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HEPA Filter Fire (and Subsequent Unfiltered Release)

G. W. Ryan

Westinghouse Hanford Company, Richland, WA 99352
U.S. Department of Energy Contract DE-AC06-87RL10930

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Key Words: contaminated fire, fire, HEPA filter fire, radioactive materials, TWRS, tank farms, ventilation system

Abstract: This document supports the development and presentation of the following accident scenario in the TWRS Final Safety Analysis Report:

HEPA Filter Failure - Exposure to High Temperature or Pressure.

The calculations needed to quantify the risk associated with this accident scenario are included within.

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Sam A. Holand
Release Approval

8/12/96
Date

Approved for Public Release

Calculation Cover Sheet

Project Accident Analysis for Hanford FSAR		Calculation No. S-CLC-G-00125		Project Number N/A	
Title HEPA Filter Fire (and subsequent unfiltered release)		Functional Classification N/A		Sheet 1 of 45	
		Discipline: Safety			
Preliminary		x Committed		Confirmed	
Computer Program: Microsoft Excel				Version Release No.: 5.0	
<u>Purpose and Objective</u> The purpose of this calculation note is to document the consequences of the fire in or around ventilation systems and subsequent unfiltered release in TWRS facilities. The consequences are for TWRS FSAR accident, HEPA Filter Fire (and subsequent unfiltered release).					
<u>Summary of Conclusions</u> The unmitigated onsite and offsite radiological and toxicological doses, shown in Table 1 are well within the evaluation guidelines except the onsite radiological consequences for SSTs (with active ventilation only), DSTs, and 244-AR. The mitigated onsite radiological doses for SSTs (with active ventilation only), DSTs, and 244-AR are orders of magnitude below the evaluation guidelines. The CAM-interlock that detects potential unfiltered release and shuts off ventilation within 10 minutes for SSTs (with active ventilation only), DSTs, and 244-AR is credited in the mitigated analysis and designated as Safety Significant.					
Revision					
Rev. No.	Revision Description				
0	Original issue				
Sign Off					
Rev. No.	Originator (Print) Sign/Date	Verification / Checking Method	Verifier/Checker (Print) Sign/Date	Manager (Print) Sign/Date	
0	M. K. Gupta <i>MKG</i> 7-3-96	Verification by Individual Review (Manual E7, Procedure 2.40)	R. D. Graves <i>R.D. Graves</i> 7-3-96	L. A. Wooten <i>LAW</i> 7/3/96	
			R. J. Van Vleet		
			<i>Check/initial/Date 07/03/1996</i>		
Classification:					
UNCLASSIFIED DOES NOT CONTAIN UNCLASSIFIED CONTROLLED NUCLEAR INFORMATION					
ADC & Reviewed by: <i>[Signature]</i> Official: <i>[Signature]</i> Plant Engineer (Name and Title) Date: <i>7/9/96</i>					

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CALC-NOTE CHECKLIST

REVIEWER(S):

NAME (PRINT OR TYPE)

SIGNATURE

DATE

R. D. Graves*R. D. Graves*8-3-96CIRCLE ONE

1. Is the Subject and/or Purpose clearly stated? ☒ YES NO
2. Are the required Input Data and their references and source provided and are they consistent with the Calc-Note purpose? ☒ YES NO
3. Are the Assumptions clearly identified, valid and consistent with the Calc-Note purpose? ☒ YES NO
4. Is the Analytical Method or Approach Used clearly identified? ☒ YES NO
5. Are all the pages consecutively numbered and identified by the Calc-Note number? ☒ YES NO
6. Is/are the version(s) of the computer program(s) used identified and QA'd adequately? ☒ YES NO NA
7. Are input listings for all computer programs documented in this Calc-Note, and are they V&Vd and appropriate for the intended use? YES NO ☒ NA
8. Are the Results and Conclusions clearly stated? ☒ YES NO
9. Are OUTPUT documents included (or if not part of the calculation, clearly referenced in the Results section?) grammatically, correct, clear, and consistent with the main calc-note text? YES NO ☒ NA
10. Are the results, methods, input, and assumptions compatible with the stated purpose? ☒ YES NO

IF NO TO ANY OF THE ABOVE, LIST SHEET NUMBER(S) WITH JUSTIFICATION AND OBTAIN MANAGER'S SIGNATURE BELOW:

Manager's Signature

REVIEWER'S NOTES (use additional pages as necessary)

Review method used:

Alternate calculation Attached?Y N Approximated Originator steps ✓

1.0 REFERENCES

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9. Deleted.
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11. Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities. Volume 1 - Analysis of Experimental Data, DOE-HDBK-3010-94, December 1994.

2.0 OPEN ITEMS

1. The IVF for Filter Dimensions needs to be confirmed.

3.0 INTRODUCTION

The consequence calculated in this calc-note is for the HEPA (High Efficiency Particulate Air) fire (and subsequent unfiltered release) accident. This accident analysis was performed to support the Final Safety Analysis Report (FSAR) for Tank Waste Remediation System (TWRS) that conforms to DOE Order 5480.23 (Ref. 1). Passive or active ventilation is maintained across each waste tank, double contained receiver tanks (DCRTs), 204-AR, 244-AR, compactor building, and catch tanks. A failure of heater can cause a fire in the ventilation system or a fire around the ventilation system can degrade the filters. The integrity of the filters (HEPA and pre-filters) could be compromised by a filter fire resulting in a release of the inventory on the filters and unfiltered release of tank contents. The detailed description of the waste tanks, 204-AR, 244-AR, compactor building, and catch tanks is in chapter 2.0 of the TWRS FSAR (Ref. 2).

A frequency of Anticipated ($> 1.0 \text{ E-02/yr}$) and Unlikely (1.0 E-04/yr to 1.0 E-02/yr) was qualitatively assigned to the active ventilation systems (with heaters) and passive ventilation system (without heaters), respectively. These frequencies are based on the operational history of the Hanford Tank Farms.

4.0 INPUT DATA

The following input data were used for the consequences analysis:

- The filter configuration is from Chapter 2 of the TWRS FSAR (Ref. 2) and the dimension of the filter from IVF (Information Validation Form) (Ref. 3).
- SSTs (Single Shell Tank) active ventilation flow rate = 3.30 cubic m/s ($7,000 \text{ cfm}$) (Ref. 2).
- SSTs passive ventilation flow rate = $6.8 \text{ E-4 cubic m/s}$ (Ref. 4).
- DSTs (Double Shell Tank) active ventilation flow rate = $5.50 \text{ E-1 cubic m/s}$ ($1,170 \text{ cfm}$) (Ref. 2).
- AWF, DSTs (Double Shell Tank) active ventilation flow rate = 1.89 cubic m/s ($4,000 \text{ cfm}$) (Ref. 2).
- DCRTs (Double Contained Receiver Tank) active ventilation flow rate = 1.98 cubic m/s ($4,200 \text{ cfm}$) (Ref. 2).
- 204-AR active ventilation flow rate = $9.44 \text{ E-1 cubic m/s}$ ($2,000 \text{ cfm}$) (Ref. 2).
- 244-AR active ventilation flow rate = 7.08 cubic m/s ($15,000 \text{ cfm}$) (Ref. 2).
- Compactor building active ventilation flow rate = $9.44 \text{ E-1 cubic m/s}$ ($2,000 \text{ cfm}$) (Ref. 5).
- Catch tanks (241-A-417 and 241-AX-152) have inlet HEPA filters only (Ref. 2).

- The unit liter dose (ULD) for different waste streams is from Reference 6. The table containing ULD is attached in Appendix B.

5.0 ASSUMPTIONS

The following assumptions were used in this analysis:

1. Dose rate at contact from pre-filters and HEPA filters is $\leq 200 \text{ mR/hr}$. According to Information Validation form (IVF), HEPA filters are changed when the contact dose rate is 160 mR/hr (Ref. 7). The location for calculating contact dose rate in pre-filter and HEPA filters is defined in Reference 8.
2. All the filters are compromised and release their content during a fire in or around the ventilation system.
3. The ventilation system remains in operation during and following the fire.
4. The CAM-interlocks will detect and shut-off the ventilation system within 10 minutes for DSTs, 244-AR and SSTs (Active ventilation tanks only). Used for mitigated analysis only.
5. An additional amount equal to the loading on pre-filter or HEPA filter is used in order to account for accumulation in the ventilation duct work.
6. The occupancy factor, (OF) for the maximum onsite individual is assumed to be 1.0 and 0.286 for a 12-hour and a 1 year release, respectively. The OF for a maximum

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offsite individual is 1.0.

