

Radiological and Toxic Air Emissions for the 224T 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

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ENVIRONMENTAL CALCULATION COVER PAGE

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ENVIRONMENTAL CALCULATION COVER PAGE (Continued)

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Contents

1	Introduction	1
2	Background	2
3	Radiological Air Emission Calculations	4
	3.1 Assumptions and Inputs	5
	3.2 Methodology	7
	3.2.1 Annual Possession Quantity	7
	3.2.2 Potential-to-Emit.....	8
	3.2.3 Total Effective Dose Equivalent to the Maximally Exposed Individual	8
	3.3 Software Applications	9
	3.4 Calculations	9
	3.5 Radiological Air Emission Results.....	9
	3.5.1 Unabated Diffuse and Fugitive TEDE to the MEI.....	10
	3.5.2 Point Source Emissions Evaluation	10
4	Criteria/Toxic Air Determination	11
5	References	13

Appendices

A	Hanford Meteorological Station Wind File and Wind Rose	A-i
B	Map Showing Distance to the Maximally Exposed Individual from the 224T Building	B-i
C	CAP88-PC Synopsis and Summary Reports for the 224T Building – Offsite Maximally Exposed Individual	C-i
D	CAP88-PC Synopsis and Summary Reports for the 224T Building – Onsite Maximally Exposed Individual	D-i
E	CAP88-PC Inputs for the 224T Building Exhauster	E-i
F	CAP88-PC Synopsis and Summary Reports for the 224T Building Exhauster – Offsite Maximally Exposed Individual	F-i
G	CAP88-PC Synopsis and Summary Reports for the 224T Building Exhauster – Onsite Maximally Exposed Individual	G-i

Figures

Figure 1.	224T Building Location within the T Plant Complex	1
Figure 2.	224T Building – Exploded View	3
Figure 3.	Near-Facility Air Monitoring Locations for the 224T Building	5

Tables

Table 1.	224T Building – Bounding Inventory (2009)	5
Table 2.	PTE Calculation for the 224T Building	9
Table 3.	Chemical Contaminants of Concern	11
Table 4.	De Minimis Emission Values for 224T Building Chemicals	12

Terms

APQ	annual possession quantity
D&D	decontamination and demolition
DOE	U.S. Department of Energy
DOE-RL	U.S. Department of Energy, Richland Operations Office
ECF	environmental calculation file
EPA	U.S. Environmental Protection Agency
HEPA	high-efficiency particulate air
LIGO	Laser Interferometer Gravitational-Wave Observatory
MEI	maximally exposed individual
NDA	nondestructive assay
NESHAP	National Emission Standards for Hazardous Air Pollutants
PNNL	Pacific Northwest National Laboratory
PTE	potential-to-emit
RAWP	removal action work plan
RCRA	<i>Resource Conservation and Recovery Act</i>
TEDE	total effective dose equivalent
TRUSAF	Transuranic Waste Storage and Assay Facility
WDOH	Washington State Department of Health

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1 Introduction

This environmental calculation file (ECF) provides air emission estimates for the removal action at the 224T Plutonium Concentration Facility (224T Building), located southeast of the 221T Building (T Plant) in the 200 West 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. The ECF was written to the calculation procedure PRC-PRO-EP-40205, *CHPRC Environmental Calculation Preparation and Issue*.



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

This ECF supports DOE/RL-2019-36, Draft A, *Removal Action Work Plan for the 224T Plutonium Concentration Facility* (hereinafter called the 224T Removal Action Work Plan [RAWP]), which implements decontamination and demolition (D&D). The removal activities outlined in the 224T RAWP will be performed in accordance with DOE/RL-2004-68, *Action Memorandum for the Non-Time Critical Removal Action for the 224-T Plutonium Concentration Facility*.

The removal action for the 224T Building, as described in the 224T RAWP, includes the following:

- 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
- 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 224T Building during the removal activities.

2 Background

Constructed in 1944, the 224T Building was used to purify and concentrate the plutonium nitrate solution that was produced in the first major step of the plutonium recovery process conducted at the 221T Separations Facility (T Plant). The concentrated plutonium nitrate solution was shipped from 224T to the 231Z Isolation Building in the 200 West Area for final purification and solidification. The resulting plutonium product was then sent offsite. Plutonium concentration operations at 224T were performed from January 1945 until early 1956, when 221T was retired from active service as a chemical processing facility. Operational reports from late 1956 and early 1957 indicate the process was shut down normally, and that process equipment and lines were flushed and drained.

The 224T Building is a three-story reinforced concrete structure that originally contained 21 rooms and 5 process cells, with a large operating gallery located on the third floor (Figure 2). A sixth process cell was constructed in 1950 to increase production. The building is 60 m (197 ft) wide and 18.3 m (60 ft) long and is divided along its length by a concrete wall into two main sections: a cold side to the northwest and a process side to the southeast that is sealed off from the cold side. The 224T Building was modified in 1975 to provide tornado and seismic resistance. In addition to these modifications, more upgrades were done. The cell access doors and viewing windows between the operating gallery and the hot cells were removed and filled with concrete. Minor upgrades were also performed on the electrical and service utilities and the heating, ventilation, and air-conditioning system. These modifications qualified the facility for storage of weapons-grade plutonium. In 1985, the building became the 224T Transuranic Waste Storage and Assay Facility (TRUSAF), permitted under the *Resource Conservation and Recovery Act* (RCRA), and operated in that capacity until the late 1990s.

As part of preparation for RCRA closure and D&D planned in the late 1990s, an assessment of the status of the tanks and lines in the building was performed. The assessment concluded that although documentation of tank and line draining and flushing did not exist, personnel accounts stated that these activities took place, and all external visual indications were that there were no liquids present in the equipment. TRUSAF was certified as clean closed in 2008.

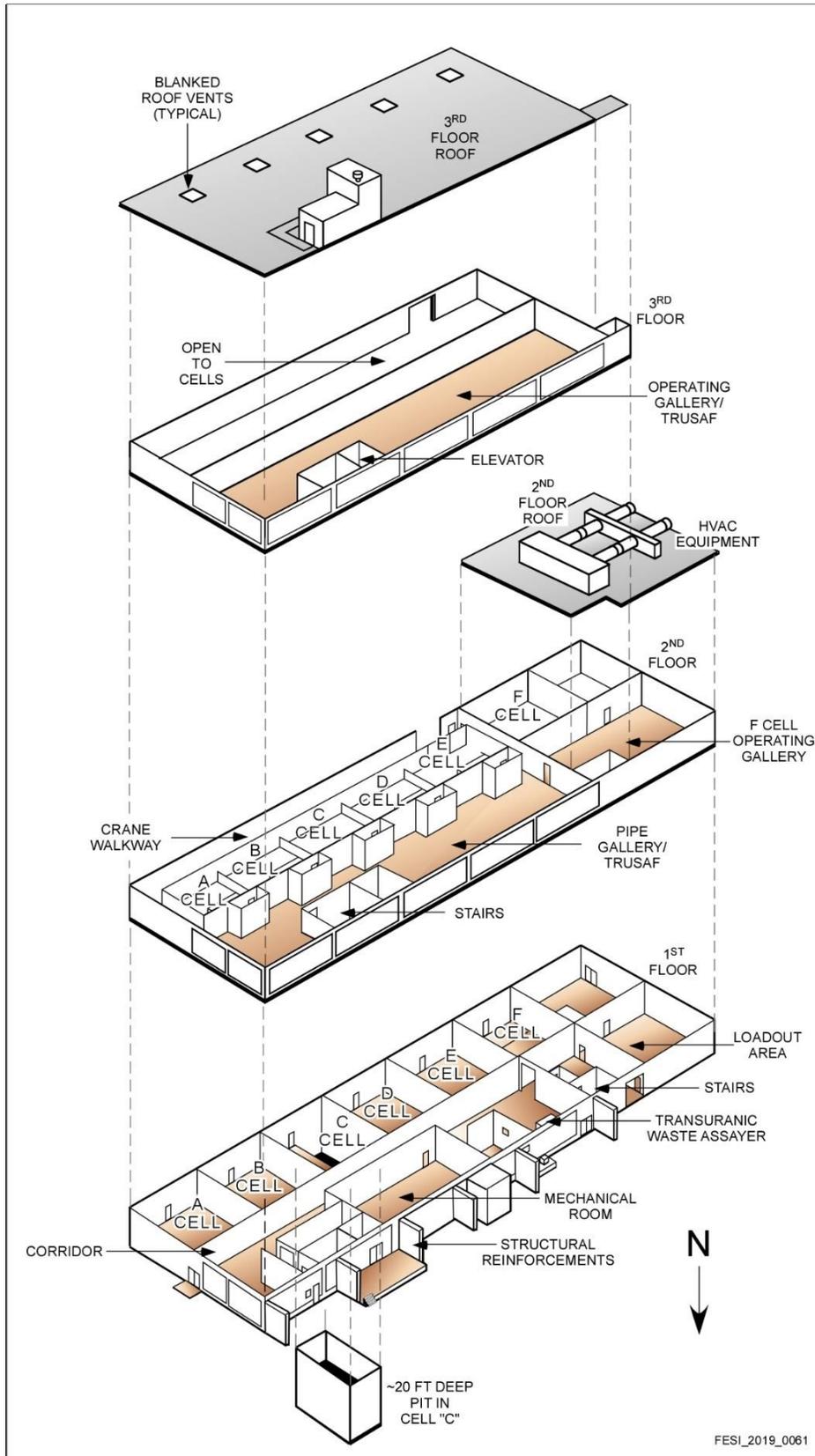


Figure 2. 224T Building – Exploded View

All 224T utilities, except electrical, have been deactivated. Originally, the T Plant (221T) main exhaust system provided ventilation to the 224T tanks and centrifuges with the vacuum created by the 291T fans. Air in-leakage provided the supply air to the process cells. Stainless-steel subheaders, connected to the tanks and centrifuges inside the cells, exit the southwest side of the building abovegrade. The stainless-steel headers are directed down and transition to a 15 cm (6 in.) clay pipe below ground level. The clay pipes connect to a 61 cm (24 in.) clay main header belowgrade. The 61 cm (24 in.) line connects to the 221T main exhaust tunnel at the west end of the 221T Building. In areas where the original soil cover was less than 1.2 m (4 ft) or greater than 2.1 m (7 ft) deep, the clay pipe is protected by a reinforced concrete encasement. The ventilation system was modified when 224T was converted to a storage facility. All ventilation penetrations between the cells and storage area were sealed to prevent the migration of contamination from the cells into the TRUSAF area. This included isolation of the 224T TRUSAF exhaust system from 221T, sealing of the interconnecting process pipe tunnel, replacement of a significant portion of the asbestos cement ducting with new metal ducting, and installation of the new ventilation system with high-efficiency particulate air filters and turbine fans. The filters and turbine fans were installed on the roof above F Cell with two stacks that exhaust horizontally to the southwest. These stacks have been capped. The 224T Building exhaust ventilation system is not in service. The flow from the sealed 224T process cells through the clay ventilation line to 221T is believed to be minimal.

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

3 Radiological Air Emission Calculations

The potential for radiological release exists at the 224T 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 224T 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 N161, N304, N456, N931, and N994 are upwind and downwind of the T Plant Complex area and are planned to be utilized for monitoring during the removal action (Figure 3).

Revision 1 of this calculation incorporates the use of CAP88-PC¹ software to calculate the TEDE to the MEI. 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 224T process cells was performed in 2001 and 2002 to support D&D activities. The results of the nondestructive assay (NDA) efforts are documented in CP-14641, *Documented Safety Analysis for the 224-T Facility*, hereinafter called the Safety Analysis, which calculated in 2009 a bounding inventory for americium-241 (Am-241) and five plutonium (Pu) isotopes (238 through 242) from the 2001 and 2002 NDA characterization results.

¹ The CAP-88 (which stands for *Clean Air Act Assessment Package-1988*) computer model is a set of computer programs, databases, and associated utility programs for estimation of dose and risk from radionuclide emissions to air. CAP-88 is a regulatory compliance tool under 40 CFR 61, "National Emission Standards for Hazardous Air Pollutants." CAP88-PC (Version 4.0) allows modeling on a personal computer and is a recent version of the code.

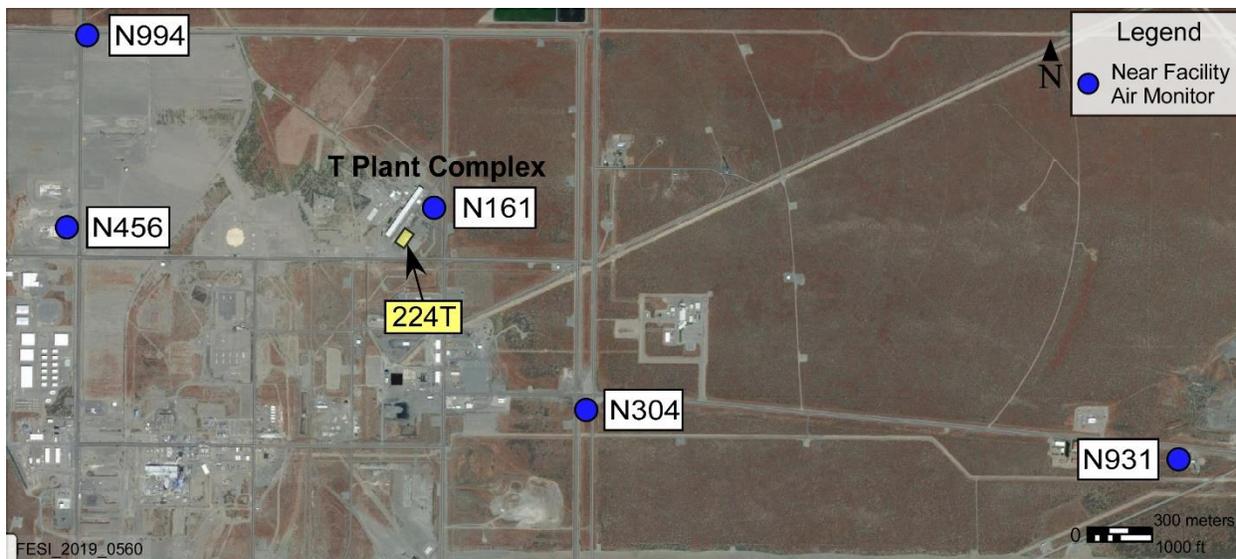


Figure 3. Near-Facility Air Monitoring Locations for the 224T Building

3.1 Assumptions and Inputs

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

1. Inventory values in Table 1 for the Pu isotopes (238 through 242) and Am-241 were obtained from the Safety Analysis (CP-14641).

