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Radiological and Toxicological Calculations for AY-102 and C-106 HEPA Filters and Prefilters

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Abstract: This document contains supporting calculations for quantifying the radiological and toxicological risks from sluicing transfer operations between tanks C-106 (high heat, SST) and AY-102 (aging waste, DST). The accident scenario has HEPA filters removed by an overpressure event.

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Radiological and Toxicological Calculations for Tank 241-AY-102 and Tank 241-C-106 HEPA Filters and Prefilters

Safety Analysis and Risk Assessment

Terry Simpson

TABLE OF CONTENTS

1.0 PURPOSE	5
2.0 SUMMARY	6
3.0 MAJOR ASSUMPTIONS	8
4.0 DETAILED CALCULATIONS OF MATERIAL RELEASED	10
4.1 GEOMETRY OF THE FILTER ELEMENTS	10
4.2 MATERIAL LOADINGS AND CRUSH RELEASE AMOUNTS	10
4.2.1 Unmitigated 90/10 Aerosol	10
4.2.2 Amount of Unmitigated 90/10 Aerosol Released from the 241-702-A Ventilation System	11
4.2.3 Mitigated 90/10 Aerosol	11
4.2.4 Amount of Mitigated 90/10 Aerosol Released from the 241-702-A Ventilation System	11
4.2.5 Amount of Unmitigated 90/10 Aerosol Released from the 241-702-AZ Ventilation System	11
4.2.6 Amount of Mitigated 90/10 Aerosol Released from the 241-702-AZ Ventilation System	12
4.2.7 Unmitigated 67/33 Aerosol	12
4.2.8 Amount of Unmitigated 67/33 Aerosol Released from the 296-P-16 Ventilation System	12
4.2.9 Mitigated 67/33 Aerosol	13
4.2.10 Amount of Mitigated 67/33 Aerosol Released from the 296-P-16 ventilation system Ventilation System	13
4.2.11 Tank 241-C-106 Solids Aerosol	14
4.2.12 Amount of Tank 241-C-106 Solids Aerosol Released from the 296-P-16 Ventilation System	14
4.2.13 AWF Solids Aerosol	15
4.2.14 Amount of AWF Solids Aerosol Released from the 241-702-A Ventilation System	15
4.2.15 Amount of AWF Solids Aerosol Released from the 241-702-AZ Ventilation System	15
4.2.16 Amount of AWF Solids Aerosol Released from the 296-P-16 Ventilation System	16
5.0 PARAMETERS FOR THE ATMOSPHERIC DISPERSION CALCULATIONS	17
5.1 METHODOLOGY	17
5.1.1 Radiological Consequences	17
5.1.2 Toxicological Consequences	18

5.2 Q, AMOUNT OF MATERIAL RELEASED	18
5.3 PARTITION FRACTION	18
5.4 RATE OF MATERIAL RELEASE, dQ/dt	19
5.5 BREATHING RATE, R	19
5.6 OCCUPANCY FACTOR, OF	19
5.7 ATMOSPHERIC DISPERSION COEFFICIENT, χ/Q	19
6.0 REFERENCES	33

LIST OF TABLES

1. Amounts of HEPA-loaded Aerosols Released as a Result of an Over Pressure Event	21
2. Bounding Radiological and Toxicological Consequences for Release of 90/10 Aerosols from the 241-702-A Ventilation System*	22
3. Radiological and Toxicological Consequences for Airborne Releases of Unmitigated 90/10 Aerosols from the 241-702-A Ventilation System	23
4. Radiological and Toxicological Consequences for Airborne Releases of Mitigated 90/10 Aerosols from the 241-702-A Ventilation System	24
5. Radiological and Toxicological Consequences for Airborne Releases of Unmitigated 90/10 Aerosols from the 241-702-AZ Ventilation System	25
6. Radiological and Toxicological Consequences for Airborne Releases of Mitigated 90/10 Aerosols from the 241-702-AZ Ventilation System	26
7. Radiological and Radiological Consequences from Airborne Release of Unmitigated 67/33 Aerosols from the 296-P-16 Ventilation System	27
8. Radiological and Toxicological Consequences for Airborne Releases of Mitigated 67/33 Aerosols from the 296-P-16 Ventilation System	28
9. Radiological and Toxicological Consequences for Airborne Releases of SST Solids as Aerosols from the 296-P-16 Ventilation System	29
10. Radiological and Toxicological Consequences for Airborne Releases of AWF Solids as Aerosols from the 241-702-A Ventilation System	30
11. Radiological and Toxicological Consequences for Airborne Releases of AWF Solids as Aerosols from the 241-701-AZ Ventilation System	31
12. Radiological and Toxicological Consequences for the Airborne Releases of AWF Solids as Aerosols from the 296-P-16 Ventilation System	32

ATTACHMENTS

1: MICROSIELD RUNS	35
2: VENTILATION SYSTEM DISCUSSION	65
3: PEER REVIEW CHECKLIST	67

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Radiological and Toxicological Calculations for Tank 241-AY-102 and Tank 241-C-106 HEPA Filters and Prefilters

1.0 PURPOSE

The high heat content solids contained in Tank 241-C-106 are to be removed and transferred to Tank 241-AY-102 by sluicing operations, to be authorized under project W-320. Once sluicing operations are underway, the state of these tanks will be transformed from "unagitated" to "agitated". This means that the partition fraction which describes the aerosol content of the head space will increase from 1×10^{-10} to 1×10^{-8} . This head space will become much more loaded with suspended material. The nature of this suspended material may change significantly: sluicing may inadvertently bring up radioactive solids which normally would lay under many meters of liquid supernate. It is an enabling assumption¹ that the headspace and filter aerosols in Tank 241-AY-102 are a 90/10 liquid/solid split; there is an unmitigated and a mitigated composition. It is an enabling assumption that the sluicing line, the headspace in Tank 241-C-106, and the filters in Tank 241-C-106 contain aerosols which are a 67/33 liquid/solid split; there is an unmitigated and mitigated composition.

The initiating event for the accident analysis is a steam bump for Tank 241-AY-102 which over pressurizes the tank and leads to a blowout of the HEPA filters in the ventilation system. The catastrophic destruction of the HEPA filters could release a fraction of the accumulated filter loadings and could lead to an unfiltered pathway from the radioactively contaminated and toxic aerosols in the head space (vapor space) into the outside environment. In the absence of controls, an active ventilation system could continue to expel the contaminated head space air into the outside environment.

Although overpressure events could occur in either tank it is an enabling assumption for the safety analysis that Tank 241-AY-102 steam bumps are to be considered bounding over steam bumps in Tank 241-C-106. Qualitatively, one can say that the increased hydrostatic head in Tank 241-AY-102 will result in a larger amount of stored energy and it is this stored energy which drives the steam release process. Qualitatively, it also makes it more likely that such an event takes place in Tank 241-AY-102. Overtemperature events caused by fire or defective heaters could also remove the final HEPA safety barrier, but the release fraction of accumulated material from filters by thermal stress is only 1/100 of that measured by overpressure-induced crushing.

¹Enabling assumptions are assumptions that the analyst made based upon information obtained from other documents, discussions with project personnel, or customer direction. They are essentially analysis assumptions that are protected, i.e., part of the basis for the safety analysis.

In order to assess the potential consequences of this accident, it is necessary to calculate the radiological and toxicological source terms. This is carried out in the following sections. Atmospheric dispersion coefficients, breathing rates, occupancy factors, and unit liter doses (ULDs) are applied, as appropriate, to each stage of the accident sequence to derive the consequences onsite (at 100 meters downwind) and offsite (at the boundary in the worst-case direction as defined by the joint frequency function for the Hanford site).

Both Tank 241-AY-102 and Tank 241-C-106 are assessed in this document. There are two alternative ventilation systems considered for Tank 241-AY-102: 241-702-A (the existing ventilation system) and 241-702-AZ (the new ventilation system being installed by project W-030). For each ventilation system in Tank 241-AY-102 there are evaluated an unmitigated 90/10 composition, a mitigated 90/10 composition, and a 100-percent AWF-solids composition aerosol. For Tank 241-C-106 there are also two alternative ventilation systems (see Attachment 2), however, only the 296-P-16 ventilation system is used in this analysis since it is clearly bounding over the 296-C-06 ventilation system. For 296-P-16, there are evaluated an unmitigated 67/33 composition, a mitigated 67/33 composition, a 100-percent Tank 241-C-106-solids composition, and a 100-percent AWF-solids composition.

An unmitigated composition has 100% of its liquids as AWF liquids and 100% of its solids as AWF solids. A mitigated composition, on the other hand, assumes that the slurry distributor has properly been operated such that only a small proportion of the liquids and solids come from the AWF inventory. See the Section 3.0 (assumptions 2 and 3) for an explicit breakdown between SST and AWF inventories.

2.0 SUMMARY

Table 1 gives the HEPA filter release amounts that could come from the ventilation systems at either Tank 241-AY-102 or 241-C-106 due to a catastrophic overpressure event. The calculations which support these numbers are found in Section 4.0. The "worst case solids" are not part of the enabling assumptions and are presented for information only, because in the preliminary stages of organizing this effort it was speculated that assessing 100% solids at each facility might be conservative; this was judged to be too conservative and unrealistic.

Table 2 summarizes results for the Tank 241-AY-102 initiating event, for the 241-702-A ventilation system.

Tables 3-12 are EXCEL² spreadsheets which list the individual radiological and toxicological source terms which correspond to the consequence items.

Selecting the offsite, 24-hour unfiltered release consequence as the figure of merit, it can be seen from an inspection of Tables 3-8, that with the exception of the unmitigated release of the 67/33 aerosols from the 296-P-16 ventilation system, all other situations are below the

²EXCEL is a trademark of Microsoft Corporation.

“anticipated” radiological guideline limit of 1×10^{-3} Sv (0.1 rem). This is summarized below. We note that simply changing from the unmitigated 67/33 composition to the mitigated 67/33 composition drops the offsite consequences to below the limit. This means that the proper operation of the slurry distributor is important. No offsite chemical toxicity consequences exceed the toxicological guideline (1.0).

Offsite Consequences

<u>composition</u>	<u>ventilation system</u>	<u>radiological, (Sv) 24-hours, offsite</u>	<u>toxicological SOF, offsite</u>
90/10 unmitigated	241-702-A	3.5E-04	1.7E-03
90/10 mitigated	241-702-A	8.2E-05	1.2E-03
90/10 unmitigated	241-702-AZ	1.8E-04	9.4E-04
90/10 mitigated	241-702-AZ	4.1E-05	6.7E-04
67/33 unmitigated	296-P-16	2.0E-03	6.2E-03
67/33 mitigated	296-P-16	4.4E-04	3.9E-03

Now consider the onsite radiological consequences as the next figure of merit. For the case of Tank 241-AY-102 with the 241-702-A ventilation system, restricting the duration of the unfiltered release to less than 5 minutes is effective in lowering the onsite radiological consequences to the “anticipated” guideline level, 5×10^{-3} Sv (0.5 rem); refer to Tables 3 and 4. That this is even possible can be inferred from the first line in Table 4. With no unfiltered flow occurring, just the initial inhalation of the expelled mitigated HEPA contaminants will result in a dose which is less than the guideline at the onsite receptor location. Line 1 in Table 3 demonstrates that the unmitigated aerosol composition will always exceed the onsite limit. This means that the proper operation of the slurry distributor is safety significant for Tank 241-AY-102 with the 241-702-A ventilation system.

Line 1 in Table 5 demonstrates that the presence of the 241-702-AZ ventilation system, by itself, is almost safety significant because the initial inhalation of HEPA material is practically at the onsite radiological guideline limit. With a mitigated 90/10 aerosol composition, the response time can be relaxed to 14 minutes; see line 2 in Table 6. Therefore, for Tank 241-AY-102 with the 241-702-AZ ventilation system, an operator response time of 14 minutes and the proper operation of the slurry distributor are jointly safety significant TSRs.

Tables 7 and 8 demonstrate that the 67/33 aerosol composition makes it impossible, by

operator action on the ventilation flow, to mitigate the onsite radiological consequences from the 296-P-16 ventilatoin system to below the onsite guideline limit. See the first line in each table.

Tables 9-12 for worst case solids are presented for information only.

3.0 MAJOR ASSUMPTIONS

1. Steam bumps in Tank 241-AY-102 are to be considered bounding over steam bumps in Tank 241-C-106.

Sensitivity of consequence analysis to this assumption. This is an enabling assumption. Qualitatively, the increased hydrostatic head in Tank 241-AY-102 will result in a larger amount of stored energy and it is this stored energy that drives the steam release process. Qualitatively, it also makes it much more likely that such an event takes place in Tank 241-AY-102 rather than in Tank 241-C-106. However, it can be demonstrated through an inspection of the tables generated in this report, that all else being equal and ignoring this (important) qualitative argument, the release of aerosols from Tank 241-C-106 will give larger downwind consequences than will release of aerosols from Tank 241-AY-102. The specific composition of aerosols differ at the two tanks; see items 2 and 3 in this section.

2. Aerosols entrained in the filter elements and in the headspace of Tank 241-AY-102 are composed of 90% liquids and 10% solids. There is an unmitigated and a mitigated composition associated with each liquid and solid component, as discussed below.

Sensitivity of consequence analysis to this assumption. This is an enabling assumption. For the unmitigated composition, the liquids component is 100% AWF liquid and the solids component is 100% AWF solid. For the mitigated composition, the liquids component is composed of 10% SST liquid plus 90% AWF liquid; for the solids component is composed of 90% SST solid plus 10% AWF solid.

The unmitigated ULD, onsite SOF multiplier, and offsite SOF multiplier for the unmitigated composition can be calculated to be 1.7×10^5 Sv/L, 1.1×10^4 , and 27, respectively. The mitigated ULD, onsite SOF multiplier, and offsite SOF multiplier for the mitigated composition can be calculated to be 3.9×10^4 Sv/L, 1.2×10^4 , and 18, respectively.

The radiological consequences are directly proportional to the ULD. The toxicological consequences are directly proportional to the SOF multiplier.

3. Aerosols coming from the slurry line and entrained in the filter elements and in the headspace of Tank 241-C-106 are composed of 67% liquids and 33% solids. There is an unmitigated and a mitigated composition associated with each liquid and solid component, as discussed below.

