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PNNL-20173 Rev. 4 Add.

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

Air Dispersion Modeling of Radioactive Releases During Proposed PFP Complex Demolition Activities: Addendum

Report to CH2M HILL Plateau Remediation Company

BA Napier
JP Rishel

August 2017

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Pacific Northwest National Laboratory
Richland, Washington 99352

Summary

This report is part of the planning process for the demolition of the 234-5Z and 236-Z structures at the Plutonium Finishing Plant (PFP) on the Hanford Site. Pacific Northwest National Laboratory (PNNL) supports the U.S. Department of Energy (DOE) and the CH2M HILL Plateau Remediation Company (CHPRC) demolition planning effort by making engineering estimates of potential releases for various potential demolition alternatives. The previous report PNNL-20173 Rev. 4 discusses the potential impacts of sequential demolition of PFP buildings. This Addendum to PNNL-20173 Rev. 4 adds information about the potential impacts of simultaneous demolition of two facilities: the 236-Z process cell and Zone 4 of the 234-5Z Building. Zone 4, with the exception of the Plutonium Process Support Laboratories (PPSL) annex that retains no appreciable holdup, posed the greatest (worst-case) source term demolished concurrently with the 236-Z process cell. This report documents an analysis considering open-air demolition using standard techniques. It does not document any decisions about the decommissioning approaches. This document is intended to guide the establishment of a boundary for the application of an air monitoring regime.

Atmospheric dispersion modeling using estimated release rates has been conducted to provide information on the location and levels of radioactive contamination that may be expected as the result of demolition activities. The close proximity of the PFP facilities to each other has the potential to affect dispersion patterns through various meteorological phenomena, including building wake effects. As the structures are demolished, the impacts on dispersion from wake effects diminish, and several structures have been demolished since issuance of the previous reports.. Hourly meteorological data collected over a 6-year period (2004–2009) were used to examine the effects of wind speed, direction, and stability on projected concentrations of contaminants in air and deposited on nearby surfaces.

The radioactive contamination of concern for the PFP complex is primarily transuranic contamination from past operations. The source terms modeled in this report are based on the residual transuranic contamination levels that are anticipated for the various structures at the time of demolition.

The radiological consequences have been established using the five-factor formula from DOE-HDBK-3010 (DOE 1994) considering material-at-risk, damage ratio, airborne release fraction, respirable fraction, and leak path factor. Radioactive contamination emissions have been calculated by release mechanism and demolition area for on-shift and off-shift activities. The emissions from the applicable sources have been combined to provide emissions estimates for each day from each demolition area.

The U.S. Environmental Protection Agency's (EPA's) AERMOD computer code is used to estimate atmospheric dispersion and deposition of the released radioactive materials in the immediate vicinity of the demolition activities. The modeling is conducted to be fully representative of the range of the weather conditions that are possible (i.e., uses multiple full annual cycles of meteorological data) and representative of the expected demolition period (i.e., models the hours of the day that demolition activities will occur). The modeling also includes the effects of local building structures on the near-field atmospheric dispersion rates due to wake effects.

Both airborne and surface concentrations are modeled with AERMOD. Hourly derived air concentrations (DAC) are modeled for an array of receptors covering the demolition site and surrounding area. Peak (95th percentile) values of time-integrated air concentrations at these receptor points are

derived from these hourly values, with modeling results reported as total incremental air concentrations in DAC-hours occurring over the selected time period. The DAC-hours are integrated values. Air concentrations are expected to not be constant during the demolition processes. There will be transient periods with higher and lower airborne concentrations. However, since computed doses are based on integrated intake, the analysis of instantaneous airborne concentrations is not necessary in this analysis. Total accumulated deposition amounts are also evaluated with AERMOD using the same array of receptors, with results reported as dpm per 100 cm^2.

Since the completion of this report in October 2016, significant progress has been made on the demolition of the Plutonium Finishing Plant, including removal of the 242Z, 291Z, and the outer shell of the 236-Z buildings, as well as the 291Z-1 stack. The northern and eastern portions of the 234-5Z building are currently being removed. This has changed the configuration of the buildings and thus, changed the potential building wake effects, which have been reflected in this new modeling effort.. In addition, due to timing considerations, concurrent demolition of portions of 234-5Z and the 236-Z process cell may occur. This addendum considers the emission and dispersion from these two demolition activities occurring at the same time:

- The various zones of the 234-5Z building are assumed to be demolished using hydraulic shears or mechanical hammer. Certain gloveboxes, ductwork, and piping may remain in the building until the time of demolition; they would be carefully removed as access is available. The entire demolition process for 234-5Z is assumed to require 70 days over a period of about 18 weeks.
- The demolition of the highly-contaminated main cell of 236-Z is projected to require from 40 to 46 working days over about 12 weeks of elapsed time. Forty-one strongbacks are expected to remain within the main cell; they will be removed and size-reduced as part of the cell demolition process. The most contaminated portion of 236-Z – the northern walls and maintenance cell areas, will be demolished first; the demolition of this portion is expected to coincide with demolition of Zone 4 of the 234-5Z building.

The modeling of demolition activities incorporates some realistic assumptions based on input from CHPRC regarding efforts to mitigate release (i.e., verification of fixative application, use of fixatives and misting/spraying throughout all demolition and waste disposition activity) Work is assumed to be performed during 10-hour day and swing shifts, with a preference for demolition during the days and rubble removal during swing shifts; however swing shifts are not planned for the 236-Z demolition.

The exposure results from simultaneous demolition of the 234-5Z and 236-Z process cell structures are presented as a local-area map of potential exposures from demolition activities. The results are expressed as total DAC-hours for demolition activities during the work week generating the highest source terms coupled with the bounding (95th percentile) meteorological conditions based on six years of hourly local climatology data (see Figure S.1). The results are based on the highest projected emission rates related to the demolition of the 236-Z process cell and Zone 4 of the 234-5Z complex. This plot presents a composite of the maximums of 95th percentile exposure values on the area surrounding the demolition activity based on all the modeled total work-week exposures. The total work-week exposures are based on the total exposures for all the contiguous 4-day periods based on data from 6 years of meteorological observations. All other demolition activities associated with demolition activities for these buildings will have lower levels of predicted weekly peak exposures.