Table 1. 224T Building – Bounding Inventory (2009)

Isotope	Mass (g)	Curies (Ci)
Pu-238	1.43E-02	2.45E-01
Pu-239	7.08E+01	4.39E+00
Pu-240	4.63E+00	1.05E+00
Pu-241	1.84E-01	1.89E+01
Pu-242	2.27E-02	8.93E-05
Am-241	8.37E+00	2.87E+01
Total	8.40E+01	5.33+01

Reference: Tables 3-3 and C-6 in CP-14641, *Documented Safety Analysis for the 224-T Facility*.

The Safety Analysis (CP-14641) values were calculated from the NDA measurements performed by Pacific Northwest National Laboratory (PNNL) in late 2001 and 2002 (PNNL, 2002a, “224-T Nondestructive Assay of Tanks in Cells A thru F”; and PNNL, 2002b, “NDA Summary Report”). PNNL provided gram quantity estimates for Pu-239 and activity estimates (in curies) for Am-241 for

tanks and centrifuges in the 224T Building. Values were reported as “measured” mass (or activity), “1 sigma” mass (or activity) and “1.96 sigma” mass (or activity), where the latter value is at the upper limit of the 95 percent confidence interval on the measurement (based solely on counting statistics). Only the data associated with plutonium and americium holdup are presented in the Safety Analysis and used to determine the dose consequences. This is appropriate since the quantities of other isotopes are negligible (Section 3.2 in CP-14641).

For the Safety Analysis, the reported data for 1.96 sigma values were analyzed to obtain a conservative estimate of the plutonium and americium inventory for tanks, centrifuges, and other miscellaneous items in the 224T Building. It was assumed that the distribution of the other plutonium isotopes expected to be present was the same as the distribution identified in PNNL, 2002b. Inferred values for Pu-238, Pu-240, Pu-241, and Pu-242 were calculated and added to the inventory. Inventory values were then decay corrected to 2009 values. Appendix C of the Safety Analysis (CP-14641) provides a more detailed description of this process.

Am-241 is the decay daughter product of Pu-241 and its inventory can increase over time. The maximum Am-241 inventory (occurring from ingrowth from Pu-241) occurs 73 years after generation. This maximum value was calculated in Appendix C of the Safety Analysis (CP-14641) and is used in this calculation.

The inventory in Table 1 and its conservatisms are assumed to address the soil inventory around and under the 224T slab. This assumption will be monitored if extensive contamination is found around or below the slab.

2. The C Cell deep pit was flooded with water at the time of the NDA surveys, but these NDA results include estimates of the total inventory (plutonium and americium) of the submerged tanks (C-4, C-7, and C-9) that could not be surveyed. A conservative estimate of their plutonium and Am-241 content was obtained by taking the largest measured plutonium and Am-241 values for a tank of the same general size as the submerged tank (CP-14641). This, combined with the inclusion of the 1.96 sigma values, is judged to be sufficiently conservative so that the annual possession quantity (APQ) for 224T used in the calculations will be equal to the inventory values from Table 1.
3. The D&D activities described in the 224T RAWP (DOE/RL-2019-36, Draft A) may be conducted over several years. For conservatism, it is assumed that the APQ is available for release within a 1-year period.
4. 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).
5. The following assumptions apply to the CAP88-PC model runs:
 - a. The lid is the inner layer of the atmosphere, within which there is normally a steady decrease of temperature with increasing altitude. Nearly all clouds form and weather conditions manifest themselves within this region. Its thermal structure is caused primarily by the heating of the earth’s surface by solar radiation, followed by heat transfer through turbulent mixing and convection. The height of lid (1,000 m) is the rounded average of winter and summer mean afternoon mixing heights (500 and 2,000 m respectively) for southeastern Washington, as shown on pages 32 and 34 of Holzworth, 1972, *Mixing Heights, Wind Speeds, and Potential for Urban Air Pollution Throughout the Contiguous United States*.

- b. 18.13 cm is the average annual precipitation for the Hanford Site from 1945 to 2018 as reported in Table 1-1 of DOE/RL-2019-33, *Hanford Site Environmental Report for Calendar Year 2018*.
- c. 12.2°C is the average annual temperature for the Hanford Site from 1945 to 2018 as reported in Table 1-1 of DOE/RL-2019-33.
- d. The CAP88-PC default value for humidity of 8 g/m³ was used. This value compares well to Hanford Site-specific historical data.
- e. Radionuclide decay chains were limited to five (a CAP88-PC default).
- f. Build-up time was set to 50 years consistent with Attachment 9, Exhibit 1, of DOE/RL-2007-53, *Methods for Calculating Doses to Demonstrate Compliance with Air Pathway Radiation Dose Standards at the Hanford Site*.
- g. The area source is based on the footprint of 224T, 60 m (197 ft) wide and 18.3 m (60 ft) long, which equals an area of 1,098 m² (11,820 ft²). As discussed in Trinity, 2014, *CAP88-PC Version 4.0 User Guide*, the ratio of distance to the receptor/source diameter is greater than 2.5; therefore, CAP88-PC automatically models the area source as a point source. CAP88-PC automatically assumes the source is a circular area and calculates a source diameter as follows:

$$1,098 \text{ m}^2 = (\text{Diameter}/2)^2 (\pi)$$

The source diameter is calculated as 37.4 m (122.7 ft), which is far less than the distance to the MEI determined to be 24,278 m (79,642 ft) away at the Hanford Site boundary. Thus, the CAP88-PC code assumes the source to be a point source.

3.2 Methodology

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 224T Building removal action. The PTE is used to determine the TEDE to the offsite and onsite MEI.

The process is outlined in the following steps:

1. Determine the APQ (Section 3.2.1).
2. Calculate the 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.

3.2.1 Annual Possession Quantity

The APQ is measured as total annual activity in curies. The building activity (bounding inventory), as specified in Section 3.1, Item 1, is equal to the APQ (as specified in Section 3.1, Item 2), divided by the 1-year project duration (as described in Section 3.1, Item 3), as shown in Equation 1.

$$\text{APQ} \left(\frac{\text{Ci}}{\text{yr}} \right) = \frac{\text{Activity (Ci)}}{1 \text{ year}} \quad (\text{Eq. 1})$$

where:

APQ = annual possession quantity

Activity = building activity.

3.2.2 Potential-to-Emit

The PTE is calculated using the APQ and a release fraction, in accordance with NESHAP (Appendix D in 40 CFR 61). APQ is multiplied by a unitless release fraction of 1.0E-03 (as described in Section 3.1, Item 4). Equation 2 shows this process.

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

where:

PTE is potential-to-emit.

3.2.3 Total Effective Dose Equivalent to the Maximally Exposed Individual

CAP88-PC, Version 4.0.1.17, was used to calculate the dose to the MEI using the PTE values calculated in Section 3.4 for each radionuclide as inputs into the CAP88-PC model run. Some of the model inputs are identified in Section 3.1, Item 5; the remainder are explained below.

A Hanford Site-specific wind file for the Hanford Meteorological Station (a13200H10.wnd) was used in the CAP88-PC model runs and is shown in Appendix A in this ECF. The Hanford Meteorological Station (Station #21) is located east of 224T between the 200 East and 200 West Areas. The wind file is based on average data collected at Station #21 between 2004 and 2013 at the 10 m (33 ft) level. A wind rose for this data range is also included in Appendix A.

The distances that are used in the CAP88-PC model run are shown in Appendix B in this ECF. In accordance with WAC 246-247-030(15), the MEI is any member of the public (real or hypothetical) who abides or resides in an unrestricted area, and may receive the highest TEDE from the emission unit(s) under remediation, taking into account all exposure pathways by the radioactive emissions. For the purposes of this calculation, the MEI was assumed to be located at the Hanford Site boundary at a compass bearing from the source that yielded the highest dose from all air pathways, as computed by the CAP88-PC program. The exception to this is where the Columbia River defines the eastern site boundary, hence the east bank is chosen as the closest habitable location. Also, as directed by Washington State Department of Health (WDOH), the Laser Interferometer Gravitational-Wave Observatory (LIGO) and the Energy Northwest Columbia Generating Station are considered onsite for the purpose of determining the location of the MEI. Distances to the site boundary were computed using the Hanford Geographic Information System. The southern boundary on the map shown in Appendix B reflects land that was transferred on September 30, 2015 from the U.S. Department of Energy (DOE) to the Tri-City Development Council.

Distances to the site boundary in 16 compass directions are input into one CAP88-PC model to show the dose at the site boundary in all directions. A separate CAP88-PC model was created using the distances to other potential non-DOE-related business locations (i.e., LIGO and the Energy Northwest Columbia Generating Station). In both cases, CAP88-PC automatically calculates the “individual effective dose equivalent” for each distance in all directions (see CAP88-PC model runs in Appendices C and D in this ECF). By default, CAP88-PC will take the maximum “individual effective dose equivalent” regardless of direction or distance and use it as the basis for the dose to the MEI and report it as the “effective dose equivalent” in the nuclide-specific dose equivalent summary. This results in the maximum “individual effective dose equivalent” selected from the matrix of individual effective dose equivalents at a location that is not on the site boundary or other non-DOE-related business location. To determine the maximum effective dose equivalent at the site boundary or non-DOE-related business location, a review of the CAP88-PC summary reports (Appendices C and D) is conducted to determine which of the 16 compass

directions at the site boundary or non-DOE-related business location distance inputs result in the maximum “individual effective dose equivalent.”

3.3 Software Applications

CAP88-PC, Version 4.0.1.17 was used to calculate the effective dose equivalent to the MEI. Software quality assurance of CAP88-PC, Version 4.0.1.17, is addressed by CHPRC-03392, *Clean Air Act Assessment Package-1988 – Combined Software Management Plan*.

3.4 Calculations

Table 2 provides the APQ and PTE calculations for the 224T Building radiological contaminants of concern. These calculations follow the methodology described in Section 3.2, using the assumptions and inputs stated in Section 3.1. The unabated PTE values in Column D of Table 2 are the source inputs for the CAP88-PC models (Appendices C and D).

Table 2. PTE Calculation for the 224T Building

A	B	C	D
Isotope	Bounding Inventory^a (Ci)	APQ^b (Ci/yr)	Unabated PTE^c (Ci/yr)
Pu-238	2.45E-01	2.45E-01	2.45E-04
Pu-239	4.39E+00	4.39E+00	4.39E-03
Pu-240	1.05E+00	1.05E+00	1.05E-03
Pu-241	1.89E+01	1.89E+01	1.89E-02
Pu-242	8.93E-05	8.93E-05	8.93E-08
Am-241	2.87E+01	2.87E+01	2.87E-02
Totals	5.33E+01	5.33E+01	5.33E-02

a. Bounding inventory values for plutonium isotopes and Am-241 were obtained from Table 3-3 in CP-14641, *Documented Safety Analysis for the 224-T Facility*.

b. APQ is calculated: **Column C (APQ) = Column B (Inventory) / Duration**

- Duration = 1 year

c. PTE is calculated: **Column D (PTE) = Column C (APQ) × Release Fraction**

- Release Fraction = 1.0E-03

APQ = annual possession quantity

PTE = potential-to-emit

3.5 Radiological Air Emission Results

Potential radionuclide air emission estimates were calculated for the 224T Building removal action described in the 224T RAWP (DOE/RL-2019-36, Draft A).

3.5.1 Unabated Diffuse and Fugitive TEDE to the MEI

Potential radionuclide air emission estimates were calculated by CAP88-PC for the 224T Building removal action described in the 224T RAWP (DOE/RL-2019-36, Draft A). The resulting unabated TEDE to the MEI are as follows:

- The unabated TEDE to the offsite MEI is 3.12E-02 mrem/yr (Appendix C). The offsite MEI is located at the Hanford Site boundary at 24,278 m (15.1 mi) east-northeast of the 224T Building.
- The unabated TEDE to the onsite MEI is 7.80E-02 mrem/yr (Appendix D). The onsite MEI is located at LIGO, which is 15,791 m (9.8 mi) east-southeast of the 224T Building.

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

As determined by the above calculations, the TEDE to the MEIs for the 224T Building are below the 0.1 mrem/yr limit in WAC 246-247-075, "Monitoring, Testing, and Quality Assurance," that requires continuous monitoring of radionuclide emissions, and below the 10 mrem/yr ambient air requirement in 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.

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 (HEPA) filtration would be implemented. To estimate the portion of the overall PTE an exhauster would address, a supplemental calculation was performed. Exhauster emissions were modeled using CAP88-PC assuming an upstream value of 1 derived air concentration or less would be maintained on average for worker safety with an exhauster flow rate of 20,000 ft³/min (model inputs are captured in Appendix E). The calculations discussed below provide values with and without abatement technology.

Using these inputs, the unabated offsite TEDE to the MEI is 7.62E-03 mrem/yr (Appendix F) while the unabated onsite TEDE to the MEI associated with the operation of the exhauster is 1.86E-02 mrem/yr (Appendix G). Both values are less than 25 percent of the values in Section 3.5.1. Assuming a conservative 99 percent HEPA filter efficiency, the abated offsite TEDE to the MEI is 7.62E-05 mrem/yr and the abated onsite TEDE to the MEI is 1.86E-04 mrem/yr.