Sensitivity of consequence analysis to this assumption. This is an enabling assumption. For the unmitigated composition, the liquids component is 100% AWF liquid and the solids component is 100% AWF solid. For the mitigated composition, the liquids component is composed of 10% SST liquid plus 90% AWF liquid; for the solids component is composed of 90% SST solid plus 10% AWF solid.

The unmitigated ULD, onsite SOF multiplier, and offsite SOF multiplier for the unmitigated composition can be calculated to be 5.6×10^5 Sv/L, 1.3×10^4 , and 68, respectively. The mitigated ULD, onsite SOF multiplier, and offsite SOF multiplier for the mitigated composition can be calculated to be 1.2×10^5 Sv/L, 1.9×10^4 , and 40, respectively.

The radiological consequences are directly proportional to the ULD. The toxicological consequences are directly proportional to the SOF multiplier.

4. Each filter element is limited to a contact dose rate equal to 200 mrem/h.

Sensitivity. The aerosol loading on each filter element is directly proportional to the contact dose rate limit. Therefore, the one-time downwind inhalation dose is directly proportional to the contact dose rate limit.

Because the geometry of each filter element and the ductwork holdup characteristics in the 241-702-A, 241-702-AZ, and Tank 241-C-106 ventilation systems are not identical, the released aerosol loadings corresponding to the 200 mrem/h limit will differ for each system. Because each combination of liquid/solid ratio and unmitigated/mitigated composition has a unique set of radionuclide compositions, the aerosol loading on each individual filter element corresponding to the 200 mrem/h limit will be different.

5. The airborne respirable released fraction from the filter elements is 1%.

Sensitivity. The one-time downwind inhalation dose is directly proportional to the airborne respirable release fraction. An overpressure event is assumed to catastrophically destroy the filter elements. DOE-HDBK-3010-94, *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*, cites 1×10^{-2} as an appropriate upper limit for fiberglass HEPA filters subjected to explosive stress. Other stress situations yield release fractions which could be factors of 100, or more lower: for a HEPA filter subjected to simply a severe "shock" overpressure, the ARRF might be less than 2×10^{-6} , and for fire-induced thermal stress, a HEPA's ARRF could be less than 1×10^{-4} .

6. The partition fraction during, and for an indefinite duration after, sluicing operations is equal to the "agitated" partition fraction found experimentally, 1×10^{-8} .

Sensitivity. The suspended aerosol loading in the vapor space of the tank is directly proportional to the partition fraction. Therefore, the downwind dose accumulated continuously

as the result of an unfiltered release is directly proportional to the partition fraction. An experimentally measured "agitated" partition fraction is 1×10^{-8} ; "unagitated" would have been 1×10^{-10} , a factor of 100 times smaller.

7. The flow rate out of the stack from Tank 241-AY-102 is equal to 1.89×10^3 L/s, and for Tank 241-C-106 is 3.30×10^3 L/s.

Sensitivity. The downwind dose accumulated continuously as the result of an unfiltered release is directly proportional to the discharge flow rate.

4.0 DETAILED CALCULATIONS OF MATERIAL RELEASED

4.1 GEOMETRY OF THE FILTER ELEMENTS

There are three geometries of interest for the ventilation system and they are carefully described in WHC-SD-WM-CN-033, *MICROSHIELD³ Dose Rate Calculations for HEPA Filters and Prefilters*. For Tanks 241-AY-102 and 241-C-106 the filter elements are the 2' x 2' x 1' (61 cm x 61 cm x 30.5 cm) Double Shell Tank (DST) filters, the 3 x 3 bank of 1' x 1' x 2.5" (30.5 cm x 30.5 cm x 6.35 cm) prefilters, and the 3 x 3 bank of 2' x 2' x 1' HEPA filters. Not only are the physical dimensions of these filters given, but just as important for calculation of the dose rate, the explicit location of the measurement position in each case is given.

4.2 MATERIAL LOADINGS AND CRUSH RELEASE AMOUNTS

Attachment 1 contains the *Microshield* cases that are appropriate to the various filter geometries and radionuclide contents. The particular aerosol loading that gives the limiting contact dose rate of 200 mrem/h depends upon the ^{137}Cs , ^{60}Co , ^{154}Eu , ^{90}Sr , and ^{90}Y content of the material.

4.2.1 Unmitigated 90/10 Aerosol

The unmitigated 90/10 aerosol has the following composition:

<u>nuclide</u>	<u>Ci/L</u>
$^{137\text{m}}\text{Ba}$	2.285
^{60}Co	1.34×10^{-3}
^{154}Eu	2.97×10^{-2}
^{90}Sr , ^{90}Y	7.974 (each)

³Microshield is a registered trademark of Grove Engineering, Inc.

4.2.2 Amount of Unmitigated 90/10 Aerosol Released from the 241-702-A Ventilation System

According to WHC-SD-WM-CN-054, *Waste Tank Ventilation System Material Accumulations*, the ventilation system (241-702-A) associated with the AY tank farm has 30 HEPA equivalents of material that would be involved in the case of an accident. The HEPA filter equivalent standard in this case is the 2' x 2' x 1' filter element.

In Attachment 1, case 1 gives 1.138×10^4 mR/h per liter from the direct gamma emitters and case 2 can be used to show that $7.974 \times 49.28 = 393$ mR/h is the contribution per liter from bremsstrahlung, or a total of 1.177×10^4 mR/h per liter of 90/10 aerosol uniformly loaded onto this filter element. It is assumed that 1 mR/h = 1 mrem/h. The critical loading which gives 200 mrem/h is then 1.7×10^{-2} L, and at 1% release the 241-702-A ventilation system would yield $1.7 \times 10^{-2} \times 10^{-2} \times 30 = 5.1 \times 10^{-3}$ L of 90/10 unmitigated aerosols having an ULD equal to 1.7×10^5 Sv/L.

4.2.3 Mitigated 90/10 Aerosol

The mitigated 90/10 aerosol has the following composition:

<u>nuclide</u>	<u>Ci/L</u>
^{137m}Ba	2.137
^{60}Co	1.19×10^{-3}
^{154}Eu	2.28×10^{-2}
$^{90}\text{Sr}, ^{90}\text{Y}$	4.824 (each)

4.2.4 Amount of Mitigated 90/10 Aerosol Released from the 241-702-A Ventilation System

In Attachment 1, case 3 gives 1.053×10^4 mR/h per liter from the direct gamma emitters and case 2 can be used to show that $4.824 \times 49.28 = 237.7$ mR/h is the contribution per liter from bremsstrahlung, or a total of 1.077×10^4 mR/h per liter of 90/10 aerosol uniformly loaded onto this filter element. It is assumed that 1 mR/h = 1 mrem/h. The critical loading which gives 200 mrem/h is then 1.86×10^{-2} L, and at 1% release the 241-702-A ventilation system would yield $1.86 \times 10^{-2} \times 10^{-2} \times 30 = 5.58 \times 10^{-3}$ L of 90/10 mitigated aerosols having an ULD equal to 3.9×10^4 Sv/L.

4.2.5 Amount of Unmitigated 90/10 Aerosol Released from the 241-702-AZ Ventilation System

Following the methodology in WHC-SD-WM-CN-054, the ventilation system associated

with the 241-702-AZ ventilation system has 9 HEPA equivalents of material per filter bank that would be involved in the case of an accident. Because there are 2 banks, we assume that there will be $2 \times 9 = 18$ HEPA equivalents involved as a result, even though only one bank is intended to be run at any one time. The HEPA filter equivalent standard in this case is the $2' \times 2' \times 1'$ filter element. As in Section 4.2.2 above, the critical loading of unmitigated 90/10 aerosol on one element is 1.7×10^{-2} L, and at 1% the 241-702-AZ ventilation system would yield $1.7 \times 10^{-2} \times 18 = 3.06 \times 10^{-3}$ L of unmitigated 90/10 aerosols having an ULD equal to 1.7×10^5 Sv/L.

4.2.6 Amount of Mitigated 90/10 Aerosol Released from the 241-702-AZ Ventilation System

As above, the 241-702-AZ ventilation system is taken to have 9 HEPA equivalents of material per filter bank that would be involved in the case of an accident. Because there are 2 banks, we assume that there will be $2 \times 9 = 18$ HEPA equivalents involved as a result, even though only one bank is intended to be run at any one time. The HEPA filter equivalent standard in this case is the $2' \times 2' \times 1'$ filter element. As in Section 4.2.4 above, the critical loading of mitigated 90/10 aerosol on one element is 1.86×10^{-2} L, and at 1% the 241-702-AZ ventilation system would yield $1.86 \times 10^{-2} \times 18 = 3.35 \times 10^{-3}$ L of mitigated 90/10 aerosols having an ULD equal to 3.9×10^4 Sv/L.

4.2.7 Unmitigated 67/33 Aerosol

The unmitigated 67/33 aerosol has the following composition:

<u>nuclide</u>	<u>Ci/L</u>
^{137m}Ba	2.34
^{60}Co	4.38×10^{-3}
^{154}Eu	9.8×10^{-2}
$^{90}\text{Sr}, ^{90}\text{Y}$	26.0 (each)

4.2.8 Amount of Unmitigated 67/33 Aerosol Released from the 296-P-16 Ventilation System

According to WHC-SD-WM-CN-054, the 296-P-16 ventilation system associated with Tank 241-C-106, has 4 HEPA plus 4 prefilter equivalents of material that would be involved in the case of an accident. The HEPA filter equivalent standard in this case is the 3×3 bank of $2' \times 2' \times 1'$ filters and the prefilter equivalent standard is the 3×3 bank of $1' \times 1' \times 2.5'$ prefilter elements.

In Attachment 1, case 4 gives 1.824×10^3 mR/h per liter for the direct gamma emitters

and case 10 can be used to show that $26 \times 7.164 = 186.3$ mR/h per liter from bremsstrahlung, giving a total of 2.010×10^3 mR/h per liter of unmitigated 67/33 aerosol uniformly distributed throughout the volume of the 3 x 3 bank of filters. The critical loading which gives a 200 mrem/h contact dose then is 9.95×10^{-2} L. At a 1% release, this is 9.95×10^{-4} L per 3 x 3 filter bank.

In Attachment 1, case 6 gives 2.363×10^3 mR/h per liter for the direct gamma emitters and case 11 can be used to show that $26 \times 9.196 = 239.1$ mR/h per liter from bremsstrahlung, giving a total of 2.602×10^3 mR/h per liter of unmitigated 67/33 aerosol uniformly distributed throughout the volume of the 3 x 3 bank of prefilters. The critical loading which gives a 200 mrem/h contact dose then is 7.69×10^{-2} L. At a 1% release, this is 7.69×10^{-4} L per 3 x 3 prefilter bank.

For the 296-P-16 ventilation system, $4 \times (9.95 \times 10^{-4} \text{ L} + 7.69 \times 10^{-4} \text{ L}) = 7.06 \times 10^{-3}$ L of unmitigated 67/33 aerosols released as a result of HEPA crushing. This composition has an ULD equal to 5.6×10^5 Sv/L.

4.2.9 Mitigated 67/33 Aerosol

The mitigated 67/33 aerosol has the following composition:

<u>nuclide</u>	<u>Ci/L</u>
^{137m}Ba	2.24
^{60}Co	3.84×10^{-3}
^{154}Eu	6.06×10^{-2}
$^{90}\text{Sr}, ^{90}\text{Y}$	15.54 (each)

4.2.10 Amount of Mitigated 67/33 Aerosol Released from the 296-P-16 ventilation system Ventilation System

In Attachment 1, case 5 gives 1.700×10^3 mR/h per liter for the direct gamma emitters and case 10 can be used to show that $15.54 \times 7.164 = 111.3$ mR/h per liter from bremsstrahlung, giving a total of 1.811×10^3 mR/h per liter of mitigated 67/33 aerosol uniformly distributed throughout the volume of the 3 x 3 bank of filters. The critical loading which gives a 200 mrem/h contact dose then is 1.10×10^{-1} L. At a 1% release, this is 1.10×10^{-3} L per 3 x 3 filter bank.

In Attachment 1, case 7 gives 2.200×10^3 mR/h per liter for the direct gamma emitters and case 11 can be used to show that $15.54 \times 9.196 = 142.9$ mR/h per liter from bremsstrahlung, giving a total of 2.343×10^3 mR/h per liter of mitigated 67/33 aerosol uniformly distributed throughout the volume of the 3 x 3 bank of prefilters. The critical loading which gives a 200

mrem/h contact dose then is 8.54×10^{-2} L. At a 1% release, this is 8.54×10^{-4} L per 3 x 3 prefilter bank.

For the 296-P-16 ventilation system, $4 \times (1.10 \times 10^{-3} \text{ L} + 8.54 \times 10^{-4} \text{ L}) = 7.82 \times 10^{-3} \text{ L}$ of mitigated 67/33 aerosols released as a result of HEPA crushing. This composition has an ULD equal to $1.2 \times 10^5 \text{ Sv/L}$.

4.2.11 Tank 241-C-106 Solids Aerosol

According to Table 1b in *Tank Waste Compositions and Atmospheric Dispersion Coefficients for Use in Safety Analysis Consequence Assessments*, WHC-SD-WM-SARR-016, Rev 2, Tank 241-C-106 solids have the following composition:

<u>nuclide</u>	<u>Ci/L</u>
^{137m} Ba	0.73
¹⁵⁴ Eu	0.03
⁹⁰ Sr, ⁹⁰ Y	2.26 (each)

4.2.12 Amount of Tank 241-C-106 Solids Aerosol Released from the 296-P-16 Ventilation System

In Attachment 1, case 8 gives 566.1 mR/h per liter for the direct gamma emitters and case 10 can be used to show that $2.62 \times 7.164 = 18.8 \text{ mR/h}$ per liter from bremsstrahlung, giving a total of 584.9 mR/h per liter of Tank 241-C-106 aerosol uniformly distributed throughout the volume of the 3 x 3 bank of filters.

However, this dose rate must be doubled to 1169.8 mR/h in order to match the observed radiogenic heat load of Tank 241-C-106, as follows:

- The current estimated heat load is 32.2 kW, as documented in WHC-SD-WM-ER-200, *Revised Thermal History of Tank 241-C-106*; WHC-SD-WM-ER-217, *Tank 241-C-106: Radial Variation of Thermal Conductivity and Heat Generation*; and WHC-SD-WM-ER-427, *Tank 241-C-106 Process Test Report*.
- The heat load as calculated from the radioactive nuclides in the list shown in SARR-016 for Tank 241-C-106 gives only 16.4 kW.
- Therefore, the radionuclide content of one liter of Tank 241-C-106 solids should be doubled.