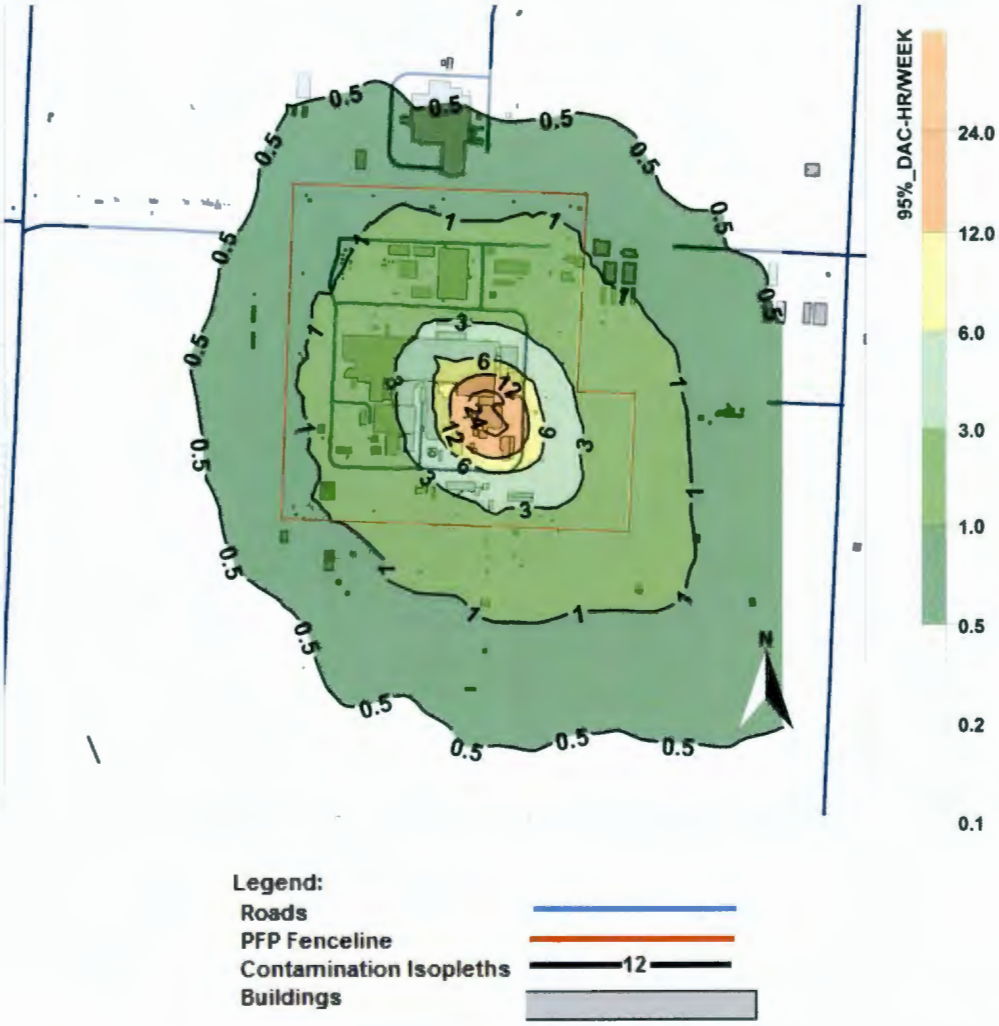

Figure S.1. Weekly Air Exposure 95th Percentile Values for simultaneous 234-5Z and 236-Z Demolition

These structures include areas with the highest contamination levels in the PFP complex. Because the activity weighted emissions from the 236-Z cell alone account for 98% of the projected emissions from demolition of both 236-Z and 234-5Z buildings combined, the results given below are essentially attributable to the demolition activities for the 236-Z cell alone.

Summary Conclusion

The analysis shows that some releases of radioactive material are to be anticipated during the demolition of the PFP structures. The modeling results presented here are closely tied to the details of how the demolition is to be conducted. The results indicate that for the bulk of the PFP facilities the radiological exposures from the planned demolition efforts will be well below the designated limits for air and soil exposures. However, the demolition of the 236-Z main process cell is expected to release some alpha-emitting radionuclides. The 95th percentile results based on 6-years' worth of hourly climatological

data, a representative demolition period, realistic mitigating actions, and a bounding source term indicate that concentrations at the fence line of the PFP facilities should remain well below 12 DAC-hours/week.

As noted in PNNL-20113 Rev. 4 (Napier et al. 2016), radiation doses to the public from PFP demolition activities should remain well within the current DOE and EPA limits for airborne radionuclide releases. Because the overall source term has remained the same, these dose projections are unchanged by the change in scheduling modeled herein.

Acknowledgments

The authors would like to extend their appreciation to Brian Oldfield and Peter Sauer of the CH2M HILL Plateau Remediation Company for financial and technical support of this work. Meteorological data from the Hanford Meteorological Station for the period was provided by Ken Burk, Pacific Northwest National Laboratory. This work was funded by CH2M HILL Plateau Remediation Company under the U.S. Department of Energy Contract DE-AC05-76RL01830.

Acronyms and Abbreviations

AERMOD	American Meteorological Society/Environmental Protection Agency Regulatory Model
Bq	Becquerel
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CHPRC	CH2M HILL Plateau Remediation Company
Ci	curie(s)
cm	centimeter(s)
DAC	derived air concentration
DOE	U.S. Department of Energy
dpm	disintegrations per minute
EPA	U.S. Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
FB	Filter Box
ft	foot (feet)
g	gram
GB	Glovebox
in.	inch(es)
lb	pound(s)
LF	linear feet
m	meter(s)
MTCE	Maintenance
PFP	Plutonium Finishing Plant
PNNL	Pacific Northwest National Laboratory
PRF	Plutonium Reclamation Facility (236-Z Building)
Pu	plutonium
QTY	quantity
RMA	Remote Mechanical "A" process line
RMC	Remote Mechanical "C" process line
TRU	Transuranic (comprised of elements with higher atomic number than uranium)

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1.0 Introduction

The Hanford Plutonium Finishing Plant (PFP), located in the 200 West Area, converted plutonium-bearing chemical solutions to metals and oxides until 1989. The current mission of the PFP requires deactivating and dismantling PFP complex systems and structures to the degree determined appropriate by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) process, thus eliminating significant hazard to workers, the public, and the environment and minimizing long-term surveillance and maintenance risks and costs. U.S. Department of Energy (DOE) and CH2M HILL Plateau Remediation Company (CHPRC) plans call for eventual demolition of most of the PFP structures.

Pacific Northwest National Laboratory (PNNL) supports the demolition planning effort by making engineering estimates of potential releases for various potential demolition alternatives. Atmospheric dispersion modeling has been conducted using projected release rates to provide information on the location and levels of radioactivity. This report documents an analysis considering open-air demolition using standard techniques. It does not document any decisions about the decommissioning approaches.

This report is part of the planning process for the demolition of the 234-5Z and 236-Z structures at the PFP complex. Figure 1.0-1 shows the state the PFP structures were in at the beginning of the initial demolitions. Not shown in the figure are structures in the immediate vicinity that have been, or will be, removed before demolition of 236Z and Zone 4 of 234-5Z Building commences.

Figure 1.0-1. The Plutonium Finishing Plant Complex in aerial view from the north

The PFP complex shown in Figure 1.0-1 has many large structures that will influence the local atmospheric dispersion. These structures have the potential to affect dispersion and deposition patterns through various meteorological phenomena, including building wake effects. As the structures are demolished, the impacts on dispersion from wake effects will change. Atmospheric dispersion calculations have been made using the AERMOD (40 CFR 51, Appendix W) dispersion model developed by the U.S. Environmental Protection Agency (EPA). AERMOD is the EPA's recommended dispersion model for regulatory applications; the model incorporates the latest understanding of atmospheric dispersion, and it explicitly accounts for building wake effects. The results from the AERMOD calculations are being used to help plan demolition activities that will keep potential contamination within the limits established for the project contamination area and to define exclusion zones.

The 234-5Z building is approximately 152 m (500 ft) long and 55 m (180 ft) wide. The floor levels are the basement, the first floor, the duct level, and the second floor. The frame is structural steel with an outer sheathing of aluminum panels over rock wool insulation and 16-guage sheet metal. There are also 20-cm (8-in.) thick interior reinforced concrete walls, principally running in the east-west direction, and two box-type reinforced concrete stairwells. The stairwells extend to the roof; the reinforced concrete walls stop at the second floor. Contamination levels are quite variable within this large structure; the bulk of residual contamination is expected to reside in the central core and on the duct level. As of this writing, portions of the north and east sides of the building are being removed to provide enhanced access to the remainder of the 236-Z building.

The 236-Z building (also known as the Plutonium Reclamation Facility - PRF) is located south of the southeastern corner of the 234-5Z building and was connected to it by the 242Z building. The building was a four-story structure ; all that remains as of this writing is the process cell which is about 18.3 m (60 ft) long, 11.6 m (38 ft) wide, and 10.4 m (34 ft) tall. With the exception of the south end of the process cell, the cell is constructed of reinforced concrete. The tanks and columns used in the solvent extraction process were located in the process cell—a large three-story room in the center of the 236-Z building.

The main report PNNL-20173 Rev. 4 (Napier et al. 2016), of which this report is an addendum, provides a description of the overall analysis approach used to evaluate the air emissions during demolition (Section 2), the local patterns of predicted incremental air concentrations and deposition rates for the major buildings and stack (Section 3), and a discussion of the results (Section 4). The appendices provide the structure-by-structure details of the source-term analysis and atmospheric dispersion modeling. The source-term appendices include the modeling phases, source-term inventories, and demolition options. The air dispersion appendices include modeling assumptions as well as the AERMOD input and output file listings. This Addendum deals only with the estimation of maximal concentrations of radioactive contaminants in air resulting from simultaneous demolition of portions of the 234-5Z building and the 236-Z process cell.

2.0 Discussion of Analysis Approach

Atmospheric dispersion modeling has been conducted in support of the demolition of the Plutonium Finishing Plant (PFP) complex using estimated release rates to provide information on the location and levels of radioactive contamination that may be expected as the result of demolition activities. The close proximity of the PFP building structures to each other has the potential to affect dispersion patterns through various meteorological phenomena, including building wake effects (note that as the buildings are torn down, the impacts from wake effects will decrease). Hourly meteorological data collected over a 6-year period (2004–2009) was used to examine the effects of wind speed, direction, and stability on projected concentrations of contaminants in air and deposited on nearby surfaces.