7. The respirable fraction (RF) for unfilled release is 1.0 for all cases.
8. The ^{Partition Factor} (PF) for sst.act, sst.pas.1, sst.pas.2, dert, 204-AR, and 244-AR is $1.0E-10$ and PF for dert, lig and dert, awt1 is $1.0E-8$.
9. The airborne release fraction (ARF) is $1.0E-4$ for a filter fire from Reference 11.
10. There is no liquid in Compactor Building or Catch tanks.

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6.0 ANALYTICAL METHODS AND CALCULATIONS

Passive or active ventilation is maintained across each waste tank, double contained receiver tanks (D CRTs), 204-AR, 244-AR, compactor building and catch tanks. A failure of heater can cause a fire in the ventilation system or a fire around the ventilation system can degrade the filters. The integrity of the filters (HEPA and pre filters) could be compromised by a filter fire resulting in a release of the inventory on the filter and unfiltered release of tank contents.

The hazard analysis performed for the TWRS facilities identified two potential scenarios:

- A. An unfiltered release due to failure of HEPA filters
- B. A filter fire in or around the ventilation system and subsequent unfiltered release of tank contents (head space gases).

Scenario A.

The details of methodology used to calculate the onsite and offsite consequences from unfiltered release are in Reference 4.

The onsite ^{and offsite} radiological dose consequences are calculated by the following equations:

$$\text{Dose (SV)} = \text{OF} \times \chi/Q \times R \times \text{ULD} \times Q' \times t \quad (1)$$

where,

OF = Occupancy factor, for 12 hour release it is assumed to be 1.0. It is assumed to be 0.286 for an onsite release that lasts a year. The OF for a maximum offsite individual is 1.0

χ/Q = Atmospheric dispersion coefficients are from reference 10.

R = Breathing Rate, $2.7 \times 10^{-4} \text{ m}^3/\text{s}$ for a 24-hour release offsite and 1-year release onsite and offsite and $3.3 \times 10^{-4} \text{ m}^3/\text{s}$ for a 12-hour release onsite

ULD = Unit-liter-dose value for different waste type are in Appendix B.

t = period of release (in seconds)

Q' = Release rate (l/s)

The Q' is defined as:

$$Q' = \text{RF} \times (1 - e) \times V \times \text{PF}$$

where,

RF = Respirable fraction. It is assumed to be 1.0 for all cases.

ϵ = HEPA filter efficiency, it is assumed to be 0.0.

V = Volume flow rate of the effluent, m^3/s

PF = Partition factor. A partition factor of 10^{-10} is used for solids and unagitated liquids and a PF of 10^{-8} is used for agitated liquids.

The dispersion coefficients for 12-hour and 24-hour release are calculated from the methodology given in Reference 10.

x/q , on site (12-hour)

From Table 4 of Reference 10, x/q for 2-hour release is $3.41 E-2$ s/m^3 ; x/q for annual release (8760 hours) from Table 9 of Reference 10 is 4.03×10^{-4}

$$\frac{\log(3.41 \times 10^{-2}) - \log(x/q, 12hr)}{\log(3.41 \times 10^{-2}) - \log(4.03 \times 10^{-4})} = \frac{\log(2hr) - \log(12hr)}{\log(2hr) - \log(8760hr)}$$

$$x/q \text{ for 12 hour release} = 1.32 E-2 \text{ s/m}^3$$

x/q , off site (24-hour)

From Table 5 of Reference 10, x/q for 2-hour release is $2.83 E-5$ s/m^3
From Table 9 of Reference 10, x/q for annual (8760hr) release is $1.24 E-7$ s/m^3

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$$\frac{\log(2.83 \text{ E-}5) - \log(x/Q, 24\text{hr})}{\log(2.83 \text{ E-}5) - \log(1.24 \text{ E-}7)} = \frac{\log(2\text{hr}) - \log(24\text{hr})}{\log(2\text{hr}) - \log(8760\text{hr})}$$

$$x/Q \text{ for 24-hour release} = 5.66 \text{ E-}6 \text{ g/m}^3$$

The tables are attached in Appendix B.

The onsite and offsite inhalation doses are calculated for different ventilation system. The methodology for calculating different onsite and offsite doses is:

12-hour Onsite dose

$$\begin{aligned} \text{Common parameter in equation 1} &= OF \times x/Q \times R \times t \\ &= 1.0 \times 1.32 \text{ E-}2 \text{ g/m}^3 \times 3.3 \text{ E-}4 \text{ m}^3/\text{s} \\ &\quad \times 12 \text{ hours} \times 3600 \text{ s/hr} \\ &= 1.88 \text{ E-}1 \text{ s} \end{aligned}$$

This is defined as $ChiQ_{\text{onsite}}$ ($1.88 \text{ E-}1$) in the excel spreadsheet in Appendix A.

The doses are then calculated by multiplying the flow rate ' Q (l/s)', 'ULD' (sv/g), PF, and a dose conversion factor of 100 (Rem/Sv). ^{and common parameter} The 12-hour Onsite dose is defined as $\text{don}(\text{rem})$

in the excel spreadsheet in Appendix A. The flow rate ' Q ' and ULD are the input data and PF is defined in assumptions.

The calculations for SST, etc are:

The flow rate is $3.3 \text{ m}^3/\text{s}$ (input data) or $3.3 \times 10^3 \text{ l/s}$

The PF is $1.0 \text{ E-}10$ (assumptions)

ULD is $2.2 \text{ E+}5 \text{ Sv/g}$

$$\begin{aligned} \text{don (rem)} &= 3.3\text{E}+3 \text{ l/s} \times 1.0\text{E}-10 \times 2.2\text{E}+5 \text{ Sy} \times 100 \text{ Rem/sy} \times 1.88\text{E}-1 \text{ s} \\ &= 1.37 \text{ rem} \end{aligned}$$

This is the value for SST_{act} under don (rem) in the excel spreadsheet in Appendix A.

The 12-hour onsite doses are calculated for SST pas1, SST pas3, dcat, dst lip, dst awt, 204-ar, 244-ar in a similar way. The doses for SST pas1 and SST pas2 are same because the flow rate is same and only the dimensions of HEPA filter are different.

Annual Onsite doses

$$\begin{aligned} \text{Common parameter in equation 1} &= 0.F \times x/q \times R \times t \\ &= 0.286 \times 4.03\text{E}-4 \text{ s/m}^2 \times 2.7\text{E}-4 \frac{\text{m}^3}{\text{s}} \\ &= 3.65 \text{ days} \times \frac{24 \text{ hours}}{\text{day}} \times 3600 \text{ s/hour} \\ &= 9.81\text{E}-1 \text{ s} \end{aligned}$$

This is defined as ChiQ_{Onsite} (9.81E-1) in the excel spreadsheet in Appendix A. and common parameter

The doses are then calculated by multiplying the Hour rate, Q(d/s), 'ULD', (SV/h), PF, and a dose conversion factor of 100 (Rem/sv).

The annual onsite dose is defined as don_{ann} (rem) in the excel spreadsheet in Appendix A.

The calculation for SST_{act} ^{is} ~~and~~:

$$\begin{aligned} \text{don}_{\text{ann}} &= 3.3\text{E}+3 \text{ l/s} \times 1.0\text{E}-10 \times 2.2\text{E}+5 \text{ Sy} \times 100 \text{ Rem/sy} \times 9.81\text{E}-1 \text{ s} \\ &= 7.12 \text{ rem} \end{aligned}$$

This is the value for SST_{act} under don_{ann} (rem) in the excel spreadsheet in Appendix A.

The annual onsite doses for SST pas1, SST pas3, dcat, dst lip, dst awt, 204-ar, and 244-ar are calculated in a similar way.

24-hour Offsite Dose

Common parameters in equation 1 = $OF \times X/Q \times R \times t$

$$= 1.0 \times 5.66 \text{E-}6 \text{ s/m}^3 \times 2.7 \text{E-}4 \text{ m}^3/\text{s} \times$$

$$24 \text{ hours} \times 3600 \text{ s/hour}$$

$$= 1.32 \text{E-}4 \text{ s}$$

This is defined as $ChiQ_{\text{offsite}}$ ($1.32 \text{E-}4$) in the excel spreadsheet in Appendix A.

