EVALUATION OF A METHOD TO CALCULATE THE SUM-OF-FRACTIONS FOR MULTIPLE RADIONUCLIDES THAT USES AQUIFER CONCENTRATIONS OF RADIONUCLIDES THAT CHANGE WITH RESPECT TO TIME

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Rev. 0

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DISCLAIMER

REVIEWS AND APPROVALS

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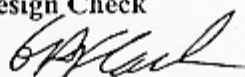
L. B. Collard _____ 9/26/02

Leonard B. Collard, Waste Processing Technology _____ Date
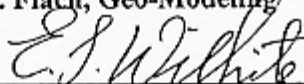
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G.P. Flach, Geo-Modeling _____ Date

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(per Manual E7, Procedure 2.40)
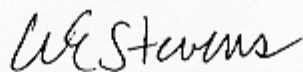
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B.T. Butcher _____ 9/30/02

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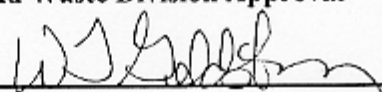
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μCi	microcuries
Ci	curie
DOE	U.S. Department of Energy
E	exponential notation (e.g., 5E-10 = 5×10^{-10} = 0.0000000005)
ER	Environmental Restoration
ETF	Effluent Treatment Facility
ft	feet
g	gram
K_d	sorption coefficient
L	liters
Log	logarithm
m	meters
MCL	maximum contaminant level
ml	milliliters
PA	performance assessment
pCi	picocuries
SA	special analysis
U.S.	United States
WSRC	Westinghouse Savannah River Company
yr	year

1.   EXECUTIVE SUMMARY

This report evaluates a new method to calculate the sum-of-fractions (SOF) for multiple radionuclides. The purpose of this report is to determine the potential benefits of the new method for the first set of five slit trenches. Actual data were employed, although they are not up-to-date because of changing inventory levels during report preparation.

The current method for calculating the SOF relies on the minimum inventory limit established for any scenario - residential, agricultural, air, radon, post-drilling, groundwater (aquifer). The new method (explained with an example in Section 2) calculates a separate SOF for each scenario and selects the maximum SOF as the replacement for the SOF calculated by the current method.

Furthermore, multiple SOFs are calculated for the aquifer scenario. Aquifer concentrations are sliced into multiple time intervals producing aquifer sub-scenarios, each with its own local peak concentration. Each aquifer sub-scenario is treated like the aquifer scenario - a single peak aquifer concentration is selected to calculate the inventory limit for that aquifer sub-scenario. The maximum SOF from among all the aquifer sub-scenario SOFs is selected to replace the aquifer scenario SOF. For this initial evaluation, aquifer concentrations were conveniently separated into three time intervals as follows:
- 0-100 years
- 101-1000 years
- 1001-10,000 years.

This method initially was applied to the first set of five slit trenches for the six radionuclides that contributed more than 96% to the SOF. The proposed method reduced the SOF by about 7%. However, the proposed method has the potential to allow much more contamination to be disposed versus the current method, because waste that does not affect the limiting scenario (see Section 2) will not change the SOF.

The current work extends the initial scope by developing a computer program to perform the calculations for all radionuclides listed in the inventory. Available data for the Intermediate Level Vault (ILV) were input to the program for testing. Using inventories from April 24, 2002 (Sink, 2002), the proposed method calculated a SOF of 0.168, a reduction of about 50 percent from the current SOF of 0.337.

2.   INTRODUCTION

This report evaluates a new method to calculate the sum-of-fractions (SOF) for multiple radionuclides. The new method incorporates the fact that aquifer concentrations of radionuclides change with respect to time. Furthermore, this report extends beyond the initial scope by calculating separate SOFs for each scenario. An example of applying the current method and the new method follows.

Assume that only two radionuclides contribute to the SOF, Radionuclide 1 and Radionuclide 2. Further, assume that only two scenarios are applicable, the Residential Scenario and a drinking water scenario, the Aquifer Scenario. The current method selects the lowest inventory limit from all the scenarios and the SOF is calculated on that basis in Table 1.

On the other hand, each scenario is generally independent of the other scenarios (e.g., the intruder during a residential scenario at 100 years is not the same intruder during an agricultural scenario at 700 years). If two scenarios are independent of each other, then the SOF can be calculated for each scenario. The maximum scenario SOF becomes the SOF for the new method, as shown in Table 2. The SOF was reduced from 0.83 to 0.75 by isolating the scenarios.