The radioactive contamination of concern for the PFP complex is largely transuranic (TRU) contamination from past operations. Operations prior to open-air demolition activities have removed a large fraction of this contamination. The source terms modeled in this report are based on the residual contamination levels that are anticipated for the various structures at the time of demolition.

The radiological consequences have been established using the methods discussed in DOE-HDBK-3010-94 (DOE 1994). The methods are fully described in PNNL-20173 Rev. 4 (Napier et al. 2016).

The U.S. Environmental Protection Agency's (EPA's) AERMOD dispersion model is used to estimate atmospheric concentration and surface deposition of the released radioactive materials in the immediate vicinity of the demolition activities. AERMOD provides hourly estimates for the time periods that demolition is planned by accounting for the ambient meteorological conditions as well as the effect of the nearby buildings on the air flow. The methods are fully described in PNNL-20173 Rev. 4 (Napier et al. 2016).

Weekly cumulative values of air concentrations are evaluated with modeling results reported as the 95th percentile of time-integrated derived air concentrations (DAC-hours) for air concentrations. As a result, the 95th percentile values for one location are most likely derived from different data than the values for any other location. Thus, the isopleths do not represent a single anticipated condition, but rather the most-likely near-worst case for all locations simultaneously.

The air concentrations and deposition rates are modeled for an array of receptors covering the demolition site and surrounding area. Weekly-averaged values of air concentrations are evaluated with modeling results reported as the 95th percentile of the time-integrated incremental derived air concentrations in DAC-hours; total estimated depositions from all activities are presented as disintegrations per minute (dpm) per 100 cm^2.

The dosimetry depends on the mixture of radioisotopes present. The spectrum of radionuclides is based on the best information available for each structure. For the PFP plutonium contamination, DACs based on Class S absorption are applicable (DOE-STD-1128-2013, Section 5.2). The initial nitrate compounds will have mostly oxidized after years of exposure to air Derived Air Concentrations (DACs) are presented based on a standard sum-of-reciprocals approach. The methods are fully described in PNNL-20173 Rev. 4 (Napier et al. 2016).

Because the various buildings and rooms within each building have different anticipated contamination levels at the time of demolition, for the purposes of demolition planning the complex has been subdivided into demolition planning zones. The major zones (seven) for 234-5Z are illustrated by numbered areas in Figure 2.0-1. Along the top and left side of this figure, numbers 1-26 and Letters A-J represent the locations of vertical/horizontal lines whose intersection identify the locations of support columns within the 234-5Z building. For this analysis, it is assumed that 234-5Z Zones 1, 2, and 3 are no longer present. Only the process cell at the center of 236-Z remains.

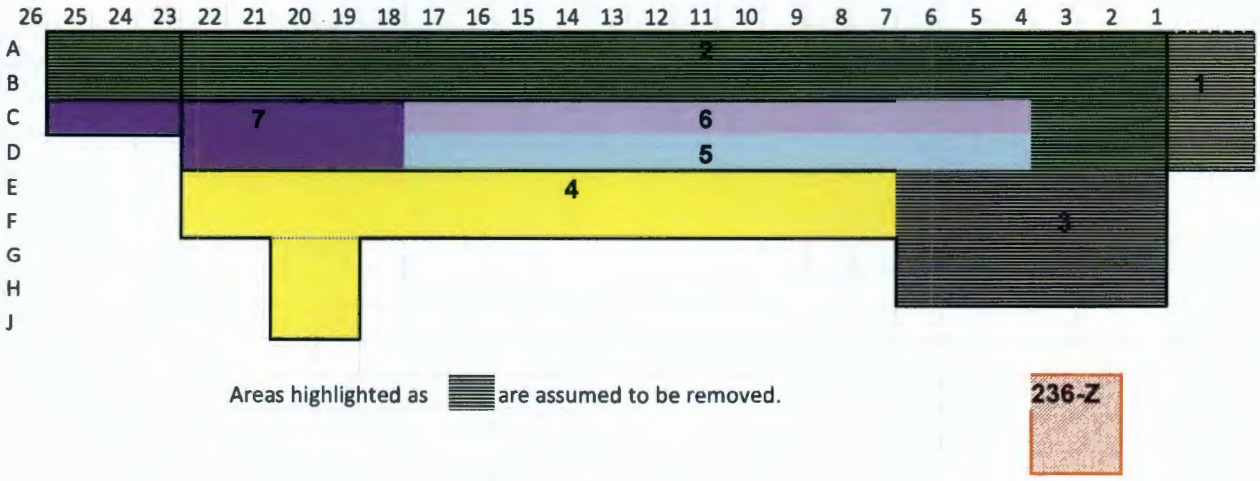

Figure 2.0-1. Demolition Areas and 234-5Z Zones Defined for this Analysis

The radioactive contamination of concern for the PFP building demolition is located on surfaces, under paint and tiles, within ducts, and in other inaccessible places. The total inventories are estimated based on the levels of residual contamination within each structure assumed at the time of demolition. The inventories are fully described in PNNL-20173 Rev. 4 (Napier et al. 2016). Figure 2.0-2 illustrates the source term captured by the concurrent demolition analysis.

Demolition Sequence/Duration			*LLW Contaminated Surfaces*				*TRU Strategic Removals*		
Facility	**Zone**	**Location**	**Debris Wt (lb)**	**Area (SF)**	**dpm/100cm^2**	**Description**	**QTY**	**Unit**	**Pu (g)**
236-Z	SZ-1	236-Z 6th Floor	193228	1216	200,000	Floors & Walls	None		
				229	100	E-3 Shaft and Plenums			
	SZ-2	236-Z 5th Floor	165307	1074	200,000	Floors & Walls	None		
				201	35,000	E-3 Shaft and Plenums			
			162	33	7,500,000	E-4 Ductwork			
	SZ-3	236-Z 4th Floor	1150415	14228	200,000	Floors & Walls	None		
				549	9,000	E-3 Shaft and Plenums			
			7948	1610	700,000	E-4 Ductwork			
	SZ-4	236-Z 3rd Floor	1050115	2629	200,000	Floors & Walls	5	Pipe Stubs	11
				427	1,000	E-3 Shaft and Plenums			
			1778	360	400,000	E-4 Ductwork			
	SZ-5	236-Z 2nd Floor	1094080	8640	200,000	Floors & Walls	21	Gallery GB's/FB's, E4, Pipe stubs	445
				1531	45,000	E-3 Shaft and Plenums			
			28506	3011	900,000	E-4 Ductwork			
	SZ-6	236-Z 1st Floor	1121343	6613	200,000	Floors & Walls	40	Gallery GB's/FB's, Sleeves, E4, stubs	853
				811	10,000	E-3 Shaft and Plenums			
			1244	252	250,000	E-4 Ductwork			
	SZ-7	236-Z Canyon	2064161	7827	24.8 nCi/g	Canyon Walls	1	MTCE Cell	37.7
							1	Man Basket	85
							41	Strongbacks	644
242-Z	SZ-1	242-Z and 242-ZA	289446	9100	8,000,000	Tank & Control Rooms	9	Tanks	532
234-5Z	SZ-1	234-5ZA	262335	1000	2,600	Floors & Walls	None		
	SZ-2	234-5Z Front Side	5319554	10000	263,434	Floors & Walls	None		
			221921	14982	41,194	E-3/4 Ductwork			
	SZ-3	234-5Z A Labs	2233034	117344	20,428	Floors & Walls	1	145-1 GB	3
			174017	11748	945,330	E-3/4 Ductwork			
			g-Pu	3.1	44 stubs	Fixed			
				2.9	3 stubs	Fixed and Verified			
	SZ-4	234-5Z Backside/ PPSL	3323369	196364	5,329	Floors & Walls	1	27" E4 Header	13
			554832	37457	1,461,425	E-3/4 Ductwork	3	Process Vac Segments	193
			g-Pu	1.8	30 stubs	Fixed			
				4.6	4 stubs	Fixed and Verified			
	SZ-5	234-5Z RMA Line	1545479	105384	123,629	Floors & Walls	1	HC 227S GB	30
			118856	8024	1,981,361	E-3/4 Ductwork			
			g-Pu	1.8	18 stubs	Fixed			
				5.9	4 stubs	Fixed and Verified			
	SZ-6	234-5Z RMC Line	1676105	99908	1,096,423	Floors & Walls	3	22" and 12" E4 Segments	24
			36528	2466	2,168,804	E-3/4 Ductwork			
			g-Pu	0	1 stub	Fixed			
				5.7	9 stubs	Fixed and Verified			
	SZ-7	234-5Z RADTU/ Basement	1510281	72496	20,428	Floors & Walls	None		
			75914	5125	262,418	E-3/4 Ductwork			
			g-Pu	0	No stubs	Fixed			
				0	No stubs	Fixed and Verified			
			18355	Fire Dam	60 nCi/g	LLW GB's/FB's (5)			
			450000	Epoxy Fill	35 nCi/g	LLW Tunnel Drains	2182	LF TRU Drains	550
291-Z	SZ-1	291-Z Fanhouse	5314936	12000	2,000	Ceiling	12	LF 26" PVS	16
	SZ-2	291-Z-001 Stack	937365	9000	6,000	Stack Interior	None		

