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Ventilation System Consequence Calculations to Support Salt Well Pumping Single-Shell Tank 241-A-101.

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Abstract: This document presents the radiological dose and toxicological exposure calculations for an accident scenario involved with the ventilation system used to support salt well pumping single-shell tank 241-A-101.

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VENTILATION SYSTEM CONSEQUENCE CALCULATIONS TO SUPPORT SALT WELL PUMPING SINGLE-SHELL TANK 241-A-101

REVISION 0

TWRS Safety Analysis

SPECIAL NOTE REGARDING PROCEDURE COMPLIANCE:

This calculation note has been developed in accordance with the requirements defined in procedure WP-6.7, Revision 1, of WHC-CM-6-32, *Safety Analysis and Nuclear Engineering Work Procedures* and has been technically peer reviewed in accordance with the requirements defined in procedure WP-6.2, Revision 1, of WHC-CM-6-32.

May 1997

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LIST OF TABLES

LIST OF TERMS

ARF	airborne release fraction
BIO	basis for interim operation
CEDE	committed effective dose equivalent
DOE	U. S. Department of Energy
FDH	Fluor Daniel Hanford
FSAR	final safety analysis report
HEDOP	Hanford Environmental Dose Overview Panel
rem	radiation effective man
RF	respirable fraction
SST	single-shell tank
Sv	sievert
TEDE	total effective dose equivalent
TWRS	Tank Waste Remediation System
ULD	unit liter dose
WHC	Westinghouse Hanford Company

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VENTILATION SYSTEM CONSEQUENCE CALCULATIONS TO SUPPORT SALT WELL PUMPING SINGLE-SHELL TANK 241-A-101

1.0 INTRODUCTION AND PURPOSE

The purpose of this document is to evaluate the potential radiological dose and toxicological exposure consequences associated with the portable ventilation system used for salt well pumping single-shell tank 241-A-101. The calculations and assumptions used in this document are, in many cases, similar or identical to those used in calculation note WHC-SD-WM-CN-062, *HEPA Filter Failure by Fire or Heater Overtemperature and Subsequent Unfiltered Release*. Some requested refinements in this analysis are the use of the maximum design flowrate of the exhaust fan used to ventilate 241-A-101 (i.e., 0.236 m^3/s [500 cfm]) and alternate radiological dose calculations to show the results of using a 241-A-101 tank-specific source term as defined in WHC-SD-WM-SAD-036, *A Safety Assessment for Salt Well Jet Pumping Operations in Tank 241-A-101: Hanford Site, Richland, Washington*.

WHC-SD-WM-CN-062 was developed to support the accident scenario, *HEPA Filter Failure - Exposure to High Temperature or Pressure*, presented in the TWRS Basis for Interim Operation (BIO) and the Final Safety Analysis Report (FSAR). The results of the consequence analysis documented in WHC-SD-WM-CN-062 demonstrated the need for safety-significant Ventilation Stack Continuous Air Monitor (CAM) Interlock Systems on actively ventilated single-shell and double-shell waste tanks. The safety functions of the ventilation stack CAM interlock systems are to limit an unfiltered release of ventilation exhaust to the atmosphere to a period of ten minutes or less, thus reducing the consequences of the *HEPA Filter Failure - Exposure to High Temperature or Pressure* accident.

Instead of accepting and implementing this safety SSC for use in the operation of the ventilation system used to support salt well pumping 241-A-101, salt well pumping project management has expressed an interest in exploring alternate control options for this ventilation system. The results of the analysis performed in this document will help to provide the basis for any safety SSCs or controls that may need to be developed specifically for the operation of this exhauster. Note that the development and documentation of any safety SSCs or controls that are necessary to control the operation of this specific exhauster will occur outside of this calculation note.

In this document, the terms ventilation system and exhauster are used interchangeably.

ACCIDENT SCENARIO DESCRIPTION

The same accident scenario that is analyzed in WHC-SD-WM-CN-062 is evaluated in this document. The scenario assumes that a fire occurs in or around the ventilation system and the heat from the fire degrades the filters. Degradation of the filters is assumed to result in the release of a fraction of the inventory of tank waste accumulated on the prefilter, the two in-series HEPA filters, and a fraction of the inventory of tank waste that has accumulated in the ventilation system ductwork. The fire ultimately results in an unfiltered release pathway to the environment. Subsequent to the fire, the exhaust fan continues to operate, exhausting the headspace constituents of the waste tank to the atmosphere.

It should be noted that the authorization basis documentation (i.e., WHC-SD-WM-SAD-036) for salt well pumping 241-A-101 did not identify or analyze this accident scenario. It is being analyzed here to demonstrate consistency with the TWRS BIO and to be sure that any additional, necessary controls are identified.

The scenario analyzed bounds the hazard associated with an unfiltered release due to seal failure, a defective or deteriorated HEPA filter, or improper installation of HEPA filter. The fire scenario is selected for analysis as its consequences are bounding due to the additional release associated with the filter inventory.

The total consequences of this event are calculated by (1) adding the consequences due to the amount of respirable material released during the HEPA filter failure and (2) the amount of respirable material released during the subsequent continuous, unfiltered release following the filter failure.

The material at risk on the pre-filter and HEPAs is assumed to have a contact dose rate of less than or equal to 200 mrem/h (2.0 E-03 Sv/h). Since this is an assumption for filter loading it requires protection via a technical safety requirement (TSR) level control (see Section 8.0). The contact dose rate is based on operational history and bounds the contact dose rates observed in the tank farms. WHC-SD-WM-CN-033, *Microshield*Dose Rate Calculations for HEPA Filters and Prefilters*, uses the contact dose rate to back calculate the inventory on the filters.

Consequences resulting from the unfiltered release pathway are calculated for 12 hours (onsite receptor only), 24 hours (offsite receptor only), and for durations of 1 week, 3 months, 6 months, and one year for both the onsite and offsite receptors. For unfiltered release durations greater than one week, the dose to the onsite receptor is adjusted by an occupancy factor of 0.286 to account for the actual time spent at work. The occupancy factor only applies to the onsite receptor (WHC-SD-WM-SARR-016). It is assumed that the exhaust fan continues to run at the maximum design ventilation flowrate of 0.236 m^3/s (500 cfm).

The consequences created as a result of the 1 yr (or annual) unfiltered release are calculated because the ventilation system operates continuously such that the release duration is essentially infinite in the absence of controls. This is in contrast to other potential accidents that have a finite duration. The consequences as a result of the annual unfiltered release show the sensitivity of the analysis to assumptions regarding release duration and can be used in conjunction with the various accident duration consequences to select the necessary and sufficient set of controls.

ACCIDENT FREQUENCY DEVELOPMENT

The event frequency for this accident scenario assuming no controls is qualitatively assessed to be anticipated ($>10^{-2}$ to $\leq 10^{0}$) based on the initiating event frequency for an external fire. An external fire around the ventilation system would likely cause a filter degradation, as analyzed here, and is consistent with the analysis presented in Section 5.3.2.3 of the TWRS

*Microshield is a registered trademark of Grove Engineering, Inc., Rockville, MD

BIO and the accompanying calculation note, WHC-SD-WM-CN-056, *Fire in a Contaminated Area*, that evaluates the consequences of a fire in a contaminated area.

The consequences associated with this accident scenario are compared to the risk acceptance guidelines for *anticipated* accidents as provided in WHC-CM-4-46, Rev. 1.

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2.0 ANALYSIS INPUT

The input data shown in Table 1 is used in this document to develop the radiological and toxicological consequence analyses for the 241-A-101 Exhauster.

