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ENVIRONMENTAL CALCULATION COVER PAGE

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Terms

COC	contaminant of concern
ECF	environmental calculation file
MAR	material at risk
MEI	maximally exposed individual
NESHAP	"National Emission Standards for Hazardous Air Pollutants" (40 CFR 61)
PTE	potential to emit
PUREX	Plutonium Uranium Extraction

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1 Introduction

This environmental calculation file (ECF) provides air emission estimates for a removal action at the 211A Chemical Storage Area (211A Area) located within the Plutonium Uranium Extraction (PUREX) Complex (Figure 1). This document summarizes the assumptions, inputs, and methodology used to calculate the potential-to-emit (PTE) radionuclide airborne emissions and potential dose to the maximally exposed individual (MEI). This ECF also documents the determination of criteria/toxic air emissions resulting from the removal action.

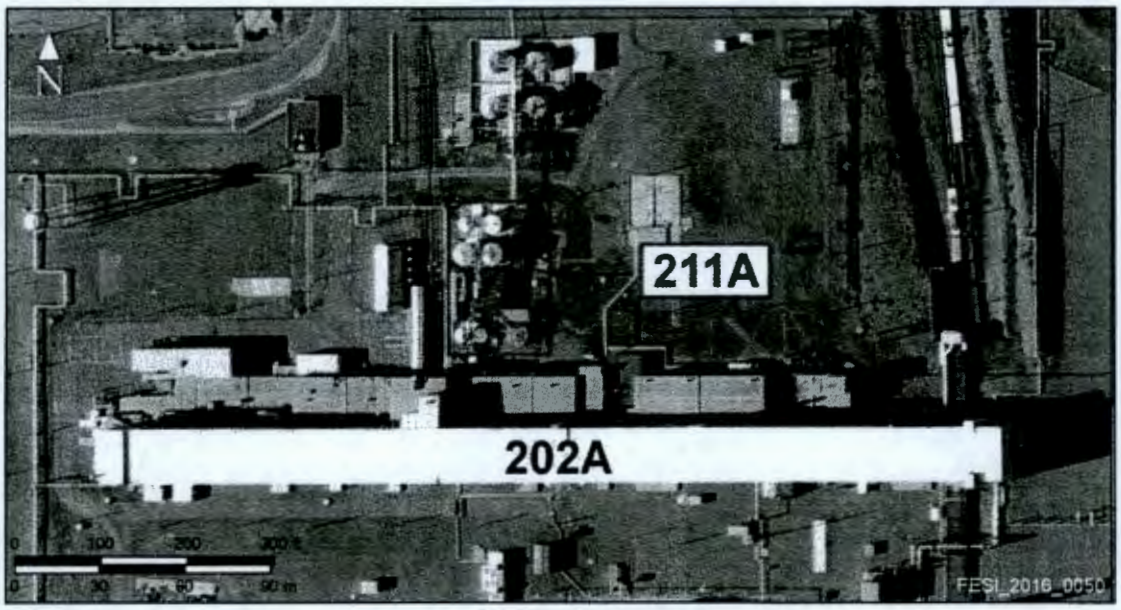

Figure 1. 211A Area within the PUREX Complex

This ECF supports DOE/RL-2016-47, *Removal Action Work Plan for the PUREX Complex Tier 2 Buildings/Structures*, which implements the demolition of the 211A Area in accordance with DOE/RL-2010-102, *Action Memorandum for Decontamination, Deactivation, Decommissioning and Demolition (D4) Activities for 200 East Tier 2 Buildings/Structures*.

2 Background

The 211A Chemical Storage Area is located in the 200 East Area north of the 202A Building (PUREX) (Figure 1). The 211A Area was constructed between 1952 and 1956 and consists of two tank storage areas separated by the 211A Pump House (Figure 2). All tanks except TK-30 are contained within individual secondary containment structures as a precaution for unplanned releases. The 211A Area currently houses 20 tanks: eight are located inside the 211A Pump House, and the remaining 12 tanks are within either the north or south tank storage sections. The 211A Area was used to store nine bulk liquid chemicals, a deionization unit, a neutralization unit, and a sump collection tank. A Resource Conservation and Recovery Act permitted unit, Tank TK-40 was also used to store slightly contaminated tributyl phosphate.