The critical loading which gives a 200 mrem/h contact dose then is $1.71 \times 10^{-1} \text{ L}$. At a

1% release, this is 1.71×10^{-3} L per 3 x 3 filter bank.

In Attachment 1, case 9 gives 731.3 mR/h per liter for the direct gamma emitters and case 11 can be used to show that $2.62 \times 9.196 = 24.1$ mR/h per liter from bremsstrahlung, giving a total of 755.4 mR/h per liter of Tank 241-C-106 solids aerosol uniformly distributed throughout the volume of the 3 x 3 bank of prefilters. As above, this must be doubled to 1.5108×10^3 mR/h. The critical loading which gives a 200 mrem/h contact dose then is 1.32×10^{-1} L. At a 1% release, this is 1.32×10^{-3} L per 3 x 3 prefilter bank.

For the 296-P-16 ventilation system, $4 \times (1.71 \times 10^{-3} \text{ L} + 1.32 \times 10^{-3} \text{ L}) = 1.21 \times 10^{-2}$ L of Tank 241-C-106 solids aerosols released as a result of HEPA crushing. This composition has an ULD equal to 1.44×10^5 Sv/L.

4.2.13 AWF Solids Aerosol

The composition of AWF solids is as follows:

<u>nuclide</u>	<u>Ci/L</u>
$^{137\text{m}}\text{Ba}$	2.506
^{60}Co	1.324×10^{-2}
^{154}Eu	2.97×10^{-1}
^{90}Sr , ^{90}Y	78.378 (each)

4.2.14 Amount of AWF Solids Aerosol Released from the 241-702-A Ventilation System

As discussed above, the ventilation system (241-702-A) associated with the AY tank farm has 30 HEPA equivalents of material that would be involved in the case of an accident. The HEPA filter equivalent standard in this case is the 2' x 2' x 1' filter element.

In Attachment 1, case 12 gives 1.520×10^4 mR/h per liter from the direct gamma emitters and case 2 can be used to show that $78.378 \times 49.28 = 3.862 \times 10^3$ mR/h is the contribution per liter from bremsstrahlung, or a total of 1.906×10^4 mR/h per liter of AWF solids aerosol uniformly loaded onto this filter element. It is assumed that 1 mR/h = 1 mrem/h. The critical loading which gives 200 mrem/h is then 1.05×10^{-2} L, and at 1% release the 241-702-A ventilation system would yield $1.05 \times 10^{-2} \times 10^{-2} \times 30 = 3.15 \times 10^{-3}$ L of AWF solids aerosols having an ULD equal to 1.7×10^6 Sv/L.

4.2.15 Amount of AWF Solids Aerosol Released from the 241-702-AZ Ventilation System

As discussed in Section 4.2.5 above, the ventilation system associated with the

241-702-AZ ventilation system has 9 HEPA equivalents of material per filter bank that would be involved in the case of an accident. Because there are 2 banks, we assume that there will be $2 \times 9 = 18$ HEPA equivalents involved as a result, even though only one bank is intended to be run at any one time. The HEPA filter equivalent standard in this case is the $2' \times 2' \times 1'$ filter element.

In Attachment 1, case 12 gives 1.520×10^4 mR/h per liter from the direct gamma emitters and case 2 can be used to show that $78.378 \times 49.28 = 3.862 \times 10^3$ mR/h is the contribution per liter from bremsstrahlung, or a total of 1.906×10^4 mR/h per liter of AWF solids aerosol uniformly loaded onto this filter element. It is assumed that $1 \text{ mR/h} = 1 \text{ mrem/h}$. The critical loading which gives 200 mrem/h is then 1.05×10^{-2} L, and at 1% release the 241-702-AZ ventilation system would yield $1.05 \times 10^{-2} \times 10^{-2} \times 18 = 1.89 \times 10^{-3}$ L of AWF solids aerosols having an ULD equal to 1.7×10^6 Sv/L.

4.2.16 Amount of AWF Solids Aerosol Released from the 296-P-16 Ventilation System

As discussed above, the 296-P-16 ventilation system associated with Tank 241-C-106, has 4 HEPA plus 4 prefilter equivalents of material that would be involved in the case of an accident. The HEPA filter equivalent standard in this case is the 3×3 bank of $2' \times 2' \times 1'$ filters and the prefilter equivalent standard is the 3×3 bank of $1' \times 1' \times 2.5''$ prefilter elements.

In Attachment 1, case 13 gives 2.253×10^3 mR/h per liter for the direct gamma emitters and case 10 can be used to show that $78.378 \times 7.164 = 561.5$ mR/h per liter from bremsstrahlung, giving a total of 2.8145×10^3 mR/h per liter of AWF solids aerosol uniformly distributed throughout the volume of the 3×3 bank of filters. The critical loading which gives a 200 mrem/h contact dose then is 7.11×10^{-2} L. At a 1% release, this is 7.11×10^{-4} L per 3×3 filter bank.

In Attachment 1, case 14 gives 2.909×10^3 mR/h per liter for the direct gamma emitters and case 11 can be used to show that $78.378 \times 9.196 = 720.8$ mR/h per liter from bremsstrahlung, giving a total of 3.629×10^3 mR/h per liter of AWF solids aerosol uniformly distributed throughout the volume of the 3×3 bank of prefilters. The critical loading which gives a 200 mrem/h contact dose then is 5.51×10^{-2} L. At a 1% release, this is 5.51×10^{-4} L per 3×3 prefilter bank.

For the 296-P-16 ventilation system, $4 \times (7.11 \times 10^{-4} \text{ L} + 5.51 \times 10^{-4} \text{ L}) = 5.05 \times 10^{-3}$ L of AWF solids aerosols released as a result of HEPA crushing. This composition has an ULD equal to 5.6×10^5 Sv/L.

5.0 PARAMETERS FOR THE ATMOSPHERIC DISPERSION CALCULATIONS

5.1 METHODOLOGY

5.1.1 Radiological Consequences

The following equation is used to calculate the committed effective dose equivalent (CEDE) for the consequences of crushing the HEPA filters and releasing the material downwind:

$$Q * ULD * R * OF * \frac{\chi}{Q} = CEDE$$

where

- Q = amount of material released (L), see Table 1,
- ULD = unit liter dose (Sv/L), see Table 1,
- R = breathing rate (m³/s),
- OF = occupancy factor,
- χ/Q = atmospheric dispersion coefficient (s/m³), at a given downwind distance, and,
- CEDE = committed effective dose equivalent (Sv).

The following equation is used to calculate the committed effective dose equivalent (CEDE) for the consequences of continuously ventilating the (now unfiltered) tank head space and releasing the material downwind:

$$\frac{dQ}{dt} * ULD * R * OF * \frac{\chi}{Q} * t = CEDE$$

where

- dQ/dt = continuous rate of material released (L/s), exhaust flow rate times the partition factor, see Table 1 for the ventilation flow rate,
- ULD = unit liter dose (Sv/L), see Table 1,
- R = breathing rate (m³/s),
- OF = occupancy factor,
- χ/Q = atmospheric dispersion coefficient (s/m³), at a given downwind distance,
- t = time duration of the continuous release, and,
- CEDE = committed effective dose equivalent (Sv).

5.1.2 Toxicological Consequences

The following equations are used to calculate the sum-of-fractions for the chemically toxic material that is released downwind:

$$\frac{dQ}{dt} = \frac{Q}{\Delta t}$$

for the crushed HEPA material,

$$\frac{dQ}{dt} = \text{exhaust flowrate} * \text{partition fraction}$$

for the continuously vented head space aerosols, and

$$\frac{dQ}{dt} * \text{SOF} = T$$

where

- Q = amount of material released (L), see Table 1,
- Δt = duration of the steam bump event,
- dQ/dt = rate of material (L/s) being released,
- SOF = sum-of-fraction multipliers (L/s)⁻¹ for specific locations downwind, and,
- T = the cumulative sum-of-fractions.

5.2 Q, AMOUNT OF MATERIAL RELEASED

See Table 1 for a summary and Section 4 for details of the calculations.

5.3 PARTITION FRACTION

A partition fraction equal to 1×10^{-8} , corresponding to tanks in an “agitated” state is used to multiply the exhaust flow rate in order to derive an effective rate of aerosol material being continuously released downwind through an unfiltered pathway. See Table 1 for the exhaust flow rates appropriate for each ventilation system.

5.4 RATE OF MATERIAL RELEASE, dQ/dt

For the radiological and toxicological consequences of material being continuously vented from the tank head space through an unfiltered pathway into the outside environment, the dQ/dt is taken to be equal to the exhaust flow rate times the partition fraction, 1×10^{-8} . The present ventilation flow rates for Tank 241-C-106 and Tank 241-AY-102 are given in WHC-SD-WM-CN-062, page 10. The flow rate for 241-702-AZ is given on section 3.2, page 2, of WHC-SD-W030-RD-001, Rev. 2-A, *Supplemental Definition of Requirements, Project W-030 Tank Farm Ventilation Upgrade*. See Table 1 for a summary. However, it may be that these are *total system*, or *design flow rates*, and as such may be much larger than what may be individually exhausted from these specific tanks. See the internal discussion documented in Attachment 2: if the ventilation system were placed into a recirculation mode, the exhaust flow rates for Tank 241-C-106 and Tank 241-AY-102 could be a factor of 19 and 40 times smaller, respectively.

For the toxicological consequences of crushed HEPA material being released, dQ/dt is taken to be equal to $Q/\Delta t$, where $\Delta t = 120$ seconds. The duration of the steam bump is taken to be 2 minutes, as shown in WHC-SD-WM-CN-022, *Evaluation of Potential and Consequences of Steam Bump in High Heat Waste Tanks and Assessment and Validation of GOTH Computer Code*.

5.5 BREATHING RATE, R

The breathing rate for exposure durations shorter than 12 hours is taken to be $3.3 \times 10^{-4} \text{ m}^3/\text{sec}$. For 24 hours or longer, this is taken to be $2.7 \times 10^{-4} \text{ m}^3/\text{sec}$.

5.6 OCCUPANCY FACTOR, OF

With the exception of the onsite position for an annual duration, all OFs are set equal to unity (1.0). For the onsite position for an annual duration OF is equal to 0.286.

5.7 ATMOSPHERIC DISPERSION COEFFICIENT, χ/Q

The following atmospheric dispersion coefficients are used, consistent with the guidance given in *Tank Waste Compositions and Atmospheric Dispersion Coefficients for Use in Safety Analysis Consequence Assessments*, WHC-SD-WM-SARR-016.

⁴GOTH is a trademark of JMI, which derived from GOTHIC - a registered trademark of the EPRI Corporation.

Atmospheric Dispersion Coefficients

Position	Duration	χ/Q (s/m ³)	Comments
Onsite	continuous, less than an hour	3.41×10^{-2}	Table 4, SARR-016
Onsite	12 hours	5.54×10^{-3}	logarithm method, see page 2-5, WHC-SD-WM-SARR-016
Onsite	annual	4.03×10^{-4}	Table 9, chronic annual release, SARR-016
Offsite	continuous, less than an hour	2.83×10^{-5}	Table 5, SARR-016
Offsite	24 hours	4.62×10^{-6}	logarithm method
Offsite	annual	1.24×10^{-7}	Table 9, chronic annual release, SARR-016

Table 1. Amounts of HEPA-loaded Aerosols Released as a Result of an Over Pressure Event.

Liquid/Solid Composition (%/%) on HEPA and in Headspace	Type	Tank	ULD (Sv/L)	Exhaust Flow Rate (L/s)	Ventilation System	Aerosols Released By HEPA Overpressure Crush (L)
90/10	Unmitigated	AY-102	1.7×10^5	1.89×10^3	241-702-A	5.10×10^{-3}
90/10	Mitigated	AY-102	3.9×10^4	1.89×10^3	241-702-A	5.58×10^{-3}
90/10	Unmitigated	AY-102	1.7×10^5	9.42×10^2	241-702-AZ	3.06×10^{-3}
90/10	Mitigated	AY-102	3.9×10^4	9.42×10^2	241-702-AZ	3.35×10^{-3}
67/33	Unmitigated	C-106	5.6×10^5	3.3×10^3	C-106	7.06×10^{-3}
67/33	Mitigated	C-106	1.2×10^5	3.3×10^3	C-106	7.82×10^{-3}
Worst Case Solids						
0/100	C-106 Solids	C-106	1.44×10^5	3.3×10^3	C-106	1.21×10^{-2}
0/100	AWF Solids	AY-102	1.7×10^6	1.89×10^3	241-702-A	3.15×10^{-3}
0/100	AWF Solids	AY-102	1.7×10^6	9.42×10^2	241-702-AZ	1.89×10^{-3}
0/100	AWF Solids	C-106	1.7×10^6	3.3×10^3	C-106	5.05×10^{-3}

Table 2. Bounding Radiological and Toxicological Consequences for Release of 90/10 Aerosols from the 241-702-A Ventilation System*.

Location	Time	Radiological		Chemical	
		CEDE (Sv)	Risk Guideline (Sv)	Sum of Fractions	Risk Guideline
Unmitigated Consequences					
Onsite	12-h	0.26 (26 rem)	5×10^{-3} (0.5 rem)	0.7	1.0
Onsite	Annual	3.2 (320 rem)	5×10^{-3} (0.5 rem)	NA	NA
Offsite	24-h	3.5×10^{-4} (0.04 rem)	1.0×10^{-3} (0.1 rem)	1.7×10^{-3}	1.0
Offsite	Annual	3.4×10^{-3} (0.3 rem)	1.0×10^{-3} (0.1 rem)	NA	1.0
Mitigated Consequences					
Onsite	5-min	5×10^{-3} (0.5 rem)	5×10^{-3} (0.5 rem)	Same as above	
Offsite	5-min	4.1×10^{-6} (0.0004 rem)	1.0×10^{-3} (0.1 rem)		

*This information is a summary of the information found in Tables 3 and 4.

Table 3. Radiological and Toxicological Consequences for Airborne Releases of Unmitigated 90/10 Aerosols from the 241-702-A Ventilation System.