Table 1. Input Data Used to Develop the Consequence Analyses.

Parameter	Value
Facility/Vent System	241-A-101 Exhauster
HEPA Filter Dimensions and Vent System Configuration	24" x 24" x 5-7/8"[a]
Maximum Design Flowrate of Vent System	0.236 m^3/s (500 cfm)
Type of Waste Released From the Vent System	SST Solids
Amount Released	3.06 E-05 L[b]

[a]These are the HEPA filter dimensions as listed on Hanford design drawing H-14-100737, sheet 10. The amount released from the ventilation system configuration consists of the amount from two HEPAs, a prefilter, and another volume equal to the prefilter for material coming out of the ventilation ducting: 2 HEPA Volumes + 2 Prefilter Volumes. Information gathered in relation to this exhauster is included in Appendix B of this document.

[b]The amount released is taken from information presented in Appendix A of this document for SSTs with active ventilation. The information presented in Appendix A was specifically developed for use in WHC-SD-WM-CN-062, HEPA Filter Failure by Fire or Heater Overtemperature and Subsequent Unfiltered Release, and is now being utilized in this calculation note. To most accurately represent the exhauster being used for 241-A-101, the value shown only reflects the volume released from one filter bank. This is a conservative value since there is a slight difference in the dimensions of the filter size evaluated (24" x 24" x 12") in CN-062 and those used in this exhauster.

Additionally, to supplement the information in Table 1, the unit liter doses (ULDs) for the bounding (from WHC-SD-WM-SARR-016) and tank-specific source terms (from WHC-SD-WM-SAD-036, last column, Table H-2, page H-4) utilized in this analysis are included in Table 2.

Table 2. Unit Liter Doses for Tank Waste Composites.

Composite	Inhalation ULD (Sv/L)	Ingestion ULD* (Sv-m^3/s-L)
SST Solids (bounding value from WHC-SD-WM-SARR-016)	2.2 E+05	4.1
SST Solids (tank-specific value from WHC-SD-WM-SAD-036)	7.39 E+04	N/A

*Includes 24 hours ingestion of fruits and vegetables, ground shine, inadvertent soil ingestion, and inhalation of material resuspended from the ground. This value has only been documented for the bounding source term value.
ULD = unit liter dose.

DISPERSION COEFFICIENTS

The following dispersion coefficients are developed for use in this accident analysis:

Onsite:

The χ/Q' for the acute release from the HEPA filter is 3.41 x 10^{-2} s/m^3 (Table 4, WHC-SD-WM-SARR-016).

To determine the χ/Q' for the 12 hour release, the logarithmic interpolation procedure described in WHC-SD-WM-SARR-016 is used to correctly identify the proper χ/Q's to be used. The χ/Q' used for the 2 hour release is 1.13 x 10^{-2} s/m^3 to account for plume meander (Table 4, WHC-SD-WM-SARR-016). Using the equation from WHC-SD-WM-SARR-016 yields:

$$\frac{\log(1.13 \times 10^{-2}) - \log(\chi/Q' \text{ 12 hr})}{\log(1.13 \times 10^{-2}) - \log(4.03 \times 10^{-4})} = \frac{\log(2 \text{ hr}) - \log(12 \text{ hr})}{\log(2 \text{ hr}) - \log(8{,}760 \text{ hr})}$$

The onsite χ/Q' (12 hr) is 5.54 x 10^{-3} s/m^3.

The χ/Q's for the 1 week, 3 month, and 6 month releases are also calculated using the logarithmic interpolation procedure. These values, along with the χ/Q's calculated above, are summarized in Table 3.

Table 3. Summary of Onsite χ/Q' Values

Duration	χ/Q' value (s/m^3)	Source
Acute Release (<1 hr)	3.41 E-02	Table 4, WHC-SD-WM-SARR-016
12 hr	5.54 E-03	Logarithmic interpolation
168.5 hr (1 week)	1.94 E-03	Logarithmic interpolation
730 hrs (1 month)	1.08 E-03	Logarithmic interpolation
2,190 hrs (3 months)	6.99 E-04	Logarithmic interpolation
4,380 hrs (6 months)	5.31 E-04	Logarithmic interpolation
8,760 hrs (1 yr)	4.03 E-04	Table 9, WHC-SD-WM-SARR-016

Offsite:

The χ/Q' for the acute release from the HEPA filter is 2.83 x 10^{-5} s/m^3 (Table 5, WHC-SD-WM-SARR-016).

To determine the χ/Q' for the 24 hour release, the logarithmic interpolation procedure described in WHC-SD-WM-SARR-016 is used to correctly identify the proper χ/Q's to be used. The χ/Q' used for the 2 hour release is 2.12 x 10^{-5} s/m^3 to account for plume meander (Table 5, WHC-SD-WM-SARR-016). Using the equation from WHC-SD-WM-SARR-016 yields:

$$\frac{\log(2.12 \times 10^{-5}) - \log(\chi/Q'\ 24\ hr)}{\log(2.12 \times 10^{-5}) - \log(1.24 \times 10^{-7})} = \frac{\log(2\ hr) - \log(24\ hr)}{\log(2\ hr) - \log(8{,}760\ hr)}$$

The offsite χ/Q' (24 hr) is 4.62 E-06 s/m^3.

The χ/Q's for the 1 week, 3 month, and 6 month releases are also calculated using the logarithmic interpolation procedure. These values, along with the χ/Q's calculated above, are summarized in Table 4.

Table 4. Summary of Offsite χ/Q' Values

Duration	χ/Q' value (s/m^3)	Source
Acute Release (<1 hr)	2.83 E-05	Table 5, WHC-SD-WM-SARR-016
24 hr	4.62 E-06	Logarithmic interpolation
168.5 hr (1 week)	1.40 E-06	Logarithmic interpolation
730 hrs (1 month)	5.69 E-07	Logarithmic interpolation
2,190 hrs (3 months)	2.90 E-07	Logarithmic interpolation
4,380 hrs (6 months)	1.90 E-07	Logarithmic interpolation
8,760 hrs (1 yr)	1.24 E-07	Table 9, WHC-SD-WM-SARR-016

For the unfiltered release following the failure of the HEPA filters, Table 5 presents the particulate release rate from the headspace of tank 241-A-101.

Table 5. Particulate Release Rates.

Facility/vent system	Flow rate[a]		Partition Fraction Applied	Particulate Release Rate[a] (L/s)
	(m^3/s)	(L/s)		
241-A-101 Exhauster	0.236	236	1.0 E-10	2.4 E-08

[a]The particulate release rate (L/s) is calculated by multiplying the ventilation flow rate (L/s) by the partition fraction.

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3.0 ASSUMPTIONS

The following assumptions were used in this analysis (in no particular order):

- The dose rate "on contact" from pre-filters and HEPA filters is $\leq$ 200 mR/hr. According to the approved Information Validation Form (IVF) provided in Appendix B of WHC-SD-WM-CN-062, *HEPA Filter Failure by Fire or Heater Overtemperature and Subsequent Unfiltered Release*, Tank Farm Operations personnel confirm that HEPA filters are changed when the contact dose rate is less than 200 mR/hr (i.e., 160 mR/hr). The location for calculating the contact dose rate on pre-filters and HEPA filters is defined in WHC-SD-WM-CN-033.

- All HEPA filters are assumed to be compromised and release a fraction of their contents during a fire in or around the ventilation system.

- The filter media making up the HEPA filters is made of fiberglass (or other non-combustible material). There is no paper (or other highly combustible) filter media used in the Tank Farm ventilation systems HEPA filters.

