ECF-Hanford-17-0042
Revision 0

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

P.O. Box 1600
Richland, Washington 99352

Approved for Public Release;
Further Dissemination Unlimited

ECF-Hanford-17-0042
Revision 0

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

C. Ervin
Freestone Environmental, Inc.

Date Published
October 2017

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

P.O. Box 1600
Richland, Washington 99352

APPROVED
By Erin C. Meegan at 7:08 am, Oct 25, 2017

Release Approval | Date

Approved for Public Release;
Further Dissemination Unlimited

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: KBO&PR

Date: 9/20/2017

Calculation Title & Description: Radiological and Toxic Air Emissions for the 224B Plutonium Concentration Facility

RELEASE / ISSUE

DATE: Oct 25, 2017 HANFORD RELEASE

Section 2: Completed by Preparer

Calculation No.: ECF-HANFORD-17-0042 **Revision No.:** 0

Revision History

Revision No.	Description	Date	Affected Pages ADD ROW
0	Initial Release		
	N/A		

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 & Approval

	Name /Position	Signature	Date
Preparer:	Carolyn Ervin, Senior Env. Engineer	CE Ervin	9/20/17
Checker:	John Young, Environmental Scientist		9/20/17
Senior Reviewer:	Richard Bloom, Frank Carleo		9/21/17 9/21/17
Responsible Manager:	George Jackson		9/26/17

Section 5: Applicable if calculation is a risk assessment or uses an environmental model

PRIOR TO INITIATING MODELING:

Required training for modelers completed:

	Name /Position	Signature	Date
Integration Lead			

Safety Software Approved:

	Name /Position	Signature	Date
Integration Lead			

CALCULATION APPROVED:

	Name /Position	Signature	Date
Risk/Modeling Integration Manager:			

A-6005-812 (REV 5)

This page intentionally left blank.

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 Material-at-Risk 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 Dose to the MEI 8

3.5.2 Point Source Emissions Evaluation 10

4 Criteria/Toxic Air Determination **10**

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 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 – Determine PTE and MEI 12

Table 6. Chemical Contaminants of Concern 13

Table 7. De Minimis Emission Values for 224B Building Chemicals 13

Terms

COC	contaminant of concern
D&D	decontamination and demolition
DAC	derived air concentration
ECF	environmental calculation file
MAR	material-at-risk
MEI	maximally exposed individual
NDA	nondestructive assay
NESHAP	"National Emission Standards for Hazardous Air Pollutants" (40 CFR 61)
NOS	not otherwise specified
PTE	potential-to-emit
RAWP	removal action work plan
SD	standard deviation

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). The ECF summarizes the assumptions, inputs, and methodology used to calculate the potential-to-emit (PTE) radionuclide airborne emissions and potential dose 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 Non-Time Critical Removal Action for the 224-B Plutonium Concentration Facility*.

The removal action for the 224B Building, as described in the RAWP, 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 224B Building is three stories high and is constructed of reinforced concrete and concrete block. The building is 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 starts 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 removal of product 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 may 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, and 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. The 224B vessels are tied to the B Plant main exhaust system via the stainless-steel ventilation headers that connect to a 61 cm (24 in.) underground clay ventilation line. The clay ventilation 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 to be less than 14.2 m^3/min (500 ft^3/min).