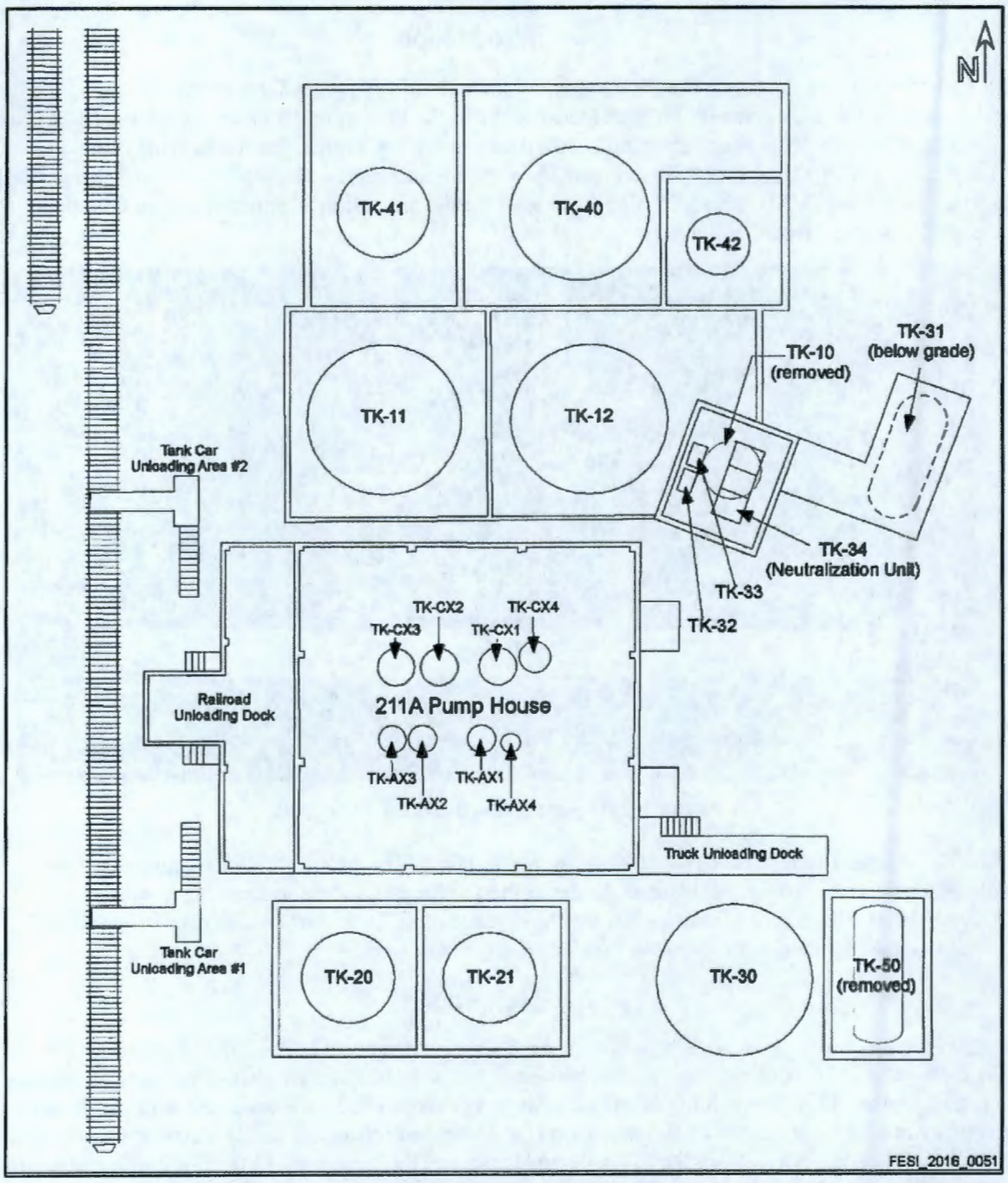

Figure 2. 211A Area

The PUREX Complex began deactivation activities following a final facility closure order from DOE in December 1992. Between 1992 and 1998, work was conducted to place the PUREX Complex in a safe configuration. At the 211A Area, bulk chemical inventory that could still be used was drained from the tanks and shipped offsite. Waste chemicals that could not be sold were drained and disposed of in the double-shell tank system.

During deactivation, approximately 21,500 gal of slightly contaminated organic solution was transferred from PUREX cells G and R to the 211A Area for temporary storage (WHC-SD-WM-AP-037, *Alternatives for the Disposition of PUREX Organic Solution*). Samples of this solution were collected in 1993, prior to transfer out of the PUREX cells. The organic solution was transferred to a facility near Oak Ridge, Tennessee for incineration, and all tanks were flushed with adequate amounts of water. 211A Area tanks were also used to support PUREX canyon deactivation by storing flushing solutions (Attachment 2 of 17710-94-005, "PUREX Deactivation Flushing Activities") until the solutions could be treated and transferred to the double-shell tank system. HNF-SD-CP-HIE-004, *PUREX Deactivated End-State Hazard Analysis*, provides information indicating that all tanks in the 211A Area were emptied or flushed with only a minimum heel remaining at the completion of deactivation.

As described in DOE/RL-2016-47, removal actions for the 211A Area include removal or demolition of all tanks; demolition of the secondary containment structures, pump house, and loading dock; excavation of underlying soils; and disposition of demolition waste. Appropriate sampling and stabilization activities will be conducted, as necessary. The remaining hazards associated with the 211A Area include fixed radioactive contamination, chemical contamination, and asbestos-containing material within tank and pipe insulation.

3 Radiological Air Emission Calculations