Table 1. SOF for example with current method

Radionuclide	Inventory (Ci)	Resident Limit (Ci)	Aquifer Limit (Ci)	Current Method Limit (Ci)	Current Method Fraction
Radionuclide 1	1	3	4	3	0.33
Radionuclide 2	1	4	2	2	0.50
Sum-of-Fractions					0.83

Table 2. SOF for example with new method

Radionuclide	Inventory (Ci)	Resident Limit (Ci)	Aquifer Limit (Ci)		Resident Fraction	Aquifer Fraction	New Method Fraction
Radionuclide 1	1	3	4		0.33	0.25	
Radionuclide 2	1	4	2		0.25	0.50	
Sum-of-Fractions					0.58	0.75	0.75

The inventory limits for the Aquifer Scenario are calculated by dividing the Maximum Contaminant Level (MCL) by the peak aquifer concentration and multiplying by the 1 Ci inventory that was assumed for the model. A hypothetical plot of aquifer concentrations versus time for the two radionuclides is shown in Figure 1. In this figure only one time slice is considered – the entire modeling duration. Calculations of inventory limits for this figure are shown in Table 3.

Figure 1. Plot of hypothetical aquifer concentrations for example with one time slice

Table 3. Inventory limit for example aquifer scenario with current method

Radionuclide	Inventory (Ci)	Peak Concentration (pCi/L)	MCL (pCi/L)	Current Method Aquifer Limit (Ci)
Radionuclide 1	1	10	40	4
Radionuclide 2	1	6	12	2

If the time is sliced into more intervals, conservatism can be reduced as the effect of the combined peaks becomes more accurate. In Figure 2 the time is sliced into two intervals. Each time interval is considered to be a sub-scenario. Calculation of the inventory limits for the aquifer sub-scenarios is shown in Table 4.

Peaks for Time Interval 1

Peaks for Time Interval 2

Radionuclide 1

Radionuclide 2
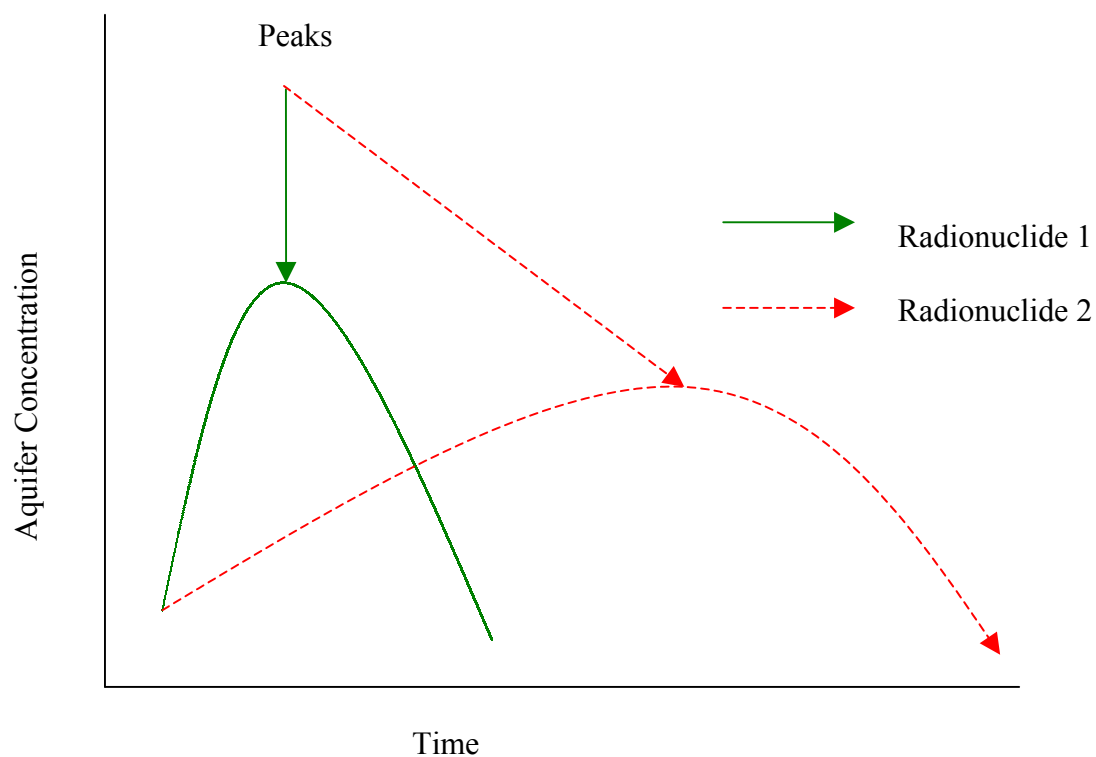
Aquifer Concentration
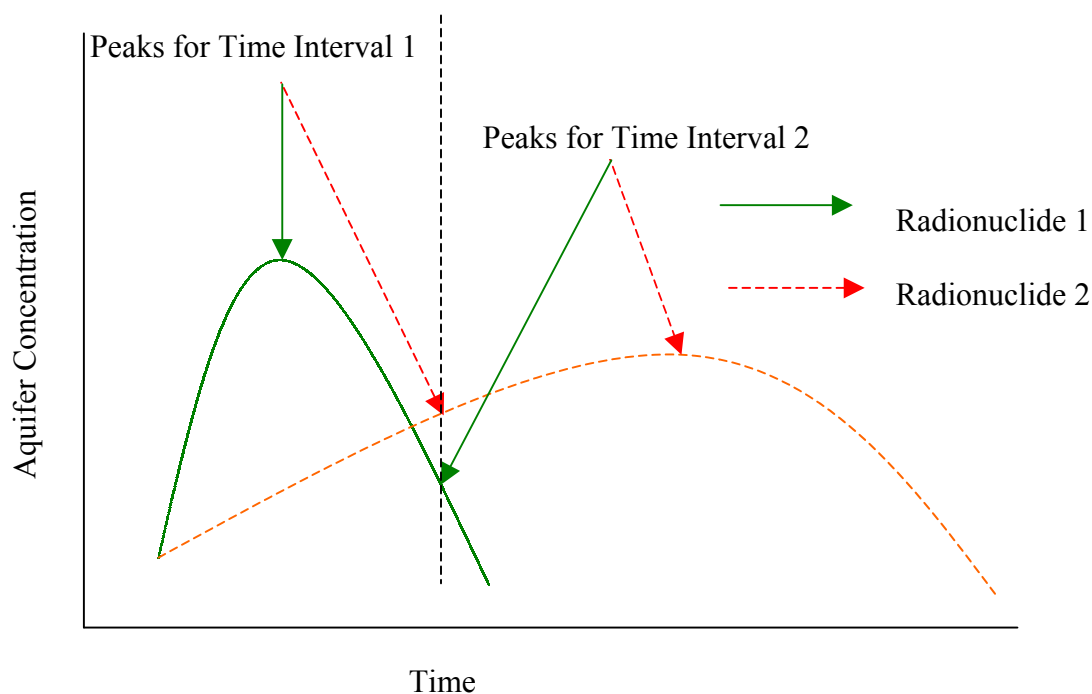
Time