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

4 Criteria/Toxic Air Determination

This chapter documents the determination of criteria/toxic air emissions resulting from the removal action at the 224T Building. This determination supports the 224T RAWP (DOE/RL-2019-36, Draft A) 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 contaminants of concern for the 224T Building (Table 3) are based on process knowledge, historical analytical data, and agreement by the original data quality objectives team, as documented in HNF-19646, *Data Quality Objectives Summary Report for the 224-T Plutonium Concentration Facility*, and DOE/RL-2019-37, Draft A, *Sampling and Analysis Plan for the 224T Plutonium Concentration Facility*. The chemical contaminants identified in Table 3 were compared to WAC 173-460-150, “Table of ASIL, SQER and de Minimis Emission Values” to identify regulated contaminants. Table 4 includes those chemicals from Table 3 that are regulated and their de minimis emission values.

Table 3. Chemical Contaminants of Concern

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

Reference: DOE/RL-2019-37, *Sampling and Analysis Plan for the 224T Plutonium Concentration Facility*, Table 1-5.

Table 4. De Minimis Emission Values for 224T Building Chemicals

Name	Chemical Abstracts Service Number	De Minimis Emission *
Arsenic and inorganic arsenic compounds, NOS	—	2.5E-03 lb/yr
Asbestos	1332-21-4	3.5E-05 fibers/cm ³ /yr
Barium chromate	10294-40-3	1.6E-04 lb/yr
Beryllium and compounds, NOS	—	3.4E-03 lb/yr
Cadmium and compounds, NOS	—	1.9E-03 lb/yr
Chromium(III), insoluble particulates, NOS	—	1.9E-02 lb/day
Chromium(III), soluble particulates, NOS	—	3.7E-04 lb/day
Chromium(VI) & compounds, NOS	—	3.3E-05 lb/yr
Fluorides (fluoride containing chemicals), NOS	—	4.8E-02 lb/day
Hydrogen fluoride	7664-39-3	5.2E-02 lb/day
Lead and compounds, NOS	—	1.0E+01 lb/yr
Manganese and compounds	—	1.1E-03 lb/day
Mercury, elemental	7439-97-6	1.1E-04 lb/day
Nickel and compounds, NOS	—	3.1E-02 lb/yr
Nitric acid	7697-37-2	8.0E-03 lb/hr
Phosphoric acid	7664-38-2	2.6E-02 lb/day
Polychlorinated biphenyls, NOS	1336-36-3	1.4E-02 lb/yr
Sodium hydroxide	1310-73-2	7.4E-04 lb/hr
Sulfuric acid	7664-93-9	3.7E-03 lb/day

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

NOS = not otherwise specified

It is recognized that several process chemicals, such as arsenic, cadmium, and chromium have low de minimis values. The toxic contaminants of concern historically at the Hanford Site are those with vapor pressures of greater than 1 mmHg at ambient temperature (20°C [68°F]). This means that metals and mercury should be considered nonvolatile at room temperature (i.e., will not produce any toxic emissions during the work) and below the WAC 173-460-150 de minimis threshold. Nitric acid and sodium hydroxide (vapor pressures greater than 1 mmHg at ambient temperature) could have some emissions if any liquid is left and exposed to ambient air. As stated in Chapter 2 of this ECF, the process tanks, chemical scale tanks, and piping in 224T were flushed and drained during past decontamination and deactivation activities. Only minimal dried residuals are expected to remain in the process equipment. The chemical scale tanks and associated piping were removed during building modifications to support

plutonium storage. This greatly reduced the potential chemical inventory within the building. Remaining tanks and piping would not be removed in such a manner to create emissions (e.g., crimping of piping, cutting tanks/piping in secondary containment). Emissions exceeding the de minimis values in WAC 173-460-150 are not anticipated from 224T due to the reduced chemical inventory combined with standard work practices. The WAC provisions are applicable or relevant and appropriate requirements for this action.

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 224T Building will be addressed in accordance with applicable NESHAP requirements. A thorough asbestos NESHAP inspection will be performed by an *Asbestos Hazard Emergency Response Act of 1986*-certified building inspector prior to abatement activities.

5 References

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Appendix A

Hanford Meteorological Station Wind File and Wind Rose

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0.000
 0.035 0.037 0.042 0.034 0.028 0.025 0.030 0.034 0.041 0.060 0.159 0.150 0.108 0.103 0.072 0.041
 1.75 1.82 2.02 1.91 1.95 1.82 2.03 2.22 2.22 2.27 3.71 3.27 2.72 3.70 3.25 2.04
 1.74 1.73 1.94 1.85 1.60 1.45 1.67 1.77 1.87 2.08 2.94 2.48 2.27 2.90 2.62 1.99
 1.84 1.67 1.75 1.60 1.42 1.49 1.34 1.46 1.75 2.03 2.82 2.64 2.29 3.05 2.88 1.90
 1.58 1.44 1.49 1.38 1.27 1.19 1.23 1.31 1.37 1.57 2.50 2.47 2.13 2.73 2.70 2.07
 1.56 1.47 1.42 1.33 1.28 1.25 1.24 1.30 1.26 1.45 2.57 2.77 2.35 2.29 2.28 1.78
 1.43 1.63 1.43 1.16 1.14 1.09 1.05 1.08 1.12 1.35 1.99 2.10 2.00 1.97 1.65 1.42
 1.56 1.63 1.40 1.08 1.10 1.09 0.95 1.03 1.05 1.29 2.00 2.12 1.89 2.13 1.89 1.71
 2.35 2.38 2.55 2.42 2.50 2.51 3.05 3.12 2.94 3.07 5.09 4.78 4.42 5.44 4.73 2.92
 2.52 2.37 2.50 2.38 2.17 1.97 2.36 2.53 2.53 2.61 4.05 3.90 3.56 4.61 4.29 2.85
 2.59 2.23 2.37 2.22 2.05 2.03 2.00 2.16 2.42 2.64 4.00 3.90 3.62 4.65 4.56 2.86
 2.64 2.16 2.06 1.92 1.76 1.69 2.03 2.03 2.00 2.20 3.82 3.86 3.53 4.64 4.87 3.90
 2.77 2.33 2.01 1.81 1.76 2.03 2.21 2.19 1.82 2.10 3.92 3.85 3.26 3.60 4.13 3.44
 1.96 2.19 1.91 1.51 1.48 1.44 1.29 1.35 1.48 1.83 2.59 2.61 2.51 2.52 2.25 1.93
 2.03 2.13 1.85 1.36 1.39 1.37 1.07 1.24 1.30 1.71 2.57 2.56 2.35 2.55 2.35 2.21
 0.0914 0.0486 0.0429 0.1829 0.2857 0.2514 0.0971
 0.0976 0.0461 0.0434 0.1951 0.2791 0.2385 0.1003
 0.1325 0.0699 0.0675 0.2506 0.2554 0.1711 0.0530
 0.1701 0.0896 0.0925 0.2746 0.2179 0.1104 0.0448
 0.1731 0.1131 0.0989 0.2827 0.1873 0.0954 0.0495
 0.1833 0.1116 0.0996 0.2908 0.1673 0.1036 0.0438
 0.2072 0.1020 0.1086 0.3289 0.1480 0.0724 0.0329
 0.2267 0.1105 0.1134 0.2994 0.1541 0.0669 0.0291
 0.1898 0.1022 0.1095 0.3066 0.1655 0.0949 0.0316
 0.1426 0.0796 0.0896 0.3134 0.1940 0.1310 0.0498
 0.1217 0.0471 0.0521 0.2528 0.3049 0.1631 0.0583
 0.0686 0.0246 0.0266 0.1738 0.4148 0.2170 0.0746
 0.0474 0.0241 0.0251 0.1309 0.4067 0.2869 0.0789
 0.0962 0.0398 0.0398 0.1555 0.3100 0.2614 0.0972
 0.1082 0.0499 0.0485 0.1803 0.3121 0.2219 0.0791
 0.0815 0.0444 0.0469 0.1802 0.3235 0.2370 0.0864

extended data

200 HMS (Station 21) - 10 M - Pasquill A - G (2004-13)

State=WA

Latitude=46.563

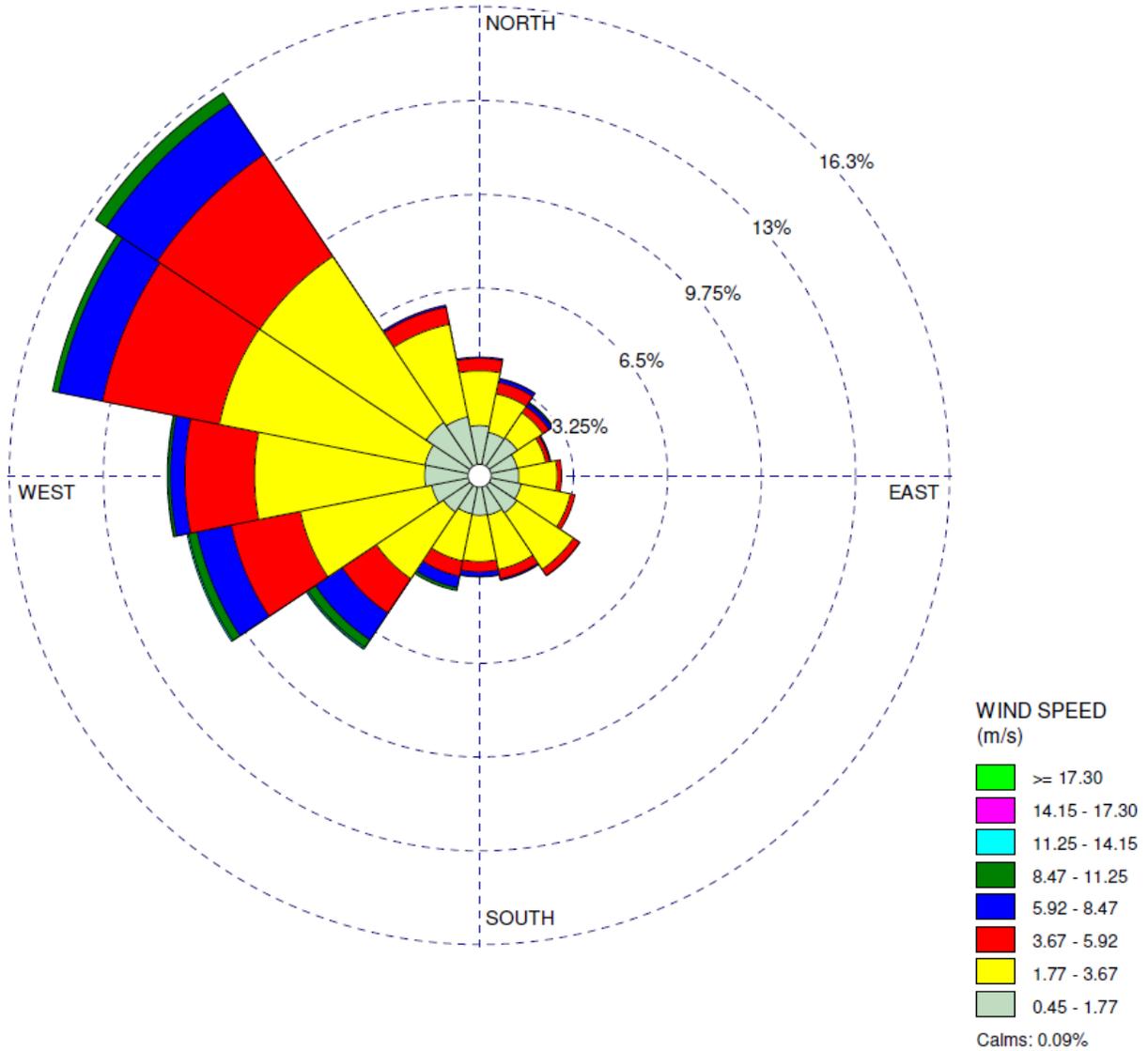
Longitude=-119.599

TimeZone=8

RecordPeriod=2004-2013

AveragePeriodTemperature=12.01

Comments=Formatted 10/12/15 SFS, Created Aug2014 KWB; Windspeed Classes (m/s): .89 2.65 4.7
 7.15 9.8 12.7 15.6 19.0