Figure 2.0-2. Concurrent Demolition Source Term
(Gray shaded areas completed or presumed complete)

3.0 Predicted Impacts

The results presented in this section use a PFP facility area map shown in Figure 3.0-1 as a base map. The map includes the facility fence line (red) and the major roads (blue). The buildings and subsets of buildings under demolition are shown as colored overlays. Structures shown in gray, most of which will be gone at the start of the PFP demolition activities, are not part of structures considered in this report. The structure marked in light blue is 234-5Z (demolition zones 4 to 7); the grey portions of the building are assumed to have been removed prior to the demolition actions considered in this addendum. The structure marked in pink is the remaining 236-Z cell which is the area with higher levels of contamination.

The air exposure results presented below are the increments predicted to result from the demolition modeling – and as such do not contain a background component. The air monitoring stations in the immediate vicinity of the PFP complex will be only able to detect increments in air exposures from demolition if those increments are large enough to be distinguished from the local background. The background for this area is estimated to be on the order of 0.015 and 0.03 DAC-hours for 1-week and 2-week background exposures, respectively.[1]

The air dispersion modeling of the PFP building demolition projects air concentration and surface deposition. Air concentration is characterized in terms of derived air concentration (DAC)-hour exposures summed over work-week time periods (4-day work weeks are assumed). Surface deposition is characterized in terms of cumulative deposition expressed in disintegrations per minute (dpm) per 100 cm^2 modeled over the elapsed time for the specific demolition activities under consideration.

The modeling of the potential impacts of this ~3-month period of projected activities required characterization of the full sequence of day-to-day demolition activities. The modeling approach used in AERMOD to analyze the potential air concentration and surface deposition included maximum-impact model runs were conducted for "worst case" demolition weeks (i.e., demolition sequences resulting in the greatest activity-based weekly emission rates) based on meteorological patterns shown in hourly data collected over 6-years. The results of these runs provide a basis for the maximum impacts that could occur expressed as the upper 95th percentile values based on meteorological data.

To maximize the number of time periods used in the climatological definition of peak exposure values, the air quality modeling of climatological peak exposures is conservatively conducted using 4-day instead of 7-day weeks. For air concentrations, each 4-day cumulative DAC exposure is the same as what would be computed based on an expanded 7-day period (with no emissions on a 3-day weekend). For surface depositions, the modeling of each demolition activity is based on the number of demolition work-days rather than the elapsed time. Because the surface deposition results are based on cumulative deposition, the use of demolition work-days will provide predicted values for deposition computed over a shorter time period. The effect of using shorter times for computing peak surface depositions is

[1] In an analysis of the routine air samplers (Napier et al. 2010), the mean of background air samples at the Hanford 200-West monitoring stations is shown to be about 1.2×10^{-15} µCi/ml of gross alpha-emitters. Most of the background will be natural alpha-emitting radionuclides, primarily progeny of the uranium chain. If the background is assumed to have the same radionuclide spectrum as the contamination of the 236-Z building (which is conservative from a dosimetric sense), the background levels of air concentration are at about 0.0001 DAC; 1-week and 2-week background exposures are estimated to be about 0.015 and 0.03 DAC-hours, respectively.

Figure 3.0-1. PFP Structures Being Considered in this Addendum

considered conservative because this covers a narrower range of ambient dispersion conditions. The demolition activities for all the PFP structures involve close to 180 work-days. Of those efforts, a total of either 40 or 46 work-days are projected for the 236-Z cell demolition with strongback removal.

3.1. Building Demolition – Air Concentrations

This section presents the air concentration modeling results for the demolition of the PFP buildings 234-5Z Zone 4 and 236-Z.

As described in Section 2, maximum-impact modeling runs are used to define the 95th percentile time-integrated air concentrations. The occurrence of the highest air concentrations will be associated with the coincidental occurrence of 1) demolition operations with the largest projected release rates and 2) the most limiting meteorological dispersion conditions. Although the operations for the PFP structures will extend over many months, the demolition of the more highly contaminated portions (i.e., areas that have the highest potential release rates) are projected to occur over a relatively short time period. To obtain the worst-case air concentrations, the maximum emission rates expected during planned work periods are modeled as potentially occurring anytime during the worst case dispersion conditions as indicated from six-years' worth of hourly meteorological data.

Air concentrations are presented as isopleths of maximum values (expressed as total DAC-hours) resulting from weekly demolition activities. The highest, 4-day source term from the source term analysis discussed in Section 2.0 is used in AERMOD. The resulting daily AERMOD concentrations outputs are post-processed to determine the 95th percentile 4-day air concentration at each PFP receptor location; the maximum air concentration isopleth presents the overall composite pattern of the maximum weekly air concentration at each receptor.

Note that actual air concentrations during demolition will depend on ambient meteorological conditions that will occur, and are likely to be less than the predicted bounding values.

This section presents the air concentrations modeling results for the demolition of the 236-Z cell and Zone 4 of the 234-5Z Building. The cell structure contains areas with the highest contamination levels in the entire PFP complex. The activity-weighted emissions from the 236-Z cell account for >99% of the projected emissions from all the 236-Z structures, and a similar fraction of the emissions including Zone 4 of 234-5Z.

Either forty or forty-six days of activities are projected for the demolition of the 236-Z cell (therefore, both cases are modeled). During those 12 work-weeks, the activity-weighted emissions from 236-Z cell account for more than 98% of the total emissions from all buildings. The projected weekly emission rates for the 236-Z cell vary with the portion of the structure being demolished. The largest emissions rates are projected to occur during the first week, which involve removal of the 236-Z cell north walls, ceiling, and maintenance cell. The other 236-Z demolition periods are projected to produce lower emission rates than during these weeks. The output products provided for the 236-Z cell air exposure modeling: 1) 95th percentile weekly air concentration isopleths for a projected 40-day demolition schedule for all dispersion conditions, and 2) 95th percentile weekly air concentration isopleths for a projected 46-day demolition schedule for all dispersion conditions.

Figure 3.1-1 shows the weekly total DAC-hours for demolition of the 236-Z Cell north end for a 40-day demolition schedule. The results are based on the highest projected weekly emission rate during the 236-Z cell demolition. All other demolition activities associated with 236-Z cell and associated buildings demolition activities will have lower levels of weekly predicted peak exposures. No weekly fence line concentrations are predicted to exceed about 3 DAC-hours.

Figure 3.1-2 shows the weekly total DAC-hours for demolition of the 236-Z Cell north end for a 46-day demolition schedule. The amount of emitted material per week is slightly reduced with the extended schedule, resulting in somewhat decreased peak air concentrations.

Note that the releases from the cell are the result the demolition of the canyon walls, with the PRF maintenance cell and mezzanine areas containing relatively higher levels of contamination than other portions of the canyon walls.