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

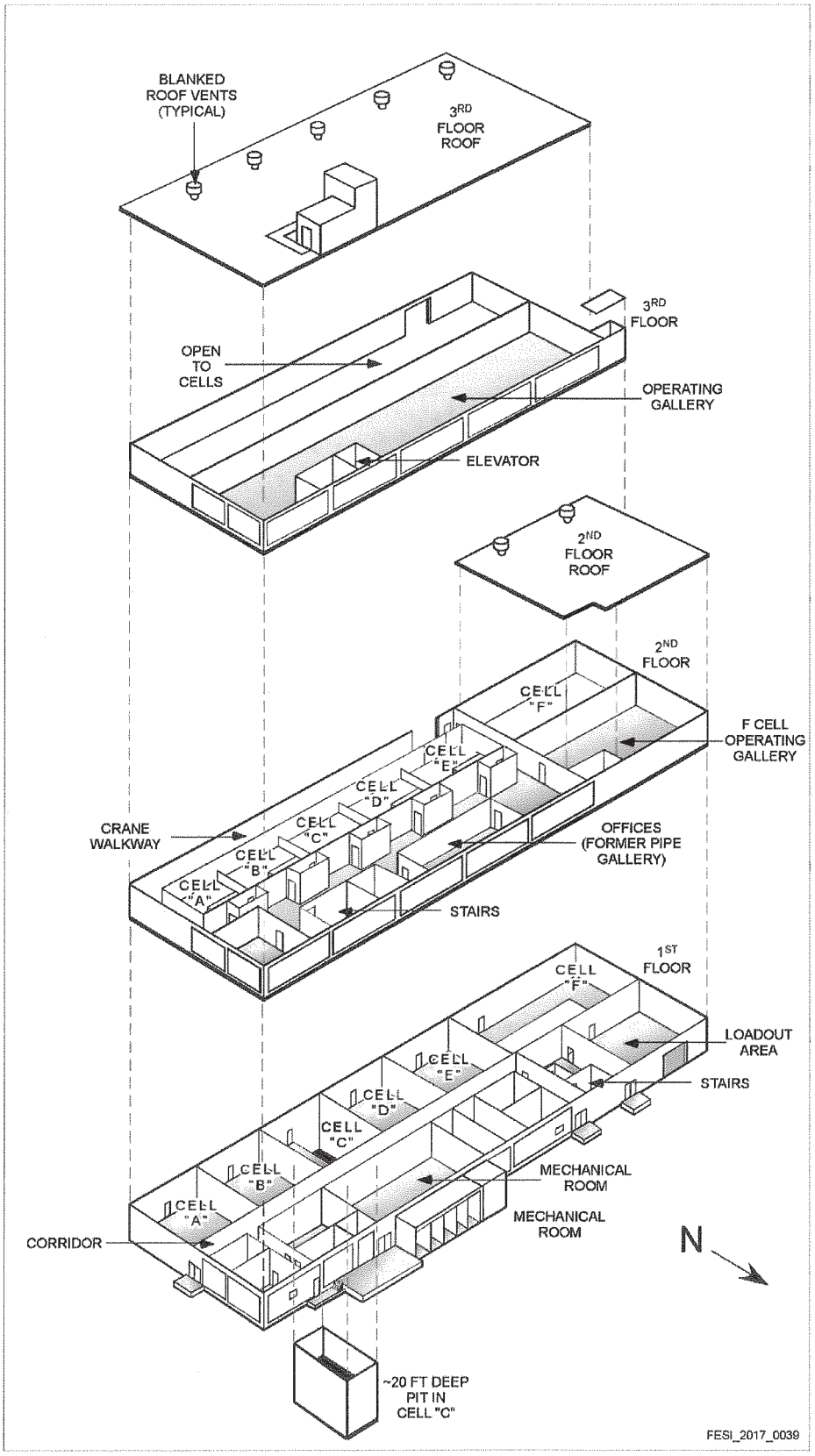

Figure 2. 224B Building – Exploded View

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 Program*. Near-facility ambient air monitoring stations N019, N481, N973, and N976 surround the B Plant Complex area and are planned to be utilized for monitoring during the removal action (Figure 3).