This chapter documents the radiological air emission calculations for the removal action at the 211A Area, where radiological release potential exists. The applicable state requirements in 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 211A Area removal action would be considered diffuse and fugitive emissions and would be monitored by the existing Hanford Site Environmental Monitoring Program, which serves as the monitoring system for all site activities, as described in DOE/RL-91-50, *Hanford Site Environmental Monitoring Plan*. Near-facility ambient air monitoring stations N969, N970, N985, and N977 surround the PUREX Complex and are planned to be used for monitoring during removal action (Figure 3).

The methodology used to estimate the PTE is based upon the guidance document DOE/RL-2006-29, Rev. 2, *Calculating Potential-to-Emit Radiological Releases and Doses*. Airborne emissions control and monitoring requirements for radiological air emissions will be identified as needed, based on the calculated value of the potential emissions and resultant public exposure.

Figure 3. Near-Field Air Monitor Locations for the 211A Area

3.1 Assumptions and Inputs

This section describes the assumptions and inputs used to calculate PTE and the onsite/offsite dose to the MEI values associated with the 211A Area removal action. The assumptions and inputs are obtained from facility descriptions and deactivation documentation.

1. A total inventory of 0.05 g of plutonium and 0.41 g of uranium were within the 21,500 gal of transferred solution (WHC-SD-WM-AP-037).

2. The plutonium inventory is conservatively assumed to be plutonium-239/240 (Pu-239/240) due to highest total dose-per-unit-release factor (dose factor) of plutonium isotopes. Uranium results are assumed to be uranium-235 (U-235), due to enrichment during fuel processing.

3. The 211A Area secondary containment structures, pump house, loading docks, and underlying soils are assumed contaminated from operations. The radiological inventory for these structures and underlying soils is conservatively assumed to contain the same radiological inventory as found in 211A Area tanks.