- The ventilation system remains in operation (i.e., fan running) during and following the fire (or overtemperature) event that fails the HEPA filters.

- An additional amount of contamination equal to the loading on the pre-filter is used in order to account for accumulation in the ventilation duct work.

- The type of waste material that is released from both the ventilation system (filters and ductwork) and the tank headspace is SST Solids with a bounding ULD of 2.2×10^{5} Sv/L (see Table 2). This source term bounds the SST Liquids waste type that has an inhalation ULD of 1.1×10^{4} Sv/L.

- The respirable fraction (RF) for the unfiltered release is assumed to be 1.0 in all cases.

- The unfiltered release amount, based on the maximum design ventilation system flowrate shown in Table 1, is calculated utilizing a partition fraction to determine the amount of contamination in the headspace air. A partition fraction of 1.0×10^{-10} is used for 241-A-101. The partition fraction cited here is based on experimental results published in RHO-RE-SA-216, *Characterization of Airborne Radionuclide Particulates in Ventilated Liquid Waste Tanks* for agitated (1.0×10^{-8}) and unagitated (1.0×10^{-10}) tanks under both active and passive ventilation. The use of the lower partition fraction is considered reasonable and conservative since the salt well pumping activity is not expected to agitate the waste inside single-shell tank 241-A-101.

- The airborne release fraction (ARF) used to determine the amount of respirable material released from the HEPA filters as a result of exposure to high temperature or fire is 1.0×10^{-4}. This bounding value, for fiberglass filters, is based on information presented in Section 5.4.1 of DOE-HDBK-3010-94, *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*, for HEPA filters subjected to thermal stress. This value is considered applicable and conservative for use in this analysis since the filters used in tank farm ventilation systems are fiberglass and similar to those empirically evaluated in DOE-HDBK-3010-94. The value for the HEPA filter release amount (including prefilter and ductwork accumulation) is summarized in Table 1. The release amount shown in Table 1 is developed in the discussion and worksheets of Appendix A.

- The typical acute breathing rate (3.3×10^{-4} m^3/s) is used to calculate the onsite receptor dose for all release durations up to one week. The chronic breathing rate (2.7×10^{-4} m^3/s) is used for onsite receptor dose calculations with release durations greater than one week (WHC-SD-WM-SARR-016, page 4-4).

  For the calculation of the offsite receptor dose, the typical acute breathing rate (3.3×10^{-4} m^3/s) is used for all release durations less than one day (24 hr). For release durations greater than or equal to one day (24 hr), the typical chronic breathing rate (2.7×10^{-4} m^3/s) is used to calculate the offsite receptor dose (WHC-SD-WM-SARR-016, page 4-4).

- For unfiltered release durations greater than one week, the dose to the onsite receptor is adjusted by an occupancy factor of 0.286 to account for the actual time spent at work. The occupancy factor only applies to the onsite receptor (WHC-SD-WM-SARR-016, page 4-4).

4.0 ANALYTICAL METHODS AND CALCULATIONS

The total consequences of this event are calculated by adding the consequences due to the amount of respirable material released during the HEPA filter failure and the amount of respirable material released during the subsequent continuous, unfiltered release following the filter failure.

Consequences resulting from the unfiltered release pathway are calculated for 12 hours (onsite receptor only), 24 hours (offsite receptor only), and for durations of 1 week, 3 months, 6 months, and one year for both the onsite and offsite receptors. For unfiltered release durations greater than one week, the dose to the onsite receptor is adjusted by an occupancy factor of 0.286 to account for the actual time spent at work. The occupancy factor only applies to the onsite receptor (WHC-SD-WM-SARR-016). It is assumed that the exhaust fan continues to run at the maximum design ventilation flowrate of 0.236 m^3/s (500 cfm).

Overall, the methodology used to calculate the radiological and toxicological consequences is presented and discussed in WHC-SD-WM-SARR-016 and WHC-SD-WM-SARR-011, respectively.

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5.0 RADIOLOGICAL DOSE CONSEQUENCE ANALYSIS

Given an airborne source term, the doses from the inhalation and ingestion pathways are calculated by the following formulas:

Inhalation:

$$D_{inh}(Sv) = Q(L) \times \frac{X}{Q'}\left[\frac{s}{m^3}\right] \times R\left[\frac{m^3}{s}\right] \times ULD_{inh}\left[\frac{Sv}{L}\right]$$

Ingestion:

$$D_{ing}(Sv) = Q(L) \times \frac{X}{Q'}\left[\frac{s}{m^3}\right] \times ULD_{ing}\left[\frac{Sv{-}m^3}{s{-}L}\right]$$

where

D_{inh} = dose due to inhalation (Sv)

D_{ing} = dose due to ingestion (Sv)

Q = respirable source term (L)

χ/Q' = appropriate atmospheric dispersion coefficient (s/m^3)

R = breathing rate (for values, see assumptions in Section 3.0)

ULD_{inh} = inhalation unit liter dose (Sv/L, see Table 2)

ULD_{ing} = ingestion unit liter dose ($Sv\text{-}m^3/s\text{-}L$, see Table 2).

For the inhalation pathway, the dose calculated is the 50-year committed effective dose equivalent (CEDE) defined as the dose received by the individual during a 50-year period following the uptake. For the maximum onsite individual, this dose must be combined with that due to external exposure (if any) to yield the TEDE. For the ingestion pathway, the dose calculated is the CEDE from ingestion plus the dose due to external exposure (e.g., ground shine) during the first 24 hours after the release. Combining the ingestion dose with the inhalation dose yields the TEDE for the maximum offsite individual.

To demonstrate the way the radiological dose consequences are calculated, a sample calculation of the onsite (filter failure, 12 hr, and 1 yr continuous releases) and offsite consequences (filter failure, 24 hr, and 1 yr continuous releases) are presented for the 241-A-101 Exhauster using the bounding composite ULD value (i.e., 2.2 x 10^5 Sv/L) from Table 2.

ONSITE RADIOLOGICAL CONSEQUENCES

Consequences from the HEPA Filter Failure (D_{filter}):

$$D_{inh}(Sv) = Q(L) \times \frac{X}{Q'}\left[\frac{s}{m^3}\right] \times R\left[\frac{m^3}{s}\right] \times ULD_{inh}\left[\frac{Sv}{L}\right]$$

where

D_{inh} = dose due to inhalation (Sv)

Q = 3.06×10^{-5} L (see Table 1)

χ/Q' = 3.41×10^{-2} s/m^3 (see Section 2.0)

R = 3.3×10^{-4} m^3/s (see Section 3.0)

ULD_{inh} = 2.2×10^5 Sv/L (see Table 2)

$$D_{filter} = (3.06 \times 10^{-5}\ L)(3.41 \times 10^{-2}\ s/m^3)(3.3 \times 10^{-4}\ m^3/s)(2.2 \times 10^5\ Sv/L)$$

$$D_{filter} = 7.58 \times 10^{-5}\ Sv$$

Consequences from the 12 hour Unfiltered Release ($D_{12\ hour}$):

$$D_{inh}(Sv) = Q(L/s) \times \frac{X}{Q'}\left[\frac{s}{m^3}\right] \times R\left[\frac{m^3}{s}\right] \times ULD_{inh}\left[\frac{Sv}{L}\right] \times t(s)$$

where

D_{inh} = dose due to inhalation (Sv)

Q = 2.4×10^{-8} L/s (see Table 5)

χ/Q' = 5.54×10^{-3} s/m^3 (see Section 2.0)

R = 3.3×10^{-4} m^3/s (see Section 3.0)