Figure 2. Plot hypothetical of aquifer concentrations for example with two time slices

Table 4. Inventory limit for example aquifer sub-scenarios with new method

Radionuclide	Inventory (Ci)	Time Interval 1 Peak Concentration (pCi/L)	Time Interval 2 Peak Concentration (pCi/L)	MCL (pCi/L)	Time Interval 1 New Method Aquifer Limit (Ci)	Time Interval 1 New Method Aquifer Limit (Ci)
Radionuclide 1	1	10	2	40	4	20
Radionuclide 2	1	3	6	12	4	2

The inventory limits for the aquifer sub-scenarios replace the inventory limit for the aquifer scenario during calculation of the SOF. The SOF calculated by the new method for the example is shown in Table 5.

Table 5 SOF for example with new method using aquifer sub-scenarios

Radionuclide	Inventory (Ci)	Resident Limit (Ci)	Time Interval 1 Aquifer Limit (Ci)	Time Interval 2 Aquifer Limit (Ci)	Resident Fraction	Time Interval 1 Aquifer Fraction	Time Interval 2 Aquifer Fraction	New Method Fraction
Radionuclide 1	1	3	4	20	0.33	0.25	0.05	
Radionuclide 2	1	4	4	2	0.25	0.25	0.50	
Sum-of-Fractions					0.58	0.50	0.55	0.58

The SOF with the current method was 0.83. Calculations for isolated scenarios reduced the SOF to 0.75. Calculations for slicing the aquifer results into different time intervals further reduced the SOF to 0.58.