4. Specific activity values from 10 CFR 71, "Packaging and Transportation of Radioactive Material," Table A-1—"A_1 and A_2 Values for Radionuclides," for Pu-239/240 and U-235 are used to convert from grams to curies. Specific activities for Pu-239/240 and U-235 are 6.20E-02 Ci/g and 2.20E-06 Ci/g, respectively.

5. It is assumed that the entire material at risk (MAR) in a particulate form is available for release within 1 year.
6. The radionuclides of concern are particulate solids; therefore, a release fraction of 1.0E-03 is used in accordance with WAC 246-247-030, "Definitions," and 40 CFR 61, "National Emission Standards for Hazardous Air Pollutants" (NESHAP), Appendix D, "Methods for Estimating Radionuclide Emissions."
7. Dose factors were taken from DOE/RL-2006-29, Rev. 2, Table 4.4, assuming an effective release height of less than 40 m (131 ft) within the 200 East Area. The dose factors include the parent isotope and its radioactive decay products (+D) in accordance with Section 3.2.3 of DOE/RL-2006-29, Rev. 2. Dose factor values are provided in Section 3.4.

3.2 Methodology

Potential radionuclide air emission estimates are determined using the Method 1: Annual Possession Quantity process as described in DOE/RL-2006-29, Rev. 2.

The inventory described in Section 3.1, Item 1 is used to estimate MAR, which is the assumed quantity of contamination present for both "211A Area Tanks" and the "211A Structures and Soils" (Section 3.1, Item 3). The MAR is used to calculate the PTE, which is an estimate of the radionuclides that could potentially be emitted during the removal action at the 211A Area. The PTE and dose factors from DOE/RL-2006-29, Rev. 2 are used to determine onsite and offsite doses to the MEI.

The calculation is outlined in the following steps:

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

The following sections provide detailed descriptions of each step. Section 3.4, Table 1 provides the air emissions calculations for Pu-239/240 and U-235.

3.2.1 Material at Risk

MAR is measured as total activity in curies. MAR is calculated as follows:

Convert the radiological inventory from grams to curies by multiplying the inventory by specific activity as shown in Equation 1.

$$\text{MAR}\ (Ci) = \text{Inventory}\ (g) \times Specific\ Activity \left(\frac{Ci}{g}\right) \quad (1)$$

3.2.2 Potential to Emit

The maximum PTE in a calendar year is calculated using the MAR and a release fraction, in accordance with NESHAP (40 CFR 61, Appendix D). Because it is assumed that the entire MAR is available for release within a 1-year period as described in Section 3.1, Item 5, Ci/yr is used for MAR units in PTE and

MEI dose calculations. The MAR is multiplied by a unitless release fraction of 1.0E-03 as described in Section 3.1, Item 6. Equation 2 shows this process:

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

3.2.3 Dose to the Maximally Exposed Individual

The potential total onsite and offsite doses to the MEI are determined by multiplying the PTE (calculated using Equation 2) by the dose-per-unit-release factors described in Section 3.1, Item 7. The potential onsite dose for the MEI for a single isotope is performed using Equation 3:

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

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

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

3.3 Software Applications

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

3.4 Calculations

Table 1 provides the potential air emission calculations for 211A Area radiological constituents of concern (Pu-239/240 and U-235). These calculations follow the methodology described in Section 3.2, using the assumptions and inputs stated in Section 3.1. Table 1 provides the total potential dose for onsite and offsite MEI by using the sum of potential air emissions for all radiological constituents of concern. The potential unabated dose to the onsite MEI is 2.03E-05 mrem/yr; the potential unabated dose to the offsite MEI is 1.72E-05 mrem/yr.