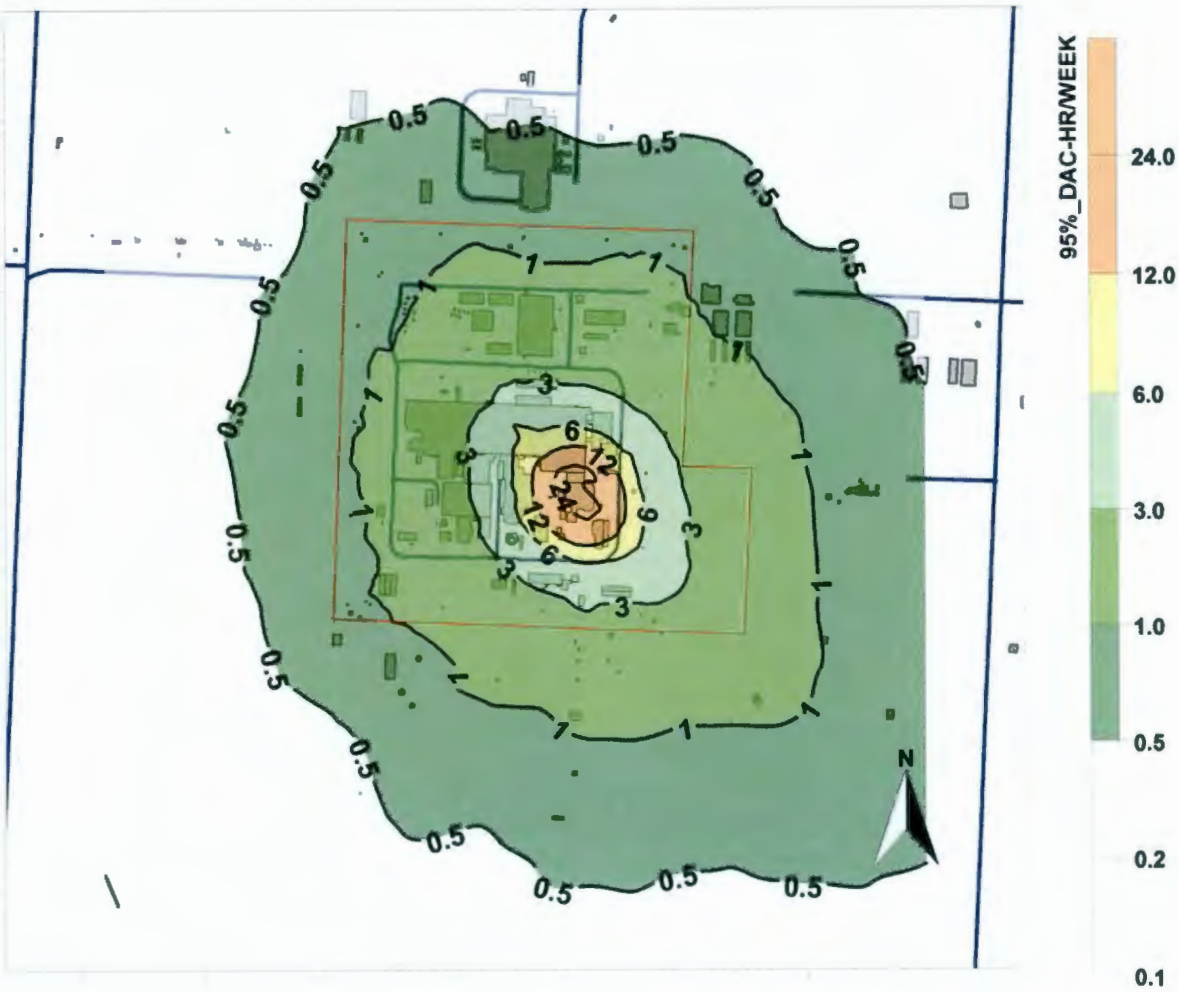

Figure 3.1-1. Predicted 236-Z Cell and 234-5Z Zone 4 Concurrent Demolition 95th Percentile Weekly Air Concentrations – 40-day Cell Demolition Schedule

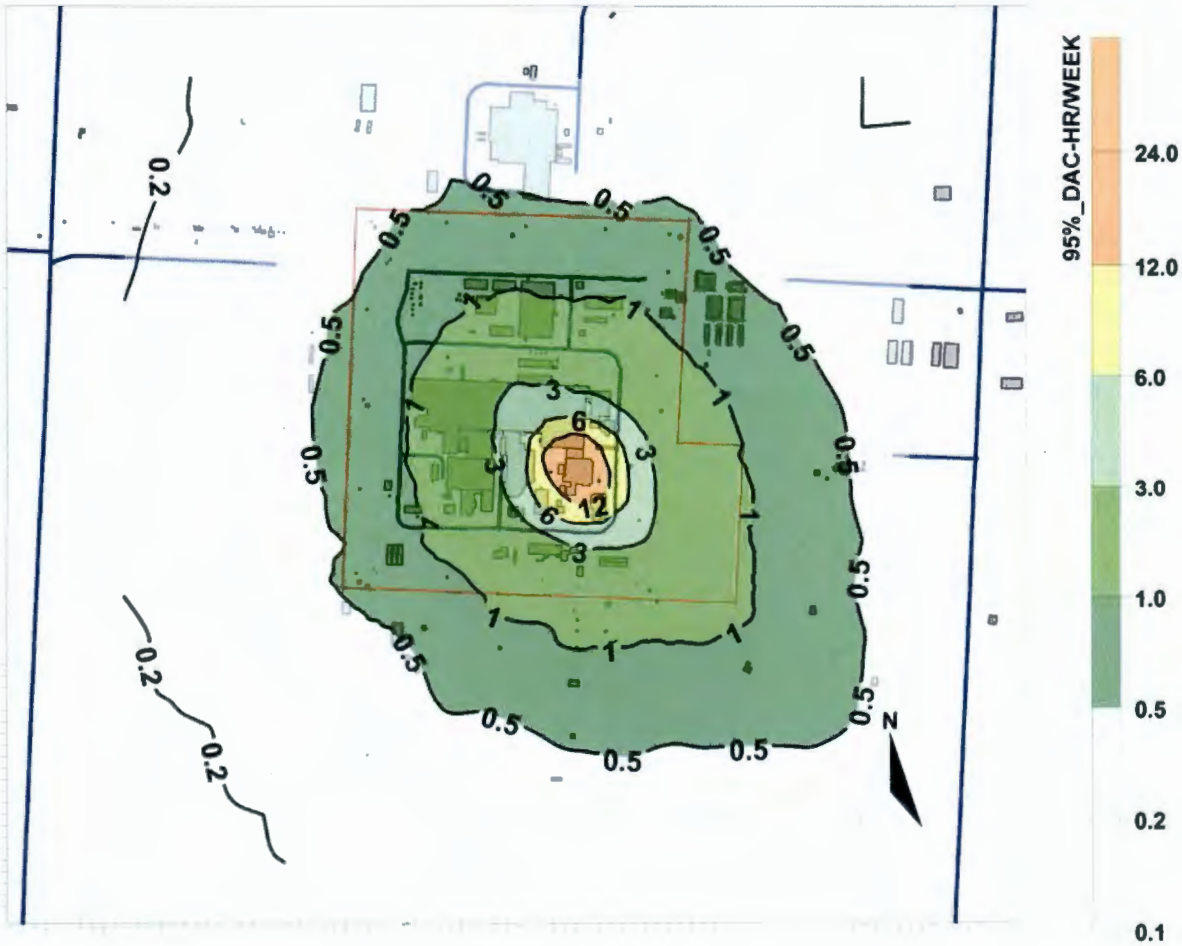

Figure 3.1-2. Predicted 236-Z Cell and 234-5Z Zone 4 Concurrent Demolition 95th Percentile Weekly Air Concentrations – 46-day Cell Demolition Schedule

3.1 Building Demolition – Surface Deposition

Surface deposition is analyzed through 95th percentile impact modeling runs. The 95th percentile surface deposition is determined by modeling the average emission rate for a given demolition activity based on 6-years' worth of hourly meteorological data. The resulting model-calculated daily surface deposition values are then summed over the actual number of days the activity is expected to be performed and the total deposition value at each receptor location is retained and sorted. These 95th percentile isopleths are presented in this section for a variety of demolition activities; isopleths are expressed in units of alpha disintegrations per minute (dpm) per 100 cm^2.

Actual surface deposition resulting from any demolition activity will depend on the ambient meteorological conditions that will occur during the demolition activities.