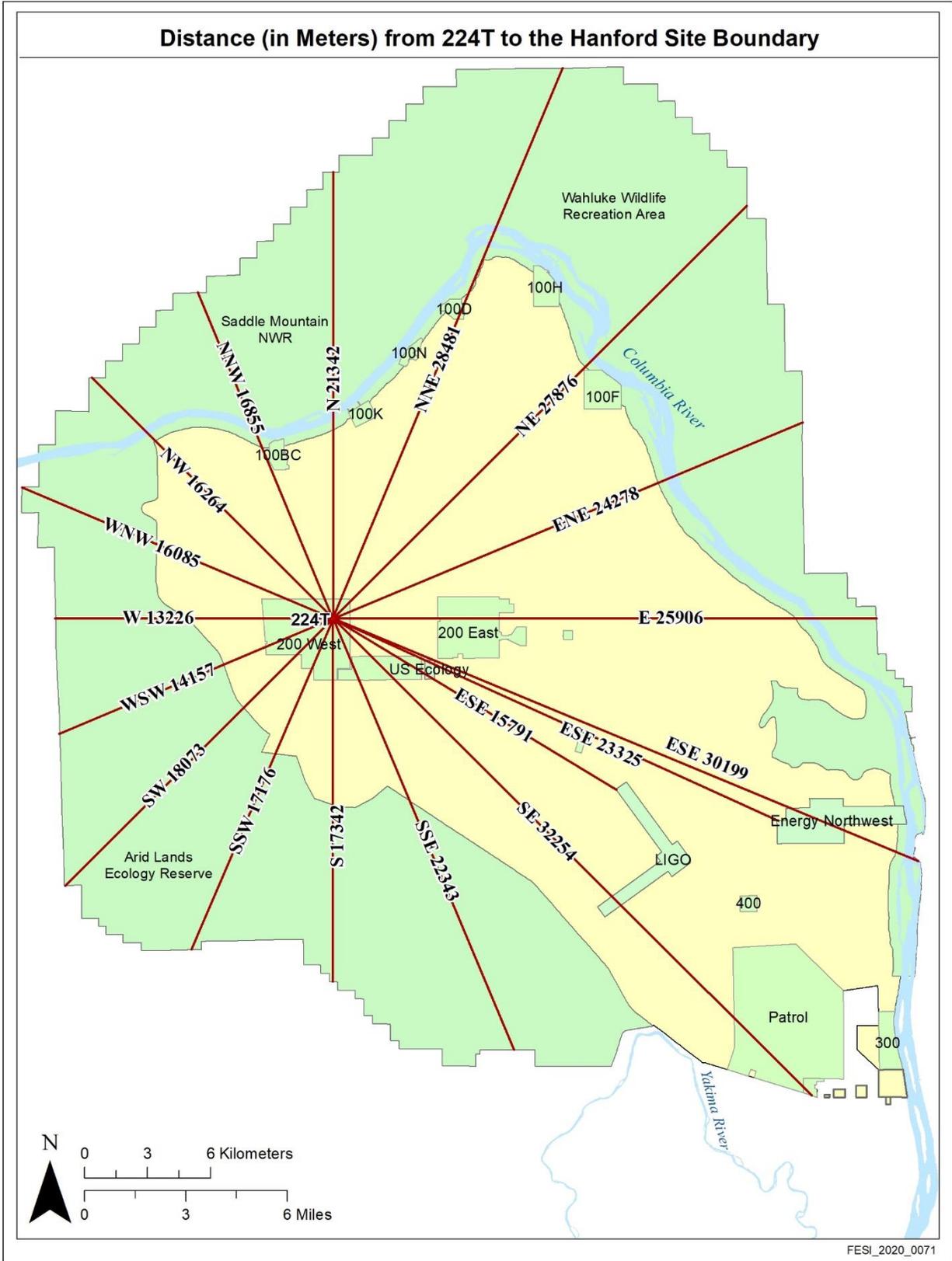
Note: Winds are predominately from the northwest and west-northwest.

Figure A-1. Wind Rose for Hanford Meteorological Station (Station #21) for 2004 to 2013 at 10 m

Appendix B

Map Showing Distance to the Maximally Exposed Individual from the 224T Building

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Appendix C

CAP88-PC Synopsis and Summary Reports for the 224T Building – Offsite Maximally Exposed Individual

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C A P 8 8 - P C

Version 4.0

Clean Air Act Assessment Package - 1988

S Y N O P S I S R E P O R T

Non-Radon Individual Assessment

Fri May 01 08:54:11 2020

Facility: 224T Plutonium Concentration Facility
Address: Hanford Site
City: Richland
State: WA Zip: 99352

Source Category:
Source Type: Area
Emission Year: 2020
DOSE Age Group: Adult

Comments: Removal action under DOE/RL-2019-36
Diffuse demolition emissions - Offsite MEI

Committed Effective Dose Equivalent
(mrem)

3.12E-02

At This Location: 24278 Meters East Northeast

Dataset Name: 224T-Offsite.
Dataset Date: May 1, 2020 08:54 AM
Wind File: C:\Users\h0017518\Documents\CAP88\Wind Files\a13200H10.

Fri May 01 08:54:11 2020

SYNOPSIS
Page 1

MAXIMALLY EXPOSED INDIVIDUAL

Location Of The Individual: 24278 Meters East Northeast
 Lifetime Fatal Cancer Risk: 2.34E-09

ORGAN DOSE EQUIVALENT SUMMARY
 (RN-222 Working Level Calculations Excluded)

Organ	Dose Equivalent (mrem)
Adrenal	2.16E-03
UB_Wall	2.16E-03
Bone_Sur	1.24E+00
Brain	2.16E-03
Breasts	2.21E-03
St_Wall	2.17E-03
SI_Wall	2.17E-03
ULI_Wall	2.24E-03
LLI_Wall	2.40E-03
Kidneys	6.18E-03
Liver	1.05E-01
Muscle	2.19E-03
Ovaries	2.28E-02
Pancreas	2.15E-03
R_Marrow	4.47E-02
Skin	2.32E-03
Spleen	2.17E-03
Testes	2.27E-02
Thymus	2.17E-03
Thyroid	2.18E-03
GB_Wall	2.16E-03
Ht_Wall	2.16E-03
Uterus	2.15E-03
ET_Reg	5.83E-03
Lung_66	2.07E-02
Effectiv	3.12E-02

RADIONUCLIDE EMISSIONS DURING THE YEAR 2020

Nuclide	Type	Size	Source	
			#1 Ci/y	TOTAL Ci/y
Pu-238	M	1.000	2.5E-04	2.5E-04
Pu-239	M	1.000	4.4E-03	4.4E-03
Pu-240	M	1.000	1.0E-03	1.0E-03
Pu-241	M	1.000	1.9E-02	1.9E-02
Pu-242	M	1.000	8.9E-08	8.9E-08
Am-241	M	1.000	2.9E-02	2.9E-02

SITE INFORMATION

Temperature: 12.200 degrees C
 Precipitation: 18.130 cm/y
 Humidity: 8.000 g/cu m
 Mixing Height: 1000.0 m

User specified location of max exposed individual.
 (ILOC, JLOC): ENE, 24278 meters

Fri May 01 08:54:11 2020

SYNOPSIS
Page 2

SOURCE INFORMATION

Source Number: 1

Source Height (m): 0.00
Area (sq m): 1098.00

Plume Rise							
Pasquill Cat:	A	B	C	D	E	F	G
Fixed (m):	None						

AGRICULTURAL DATA

	Vegetable	Milk	Meat
Fraction Home Produced:	1.0000	1.0000	1.0000
Fraction From Assessment Area:	0.0000	0.0000	0.0000
Fraction Imported:	0.0000	0.0000	0.0000

Food Arrays were not generated for this run.
Default Values used.

DISTANCES (M) USED FOR MAXIMUM INDIVIDUAL ASSESSMENT

13226	14157	16085	16264	16855	17176	17342
18073	21342	22343	24278	25906	27876	28481
30199	32254					

D O S E A N D R I S K S U M M A R I E S

Non-Radon Individual Assessment
Fri May 01 08:54:11 2020

Facility: 224T Plutonium Concentration Facility
Address: Hanford Site
City: Richland
State: WA Zip: 99352

Source Category:
Source Type: Area
Emission Year: 2020
DOSE Age Group: Adult

Comments: Removal action under DOE/RL-2019-36
Diffuse demolition emissions - Offsite MEI

Dataset Name: 224T-Offsite.
Dataset Date: May 1, 2020 08:54 AM
Wind File: C:\Users\h0017518\Documents\CAP88\Wind
Files\a13200H10.wnd

Fri May 01 08:54:11 2020

SUMMARY
Page 1

ORGAN DOSE EQUIVALENT SUMMARY

Organ	Selected Individual (mrem)
Adrenal	2.16E-03
UB_Wall	2.16E-03
Bone_Sur	1.24E+00
Brain	2.16E-03
Breasts	2.21E-03
St_Wall	2.17E-03
SI_Wall	2.17E-03
ULI_Wall	2.24E-03
LLI_Wall	2.40E-03
Kidneys	6.18E-03
Liver	1.05E-01
Muscle	2.19E-03
Ovaries	2.28E-02
Pancreas	2.15E-03
R_Marrow	4.47E-02
Skin	2.32E-03
Spleen	2.17E-03
Testes	2.27E-02
Thymus	2.17E-03
Thyroid	2.18E-03
GB_Wall	2.16E-03
Ht_Wall	2.16E-03
Uterus	2.15E-03
ET_Reg	5.83E-03
Lung_66	2.07E-02
Effectiv	3.12E-02

PATHWAY COMMITTED EFFECTIVE DOSE EQUIVALENT SUMMARY

Pathway	Selected Individual (mrem)
INGESTION	8.60E-04
INHALATION	3.02E-02
AIR IMMERSION	2.42E-09
GROUND SURFACE	7.55E-05
INTERNAL	3.11E-02
EXTERNAL	7.55E-05
TOTAL	3.12E-02

Fri May 01 08:54:11 2020

SUMMARY
Page 2

NUCLIDE COMMITTED EFFECTIVE DOSE EQUIVALENT SUMMARY

Nuclide	Selected Individual (mrem)
Pu-238	2.35E-04
U-234	9.32E-13
Th-230	1.45E-16
Ra-226	7.84E-18
Rn-222	4.36E-19
Pu-239	4.59E-03
U-235m	0.00E+00
U-235	1.65E-12
Th-231	1.68E-13
Pa-231	1.24E-16
Pu-240	1.10E-03
U-236	3.90E-14
Th-232	2.70E-23
Ra-228	2.72E-23
Ac-228	3.11E-20
Pu-241	3.61E-04
Am-241	2.49E-02
U-237	3.13E-09
Np-237	5.74E-10
Pa-233	4.72E-09
Pu-242	8.87E-08
U-238	1.42E-20
Th-234	2.90E-19
Pa-234m	3.96E-18
Pa-234	7.81E-20
U-233	7.30E-16
Th-229	1.33E-16
TOTAL	3.12E-02

Fri May 01 08:54:11 2020

SUMMARY
Page 3

CANCER RISK SUMMARY

Cancer	Selected Individual Total Lifetime Fatal Cancer Risk
-----	-----

PATHWAY RISK SUMMARY

Pathway	Selected Individual Total Lifetime Fatal Cancer Risk
-----	-----
INGESTION	6.60E-11
INHALATION	2.24E-09
AIR IMMERSION	1.19E-15
GROUND SURFACE	3.70E-11
INTERNAL	2.30E-09
EXTERNAL	3.70E-11
TOTAL	2.34E-09

Fri May 01 08:54:11 2020

SUMMARY
Page 4

NUCLIDE RISK SUMMARY

Nuclide	Selected Individual Total Lifetime Fatal Cancer Risk
Pu-238	2.01E-11
U-234	3.21E-19
Th-230	6.16E-23
Ra-226	4.26E-24
Rn-222	2.38E-25
Pu-239	3.40E-10
U-235m	0.00E+00
U-235	8.94E-19
Th-231	7.69E-20
Pa-231	6.44E-23
Pu-240	8.57E-11
U-236	1.28E-20
Th-232	1.06E-29
Ra-228	8.28E-30
Ac-228	1.66E-26
Pu-241	1.57E-11
Am-241	1.88E-09
U-237	1.66E-15
Np-237	2.82E-16
Pa-233	2.54E-15
Pu-242	6.92E-15
U-238	4.63E-27
Th-234	1.50E-25
Pa-234m	6.93E-25
Pa-234	4.24E-26
U-233	3.01E-22
Th-229	7.03E-23
TOTAL	2.34E-09

Fri May 01 08:54:11 2020

SUMMARY
Page 5

INDIVIDUAL COMMITTED EFFECTIVE DOSE EQUIVALENT (mrem)
(All Radionuclides and Pathways)

Direction	Distance (m)						
	13226	14157	16085	16264	16855	17176	17342
N	3.0E-02	2.7E-02	2.3E-02	2.3E-02	2.2E-02	2.1E-02	2.1E-02
NNW	3.1E-02	2.8E-02	2.4E-02	2.4E-02	<u>2.2E-02</u>	2.2E-02	2.2E-02
NW	2.9E-02	2.7E-02	2.2E-02	<u>2.2E-02</u>	<u>2.1E-02</u>	2.0E-02	2.0E-02
WNW	2.1E-02	1.9E-02	<u>1.6E-02</u>	1.6E-02	1.5E-02	1.4E-02	1.4E-02
W	<u>1.7E-02</u>	1.5E-02	<u>1.3E-02</u>	1.2E-02	1.2E-02	1.1E-02	1.1E-02
WSW	<u>1.5E-02</u>	<u>1.4E-02</u>	1.1E-02	1.1E-02	1.1E-02	1.0E-02	1.0E-02
SW	1.6E-02	<u>1.4E-02</u>	1.2E-02	1.2E-02	1.1E-02	1.1E-02	1.1E-02
SSW	1.7E-02	1.5E-02	1.3E-02	1.2E-02	1.2E-02	<u>1.2E-02</u>	1.1E-02
S	2.2E-02	2.0E-02	1.7E-02	1.7E-02	1.6E-02	<u>1.5E-02</u>	<u>1.5E-02</u>
SSE	3.6E-02	3.3E-02	2.8E-02	2.7E-02	2.6E-02	2.5E-02	<u>2.5E-02</u>
SE	8.7E-02	8.0E-02	6.8E-02	6.7E-02	6.4E-02	6.3E-02	6.2E-02
ESE	9.7E-02	8.9E-02	7.6E-02	7.5E-02	7.2E-02	7.0E-02	6.9E-02
E	8.2E-02	7.6E-02	6.4E-02	6.4E-02	6.1E-02	5.9E-02	5.9E-02
ENE	7.4E-02	6.8E-02	5.8E-02	5.7E-02	5.4E-02	5.3E-02	5.2E-02
NE	4.9E-02	4.5E-02	3.8E-02	3.8E-02	3.6E-02	3.5E-02	3.5E-02
NNE	3.3E-02	3.0E-02	2.5E-02	2.5E-02	2.4E-02	2.3E-02	2.3E-02