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

Table 1. PTE Calculation for the 211A Chemical Storage Area

A	B	C	D	E	F	G	H	I	J
						Dose Factor[f] (mrem/yr per Ci/yr)		Unabated Dose to MEI (mrem/yr)	
Radionuclide	Inventory[a] (g)	Specific Activity[b] (Ci/g)	MAR[c] (Ci)	Release Fraction[d]	PTE[e] (Ci/yr)	Onsite MEI	Offsite MEI	Onsite MEI[g]	Offsite MEI[h]
211A Area Tanks									
Pu-239/240	0.05	6.20E-02	3.10E-03	1.00E-03	3.10E-06	3.28E+00	2.78E+00	1.02E-05	8.62E-06
U-235	0.41	2.20E-06	9.02E-07	1.00E-03	9.02E-10	2.27E-01	2.05E-01	2.05E-10	1.85E-10
211A Structures and Soils[i]									
Pu-239/240	0.05	6.20E-02	3.10E-03	1.00E-03	3.10E-06	3.28E+00	2.78E+00	1.02E-05	8.62E-06
U-235	0.41	2.20E-06	9.02E-07	1.00E-03	9.02E-10	2.27E-01	2.05E-01	2.05E-10	1.85E-10
							Total (mrem/yr)	**2.03E-05**	**1.72E-05**

a. Inventory per WHC-SD-WM-AP-037.

b. Specific activity (Ci/g) obtained from 10 CFR 71, Appendix A Table A-1.

c. MAR (Ci) = Inventory (Column B) × Specific Activity (Column C); see Section 3.2.1, Equation 1.

d. Release fraction used in accordance with WAC 246-247-030 and 40 CFR 61, Appendix D.

e. PTE (Ci/yr) = MAR (Column D) × Release Fraction (Column E); see Section 3.2.2, Equation 2.

f. Dose factors from DOE/RL-2006-29, Rev. 2, Table 4.4, assuming an effective release height of less than 40 m (131 ft) within the 200 East Area.

g. Onsite MEI (mrem/yr) = PTE (Column F) × Onsite MEI Dose Factor (Column G); see Section 3.2.3, Equation 3.

h. Offsite MEI (mrem/yr) = PTE (Column F) × Offsite MEI Dose Factor (Column H); see Section 3.2.3, Equation 4.

i. Contamination associated with secondary containment structures, pump house, loading docks, and underlying soils are conservatively assumed to contain an inventory equal to the tanks within the 211A Area.

3.5 Radiological Air Emission Results

Potential radionuclide air emission estimates were calculated for the 211A Area removal action described in DOE/RL-2016-47. The resulting onsite and offsite MEI are as follows:

- The potential unabated dose to the onsite MEI is 2.03E-05 mrem/yr. The onsite MEI is located at Energy Northwest. The distance from the 200 East Area emission zone to Energy Northwest is 16.7 km (10.4 mi) east-southeast.
- The potential unabated dose to the offsite MEI is 1.72E-05 mrem/yr. The offsite MEI is located at the Hanford Site boundary. The distance from the 200 East Area emission zone to the Hanford Site boundary is 19.4 km (12.1 mi) east-southeast.

As determined by the above calculations, the effective dose equivalent to the MEI emission values for the 211A Area are well below the National Emission Standard for U.S. Department of Energy facility emissions of radionuclides to the ambient air (40 CFR 61, Subpart H, "National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities"). They are also well within compliance with WAC 246-221-060, "Dose Limits for Individual Members of the Public," which requires that Hanford Site operations not result in a dose to an individual members of the public in excess of 10 mrem/yr.

4 Criteria/Toxic Air Determination

This section documents the determination of criteria and toxic air emissions resulting from the removal action at the 211A Area. This determination supports DOE/RL-2016-47 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 and toxic emissions are expected.

During deactivation in the 1990s, tanks were emptied of resins or residual chemicals and then flushed with water until the rinsate was verified to have a pH greater than 2 but less than 12.5 (i.e., no longer exhibited the dangerous waste characteristic of corrosivity). It was assumed that each flush reduced the concentration in a vessel by $10^{(n+1)}$ for one to three flushes (HNF-SD-CP-HIE-004). The rinsate and tank heels were removed to the extent possible using existing piping and equipment.