Radiological								
Item	Q (L)	dQ/dt (L/s)	R (m ³ /s)	OF	χ/Q (s/m ³)	t (s)	CEDE (Sv)	sum CEDE (Sv)
HEPA Crush, Onsite	5.10E-03	NA	3.30E-04	1	3.41E-02	NA	9.76E-3	
Continuous Unfiltered Release, 5 Minutes, Onsite	NA	1.89E-05	3.30E-04	1	3.41E-02	300	1.08E-2	2.06E-2
Continuous Unfiltered Release, 12 Hours, Onsite	NA	1.89E-05	3.30E-04	1	5.54E-03	4.32E +04	0.254	2.64E-1
Continuous Unfiltered Release, Annual, Onsite	NA	1.89E-05	2.70E-04	0.286	4.03E-04	3.15E +07	3.153	3.163
HEPA Crush, Offsite	5.10E-03	NA	3.30E-04	1	2.83E-05	NA	8.10E-6	
Continuous Unfiltered Release, 5 Minutes, Offsite	NA	1.89E-05	3.30E-04	1	2.83E-05	300	9.00E-6	1.71E-5
Continuous Unfiltered Release, 24 Hours, Offsite	NA	1.89E-05	2.70E-04	1	4.62E-06	8.64E +04	3.46E-4	3.54E-4
Continuous Unfiltered Release, Annual, Offsite	NA	1.89E-05	2.70E-04	1	1.24E-07	3.15E +07	3.39E-3	3.40E-3
Toxicological								
Item	dQ/dt (L/s)	SOF	sum, SOF		Item	dQ/dt (L/s)		SOF
HEPA Crush, Onsite	4.25E-05	0.468			HEPA Crush, Offsite	4.25E- 05	1.15E-03	
Continuous, Onsite	1.89E-05	0.208	0.675		Continuous, Offsite	1.89E- 05	5.10E-04	1.66E-03

Table 4. Radiological and Toxicological Consequences for Airborne Releases of Mitigated 90/10 Aerosols from the 241-702-A Ventilation System.

Radiological								
Item	Q (L)	dQ/dt (L/s)	R (m ³ /s)	OF	χ/Q (s/m ³)	t (s)	CEDE (Sv)	sum CEDE (Sv)
HEPA Crush, Onsite	5.58E-03	NA	3.30E-04	1	3.41E-02	NA	2.45E-3	
Continuous Unfiltered Release, 5 Minutes, Onsite	NA	1.89E-05	3.30E-04	1	3.41E-02	300	2.49E-3	4.94E-3
Continuous Unfiltered Release, 12 Hours, Onsite	NA	1.89E-05	3.30E-04	1	5.54E-03	4.32E+04	0.058	6.07E-2
Continuous Unfiltered Release, Annual, Onsite	NA	1.89E-05	2.70E-04	0.286	4.03E-04	3.15E+07	0.723	0.726
HEPA Crush, Offsite	5.58E-03	NA	3.30E-04	1	2.83E-05	NA	2.03E-6	
Continuous Unfiltered Release, 5 Minutes, Offsite	NA	1.89E-05	3.30E-04	1	2.83E-05	300	2.07E-6	4.10E-6
Continuous Unfiltered Release, 24 Hours, Offsite	NA	1.89E-05	2.70E-04	1	4.62E-06	8.64E+04	7.94E-5	8.15E-5
Continuous Unfiltered Release, Annual, Offsite	NA	1.89E-05	2.70E-04	1	1.24E-07	3.15E+07	7.78E-4	7.80E-4
Toxicological								
Item	dQ/dt (L/s)	SOF	sum, SOF		Item	dQ/dt (L/s)		SOF
HEPA Crush, Onsite	4.65E-05	0.558			HEPA Crush, Offsite	4.65E-05	8.37E-04	
Continuous, Onsite	1.89E-05	0.227	0.785		Continuous, Offsite	1.89E-05	3.40E-04	1.18E-03

Table 5. Radiological and Toxicological Consequences for Airborne Releases of Unmitigated 90/10 Aerosols from the 241-702-AZ Ventilation System.

Radiological								
Item	Q (L)	dQ/dt (L/s)	R (m ³ /s)	OF	χ/Q (s/m ³)	t (s)	CEDE (Sv)	sum CEDE (Sv)
HEPA Crush, Onsite	3.06E-03	NA	3.30E-04	1	3.41E-02	NA	5.85E-3	
Continuous Unfiltered Release, 5 Minutes, Onsite	NA	9.42E-06	3.30E-04	1	3.41E-02	300	5.41E-3	1.13E-2
Continuous Unfiltered Release, 12 Hours, Onsite	NA	9.42E-06	3.30E-04	1	5.54E-03	4.32E+04	0.126	1.32E-1
Continuous Unfiltered Release, Annual, Onsite	NA	9.42E-06	2.70E-04	0.286	4.03E-04	3.15E+07	1.572	1.577
HEPA Crush, Offsite	3.06E-03	NA	3.30E-04	1	2.83E-05	NA	4.86E-6	
Continuous Unfiltered Release, 5 Minutes, Offsite	NA	9.42E-06	3.30E-04	1	2.83E-05	300	4.49E-6	9.34E-6
Continuous Unfiltered Release, 24 Hours, Offsite	NA	9.42E-06	2.70E-04	1	4.62E-06	8.64E+04	1.73E-4	1.77E-4
Continuous Unfiltered Release, Annual, Offsite	NA	9.42E-06	2.70E-04	1	1.24E-07	3.15E+07	1.69E-3	1.70E-3
Toxicological								
Item	dQ/dt (L/s)	SOF	sum, SOF		Item	dQ/dt (L/s)		SOF
HEPA Crush, Onsite	2.55E-05	0.281			HEPA Crush, Offsite	2.55E-05	6.89E-04	
Continuous, Onsite	9.42E-06	0.104	0.384		Continuous, Offsite	9.42E-06	2.54E-04	9.43E-04

Table 6. Radiological and Toxicological Consequences for Airborne Releases of Mitigated 90/10 Aerosols from the 241-702-AZ Ventilation System.

Radiological								
Item	Q (L)	dQ/dt (L/s)	R (m ³ /s)	OF	χ/Q (s/m ³)	t (s)	CEDE (Sv)	sum CEDE (Sv)
HEPA Crush, Onsite	3.35E-03	NA	3.30E-04	1	3.41E-02	NA	1.47E-3	
Continuous Unfiltered Release, 14 Minutes, Onsite	NA	9.42E-06	3.30E-04	1	3.41E-02	840	3.47E-3	4.94E-3
Continuous Unfiltered Release, 12 Hours, Onsite	NA	9.42E-06	3.30E-04	1	5.54E-03	4.32E+04	0.029	3.05E-2
Continuous Unfiltered Release, Annual, Onsite	NA	9.42E-06	2.70E-04	0.286	4.03E-04	3.15E+07	0.361	0.362
HEPA Crush, Offsite	3.35E-03	NA	3.30E-04	1	2.83E-05	NA	1.22E-6	
Continuous Unfiltered Release, 14 Minutes, Offsite	NA	9.42E-06	3.30E-04	1	2.83E-05	840	2.88E-6	4.10E-6
Continuous Unfiltered Release, 24 Hours, Offsite	NA	9.42E-06	2.70E-04	1	4.62E-06	8.64E+04	3.96E-5	4.08E-5
Continuous Unfiltered Release, Annual, Offsite	NA	9.42E-06	2.70E-04	1	1.24E-07	3.15E+07	3.88E-4	3.89E-4
Toxicological								
Item	dQ/dt (L/s)	SOF	sum, SOF		Item	dQ/dt (L/s)		SOF
HEPA Crush, Onsite	2.79E-05	0.335			HEPA Crush, Offsite	2.79E-05	5.03E-04	
Continuous, Onsite	9.42E-06	0.113	0.448		Continuous, Offsite	9.42E-06	1.70E-04	6.72E-04

Table 7. Radiological and Radiological Consequences from Airborne Release of Unmitigated 67/33 Aerosols from the 296-P-16 Ventilation System.

Radiological								
Item	Q (L)	dQ/dt (L/s)	R (m ³ /s)	OF	χ /Q (s/m ³)	t (s)	CEDE (Sv)	sum CEDE (Sv)
HEPA Crush, Onsite	7.06E-03	NA	3.30E-04	1	3.41E-02	NA	4.45E-2	
Continuous Unfiltered Release, 5 Minutes, Onsite	NA	3.30E-05	3.30E-04	1	3.41E-02	300	6.24E-2	1.07E-1
Continuous Unfiltered Release, 12 Hours, Onsite	NA	3.30E-05	3.30E-04	1	5.54E-03	4.32E+04	1.460	1.50E+0
Continuous Unfiltered Release, Annual, Onsite	NA	3.30E-05	2.70E-04	0.286	4.03E-04	3.15E+07	18.136	18.181
HEPA Crush, Offsite	7.06E-03	NA	3.30E-04	1	2.83E-05	NA	3.69E-5	
Continuous Unfiltered Release, 5 Minutes, Offsite	NA	3.30E-05	3.30E-04	1	2.83E-05	300	5.18E-5	8.87E-5
Continuous Unfiltered Release, 24 Hours, Offsite	NA	3.30E-05	2.70E-04	1	4.62E-06	8.64E+04	1.99E-3	2.03E-3
Continuous Unfiltered Release, Annual, Offsite	NA	3.30E-05	2.70E-04	1	1.24E-07	3.15E+07	1.95E-2	1.95E-2
Toxicological								
Item	dQ/dt (L/s)	SOF	sum, SOF		Item	dQ/dt (L/s)		SOF
HEPA Crush, Onsite	5.88E-05	0.765			HEPA Crush, Offsite	5.88E-05	4.00E-03	
Continuous, Onsite	3.30E-05	0.429	1.194		Continuous, Offsite	3.30E-05	2.24E-03	6.24E-03

Table 8. Radiological and Toxicological Consequences for Airborne Releases of Mitigated 67/33 Aerosols from the 296-P-16 Ventilation System.

Radiological								
Item	Q (L)	dQ/dt (L/s)	R (m ³ /s)	OF	χ/Q (s/m ³)	t (s)	CEDE (Sv)	sum CEDE (Sv)
HEPA Crush, Onsite	7.82E-03	NA	3.30E-04	1	3.41E-02	NA	1.06E-2	
Continuous Unfiltered Release, 5 Minutes, Onsite	NA	3.30E-05	3.30E-04	1	3.41E-02	300	1.34E-2	2.39E-2
Continuous Unfiltered Release, 12 Hours, Onsite	NA	3.30E-05	3.30E-04	1	5.54E-03	4.32E+04	0.313	3.23E-1
Continuous Unfiltered Release, Annual, Onsite	NA	3.30E-05	2.70E-04	0.286	4.03E-04	3.15E+07	3.886	3.897
HEPA Crush, Offsite	7.82E-03	NA	3.30E-04	1	2.83E-05	NA	8.76E-6	
Continuous Unfiltered Release, 5 Minutes, Offsite	NA	3.30E-05	3.30E-04	1	2.83E-05	300	1.11E-5	1.99E-5
Continuous Unfiltered Release, 24 Hours, Offsite	NA	3.30E-05	2.70E-04	1	4.62E-06	8.64E+04	4.27E-4	4.36E-4
Continuous Unfiltered Release, Annual, Offsite	NA	3.30E-05	2.70E-04	1	1.24E-07	3.15E+07	4.18E-3	4.19E-3
Toxicological								
Item	dQ/dt (L/s)	SOF	sum, SOF		Item	dQ/dt (L/s)		SOF
HEPA Crush, Onsite	6.52E-05	1.238166 7			HEPA Crush, Offsite	6.52E-05	2.61E-03	
Continuous, Onsite	3.30E-05	0.627	1.865166 7		Continuous, Offsite	3.30E-05	1.32E-03	3.93E-03

Table 9. Radiological and Toxicological Consequences for Airborne Releases of SST Solids as Aerosols from the 296-P-16 Ventilation System.

Radiological								
Item	Q (L)	dQ/dt (L/s)	R (m ³ /s)	OF	χ/Q (s/m ³)	t (s)	CEDE (Sv)	sum CEDE (Sv)
HEPA Crush, Onsite	1.21E-02	NA	3.30E-04	1	3.41E-02	NA	1.96E-2	
Continuous Unfiltered Release, 5 Minutes, Onsite	NA	3.30E-05	3.30E-04	1	3.41E-02	300	1.60E-2	3.56E-2
Continuous Unfiltered Release, 12 Hours, Onsite	NA	3.30E-05	3.30E-04	1	5.54E-03	4.32E+04	0.375	3.95E-1
Continuous Unfiltered Release, Annual, Onsite	NA	3.30E-05	2.70E-04	0.286	4.03E-04	3.15E+07	4.664	4.683
HEPA Crush, Offsite	1.21E-02	NA	3.30E-04	1	2.83E-05	NA	1.63E-5	
Continuous Unfiltered Release, 5 Minutes, Offsite	NA	3.30E-05	3.30E-04	1	2.83E-05	300	1.33E-5	2.96E-5
Continuous Unfiltered Release, 24 Hours, Offsite	NA	3.30E-05	2.70E-04	1	4.62E-06	8.64E+04	5.12E-4	5.28E-4
Continuous Unfiltered Release, Annual, Offsite	NA	3.30E-05	2.70E-04	1	1.24E-07	3.15E+07	5.02E-3	5.03E-3
Toxicological								
Item	dQ/dt (L/s)	SOF	sum, SOF		Item	dQ/dt (L/s)		SOF
HEPA Crush, Onsite	1.01E-04	4.033333			HEPA Crush, Offsite	1.01E-04	9.48E-03	
Continuous, Onsite	3.30E-05	1.32	5.353333		Continuous, Offsite	3.30E-05	3.10E-03	1.26E-02

Table 10. Radiological and Toxicological Consequences for Airborne Releases of AWF Solids as Aerosols from the 241-702-A Ventilation System.