The maximum utility for time slicing occurs when two radionuclides exhibit concentration curves that do not intersect. An example is shown in Figure 3. If all other scenarios can be ignored and if the new method is applied, then the inventory of Radionuclide 1 can match its inventory limit and the inventory of Radionuclide 2 can match its inventory limit. Under the current method if equivalent amounts of inventory are consumed by each radionuclide, then the inventory of Radionuclide 1 can only be ½ of its inventory limit and the inventory of Radionuclide 2 can only be ½ of its inventory limit. In the former case of the new method, the SOF is 1.0 for each radionuclide, but those two SOFs are not additive. In the latter case of the current method the SOFs are additive, thus neither can exceed 0.5
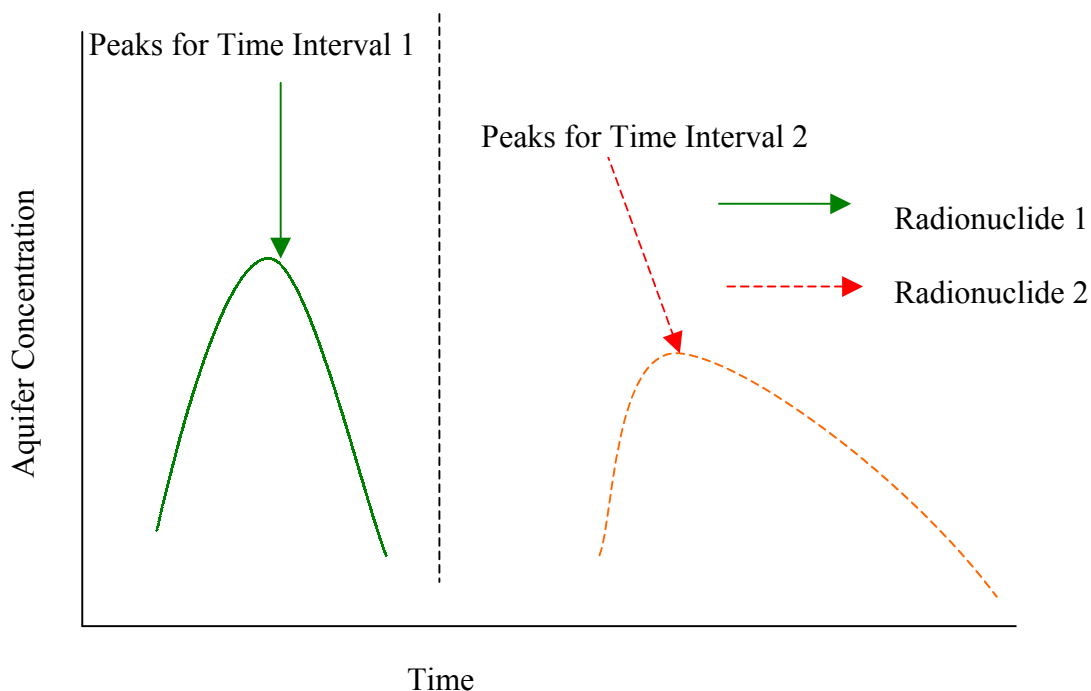
Figure 3. Plot of non-intersecting hypothetical aquifer concentrations for example with two time slices

For the initial evaluation of the new method and for the sake of convenience, aquifer concentrations were separated into three time intervals as follows:
1. 0-100 years
2. 101-1000 years
3. 1001-10,000 years.

The maximum aquifer concentration within a time interval was assumed to apply for all times in that time interval. For example, if the aquifer concentration during the second time interval (101-1000 years) ranged from 1 pCi/L to 10 pCi/L, then 10 pCi/L was assumed to replace all concentrations during that time interval.

The principles of the simplified example are easily extended to include multiple radionuclides, scenarios and aquifer sub-scenarios. These extensions are discussed in the next section.

3.   IMPLEMENTATION OF NEW METHOD

The SOF for the new method is calculated using all radionuclides in inventory. However, for ease of discussion, the major contributors to the SOF for the first set of five slit trenches were examined. Table 6 shows the total SOF as of March 25, 2002 (Sink, 2002) and the radionuclides that contribute at least 0.01 percent (1E-4 as a fraction) to the total SOF. From this list a subset of radionuclides that contribute at least 1 percent (1E-2 as a fraction) was further evaluated. This subset contributes 0.775 as a SOF versus the total SOF of 0.801, which is 97% of the SOF on a percentage basis.