ULD_{inh} = 2.2×10^5 Sv/L (see Table 2)

t = 43,200 s (12 h)

$$D_{12\ hour} = (2.4 \times 10^{-8}\ L/s)(5.54 \times 10^{-3}\ s/m^3)(3.3 \times 10^{-4}\ m^3/s) \times (2.2 \times 10^5\ Sv/L)(43{,}200\ s)$$

$$D_{12\ hour} = 4.17 \times 10^{-4}\ Sv$$

<u>Consequences from an Annual (8,760 h) Unfiltered Release</u> (D_{annual}):

$$D_{inh}(Sv) = Q(L/s) \times \frac{X}{Q'}\left[\frac{s}{m^3}\right] \times R\left[\frac{m^3}{s}\right] \times ULD_{inh}\left[\frac{Sv}{L}\right] \times t(s) \times OF$$

where

D_{inh} = dose due to inhalation (Sv)

Q = 2.4×10^{-8} L/s (see Table 5)

χ/Q' = 4.03×10^{-4} s/m^3 (see Section 2.0)

R = 2.7×10^{-4} m^3/s (see Section 3.0)

ULD_{inh} = 2.2×10^5 Sv/L (see Table 2)

t = 3.1536×10^7 s (8,760 h) [additional significant figures included to reduce error in final answer]

OF = 0.286 (see Section 3.0)

D_{annual} = $(2.4 \times 10^{-8}$ L/s$)(4.03 \times 10^{-4}$ s/m$^3)(2.7 \times 10^{-4}$ m^3/s$)(2.2 \times 10^5$ Sv/L$) \times (3.1536 \times 10^7$ s$)(0.286)$

$$D_{annual} = 5.18 \times 10^{-3} \text{ Sv}$$

Total onsite consequences (12 hour release):

$$D_{onsite\ (12\ h)} = D_{filter} + D_{12\ hour}$$

$$= 7.58 \times 10^{-5} \text{ Sv} + 4.17 \times 10^{-4} \text{ Sv}$$

$$D_{onsite\ (12\ h)} = 4.93 \times 10^{-4} \text{ Sv}$$

Total onsite consequences (Annual release):

$$D_{onsite\ (annual)} = D_{filter} + D_{annual}$$

$$= 7.58 \times 10^{-5} \text{ Sv} + 5.18 \times 10^{-3} \text{ Sv}$$

$$D_{onsite\ (annual)} = 5.26 \times 10^{-3} \text{ Sv}$$

By the same method, onsite radiological consequences are calculated for all release durations using the source term shown in the calculations above and also using the 241-A-101 tank-specific source term ULD (see Table 2). Worksheets detailing the calculations are included in Appendix C with summary results presented in Section 7.0.

OFFSITE RADIOLOGICAL CONSEQUENCES

Consequences from the HEPA Filter Failure ($D_{filter-inhalation}$ and $D_{filter-ingestion}$):

$$D_{inh}(Sv) = Q(L) \times \frac{X}{Q'}\left[\frac{s}{m^3}\right] \times R\left[\frac{m^3}{s}\right] \times ULD_{inh}\left[\frac{Sv}{L}\right]$$

where

D_{inh} = dose due to inhalation (Sv)

Q = 3.06×10^{-5} L (see Table 1)

χ/Q' = 2.83×10^{-5} s/m^3 (see Section 2.0)

R = 3.3×10^{-4} m^3/s (see Section 3.0)

ULD_{inh} = 2.2×10^5 Sv/L (see Table 2)

$D_{filter-inhalation}$ = $(3.06 \times 10^{-5}$ L$)(2.83 \times 10^{-5}$ s/m$^3)(3.3 \times 10^{-4}$ m^3/s$) \times (2.2 \times 10^5$ Sv/L$)$

$D_{filter-inhalation}$ = 6.29×10^{-8} Sv

$$D_{ing}(Sv) = Q(L) \times \frac{X}{Q'}\left[\frac{s}{m^3}\right] \times ULD_{ing}\left[\frac{Sv-m^3}{s-L}\right]$$

where

D_{ing} = dose due to inhalation (Sv)

Q = 3.06×10^{-5} L (see Table 1)

χ/Q' = 2.83×10^{-5} s/m^3 (see Section 2.0)

ULD_{ing} = 4.1 Sv-m^3/s-L (see Table 2)

$D_{filter-ingestion}$ = $(3.06 \times 10^{-5}$ L$)(2.83 \times 10^{-5}$ s/m$^3)(4.1$ Sv-m^3/s-L$)$

$D_{filter-ingestion}$ = 3.55×10^{-9} Sv

<u>Consequences from the 24 hour Unfiltered Release</u> ($D_{24\ h\text{-}inhalation}$ and $D_{24\ h\text{-}ingestion}$):

$$D_{inh}(Sv) = Q(L/s) \times \frac{X}{Q'}\left[\frac{s}{m^3}\right] \times R\left[\frac{m^3}{s}\right] \times ULD_{inh}\left[\frac{Sv}{L}\right] \times t(s)$$

where

D_{inh} = dose due to inhalation (Sv)

Q = 2.4 x 10^{-8} L/s (see Table 5)

χ/Q' = 4.62 x 10^{-6} s/m^3 (see Section 2.0)

R = 2.7 x 10^{-4} m^3/s (see Section 3.0)

ULD_{inh} = 2.2 x 10^5 Sv/L (see Table 2)

t = 86,400 s (24 h)

$D_{24\ h\text{-}inhalation}$ = (2.4 x 10^{-8} L/s)(4.62 x 10^{-6} s/m^3)(2.7 x 10^{-4} m^3/s) x (2.2 x 10^5 Sv/L) x (86,400 s)

$D_{24\ h\text{-}inhalation}$ = 5.69 x 10^{-7} Sv

$$D_{ing}(Sv) = Q(L/s) \times \frac{X}{Q'}\left[\frac{s}{m^3}\right] \times ULD_{ing}\left[\frac{Sv\text{-}m^3}{s\text{-}L}\right] \times t(s)$$

where

D_{ing} = dose due to inhalation (Sv)

Q = 2.4 x 10^{-8} L/s (see Table 5)

χ/Q' = 4.62 x 10^{-6} s/m^3 (see Section 2.0)

ULD_{ing} = 4.1 Sv-m^3/s-L (see Table 2)

t = 86,400 s (24 h)

$D_{24\ h\text{-}ingestion}$ = (2.4 x 10^{-8} L/s)(4.62 x 10^{-6} s/m^3)(4.1 Sv-m^3/s-L)(86,400 s)

$D_{24\ h\text{-}ingestion}$ = 3.93 x 10^{-8} Sv

<u>Consequences from an Annual (8,760 h) Unfiltered Release</u> ($D_{annual-inhalation}$ and $D_{annual-ingestion}$):

$$D_{inh}(Sv) = Q(L/s) \times \frac{X}{Q'}\left[\frac{s}{m^3}\right] \times R\left[\frac{m^3}{s}\right] \times ULD_{inh}\left[\frac{Sv}{L}\right] \times t(s)$$

where

D_{inh} = dose due to inhalation (Sv)

Q = 2.4×10^{-8} L/s (see Table 5)

χ/Q' = 1.24×10^{-7} s/m³ (see Section 2.0)

R = 2.7×10^{-4} m³/s (see Section 3.0)

ULD_{inh} = 2.2×10^{5} Sv/L (see Table 2)

t = 3.1536×10^{7} s (8,760 h) [additional significant figures included to reduce error in final answer]