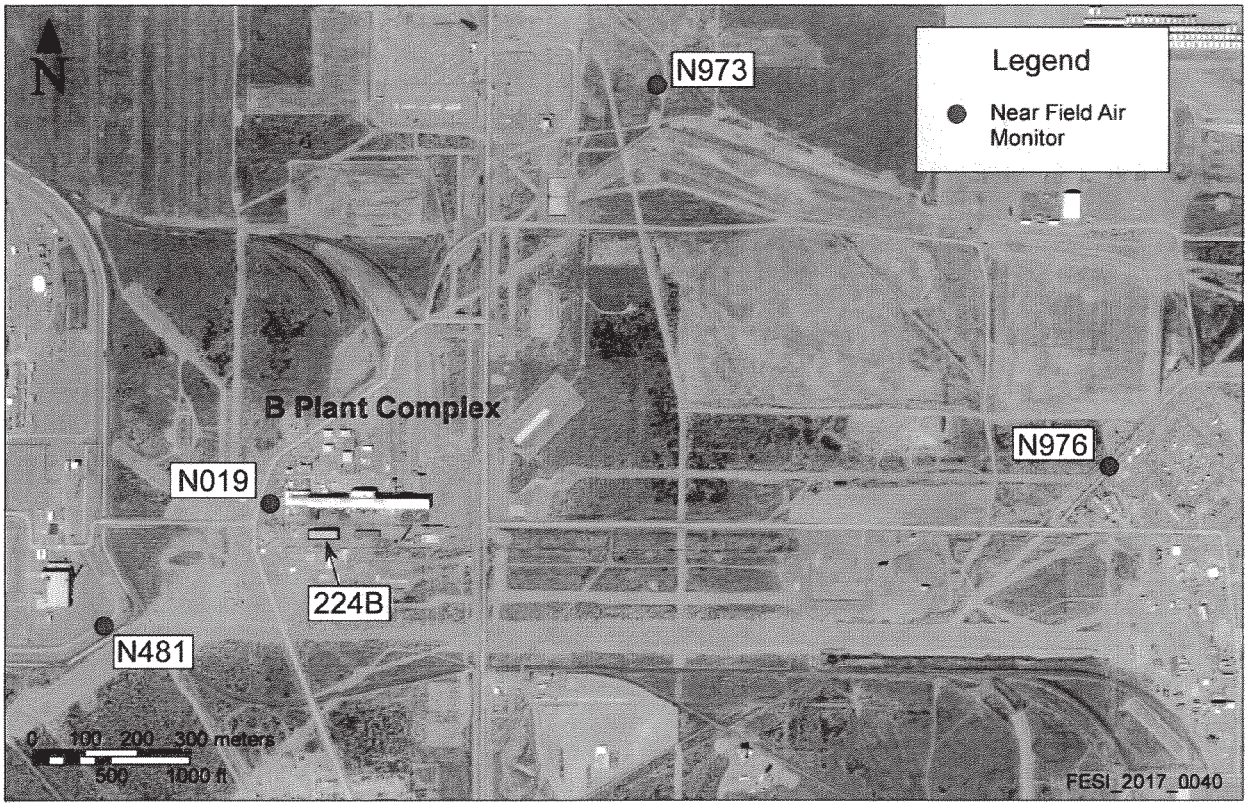

Figure 3. Near-Field Air Monitor Locations for the 224B Building

The methodology used to estimate the PTE is based upon the guidance document DOE/RL-2006-29, Rev. 2, *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 inventory within the process tanks and centrifuges accounts for about 95% of the total inventory (Hot Cell Characterization [SD-DD-TRP-002], Tables 4.1 and 4.2). CP-18179, *224-B Facility Documented Safety Analysis*, hereinafter called the Safety Analysis, calculated in 2008 a

bounding inventory for americium-241 and five plutonium isotopes (238 through 242) from the 1985 characterization results.

3.1 Assumptions and Inputs

This section provides the assumptions and inputs used to calculate PTE and the onsite/offsite doses to the MEI values 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: CP-18179, *224-B Facility Documented Safety Analysis*, Table B-8.

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×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 (Cs-137, Sr-90, and 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×SD), as stated in the Table 4.2 footnote. 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**

a. Values from Table 4.2 of SD-DD-TRP-002, *Radiological Characterization of the 224B Hot Cells*.

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 cobalt-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 material-at-risk (MAR) 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. It is assumed, for conservatism, that the entire MAR 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," as amended, and 40 CFR 61, "National Emission Standards for Hazardous Air Pollutants" (NESHAP), Appendix D, "Methods for Estimating Radionuclide Emissions."
6. The dose factors were taken from DOE/RL-2006-29, Rev. 2, Table 4.4, 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, Rev. 2. 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, Rev. 2.

Building radiological reports and process knowledge are used to estimate MAR, which is the assumed quantity of contamination present. The MAR 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, Rev. 2, are used to determine offsite and onsite doses to the MEI.