The doses are then calculated by multiplying the flow rate, ULD, PF, and a dose conversion factor. The calculation for SST, act are:

$$24\text{-hr offsite dose, inhalation} = 3.3 \text{E+}3 \text{ Bq} \times 1.0 \text{E-}10 \times 2.2 \text{E+}5 \text{ Sv/Bq} \times 100 \text{ rem/Sv} \times 1.32 \text{E-}4 \text{ s}$$

$$= 9.58 \text{E-}4 \text{ rem}$$

The offsite doses include the contribution of the ingestion doses also. The ingestion doses are calculated by the following equation from Ref. 10:

$$\text{Dose, ingestion} = Q' \left(\frac{\text{Bq}}{\text{s}} \right) \times X/Q \left(\frac{\text{s}}{\text{m}^3} \right) = \text{ULD} \left(\frac{\text{Sv-m}^3}{\text{s}} \right) \times t \text{ (s)} \quad (2)$$

$$Q' = RF \times (1-x) \times V \left(\frac{\text{Bq}}{\text{s}} \right) \times PF$$

Common parameters in equation 2 = $X/Q \left(\frac{\text{s}}{\text{m}^3} \right) \times t \text{ (s)}$

$$= 5.66 \text{E-}6 \left(\frac{\text{s}}{\text{m}^3} \right) \times 24 \text{ hour} \times 3600 \text{ s/hour}$$

$$= 4.89 \text{E-}1 \text{ s}^2/\text{m}^3$$

This is defined as second $ChiQ_{\text{offsite}}$ ($4.89 \text{E-}1$) in the excel spreadsheet in Appendix A.

The doses are then calculated by multiplying the flow rate, PF, ULD, and a dose conversion factor. The calculation for SST, act are:

and common parameters.

$$\begin{aligned}
 \text{24-hour offsite dose, ingestion} &= 3.3\text{E}+3 \frac{\text{L}}{\text{s}} \times 1.0\text{E}-10 \times 4.1 \frac{(\text{SV}-\text{m}^2)}{\text{S}-\text{A}} \times 4.89\text{E}-1 \frac{\text{S}^2}{\text{m}^2} \\
 &\quad \times 100 \frac{\text{cm}}{\text{ft}} \\
 &= 6.61\text{E}-5 \text{ rem}
 \end{aligned}$$

The 24-hour offsite dose is then sum of inhalation and ingestion doses defined as $\text{doff}(\text{rem})$ in excel spreadsheet in Appendix A

$$\text{doff}(\text{rem}) = 9.58\text{E}-4 + 6.61\text{E}-5 = 1.02\text{E}-3 \text{ rem}$$

This is the value for sst, ad under $\text{doff}(\text{rem})$ in the excel spreadsheet in Appendix A.

The 24-hour offsite doses to $\text{sst}, \text{pas1}, \text{sst}, \text{pas2}, \text{dest}, \text{dst}, \text{lip}, \text{dst}, \text{awfl}, \text{204-ax},$ and 244-ax are calculated in a similar way.

Annual Offsite Doses

$$\begin{aligned}
 \text{Common parameter in equation 1} &= \text{PF} \times \text{X/Q} \times \text{R} \times \text{t} \\
 &= 1.0 \times 1.24\text{E}-7 \frac{\text{S}}{\text{m}^3} \times 2.7\text{E}-4 \frac{\text{m}^3}{\text{s}} \times \\
 &\quad \frac{365 \text{ days} \times 24 \text{ hours}}{\text{day}} \times 3600 \frac{\text{s}}{\text{hour}} \\
 &= 1.06\text{E}-3 \text{ s}
 \end{aligned}$$

This is defined as Chrg Offsite Ann (1.06E-3) in the excel spreadsheet in Appendix A.

and common parameter
The doses are then calculated by multiplying the flow rate, ULD, PF, and a dose conversion factor. The calculation for sst, act are:

$$\begin{aligned}
 \text{annual offsite dose, inhalation} &= 3.3\text{E}+3 \frac{\text{L}}{\text{s}} \times 1.0\text{E}-10 \times 2.2\text{E}+5 \frac{\text{S}^2}{\text{ft}} \times 100 \frac{\text{cm}}{\text{ft}} \\
 &\quad \times 1.06\text{E}-3 \text{ s} \\
 &= 7.66\text{E}-3 \text{ rem}
 \end{aligned}$$

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Common parameters in equation 2: $\times 1/2$ (4/m³) $\times$ t (s)

$$= 1.24E-7 \text{ 5/m}^3 \times 365 \text{ days} \times 24 \text{ hours} \times 3600 \text{ s}$$

$$= 3.91E-0 \text{ s}^2/\text{m}^3$$

This is defined as second order offsite term (3916700) in the excel

spreadsheet in Appendix A.

The doses are then calculated by multiplying the Hazard, RF, UCD, dose conversion factor, and common parameters. The calculation for

is, as follows:

$$\text{annual offsite dose, ingestion} = 3.3E+3 \text{ kg} \times 1.0E-10 \times 41 \left(\frac{50-1}{50-3} \right) \times 100 \text{ km}^2$$

$$\times 3.91E-0 \text{ s}^2/\text{m}^3$$

$$= 5.29E-4 \text{ rem}$$

The annual offsite dose is the sum of inhalation and ingestion doses and is defined as doffann(rem) in the excel spreadsheet in Appendix A. The annual offsite dose for sst,at is:

$$\text{d offann (rem)} = 7.66E-3 + 5.29E-4 = 8.19E-3 \text{ rem}$$

This is the value for sst,at and doffann(rem) in the excel spreadsheet in Appendix A.

The annual offsite doses for sst,post, sst,pre, dcd, dist, ing, dcd,at, 204-as, and 244-as are calculated in a similar way.

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Toxicological Doses

The methodology for calculating toxicological doses is described in Reference 10. The following equation is used to calculate the peak concentration for a continuous release of solid or liquid toxic material.

$$\text{Dose} = \text{Sum of Fractions} \times Q'$$

Sum of Fractions is defined in Table 3-8 (attached in Appendix) for different waste types and as a function of accident frequency.

$$Q' = V_{\text{site}} \times PF$$

Onsite

For sst, act, $\text{the } \text{sum of fractions}_{\text{onsite}}$ from Table 3-8 is $4.0 \text{ E}+4 \text{ y/a}$ (defined as 'SOF_{site}') in the excel spread sheet in Appendix A)

$$Q' = 3.3 \text{ E}+3 \text{ kg} \times 1.0 \text{ E}-10 = 3.3 \text{ E}-7 \text{ kg/s}$$

$$\text{Dose}_{\text{onsite}} = 3.3 \text{ E}-7 \text{ kg/s} \times 4.0 \text{ E}+4 = 1.32 \text{ E}-2$$

This is the value for sst, act under $\text{Dose}_{\text{onsite}}$ ($1.32 \text{ E}-02$) in the excel spread sheet in Appendix A

The onsite toxicological dose for sst pool, sst pass 2, dcat, dst lig, dst, wff, 204-a1, and 244-a1 are calculated in a similar way.

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Offsite

For sst, act, the offsite sum of fractions from Table 3-8 is $9.4E+01$ (defined as SDF G/R) in the excel spreadsheet in Appendix A.

$$\text{Dose, offsite} = 3.3E-7 \text{ l/s} \times 9.4E+01 \text{ s/l} = 3.1E-5$$

This is the value for sst, act ($3.1E-05$) under Dose offsite in the excel spreadsheet in Appendix A.

The offsite toxicological dose for sst pass, sst pass, dent, dst lig, dst awt, 204-a1, and 244-a1 are calculated in a similar way.

Scenario B

The methodology and doses from the filter fire are in Appendix B.

The unfiltered release that occurs after the filter fire are calculated in Scenario A.

The combined radiological and toxicological dose consequences for Scenario B are in Table 2. These consequences are the sum of consequences calculated in Appendix B and Scenario A. The puff release toxicological consequences are used from Appendix B. It is assumed that no liquid are present in compact building and catch tanks therefore there is no contribution

due to unfiltered release

7.0 RESULTS

The unmitigated radiological doses from unfiltered releases (U.R) for Single Shell Tanks (SSTs) with active ventilation, Double Shell Tanks (DSTs) and 244-AR, shown in Table 1, are above onsite risk evaluation guideline of 0.5 rem. Therefore, a safety significant CAM-interlock to detect potential unfiltered releases and to shut off ventilation within 10 minutes is required for the ventilation systems on SSTs (with active ventilation only), DSTs and 244-AR.

The mitigated onsite radiological consequences for SSTs (with active ventilation), DSTs, and 244-AR are shown in Table 2. The calculations were performed according to the methodology described in scenario and shown in dcn (rem) in the excel spreadsheet in Appendix A (Sheet 2). The mitigated onsite radiological doses for SSTs (with active ventilation), DSTs, and 244-AR are orders of magnitude below the evaluation guideline of 0.5 rem.