Direction	Distance (m)						
	18073	21342	22343	24278	25906	27876	28481
N	2.0E-02	<u>1.5E-02</u>	1.4E-02	1.2E-02	9.8E-03	8.9E-03	8.7E-03
NNW	2.0E-02	<u>1.6E-02</u>	1.5E-02	1.2E-02	1.0E-02	9.4E-03	9.2E-03
NW	1.9E-02	1.5E-02	1.4E-02	1.2E-02	9.8E-03	8.9E-03	8.7E-03
WNW	1.3E-02	1.0E-02	9.5E-03	8.0E-03	6.8E-03	6.2E-03	6.0E-03
W	1.1E-02	8.2E-03	7.6E-03	6.3E-03	5.4E-03	4.9E-03	4.7E-03
WSW	9.5E-03	7.3E-03	6.7E-03	5.7E-03	4.8E-03	4.3E-03	4.2E-03
SW	<u>1.0E-02</u>	7.7E-03	7.1E-03	6.0E-03	5.2E-03	4.7E-03	4.5E-03
SSW	1.1E-02	8.2E-03	7.6E-03	6.5E-03	5.6E-03	5.0E-03	4.9E-03
S	1.4E-02	1.1E-02	1.0E-02	8.5E-03	7.3E-03	6.6E-03	6.4E-03
SSE	2.4E-02	1.8E-02	<u>1.7E-02</u>	1.4E-02	1.2E-02	1.1E-02	1.1E-02
SE	5.8E-02	4.6E-02	<u>4.3E-02</u>	3.7E-02	3.2E-02	2.9E-02	2.8E-02
ESE	6.6E-02	5.2E-02	4.9E-02	4.2E-02	3.6E-02	3.3E-02	3.2E-02
E	5.5E-02	4.4E-02	4.1E-02	3.5E-02	<u>3.0E-02</u>	2.7E-02	2.7E-02
ENE	4.9E-02	3.9E-02	3.6E-02	<u>3.1E-02</u>	<u>2.6E-02</u>	2.4E-02	2.3E-02
NE	3.3E-02	2.6E-02	2.4E-02	2.0E-02	1.7E-02	<u>1.6E-02</u>	1.5E-02
NNE	2.2E-02	1.7E-02	1.6E-02	1.3E-02	1.1E-02	<u>1.0E-02</u>	<u>9.8E-03</u>

Fri May 01 08:54:11 2020

SUMMARY
Page 6

INDIVIDUAL COMMITTED EFFECTIVE DOSE EQUIVALENT (mrem)
(All Radionuclides and Pathways)

Distance (m)

Direction	30199	32254
N	8.1E-03	7.4E-03
NNW	8.5E-03	7.8E-03
NW	8.0E-03	7.4E-03
WNW	5.5E-03	5.1E-03
W	4.4E-03	4.0E-03
WSW	3.9E-03	3.5E-03
SW	4.2E-03	3.8E-03
SSW	4.5E-03	4.1E-03
S	5.9E-03	5.4E-03
SSE	9.8E-03	9.0E-03
SE	<u>2.6E-02</u>	<u>2.4E-02</u>
ESE	<u>3.0E-02</u>	<u>2.7E-02</u>
E	<u>2.5E-02</u>	2.3E-02
ENE	2.2E-02	2.0E-02
NE	1.4E-02	1.3E-02
NNE	9.1E-03	8.4E-03

- Underlined numbers are the MEI values at the Hanford Site boundary.
- **Shaded number** is the maximum value to the offsite MEI at the Hanford Site boundary.

Fri May 01 08:54:11 2020

SUMMARY
Page 7

INDIVIDUAL LIFETIME RISK (deaths)
(All Radionuclides and Pathways)

	Distance (m)						
Direction	13226	14157	16085	16264	16855	17176	17342
N	2.2E-09	2.0E-09	1.7E-09	1.7E-09	1.6E-09	1.6E-09	1.6E-09
NNW	2.3E-09	2.1E-09	1.8E-09	1.8E-09	1.7E-09	1.6E-09	1.6E-09
NW	2.2E-09	2.0E-09	1.7E-09	1.7E-09	1.6E-09	1.5E-09	1.5E-09
WNW	1.6E-09	1.4E-09	1.2E-09	1.2E-09	1.1E-09	1.1E-09	1.1E-09
W	1.2E-09	1.1E-09	9.5E-10	9.3E-10	8.9E-10	8.6E-10	8.5E-10
WSW	1.1E-09	1.0E-09	8.5E-10	8.4E-10	7.9E-10	7.7E-10	7.6E-10
SW	1.2E-09	1.1E-09	9.0E-10	8.9E-10	8.4E-10	8.2E-10	8.1E-10
SSW	1.3E-09	1.1E-09	9.5E-10	9.4E-10	8.9E-10	8.7E-10	8.6E-10
S	1.7E-09	1.5E-09	1.3E-09	1.2E-09	1.2E-09	1.2E-09	1.1E-09
SSE	2.7E-09	2.5E-09	2.1E-09	2.1E-09	2.0E-09	1.9E-09	1.9E-09
SE	6.6E-09	6.0E-09	5.1E-09	5.0E-09	4.8E-09	4.7E-09	4.6E-09
ESE	7.3E-09	6.7E-09	5.7E-09	5.6E-09	5.4E-09	5.3E-09	5.2E-09
E	6.2E-09	5.7E-09	4.8E-09	4.8E-09	4.6E-09	4.4E-09	4.4E-09
ENE	5.5E-09	5.1E-09	4.3E-09	4.3E-09	4.1E-09	4.0E-09	3.9E-09
NE	3.7E-09	3.4E-09	2.9E-09	2.8E-09	2.7E-09	2.6E-09	2.6E-09
NNE	2.5E-09	2.3E-09	1.9E-09	1.9E-09	1.8E-09	1.7E-09	1.7E-09

	Distance (m)						
Direction	18073	21342	22343	24278	25906	27876	28481
N	1.5E-09	1.1E-09	1.1E-09	8.9E-10	7.4E-10	6.7E-10	6.5E-10
NNW	1.5E-09	1.2E-09	1.1E-09	9.4E-10	7.8E-10	7.1E-10	6.9E-10
NW	1.4E-09	1.1E-09	1.0E-09	8.7E-10	7.4E-10	6.7E-10	6.5E-10
WNW	1.0E-09	7.7E-10	7.1E-10	6.0E-10	5.1E-10	4.6E-10	4.5E-10
W	8.0E-10	6.2E-10	5.7E-10	4.8E-10	4.0E-10	3.7E-10	3.5E-10
WSW	7.2E-10	5.5E-10	5.1E-10	4.3E-10	3.6E-10	3.3E-10	3.2E-10
SW	7.6E-10	5.8E-10	5.4E-10	4.5E-10	3.9E-10	3.5E-10	3.4E-10
SSW	8.1E-10	6.2E-10	5.7E-10	4.9E-10	4.2E-10	3.8E-10	3.7E-10
S	1.1E-09	8.2E-10	7.6E-10	6.4E-10	5.5E-10	5.0E-10	4.8E-10
SSE	1.8E-09	1.4E-09	1.3E-09	1.1E-09	9.1E-10	8.2E-10	8.0E-10
SE	4.4E-09	3.5E-09	3.2E-09	2.8E-09	2.4E-09	2.2E-09	2.1E-09
ESE	4.9E-09	3.9E-09	3.7E-09	3.1E-09	2.7E-09	2.5E-09	2.4E-09
E	4.2E-09	3.3E-09	3.1E-09	2.6E-09	2.2E-09	2.0E-09	2.0E-09
ENE	3.7E-09	2.9E-09	2.7E-09	2.3E-09	2.0E-09	1.8E-09	1.8E-09
NE	2.5E-09	1.9E-09	1.8E-09	1.5E-09	1.3E-09	1.2E-09	1.1E-09
NNE	1.6E-09	1.3E-09	1.2E-09	1.0E-09	8.3E-10	7.6E-10	7.4E-10

Fri May 01 08:54:11 2020

SUMMARY
Page 8INDIVIDUAL LIFETIME RISK (deaths)
(All Radionuclides and Pathways)

	Distance (m)	
Direction	30199	32254
N	6.1E-10	5.6E-10
NNW	6.4E-10	5.9E-10
NW	6.0E-10	5.5E-10
WNW	4.2E-10	3.8E-10
W	3.3E-10	3.0E-10
WSW	2.9E-10	2.7E-10
SW	3.1E-10	2.9E-10
SSW	3.4E-10	3.1E-10
S	4.5E-10	4.1E-10
SSE	7.4E-10	6.8E-10
SE	2.0E-09	1.8E-09
ESE	2.2E-09	2.1E-09
E	1.9E-09	1.7E-09
ENE	1.6E-09	1.5E-09
NE	1.1E-09	9.8E-10
NNE	6.9E-10	6.3E-10

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Appendix D

CAP88-PC Synopsis and Summary Reports for the 224T Building – Onsite Maximally Exposed Individual

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C A P 8 8 - P C

Version 4.0

Clean Air Act Assessment Package - 1988

S Y N O P S I S R E P O R T

Non-Radon Individual Assessment

Fri May 01 08:52:47 2020

Facility: 224T Plutonium Concentration Facility
Address: Hanford Site
City: Richland
State: WA Zip: 99352

Source Category:
Source Type: Area
Emission Year: 2020
DOSE Age Group: Adult

Comments: Removal action under DOE/RL-2019-36
Diffuse demolition emissions - Onsite MEI

Committed Effective Dose Equivalent
(mrem)

7.80E-02

At This Location: 15791 Meters East Southeast

Dataset Name: 224T-Onsite.
Dataset Date: May 1, 2020 08:52 AM
Wind File: C:\Users\h0017518\Documents\CAP88\Wind Files\a13200H10.

Fri May 01 08:52:47 2020

SYNOPSIS
Page 1

MAXIMALLY EXPOSED INDIVIDUAL

Location Of The Individual: 15791 Meters East Southeast
 Lifetime Fatal Cancer Risk: 5.86E-09

ORGAN DOSE EQUIVALENT SUMMARY
 (RN-222 Working Level Calculations Excluded)

Organ	Dose Equivalent (mrem)
Adrenal	5.40E-03
UB_Wall	5.42E-03
Bone_Sur	3.10E+00
Brain	5.40E-03
Breasts	5.53E-03
St_Wall	5.43E-03
SI_Wall	5.43E-03
ULI_Wall	5.61E-03
LLI_Wall	6.00E-03
Kidneys	1.55E-02
Liver	2.64E-01
Muscle	5.48E-03
Ovaries	5.70E-02
Pancreas	5.39E-03
R_Marrow	1.12E-01
Skin	5.79E-03
Spleen	5.42E-03
Testes	5.68E-02
Thymus	5.43E-03
Thyroid	5.45E-03
GB_Wall	5.40E-03
Ht_Wall	5.41E-03
Uterus	5.39E-03
ET_Reg	1.46E-02
Lung_66	5.19E-02
Effectiv	7.80E-02

RADIONUCLIDE EMISSIONS DURING THE YEAR 2020

Nuclide	Type	Size	Source	
			#1 Ci/y	TOTAL Ci/y
Pu-238	M	1.000	2.5E-04	2.5E-04
Pu-239	M	1.000	4.4E-03	4.4E-03
Pu-240	M	1.000	1.0E-03	1.0E-03
Pu-241	M	1.000	1.9E-02	1.9E-02
Pu-242	M	1.000	8.9E-08	8.9E-08
Am-241	M	1.000	2.9E-02	2.9E-02

SITE INFORMATION

Temperature: 12.200 degrees C
 Precipitation: 18.130 cm/y
 Humidity: 8.000 g/cu m
 Mixing Height: 1000.0 m

User specified location of max exposed individual.
 (ILOC, JLOC): ESE,15791 meters

Fri May 01 08:52:47 2020

SYNOPSIS
Page 2

SOURCE INFORMATION

Source Number: 1

Source Height (m): 0.00
Area (sq m): 1098.00

Plume Rise							
Pasquill Cat:	A	B	C	D	E	F	G
Fixed (m):	None						

AGRICULTURAL DATA

	Vegetable	Milk	Meat
Fraction Home Produced:	1.0000	1.0000	1.0000
Fraction From Assessment Area:	0.0000	0.0000	0.0000
Fraction Imported:	0.0000	0.0000	0.0000

Food Arrays were not generated for this run.
Default Values used.