The calculation is outlined in the following steps:

1. Calculate the MAR (Section 3.2.1).
2. Determine PTE (Section 3.2.2).
3. Calculate offsite and onsite doses to the 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 Material-at-Risk

The MAR is measured as total activity in curies. The building activity (bounding inventory), as specified in Section 3.1, Items 1 and 2, is used to calculate the MAR, as shown in Equation 1. For the purposes of this calculation, the MAR 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:

$$\text{MAR } (Ci) = \text{Activity } (Ci) \times 4 \quad (1)$$

where:

MAR = material-at-risk
Activity = building activity
4 = conservatism multiplier

3.2.2 Potential-to-Emit

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

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

where PTE is potential-to-emit.

3.2.3 Dose to the Maximally Exposed Individual

The potential total onsite and offsite dose to the MEI are 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 potential onsite dose for the MEI for a single isotope is performed using Equation 3:

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

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

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

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 total potential dose for onsite and offsite MEIs by using the sum of potential air emission for all radiological COCs. The potential unabated dose to the onsite MEI is 1.35E+00 mrem/yr; the potential unabated dose to the offsite MEI is 1.17E+00 mrem/yr.

3.5 Radiological Air Emission Results

3.5.1 Unabated Diffuse and Fugitive Dose to the MEI

Potential radionuclide air emission estimates were calculated for the 224B Building removal action described in the RAWP (DOE/RL-2017-33). The resulting unabated onsite and offsite dose to the MEI are as follows:

- The potential dose equivalent to the onsite MEI is 1.35E+00 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.
- The potential dose equivalent to the offsite MEI is 1.17E+00 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 effective dose equivalent to the MEI emission values for the 224B Building are below the 10 mrem/yr ambient air NESHAP (40 CFR 61, Subpart H, "National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities"). They are also within compliance with WAC 246-221-060, "Radiation Protection Standards," "Dose Limits for Individual Members of the Public," which requires that the 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 Calculation for the 224B Building

A	B	C	D	E	F	G	H
Isotopes	Inventory[a,b] (Ci)	MAR[c] (Ci)	Unabated PTE[d] (Ci/yr)	Dose Factor[e] (mrem/yr per Ci/yr)		Unabated Dose (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**

a. Bounding inventory values for plutonium isotopes and Am-241 were obtained from CP-18179, *224-B Facility Documented Safety Analysis,* Table B-8 (as specified in Section 3.1, Item 1).

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

c. MAR is calculated: **Column C** (MAR) = **Column B** (Inventory) × **Conservatism Multiplier** (see Section 3.2.1, Equation 1)
• Conservatism Multiplier = 4 (as specified in Section 3.1, Item 3).

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

e. Dose factors were obtained from DOE/RL-2006-29, Rev. 2, *Calculating Potential-to-Emit Radiological Releases and Doses,* Table 4.4, with an effective release height of less than 40 m (131 ft) (as specified in Section 3.1, Item 6.).

f. Onsite MEI dose is calculated: **Column G** (Onsite Dose) = **Column D** (PTE) × **Column E** (Onsite Dose Factor) (see Section 3.2.3, Equation 3)

g. Offsite MEI dose is calculated: **Column H** (Offsite Dose) = **Column D** (PTE) × **Column F** (Offsite Dose Factor) (see Section 3.2.3, Equation 4)

3.5.2 Point Source Emissions Evaluation

To facilitate working in the building, an exhauster may be used to provide ventilation for the building 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 (Rev. 2), and assumes 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 ft^3/min.

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

- 1 DAC at 10,000 ft^3/min is 1/10 of the calculated unabated dose to the MEI
- 10 DAC at 20,000 ft^3/min is twice the calculated unabated dose to the MEI

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, 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. Because the process equipment will not be handled in a manner to create emissions, no emissions in excess of the de minimis emission values are anticipated.

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.