8.0 CONCLUSIONS

The unmitigated onsite and offsite radiological and toxicological consequences are well within the evaluation guidelines (0.5 rem and 1.0 - onsite and 0.1 rem and 1.0 - offsite)

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except the onsite radiological consequences for SSTs (with active ventilation), DSTs, and 244-AE. The mitigated onsite radiological doses for SSTs (with active ventilation), DSTs, and 244-AE are order of magnitude below the evaluation guideline.

A safety significant CAH indicate that delta potential might release and shuts off ventilation within 10 minutes for SSTs (with active ventilation), DSTs, and 244-AE is credited in the mitigated analysis.

9.0 Computer Program Input Listing

Microsoft Excel for the IBM (Windows, Version 5.0) was used in this analysis. This is a spreadsheet computer application program. There is no input listing for this type of

10.0 Computer Program Documentation

The only computer program used in this analysis was Microsoft Excel, Version 5.0. This is a commonly available, over-the-counter, spreadsheet computer program.

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Table 1
Unmutilated
Radiological and Toxicological Doses

Accident	Radiological Doses, Rem			Toxicological Doses		
	Onsite	Offsite	Total	Onsite	Offsite	Total
	Fillerine	U.R.	Total	Fillerine	U.R.	Total
45 PA with fine	1.5E-2	1.31E ⁺	1.4	1.3E-5	1.0E-3	1.0E-3
45 PA with fine	1.5E-2	7.12E ⁺	7.1	1.3E-5	8.2E-3	8.2E-3
SSS with personal	3.1E-4	2.82E ⁺	5.9E-4	2.7E-7	2.1E-7	4.8E-7
SSS with personal	3.1E-4	1.47E-3	1.8E-3	2.7E-7	1.7E-6	2.0E-6
SSS with personal	1.2E-4	2.8E ⁺	4.0E-4	1.0E-7	2.1E-7	3.1E-7
SSS with personal	1.2E-4	1.47E-3	1.6E-3	1.0E-7	1.7E-6	1.8E-6
Double Contained	2.8E-4	4.1E-2	4.1E-2	2.4E-7	2.9E-5	2.9E-5
Double Contained	2.8E-4	2.1E-1	2.1E-1	2.4E-7	2.3E-4	2.3E-4
Dsts (dist kg)	6.7E-5	6.3E ⁺	6.3E-1	5.8E-8	4.6E ⁺	4.6E-4
Dsts (dist kg)	6.7E-5	3.29E ⁺	3.3E-1	5.8E-8	3.7E-3	3.7E-3
Dsts (port kg)	8.9E-5	5.0E-1	5.0E-1	8.8E-8	4.3E-4	4.4E-4
Dsts (port kg)	8.9E-5	2.6E ⁺	2.6E-1	8.8E-8	3.5E-3	3.5E-3
04 AR (dist kg)	1.6E-4	1.08E-2	1.1E-2	1.4E-7	7.9E-6	8.1E-6
04 AR (dist kg)	1.6E-4	5.65E-2	5.7E-2	1.4E-7	6.3E-5	6.3E-5
04 AR (dist kg)	1.6E-4	8.1E-2	8.1E-2	1.4E-7	5.9E-5	6.0E-5
04 AR (dist kg)	1.6E-4	4.2E-1	4.2E-1	1.4E-7	4.7E-4	4.7E-4

Table 1 - Continued

Accident	Radiological Doses, Rem		Toxicological Doses	
	Onsite Filter Fine U.R.	Offsite Filter Fine U.R.	Onsite Filter Fine U.R.	Offsite Filter Fine U.R.
Compressor Bldg. (dst liquid)	67E-5 ***	5.8E-8	2.8E-2 ***	3.3E-7 ***
Catch tank (dst liquid)	67E-5 ***	5.8E-8	2.8E-2 ***	3.3E-7 ***

12-hour onsite release

annual unfiltered release

24-hour offsite release

*** The doses from unfiltered releases are not calculated because no liquid is present in these systems

U.R. - unfiltered releases

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Table 2 Mitigated Radiological Doses

Accident	Radiological Doses, Rem			
	Onsite Filter Fine	U.R. ² Total	Offsite Filter Fine	Total U.R. ²
HEPA Filter from SST with active ventilation	1.5E-2	1.9E-2	3.4E-2	
DSTs (distig)	6.7E-5	8.77E-3	88E-3	
DSTs (aut lig)	8.9E-5	6.92E-3	7.0E-3	
244-AR	1.6E-4	1.13E-3	1.3E-3	

* A mitigated analysis was not performed because the unmitigated doses were well within the evaluation guideline.

** The doses are for a 10-minute unfilled release.

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Appendix A Dose Consequences of Unfiltered
Releases.

		ChiQ Onsite	ChiQ Offsite	ChiQ Onsite Ann	ChiQ Offsite Ann	
		1.88E-01	1.32E-04	9.81E-01	1.06E-03	
	Q(L/s)	ULD	don (rem)	doff (rem)	donann (rem)	loffann (rem)
set_act	3.30E-07	2.20E+05	1.37E+00	1.02E-03	7.12E+00	8.19E-03
set_pas1	6.80E-11	2.20E+05	2.82E-04	2.11E-07	1.47E-03	1.66E-06
set_pas2	6.80E-11	2.20E+05	2.82E-04	2.11E-07	1.47E-03	1.66E-06
dcr1	1.98E-07	1.10E+04	4.10E-02	2.93E-05	2.14E-01	2.34E-04
dst_liq	5.50E-06	6.10E+03	6.31E-01	4.61E-04	3.29E+00	3.69E-03
dst_awfl	1.89E-05	1.40E+03	4.98E-01	4.34E-04	2.60E+00	3.47E-03
204-ar	9.44E-08	6.10E+03	1.08E-02	7.92E-06	6.65E-02	6.33E-05
244-ar	7.08E-07	6.10E+03	8.13E-02	6.94E-05	4.24E-01	4.75E-04
			ChiQ Offsite	ChiQ Offsite Ann		
			4.89E-01	3.91E+00		
	Q(L/s)	ULD				
set_act	3.30E-07	4.10E+00	6.62E-05	5.29E-04		
set_pas1	6.80E-11	4.10E+00	1.36E-08	1.09E-07		
set_pas2	6.80E-11	4.10E+00	1.36E-08	1.09E-07		
dcr1	1.98E-07	5.20E-02	5.03E-07	4.03E-06		
dst_liq	5.50E-06	6.80E-02	1.83E-05	1.46E-04		
dst_awfl	1.89E-05	9.20E-02	8.60E-05	6.80E-04		
204-ar	9.44E-08	6.80E-02	3.14E-07	2.51E-06		
244-ar	7.08E-07	6.80E-02	2.35E-06	1.88E-05		
Toxicological Dose Consequence						
	Q(L/s)	SOF (g/L)	Dose onsite	SOF (g/L)	Dose offsite	
set_act	3.30E-07	4.00E+04	1.32E-02	9.40E+01	3.10E-05	
set_pas1	6.80E-11	2.10E+03	1.43E-07	3.30E+01	2.24E-09	
set_pas2	6.80E-11	2.10E+03	1.43E-07	3.30E+01	2.24E-09	
dcr1	1.98E-07	9.60E+03	1.90E-03	8.00E+00	1.58E-06	
dst_liq	5.50E-06	9.60E+03	5.28E-02	8.00E+00	4.40E-05	
dst_awfl	1.89E-05	1.00E+04	1.89E-01	8.40E+00	1.59E-04	
204-ar	9.44E-08	1.00E+04	9.44E-04	8.40E+00	7.93E-07	
244-ar	7.08E-07	9.60E+03	6.80E-03	8.00E+00	6.66E-06	