Table 6. Major Contributors to the SOF for First Set of Slit Trenches

Radionuclide	First Set of Slit Trenches Inventory as of 3/25/02 (Ci)	PA Revision With Adj. Wood Limits (Ci)	Fraction Of Limit
H3	4.35688E+00	6.3E+00	6.92E-01
I129	1.43392E-05	5.2E-04	2.76E-02
PU239	1.56353E-02	8.8E-01	1.78E-02
I129J	2.46160E-05	1.6E-03	1.53E-02
NP237	5.58829E-04	4.8E-02	1.16E-02
U238	5.67228E-02	5.0E+00	1.13E-02
Sum-of-Fraction for above subset			**7.75E-01**
TC99	3.64022E-03	5.5E-01	6.62E-03
SR90	3.05676E+00	5.2E+02	5.88E-03
PU240	4.76679E-03	1.1E+00	4.33E-03
C14	6.35895E-03	2.7E+00	2.36E-03
PU242	3.46535E-05	1.6E-02	2.17E-03
TH232	2.34134E-03	1.3E+00	1.80E-03
U236	1.74287E-03	2.0E+00	8.71E-04
PU238	1.70087E-01	2.6E+02	6.54E-04
CS137	6.66725E+00	2.1E+04	3.17E-04
U234	3.66170E-02	1.8E+02	2.03E-04
AM241	2.38723E-02	2.2E+02	1.09E-04
Sum-of-Fraction for above radionuclides			**8.00E-01**
Sum-of-Fraction for all radionuclides			**8.01E-01**

To determine the inventory limit for each aquifer's sub-scenario, the aquifer concentrations in modeling output files were examined. The peak aquifer concentrations for each time interval are provided in Table 7.

Table 7. Aquifer Concentrations by Radionuclide and Time Interval for Slit Trenches

	Peak Aquifer Concentration (pCi/L)		
Radionuclide	0-100 years	101-1000 years	1001-10,000 years
H-3	1587	8	0[1]
I-129	477	139	0[1]
Pu-239	0[1]	0[1]	4.2
I-129J[2] (F-Area filtercake)	9.9	155.7	0
Np-237	2.8E-2	92.3	0[1]
U-238	0[1]	12.0	14.1

[1]No value in data files because finding global peak value was emphasized
[2]Used I-129 with K_d of 50 ml/g as a surrogate for K_d of 56.7 ml/g (Collard, 2001)
(Table values are explicit values from modeling output files without linear interpolation)

An alternative method to calculate the inventory limit (Inv_i) for the ith specific time interval is

$$Inv_i = Inv_{PA} \times Maximum(C) / peak\ C_i$$

where

Inv_{PA} is the inventory limit from the Performance Assessment (PA, McDowell-Boyer, et al., 2000), revised for the effect of wood products (Cook, 2000). These limits were selected to match those provided in Table 6.

Maximum C is the maximum concentration over all time intervals, and

Peak C_i is the peak aquifer concentration for the ith time interval.

Inventory limits for each time interval of the aquifer sub-scenarios are provided in Table 8. Table 8 also includes inventory limits for all other scenarios.

Table 8. Inventory Limit by Radionuclide and Scenario for First Set of Slit Trenches using Proposed Method

	Inventory Limit for 5 Slit Trenches (Ci)[1]						
Radionuclide	Air	Post-Drill	Res. – 100 yr	Ag. - 700 yr	Aq. 1	Aq. 2	Aq. 3
H-3	3.2E5	NA	NA	NA	6.30E+00	1.25E+03	NA
I-129	NA	4.4E7	NA	NA	5.20E-04	1.78E-03	NA
Pu-239	NA	1.1E3	NA	3.1E3	NA	NA	8.80E-01
I-129J[2]	NA	320	NA	NA	2.53E-02	1.61E-03	NA
Np-237	NA	210		9.1E7	3.00E+02	9.10E-02	NA
U-238	NA	4.8E3	1.9E6	1E4	NA	5.88E+00	5.00E+00

[1]Radon is not applicable for any of the above radionuclides and no limit is listed
[2]F-Area filtercake with I-129 K_d of 50ml/g used as a surrogate for K_d of 56.7 ml/g
(Table values from Cook, 2000.)

The inventory consumption fraction for a specific radionuclide in a specific scenario is calculated by dividing the inventory by its inventory limit for that scenario. The SOF for that scenario is

calculated by summing the inventory consumption factors for all radionuclides. Table 9 shows the inventory consumption factors and the SOF by scenario for the most important radionuclides for the first set of slit trenches.

Table 9. Fractions and SOF by Scenario for First Set of Slit Trenches using Proposed Method

Radionuclide	Inv (Ci)	Fractions Air	Drill	Res.	Ag.	Aq. 1	Aq. 2	Aq. 3
H-3	4.36E+00	1.36E-05				6.92E-01	3.49E-03	
I-129	1.43E-05		3.26E-13			2.76E-02	8.04E-03	
Pu-239	1.56E-02		1.42E-05		5.04E-06			1.78E-02
I-129J	2.46E-05		7.69E-08			9.72E-04	1.53E-02	
Np-237	5.59E-04		2.66E-06		6.14E-12	1.86E-06	6.14E-03	
U-238	5.67E-02		1.18E-05	2.99E-08	5.67E-06		9.65E-03	1.13E-02
SOF for above nuclides		1.36E-05	2.88E-05	2.99E-08	1.07E-05	7.20E-01	4.26E-02	2.91E-02

The aquifer sub-scenario during the first time interval produces the highest SOF of 0.720. This results in a reduction of 0.07 (or 7 percent) from 0.775 calculated using the current method.