DISTANCES (M) USED FOR MAXIMUM INDIVIDUAL ASSESSMENT

15791 23325

D O S E A N D R I S K S U M M A R I E S

Non-Radon Individual Assessment
Fri May 01 08:52:47 2020

Facility: 224T Plutonium Concentration Facility
Address: Hanford Site
City: Richland
State: WA Zip: 99352

Source Category:
Source Type: Area
Emission Year: 2020
DOSE Age Group: Adult

Comments: Removal action under DOE/RL-2019-36
Diffuse demolition emissions - Onsite MEI

Dataset Name: 224T-Onsite.
Dataset Date: May 1, 2020 08:52 AM
Wind File: C:\Users\h0017518\Documents\CAP88\Wind
Files\a13200H10.wnd

Fri May 01 08:52:47 2020

SUMMARY
Page 1

ORGAN DOSE EQUIVALENT SUMMARY

Organ	Selected Individual (mrem)
Adrenal	5.40E-03
UB_Wall	5.42E-03
Bone_Sur	3.10E+00
Brain	5.40E-03
Breasts	5.53E-03
St_Wall	5.43E-03
SI_Wall	5.43E-03
ULI_Wall	5.61E-03
LLI_Wall	6.00E-03
Kidneys	1.55E-02
Liver	2.64E-01
Muscle	5.48E-03
Ovaries	5.70E-02
Pancreas	5.39E-03
R_Marrow	1.12E-01
Skin	5.79E-03
Spleen	5.42E-03
Testes	5.68E-02
Thymus	5.43E-03
Thyroid	5.45E-03
GB_Wall	5.40E-03
Ht_Wall	5.41E-03
Uterus	5.39E-03
ET_Reg	1.46E-02
Lung_66	5.19E-02
Effectiv	7.80E-02

PATHWAY COMMITTED EFFECTIVE DOSE EQUIVALENT SUMMARY

Pathway	Selected Individual (mrem)
INGESTION	2.15E-03
INHALATION	7.57E-02
AIR IMMERSION	6.06E-09
GROUND SURFACE	1.88E-04
INTERNAL	7.78E-02
EXTERNAL	1.88E-04
TOTAL	7.80E-02

Fri May 01 08:52:47 2020

SUMMARY
Page 2

NUCLIDE COMMITTED EFFECTIVE DOSE EQUIVALENT SUMMARY

Nuclide	Selected Individual (mrem)
Pu-238	5.89E-04
U-234	2.31E-12
Th-230	3.62E-16
Ra-226	1.96E-17
Rn-222	1.09E-18
Pu-239	1.15E-02
U-235m	0.00E+00
U-235	4.12E-12
Th-231	4.20E-13
Pa-231	3.08E-16
Pu-240	2.75E-03
U-236	9.68E-14
Th-232	6.75E-23
Ra-228	6.80E-23
Ac-228	7.77E-20
Pu-241	9.05E-04
Am-241	6.23E-02
U-237	7.82E-09
Np-237	1.43E-09
Pa-233	1.18E-08
Pu-242	2.22E-07
U-238	3.51E-20
Th-234	7.23E-19
Pa-234m	9.89E-18
Pa-234	1.95E-19
U-233	1.82E-15
Th-229	3.32E-16
TOTAL	7.80E-02

Fri May 01 08:52:47 2020

SUMMARY
Page 3

CANCER RISK SUMMARY

Cancer	Selected Individual Total Lifetime Fatal Cancer Risk
-----	-----

PATHWAY RISK SUMMARY

Pathway	Selected Individual Total Lifetime Fatal Cancer Risk
-----	-----
INGESTION	1.65E-10
INHALATION	5.60E-09
AIR IMMERSION	2.99E-15
GROUND SURFACE	9.24E-11
INTERNAL	5.77E-09
EXTERNAL	9.24E-11
TOTAL	5.86E-09

Fri May 01 08:52:47 2020

SUMMARY
Page 4

NUCLIDE RISK SUMMARY

Nuclide	Selected Individual Total Lifetime Fatal Cancer Risk
Pu-238	5.04E-11
U-234	7.97E-19
Th-230	1.54E-22
Ra-226	1.06E-23
Rn-222	5.94E-25
Pu-239	8.52E-10
U-235m	0.00E+00
U-235	2.23E-18
Th-231	1.92E-19
Pa-231	1.61E-22
Pu-240	2.14E-10
U-236	3.17E-20
Th-232	2.64E-29
Ra-228	2.07E-29
Ac-228	4.13E-26
Pu-241	3.93E-11
Am-241	4.70E-09
U-237	4.14E-15
Np-237	7.03E-16
Pa-233	6.35E-15
Pu-242	1.73E-14
U-238	1.15E-26
Th-234	3.74E-25
Pa-234m	1.73E-24
Pa-234	1.06E-25
U-233	7.51E-22
Th-229	1.75E-22
TOTAL	5.86E-09

Fri May 01 08:52:47 2020

SUMMARY
Page 5

INDIVIDUAL COMMITTED EFFECTIVE DOSE EQUIVALENT (mrem)
(All Radionuclides and Pathways)

Distance (m)

Direction	15791	23325
N	2.4E-02	1.3E-02
NNW	2.5E-02	1.4E-02
NW	2.3E-02	1.3E-02
WNW	1.6E-02	8.7E-03
W	1.3E-02	7.0E-03
WSW	1.2E-02	6.2E-03
SW	1.2E-02	6.6E-03
SSW	1.3E-02	7.0E-03
S	1.7E-02	9.3E-03
SSE	2.9E-02	1.6E-02
SE	7.0E-02	4.0E-02
ESE	<u>7.8E-02</u>	<u>4.5E-02</u>
E	6.6E-02	3.8E-02
ENE	5.9E-02	3.4E-02
NE	3.9E-02	2.2E-02
NNE	2.6E-02	1.5E-02

- Double underlined number is the MEI value at the LIGO boundary.
- Wavy underlined number is the MEI value at the nearest Energy Northwest boundary.
- **Shaded number** is the maximum value to the onsite MEI at LIGO or Energy Northwest.

Fri May 01 08:52:47 2020

SUMMARY

Page 6

INDIVIDUAL LIFETIME RISK (deaths)
(All Radionuclides and Pathways)

	Distance (m)	
Direction	15791	23325
N	1.8E-09	9.8E-10
NNW	1.8E-09	1.0E-09
NW	1.7E-09	9.5E-10
WNW	1.2E-09	6.6E-10
W	9.7E-10	5.2E-10
WSW	8.7E-10	4.7E-10
SW	9.2E-10	4.9E-10
SSW	9.8E-10	5.3E-10
S	1.3E-09	7.0E-10
SSE	2.1E-09	1.2E-09
SE	5.2E-09	3.0E-09
ESE	5.9E-09	3.4E-09
E	5.0E-09	2.9E-09
ENE	4.4E-09	2.5E-09
NE	2.9E-09	1.7E-09
NNE	2.0E-09	1.1E-09

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Appendix E

CAP88-PC Inputs for the 224T Building Exhauster

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E1 Introduction

This appendix identifies the following inputs to the CAP88-PC models for the 224T Plutonium Concentration Facility (224T Building) exhauster scenario (Section 3.5.2 in the main text of this environmental calculation file [ECF]):

1. Wind data from 200 Area Hanford Meteorological Station, Weather Station #21 (10 m), for 2004 through 2013 (a13200H10.wnd; Appendix A in this ECF)
2. Lid height of 1,000 m which is the rounded average of winter and summer mean afternoon mixing heights (500 and 2,000 m, respectively) for southeastern Washington (Holzworth, 1972, *Mixing Heights, Wind Speeds, and Potential for Urban Air Pollution Throughout the Contiguous United States*).
3. 18.13 cm is the average annual precipitation for the Hanford Site from 1945 to 2018 as reported in Table 1-1 of DOE/RL-2019-33, *Hanford Site Environmental Report for Calendar Year 2018*.
4. 12.2°C is the average annual temperature for the Hanford Site from 1945 to 2018 as reported in Table 1-1 of DOE/RL-2019-33.
5. The CAP88-PC default value for humidity of 8 g/m³ was used. This value compares well to Hanford Site-specific historical data.
6. Radionuclide decay chains were limited to five (a CAP88-PC default).
7. Build-up time was set to 50 years consistent with Attachment 9, Exhibit 1, of DOE/RL-2007-53, *Methods for Calculating Doses to Demonstrate Compliance with Air Pathway Radiation Dose Standards at the Hanford Site*.
8. Distances to the maximum exposed individual at the Laser Interferometer Gravitational-Wave Observatory and Energy Northwest (onsite) and at the Hanford Site boundary (offsite) from Appendix B in this ECF.
9. Exhauster model is assumed to be equivalent to the model recently used at the Plutonium Finishing Plant. The following exhauster specifications were taken from REG-0957, *PFM Exhauster Agreement*:
 - a. Height to the centerline of the horizontal exhaust duct is 3.71 m (146.25 in.)
 - b. Diameter of exhaust duct is 0.91 m (36 in.)
 - c. Maximum airflow of 20,000 ft³/min
10. Exit velocity for the exhauster is calculated by dividing the exhauster airflow by the area of the exhaust duct and converting units:

$$V = \frac{20,000 \frac{ft^3}{min}}{60 \frac{sec}{min} \times \frac{\pi}{4} (3 ft)^2} = 47.16 \frac{ft}{sec} \times 0.3048 \frac{m}{ft} = 14.37 \frac{m}{sec}$$

11. The potential-to-emit is calculated (Table E-1) assuming a 1 derived air concentration value upstream of the exhauster, airflow of 20,000 ft³/min over 1 year, and isotopic percentages based on the 224T Building inventory in CP-14641, *Documented Safety Analysis for the 224-T Facility*. The PTE values from Column G in the table are the source inputs for the CAP88-PC models (Appendices F and G in this ECF).

Table E-1. Potential-to-Emit Calculation for the 224T Building

A	B	C	D	E	F	G
Isotopes	Inventory ^a (Ci)	Percent of Inventory ^b	Isotopic DAC Value ^c (μCi/mL)	Inventory Percentage of Isotopic DAC Value at 1 DAC Uniformly Dispersed ^d (Ci/mL)	Exhauster Air Volume ^e (mL/yr)	PTE at 1 DAC and 20,000 ft ³ /min ^f (Ci/yr)
Pu-238	2.45E-01	0.46	5.00E-11	2.30E-19	2.98E+14	6.84E-05
Pu-239	4.39E+00	8.24	6.00E-11	4.94E-18	2.98E+14	1.47E-03
Pu-240	1.05E+00	1.97	6.00E-11	1.18E-18	2.98E+14	3.52E-04
Pu-241	1.89E+01	35.47	2.00E-09	7.09E-16	2.98E+14	2.11E-01
Pu-242	8.93E-05	0.0002	6.00E-11	1.01E-22	2.98E+14	2.99E-08
Am-241	2.87E+01	53.86	5.00E-12	2.69E-18	2.98E+14	8.02E-04
Totals	5.33E+01	100.0				2.14E-01

a. Inventory from Table 3-3 in CP-14641, *Documented Safety Analysis for the 224-T Facility*.

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

c. Highest isotopic DAC value from 10 CFR 835, "Occupational Radiation Protection," Appendix A, "Derived Air Concentrations (DAC) for Controlling Radiation Exposure to Workers at DOE Facilities."

d. Inventory Percentage of Isotopic DAC Value is calculated, and units converted:

Column E = Column C × Column D × CF1

- CF1: 1 Ci = 1E+06 μCi

e. Exhauster Air Volume is calculated, and units converted: **Column F = Flow Rate × CF2 × CF3**

- Flow rate: 20,000 ft³/min (assumed exhauster flow rate)
- CF2: 1 year = 525,600 min (assumes 24/7 operation)
- CF3: 1 ft³ = 28,316.85 mL

f. PTE at 1 DAC and 20,000 ft³/min is calculated: **Column G = Column E × Column F**

DAC = derived air concentration

PTE = potential-to-emit

E2 References

- 10 CFR 835, "Occupational Radiation Protection," Appendix A, "Derived Air Concentrations (DAC) for Controlling Radiation Exposure to Workers at DOE Facilities," *Code of Federal Regulations*. Available at: <http://www.gpo.gov/fdsys/pkg/CFR-2010-title10-vol4/xml/CFR-2010-title10-vol4-part835-appA.xml>.
- CP-14641, 2018, *Documented Safety Analysis for the 224-T Facility*, Rev. 7, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0071513H>.
- DOE/RL-2007-53, 2008, *Methods for Calculating Doses to Demonstrate Compliance with Air Pathway Radiation Dose Standards at the Hanford Site*, Rev. 0, U.S. Department of Energy, Richland, Washington.
- DOE/RL-2019-33, 2019, *Hanford Site Environmental Report for Calendar Year 2018*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
- Holzworth, G.C., 1972, *Mixing Heights, Wind Speeds, and Potential for Urban Air Pollution Throughout the Contiguous United States*, AP-101, (NTIS Accession No. PB 207103), U.S. Environmental Protection Agency, Office of Air Programs, Research Triangle Park, North Carolina. Available at: <http://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=20013CDS.PDF>.
- REG-0957, 2018, *PFP Exhauster Agreement*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

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Appendix F

CAP88-PC Synopsis and Summary Reports for the 224T Building Exhauster – Offsite Maximally Exposed Individual

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C A P 8 8 - P C

Version 4.0

Clean Air Act Assessment Package - 1988

S Y N O P S I S R E P O R T

Non-Radon Individual Assessment
Fri Jul 10 09:40:18 2020

Facility: 224T Plutonium Concentration Facility
Address: Hanford Site
City: Richland
State: WA Zip: 99352

Source Category:
Source Type: Stack
Emission Year: 2020
DOSE Age Group: Adult

Comments: Removal action under DOE/RL-2019-36
Exhauster @ 1 DAC & 20,000 cfm - Offsite MEI

Committed Effective Dose Equivalent
(mrem)

7.62E-03

At This Location: 24278 Meters East Northeast

Dataset Name: 224T-Exh-Offsite
Dataset Date: Jul 10, 2020 09:40 AM
Wind File: C:\Users\h0017518\Documents\CAP88\Wind Files\a13200H10.

Fri Jul 10 09:40:18 2020

SYNOPSIS
Page 1

MAXIMALLY EXPOSED INDIVIDUAL

Location Of The Individual: 24278 Meters East Northeast
 Lifetime Fatal Cancer Risk: 4.32E-10

ORGAN DOSE EQUIVALENT SUMMARY
 (RN-222 Working Level Calculations Excluded)

Organ	Dose Equivalent (mrem)
Adrenal	4.75E-04
UB_Wall	4.76E-04
Bone_Sur	2.62E-01
Brain	4.75E-04
Breasts	4.85E-04
St_Wall	4.77E-04
SI_Wall	4.76E-04
ULI_Wall	4.85E-04
LLI_Wall	5.03E-04
Kidneys	9.56E-04
Liver	4.96E-02
Muscle	4.81E-04
Ovaries	3.65E-03
Pancreas	4.74E-04
R_Marrow	1.07E-02
Skin	5.05E-04
Spleen	4.77E-04
Testes	3.71E-03
Thymus	4.77E-04
Thyroid	4.79E-04
GB_Wall	4.75E-04
Ht_Wall	4.76E-04
Uterus	4.74E-04
ET_Reg	8.13E-04
Lung_66	2.08E-03
Effectiv	7.62E-03

RADIONUCLIDE EMISSIONS DURING THE YEAR 2020

Nuclide	Type	Size	Source	
			#1 Ci/y	TOTAL Ci/y
Pu-238	M	1.000	6.8E-05	6.8E-05
Pu-239	M	1.000	1.5E-03	1.5E-03
Pu-240	M	1.000	3.5E-04	3.5E-04
Pu-241	M	1.000	2.1E-01	2.1E-01
Pu-242	M	1.000	3.0E-08	3.0E-08
Am-241	M	1.000	8.0E-04	8.0E-04

SITE INFORMATION

Temperature: 12.200 degrees C
 Precipitation: 18.130 cm/y
 Humidity: 8.000 g/cu m
 Mixing Height: 1000.0 m

User specified location of max exposed individual.
 (ILOC, JLOC): ENE,24278 meters

Fri Jul 10 09:40:18 2020

SYNOPSIS
Page 2

SOURCE INFORMATION

Source Number: 1

Stack Height (m): 3.71
Diameter (m): 0.91

Plume Rise
Momentum (m/s): 14.37
(Exit Velocity)

AGRICULTURAL DATA

	Vegetable	Milk	Meat
	<hr/>	<hr/>	<hr/>
Fraction Home Produced:	1.0000	1.0000	1.0000
Fraction From Assessment Area:	0.0000	0.0000	0.0000
Fraction Imported:	0.0000	0.0000	0.0000

Food Arrays were not generated for this run.
Default Values used.