		ChiQ Onsite	ChiQ Offsite	ChiQ Onsite Ann	ChiQ Offsite Ann		
		2.61E-03	1.32E-04	9.81E-01	1.06E-03		
		10 min y.r.					
	Q(L/s)	ULD	don (rem)	doff (rem)	donann (rem)	doffann (rem)	
net, act	3.30E-07	2.20E-06	1.90E-02	1.02E-03	7.12E+00	8.19E-03	
net pas1	6.80E-11	2.20E-06	3.91E-06	2.11E-07	1.47E-03	1.69E-06	
net pas2	6.80E-11	2.20E-06	3.91E-06	2.11E-07	1.47E-03	1.69E-06	
dcr1	1.98E-07	1.10E-04	5.69E-04	2.93E-05	2.14E-01	2.34E-04	
det, liq	5.50E-06	8.10E+03	8.77E-03	4.61E-04	3.29E+00	3.69E-03	
det, awfl	1.89E-05	1.40E+03	6.92E-03	4.34E-04	2.60E+00	3.47E-03	
204-ar	9.44E-08	6.10E+03	1.51E-04	7.92E-06	5.66E-02	6.33E-05	
244-ar	7.08E-07	6.10E+03	1.13E-03	5.94E-05	4.24E-01	4.75E-04	
			ChiQ Offsite	ChiQ Offsite Ann			
			4.89E-01	3.91E+00			
	Q(L/s)	ULD					
net, act	3.30E-07	4.10E+00	6.62E-05	5.29E-04			
net pas1	6.80E-11	4.10E+00	1.36E-08	1.09E-07			
net pas2	6.80E-11	4.10E+00	1.36E-08	1.09E-07			
dcr1	1.98E-07	5.20E-02	5.03E-07	4.03E-06			
det, liq	5.50E-06	6.80E-02	1.83E-05	1.46E-04			
det, awfl	1.89E-05	9.20E-02	8.60E-05	6.80E-04			
204-ar	9.44E-08	6.80E-02	3.14E-07	2.51E-06			
244-ar	7.08E-07	6.80E-02	2.35E-06	1.88E-05			
Toxicological Dose Consequence							
	Q(L/s)	SOF (g/L)	Dose onsite	SOF (g/L)	Dose offsite		
net, act	3.30E-07	4.00E+04	1.32E-02	9.40E+01	3.10E-05		
net pas1	6.80E-11	2.10E+03	1.43E-07	3.30E+01	2.24E-06		
net pas2	6.80E-11	2.10E+03	1.43E-07	3.30E+01	2.24E-06		
dcr1	1.98E-07	9.60E+03	1.90E-03	8.00E+00	1.58E-06		
det, liq	5.50E-06	9.60E+03	5.28E-02	8.00E+00	4.40E-05		
det, awfl	1.89E-05	1.00E+04	1.89E-01	8.40E+00	1.59E-04		
204-ar	9.44E-08	1.00E+04	9.44E-04	8.40E+00	7.93E-07		
244-ar	7.08E-07	9.60E+03	6.80E-03	8.00E+00	5.66E-06		

Table 3-8. Sum-of-Fraction of Risk Guidelines for a Unit Release of Chemicals and Gases. (3 sheets)

*The sum of fractions are multiplied by the release rate for continuous release and release amount for a puff releases. Release rates for continuous releases are in units of liters per second for liquids and solids, and m3/s for gases. Puff release quantities are in units of liters for solids and liquids and m3 for gases.

Tank waste type (Units of sum of fractions follow tank waste type)	Maximum individual	Accident frequency, 1/yr		
		1 - 10-2	10-2 - 10-4	10-4 - 10-6
DST or SST solid or liquid continuous release				
Single-shell liquids(s/L)	Onsite	9.6 E+03	7.5 E+02	2.0 E+02
Single-shell liquids(s/L)	Offsite	8.0 E+00	8.0 E+00	6.2 E-01
Single-shell solids(s/L)	Onsite	4.0 E+04	2.1 E+03	1.0 E+03
Single-shell solids(s/L)	Offsite	9.4 E+01	3.3 E+01	1.7 E+01
Double-shell liquids(s/L)	Onsite	1.0 E+04	7.5 E+02	2.1 E+02
Double-shell liquids(s/L)	Offsite	8.4 E+00	8.4 E+00	6.2 E-01
Double-shell solids (s/L)	Onsite	1.8 E+04	3.3 E+03	6.3 E+02
Double-shell solids(s/L)	Offsite	1.9 E+02	1.5 E+01	2.8 E+00
DST or SST liquid or solid puff release				
Single-shell liquids (L-1)	Onsite	2.8 E+03	2.2 E+02	5.7 E+01
Single-shell liquids (L-1)	Offsite	3.2 E-02	3.2 E-02	2.5 E-03
Single-shell solids (L-1)	Onsite	1.2 E+04	6.0 E+03	2.9 E+02
Single-shell solids (L-1)	Offsite	3.8 E-01	1.3 E-01	6.9 E-02
Double-shell liquids (L-1)	Onsite	2.9 E+03	2.2 E+02	6.0 E+01
Double-shell liquids (L-1)	Offsite	3.4 E-02	3.4 E-02	2.5 E-03
Double-shell solids (L-1)	Onsite	5.2 E+03	9.7 E+02	1.8 E+02
Double-shell solids (L-1)	Onsite	7.7 E-01	5.9 E-02	1.1 E-02
Flammable gas watch list composite				
Continuous Release (s/L)	Onsite	1.3 E+04	1.1 E+03	2.6 E+02
Continuous Release (s/L)	Offsite	1.4 E+01	7.2 E+00	6.1 E-01
Puff Release (L-1)	Onsite	3.7 E+03	3.2 E+02	7.7 E+01
Puff Release (L-1)	Offsite	3.4 E-02	1.7 E-02	1.4 E-03

Gas Release - Worst Case Composite

Continuous (s/m3)	Onsite	7.7 E+01	9.4 E+00	1.9 E+00
Continuous (s/m3)	Offsite	6.6 E-02	6.6 E-02	8.1 E-03
Puff (m-3)	Onsite	2.3 E+01	2.8 E+00	5.8 E-01
Puff (m-3)	Offsite	2.7 E-04	2.7 E-04	3.2 E-05

Gas Release - Maximum Sample Composite

Note this data should be used only when the accident scenario does not involve a slurry gas release
Otherwise use the above sum of fractions.

Continuous (s/m3)	Onsite	2.6 E+00	3.3 E-01	7.1 E-02
Continuous (s/m3)	Offsite	2.3 E-03	2.3 E-03	2.8 E-04
Puff (m-3)	Onsite	7.9 E-01	9.9 E-02	2.1 E-02
Puff (m-3)	Offsite	9.3 E-06	9.2 E-06	1.1 E-06

50% NaOH releases

Continuous (s/L)	Onsite	1.3 E+04	1.0 E+03	2.6 E+02
Continuous (s/L)	Offsite	1.1 E+01	1.1 E+01	8.6 E-01
Puff (L-1)	Onsite	3.8 E+03	3.0 E+02	7.5 E+01
Puff (L-1)	Offsite	4.3 E-02	4.3 E-02	3.5 E-03

All liquids and all solids continuous release

All liquids (s/L)	Onsite	1.0 E+04	7.5 E+02	2.1 E+02
All Liquids (s/L)	Offsite	8.4 E+00	8.4 E+00	6.2 E-01
All solids (s/L)	Onsite	5.1 E+04	2.3 E+04	1.2 E+03
All solids (s/L)	Offsite	2.5 E+02	4.2 E+01	1.9 E+01

All liquids or solids puff release				
All liquids (L-1)	Onsite	2.9 E+03	2.2 E+02	6.0 E+01
All liquids (L-1)	Offsite	3.4 E-02	3.4 E-02	2.5 E-03
All solids (L-1)	Onsite	1.5 E+04	6.6 E+03	3.6 E+02
All solids (L-1)	Offsite	1.0 E+00	1.7 E-01	7.6 E-02
C-106 solids				
Continuous (s/L)	Onsite	5.9 E+03	1.1 E+03	3.0 E+02
Continuous (s/L)	Offsite	1.0 E+01	5.0 E+00	9.2 E-01
Puff (L-1)	Onsite	1.7 E+03	3.2 E+02	8.8 E+01
Puff (L-1)	Offsite	4.1 E-02	2.0 E-02	3.6 E-03

The comparison to risk guidelines for chemical release consequences for a given accident scenario is determined using the following steps:

1. Determine the accident frequency range for the event.
2. Determine the type of material being released (i.e., SST solids or liquids, DST solids or liquids, ~~flammable gas watch list composite~~, headspace gases, 50% NaOH, all solids, all liquids, or the C-106 composite).
3. Determine whether the release is a puff release or a continuous release. A release with a duration of less than 3.5 seconds can be treated as a puff release for maximum onsite individual evaluations. A release with a duration of less than 420 seconds can be treated as a puff release for maximum offsite individual evaluations. A puff release can be modeled as a 1 minute continuous release.

Exposure Time:

Exposure time may be determined based on the following guidance taken from Craig 1995a "Exposure time: In practice, observed atmospheric concentrations of chemicals downwind of a source vary widely about the mean concentration measured over a period of time. Unless information to the contrary is available, published limit parameters or guidelines must be treated as ceiling values at the point of interest. For practical purposes, the peak 15 minute average concentration is treated as the instantaneous concentration. It is recommended that this concentration value be used for comparison with the primary concentration guidelines."