This section presents the surface deposition modeling results for the 236-Z cell; this structure is identified in pink in Figure 3.0-1. The 236-Z cell structures have the highest contamination levels in the

PFP complex. Because the activity-weighted emissions from the 236-Z cell account for about 98% of the projected emissions from demolition of all the 236-Z structures, the results presented in this section are associated with the demolition activities for the 236-Z cell. The 236-Z structure demolition activities leading to surface deposition were projected to occur for a total of 69 working days of which 40 to 46 days are related to the 236-Z cell.

Figure 3.2-1 is the resulting composite isopleth of the 95th percentile surface deposition (expressed as alpha dpm per 100 cm^2) for demolition of the 236-Z cell. As noted in Section 3.2, the 95th percentile deposition is determined by modeling the average emission rate for a given demolition activity over the entire 6-year (2004–2009) meteorological period. The resulting model-calculated daily surface deposition values are then summed over the actual number of days the activity is expected to be performed and the total deposition value at each receptor location is retained, sorted, and output for isopleth plotting. For the 236-Z cell, activities leading to surface deposition from demolition were projected to occur for a total of 40 to 46 days.

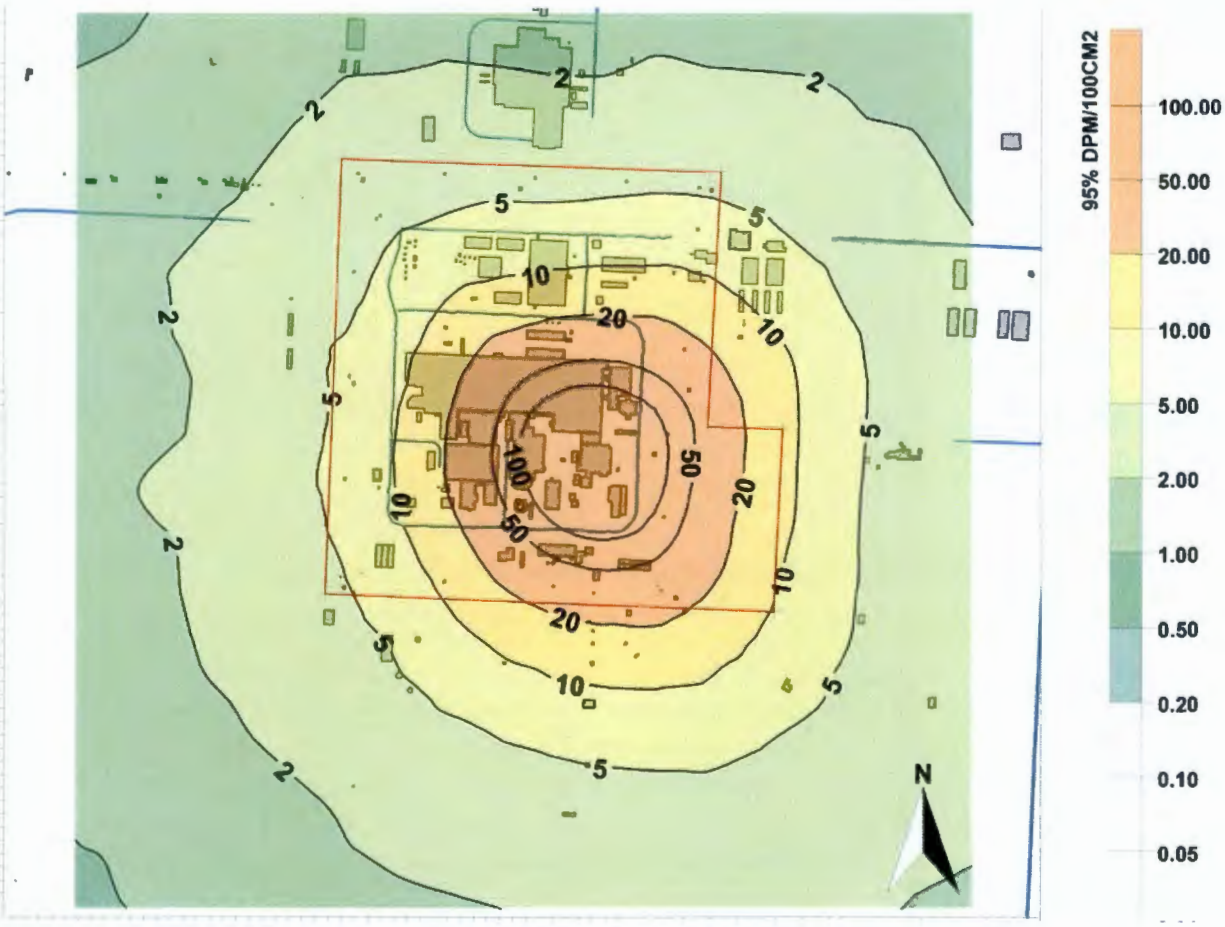

Figure 3.2-1. Predicted 95th Percentile Surface Deposition for 236-Z Cell from Demolition

The climatologically-based pattern of predicted 95th percentile soil exposures (expressed as dpm per 100 cm^2) from demolition of all PFP buildings is shown in Figure 3.2-2. The plot for all buildings is essentially identical to the plot for 236-Z that represented more than 98% of the total projected emissions from demolition of all the PFP buildings. The activities leading to surface deposition from demolition of all the PFP buildings were projected to occur for a total of about 160 days.

It should be noted that the administrative limit for surface contamination of 20 dpm/100 cm^2 of alpha-particle emitters has been used as an indicator of the spread of surficial deposition. AERMOD modeling projects this level to be exceeded somewhat beyond the immediate PFP fenceline in Figure 3.2-2 at the 95th percentile. Because deposition is a cumulative process over the entire period of demolition, there is relatively little variation in the predictions; without ongoing efforts to minimize and remediate the deposition, spread of contamination could be the controlling factor in the demolition.