The second part of this evaluation was to commence development of a computer program to automate the calculations, because the proposed method introduces complexities, e.g., the number of time intervals could become quite extensive. The first phase of the computer program has been completed. The dialog box from the computer program (TimeSOF) is shown in Figure 4.

Figure 4. Dialog Box for TimeSOF Computer Program that Calculates Timed SOF

Data from the Intermediate Level Vault were input to the database that the computer program reads. The current method for the SOF produces the results shown in Table 10 for those radionuclides that contribute 99% of the total SOF.

Table 10. Intermediate Level Vault Inventories and Sum-Of-Fractions

Radionuclide	ILV Inventory as of 4/24/02 (Ci)	Existing PA Limit (Ci)	Fraction Of Limit
I129	3.5588E-05	2.6E-04	1.37E-01
C14	2.9991E-01	2.7E+00	1.11E-01
I129C	1.9920E-03	7.1E-02	2.81E-02
U233D	1.1198E-01	7.0E+00	1.60E-02
U234	2.2547E-01	1.5E+01	1.50E-02
U238	5.7269E-01	4.9E+01	1.17E-02
H3	4.6612E+05	5.5E+07	8.47E-03
PU244	1.1560E-02	3.1E+00	3.73E-03
TC99	5.2962E-02	2.2E+01	2.41E-03
U235D	6.0500E-03	6.0E+00	1.01E-03
SN126	4.8512E-04	7.5E-01	6.47E-04
U233	4.1364E-03	7.0E+00	5.91E-04
U235	2.1846E-03	6.0E+00	3.64E-04
NP237	1.5361E-03	6.0E+00	2.56E-04
CS137	1.5115E+02	6.5E+05	2.33E-04
Sum-of-Fraction for above radionuclides			**3.36E-01**
Sum-of-Fraction for all radionuclides			**3.37E-01**

I129C is the ETF Activated Carbon Vessels

Results from the computer program for the proposed method are presented in Table 11. (Results for the ETF Activated Carbon Vessels were manually added to the computer results, because the ETF vessel information is not currently in the computer database.) The current method shows a SOF of 0.337, while the proposed method shows a SOF of 0.168, a reduction of about 50 percent.

Table 11. Important Fractions and SOF from Computer Program for Intermediate Level Vault with Proposed Method

Radionuclide	Inv (Ci)	Fractions Air	Radon	Res. 100 yr	Res. 10000 yr	Aq. 1	Aq. 2	Aq. 3
C-14	2.99910E-01	1.10E-01						
U-234	2.25470E-01		1.50E-02					
U-233D	1.11980E-01				1.60E-02			
U-238	5.72690E-01				1.10E-02			
I-129	3.55880E-05							1.38E-01
I-129C	1.99200E-03							2.79E-02
SOF for above radionuclides		1.10E-01	1.50E-02	0.00E+00	2.70E-02	0.00E+00	0.00E+00	1.66E-01
SOF for all radionuclides		1.20E-01	1.50E-02	1.00E-06	4.30E-02	4.00E-10	2.00E-06	1.68E-01

4.   SUMMARY AND CONCLUSIONS

The proposed method for calculating the SOF involved two changes to the current method. First, the aquifer scenario was sliced into multiple time intervals that represent sub-scenarios. In this report, three time intervals were selected, but the number of time intervals can be increased.

The second change was that a SOF was calculated for each scenario. This change bears the intrinsic assumption that the receptor for each scenario is different. Obviously, the resident at 100 years is different than the receptor at 10,000 years. The groundwater scenario is based on the MCL, thus it is independent of the other scenarios for the purpose of calculating the SOF. The air and radon scenarios are independent by definition, not time.

The proposed method produced a SOF for the slit trenches that was only 7 percent lower than the SOF calculated with the current method. However, disposing of selected waste that has minimal impact on the SOF for the dominant scenario would allow substantially more waste to be disposed under the proposed SOF method. Meanwhile, the proposed SOF method would reduce the SOF by 50 percent for contaminants in the Intermediate Level Vault. Other disposal facilities were not evaluated because the scope of work was limited to the first set of five slit trenches.