DISTANCES (M) USED FOR MAXIMUM INDIVIDUAL ASSESSMENT

13226	14157	16085	16264	16855	17176	17342
18073	21342	22343	24278	25906	27876	28481
30199	32254					

D O S E A N D R I S K S U M M A R I E S

Non-Radon Individual Assessment
Fri Jul 10 09:40:18 2020

Facility: 224T Plutonium Concentration Facility
Address: Hanford Site
City: Richland
State: WA Zip: 99352

Source Category:
Source Type: Stack
Emission Year: 2020
DOSE Age Group: Adult

Comments: Removal action under DOE/RL-2019-36
Exhauster @ 1 DAC & 20,000 cfm - Offsite MEI

Dataset Name: 224T-Exh-Offsite
Dataset Date: Jul 10, 2020 09:40 AM
Wind File: C:\Users\h0017518\Documents\CAP88\Wind
Files\a13200H10.wnd

Fri Jul 10 09:40:18 2020

SUMMARY
Page 1

ORGAN DOSE EQUIVALENT SUMMARY

Organ	Selected Individual (mrem)
Adrenal	4.75E-04
UB_Wall	4.76E-04
Bone_Sur	2.62E-01
Brain	4.75E-04
Breasts	4.85E-04
St_Wall	4.77E-04
SI_Wall	4.76E-04
ULI_Wall	4.85E-04
LLI_Wall	5.03E-04
Kidneys	9.56E-04
Liver	4.96E-02
Muscle	4.81E-04
Ovaries	3.65E-03
Pancreas	4.74E-04
R_Marrow	1.07E-02
Skin	5.05E-04
Spleen	4.77E-04
Testes	3.71E-03
Thymus	4.77E-04
Thyroid	4.79E-04
GB_Wall	4.75E-04
Ht_Wall	4.76E-04
Uterus	4.74E-04
ET_Reg	8.13E-04
Lung_66	2.08E-03
Effectiv	7.62E-03

PATHWAY COMMITTED EFFECTIVE DOSE EQUIVALENT SUMMARY

Pathway	Selected Individual (mrem)
INGESTION	2.16E-04
INHALATION	7.39E-03
AIR IMMERSION	7.96E-11
GROUND SURFACE	1.39E-05
INTERNAL	7.60E-03
EXTERNAL	1.39E-05
TOTAL	7.62E-03

Fri Jul 10 09:40:18 2020

SUMMARY
Page 2

NUCLIDE COMMITTED EFFECTIVE DOSE EQUIVALENT SUMMARY

Nuclide	Selected Individual (mrem)
Pu-238	7.45E-05
U-234	2.95E-13
Th-230	4.59E-17
Ra-226	2.48E-18
Rn-222	1.38E-19
Pu-239	1.75E-03
U-235m	0.00E+00
U-235	6.26E-13
Th-231	6.38E-14
Pa-231	4.68E-17
Pu-240	4.18E-04
U-236	1.48E-14
Th-232	1.03E-23
Ra-228	1.03E-23
Ac-228	1.18E-20
Pu-241	4.58E-03
Am-241	8.00E-04
U-237	3.96E-08
Np-237	8.93E-11
Pa-233	7.34E-10
Pu-242	3.37E-08
U-238	5.37E-21
Th-234	1.10E-19
Pa-234m	1.50E-18
Pa-234	2.96E-20
U-233	2.31E-17
Th-229	4.20E-18
TOTAL	7.62E-03

Fri Jul 10 09:40:18 2020

SUMMARY
Page 3

CANCER RISK SUMMARY

Cancer	Selected Individual Total Lifetime Fatal Cancer Risk
-----	-----

PATHWAY RISK SUMMARY

Pathway	Selected Individual Total Lifetime Fatal Cancer Risk
-----	-----
INGESTION	6.91E-12
INHALATION	4.19E-10
AIR IMMERSION	3.92E-17
GROUND SURFACE	6.81E-12
INTERNAL	4.26E-10
EXTERNAL	6.81E-12
TOTAL	4.32E-10

Fri Jul 10 09:40:18 2020

SUMMARY
Page 4

NUCLIDE RISK SUMMARY

Nuclide	Selected Individual Total Lifetime Fatal Cancer Risk
Pu-238	6.37E-12
U-234	1.02E-19
Th-230	1.95E-23
Ra-226	1.35E-24
Rn-222	7.52E-26
Pu-239	1.29E-10
U-235m	0.00E+00
U-235	3.39E-19
Th-231	2.91E-20
Pa-231	2.44E-23
Pu-240	3.26E-11
U-236	4.86E-21
Th-232	4.01E-30
Ra-228	3.14E-30
Ac-228	6.28E-27
Pu-241	1.99E-10
Am-241	6.52E-11
U-237	2.10E-14
Np-237	4.39E-17
Pa-233	3.96E-16
Pu-242	2.63E-15
U-238	1.75E-27
Th-234	5.68E-26
Pa-234m	2.63E-25
Pa-234	1.61E-26
U-233	9.51E-24
Th-229	2.22E-24
TOTAL	4.32E-10

Fri Jul 10 09:40:18 2020

SUMMARY
Page 5

INDIVIDUAL COMMITTED EFFECTIVE DOSE EQUIVALENT (mrem)
(All Radionuclides and Pathways)

	Distance (m)						
Direction	13226	14157	16085	16264	16855	17176	17342
N	7.6E-03	7.0E-03	5.9E-03	5.9E-03	5.6E-03	5.4E-03	5.4E-03
NNW	7.8E-03	7.2E-03	6.1E-03	6.0E-03	<u>5.7E-03</u>	5.6E-03	5.5E-03
NW	7.4E-03	6.7E-03	5.7E-03	<u>5.6E-03</u>	5.3E-03	5.2E-03	5.1E-03
WNW	5.4E-03	4.9E-03	<u>4.1E-03</u>	4.1E-03	3.9E-03	3.8E-03	3.7E-03
W	<u>4.3E-03</u>	4.0E-03	3.3E-03	3.3E-03	3.1E-03	3.0E-03	3.0E-03
WSW	3.9E-03	<u>3.6E-03</u>	3.0E-03	2.9E-03	2.8E-03	2.7E-03	2.7E-03
SW	4.0E-03	3.7E-03	3.1E-03	3.0E-03	2.9E-03	2.8E-03	2.8E-03
SSW	4.3E-03	3.9E-03	3.3E-03	3.2E-03	3.1E-03	<u>3.0E-03</u>	2.9E-03
S	5.7E-03	5.2E-03	4.4E-03	4.3E-03	4.1E-03	4.0E-03	<u>3.9E-03</u>
SSE	9.3E-03	8.5E-03	7.2E-03	7.0E-03	6.7E-03	6.5E-03	6.5E-03
SE	2.1E-02	1.9E-02	1.6E-02	1.6E-02	1.5E-02	1.5E-02	1.5E-02
ESE	2.3E-02	2.1E-02	1.8E-02	1.8E-02	1.7E-02	1.7E-02	1.7E-02
E	2.0E-02	1.8E-02	1.6E-02	1.5E-02	1.5E-02	1.4E-02	1.4E-02
ENE	1.8E-02	1.6E-02	1.4E-02	1.4E-02	1.3E-02	1.3E-02	1.3E-02
NE	1.2E-02	1.1E-02	9.4E-03	9.3E-03	8.9E-03	8.6E-03	8.5E-03
NNE	8.3E-03	7.6E-03	6.4E-03	6.3E-03	6.1E-03	5.9E-03	5.8E-03

	Distance (m)						
Direction	18073	21342	22343	24278	25906	27876	28481
N	5.1E-03	<u>4.0E-03</u>	3.7E-03	3.1E-03	2.6E-03	2.4E-03	2.3E-03
NNW	5.2E-03	4.1E-03	3.8E-03	3.2E-03	2.7E-03	2.5E-03	2.4E-03
NW	4.9E-03	3.8E-03	3.5E-03	3.0E-03	2.6E-03	2.3E-03	2.3E-03
WNW	3.5E-03	2.7E-03	2.5E-03	2.1E-03	1.8E-03	1.7E-03	1.6E-03
W	2.8E-03	2.2E-03	2.0E-03	1.7E-03	1.5E-03	1.3E-03	1.3E-03
WSW	2.5E-03	1.9E-03	1.8E-03	1.5E-03	1.3E-03	1.2E-03	1.2E-03
SW	<u>2.6E-03</u>	2.0E-03	1.9E-03	1.6E-03	1.4E-03	1.3E-03	1.2E-03
SSW	<u>2.8E-03</u>	2.1E-03	2.0E-03	1.7E-03	1.5E-03	1.3E-03	1.3E-03
S	3.7E-03	2.9E-03	2.6E-03	2.2E-03	1.9E-03	1.8E-03	1.7E-03
SSE	6.1E-03	4.7E-03	<u>4.4E-03</u>	3.7E-03	3.2E-03	2.9E-03	2.8E-03
SE	1.4E-02	1.1E-02	<u>1.0E-02</u>	8.9E-03	7.7E-03	7.1E-03	6.9E-03
ESE	1.6E-02	1.3E-02	1.2E-02	1.0E-02	8.7E-03	8.0E-03	7.8E-03
E	1.3E-02	1.1E-02	1.0E-02	8.5E-03	<u>7.4E-03</u>	6.8E-03	6.6E-03
ENE	1.2E-02	9.6E-03	8.9E-03	<u>7.6E-03</u>	<u>6.5E-03</u>	6.0E-03	5.8E-03
NE	8.1E-03	6.4E-03	5.9E-03	5.0E-03	4.3E-03	<u>4.0E-03</u>	3.8E-03
NNE	5.5E-03	4.3E-03	4.0E-03	3.4E-03	2.9E-03	2.6E-03	<u>2.6E-03</u>

Fri Jul 10 09:40:18 2020

SUMMARY
Page 6

INDIVIDUAL COMMITTED EFFECTIVE DOSE EQUIVALENT (mrem)
(All Radionuclides and Pathways)

Distance (m)

Direction	30199	32254
N	2.2E-03	2.0E-03
NNW	2.2E-03	2.1E-03
NW	2.1E-03	1.9E-03
WNW	1.5E-03	1.4E-03
W	1.2E-03	1.1E-03
WSW	1.1E-03	9.8E-04
SW	1.1E-03	1.0E-03
SSW	1.2E-03	1.1E-03
S	1.6E-03	1.5E-03
SSE	2.6E-03	2.4E-03
SE	6.4E-03	<u>5.9E-03</u>
ESE	<u>7.2E-03</u>	6.7E-03
E	6.1E-03	5.7E-03
ENE	5.4E-03	5.0E-03
NE	3.6E-03	3.3E-03
NNE	2.4E-03	2.2E-03

- Underlined numbers are the MEI values at the Hanford Site boundary.
- Shaded number is the maximum value to the offsite MEI at the Hanford Site boundary.