$D_{annual-inhalation}$ = $(2.4 \times 10^{-8}$ L/s$)(1.24 \times 10^{-7}$ s/m$^3)(2.7 \times 10^{-4}$ m^3/s$) \times (2.2 \times 10^{5}$ Sv/L$)(3.1536 \times 10^{7}$ s$)$

$D_{annual-inhalation}$ = 5.57×10^{-6} Sv

$$D_{ing}(Sv) = Q(L/s) \times \frac{X}{Q'}\left[\frac{s}{m^3}\right] \times ULD_{ing}\left[\frac{Sv\text{-}m^3}{s\text{-}L}\right] \times t(s)$$

where

D_{ing} = dose due to inhalation (Sv)

Q = 2.4×10^{-8} L/s (see Table 5)

χ/Q' = 1.24×10^{-7} s/m³ (see Section 2.0)

ULD_{ing} = 4.1 Sv-m³/s-L (see Table 2)

t = 3.1536×10^{7} s (8,760 h) [additional significant figures included to reduce error in final answer]

$D_{annual-ingestion}$ = $(2.4 \times 10^{-8}$ L/s$)(1.24 \times 10^{-7}$ s/m$^3)(4.1$ Sv-m^3/s-L$) \times (3.1536 \times 10^{7}$ s$)$

$D_{annual-ingestion}$ = 3.85×10^{-7} Sv

Total offsite consequences (24 hour release):

$$D_{24\ h} = (D_{filter-inhalation)} + D_{filter-ingestion} + D_{24\ h-inhalation} + D_{24\ h-ingestion})$$

$$= 6.29 \times 10^{-8}\ Sv + 3.55 \times 10^{-9}\ Sv + 5.69 \times 10^{-7}\ Sv + 3.93 \times 10^{-8}\ Sv$$

$$D_{24\ h} = 6.48 \times 10^{-7}\ Sv$$

Total offsite consequences (Annual release):

$$D_{annual} = (D_{filter-inhalation)} + D_{filter-ingestion} + D_{annual-inhalation} + D_{annual-ingestion})$$

$$= 6.29 \times 10^{-8}\ Sv + 3.55 \times 10^{-9}\ Sv + 5.57 \times 10^{-6}\ Sv + 3.85 \times 10^{-7}\ Sv$$

$$D_{annual} = 6.02 \times 10^{-6}\ Sv$$

By the same method, offsite radiological consequences are calculated for all release durations using the source term shown in the calculations above and also using the 241-A-101 tank-specific source term ULD (see Table 2). Worksheets detailing the calculations are included in Appendix C with summary results presented in Section 7.0.

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6.0 TOXICOLOGICAL EXPOSURE CONSEQUENCE ANALYSIS

The methodology that is used to calculate toxicological exposure consequences is documented in WHC-SD-WM-SARR-011, Rev. 2, *Toxic Chemical Considerations for Tank Farm Releases*. In this method, the released quantity (or release rate) is multiplied by the appropriate sum-of-fraction (SOF) value from Table 3-8 of WHC-SD-WM-SARR-011. Sum-of-fraction (SOF) values are dependent on the type of release (puff-type or continuous), the waste material released, and the event frequency.

All toxicological exposure calculations in this document are evaluated at a frequency of *anticipated* (see Section 1.0).

$$D = Q \cdot SOF$$

Where

D = the variable D is used to denote the toxicological exposure consequences and should not be confused with dose (in the radiological sense).

Q = the quantity released, in units of L or L/s

SOF = the appropriate sum-of-fraction value, in units of L^{-1} or s/L

To demonstrate the way the toxicological consequences are calculated, a sample calculation of the onsite and offsite consequences are presented for the 241-A-101 Exhauster.

ONSITE TOXICOLOGICAL CONSEQUENCES

<u>Consequences from the HEPA Filter Failure</u> (D_{filter}):

$$\text{Toxicological Exposure Consequences} = Q \cdot SOF$$

Where

Q = 3.06×10^{-5} L

SOF = 1.2×10^{4} L^{-1}

$$D_{filter} = (3.06 \times 10^{-5} \text{ L})(1.2 \times 10^{4} \text{ L}^{-1})$$

$$D_{filter} = 3.67 \times 10^{-1}$$

Consequences from the Unfiltered Release ($D_{unfiltered}$): [Note that since the release rate is constant with respect to time (i.e., linear), the evaluated time period of the release (i.e., 12 h, 24 h, etc.) is not relevant to the calculation.]

$$D = Q \cdot SOF$$

Where

$Q = 2.4 \times 10^{-8}$ L/s

$SOF = 4.0 \times 10^{4}$ s/L

$$D_{unfiltered} = (2.4 \times 10^{-8} \text{ L/s})(4.0 \times 10^{4} \text{ s/L})$$

$$D_{unfiltered} = 9.60 \times 10^{-4}$$

Total onsite consequences:

$$D_{onsite} = D_{filter} + D_{unfiltered}$$

$$= 3.67 \times 10^{-1} + 9.60 \times 10^{-4}$$

$$D_{onsite} = 3.68 \times 10^{-1}$$

These consequences are identical for any of the continuous release durations. Since a separate or tank-specific toxicological source term was not developed in WHC-SD-WM-SAD-036, toxicological exposure calculations using an alternate source term are not performed in this document. Summary results of toxicological consequence calculations are presented in Section 7.0.

OFFSITE TOXICOLOGICAL CONSEQUENCES

Consequences from the HEPA Filter Failure (D_{filter}):

$$D = Q \cdot SOF$$

Where

$Q = 3.06 \times 10^{-5}$ L

$SOF = 3.8 \times 10^{-1}$ L^{-1}

$$D_{filter} = (3.06 \times 10^{-5} \text{ L})(3.8 \times 10^{-1} \text{ L}^{-1})$$

$$D_{filter} = 1.16 \times 10^{-5}$$

<u>Consequences from the Unfiltered Release</u> ($D_{unfiltered}$): [Note that since the release rate is constant with respect to time (i.e., linear), the evaluated time period of the release (i.e., 12 h, 24 h, etc.) is not relevant to the calculation.]

$$D = Q \cdot SOF$$

Where

$Q = 2.4 \times 10^{-8}$ L/s

$SOF = 9.4 \times 10^{1}$ s/L

$$D_{unfiltered} = (2.4 \times 10^{-8} \text{ L/s})(9.4 \times 10^{1} \text{ s/L})$$

$$D_{unfiltered} = 2.26 \times 10^{-6}$$

Total offsite consequences:

$$D_{offsite} = D_{filter} + D_{unfiltered}$$

$$= 1.16 \times 10^{-5} + 2.26 \times 10^{-6}$$

$$D_{offsite} = 1.39 \times 10^{-5}$$

These consequences are identical for any of the continuous release durations. Since a separate or tank-specific toxicological source term was not developed in WHC-SD-WM-SAD-036, toxicological exposure calculations using an alternate source term are not performed in this document. Summary results of toxicological exposure calculations are presented in Section 7.0.

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7.0 ANALYSIS RESULTS

7.1 RADIOLOGICAL CONSEQUENCES

The onsite and offsite radiological consequences of this scenario are summarized in Tables 6 and 7, respectively, for comparison with the risk guidelines.

Bounding Source Term ULD

The onsite radiological consequences calculated using the bounding source term ULD (see Table 2) show that for release durations of 12 hrs, 1 week, 1 month, 3 months, and 6 months, the consequences are below the risk guidelines. As such, no controls are necessary to protect required for these systems. However, the onsite radiological consequences calculated for the 1 yr (annual) unfiltered release following the HEPA failure are slightly above the risk guidelines and would therefore require the development of a safety SSC or controls to protect the onsite receptor from a year-long release from this ventilation system.