For chemicals that are known to have dose dependent health effects rather than concentration dependent effects, a 1 hour average may be used. However if the chemicals are not all known to be dose dependent, the 15 minute average should be used for releases of 15 minute to one hour. Tank waste, for instance, contains a mixture of dose dependent and concentration dependent chemicals. A peak 15 minute average should be used for the tank waste evaluations

Averaging over 15 minutes for a very short release duration and hence a very short exposure time (such as a puff release) is potentially nonconservative since some chemicals have ceiling limits, i.e. concentrations that should not be exceeded. There is some recent guidance from Craig (Craig 1995b) that states:

"For practical reasons (e.g. limitations of instantaneous concentration monitoring for many chemicals) the peak 15 minute average value at the receptor point of interest is used except for those substances that may cause immediate irritation when exposure is short (e.g. hydrogen sulfide, sulfur dioxide). In such cases if the release scenario gives rise to peak concentrations significantly higher than the peak 15-minute average concentration, then a shorter averaging time (not less than 1 minute) should be used." The chemicals involved in a release should be examined to determine if the chemicals involved cause immediate irritation. The chemicals should be assumed to cause immediate irritation unless it can be demonstrated otherwise.

A very short duration release (puff release) of chemicals including corrosives and irritants can be modelled conservatively as a one minute continuous release.

4. Determine the release quantity or release rate. For puff releases of solids or liquids, the number of liters released is required; for continuous releases of solids or liquids, the release rate is required. For puff releases of gases, the number of cubic meters released is required; for continuous releases of gases, the release rate is required.
5. Multiply the release quantity or release rate determined in step 4 by the appropriate value from Table 3-8. The product is the sum of the concentrations divided by ERPG values. Values less than one indicate that the risk acceptance guidelines are met.

NOTE: The concentration of gases at the receptor is not linear with release rate or release amount. Determining acceptability by multiplying the values in Table 3-8 by the release rate or amount results in an approximation. The approximation is conservative because using the linear relationship over-predicts concentrations for releases larger than 1 L (0.26 gal) or 1 L/s (0.26 gal/s). The difference between linear scaling and the more exact method is negligible below release rates of about 5 m³/s (180 ft³/s) or release amounts of 5 m³ (180 ft³). Because the nonlinear term in the gas equation is $1/(1 + V' \times +/Q')$, this effect is only significant for the maximum onsite individual. For the maximum offsite individual, $V' \times +/Q'$ will be much smaller than one for any credible release from the tanks. The largest offsite $+/Q'$ is $2.83 \pm 88 \times 10^{-5}$ s/m³ and all credible releases are much smaller than 105 m³/s.

Step 5 can also be written as the following formulae:

- Liquid or solid continuous release:

Sum-of-fractions of acceptance limits = [release rate] x [Table 3-8 continuous release value]

- Liquid or solid puff release:

Sum-of-fractions of acceptance limits = [release quantity x [Table 3-8 puff value]

Accident scenarios involving a release of both gases and solid or liquids should be treated by adding the sum of fractions for the gases and liquids or solids together. That is, the quantity of gas released should be multiplied by the sum of fraction and the product determined. The quantity of liquid or solid should multiplied by the appropriate sum of fraction. To meet risk acceptance criteria, the sum of these two products must be less than or equal to one.

The sum of fraction assumes that the chemicals involved are being released with the same release fraction. If the accident scenario involves a significant preferential release of certain chemicals, a more detailed analysis should be performed that includes the chemical dependent release fractions.

Appendix B
HEPA Filter Doses

This appendix discusses the method used to calculate the amount of material on the filters in various tank farm facilities. To do this, Savino (1996) modeled 3.7×10^{10} Bq (1 Ci) of gamma emitters in different filter configurations and calculated the contact doses. Depending on the source material, the gamma emitters are different. For example, single-shell solids uses ^{90}Sr , ^{90}Y , ^{137}Cs and ^{154}Eu for gamma emitters while double-shell liquids uses predominantly ^{137}Cs (the other gamma emitters have much smaller concentrations). The spreadsheet tables give the relative amounts for each of the cases that were analyzed.

Different filter geometries were modeled. These include high efficiency particulate air filters and prefilters. After inputting the geometry and the loading, a dose rate (mSv/hr) was calculated.

High efficiency particulate air filters and prefilters have pre-specified operating limits. These were used, along with the calculated dose rate to form a ratio of the operating limit to the calculated dose limit. This gives the fraction of the assumed waste volume that could be loaded on the filter and give the operating limit. The amount of material released from the a single bank of filters was calculated using one of the following schemes.

- The system is a standard active ventilation system with a prefilter, a first stage and second stage high efficiency particulate air filter. An additional amount, equal to another prefilter loading, was used to account for material that will come out of the ventilation duct work. That is, two prefilter volumes plus two high efficiency particulate air filter volumes will be used.
- The system is passively ventilated. The system is basically one high efficiency particulate filter sitting on a riser. There is not a prefilter and there is no ventilation ducting to speak of. That is, one high efficiency particulate air filter will be used.
- The system has two de-entrainers, a first stage and second stage high efficiency particulate air filter. To account for the loading in the de-entrainers and the material that will come out of the ventilation duct work, an additional volume equivalent to three high efficiency particulate filters will be used. That is a total of five times the loading for one high efficiency particulate filter will be used.
- The system consists of a prefilter, a low efficiency filter (treated as another prefilter), a first stage and second stage high efficiency particulate air filter. In addition, a volume equal to the prefilter will be used to account for material from the ventilation ducting. That is, a total of three prefilter volumes and two high efficiency particulate volumes will be used.

The spreadsheet pages also identify how many filter banks are running at the same time. A total amount of material released from the filters is found by multiplying by the appropriate release fraction. For a filter fire, the

release fraction is 1/10,000 of the volume is released. The volumes released are then be used to calculate radiological and toxicological doses.

The radiological consequences were calculated using the unit liter doses found in Cowley (1996) and the methodology for calculating consequences is found in Van Keuren and Savino (1996). The unit liter doses are the radiation doses received per liter of tank waste. The doses are calculated using the pathways of submersion (direct radiation), inhalation, and 24-hour ingestion. Cowley (1996) provides the technical basis for the unit liter doses. Van Keuren and Savino (1996) states that the following equation is to be used for calculating the inhalation and submersion dose.

$$EDE_{inhalation} = Q \frac{X}{Q'} B_r ULD_{inhalation}$$

where Q is the volume of waste resuspended (L), X/Q' is the atmospheric dispersion coefficient (s/m^3), B_r is the standard man breathing rate during light activity (m^3/s), and the $ULD_{inhalation}$ is the unit liter dose (Sv/L) due to inhalation and submersion.

Ingestion doses are calculated using the following equation.

$$EDE_{ingestion} = Q \frac{X}{Q'} ULD_{ingestion}$$

where again, Q is the volume of waste resuspended (L), X/Q' is the atmospheric dispersion coefficient (s/m^3) and $ULD_{ingestion}$ is the unit liter dose ($\frac{Sv \cdot m^3}{s \cdot L}$) due to 24-hour ingestion.

The toxicological consequences are calculated using the sum-of-fractions values and methodology found in Van Keuren (1996). For a release of solid or liquid toxic materials, the peak concentration is of concern. For a continuous release the integrated X/Q' (s/m^3) can be used since it is equivalent to the continuous plume X/Q' . The following equation is used to calculate the peak concentration, C (mg/m^3) for a continuous release of solid or liquid toxic material.

$$C = Q' \frac{X}{Q'}$$

where Q' is the toxic material release rate (mg/s) and X/Q' is the integrated atmospheric dispersion coefficient (s/m^3).

This method has been extended to include the multiple chemicals contained in the tank waste. To do this, a sum-of-fractions methodology has been applied. That is, on a per unit basis, the ratio of a chemical's concentration (calculated either at the 100 m receptor or the offsite receptor) is compared to the appropriate limit, this is done for all chemicals involved, then the ratios or fractions are summed. If the sum-of-fractions is less than or equal to 1, the risk guidelines have been met. If the sum-of-fractions is greater than 1, the risk guidelines have been exceeded. Thus, the above equation now becomes,

$$T = Q' \text{ SOF}$$

where T is the measure of acceptance, Q' is the toxic material release rate (L/s) and SOF is the sum-of-fractions of the risk guidelines (s/L) for either the onsite or offsite receptor.