Radiological								
Item	Q (L)	dQ/dt (L/s)	R (m ³ /s)	OF	χ /Q (s/m ³)	t (s)	CEDE (Sv)	sum CEDE (Sv)
HEPA Crush, Onsite	3.15E-03	NA	3.30E-04	1	3.41E-02	NA	6.03E-2	
Continuous Unfiltered Release, 5 Minutes, Onsite	NA	1.89E-05	3.30E-04	1	3.41E-02	300	1.08E-1	1.69E-1
Continuous Unfiltered Release, 12 Hours, Onsite	NA	1.89E-05	3.30E-04	1	5.54E-03	4.32E+04	2.538	2.60E+0
Continuous Unfiltered Release, Annual, Onsite	NA	1.89E-05	2.70E-04	0.286	4.03E-04	3.15E+07	31.532	31.592
HEPA Crush, Offsite	3.15E-03	NA	3.30E-04	1	2.83E-05	NA	5.00E-5	
Continuous Unfiltered Release, 5 Minutes, Offsite	NA	1.89E-05	3.30E-04	1	2.83E-05	300	9.00E-5	1.40E-4
Continuous Unfiltered Release, 24 Hours, Offsite	NA	1.89E-05	2.70E-04	1	4.62E-06	8.64E+04	3.46E-3	3.51E-3
Continuous Unfiltered Release, Annual, Offsite	NA	1.89E-05	2.70E-04	1	1.24E-07	3.15E+07	3.39E-2	3.40E-2
Toxicological								
Item	dQ/dt (L/s)	SOF	sum, SOF		Item	dQ/dt (L/s)		SOF
HEPA Crush, Onsite	2.63E-05	0.473			HEPA Crush, Offsite	2.63E-05	4.99E-03	
Continuous, Onsite	1.89E-05	0.340	0.813		Continuous, Offsite	1.89E-05	3.59E-03	8.58E-03

Table 11. Radiological and Toxicological Consequences for Airborne Releases of AWF Solids as Aerosols from the 241-701-AZ Ventilation System.

Radiological								
Item	Q (L)	dQ/dt (L/s)	R (m ³ /s)	OF	χ/Q (s/m ³)	t (s)	CEDE (Sv)	sum CEDE (Sv)
HEPA Crush, Onsite	1.89E-03	NA	3.30E-04	1	3.41E-02	NA	3.62E-2	
Continuous Unfiltered Release, 5 Minutes, Onsite	NA	9.42E-06	3.30E-04	1	3.41E-02	300	5.41E-2	9.02E-2
Continuous Unfiltered Release, 12 Hours, Onsite	NA	9.42E-06	3.30E-04	1	5.54E-03	4.32E+04	1.265	1.30E+0
Continuous Unfiltered Release, Annual, Onsite	NA	9.42E-06	2.70E-04	0.286	4.03E-04	3.15E+07	15.716	15.752
HEPA Crush, Offsite	1.89E-03	NA	3.30E-04	1	2.83E-05	NA	3.00E-5	
Continuous Unfiltered Release, 5 Minutes, Offsite	NA	9.42E-06	3.30E-04	1	2.83E-05	300	4.49E-5	7.49E-5
Continuous Unfiltered Release, 24 Hours, Offsite	NA	9.42E-06	2.70E-04	1	4.62E-06	8.64E+04	1.73E-3	1.76E-3
Continuous Unfiltered Release, Annual, Offsite	NA	9.42E-06	2.70E-04	1	1.24E-07	3.15E+07	1.69E-2	1.69E-2
Toxicological								
Item	dQ/dt (L/s)	SOF	sum, SOF		Item	dQ/dt (L/s)		SOF
HEPA Crush, Onsite	1.58E-05	0.284			HEPA Crush, Offsite	1.58E-05	2.99E-03	
Continuous, Onsite	9.42E-06	0.170	0.453		Continuous, Offsite	9.42E-06	1.79E-03	4.78E-03

Table 12. Radiological and Toxicological Consequences for the Airborne Releases of AWF Solids as Aerosols from the 296-P-16 Ventilation System.

Radiological								
Item	Q(L)	dQ/dt (L/s)	R (m ³ /s)	OF	χ/Q (s/m ³)	t (s)	CEDE (Sv)	sum CEDE (Sv)
HEPA Crush, Onsite	1.89E-03	NA	3.30E-04	1	3.41E-02	NA	3.62E-2	
Continuous Unfiltered Release, 5 Minutes, Onsite	NA	9.42E-06	3.30E-04	1	3.41E-02	300	5.41E-2	9.02E-2
Continuous Unfiltered Release, 12 Hours, Onsite	NA	9.42E-06	3.30E-04	1	5.54E-03	4.32E+04	1.265	1.30E+0
Continuous Unfiltered Release, Annual, Onsite	NA	9.42E-06	2.70E-04	0.286	4.03E-04	3.15E+07	15.716	15.752
HEPA Crush, Offsite	1.89E-03	NA	3.30E-04	1	2.83E-05	NA	3.00E-5	
Continuous Unfiltered Release, 5 Minutes, Offsite	NA	9.42E-06	3.30E-04	1	2.83E-05	300	4.49E-5	7.49E-5
Continuous Unfiltered Release, 24 Hours, Offsite	NA	9.42E-06	2.70E-04	1	4.62E-06	8.64E+04	1.73E-3	1.76E-3
Continuous Unfiltered Release, Annual, Offsite	NA	9.42E-06	2.70E-04	1	1.24E-07	3.15E+07	1.69E-2	1.69E-2
Toxicological								
Item	dQ/dt (L/s)		SOF		Item	dQ/dt (L/s)		SOF
HEPA Crush, Onsite	1.58E-05	0.284			HEPA Crush, Offsite	1.58E-05	2.99E-03	
Continuous, Onsite	9.42E-06	0.170	0.453		Continuous, Offsite	9.42E-06	1.79E-03	4.78E-03

6.0 REFERENCES

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ATTACHMENT 1: MICROSHIELD RUNS

Summary of the Microshield runs.

Microshield Cases

#	Case	mR/h
1	1 Liter unmitigated 90/10 on 2 x 2 x 1 filter	1.138×10^4
2	1 curie (each) ^{90}Sr and ^{90}Y on 2 x 2 x 1 filter	4.928×10^1
3	1 Liter mitigated 90/10 on 2 x 2 x 1 filter	1.053×10^4
4	1 Liter unmitigated 67/33 on 3 x 3 filter bank	1.824×10^3
5	1 Liter mitigated 67/33 on 3 x 3 filter bank	1.700×10^3
6	1 Liter unmitigated 67/33 on 3 x 3 prefilter bank	2.363×10^3
7	1 Liter mitigated 67/33 on 3 x 3 prefilter bank	2.200×10^3
8	1 Liter Tank 241-C-106 solids on 3 x 3 filter bank	5.661×10^2
9	1 Liter Tank 241-C-106 solids on 3 x 3 prefilter bank	7.313×10^2
10	1 curie (each) ^{90}Sr and ^{90}Y on 3 x 3 filter bank	7.164×10^0
11	1 curie (each) ^{90}Sr and ^{90}Y on 3 x 3 prefilter bank	9.196×10^0
12	1 Liter AWF solids on 2 x 2 x 1 filter	1.520×10^4
13	1 Liter AWF solids on 3 x 3 filter bank	2.253×10^3
14	1 Liter AWF solids on 3 x 3 prefilter bank	2.909×10^3

HNF-SD-WM-CN-099 REV 0

MicroShield 4.00 - Serial #4.00-00128
Westinghouse Hanford Company

Page : 1
DOS File: UN9010AY.MS4
Run Date: April 9, 1997
Run Time: 3:23 p.m. Wednesday
Duration: 0:00:52

File Ref: _____
Date: ____/____/____
By: _____
Checked: _____

Case Title: 1 liter 90/10 unmitigated on 2x2x1 filter for ay102

GEOMETRY 11 - Rectangular Volume

	centimeters	feet	and inches
Dose point coordinate X:	62.484	2.0	.6
Dose point coordinate Y:	30.48	1.0	.0
Dose point coordinate Z:	15.24	0.0	6.0
Rectangular volume width :	30.48	1.0	.0
Rectangular volume length:	60.96	2.0	.0
Rectangular volume height:	60.96	2.0	.0
Shield 1:	0.2032	0.0	.1
Air Gap:	1.3208	0.0	.5

Source Volume: 113267. cm³ 4 cu ft. 6912. cu in.

MATERIAL DENSITIES (g/cm³)

Material	Source Shield	Shield 1 Slab	Air Gap
Air			0.00122
Aluminum	0.03	2.702	
glass	0.02		

BUILDUP
Method: Buildup Factor Tables
The material reference is Shield 1

INTEGRATION PARAMETERS

	Quadrature Order
X Direction	20
Y Direction	20
Z Direction	10

SOURCE NUCLIDES

Nuclide	curies	μCi/cm ³	Nuclide	curies	μCi/cm ³
Ba-137m	2.2850e+000	2.0174e+001	Co-60	1.3400e-003	1.1830e-002
Eu-154	2.9700e-002	2.6221e-001			

HNF-SD-WM-CN-099 REV 0

Page : 2
 DOS File: UN9010AY.MS4
 Run Date: April 9, 1997
 Run Time: 3:23 p.m. Wednesday
 Title : 1 liter 90/10 unmitigated on 2x2x1 filter for ay102

===== RESULTS =====					
Energy (MeV)	Activity (photons/sec)	Energy Fluence Rate (MeV/sq cm/sec)		Exposure Rate In Air (mR/hr)	
		No Buildup	With Buildup	No Buildup	With Buildup
0.0392	6.880e+009	1.159e+004	1.651e+004	5.412e+001	7.708e+001
0.246	7.505e+007	1.705e+003	2.188e+003	3.136e+000	4.026e+000
0.4426	1.022e+007	4.372e+002	5.183e+002	8.562e-001	1.015e+000
0.5907	6.849e+007	3.992e+003	4.581e+003	7.799e+000	8.949e+000
0.6619	7.638e+010	5.027e+006	5.704e+006	9.745e+003	1.106e+004
0.8723	1.542e+008	1.362e+004	1.510e+004	2.562e+001	2.842e+001
1.0024	3.124e+008	3.198e+004	3.513e+004	5.893e+001	6.473e+001
1.2611	4.563e+008	5.957e+004	6.448e+004	1.047e+002	1.134e+002
1.3325	4.958e+007	6.861e+003	7.403e+003	1.190e+001	1.284e+001
1.5767	3.873e+007	6.400e+003	6.843e+003	1.062e+001	1.136e+001
TOTAL:	8.442e+010	5.163e+006	5.857e+006	1.002e+004	1.138e+004

HNF-SD-WM-CN-099 REV 0

MicroShield 4.00 - Serial #4.00-00128

Westinghouse Hanford Company

Page : 1

DOS File: 1SRV_AY.MS4

Run Date: April 9, 1997

Run Time: 3:29 p.m. Wednesday

Duration: 0:01:43

File Ref: _____

Date: ____/____/____

By: _____

Checked: _____

Case Title: 1 ci sr90 & y90 on 2x2x1 filter for ay102

GEOMETRY 11 - Rectangular Volume

	centimeters	feet	and inches
Dose point coordinate X:	62.484	2.0	.6
Dose point coordinate Y:	30.48	1.0	.0
Dose point coordinate Z:	15.24	0.0	6.0
Rectangular volume width :	30.48	1.0	.0
Rectangular volume length:	60.96	2.0	.0
Rectangular volume height:	60.96	2.0	.0
Shield 1:	0.2032	0.0	.1
Air Gap:	1.3208	0.0	.5

Source Volume: 113267. cm³ 4 cu ft. 6912. cu in.

MATERIAL DENSITIES (g/cm³)

Material	Source Shield	Shield 1 Slab	Air Gap
Air			0.00122
Aluminum	0.03	2.702	
glass	0.02		

BUILDUP

Method: Buildup Factor Tables
The material reference is Shield 1

INTEGRATION PARAMETERS

	Quadrature Order
X Direction	20
Y Direction	20
Z Direction	10

SOURCE WAS ENTERED AS ENERGIES ONLY

HNF-SD-WM-CN-099 REV 0

Page : 2
 DOS File: 1SRV_AY.MS4
 Run Date: April 9, 1997
 Run Time: 3:29 p.m. Wednesday
 Title : 1 ci sr90 & y90 on 2x2x1 filter for ay102

===== RESULTS =====					
Energy (MeV)	Activity (photons/sec)	Energy Fluence Rate (MeV/sq cm/sec)		Exposure Rate In Air (mR/hr)	
		No Buildup	With Buildup	No Buildup	With Buildup
0.045	1.800e+008	4.383e+002	6.333e+002	1.458e+000	2.106e+000
0.055	1.400e+008	5.128e+002	7.944e+002	1.154e+000	1.788e+000
0.065	1.100e+008	5.275e+002	8.658e+002	9.575e-001	1.572e+000
0.075	8.900e+007	5.215e+002	8.362e+002	8.499e-001	1.363e+000
0.085	7.400e+007	5.093e+002	7.938e+002	7.912e-001	1.233e+000
0.095	6.300e+007	4.965e+002	7.595e+002	7.599e-001	1.162e+000
0.15	3.300e+008	4.372e+003	6.126e+003	7.199e+000	1.009e+001
0.25	1.300e+008	3.005e+003	3.848e+003	5.545e+000	7.099e+000
0.35	6.900e+007	2.293e+003	2.798e+003	4.424e+000	5.398e+000
0.475	5.500e+007	2.538e+003	2.984e+003	4.980e+000	5.855e+000
0.65	3.500e+007	2.259e+003	2.568e+003	4.386e+000	4.986e+000
0.825	1.400e+007	1.165e+003	1.298e+003	2.208e+000	2.460e+000
1.0	9.800e+006	1.001e+003	1.099e+003	1.845e+000	2.027e+000
1.225	5.500e+006	6.964e+002	7.551e+002	1.233e+000	1.336e+000
1.475	2.100e+006	3.235e+002	3.471e+002	5.467e-001	5.866e-001
1.7	5.300e+005	9.478e+001	1.010e+002	1.539e-001	1.640e-001
1.9	1.400e+005	2.813e+001	2.982e+001	4.420e-002	4.686e-002
2.1	1.500e+004	3.346e+000	3.533e+000	5.096e-003	5.379e-003
2.3	8.300e+001	2.036e-002	2.141e-002	3.011e-005	3.166e-005
TOTAL:	1.307e+009	2.079e+004	2.664e+004	3.854e+001	4.928e+001

HNF-SD-WM-CN-099 REV 0

MicroShield 4.00 - Serial #4.00-00128
Westinghouse Hanford Company

Page : 4

DOS File: M9010AY.MS4

Run Date: April 9, 1997

Run Time: 3:46 p.m. Wednesday

Duration: 0:00:51

File Ref: _____

Date: ____/____/____

By: _____

Checked: _____

Case Title: 1 liter 90/10 mitigated on 2x2x1 filter for ay102

GEOMETRY 11 - Rectangular Volume

	centimeters	feet	and inches
Dose point coordinate X:	62.484	2.0	.6
Dose point coordinate Y:	30.48	1.0	.0
Dose point coordinate Z:	15.24	0.0	6.0
Rectangular volume width :	30.48	1.0	.0
Rectangular volume length:	60.96	2.0	.0
Rectangular volume height:	60.96	2.0	.0
Shield 1:	0.2032	0.0	.1
Air Gap:	1.3208	0.0	.5

Source Volume: 113267. cm³ 4 cu ft. 6912. cu in.