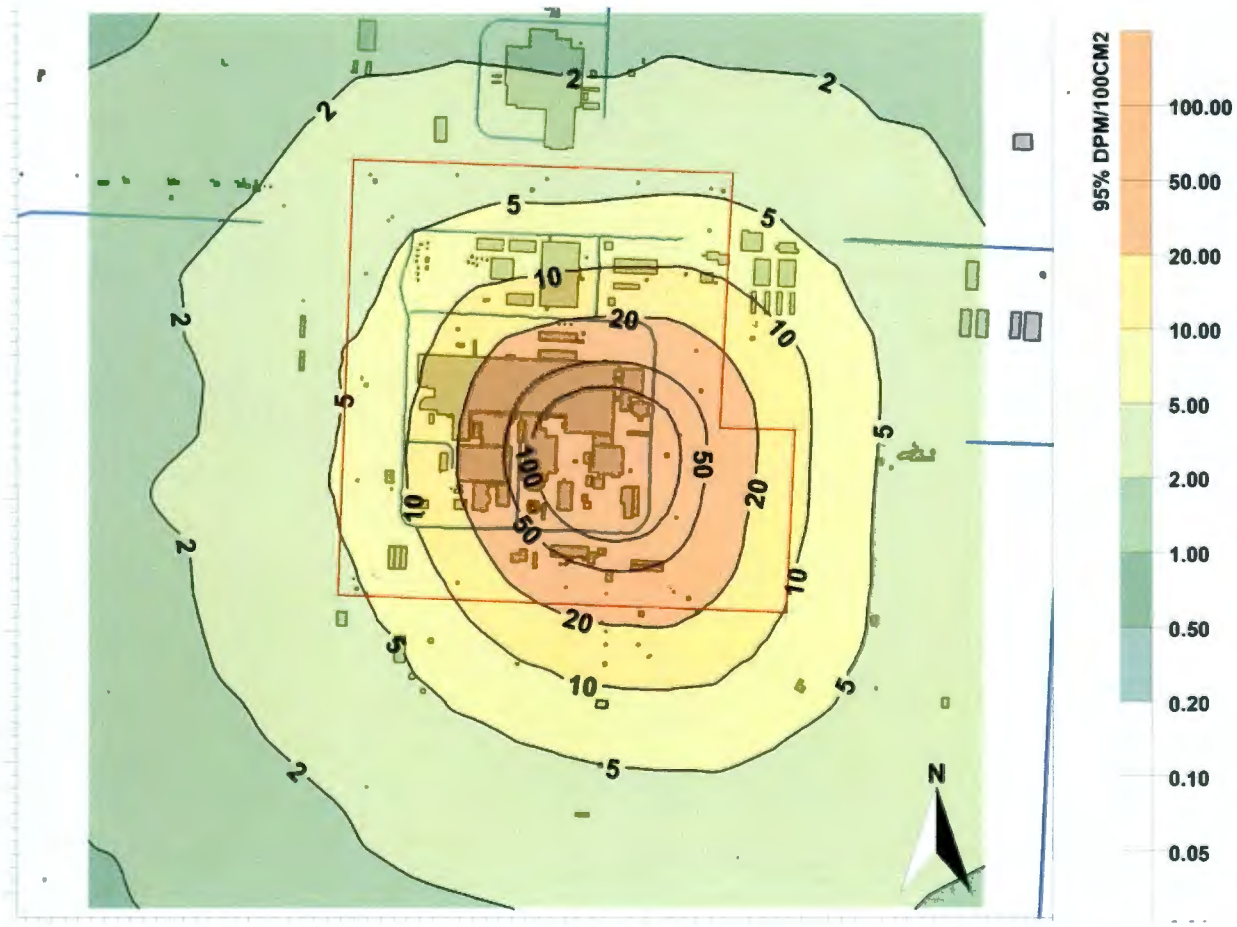

Figure 3.2-2. Predicted 95th Percentile Surface Deposition for Demolition of all PFP Buildings

4.0 Discussion of Results

The source-term analysis projected the levels of releases of radioactive material that is to be anticipated during the demolition of the Plutonium Finishing Plant (PFP) facilities 236-Z cell and 234-5Z Zone 4. The modeling results presented here are closely tied to the details of how the demolition is planned to be conducted. The shearing or mechanical hammering option using emission mitigation methods was considered for all the proposed demolition activities (with the exceptions of careful removal of pieces of highly contaminated equipment). This option represents a standard demolition approach that has been used in several past demolition efforts at Hanford. These modeling results indicate that the radiological exposures from the planned demolition efforts should be below the designated limits for air and soil exposures outside of the existing PFP fenceline.

The releases from the 236-Z cell produce predicted air concentration increments that are of concern in terms of the projected worst-case levels of air exposures based on 95th percentile meteorological conditions. The assumed shearing or mechanical hammering demolition option that includes extensive pre-demolition structure decontamination and preparation is widely used for demolition of structures with hazardous contamination. However, using this demolition option for the 236-Z Cell could spread surface contamination in excess of Hanford administrative limits beyond the edges of the current buildings and potentially beyond the current fence line of the PFP area under worst-case meteorological conditions.. It needs to be noted that the assumed 236-Z cell contamination levels are the highest of the entire PFP structure. Different demolition methods and/or extensive decontamination could reduce the potential for releases, and thus reduce the levels of potential radiological exposures.

The demolition of the PFP facilities will also result in deposition of alpha-emitting radionuclides on the soil surfaces nearby. The administrative limit for surface contamination of 20 dpm/100 cm^2 of alpha-particle emitters has been used as an indicator of the spread of surficial deposition. As indicated in Figures 3.2-1 and 3.2-2, this administrative limit may be reached in areas near the current PFP fenceline. This suggests that efforts to minimize and remediate the deposition should be considered to minimize the spread of contamination in the demolition.

4.1 Comparison of Modeling and Monitoring Units

It should be noted that the results presented in this addendum use the convention of the original work (Napier et al. 2016) and report DAC units derived for the 236-Z facility specifically. That derivation was based on the assumption that the plutonium isotopes in the facility had oxidized and could be considered to be inhalation Class S (Class Y in ICRP 30 terminology). The operating crews currently performing the demolition use monitoring equipment calibrated in terms of DAC defined for nitrates, given in 10 CFR 835 (DOE 1998) as Class M (or Class W in ICRP-30 terms). As a result there is about a 6-fold difference in the conversion of activity concentration to DAC between the two methods, with the reported DAC being higher for a given air concentration assuming Class M nitrates. This must be kept in mind when comparing these predictions with the reported operational measurements.

The difference in units is important should it be desired to compare the results of the modeling work in this series of reports with field measurements made concurrently with the demolition. Figure 4.1-1 shows the same results as Figure 3.1-1 but normalized to the concentration value for DAC used by the

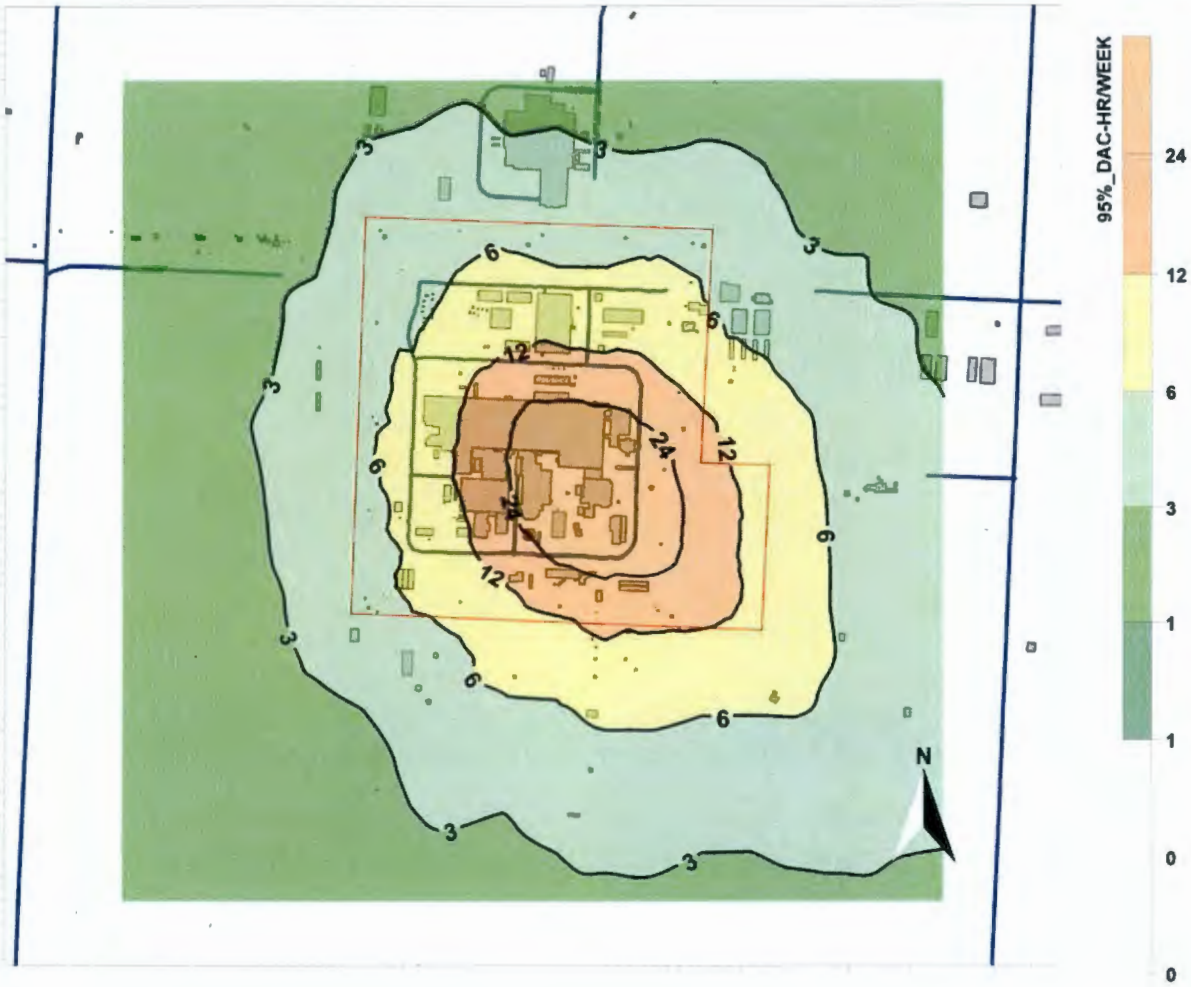

Figure 4.1-1. Predicted 236-Z Cell and 234-5Z Zone 4 Concurrent Demolition 95th Percentile Weekly Air Concentrations – 40-day Cell Demolition Schedule – Normalized to Monitoring DAC Units

field monitoring crew. Figure 4.1-2 shows the same results as Figure 3.1-2 but normalized to the concentration value for DAC used by the field monitoring crew.