It is also interesting to note that even if the dose contribution from the failed HEPAs is not included in the total onsite radiological dose for the year-long release, the consequences still exceed the risk guidelines. This demonstrates the maximum radiological dose consequences that could be attributed to an unfiltered release (e.g., due to seal failure, defective or deteriorated HEPA filters, or improper installation of the HEPA filters).

The offsite radiological consequences calculated using the bounding source term ULD (see Table 2) show that for all release durations the consequences are below the risk guidelines. As such, no safety SSCs or controls are necessary to protect the offsite receptor.

In addition to the discussion provided, there is still the requirement for the control cited in Section 1 to protect the key assumption regarding the HEPA filter loading amount. Table 10 in Section 8 summarizes this control.

Tank-Specific Source Term ULD

The onsite and offsite radiological consequences calculated using the tank-specific source term ULD (see Table 2) show that for all release durations the consequences are below the risk guidelines. As such, no safety SSCs or controls are necessary to protect either the onsite or offsite receptors.

In addition to the discussion provided, there is still the requirement for the control cited in Section 1 to protect the key assumption regarding the HEPA filter loading amount. Table 10 in Section 8 summarizes this control.

7.2 TOXICOLOGICAL CONSEQUENCES

Similarly, the onsite and offsite toxicological consequences of this scenario are summarized in Tables 8 and 9, respectively. The onsite and offsite toxicological consequences for all release durations are below the risk guidelines.

Table 6. Summary of Onsite Radiological Consequences Assuming No Controls.

FACILITY/VENT SYSTEM	ONSITE RADIOLOGICAL CONSEQUENCES							Risk Guideline (Sv)
	Dose from Filter Failure (Sv)	Total Dose from 12 h Unfiltered Release (Sv) (includes amount from Column A)	Total Dose from 1 wk Unfiltered Release (Sv) (includes amount from Column A)	Total Dose from 1 Month Unfiltered Release (Sv) (includes amount from Column A)	Total Dose from 3 Month Unfiltered Release (Sv) (includes amount from Column A)	Total Dose from 6 Month Unfiltered Release (Sv) (includes amount from Column A)	Total Dose from 1 yr Unfiltered Release (Sv) (includes amount from Column A)	
	A	B	C	D	E	F	G	
241-A-101 Exhauster (bounding ST)	7.58 E-05	4.93 E-04	2.13 E-03	1.23 E-03	2.32 E-03	3.49 E-03	5.26 E-03	5.0 E-03
241-A-101 Exhauster (SAD-036 ST)	2.54 E-05	1.65 E-04	7.14 E-04	4.14 E-04	7.80 E-04	1.17 E-03	1.77 E-03	5.0 E-03

ST = Source Term
rem = Sv x 100

Table 7. Summary of Offsite Radiological Consequences Assuming No Controls.

FACILITY/VENT SYSTEM	ONSITE RADIOLOGICAL CONSEQUENCES							Risk Guideline (Sv)
	Dose from Filter Failure (Sv)	Total Dose from 24 h Unfiltered Release (Sv) (includes amount from Column A)	Total Dose from 1 wk Unfiltered Release (Sv) (includes amount from Column A)	Total Dose from 1 Month Unfiltered Release (Sv) (includes amount from Column A)	Total Dose from 3 Month Unfiltered Release (Sv) (includes amount from Column A)	Total Dose from 6 Month Unfiltered Release (Sv) (includes amount from Column A)	Total Dose from 1 yr Unfiltered Release (Sv) (includes amount from Column A)	
	A	B	C	D	E	F	G	
241-A-101 Exhauster (bounding ST)	6.65 E-08	6.75 E-07	1.36 E-06	8.23 E-07	1.22 E-06	1.58 E-06	2.05 E-06	1.0 E-03
241-A-101 Exhauster (SAD-036 ST)	2.11 E-08	2.12 E-07	1.37 E-07	2.26 E-07	3.34 E-07	4.31 E-07	5.57 E-07	1.0 E-03

ST = Source Term
rem = Sv x 100

Table 8. Summary of Onsite Toxicological Consequences Assuming No Controls.

FACILITY/VENT SYSTEM	ONSITE TOXICOLOGICAL CONSEQUENCES			RISK GUIDELINE
	Dose from Filter Failure	Dose from Unfiltered Release	Total Onsite Dose	
	A	B	A + B	
241-A-101 Exhauster	3.67 E-01	9.60 E-04	3.68 E-01	1

Table 9. Summary of Offsite Toxicological Consequences Assuming No Controls.

FACILITY/VENT SYSTEM	OFFSITE TOXICOLOGICAL CONSEQUENCES			RISK GUIDELINE
	Dose from Filter Failure	Dose from Unfiltered Release	Total Offsite Dose	
	A	B	A + B	
241-A-101 Exhauster	1.16 E-05	2.26 E-06	1.39 E-05	1

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8.0 CONCLUSIONS

The onsite radiological consequences, when calculated using the bounding source term ULD, exceed the risk guideline for the 1 yr (annual) release duration of this accident. Therefore, to protect the onsite receptor from a year-long release from this ventilation system, the development of a safety SSC or control(s) are required to satisfy the safety function of limiting an unfiltered release of ventilation exhaust to the atmosphere to period of 6 months or less. The onsite radiological dose consequences for a 6 month release are significantly below the risk guideline value.

The onsite radiological dose consequences from all other release durations, calculated using the bounding source term ULD, are below the risk guidelines.

The offsite radiological dose consequences calculated using the bounding source term ULD and the onsite and offsite radiological dose consequences calculated using the tank-specific source term ULD are all shown to be below the risk guidelines.

For toxicological exposure consequences, all calculated values (onsite and offsite receptors) are below the risk guidelines.

Table 10 lists a summary of the Technical Safety Requirements selected to mitigate the risk of HEPA filter failure due to a fire (or overtemperature) for the 241-A-101 exhauster. For the TSR listed, the safety function is described and additional comments are provided as appropriate. This control is credited in the BIO and further details regarding its development are provided in HNF-SD-WM-TSR-006, *Tank Waste Remediation System Technical Safety Requirements*.

Table 10. Summary of Technical Safety Requirements.

Control	Safety function	Comments
HEPA Filter Control Program with the following key elements: 1. Periodic radiation survey to monitor HEPA filter loading 2. HEPA filter replacement per change-out criteria, i.e., 2 mSv/h (200 mrem/h)	Reduce consequences from a possible HEPA filter failure by limiting the inventory available	Applies to all HEPA filters and prefilters in the ventilation system

HEPA = high-efficiency particulate air (filter).

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9.0 REFERENCES

Documents

DOE-HDBK-3010-94, *DOE Handbook Airborne Release Fractions/Rates and Restorable Fraction for Nonreactor Nuclear Facilities*, U.S. Department of Energy, Richland, Washington.

HNF-SD-WM-TSR-006, *Tank Waste Remediation System Technical Safety Requirements*, Rev. J, Fluor Daniel Hanford, Richland, Washington.

RHO-RE-SA-216, 1987, *Characterization of Airborne Radionuclide Particulates in Ventilated Liquid Waste Tanks*, Rockwell Hanford Operations, Richland, Washington.

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

WHC-SD-WM-CN-056, 1996, *Fire in a Contaminated Area*, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-CN-062, 1996, *HEPA Filter Failure by Fire or Heater Overtemperature and Subsequent Unfiltered Release*, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-SAD-036, *Safety Assessment for Salt Well Jet Pumping Operations in Tank 241-A-101: Hanford Site, Richland, Washington*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-SARR-011, *Toxicological Chemical Considerations for Tank Farm Releases*, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-SARR-016, *Tank Waste Compositions and Atmospheric Dispersion Coefficients for Use in Safety Analysis Consequence Assessments*, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

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

WHC-CM-4-46, *Safety Analysis Manual*, Section 4.0, Rev. 1, November 15, 1991, Westinghouse Hanford Company, Richland, Washington.