4.1   Recommendations

The proposed method of calculating SOFs presents an opportunity to reduce conservatisms, generally allowing more curies of contaminants to be disposed in the same volume. Increasing allowable contaminant inventories for one disposal facility will not affect other disposal facilities, because each disposal facility has a SOF that is independent of all others.

It is recommended that the proposed method be adopted for all facilities where a substantial benefit would be achieved. Facilities that are constrained such that the entire volume could not be filled without exceeding the SOF are candidates for applying the proposed method. If a facility has no such constraint, then there is no need to use a more sophisticated method to calculate the SOF.

Solid Waste would need to implement the proposed method in WITS. WITS could include the algorithms from TimeSOF or it could access TimeSOF as an external program. Because several months will be required to modify WITS, it is recommended that the computer program that calculates the proposed method (TimeSOF) be completed independent of WITS and that its database be fully populated. TimeSOF could be independently operated for three to six months to find and fix any errors. Any recommended changes to the algorithms that calculate the SOF for aquifer slicing and isolated scenarios could be incorporated and tested before modifying WITS.

4.2   Further Work

If it is decided to adopt the proposed method, then the first step is to select the facilities to which the proposed method will apply. The first set of slit trenches is not operating at this time. Thus the first set of slit trenches is an ideal first candidate for full implementation, because it would provide static information for fully testing computer programs without affecting day-to-day

operations. The second recommended candidate is the LAW Vault because it receives much attention regarding its disposal lifecycle.

The second step is to identify the radionuclides to which the proposed method will apply. For radionuclides that have little impact, their fraction of the SOF can be calculated by the current method. On the other hand, computer programs can easily accommodate all radionuclides in inventory without the bother of determining the most important contributors.

The third step is to select the number of time intervals for the aquifer model. Theoretically, the time intervals can be refined almost without limit. Selecting very small time intervals could isolate sharp peaks for two highly mobile contaminants, such as for H-3 and I-129. However, uncertainties in K_ds and operations could cause the peaks to overlap under real field conditions, thus the selection of time intervals should be tempered by the uncertainties involved.

Because radionuclides were analyzed to calculate the peak aquifer concentration only, some data were ignored, leading to zero values in other time intervals. The existing modeling data need to be examined to determine if more detailed modeling is required.

Some modeling output files do not exist. For these cases the peak concentration value must be used unless the model is regenerated and reexecuted.

The computer program (TimeSOF) will have options to calculate the sum-of-fractions using either the PA/SA analysis results that currently form the basis for WITS or other methods that likely will replace those results. One example would be if a new PA/SA has been issued but not yet implemented in WITS, then the user would have the option to see the sum-of-fractions using values from new PA/SA. Another example would be that for inventory limits for the groundwater pathway are established based on the most critical radionuclide in a decay chain. The user would have the option to use that method or to use a sum-of-fraction method that incorporates all members of the decay chain that were modeled.

5.   REFERENCES

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Sink, D.F., Jr. 2002. Personal Communication, May 7.

APPENDIX A

Copies of the design reviews are provided below. Comment resolutions are provided after the design review.

Design Review from G.P. Flach

SRT-EST-2002-00172

To: Tom Butcher, 773-43A
           Len Collard, 773-43A

From: Greg Flach, 773-42A

Copy: Mary Harris, 773-42A
           File, 773-42A

Date: September 26, 2002

Subject: **Design Check of Time-Dependent Sum of Fractions Evaluation**
           (WSRC-TR-2002-00430 draft)

A design check of "Evaluation of a method to calculate the sum-of-fractions for multiple radionuclides that uses aquifer concentrations of radionuclides that change with respect to time", WSRC-TR-2002-00430 (September 24, 2002 draft) was performed following the general guidance provided in WSRC-IM-2002-00011 and the specific instruction:

1. Check the APPROACH to make recommendations on better ways to implement the new method, e.g.,
    - Ease of use of computer program
    - Flexibility and robustness
    - Better ways to display results
2. Check the MATHEMATICS by
    - Spot checking the slit trench for 1 key radionuclide
    - Spot checking the ILV for 1 key radionuclide
3. Check to ensure that the INPUTS are correct for
    - the inventory and current sum-of-fractions for the major contributors
    - the time slice peak concentrations for one key radionuclide
    - (the base files from which these data were selected will be provided)
4. Check to ensure that the OUTPUTS are reasonable by
    - Spot check the sum-of-fractions for one pathway for the slit trench
    - Spot check the sum-of-fractions for one pathway for the ILV

Check that all major uncertainties that could lead to different recommendations are

presented and discussed. Mention any beneficial outputs that are not presented.

5. TRANSCRIPTION: Check to ensure that important numerical values (i.e., sums-of-fractions) are consistent throughout the report. If the numbers are presented at two different locations throughout the report, they should be identical, except for rounding.