The chemical contaminants of concern (COCs) for the 211A Area are as follows (DOE/RL-2016-47):

- Asbestos
- Aluminum nitrate nonahydrate
- Ammonium fluoride
- Ammonium nitrate
- Cadmium nitrate
- Nitric acid
- Normal paraffin hydrocarbon
- Potassium hydroxide
- Sodium hydroxide
- Sulfuric acid
- Tetradecane
- Tributyl phosphate

The COCs were identified using process knowledge, deactivation activities, and construction materials. The chemical contaminants were compared to WAC 173-460-150, "Table of ASIL, SQER and de Minimis Emission Values," to identify regulated contaminants. Of the COCs, asbestos, cadmium, fluoride, nitric acid, sodium hydroxide, and sulfuric acid are regulated. Table 2 lists the regulated COCs with their de minimis emission values.

Table 2. De Minimis Emission Values for 211A Area Chemicals

Name	Chemical Abstracts Service Number	De Minimis Emission*
Asbestos	1332-21-4	1.53E-04 lb/yr
Cadmium and compounds	7440-43-9	2.28E-03 lb/yr
Fluoride containing chemicals (not otherwise specified)	--	8.54E-02 lb/day
Nitric acid	7697-37-2	9.42E-03 lb/hr
Sodium hydroxide	1310-73-2	8.76E-04 lb/hr
Sulfuric acid	7664-93-9	6.57E-03 lb/day

*Values from WAC 173-460-150.

Toxic air requirements associated with asbestos-containing materials at the 211A Area will be addressed in accordance with applicable NESHAP requirements. An asbestos inspection will be performed by an *Asbestos Hazard Emergency Response Act of 1986*-certified building inspector and necessary abatement performed.

Toxic emissions from the other regulated chemicals are not expected, as explained below.

- TK-10, which contained cadmium nitrate, was flushed, drained, and removed during the 1980s prior to deactivation; thus, toxic air emissions for cadmium are not expected.
- Chemical concentrations in the remaining tanks (fluoride, nitric acid, sodium hydroxide, and sulfuric acid) were greatly reduced by the deactivation flushing activities. For example, the ammonium nitrate concentration in TK-11 was reduced from 7.2 wt% during operations (Section 4.11.4.4 of RHO-MA-116, *PUREX Technical Manual*) to 0.0766 wt% after flushing (17710-94-005).

Therefore, remaining concentrations are not expected to be significant enough to result in toxic air emissions during the removal action. In addition, any remaining liquid heels will be solidified prior to tank removals, eliminating the potential for emission.

5 References

17710-94-005, 1994, "PUREX Deactivation Flushing Activities" (Internal Memo to G.J. LeBaron from W.A. Peiffer), Westinghouse Hanford Company, Richland, Washington, April 4.

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Environmental Calculation Review Checklist

Calculation Title: Radiological and Toxic Air Emission for 211A Chemical Storage Area
Calculation Number: ECF-Hanford-17-41
Revision: 0
Preparer: John Young
Checker: Carolyn Ervin

Items to Verify	Yes	No	N/A	Comments
1) Are the following elements clearly described? a) Purpose b) Calculation approach c) Assumptions d) Inputs e) Equations used f) Results/conclusions g) References	☒	☐	☐	
2) Are necessary assumptions explicitly stated and supported?	☒	☐	☐	
3) Are data files identified in the document?	☐	☐	☒	
4) Are table lookups correct?	☐	☐	☒	
5) Is data used in the calculation explicitly stated in the document?	☒	☐	☐	
6) Was data checked for consistency with the original source information?	☒	☐	☐	
7) Were mathematical derivations checked, including dimensional consistency of results?	☒	☐	☐	
8) Was the data input into the spreadsheet correctly?	☒	☐	☐	
9) Was the calculation performed to verify it is free of errors?	☒	☐	☐	

I verify that all numbers have been checked and that comments have been addressed appropriately.

Checker: Carolyn Ervin CEErvin 8/21/2017
Print/Signature/Date

Preparer: John Young [signature] 8/21/2017
Print/Signature/Date