Drawings

Hanford design drawing H-14-100737, sheet 10, revision 0, dated 8/29/96, and titled *500 CFM PORTABLE EXHAUSTER DETAILS*.

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APPENDIX A

DEVELOPMENT AND DISCUSSION OF HEPA FILTER RELEASE AMOUNTS

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This appendix discusses the method used to calculate the amount of material on the filters in various tank farm facilities. To do this, WHC-SD-WM-CN-033 modeled 3.7 x 10^{10} Bq (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 are dominated by ^{90}Sr, ^{90}Y, ^{137}Cs and ^{154}Eu for gamma emitters while double-shell liquids are dominated by ^{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 putting in 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 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 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 to be used to calculate radiological and toxicological doses (see Sections 5.0 and 6.0, respectively).

WHC-SD-WM-SARR-037					SX, C-106			SSTs with Passive Breather Filters					
	SST Solids	SST Liquids	DST Liquids	AWF Liquids	SST Solids on a 3X3 Array of 24x24x12 Filters			SST Solids on a 24x24x12 Filter			SST Solids on a 12x12x12 Filter		
	(Bq/L)	(Bq/L)	(Bq/L)	(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									
				TOTAL	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							7.7821			1.12994			0.42105
HEPA Loading to give OL (L)							0.08725			0.01267			0.00472
0.01% Release (L)							8.7E-06			1.3E-06			4.7E-07
MicroShield Calculated Dose for Prefilter (mSv/hr)							0.34			No Prefilter			No Prefilter
Prefilter Operating Limit (mSv/hr)							2						
OL/CD							5.88235						
Prefilter Loading to give OL (L)							0.06595						
0.01% Release (L)							6.6E-06						
Volume Released from One Filter Bank (L)						D	3.06E-05		P	1.27E-06		P	4.72E-07
umber of Parallel Banks Operating at the Same Time							2			1			1
TOTAL RELEASED (L)							6.13E-05			1.27E-06			4.72E-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											

DCRTs			SY, AN, AP, AW			AY & AZ			204AR/244AR		
SST Liquids on a 12x12x12 Filter			DST Liquids on a 24x24x12 Filter			AWF Liquids on a 24x24x12 Filter			DST 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
		0.01538			0.04474			0.04474			0.04474
		0.02384			0.02825			0.01873			0.02825
		2.4E-06			2.8E-06			1.9E-06			2.8E-06
		220.00			61			No Prefilter			61
		2			2						2
		0.00909			0.03279						0.03279
		0.01408			0.0207						0.0207
		1.4E-06			2.1E-06						2.1E-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

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APPENDIX B

BACKGROUND INFORMATION

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Author: Michael A (Mike) Lane at ~HANFORD04C
Date: 3/4/97 10:31 AM
Priority: Normal
CC: David T Vladimiroff at ~KEH10
CC: William H (Bill) Meader at ~WHC225
CC: Gary W Gault at ~HANFORD07E
CC: Ryan D Smith at ~HANFORD07E
TO: Grant W Ryan at ~HANFORD02D
Subject: Re: Ventilation System Info. Requested

------------------------------ Message Contents ----------------------------

Mike,

To be able to complete the analysis that was discussed this morning, this is some of the information that I need on the SWP exhausters:

With respect to the A-101 SWP exhauster (if you want to know specifics on the 1,000 scfm units, you need to talk to Eric Veith, Owen Nelson or Jim Kriskovich):

1. Maximum design flowrate (cfm) 500

2. Number, size, and configuration of filters (parallel or series) 2, 24" X 24" X 5-7/8", series

3. Inside dimensions of inlet and outlet exhaust piping.12" inlet, 6" stack

4. Will all the filters be replaced at the same time? You need to ask Krisko or Owen Nelson this.

5. Will the efficiency testing be performed by the same crew that installs the filters? You need to ask Krisko or Owen Nelson this.

6. Drawing numbers (H-2s) of ventilation system or supply a copy of the drawings. H-14-020160, H-14-100737, H-14-100763, H-14-100764, H-14-100765, H-14-100766 (also ECN 627434)

7. Filter media (e.g., fiberglass?) I believe it is some kind of fiberglass, but you should check this with Krisko or Owen Nelson.

8. Positioning of the exhauster in relation to the tank being exhausted. see ECNs 627398, 633119 and 635642

We can discuss the other design features of the exhauster later, after we know if we have to look at them as possible controls.

Once I get this information I can submit it back to someone on your side who can sign off on the assumptions so there will be no questions later why I used the information that I did. I suggest that you have Krisko do it.

Thanks.

Grant

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APPENDIX C

DETAILED CONSEQUENCE ANALYSIS RESULTS

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			ONSITE RADIOLOGICAL CONSEQUENCES (ASSUMING NO CONTROLS)						
Facility/Vent System	Amount of Waste Released from HEPA Filter (L)	Particulate Release Rate (L/s)	Dose from Filter Failure [D, filter] (Sv)	Dose from 12 h Unfiltered Release [D,12 hour] (Sv)	Dose from 1 wk Unfiltered Release [D,1 wk] (Sv)	Dose from 1 month Unfiltered Release [D,1 month] (Sv)	Dose from 3 month Unfiltered Release [D,3 month] (Sv)	Dose from 6 month Unfiltered Release [D,6 month] (Sv)	Dose from Annual Unfiltered Release [D,1 yr] (Sv)
241-A-101 Exhauster (bounding ST)	3.06 E-05	2.4 E-08	7.58 E-05	4.17 E-04	2.05 E-03	1.16 E-03	2.25 E-03	3.41 E-03	5.18 E-03
241-A-101 Exhauster (SAD-036 ST)	3.06 E-05	2.4 E-08	2.54 E-05	1.40 E-04	6.89 E-04	3.89 E-04	7.55 E-04	1.15 E-03	1.74 E-03
ST = source term		**Dispersion Coefficients**			**Release Period (s)**				
		onsite	offsite		43,200	(12 hr)			
		(s/m3)	(s/m3)		86,400	(24 hr)			
	acute	3.41E-02	2.83E-05		606,600	(1 wk)			
	12 hour	5.54E-03	NA		2,628,000	(1 month)			
	24 hour	N/A	4.62E-06		7,884,000	(3 months)			
	1 week	1.94E-03	1.40E-06		15,768,000	(6 months)			
	1 month	1.08E-03	5.69E-07		31,536,000	(1 yr)			
	3 months	6.99E-04	2.90E-07						
	6 months	5.31E-04	1.90E-07			**ULDs**			
	annual	4.03E-04	1.24E-07			Inhalation	Ingestion		
						(Sv/L)	(Sv m3)/(s L)		
	Occupancy Factor			**SST Solids (bounding)**		2.2E+05	4.1		
		0.286		**SST Solids (SAD-036)**		7.4E+04	0		
		Standard Man Breathing Rate							
		(m3/s)							
		2.70E-04							
		3.30E-04							