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

A	B	C	D	E	F	G
Isotopes (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 10 DAC alpha[e] (µCi/ft³)
			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%**		

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

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

c. Percent of α or β/γ inventory is calculated:
- 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: **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 10 CFR 20, Appendix B, "Annual Limits on Intake (ALIs) and Derived Air Concentrations (DACs) of Radionuclides for Occupational Exposure; Effluent Concentrations; Concentrations for Release to Sewerage."
- 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 since 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:
Column G = Column F × 10 × CF1
- CF1: 1 ft^3 = 28,316.85 mL

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

A	B	C	D	E	F	G	H
Isotopes (ray type)	**Activity at 10 DAC alpha[a] (μCi/ft³)**	**Exhauster Flow Rate[b] (ft³/min)**	**Release PTE[c] (Ci/yr)**	**Dose Factor[d] (mrem/yr per Ci/yr)**		**Exhauster Dose (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**

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**
- CF2: 1 year = 525,600 minutes
- CF3: 1 Ci = 1E+06 μCi

d. Dose factors were obtained from DOE/RL-2006-29, Rev. 2, *Calculating Potential-to-Emit Radiological Releases and Doses,* Table 4.4, with an effective release height of less than 40 m (131 ft).

e. Onsite MEI dose is calculated: **Column G = Column D × Column E**

f. Offsite MEI dose is calculated: **Column H = Column D × Column F**

Table 6. Chemical Contaminants of Concern

Anions (bromide, fluoride, nitrate, nitrite, phosphate, and sulfate)[a]	Corrosives (acids and caustics), including:
Asbestos fibers	• Ammonium sulfate, $(NH_4)_2SO_4$ • Ammonium nitrate, NH_4NO_3 • Bismuth phosphate, $BiPO_4$ • Chromium nitrate, $Cr(NO_3)_3$ • Hydrofluoric acid, HF • Hydrogen peroxide, H_2O_2 • Lanthanum salts, $La(NO_3)_3 \cdot 2NH_4NO_3 \cdot 4H_2O$ • Lanthanum fluoride, LaF_3 • Lanthanum hydroxide, $La(OH)_3$ • Magnesium oxide, MgO • Magnesium nitrate, $Mg(NO_3)_2$ • Manganese nitrate, $Mn(NO_3)_2$ • Nitric acid, HNO_3 • Oxalic acid, $C_2H_2O_4$ • Phosphoric acid, H_3PO_4 • Potassium fluoride, KF • Potassium hydroxide, KOH • Potassium nitrate, KNO_3 • Potassium permanganate, $KMnO_4$ • Sodium bismuthate, $NaBiO_3$ • Sodium citrate, $Na_2C_6H_5O_7 \cdot 2H_2O$ • Sodium dichromate, $Na_2Cr_2O_7$ • Sodium hydroxide, NaOH • Sodium nitrate, $NaNO_3$ • Sodium tartrate, $Na_2C_4H_4O_6 \cdot 2H_2O$ • Sulfuric acid, H_2SO_4
Beryllium[a]	
Lubricants/oils[a]	
Metals (arsenic, barium, cadmium, chromium, hexavalent chromium[a], lead, mercury, niobium, nickel, and silver)	
Polychlorinated biphenyls	
Total inorganic carbon[b]	
Total organic carbon[a,b]	
Total organic halides[a]	

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

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	Chemical Abstracts Service 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

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

Name	Chemical Abstracts Service Number	De Minimis Emission*
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."

NOS = not otherwise specified

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.gpo.gov/fdsys/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: http://www.gpo.gov/fdsys/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."

Asbestos Hazard Emergency Response Act of 1986, 15 USC 2614-2656, et seq. Available at: https://www.govtrack.us/congress/bills/99/s2083.

CP-18179, 2016, *224-B Facility Documented Safety Analysis*, Rev. 8, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0071513H.

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 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 pending, 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, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0071512H.

PRC-PRO-IRM-309, 2014, *Controlled Software Management*, Revision 5, Change 0, CH2M HILL Plateau Remediation Company, Richland, Washington.

SD-DD-TRP-002, 1985, *Radiological Characterization of the 224B Hot Cells*, Rev. 0, Rockwell Hanford Operations, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D197083451.

WAC 173-400-040, "General Regulations for Air Pollution Sources," "General Standards for Maximum Emissions," *Washington Administrative Code*, Olympia, Washington. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=173-400-040.

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.

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 246-247-030, "Radiation Protection—Air Emissions," "Definitions," *Washington Administrative Code*, Olympia, Washington. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=246-247-030.

This page intentionally left blank.