Fri Jul 10 09:40:18 2020

SUMMARY
Page 7

INDIVIDUAL LIFETIME RISK (deaths)
(All Radionuclides and Pathways)

Direction	Distance (m)						
	13226	14157	16085	16264	16855	17176	17342
N	4.3E-10	4.0E-10	3.4E-10	3.3E-10	3.2E-10	3.1E-10	3.1E-10
NNW	4.4E-10	4.1E-10	3.5E-10	3.4E-10	3.3E-10	3.2E-10	3.1E-10
NW	4.2E-10	3.8E-10	3.2E-10	3.2E-10	3.0E-10	3.0E-10	2.9E-10
WNW	3.1E-10	2.8E-10	2.4E-10	2.3E-10	2.2E-10	2.1E-10	2.1E-10
W	2.5E-10	2.3E-10	1.9E-10	1.9E-10	1.8E-10	1.7E-10	1.7E-10
WSW	2.2E-10	2.0E-10	1.7E-10	1.7E-10	1.6E-10	1.5E-10	1.5E-10
SW	2.3E-10	2.1E-10	1.8E-10	1.7E-10	1.6E-10	1.6E-10	1.6E-10
SSW	2.4E-10	2.2E-10	1.9E-10	1.8E-10	1.7E-10	1.7E-10	1.7E-10
S	3.2E-10	3.0E-10	2.5E-10	2.4E-10	2.3E-10	2.3E-10	2.2E-10
SSE	5.3E-10	4.8E-10	4.1E-10	4.0E-10	3.8E-10	3.7E-10	3.7E-10
SE	1.2E-09	1.1E-09	9.3E-10	9.1E-10	8.7E-10	8.5E-10	8.4E-10
ESE	1.3E-09	1.2E-09	1.0E-09	1.0E-09	9.7E-10	9.5E-10	9.4E-10
E	1.1E-09	1.0E-09	8.9E-10	8.8E-10	8.4E-10	8.2E-10	8.1E-10
ENE	1.0E-09	9.3E-10	7.9E-10	7.8E-10	7.5E-10	7.3E-10	7.2E-10
NE	6.8E-10	6.3E-10	5.3E-10	5.3E-10	5.0E-10	4.9E-10	4.8E-10
NNE	4.7E-10	4.3E-10	3.7E-10	3.6E-10	3.4E-10	3.4E-10	3.3E-10

Direction	Distance (m)						
	18073	21342	22343	24278	25906	27876	28481
N	2.9E-10	2.3E-10	2.1E-10	1.8E-10	1.5E-10	1.4E-10	1.3E-10
NNW	3.0E-10	2.3E-10	2.2E-10	1.8E-10	1.5E-10	1.4E-10	1.4E-10
NW	2.8E-10	2.1E-10	2.0E-10	1.7E-10	1.5E-10	1.3E-10	1.3E-10
WNW	2.0E-10	1.5E-10	1.4E-10	1.2E-10	1.0E-10	9.5E-11	9.2E-11
W	1.6E-10	1.2E-10	1.1E-10	9.6E-11	8.3E-11	7.6E-11	7.4E-11
WSW	1.4E-10	1.1E-10	1.0E-10	8.6E-11	7.4E-11	6.7E-11	6.6E-11
SW	1.5E-10	1.1E-10	1.1E-10	9.0E-11	8.0E-11	7.2E-11	7.0E-11
SSW	1.6E-10	1.2E-10	1.1E-10	9.5E-11	8.3E-11	7.6E-11	7.3E-11
S	2.1E-10	1.6E-10	1.5E-10	1.3E-10	1.1E-10	1.0E-10	9.8E-11
SSE	3.5E-10	2.7E-10	2.5E-10	2.1E-10	1.8E-10	1.6E-10	1.6E-10
SE	8.0E-10	6.3E-10	5.9E-10	5.1E-10	4.4E-10	4.0E-10	3.9E-10
ESE	8.9E-10	7.1E-10	6.6E-10	5.7E-10	5.0E-10	4.5E-10	4.4E-10
E	7.6E-10	6.1E-10	5.7E-10	4.8E-10	4.2E-10	3.8E-10	3.7E-10
ENE	6.8E-10	5.4E-10	5.1E-10	4.3E-10	3.7E-10	3.4E-10	3.3E-10
NE	4.6E-10	3.6E-10	3.4E-10	2.9E-10	2.5E-10	2.2E-10	2.2E-10
NNE	3.1E-10	2.5E-10	2.3E-10	1.9E-10	1.6E-10	1.5E-10	1.5E-10

Fri Jul 10 09:40:18 2020

SUMMARY
Page 8

INDIVIDUAL LIFETIME RISK (deaths)
(All Radionuclides and Pathways)

	Distance (m)	
Direction	30199	32254
N	1.2E-10	1.1E-10
NNW	1.3E-10	1.2E-10
NW	1.2E-10	1.1E-10
WNW	8.6E-11	7.8E-11
W	6.8E-11	6.2E-11
WSW	6.1E-11	5.5E-11
SW	6.5E-11	5.9E-11
SSW	6.8E-11	6.2E-11
S	9.0E-11	8.2E-11
SSE	1.5E-10	1.3E-10
SE	3.6E-10	3.4E-10
ESE	4.1E-10	3.8E-10
E	3.5E-10	3.2E-10
ENE	3.1E-10	2.8E-10
NE	2.0E-10	1.9E-10
NNE	1.4E-10	1.2E-10

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Appendix G

CAP88-PC Synopsis and Summary Reports for the 224T Building Exhauster – Onsite Maximally Exposed Individual

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C A P 8 8 - P C

Version 4.0

Clean Air Act Assessment Package - 1988

S Y N O P S I S R E P O R T

Non-Radon Individual Assessment
Fri Jul 10 09:16:48 2020

Facility: 224T Plutonium Concentration Facility
Address: Hanford Site
City: Richland
State: WA Zip: 99352

Source Category:
Source Type: Stack
Emission Year: 2020
DOSE Age Group: Adult

Comments: Removal action under DOE/RL-2019-36
Exhauster @ 1 DAC & 20,000 cfm - Onsite MEI

Committed Effective Dose Equivalent
(mrem)

1.86E-02

At This Location: 15791 Meters East Southeast

Dataset Name: 224T-Exh-Onsite.
Dataset Date: Jul 10, 2020 09:16 AM
Wind File: C:\Users\h0017518\Documents\CAP88\Wind Files\a13200H10.

Fri Jul 10 09:16:48 2020

SYNOPSIS
Page 1

MAXIMALLY EXPOSED INDIVIDUAL

Location Of The Individual: 15791 Meters East Southeast
 Lifetime Fatal Cancer Risk: 1.06E-09

ORGAN DOSE EQUIVALENT SUMMARY
 (RN-222 Working Level Calculations Excluded)

Organ	Dose Equivalent (mrem)
Adrenal	1.16E-03
UB_Wall	1.16E-03
Bone_Sur	6.40E-01
Brain	1.16E-03
Breasts	1.18E-03
St_Wall	1.17E-03
SI_Wall	1.16E-03
ULI_Wall	1.19E-03
LLI_Wall	1.23E-03
Kidneys	2.34E-03
Liver	1.21E-01
Muscle	1.18E-03
Ovaries	8.93E-03
Pancreas	1.16E-03
R_Marrow	2.62E-02
Skin	1.23E-03
Spleen	1.17E-03
Testes	9.07E-03
Thymus	1.17E-03
Thyroid	1.17E-03
GB_Wall	1.16E-03
Ht_Wall	1.16E-03
Uterus	1.16E-03
ET_Reg	1.99E-03
Lung_66	5.08E-03
Effectiv	1.86E-02

RADIONUCLIDE EMISSIONS DURING THE YEAR 2020

Nuclide	Type	Size	Source	
			#1 Ci/y	TOTAL Ci/y
Pu-238	M	1.000	6.8E-05	6.8E-05
Pu-239	M	1.000	1.5E-03	1.5E-03
Pu-240	M	1.000	3.5E-04	3.5E-04
Pu-241	M	1.000	2.1E-01	2.1E-01
Pu-242	M	1.000	3.0E-08	3.0E-08
Am-241	M	1.000	8.0E-04	8.0E-04

SITE INFORMATION

Temperature: 12.200 degrees C
 Precipitation: 18.130 cm/y
 Humidity: 8.000 g/cu m
 Mixing Height: 1000.0 m

User specified location of max exposed individual.
 (ILOC, JLOC): ESE,15791 meters

Fri Jul 10 09:16:48 2020

SYNOPSIS
Page 2

SOURCE INFORMATION

Source Number: 1

Stack Height (m): 3.71
Diameter (m): 0.91

Plume Rise
Momentum (m/s): 14.37
(Exit Velocity)

AGRICULTURAL DATA

	Vegetable	Milk	Meat
	<hr/>	<hr/>	<hr/>
Fraction Home Produced:	1.0000	1.0000	1.0000
Fraction From Assessment Area:	0.0000	0.0000	0.0000
Fraction Imported:	0.0000	0.0000	0.0000

Food Arrays were not generated for this run.
Default Values used.

DISTANCES (M) USED FOR MAXIMUM INDIVIDUAL ASSESSMENT

15791 23325

D O S E A N D R I S K S U M M A R I E S

Non-Radon Individual Assessment
Fri Jul 10 09:16:48 2020

Facility: 224T Plutonium Concentration Facility
Address: Hanford Site
City: Richland
State: WA Zip: 99352

Source Category:
Source Type: Stack
Emission Year: 2020
DOSE Age Group: Adult

Comments: Removal action under DOE/RL-2019-36
Exhauster @ 1 DAC & 20,000 cfm - Onsite MEI

Dataset Name: 224T-Exh-Onsite.
Dataset Date: Jul 10, 2020 09:16 AM
Wind File: C:\Users\h0017518\Documents\CAP88\Wind
Files\a13200H10.wnd

Fri Jul 10 09:16:48 2020

SUMMARY
Page 1

ORGAN DOSE EQUIVALENT SUMMARY

Organ	Selected Individual (mrem)
Adrenal	1.16E-03
UB_Wall	1.16E-03
Bone_Sur	6.40E-01
Brain	1.16E-03
Breasts	1.18E-03
St_Wall	1.17E-03
SI_Wall	1.16E-03
ULI_Wall	1.19E-03
LLI_Wall	1.23E-03
Kidneys	2.34E-03
Liver	1.21E-01
Muscle	1.18E-03
Ovaries	8.93E-03
Pancreas	1.16E-03
R_Marrow	2.62E-02
Skin	1.23E-03
Spleen	1.17E-03
Testes	9.07E-03
Thymus	1.17E-03
Thyroid	1.17E-03
GB_Wall	1.16E-03
Ht_Wall	1.16E-03
Uterus	1.16E-03
ET_Reg	1.99E-03
Lung_66	5.08E-03
Effectiv	1.86E-02

PATHWAY COMMITTED EFFECTIVE DOSE EQUIVALENT SUMMARY

Pathway	Selected Individual (mrem)
INGESTION	5.27E-04
INHALATION	1.81E-02
AIR IMMERSION	1.95E-10
GROUND SURFACE	3.39E-05
INTERNAL	1.86E-02
EXTERNAL	3.39E-05
TOTAL	1.86E-02

Fri Jul 10 09:16:48 2020

SUMMARY
Page 2

NUCLIDE COMMITTED EFFECTIVE DOSE EQUIVALENT SUMMARY

Nuclide	Selected Individual (mrem)
Pu-238	1.82E-04
U-234	7.14E-13
Th-230	1.12E-16
Ra-226	6.05E-18
Rn-222	3.36E-19
Pu-239	4.27E-03
U-235m	0.00E+00
U-235	1.53E-12
Th-231	1.56E-13
Pa-231	1.14E-16
Pu-240	1.02E-03
U-236	3.59E-14
Th-232	2.50E-23
Ra-228	2.52E-23
Ac-228	2.88E-20
Pu-241	1.12E-02
Am-241	1.96E-03
U-237	9.66E-08
Np-237	2.18E-10
Pa-233	1.79E-09
Pu-242	8.24E-08
U-238	1.30E-20
Th-234	2.68E-19
Pa-234m	3.66E-18
Pa-234	7.22E-20
U-233	5.64E-17
Th-229	1.03E-17
TOTAL	1.86E-02

Fri Jul 10 09:16:48 2020

SUMMARY
Page 3

CANCER RISK SUMMARY

Cancer	Selected Individual Total Lifetime Fatal Cancer Risk
-----	-----

PATHWAY RISK SUMMARY

Pathway	Selected Individual Total Lifetime Fatal Cancer Risk
-----	-----
INGESTION	1.69E-11
INHALATION	1.02E-09
AIR IMMERSION	9.59E-17
GROUND SURFACE	1.66E-11
INTERNAL	1.04E-09
EXTERNAL	1.66E-11
TOTAL	1.06E-09

Fri Jul 10 09:16:48 2020

SUMMARY
Page 4

NUCLIDE RISK SUMMARY

Nuclide	Selected Individual Total Lifetime Fatal Cancer Risk
Pu-238	1.56E-11
U-234	2.46E-19
Th-230	4.75E-23
Ra-226	3.29E-24
Rn-222	1.84E-25
Pu-239	3.16E-10
U-235m	0.00E+00
U-235	8.27E-19
Th-231	7.11E-20
Pa-231	5.96E-23
Pu-240	7.97E-11
U-236	1.18E-20
Th-232	9.78E-30
Ra-228	7.66E-30
Ac-228	1.53E-26
Pu-241	4.87E-10
Am-241	1.59E-10
U-237	5.12E-14
Np-237	1.07E-16
Pa-233	9.67E-16
Pu-242	6.43E-15
U-238	4.25E-27
Th-234	1.39E-25
Pa-234m	6.41E-25
Pa-234	3.93E-26
U-233	2.32E-23
Th-229	5.43E-24
TOTAL	1.06E-09

Fri Jul 10 09:16:48 2020

SUMMARY
Page 5

INDIVIDUAL COMMITTED EFFECTIVE DOSE EQUIVALENT (mrem)
(All Radionuclides and Pathways)

	Distance (m)	
Direction	15791	23325
N	6.1E-03	3.4E-03
NNW	6.3E-03	3.5E-03
NW	5.8E-03	3.2E-03
WNW	4.3E-03	2.3E-03
W	3.4E-03	1.9E-03
WSW	3.1E-03	1.7E-03
SW	3.2E-03	1.7E-03
SSW	3.3E-03	1.8E-03
S	4.5E-03	2.4E-03
SSE	7.3E-03	4.0E-03
SE	1.7E-02	9.7E-03
ESE	<u><u>1.9E-02</u></u>	<u>1.1E-02</u>
E	1.6E-02	9.3E-03
ENE	1.4E-02	8.3E-03
NE	9.6E-03	5.5E-03
NNE	6.6E-03	3.7E-03

- Double underlined number is the MEI value at the LIGO boundary.
- Wavy underlined number is the MEI value at the nearest Energy Northwest boundary.
- **Shaded number** is the maximum value to the onsite MEI at LIGO or Energy Northwest.

Fri Jul 10 09:16:48 2020

SUMMARY

Page 6

INDIVIDUAL LIFETIME RISK (deaths)
(All Radionuclides and Pathways)

	Distance (m)	
Direction	15791	23325
N	3.5E-10	1.9E-10
NNW	3.5E-10	2.0E-10
NW	3.3E-10	1.8E-10
WNW	2.4E-10	1.3E-10
W	1.9E-10	1.1E-10
WSW	1.7E-10	9.4E-11
SW	1.8E-10	9.8E-11
SSW	1.9E-10	1.0E-10
S	2.5E-10	1.4E-10
SSE	4.2E-10	2.3E-10
SE	9.5E-10	5.5E-10
ESE	1.1E-09	6.2E-10
E	9.1E-10	5.3E-10
ENE	8.1E-10	4.7E-10
NE	5.5E-10	3.1E-10
NNE	3.7E-10	2.1E-10

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