	ONSITE RADIOLOGICAL CONSEQUENCES (ASSUMING NO CONTROLS)					
Facility/Vent System	Total Onsite Dose (12 h Release) [D, onsite (12 h)] (Sv)	Total Onsite Dose (1 wk Release) [D, onsite (1 wk)] (Sv)	Total Onsite Dose (1 month Release) [D, onsite (1 month)] (Sv)	Total Onsite Dose (3 month Release) [D, onsite (3 month)] (Sv)	Total Onsite Dose (6 month Release) [D, onsite (6 month)] (Sv)	Total Onsite Dose (1 yr Release) [D, onsite (1 yr)] (Sv)
241-A-101 Exhauster (bounding ST)	4.93 E-04	2.13 E-03	1.23 E-03	2.32 E-03	3.49 E-03	5.26 E-03
241-A-101 Exhauster (SAD-036 ST)	1.66 E-04	7.14 E-04	4.14 E-04	7.80 E-04	1.17 E-03	1.77 E-03
ST = source term						

Facility/Vent System	OFFSITE RADIOLOGICAL CONSEQUENCES (ASSUMING NO CONTROLS)								
	Dose from Filter Failure [D, filter-inhalation] (Sv)	Dose from Filter Failure [D, filter-ingestion] (Sv)	Dose from 24 h Unfiltered Release [D, 24 h-inhalation] (Sv)	Dose from 24 h Unfiltered Release [D, 24 h-ingestion] (Sv)	Dose from 1 wk Unfiltered Release [D, 1 wk-inhalation] (Sv)	Dose from 1 wk Unfiltered Release [D, 1 wk-ingestion] (Sv)	Dose from 1 month Unfiltered Release [D, 1 month inhalation] (Sv)	Dose from 1 month Unfiltered Release [D, 1 month ingestion] (Sv)	Dose from 3 month Unfiltered Release [D, 3 month inhalation] (Sv)
241-A-101 Exhauster (bounding ST)	6.29 E-08	3.55 E-09	5.69 E-07	3.93 E-08	1.21 E-06	8.36 E-08	6.10 E-07	1.47 E-07	9.32 E-07
241-A-101 Exhauster (SAD-036 ST)	2.11 E-08	0.00 E+00	1.91 E-07	0.00 E+00	1.16 E-07	0.00 E+00	2.05 E-07	0.00 E+00	3.13 E-07

ST = source term

	OFFSITE RADIOLOGICAL CONSEQUENCES (ASSUMING NO CONTROLS)								
Facility/Vent System	Dose from 3 month Unfiltered Release [D, 3 month ingestion] (Sv)	Dose from 6 month Unfiltered Release [D, 6 month inhalation] (Sv)	Dose from 6 month Unfiltered Release [D, 6 month ingestion] (Sv)	Dose from Annual 1 yr Release [D, 1 yr-inhalation] (Sv)	Dose from 1 yr Unfiltered Release [D, 1 yr-ingestion] (Sv)	Total Offsite Dose (24 h Release) [D, 24 h] (Sv)	Total Offsite Dose (1 wk Release) [D, 1 wk] (Sv)	Total Offsite Dose (1 month Release) [D, 1 month] (Sv)	Total Offsite Dose (3 month Release) [D, 3 month] (Sv)
241-A-101 Exhauster (bounding ST)	2.25 E-07	1.22 E-06	2.95 E-07	1.59 E-06	3.85 E-07	6.75 E-07	1.36 E-06	8.23 E-07	1.22 E-06
241-A-101 Exhauster (SAD-036 ST)	0.00 E+00	4.10 E-07	0.00 E+00	5.36 E-07	0.00 E+00	2.12 E-07	1.37 E-07	2.26 E-07	3.34 E-07

ST = source term

	OFFSITE RADIOLOGICAL CONSEQUENCES (ASSUMING NO CONTROLS)								
Facility/Vent System	Total Offsite Dose (6 month Release) [D, 6 month] (Sv)	Total Offsite Dose (1 yr Release) [D, 1 yr] (Sv)							
241-A-101 Exhauster (bounding ST)	1.58 E-06	2.05 E-06							
241-A-101 Exhauster (SAD-036 ST)	4.31 E-07	5.57 E-07							
ST = source term									

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APPENDIX D

PEER REVIEW AND HEDOP REVIEW CHECKLISTS

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CHECKLIST FOR PEER REVIEW

Document Reviewed: HNF-SD-WM-CN-107, Rev. 0, *Ventilation System Consequence Calculations to Support Salt Well Pumping Single-Shell Tank 241-A-101.*

Scope of Review:

Yes	No	NA		
[X]	[ ]	[ ]	*	Previous reviews complete and cover analysis, up to scope of this review, with no gaps.
[X]	[ ]	[ ]		Problem completely defined.
[X]	[ ]	[ ]		Accident scenarios developed in a clear and logical manner.
[X]	[ ]	[ ]		Necessary assumptions explicitly stated and supported.
[ ]	[ ]	[X]		Computer codes and data files documented.
[X]	[ ]	[ ]		Data used in calculations explicitly stated in document.
[X]	[ ]	[ ]		Data checked for consistency with original source information as applicable.
[X]	[ ]	[ ]		Mathematical derivations checked including dimensional consistency of results.
[X]	[ ]	[ ]		Models appropriate and used within range of validity or use outside range of established validity justified.
[X]	[ ]	[ ]		Hand calculations checked for errors. Spreadsheet results should be treated exactly the same as hand calculations.
[ ]	[ ]	[X]		Software input correct and consistent with document reviewed.
[ ]	[ ]	[X]		Software output consistent with input and with results reported in document reviewed.
[X]	[ ]	[ ]		Limits/criteria/guidelines applied to analysis results are appropriate and referenced. Limits/criteria/guidelines checked against references.
[X]	[ ]	[ ]		Safety margins consistent with good engineering practices.
[X]	[ ]	[ ]		Conclusions consistent with analytical results and applicable limits.
[X]	[ ]	[ ]		Results and conclusions address all points required in the problem statement.
[X]	[ ]	[ ]		Format consistent with appropriate NRC Regulatory Guide or other standards
[ ]		[X]	*	Review calculations, comments, and/or notes are attached.
[X]	**[ ]**	**[ ]**		**Document approved.**

B. J. Niemi *B.J. Niemi* 5/1/97

Reviewer (Printed Name and Signature) Date

* Any calculations, comments, or notes generated as part of this review should be signed, dated and attached to this checklist. Such material should be labeled and recorded in such a manner as to be intelligible to a technically qualified third party.

NOTE: HEDOP REVIEW NOT REQUIRED SINCE DATA USED IN THE DEVELOPMENT OF THE CALC. NOTE WAS EXTRACTED FROM BOTH SARR-011 AND SARR-016. THESE DOCUMENTS HAVE BEEN FORMERLY HEDOP REVIEWED AND APPROVED.

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DISTRIBUTION SHEET

To	From	Page 1 of 1
Distribution	TWRS Safety Analysis	Date May 2, 1997
Project Title/Work Order		EDT No. 621228
HNF-SD-WM-CN-107, Ventilation System Consequence Calculations to Support Salt Well Pumping Single-Shell Tank 241-A-101		ECN No. N/A

Name	MSIN	Text With All Attach.	Text Only	Attach./ Appendix Only	EDT/ECN Only
G. W. Gault	R1-44	X			
T. C. Geer	R1-43	X			
G. L. Jones	R1-44	X			
J. R. Kriskovich	R1-56	X			
W. H. Meader	S8-05	X			
B. J. Niemi	R1-44	X			
G. W. Ryan (3)	R1-44	X			
R. D. Smith	R1-49	X			
A. R. Tedeschi	R1-56	X			
D. T. Vladimiroff	S8-05	X			
TWRS S&L Files (2)	A2-26	X			
Central Files (original + 1)	A3-88 ~~A3-34~~	X			