MATERIAL DENSITIES (g/cm³)

Material	Source Shield	Shield 1 Slab	Air Gap
Air			0.00122
Aluminum	0.03	2.702	
glass	0.02		

BUILDUP

Method: Buildup Factor Tables
The material reference is Shield 1

INTEGRATION PARAMETERS

	Quadrature Order
X Direction	20
Y Direction	20
Z Direction	10

SOURCE NUCLIDES

Nuclide	curies	$\mu\text{Ci/cm}^3$	Nuclide	curies	$\mu\text{Ci/cm}^3$
Ba-137m	2.1370e+000	1.8867e+001	Co-60	1.1900e-003	1.0506e-002
Eu-154	2.2800e-002	2.0129e-001			

Page : 2
 DOS File: W9010AY.MS4
 Run Date: April 9, 1997
 Run Time: 3:46 p.m. Wednesday
 Title : 1 liter 90/10 mitigated on 2x2x1 filter for ay102

===== RESULTS =====					
Energy (MeV)	Activity (photons/sec)	Energy Fluence Rate (MeV/sq cm/sec)		Exposure Rate In Air (mR/hr)	
		No Buildup	With Buildup	No Buildup	With Buildup
0.0925	5.567e+008	4.247e+003	6.525e+003	6.511e+000	1.000e+001
0.246	5.761e+007	1.309e+003	1.680e+003	2.407e+000	3.090e+000
0.4426	7.845e+006	3.356e+002	3.979e+002	6.573e-001	7.792e-001
0.5907	5.258e+007	3.065e+003	3.517e+003	5.987e+000	6.870e+000
0.6619	7.138e+010	4.698e+006	5.331e+006	9.107e+003	1.033e+004
0.8723	1.184e+008	1.045e+004	1.160e+004	1.967e+001	2.182e+001
1.0024	2.398e+008	2.455e+004	2.697e+004	4.524e+001	4.969e+001
1.2597	3.562e+008	4.645e+004	5.029e+004	8.169e+001	8.843e+001
1.3325	4.403e+007	6.093e+003	6.574e+003	1.057e+001	1.141e+001
1.5767	2.973e+007	4.913e+003	5.254e+003	8.153e+000	8.719e+000
TOTAL:	7.284e+010	4.799e+006	5.444e+006	9.288e+003	1.053e+004

HNF-SD-WM-CN-099 REV 0

MicroShield 4.00 - Serial #4.00-00128
Westinghouse Hanford Company

Page : 1
DOS File: UNMIT3X3.MS4
Run Date: March 26, 1997
Run Time: 12:26 p.m. Wednesday
Duration: 0:00:56

File Ref: _____
Date: ____/____/____
By: _____
Checked: _____

Case Title: 1 liter unmitigated(.67awf_l+.33awf_s), 3X3 filter bank co60

GEOMETRY 11 - Rectangular Volume

	centimeters	feet	inches
Dose point coordinate X:	184.404	6.0	.6
Dose point coordinate Y:	30.48	1.0	.0
Dose point coordinate Z:	15.24	0.0	6.0
Rectangular volume width :	30.48	1.0	.0
Rectangular volume length:	182.88	6.0	.0
Rectangular volume height:	182.88	6.0	.0
Shield 1:	1.016	0.0	.4
Air Gap:	0.508	0.0	.2

Source Volume: 1.01941e+6 cm³ 36. cu ft. 62208 cu in.

MATERIAL DENSITIES (g/cm³)

Material	Source Shield	Shield 1 Slab	Air Gap
Air			0.00122
Aluminum		2.702	
glass	0.02		

BUILDUP

Method: Buildup Factor Tables
The material reference is Shield 1

INTEGRATION PARAMETERS

	Quadrature Order
X Direction	20
Y Direction	20
Z Direction	10

SOURCE NUCLIDES

Nuclide	curies	$\mu\text{Ci/cm}^3$	Nuclide	curies	$\mu\text{Ci/cm}^3$
Ba-137m	2.3400e+000	2.2955e+000	Co-60	4.3800e-003	4.2966e-003
Eu-154	9.8100e-002	9.6232e-002			

Page : 2
 DOS File: UNMI13X3.MS4
 Run Date: March 26, 1997
 Run Time: 12:26 p.m. Wednesday
 Title : 1 liter unmitigated(.67awf_1+.33awf_s), 3X3 filter bank co60

===== RESULTS =====					
Energy (MeV)	Activity (photons/sec)	Energy Fluence Rate (MeV/sq cm/sec)		Exposure Rate In Air (mR/hr)	
		No Buildup	With Buildup	No Buildup	With Buildup
0.246	2.479e+008	5.914e+002	1.122e+003	1.088e+000	2.064e+000
0.4426	3.376e+007	1.637e+002	2.591e+002	3.205e-001	5.074e-001
0.5907	2.262e+008	1.548e+003	2.262e+003	3.025e+000	4.420e+000
0.6625	7.891e+010	6.188e+005	8.789e+005	1.200e+003	1.704e+003
0.8723	5.093e+008	5.528e+003	7.404e+003	1.040e+001	1.393e+001
1.0024	1.032e+009	1.319e+004	1.721e+004	2.429e+001	3.171e+001
1.2612	1.505e+009	2.515e+004	3.156e+004	4.422e+001	5.549e+001
1.3325	1.621e+008	2.886e+003	3.590e+003	5.007e+000	6.229e+000
1.5767	1.279e+008	2.766e+003	3.359e+003	4.590e+000	5.575e+000
TOTAL:	8.275e+010	6.706e+005	9.457e+005	1.292e+003	1.824e+003

HNF-SD-WM-CN-099 REV 0

MicroShield 4.00 - Serial #4.00-00128
Westinghouse Hanford Company

Page : 1
DOS File: MIT3X3.MS4
Run Date: March 26, 1997
Run Time: 12:34 p.m. Wednesday
Duration: 0:00:56

File Ref: _____
Date: ____/____/____
By: _____
Checked: _____

Case Title: 1 Liter mitigated, 3X3 filter bank co60

GEOMETRY 11 - Rectangular Volume

	centimeters	feet	and inches
Dose point coordinate X:	184.404	6.0	.6
Dose point coordinate Y:	30.48	1.0	.0
Dose point coordinate Z:	15.24	0.0	6.0
Rectangular volume width :	30.48	1.0	.0
Rectangular volume length:	182.88	6.0	.0
Rectangular volume height:	182.88	6.0	.0
Shield 1:	1.016	0.0	.4
Air Gap:	0.508	0.0	.2

Source Volume: 1.01941e+6 cm³ 36. cu ft. 62208 cu in.

MATERIAL DENSITIES (g/cm³)

Material	Source	Shield 1	Air Gap
	Shield	Slab	
Air			0.00122
Aluminum		2.702	
glass	0.02		

BUILDUP
Method: Buildup Factor Tables
The material reference is Shield 1

INTEGRATION PARAMETERS

	Quadrature Order
X Direction	20
Y Direction	20
Z Direction	10

SOURCE NUCLIDES

Nuclide	curies	$\mu\text{Ci/cm}^3$	Nuclide	curies	$\mu\text{Ci/cm}^3$
Ba-137m	2.2400e+000	2.1974e+000	Co-60	3.8400e-003	3.7669e-003
Eu-154	6.0600e-002	5.9446e-002			

HNF-SD-WM-CN-099 REV 0

Page : 2
 DOS File: MIT3X3.MS4
 Run Date: March 26, 1997
 Run Time: 12:34 p.m. Wednesday
 Title : 1 liter mitigated, 3X3 filter bank co60

===== RESULTS =====					
Energy (MeV)	Activity (photons/sec)	Energy Fluence Rate (MeV/sq cm/sec)		Exposure Rate in Air (mR/hr)	
		No Buildup	With Buildup	No Buildup	With Buildup
0.246	1.531e+008	3.653e+002	6.931e+002	6.720e-001	1.275e+000
0.4426	2.085e+007	1.011e+002	1.601e+002	1.980e-001	3.134e-001
0.5907	1.398e+008	9.565e+002	1.398e+003	1.869e+000	2.730e+000
0.6622	7.519e+010	5.894e+005	8.372e+005	1.143e+003	1.623e+003
0.8723	3.146e+008	3.415e+003	4.574e+003	6.425e+000	8.606e+000
1.0024	6.374e+008	8.145e+003	1.063e+004	1.501e+001	1.959e+001
1.2574	9.719e+008	1.618e+004	2.032e+004	2.847e+001	3.574e+001
1.3325	1.421e+008	2.530e+003	3.148e+003	4.390e+000	5.461e+000
1.5767	7.903e+007	1.708e+003	2.075e+003	2.835e+000	3.444e+000
TOTAL:	7.765e+010	6.228e+005	8.802e+005	1.202e+003	1.700e+003

HNF-SD-WM-CN-099 REV 0

MicroShield 4.00 - Serial #4.00-00128
Westinghouse Hanford Company

Page : 1
DOS File: U6733PRE.MS4
Run Date: April 14, 1997
Run Time: 1:41 p.m. Monday
Duration: 0:01:11

File Ref: _____
Date: ____/____/____
By: _____
Checked: _____

Case Title: 1 liter unmit 67/33 for C-106, 3x3 bank 1x1 prefilters

GEOMETRY 11 - Rectangular Volume

	centimeters	feet	and inches
Dose point coordinate X:	184.404	6.0	.6
Dose point coordinate Y:	30.48	1.0	.0
Dose point coordinate Z:	3.175	0.0	1.3
Rectangular volume width :	6.35	0.0	2.5
Rectangular volume length:	182.88	6.0	.0
Rectangular volume height:	182.88	6.0	.0
Shield 1:	1.016	0.0	.4
Air Gap:	0.508	0.0	.2

Source Volume: 212376. cm³ 7.5 cu ft. 12960 cu in.

MATERIAL DENSITIES (g/cm³)

Material	Source Shield	Shield 1 Slab	Air Gap
Air			0.00122
Aluminum	0.03	2.702	
glass	0.02		

BUILDUP

Method: Buildup Factor Tables
The material reference is Shield 1

INTEGRATION PARAMETERS

	Quadrature Order
X Direction	20
Y Direction	20
Z Direction	10

SOURCE NUCLIDES

Nuclide	curies	$\mu\text{Ci/cm}^3$	Nuclide	curies	$\mu\text{Ci/cm}^3$
Ba-137m	2.3400e+000	1.1018e+001	Co-60	4.3800e-003	2.0624e-002
Eu-154	9.8100e-002	4.6192e-001			

HNF-SD-WM-CN-099 REV 0

Page : 2
 DOS File: U6733PRE.MS4
 Run Date: April 14, 1997
 Run Time: 1:41 p.m. Monday
 Title : 1 liter unmit 67/33 for C-106, 3x3 bank 1x1 prefilters

===== RESULTS =====					
Energy (MeV)	Activity (photons/sec)	Energy Fluence Rate (MeV/sq cm/sec)		Exposure Rate In Air (mR/hr)	
		No Buildup	With Buildup	No Buildup	With Buildup
0.044	9.874e+009	1.193e+003	2.281e+003	4.177e+000	7.989e+000
0.246	2.479e+008	7.460e+002	1.450e+003	1.372e+000	2.668e+000
0.4426	3.376e+007	2.076e+002	3.349e+002	4.065e-001	6.558e-001
0.5907	2.262e+008	1.969e+003	2.922e+003	3.846e+000	5.709e+000
0.6625	7.891e+010	7.875e+005	1.135e+006	1.527e+003	2.200e+003
0.8723	5.093e+008	7.050e+003	9.560e+003	1.327e+001	1.799e+001
1.0024	1.032e+009	1.683e+004	2.222e+004	3.102e+001	4.094e+001
1.2612	1.505e+009	3.217e+004	4.075e+004	5.655e+001	7.164e+001
1.3325	1.621e+008	3.692e+003	4.636e+003	6.406e+000	8.043e+000
1.5767	1.279e+008	3.542e+003	4.337e+003	5.879e+000	7.198e+000
TOTAL:	9.263e+010	8.549e+005	1.224e+006	1.650e+003	2.363e+003

HNF-SD-WM-CN-099 REV 0

MicroShield 4.00 - Serial #4.00-00128
Westinghouse Hanford Company

Page : 1	File Ref: _____
DOS File: M6733PRE.MS4	Date: ____/____/____
Run Date: April 14, 1997	By: _____
Run Time: 1:50 p.m. Monday	Checked: _____
Duration: 0:01:11	

Case Title: 1 liter mitigated 67/33 for C-106, 3x3 bank 1x1 prefilters

GEOMETRY 11 - Rectangular Volume

	centimeters	feet and inches
Dose point coordinate X:	184.404	6.0 .6
Dose point coordinate Y:	30.48	1.0 .0
Dose point coordinate Z:	3.175	0.0 1.3
Rectangular volume width :	6.35	0.0 2.5
Rectangular volume length:	182.88	6.0 .0
Rectangular volume height:	182.88	6.0 .0
Shield 1:	1.016	0.0 .4
Air Gap:	0.508	0.0 .2

Source Volume: 212376. cm³ 7.5 cu ft. 12960 cu in.