Cowley, W. L., 1996, *Development of Radiological Concentration and Unit Liter Doses for Tank Waste Remediation System Final Safety Analysis Report Radiological Consequence Calculations*, WHC-SD-WM-SARR-037, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Savino, A. V., 1996, *MICROSHIELD Dose Rate Calculations for HEPA Filters and Prefilters*, WHC-SD-WM-CN-033, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Van Keuren, J. C., and A. V. Savino, 1996, *Tank Waste Compositions and Atmospheric Dispersion Coefficients for use in Safety Analysis Consequence Assessments*, WHC-SD-WM-SARR-016, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

Van Keuren, J. C., 1996, *Toxic Chemical Considerations for Tank Farm Releases*, WHC-SD-WM-SARR-011, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-SARR-037					SX, C-106			SSTs with Passive Breather Filters					
	SST Solids (Bq/L)	SST Liquids (Bq/L)	DST Liquids (Bq/L)	AWF Liquids (Bq/L)	(Ci)	(Bq)	(L)	(Ci)	(Bq)	(L)	(Ci)	(Bq)	(L)
Co60	4.2E+08	9.5E+06	7.0E+06	7.7E+05									
Sr90	1.6E+12	1.1E+10	4.6E+09	5.6E+09	0.4840	1.8E+10	0.011	0.4840	1.8E+10	0.011	0.4840	1.8E+10	0.011
Y 90	1.6E+12	1.1E+10	4.6E+09	5.6E+09	0.4840	1.8E+10	0.011	0.4840	1.8E+10	0.011	0.4840	1.8E+10	0.011
Cs137	1.0E+11	2.2E+10	5.9E+10	8.8E+10	0.0303	1.1E+09	0.011	0.0303	1.1E+09	0.011	0.0303	1.1E+09	0.011
Eu154	5.8E+09	2.4E+09	4.2E+07	0.0E+00	0.0017	6.3E+07	0.011	0.0017	6.3E+07	0.011	0.0017	6.3E+07	0.011
Np237	3.0E+07	0.0E+00	2.3E+05	9.2E+04									
Pu238	1.9E+08	9.2E+04	1.8E+06	2.8E+03									
Pu239	4.4E+08	3.6E+07	7.7E+06	1.2E+06									
Pu241	3.2E+09	2.6E+08	1.8E+07	3.4E+05									
Am241	2.3E+08	4.2E+07	3.4E+07	1.1E+06									
Cm244	2.3E+06	4.2E+05	1.2E+05	1.1E+04									
					1.00	3.7E+10	0.011	1.00	3.7E+10	0.011	1.00	3.7E+10	0.011
MicroShield Calculated Dose for HEPA (mSv/hr)						0.257				1.77			4.75
HEPA Operating Limit (mSv/hr)						2				2			2
OL/CD						7.782101				1.129944			0.421053
HEPA Loading to give OL (L)						0.087245				0.012668			0.00472
0.01% Release (L)						8.72E-06				1.27E-06			4.72E-07
MicroShield Calculated Dose for Prefilter (mSv/hr)						0.34			No Prefilter			No Prefilter	
Prefilter Operating Limit (mSv/hr)						2							
OL/CD						5.882353							
Prefilter Loading to give OL (L)						0.065947							
0.01% Release (L)						6.59E-06							
Volume Released from One Filter Bank (L)					D	3.06E-05		P		1.27E-06	P		4.72E-07
Number of Parallel Banks Operating at the Same Time						2				1			1
TOTAL RELEASED (L)						6.13E-05				1.27E-06			4.72E-07
Onsite Inhalation EDE (Sv)						1.5E-04				3.1E-06			1.2E-06
Offsite Inhalation & Ingestion EDE (Sv)						1.3E-07				2.7E-09			1.0E-09
						Anticipated			Unlikely			Unlikely	
						Cont. Puff			Cont. Puff			Cont. Puff	
Onsite Sum-of-Fraction						7.0E-01 7.4E-01			7.6E-04 7.6E-03			2.8E-04 2.8E-03	
Offsite Sum-of-Fraction						1.6E-03 2.3E-05			1.2E-05 1.6E-07			4.5E-06 6.1E-08	

WHC-SD-WM-CN-062 REV 0

S-CLC-6-00125
Sheet 37

DCRTs			SY, AN, AP, AW			AY & AZ			204AR/244AR		
						AWF Liquids on a 24x24x12 Filter					
(Ci)	(Bq)	(L)	(Ci)	(Bq)	(L)	(Ci)	(Bq)	(L)	(Ci)	(Bq)	(L)
0.9016	3.3E+10	1.509	1	3.7E+10	0.631	1	3.7E+10	0.419	1	3.7E+10	0.631
0.0984	3.6E+09	1.549									
1.00	3.7E+10	1.549	1.00	3.7E+10	0.631	1.00	3.7E+10	0.419	1.00	3.7E+10	0.631
		130.00			44.7			44.7			44.7
		2			2			2			2
		0.015385			0.044743			0.044743			0.044743
		0.023835			0.028251			0.018727			0.028251
		2.38E-06			2.83E-06			1.87E-06			2.83E-06
		220.00			61			No Prefilter			61
		2			2						2
		0.009091			0.032787						0.032787
		0.014084			0.020702						0.020702
		1.41E-06			2.07E-06						2.07E-06
D	7.58E-06		D	9.79E-06		A	9.36E-06		C	1.19E-05	
		3			1			6			2
	2.28E-05			9.79E-06			5.62E-05			2.37E-05	
	2.8E-06			6.7E-07			8.9E-07			1.6E-06	
	2.4E-09			5.8E-10			8.8E-10			1.4E-09	
Anticipated			Anticipated			Anticipated			Anticipated		
Cont.	Puff		Cont.	Puff		Cont.	Puff		Cont.	Puff	
6.2E-02	6.4E-02		2.8E-02	2.8E-02		1.8E-01	1.6E-01		6.8E-02	6.9E-02	
5.2E-05	7.3E-07		2.3E-05	3.3E-07		1.3E-04	1.9E-06		5.7E-05	8.1E-07	

D = Two HEPAs, a Prefilter, and another volume equal to the prefilter for stuff coming out of the ventilation ducting = 2*HEPA Volume + 2* Prefilter Volume P = Passive breather HEPA, no prefilter, no second HEPA, and no appreciable ventilation ducting = 1*HEPA Volume A = Two (2) HEPAs, no prefilter but there are two (2) de-entrainers and material in the ventilation ducting (1) = 5*HEPA Volume C = Two HEPAs, a prefilter, a low efficiency filter (treated as a prefilter), and another volume equal to the prefilter for stuff coming out of the ventilation ducting = 2*HEPA Volume + 3*Prefilter Volume										
X/Q Values					ULDs					
	(s/m3)				Inhalation	Ingestion				
Onsite	3.41E-02				(Sv/L)	(Sv m3)/(s L)				
Offsite	2.83E-05				All Liquids	1.2E+04 0.11				
					All Solids	1.9E+06 8.2				
					SST Liquids	1.1E+04 0.052				
					SST Solids	2.2E+05 4.1				
					DST Liquids	6.1E+03 0.068				
					DST Solids	5.3E+05 0.48				
					AWF Liquids	1.4E+03 0.092				
					AWF Solids	1.7E+06 8.1				
Note: for toxicological calculations DST and AWF are synonymous										
Toxic Sum-of-Fractions of Risk Guidelines per Liter, 10+0 to 10-2 frequency range										
Continuous Release					Puff Release					
	(s/L)				(s/m3)	(1/L)			(1/m3)	
	DST Solids	DST Liquids	SST Solids	SST Liquids	Vapor Space	DST Solids	DST Liquids	SST Solids	SST Liquids	Vapor Space
Onsite	1.8E+04	1.0E+04	4.0E+04	9.6E+03	7.7E+01	5.2E+03	2.9E+03	1.2E+04	2.8E+03	2.3E+01
Offsite	1.9E+02	8.4E+00	9.4E+01	8.0E+00	6.6E-02	7.7E-01	3.4E-02	3.8E-01	3.2E-02	2.7E-04
Toxic Sum-of-Fractions of Risk Guidelines per Liter, 10-2 to 10-4 frequency range										
Continuous Release					Puff Release					
	(s/L)				(s/m3)	(1/L)			(1/m3)	
	DST Solids	DST Liquids	SST Solids	SST Liquids	Vapor Space	DST Solids	DST Liquids	SST Solids	SST Liquids	Vapor Space
Onsite	3.3E+03	7.5E+02	2.1E+03	7.5E+02	9.4E+00	9.7E+02	2.2E+02	6.0E+03	2.2E+02	2.8E+00
Offsite	1.5E+01	8.4E+00	3.3E+01	8.0E+00	6.6E-02	5.9E-02	3.4E-02	1.3E-01	3.2E-02	2.7E-04
Toxic Sum-of-Fractions of Risk Guidelines per Liter, 10-4 to 10-6 frequency range										
Continuous Release					Puff Release					
	(s/L)				(s/m3)	(1/L)			(1/m3)	
	DST Solids	DST Liquids	SST Solids	SST Liquids	Vapor Space	DST Solids	DST Liquids	SST Solids	SST Liquids	Vapor Space
Onsite	6.3E+02	2.1E+02	1.0E+03	2.0E+02	1.9E+00	1.8E+02	6.0E+01	2.9E+02	5.7E+01	5.8E-01
Offsite	2.8E+00	6.2E-01	1.7E+01	6.2E-01	8.1E-03	1.1E-02	2.5E-03	6.9E-02	2.5E-03	3.2E-05

