (ALIs) and Derived Air Concentrations (DACs) of Radionuclides for Occupational Exposure; Effluent Concentrations; Concentrations for Release to Sewerage," *Code of Federal Regulations*. Available at: <https://www.govinfo.gov/content/pkg/CFR-2017-title10-vol1/xml/CFR-2017-title10-vol1-part20-appB.xml>.

40 CFR 61, "National Emission Standards for Hazardous Air Pollutants," *Code of Federal Regulations*. Available at: <https://www.govinfo.gov/content/pkg/CFR-2010-title40-vol8/xml/CFR-2010-title40-vol8-part61.xml>.

Appendix D, "Methods for Estimating Radionuclide Emissions."

Subpart H, "National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities."

- AIR 00-1012, 2000, “New Onsite MEI” (letter to S.H. Wiseness, U.S. Department of Energy, Richland Operations Office, from A.W. Conklin), Washington State Department of Health, Olympia, Washington. October 18. Available at: <https://pdw.hanford.gov/document/AR-03321>
- Asbestos Hazard Emergency Response Act of 1986*, 15 USC 2641 et seq. Available at: <https://www.govinfo.gov/content/pkg/USCODE-2009-title15/html/USCODE-2009-title15-chap53-subchapII.htm>.
- CP-18179, 2016, *224-B Facility Documented Safety Analysis*, Rev. 9, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: <https://pdw.hanford.gov/document/AR-02791>.
- DOE/RL-91-50, 2013, *Hanford Site Environmental Monitoring Plan*, Rev. 6A, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=1503160460>.
- DOE/RL-2004-36, 2004, *Action Memorandum for the Non-Time Critical Removal Action for the 224-B Plutonium Concentration Facility*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D6731933>.
- DOE/RL-2006-29, 2016, *Calculating Potential-to-Emit Radiological Releases and Doses*, Rev. 2, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0072749H>.
- DOE/RL-2017-33, 2017, *Removal Action Work Plan for the 224B Plutonium Concentration Facility*, Draft A, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
- HNF-19589, 2004, *Data Quality Objectives Summary Report for D&D of the 224-B Facility*, Rev. 0, Fluor Hanford, Richland, Washington. Available at: <https://pdw.hanford.gov/document/0071512H>.
- SD-DD-TRP-002, 1985, *Radiological Characterization of the 224B Hot Cells*, Rev. 0, Rockwell Hanford Operations, Richland, Washington. Available at: <https://pdw.hanford.gov/document/D197083451>.
- WAC 173-400, “General Regulations for Air Pollution Sources,” *Washington Administrative Code*, Olympia, Washington. Available at: <http://apps.leg.wa.gov/WAC/default.aspx?cite=173-400>.
- 173-400-040, “General Standards for Maximum Emissions.”
- WAC 173-460, “Controls for New Sources of Toxic Air Pollutants,” *Washington Administrative Code*, Olympia, Washington. Available at: <http://apps.leg.wa.gov/WAC/default.aspx?cite=173-460>.
- 173-460-150, “Table of ASIL, SQER and de Minimis Emission Values.”
- WAC 246-221-060, “Radiation Protection Standards,” “Dose Limits for Individual Members of the Public,” *Washington Administrative Code*, Olympia, Washington. Available at: <http://apps.leg.wa.gov/WAC/default.aspx?cite=246-221-060>.
- WAC 246-247, “Radiation Protection—Air Emissions,” *Washington Administrative Code*, Olympia, Washington. Available at: <https://apps.leg.wa.gov/WAC/default.aspx?cite=246-247>.
- 247-030, “Definitions, Abbreviations, and Acronyms.”
- 247-075, “Monitoring, Testing, and Quality Assurance.”