Material	Source Shield	MATERIAL DENSITIES (g/cm ³)	
		Shield 1 Slab	Air Gap
Air			0.00122
Aluminum	0.03	2.702	
glass	0.02		

BUILDUP
Method: Buildup Factor Tables
The material reference is Shield 1

INTEGRATION PARAMETERS

	Quadrature Order
X Direction	20
Y Direction	20
Z Direction	10

SOURCE NUCLIDES					
Nuclide	curies	μCi/cm ³	Nuclide	curies	μCi/cm ³
Ba-137m	2.2400e+000	1.0547e+001	Co-60	3.8400e-003	1.8081e-002
Eu-154	6.0600e-002	2.8534e-001			

HNF-SD-WM-CN-099 REV 0

Page : 2
 DOS File: M6733PRE.MS4
 Run Date: April 14, 1997
 Run Time: 1:50 p.m. Monday
 Title : 1 liter mitigated 67/33 for C-106, 3x3 bank 1x1 prefilters

===== RESULTS =====					
Energy (MeV)	Activity (photons/sec)	Energy Fluence Rate (MeV/sq cm/sec)		Exposure Rate In Air (mR/hr)	
		No Buildup	With Buildup	No Buildup	With Buildup
0.0398	8.545e+009	6.095e+002	1.078e+003	2.729e+000	4.829e+000
0.246	1.531e+008	4.609e+002	8.960e+002	8.478e-001	1.648e+000
0.4426	2.085e+007	1.282e+002	2.069e+002	2.511e-001	4.051e-001
0.5907	1.398e+008	1.216e+003	1.805e+003	2.376e+000	3.527e+000
0.6622	7.519e+010	7.501e+005	1.081e+006	1.454e+003	2.096e+003
0.8723	3.146e+008	4.355e+003	5.906e+003	8.195e+000	1.111e+001
1.0024	6.374e+008	1.040e+004	1.373e+004	1.916e+001	2.529e+001
1.2574	9.719e+008	2.069e+004	2.623e+004	3.641e+001	4.615e+001
1.3325	1.421e+008	3.237e+003	4.064e+003	5.616e+000	7.051e+000
1.5767	7.903e+007	2.188e+003	2.679e+003	3.631e+000	4.447e+000
TOTAL:	8.620e+010	7.934e+005	1.138e+006	1.533e+003	2.200e+003

HNF-SD-WM-CN-099 REV 0

MicroShield 4.00 - Serial #4.00-00128
Westinghouse Hanford Company

Page : 1
DOS File: C1063X3.MS4
Run Date: March 11, 1997
Run Time: 3:55 p.m. Tuesday
Duration: 0:00:58

File Ref: _____
Date: ____/____/____
By: _____
Checked: _____

Case Title: 1 liter c-106, 3X3 filter bank

GEOMETRY 11 - Rectangular Volume

	centimeters	feet	inches
Dose point coordinate X:	184.404	6.0	.6
Dose point coordinate Y:	30.48	1.0	.0
Dose point coordinate Z:	15.24	0.0	6.0
Rectangular volume width :	30.48	1.0	.0
Rectangular volume length:	182.88	6.0	.0
Rectangular volume height:	182.88	6.0	.0
Shield 1:	1.016	0.0	.4
Air Gap:	0.508	0.0	.2

Source Volume: 1.01941e+6 cm³ 36. cu ft. 62208 cu in.

MATERIAL DENSITIES (g/cm³)

Material	Source Shield	Shield 1 Slab	Air Gap
Air			0.00122
Aluminum		2.702	
glass	0.02		

BUILDUP
Method: Buildup Factor Tables
The material reference is Shield 1

INTEGRATION PARAMETERS

	Quadrature Order
X Direction	20
Y Direction	20
Z Direction	10

SOURCE NUCLIDES

Nuclide	curies	$\mu\text{Ci/cm}^3$	Nuclide	curies	$\mu\text{Ci/cm}^3$
Ba-137m	7.3000e-001	7.1610e-001	Eu-154	3.0000e-002	2.9429e-002

Page : 2
 DOS File: C1063X3.MS4
 Run Date: March 11, 1997
 Run Time: 3:55 p.m. Tuesday
 Title : 1 liter c-106, 3X3 filter bank

===== RESULTS =====					
Energy (MeV)	Activity (photons/sec)	Energy Fluence Rate (MeV/sq cm/sec)		Exposure Rate In Air (mR/hr)	
		No Buildup	With Buildup	No Buildup	With Buildup
0.1231	4.491e+008	4.500e+002	1.073e+003	7.067e-001	1.686e+000
0.246	7.580e+007	1.808e+002	3.431e+002	3.327e-001	6.312e-001
0.4426	1.032e+007	5.005e+001	7.923e+001	9.802e-002	1.552e-001
0.5907	6.919e+007	4.735e+002	6.919e+002	9.251e-001	1.352e+000
0.6624	2.461e+010	1.930e+005	2.741e+005	3.741e+002	5.313e+002
0.8723	1.557e+008	1.690e+003	2.264e+003	3.181e+000	4.261e+000
1.0024	3.155e+008	4.032e+003	5.263e+003	7.429e+000	9.698e+000
1.2719	4.108e+008	6.931e+003	8.686e+003	1.216e+001	1.524e+001
1.5767	3.912e+007	8.458e+002	1.027e+003	1.404e+000	1.705e+000
TOTAL:	2.614e+010	2.077e+005	2.935e+005	4.004e+002	5.661e+002

HNF-SD-WM-CN-099 REV 0

MicroShield 4.00 - Serial #4.00-00128
Westinghouse Hanford Company

Page : 1

DOS File: C106_PRE.MS4

Run Date: April 14, 1997

Run Time: 1:55 p.m. Monday

Duration: 0:01:05

File Ref: _____

Date: ____/____/____

By: _____

Checked: _____

Case Title: 1 liter c-106, 3x3 bank 1x1 prefilters

GEOMETRY 11 - Rectangular Volume

	centimeters	feet and inches
Dose point coordinate X:	184.404	6.0 .6
Dose point coordinate Y:	30.48	1.0 .0
Dose point coordinate Z:	3.175	0.0 1.3
Rectangular volume width :	6.35	0.0 2.5
Rectangular volume length:	182.88	6.0 .0
Rectangular volume height:	182.88	6.0 .0
Shield 1:	1.016	0.0 .4
Air Gap:	0.508	0.0 .2

Source Volume: 212376. cm³ 7.5 cu ft. 12960 cu in.

MATERIAL DENSITIES (g/cm³)

Material	Source Shield	Shield 1 Slab	Air Gap
Air			0.00122
Aluminum	0.03	2.702	
glass	0.02		

BUILDUP

Method: Buildup Factor Tables
The material reference is Shield 1

INTEGRATION PARAMETERS

	Quadrature Order
X Direction	20
Y Direction	20
Z Direction	10

SOURCE NUCLIDES

Nuclide	curies	$\mu\text{Ci/cm}^3$	Nuclide	curies	$\mu\text{Ci/cm}^3$
Ba-137m	7.3000e-001	3.4373e+000	Eu-154	3.0000e-002	1.4126e-001

Page : 2
 DOS File: C106 PRE.MS4
 Run Date: April 14, 1997
 Run Time: 1:55 p.m. Monday
 Title : 1 liter c-106, 3x3 bank 1x1 prefilters

===== RESULTS =====					
Energy (MeV)	Activity (photons/sec)	Energy Fluence Rate (MeV/sq cm/sec)		Exposure Rate In Air (mR/hr)	
		No Buildup	With Buildup	No Buildup	With Buildup
0.0438	3.064e+009	3.618e+002	6.895e+002	1.281e+000	2.442e+000
0.246	7.580e+007	2.281e+002	4.435e+002	4.197e-001	8.160e-001
0.4426	1.032e+007	6.348e+001	1.024e+002	1.243e-001	2.005e-001
0.5907	6.919e+007	6.021e+002	8.937e+002	1.176e+000	1.746e+000
0.6624	2.461e+010	2.456e+005	3.540e+005	4.761e+002	6.862e+002
0.8723	1.557e+008	2.156e+003	2.924e+003	4.057e+000	5.501e+000
1.0024	3.155e+008	5.148e+003	6.796e+003	9.486e+000	1.252e+001
1.2719	4.108e+008	8.864e+003	1.121e+004	1.555e+001	1.968e+001
1.5767	3.912e+007	1.083e+003	1.326e+003	1.798e+000	2.201e+000
TOTAL:	2.875e+010	2.641e+005	3.784e+005	5.100e+002	7.313e+002

HNF-SD-WM-CN-099 REV 0

MicroShield 4.00 - Serial #4.00-00128
Westinghouse Hanford Company

Page : 1

DOS File: 1SRV_3X3.MS4

Run Date: April 10, 1997

Run Time: 8:35 a.m. Thursday

Duration: 0:02:28

File Ref: _____

Date: ____/____/____

By: _____

Checked: _____

Case Title: 1 curie (each) sr-90 & Y-90, 3X3 filter bank

GEOMETRY 11 - Rectangular Volume

	centimeters	feet	and inches
Dose point coordinate X:	184.404	6.0	.6
Dose point coordinate Y:	30.48	1.0	.0
Dose point coordinate Z:	15.24	0.0	6.0
Rectangular volume width :	30.48	1.0	.0
Rectangular volume length:	182.88	6.0	.0
Rectangular volume height:	182.88	6.0	.0
Shield 1:	1.016	0.0	.4
Air Gap:	0.508	0.0	.2

Source Volume: 1.01941e+6 cm³ 36. cu ft. 62208 cu in.

MATERIAL DENSITIES (g/cm³)

Material	Source	Shield 1	Air Gap
	Shield	Slab	
Air			0.00122
Aluminum		2.702	
glass	0.02		

BUILDUP

Method: Buildup Factor Tables
The material reference is Shield 1

INTEGRATION PARAMETERS

	Quadrature Order
X Direction	20
Y Direction	20
Z Direction	10

SOURCE WAS ENTERED AS ENERGIES ONLY

HNF-SD-WM-CN-099 REV 0

Page : 2
 DOS File: 1SRV_3X3.MS4
 Run Date: April 10, 1997
 Run Time: 8:35 a.m. Thursday
 Title : 1 curie (each) sr-90 & Y-90, 3X3 filter bank

===== RESULTS =====					
Energy (MeV)	Activity (photons/sec)	Energy Fluence Rate (MeV/sq cm/sec)		Exposure Rate In Air (mR/hr)	
		No Buildup	With Buildup	No Buildup	With Buildup
0.015	7.800e+008	7.095e-010	7.805e-010	6.086e-011	6.695e-011
0.025	4.000e+008	1.771e-001	2.301e-001	3.055e-003	3.969e-003
0.035	2.600e+008	6.812e+000	1.088e+001	4.316e-002	6.895e-002
0.045	1.800e+008	2.043e+001	3.936e+001	6.796e-002	1.309e-001
0.055	1.400e+008	3.244e+001	7.202e+001	7.302e-002	1.621e-001
0.065	1.100e+008	3.892e+001	9.585e+001	7.064e-002	1.740e-001
0.075	8.900e+007	4.200e+001	1.058e+002	6.845e-002	1.724e-001
0.085	7.400e+007	4.336e+001	1.089e+002	6.736e-002	1.692e-001
0.095	6.300e+007	4.391e+001	1.097e+002	6.719e-002	1.680e-001
0.15	3.300e+008	4.270e+002	9.586e+002	7.032e-001	1.579e+000
0.25	1.300e+008	3.164e+002	5.969e+002	5.837e-001	1.101e+000
0.35	6.900e+007	2.523e+002	4.276e+002	4.867e-001	8.249e-001
0.475	5.500e+007	2.902e+002	4.502e+002	5.694e-001	8.833e-001
0.65	3.500e+007	2.684e+002	3.829e+002	5.210e-001	7.433e-001
0.825	1.400e+007	1.423e+002	1.927e+002	2.697e-001	3.652e-001
1.0	9.800e+006	1.249e+002	1.631e+002	2.302e-001	3.006e-001
1.225	5.500e+006	8.883e+001	1.120e+002	1.572e-001	1.982e-001
1.475	2.100e+006	4.205e+001	5.154e+001	7.107e-002	8.711e-002
1.7	5.300e+005	1.249e+001	1.502e+001	2.028e-002	2.440e-002
1.9	1.400e+005	3.744e+000	4.443e+000	5.882e-003	6.980e-003
2.1	1.500e+004	4.492e-001	5.267e-001	6.840e-004	8.021e-004
2.3	8.300e+001	2.753e-003	3.195e-003	4.071e-006	4.725e-006
TOTAL:	2.747e+009	2.197e+003	3.898e+003	4.080e+000	7.164e+000

HNF-SD-WM-CN-099 REV 0

MicroShield 4.00 - Serial #4.00-00128
Westinghouse Hanford Company

Page : 1
DOS File: 1SRV.PRE.MS4
Run Date: April 14, 1997
Run Time: 2:04 p.m. Monday
Duration: 0:02:40

File Ref: _____
Date: ____/____/____
By: _____
Checked: _____

Case Title: 1 curie (each) sr-90 & y-90, 3x3 bank 1x1 prefilters

GEOMETRY 11 - Rectangular Volume

	centimeters	feet and inches
Dose point coordinate X:	184.404	6.0 .6
Dose point coordinate Y:	30.48	1.0 .0
Dose point coordinate Z:	3.175	0.0 1.3
Rectangular volume width :	6.35	0.0 2.5
Rectangular volume length:	182.88	6.0 .0
Rectangular volume height:	182.88	6.0 .0
Shield 1:	1.016	0.0 .4
Air Gap:	0.508	0.0 .2

Source Volume: 212376. cm³ 7.5 cu ft. 12960 cu in.