The document was checked at a level sufficient to address the 5 specific items listed above. No major technical issues were identified during the course of the review. However, a few minor corrections and comments are identified in the table below, along with suggested resolutions.

Comment	Suggested Resolution
Section 3, first paragraph text should read "contribute at least 0.01 percent (1E-4 as a fraction)"	revise text
Table 7 Some minor discrepancies in peak concentrations, compared to the '94 E-area PA and modeling output files provided, were observed. This appeared to be the result of ambiguity in the 3 aquifer time intervals and whether discrete model output values or interpolated values were intended. In the final (future) product, the breakpoint between time periods and chosen interpolation algorithm should be clearly defined.	note comment for future reference
Table 8 A reference document for the values in the table should be cited.	add reference
Table 9 The consumption fraction for U-238 under the Aq. 3 scenario is missing. The corrected values are shown in bold in the table below	make correction to Table 9

Radionuclide	Current Inventory	Fractions Air	Drill	Res	Ag	Aq1	Aq2	Aq3
H-3	4.36E+00	1.36E-05				6.92E-01	3.49E-03	
I-129	1.43E-05		3.26E-13			2.76E-02	8.04E-03	
Pu-239	1.56E-02		1.42E-05		5.04E-06			1.78E-02
I-129J	2.46E-05		7.69E-08			9.73E-04	1.53E-02	
Np-237	5.59E-04		2.66E-06		6.14E-12	1.86E-06	6.14E-03	
U-238	5.67E-02		1.18E-05	2.99E-08	5.67E-06		9.65E-03	**1.13E-02**
	SOF	1.36E-05	2.88E-05	2.99E-08	1.07E-05	7.20E-01	4.26E-02	**2.91E-02**

Comment Resolutions for G.P. Flach

1. The text was revised.
2. A note was added to the tables that explicit values from modeling output were used, but that interpolation was not performed.
3. A reference was added.
4. Table 9 was corrected.

Design Review from E.L. Wilhite

Len:

Per your instructions, I've conducted a design check of your document "Evaluation of a Method to Calculate the Sum-of-Fractions for Multiple Radionuclides that uses Aquifer Concentrations of Radionuclides that change with respect to time", WSRC-TR-2002-00430.

Following are my comments versus each of your instructions. My task was to "Check the APPROACH to ensure the following conditions are satisfied (this review covers ASSUMPTIONS as well):

The pathways are independent of each other, other than radon and the air pathway, and that it is appropriate to calculate a separte sum-of-fractions for each pathway.

Each of the pathways is independent of the others. In fact, the air and radon pathways are independent. DOE 435.1 makes this clear in the statement of the air pathway performance objective: "Dose to representative members of the public via the air pathway shall not exceed 10 mrem (0.10 mSv) in a year total effective dose equivalent, excluding the dose from radon and its progeny."

Section 4 of the document (second paragraph, last two sentences) should be revised to reflect this.

Given the uncertainty in assumptions, comment on the selection of time slices for future work.

Future work should focus on each of the disposal units and time slices should be established based on the timing of doses and/or concentrations for each of the units.

Comment on any additional capabilities that the user may require.

Further work should develop, for each disposal unit, the potential maximum benefit of tracking sums-of-fractions separately for each performance objective and within performance objectives (e.g., different intruder scenarios and different times for the groundwater and air pathways).

Check that the report is presented in a logical manner that is not unduly complicated

The report is presented in a logical manner and is not unduly complicated.

Check that the report accomplished its purpose.

The report accomplished its purpose.

I have a few minor editiorial comments that should be considered.

In Section 2, in the third paragraph, in the first sentence, in the parenthetical statement, the person exposed in the residential or agricultural scenarios is not a member of the public, rather, the person is a hypothetical inadvertent intruder). The statement should be revised to read: "e.g., the intruder during a residential scenario at 100 years is not the same person as that during an agricultural scenario at 700 years".
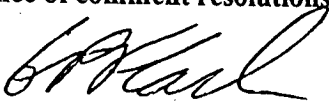
The titles for Figures 1,2, and 3 should be revised to have the word "hypothetical" to modify that which is being plotted rather than the plot.
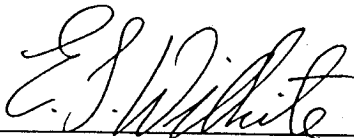
Elmer

Comment Resolutions for **E. L. Wilhite**

Text revised to match comments.

Acceptance of comment resolutions

_____   9/30/02
G.P. Flach

_____   9/31/2002
E..L. Wilhite