It is important to note that the dose consequences for Figures 3.1-1 and 4.1-1, and for Figures 3.1-2 and 4.1-2, are exactly the same, because they are based on the same predicted time-integrated air concentrations. Only the reporting units of DAC (based on facility-specific radionuclide mixtures in Figures 3.1-1 and 3.1-2, and on an operational level of 5E-12 μCi/ml for Figures 4.1-1 and 4.1-2) differ. The Figures in Section 4 are presented to allow comparisons of the operational monitoring results to the demolition modeling predictions presented in this and prior reports.

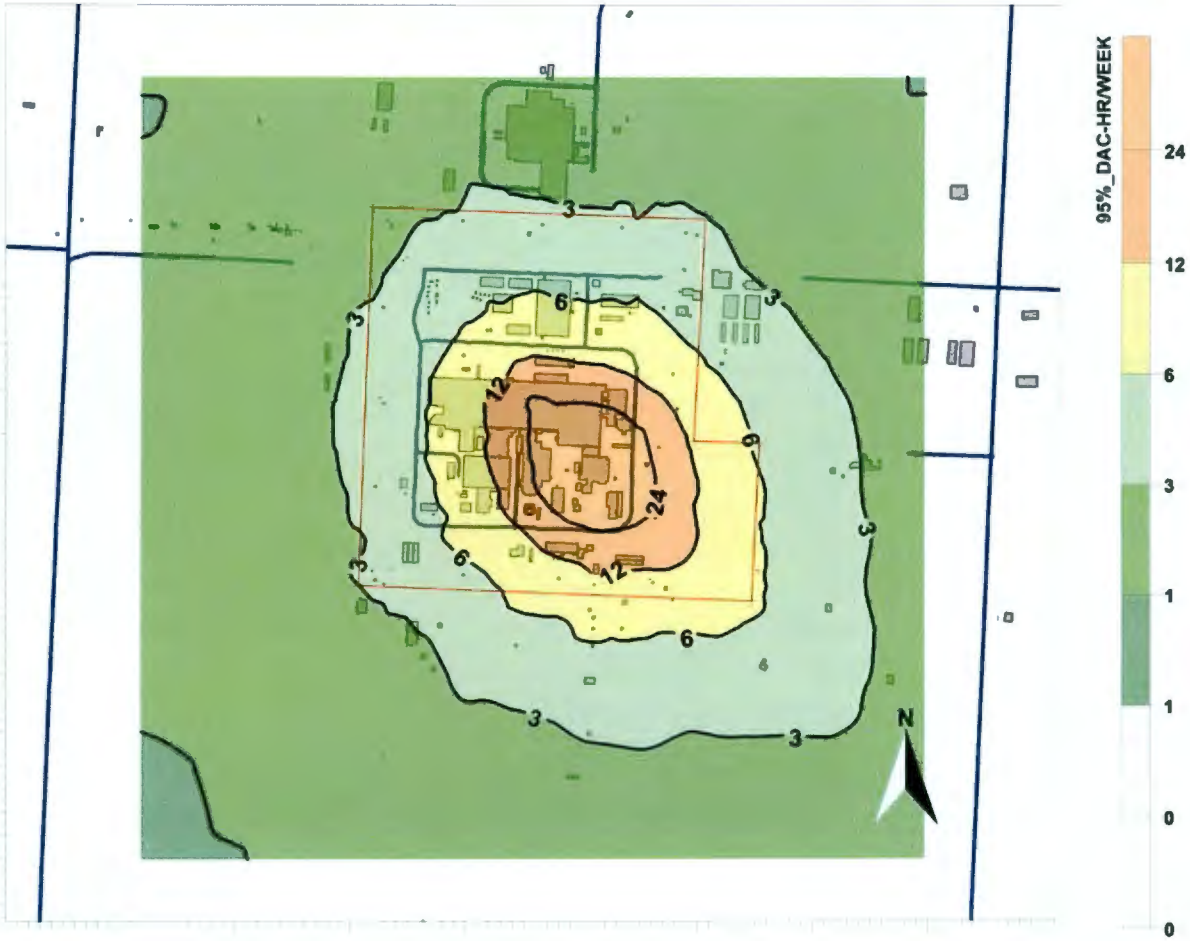

Figure 4.1-2. Predicted 236-Z Cell and 234-5Z Zone 4 Concurrent Demolition 95th Percentile Weekly Air Concentrations – 46-day Cell Demolition Schedule – Normalized to Monitoring DAC Units

It is also important to note that neither approach to use of DAC units is "wrong". The values used in this Addendum and in the series by Napier et al. are based on a scientific interpretation of the hazard presented by the radionuclides in the facility. The DAC values used in the demolition operations are standardized and remain the same from facility to facility, for reasons of simplicity and reporting coherence, and provide an additional degree of protection to the workers.

In summary, this report documents anticipated releases and environmental contamination that could be expected for open-air demolition of the PFP facilities using typical demolition techniques. These results are provided for planning purposes. This report does not document any decisions about the decommissioning approaches.

5.0 References

40 CFR Part 51. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 51, "Revision to the Guideline on Air Quality Models: Adoption of a Preferred General Purpose (Flat and Complex Terrain) Dispersion Model and Other Revisions; Final Rule."

DOE – U.S. Department of Energy. 1994. DOE Handbook, *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*, Volume 1 - Analysis of Experimental Data. DOE-HDBK-3010-94, Washington, D.C.

DOE – U.S. Department of Energy. 1998. Title 10, U.S. Code of Federal Regulations, Part 835. Occupational Radiation Protection. FR 63:213, pp. 59662-59689, Washington, D.C

DOE – U.S. Department of Energy. 2013. Good Practices for Occupational Radiological Protection in Plutonium Facilities, DOE-STD-1128-2013, Washington, D.C.

Droppo JG, Napier BA. 2006. *Analysis of Radioactive Releases During Proposed Demolition Activities for the 232-Z Building,* PNNL-15851, Pacific Northwest National Laboratory, Richland, Washington.

Droppo, JG, Jr, Napier BA. 2011."Use of Source Term and Air Dispersion Modeling in Planning Demolition of Highly Alpha-Contaminated Buildings." *Proceedings of the 14th International Conference on Environmental Remediation and Radioactive Waste Management (ICEM 2011)* , September 25 – 29, Reims, France.

EPA – U.S. Environmental Protection Agency. 1995. Compilation of Air Pollutant Emission Factors AP-42, Fifth Edition, Volume 1: Stationary Point and Area Sources. Research Triangle Park, North Carolina.

EPA – U.S. Environmental Protection Agency. 2008. Technology Transfer Network Support Center for Regulatory Air Models, http://www.epa.gov/scram001/(Access last checked 6/5/2008).

Napier BA, Droppo JG, Rishel JP. 2008. *Analysis of Radioactive Releases During Proposed Demolition Activities for the 105-KE Basin,* PNNL-17631, Pacific Northwest National Laboratory, Richland, Washington.

Napier BA, JP Rishel, JG Droppo. 2009. *Analysis of Radioactive Releases during Proposed Demolition Activities for the 224-U and 224-UA Buildings*. PNNL-18332, Pacific Northwest National Laboratory, Richland, Washington.

Napier BA, Rishel JP, Droppo JG., Strom DJ, Joyce KE. 2010. *Analysis of Radioactive Releases during Proposed Demolition Activities for the 224-U and 224-UA Buildings*. PNNL-18332 Addendum , Pacific Northwest National Laboratory, Richland, Washington.

Napier BA, Rishel JP, El Mart. 2016. Air Dispersion Modeling of Radioactive Releases During Proposed PFP Complex Demolition Activities. PNNL-20173 Revision 4. Pacific Northwest National Laboratory, Richland, Washington.

Sauer, PM, KJ Maloy, JL Westcott, 2016. *Radiological Characterization of Plutonium Reclamation Facility Canyon Walls and Gallery Gloveboxes*. CHPRC-03038, Rev 0, CH2M Hill Plateau Remediation Company, Richland, Washington.

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SR Godfrey	T4-22
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