MATERIAL DENSITIES (g/cm³)

Material	Source Shield	Shield 1 Slab	Air Gap
Air			0.00122
Aluminum	0.03	2.702	
glass	0.02		

BUILDUP

Method: Buildup Factor Tables
The material reference is Shield 1

INTEGRATION PARAMETERS

	Quadrature Order
X Direction	20
Y Direction	20
Z Direction	10

SOURCE WAS ENTERED AS ENERGIES ONLY

HNF-SD-WM-CN-099 REV 0

Page : 2
 DOS File: 1SRV PRE.MS4
 Run Date: April 14, 1997
 Run Time: 2:04 p.m. Monday
 Title : 1 curie (each) sr-90 & y-90, 3x3 bank 1x1 prefilters

===== RESULTS =====					
Energy (MeV)	Activity (photons/sec)	Energy Fluence Rate (MeV/sq cm/sec)		Exposure Rate In Air (mR/hr)	
		No Buildup	With Buildup	No Buildup	With Buildup
0.015	7.800e+008	3.095e-010	3.407e-010	2.654e-011	2.923e-011
0.025	4.000e+008	1.824e-001	2.374e-001	3.147e-003	4.095e-003
0.035	2.600e+008	7.685e+000	1.233e+001	4.868e-002	7.811e-002
0.045	1.800e+008	2.410e+001	4.686e+001	8.016e-002	1.558e-001
0.055	1.400e+008	3.921e+001	8.827e+001	8.824e-002	1.987e-001
0.065	1.100e+008	4.766e+001	1.194e+002	8.652e-002	2.167e-001
0.075	8.900e+007	5.185e+001	1.333e+002	8.450e-002	2.172e-001
0.085	7.400e+007	5.379e+001	1.383e+002	8.356e-002	2.149e-001
0.095	6.300e+007	5.465e+001	1.401e+002	8.363e-002	2.144e-001
0.15	3.300e+008	5.359e+002	1.236e+003	8.824e-001	2.035e+000
0.25	1.300e+008	3.992e+002	7.716e+002	7.365e-001	1.424e+000
0.35	6.900e+007	3.193e+002	5.528e+002	6.160e-001	1.066e+000
0.475	5.500e+007	3.683e+002	5.818e+002	7.226e-001	1.142e+000
0.65	3.500e+007	3.415e+002	4.945e+002	6.629e-001	9.600e-001
0.825	1.400e+007	1.814e+002	2.488e+002	3.438e-001	4.715e-001
1.0	9.800e+006	1.594e+002	2.106e+002	2.939e-001	3.881e-001
1.225	5.500e+006	1.136e+002	1.446e+002	2.010e-001	2.560e-001
1.475	2.100e+006	5.384e+001	6.655e+001	9.099e-002	1.125e-001
1.7	5.300e+005	1.600e+001	1.940e+001	2.599e-002	3.151e-002
1.9	1.400e+005	4.800e+000	5.736e+000	7.541e-003	9.013e-003
2.1	1.500e+004	5.762e-001	6.801e-001	8.774e-004	1.036e-003
2.3	8.300e+001	3.533e-003	4.125e-003	5.225e-006	6.100e-006
TOTAL:	2.747e+009	2.773e+003	5.012e+003	5.143e+000	9.196e+000

HNF-SD-WM-CN-099 REV 0

MicroShield 4.00 - Serial #4.00-00128

Westinghouse Hanford Company

Page : 1

DOS File: AWF 221.MS4

Run Date: April 10, 1997

Run Time: 8:37 a.m. Thursday

Duration: 0:00:52

File Ref: _____

Date: ____/____/____

By: _____

Checked: _____

Case Title: 1 liter awf solids on 2x2x1 filter for ay102

GEOMETRY 11 - Rectangular Volume

	centimeters	feet	and inches
Dose point coordinate X:	62.484	2.0	.6
Dose point coordinate Y:	30.48	1.0	.0
Dose point coordinate Z:	15.24	0.0	6.0
Rectangular volume width :	30.48	1.0	.0
Rectangular volume length:	60.96	2.0	.0
Rectangular volume height:	60.96	2.0	.0
Shield 1:	0.2032	0.0	.1
Air Gap:	1.3208	0.0	.5

Source Volume: 113267. cm³ 4 cu ft. 6912. cu in.

MATERIAL DENSITIES (g/cm³)

Material	Source Shield	Shield 1 Slab	Air Gap
Air			0.00122
Aluminum	0.03	2.702	
glass	0.02		

BUILDUP

Method: Buildup Factor Tables

The material reference is Shield 1

INTEGRATION PARAMETERS

	Quadrature Order
X Direction	20
Y Direction	20
Z Direction	10

SOURCE NUCLIDES

Nuclide	curies	μCi/cm ³	Nuclide	curies	μCi/cm ³
Ba-137m	2.5060e+000	2.2125e+001	Co-60	1.3240e-002	1.1689e-001
Eu-154	2.9700e-001	2.6221e+000			

Page : 2
 DOS File: AWF_221.MS4
 Run Date: April 10, 1997
 Run Time: 8:37 a.m. Thursday
 Title : 1 liter awf solids on 2x2x1 filter for ay102

===== RESULTS =====					
Energy (MeV)	Activity (photons/sec)	Energy Fluence Rate (MeV/sq cm/sec)		Exposure Rate In Air (mR/hr)	
		No Buildup	With Buildup	No Buildup	With Buildup
0.0571	1.580e+010	6.170e+004	9.770e+004	1.312e+002	2.078e+002
0.246	7.505e+008	1.705e+004	2.188e+004	3.136e+001	4.026e+001
0.4426	1.022e+008	4.372e+003	5.183e+003	8.562e+000	1.015e+001
0.5907	6.849e+008	3.992e+004	4.581e+004	7.799e+001	8.949e+001
0.6639	8.647e+010	5.709e+006	6.477e+006	1.106e+004	1.255e+004
0.8723	1.542e+009	1.362e+005	1.510e+005	2.562e+002	2.842e+002
1.0024	3.124e+009	3.198e+005	3.513e+005	5.893e+002	6.473e+002
1.2613	4.557e+009	5.950e+005	6.440e+005	1.046e+003	1.132e+003
1.3325	4.899e+008	6.779e+004	7.314e+004	1.176e+002	1.269e+002
1.5767	3.873e+008	6.400e+004	6.843e+004	1.062e+002	1.136e+002
TOTAL:	1.139e+011	7.015e+006	7.935e+006	1.343e+004	1.520e+004

HNF-SD-WM-CN-099 REV 0

MicroShield 4.00 - Serial #4.00-00128

Westinghouse Hanford Company

Page : 1

DOS File: AWF_3X3.MS4

Run Date: April 10, 1997

Run Time: 8:39 a.m. Thursday

Duration: 0:01:03

File Ref: _____

Date: ____/____/____

By: _____

Checked: _____

Case Title: 1 liter awf solids, 3X3 filter bank

GEOMETRY 11 - Rectangular Volume

	centimeters	feet and inches
Dose point coordinate X:	184.404	6.0 .6
Dose point coordinate Y:	30.48	1.0 .0
Dose point coordinate Z:	15.24	0.0 6.0
Rectangular volume width :	30.48	1.0 .0
Rectangular volume length:	182.88	6.0 .0
Rectangular volume height:	182.88	6.0 .0
Shield 1:	1.016	0.0 .4
Air Gap:	0.508	0.0 .2

Source Volume: 1.01941e+6 cm³ 36. cu ft. 62208 cu in.

MATERIAL DENSITIES (g/cm³)

Material	Source	Shield 1	Air Gap
	Shield	Slab	
Air			0.00122
Aluminum		2.702	
glass	0.02		

BUILDUP

Method: Buildup Factor Tables

The material reference is Shield 1

INTEGRATION PARAMETERS

	Quadrature Order
X Direction	20
Y Direction	20
Z Direction	10

SOURCE NUCLIDES

Nuclide	curies	μCi/cm ³	Nuclide	curies	μCi/cm ³
Ba-137m	2.5060e+000	2.4583e+000	Co-60	1.3240e-002	1.2988e-002
Eu-154	2.9700e-001	2.9135e-001			

HNF-SD-WM-CN-099 REV 0

Page : 2
 DOS File: AWF_3X3.MS4
 Run Date: April 10, 1997
 Run Time: 8:39 a.m. Thursday
 Title : 1 liter awf solids, 3X3 filter bank

===== RESULTS =====					
Energy (MeV)	Activity (photons/sec)	Energy Fluence Rate (MeV/sq cm/sec)		Exposure Rate In Air (mR/hr)	
		No Buildup	With Buildup	No Buildup	With Buildup
0.0571	1.580e+010	4.064e+003	9.288e+003	8.644e+000	1.975e+001
0.246	7.505e+008	1.790e+003	3.397e+003	3.294e+000	6.249e+000
0.4426	1.022e+008	4.955e+002	7.844e+002	9.704e-001	1.536e+000
0.5907	6.849e+008	4.688e+003	6.850e+003	9.158e+000	1.338e+001
0.6639	8.647e+010	6.799e+005	9.651e+005	1.318e+003	1.870e+003
0.8723	1.542e+009	1.674e+004	2.242e+004	3.149e+001	4.218e+001
1.0024	3.124e+009	3.992e+004	5.211e+004	7.355e+001	9.601e+001
1.2613	4.557e+009	7.613e+004	9.554e+004	1.338e+002	1.680e+002
1.3325	4.899e+008	8.724e+003	1.085e+004	1.514e+001	1.883e+001
1.5767	3.873e+008	8.373e+003	1.017e+004	1.390e+001	1.688e+001
TOTAL:	1.139e+011	8.408e+005	1.176e+006	1.608e+003	2.253e+003

HNF-SD-WM-CN-099 REV 0

MicroShield 4.00 - Serial #4.00-00128

Westinghouse Hanford Company

Page : 1

DOS File: AWF_PRE.MS4

Run Date: April 14, 1997

Run Time: 2:11 p.m. Monday

Duration: 0:01:11

File Ref: _____

Date: ____/____/____

By: _____

Checked: _____

Case Title: 1 liter awf solids, 3x3 bank 1x1 prefilters

GEOMETRY 11 - Rectangular Volume

	centimeters	feet	and inches
Dose point coordinate X:	184.404	6.0	.6
Dose point coordinate Y:	30.48	1.0	.0
Dose point coordinate Z:	3.175	0.0	1.3
Rectangular volume width :	6.35	0.0	2.5
Rectangular volume length:	182.88	6.0	.0
Rectangular volume height:	182.88	6.0	.0
Shield 1:	1.016	0.0	.4
Air Gap:	0.508	0.0	.2

Source Volume: 212376. cm³ 7.5 cu ft. 12960 cu in.

MATERIAL DENSITIES (g/cm³)

Material	Source Shield	Shield 1 Slab	Air Gap
Air			0.00122
Aluminum	0.03	2.702	
glass	0.02		

BUILDUP

Method: Buildup Factor Tables

The material reference is Shield 1

INTEGRATION PARAMETERS

	Quadrature Order
X Direction	20
Y Direction	20
Z Direction	10

SOURCE NUCLIDES

Nuclide	curies	$\mu\text{Ci/cm}^3$	Nuclide	curies	$\mu\text{Ci/cm}^3$
Ba-137m	2.5060e+000	1.1800e+001	Co-60	1.3240e-002	6.2342e-002
Eu-154	2.9700e-001	1.3985e+000			

HNF-SD-WM-CN-099 REV 0

Page : 2
 DOS File: AWF PRE.MS4
 Run Date: April 14, 1997
 Run Time: 2:11 p.m. Monday
 Title : 1 liter awf solids, 3x3 bank 1x1 prefilters

===== RESULTS =====					
Energy (MeV)	Activity (photons/sec)	Energy Fluence Rate (MeV/sq cm/sec)		Exposure Rate In Air (mR/hr)	
		No Buildup	With Buildup	No Buildup	With Buildup
0.0571	1.580e+010	4.929e+003	1.143e+004	1.048e+001	2.430e+001
0.246	7.505e+008	2.259e+003	4.391e+003	4.155e+000	8.078e+000
0.4426	1.022e+008	6.285e+002	1.014e+003	1.231e+000	1.985e+000
0.5907	6.849e+008	5.960e+003	8.848e+003	1.164e+001	1.728e+001
0.6639	8.647e+010	8.652e+005	1.246e+006	1.677e+003	2.416e+003
0.8723	1.542e+009	2.134e+004	2.894e+004	4.016e+001	5.446e+001
1.0024	3.124e+009	5.097e+004	6.728e+004	9.391e+001	1.240e+002
1.2613	4.557e+009	9.737e+004	1.234e+005	1.712e+002	2.169e+002
1.3325	4.899e+008	1.116e+004	1.401e+004	1.936e+001	2.431e+001
1.5767	3.873e+008	1.072e+004	1.313e+004	1.780e+001	2.179e+001
TOTAL:	1.139e+011	1.071e+006	1.519e+006	2.047e+003	2.909e+003

ATTACHMENT 2: VENTILATION SYSTEM DISCUSSION

There are four ventilation systems that could be involved in the W-320 sluicing operations. These are the existing system for Tank 241-C-106 (296-P-16), the new ventilation system for Tank 241-C-106 (296-C-006), the existing system for Tank 241-AY-102 (241-702-A), and the new ventilation system for Tank 241-AY-102 (241-702-AZ). The following table lists the flow rates for each of the systems.

Table 1. Ventilation Flow Rates for the Various Ventilation Systems

System	System flow rate, L/s (scfm)
296-P-16	3.30×10^3 (7000)†
296-C-006	4.06×10^2 (860)‡
241-702-A	1.89×10^3 (4000)♣
241-702-AZ	2.36×10^2 (500)♠

†The exhauster is rated for this flow, however, it is currently operated at approximately 1132.67 L/s (2400 scfm).

‡This is the recirculation flow rate. The bleed off flow rate, i.e., the flow actually exhausted to the atmosphere is 169.90 L/s (360 scfm). Note: the 296-P-16 flow rate is bounding and was used for this analysis.

♣The exhauster is rated for this flow and services four tanks. Individual tank measurements are not taken.

♠This is the recirculation flow rate for one tank. The bleed off flow rate for one tank, i.e., the flow actually exhausted to the atmosphere is 47.19 L/s (100 scfm). Since the recirculation mode can be bypassed the total flow rate for the new system is 942 L/s (2000 scfm).

ATTACHMENT 3: PEER REVIEW CHECKLIST

CHECKLIST FOR PEER REVIEW

Document Reviewed: HNF-SD-WM-CN-099, Rev. 0, *Radiological and Toxicological Calculations for Tank 241-AY-102 and Tank 241-C-106 HEPA Filters and Prefilters*

Scope of Review: Entire document.

Yes No NA

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

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.

DISTRIBUTION SHEET

To	From	Page 1 of 1
Project W-320 DE&S Hanford, Inc.	Fluor Daniel Northwest Safety Analysis & Risk Assessment	Date 06/27/97
Project Title/Work Order		EDT No. 621243
Radiological and Toxicological Calculations for AY-102 and C-106 HEPA Filters and Prefilters		ECN No. N/A

Name	MSIN	Text With All Attach.	Text Only	Attach./ Appendix Only	EDT/ECN Only
J.C. Conner	A2-25	X			
J.P. Harris	S2-48	X			
B.E. Hey	A3-34	X			
R.J. Van Vleet	A3-34	X			
S. R. Gedeon	H0-35	X			
Central Files	A3-88	X (Original + 1)			
Docket Files	B1-17	X (2)			
TWRS S&L Files	A2-26	X (2)			