Table 3.4.1-5. Unit Liter Doses for Inhalation and Ingestion.*

Composite	Inhalation ULD (Sv/L)	Ingestion ULD* (Sv-m ³ /g-L)
Single-shell tank liquids	1.1 E+04	0.052
Single-shell tank solids	2.2 E+05	4.1
Double-shell tank liquids	6.1 E+03	0.068
Double-shell tank solids	5.3 E+05	0.48
Aging waste facility liquids	1.4 E+03	0.092
Aging waste facility solids	1.7 E+06	8.1

*From WHC-SD-WM-SARR-037 (Crowley et al. 1996)

Table 4. Centerline Atmospheric Dispersion Coefficients for 200-Area Tank Farm Acute Release to 100-m Onsite Receptor Located in Worst Sector.

Meteorological condition	Integrated $+/\bar{Q}'$ (s/m ³)	Integrated $+/\bar{Q}'$ (s/m ³) with PMa	Maximum puff $+/\bar{Q}$ (1/m ³)
99.5 percentile (bounding)	3.41 E-02 E 100 m	1.13 E-02 ESE 100 m	9.85 E-03 E 100 m
Annual Average	1.20 E-02 N 100 m	3.80 E-03 N 100 m	NA
50 percentile	5.33 E-03 N 100 m	2.27 E-03 N 100 m	9.48 E-04 E 100 m

aNRC Regulatory Guide 1.145 (NRC 1982) plume meander correction applied.

Table 5. Centerline Atmospheric Dispersion Coefficients for 200-Area Tank Farm Acute Release to Site Boundary Receptor Located in Worst Sector.

Meteorological condition	Integrated $+/\bar{Q}'$ (s/m ³)	Integrated $+/\bar{Q}'$ (s/m ³) with PMa	Maximum puff $+/\bar{Q}$ (1/m ³)
99.5 Percentile (bounding)	2.83 E-05 N 8,760 m	2.12 E-05 N 8,760 m	1.14 E-07 NNW 8,690 m
Annual average	1.05 E-05 N 8,760 m	7.92 E-06 N 8,760 m	NA
50 percentile	4.43 E-06 N 8,760 m	3.79 E-06 N 8,760 m	1.02 E-08 N 8,760 m

aNRC Regulatory Guide 1.145 (NRC 1982) plume meander correction applied.

Table 6. Population Weighted Atmospheric Dispersion Coefficients for 200-Area Tank Farm Acute Release to 50-Mile Population Located in Worst Sector.

Meteorological condition	Integrated $+/\bar{Q}'$ (person-s/m ³)
99.5 Percentile (bounding)	4.86 E-02 SE pop = 114,734
Annual average	1.25 E-02 SE pop = 114,734
50 Percentile	6.05 E-03 SE pop = 114,734

Table 7. Centerline Atmospheric Dispersion Coefficients for 200-Area Tank Farm Acute Release to Onsite Receptor Located in Worst Sector for a 46 m (150 ft) Stack Release.

Meteorological condition	Integrated $\div/Q'$ (s/m ³)	Maximum puff $\div/Q$ (1/m ³)
99.5 Percentile (bounding)	6.55 E-05 W 260 m	6.47 E-7 W 210 m
Annual Average	1.76 E-05 WSW 270 m	NA
50 Percentile	1.26 E-05 WSW 440 m	1.41 E-07 WSW 490 m

Table 8. Centerline Atmospheric Dispersion Coefficients for 200-Area Tank Farm Acute Release to Site Boundary Receptor Located in Worst Sector for a 46 m (150 ft) Stack Release.

Meteorological Condition	Integrated $\div/Q'$ (s/m ³)	Maximum Puff $\div/Q$ (1/m ³)
99.5 Percentile (bounding)	1.78 E-05 N 8,760 m	3.10 E-08 NNW 8,690 m
Annual average	5.26 E-06 N 8,760 m	NA
50 Percentile	2.36 E-06 N 8,760 m	8.31 E-09 N 8,760 m

Table 9. Chronic Annual Average Atmospheric Dispersion Coefficients for 200-Area Tank Farm for Onsite and Site Boundary Receptors.

Meteorological condition	Onsite integrated $\div/Q'$ (s/m ³)	Site boundary integrated $\div/Q'$ (s/m ³)
Chronic annual average for ground level releases	4.03 E-04 ESE 100 m	1.24 E-07 E 12,630 m
Chronic annual average for 46 m (150 ft) stack releases	9.45 E-07 S 250 m	6.81 E-08 E 12,630 m

Tracking # MKG-Chapter 3-01

Name of Originator 1 M. K. Gupta/D. S. Leach	Organization or Team 2 Chapter 3 Team for TWRS FSAR	Date 3 4/12/96
Statement of Problem The dose rate at 30cm from HEPA filters in the TWRS would be less than 150 mrem/hr		
4		
Alternatives 5	Consequences to Alternatives 6	
Decision Reached 7	Basis for Decision 8	
Date Requested 9 4/23/96	Sent To 10 Lankford Ruffin	Date Requested By 11 M. K. Gupta/D. S. Leach
Response #1: Health Physics Technicians (HPT's) perform weekly HEPA filter radiation surveys per the attached task description. These surveys are taken "on contact" 1-2 CM from the filters. If levels were to reach 160 MR/HR, preparations would be made to change out the HEPA filters prior to reaching 200 MR/HR on contact. Dose levels at 30 CM would be at least 10 times less than on contact. Therefore, it is not expected that levels at 30 CM would ever exceed 150 MR/HR under normal conditions.		
12		
Response #2		
13		

Attachments (List) 1. Scheduled radiation survey tank description WTF-W-2. 14	References (List) 15
Responder #1 Name and Signature 16 R.P. Tucker TML/TJH 4/23/96	Responder #2 Name and Signature 17
POC: Filed: Routed:	
Further Action Required (i.e., RML, Senior Management Attention, etc.) 18	

Radiological Control SCHEDULED RADIATION SURVEY TASK DESCRIPTION	Task No. WTF-W-2	Frequency Weekly	RWP No. N/A
Governing Directive HSPCH 552.1.d	Issue Date 01/02/96 Rev. 0		

Area: West Tank Farms
 Building: N/A
 Location(s): Active Exhausters
 Description:

- Take contact radiation readings on the HEPA filters, and pre-filters of active exhausters.
- Document the survey results on a Radiological Survey Report

Special Circumstances: None

Required Instrumentation:

CP and/or RO 2 dose rate instrument.

Action Levels:

- Immediately contact Shift Operations and RC Management of readings of greater than 160 mR/hr for primary filters and 80 mR/hr for pre-filters. (These readings are 80% of OSA notification readings.)
- Any conditions inconsistent with radiological postings.

Notification or Actions (If Action Levels exceeded):

- Notify First Line Radiological Control Manager & WTFP Operations Shift Manager
- Establish appropriate radiological postings and area control.
- Initiate a Radiological Problem Report.
- Document all actions and notifications in the RC Shift Log.

BEST AVAILABLE COPY

RC Manager (Print and Sign)	Approved By RC Section/Unit Manager (Print and Sign)
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DISTRIBUTION SHEET

To	From	Page 1 of 1			
Distribution	G. W. Ryan	Date 8/9/96			
Project Title/Work Order		EDT No. 614551			
HEPA Filter Fire (and Subsequent Unfiltered Release)		ECN No. N/A			
Name	MSIN	Text With All Attach.	Text Only	Attach./ Appendix Only	EDT/ECN Only
E. R. Bruschi	A2-34	X			
C. Carro	A2-34	X			
D. S. Leach	A3-34	X			
TWRS S & L Project Files (6)	A2-26	X			
G. W. Ryan (3)	A3-37	X			
Central Files (Original + 1)	A3-88	X			