METHOD FOR SURVEYING AND AVERAGING CONCENTRATIONS OF THORIUM IN CONTAMINATED SUBSURFACE SOIL

Prepared by NRC Staff in Connection
With the Review of the AAR "Site
Remediation Plan for the Former Brooks
and Perkins, Inc. Site," Docket #040-00235
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I. INTRODUCTION

Current NRC guidance for conducting final surveys at decommissioning facilities is contained in Draft NUREG/CR-5849, "Manual for Conducting Surveys in Support of License Termination." NUREG/CR-5849 primarily addresses the final surveys of surface contamination on both buildings and open land areas, including guidance on acceptable averaging methods for surface contamination that exceeds the unrestricted use criteria (i.e., elevated areas). However, methods for surveying and averaging subsurface contamination are not discussed. This document provides a method for averaging elevated areas of subsurface soil contamination. Note that the potential for exposure from subsurface contamination via the groundwater pathway is not addressed in this document. The groundwater pathway should be evaluated on a case-by-case basis.

The averaging method in NUREG/CR-5849 assumes that soil samples are collected from the ground surface (first 15 cm). This sampling and averaging method is acceptable for the majority of decommissioning sites since the surface samples are considered sufficiently representative to assess the potential dose using conventional pathway analysis. However, conventional pathway analysis, and the NUREG/CR-5849 averaging method, may not be appropriate if significant subsurface contamination is present.

Conventional pathway analysis concludes that the dose from subsurface contamination is essentially zero, except from the groundwater pathway (see discussion below for other exceptions). This conclusion assumes that the contamination will remain at depth for very long periods of time (the typical pathway analysis is run for a 1000 year period). Since it is not reasonable to assume that the subsurface soil will remain undisturbed for a 1000 year period, simple scenarios were developed to predict how subsurface soil would be excavated in the future, the volume of the excavated soil, and the dose consequences of the contaminated soil in the post-excavation geometry. Based on the predicted excavation volumes and the dose consequences, surveying and averaging protocol were developed for in-situ subsurface soil.

Two excavation scenarios were evaluated. The first scenario assumes the construction of a slab-on-grade house; the second a house with a basement. For each of the construction scenarios, the volume of excavated soil and the extent of surface spreading, as well as the depth of surfaces on which the foundations could be built, were estimated. The potential dose from the subsurface soil, after excavation, was estimated by: 1) calculating the dose

Attachment

from the contaminated soil spread on the ground surface and 2) calculating the dose from the in-situ contaminated surface that is exposed after excavation, assuming that the foundation of the house is built on the exposed surface.

It is recognized that subsurface contamination contained closer to the surface, say 0-1 meter, may deliver dose without being excavated. This exposure may occur from: 1) direct gamma radiation from in-situ soil closer to the surface, 2) the root uptake pathway down to about the first meter, and 3) the uncovering of contaminated surfaces through grading during construction, and surface erosion over time, which could then cause dose through surface exposure pathways. However, the average concentration allowed for the in-situ soil from 0-1 meter would be greater than that allowed under the excavation scenario due to the soil being spread over a larger area after excavation. Therefore, the excavation scenario is used to determine acceptable averaging limits for the 0-1 meter layer. This conservatism is appropriate because of the uncertainty as to potential exposure pathways for near surface contamination.

Finally, after the concentrations and averaging volumes were determined, a survey method was developed that would be acceptable to NRC for demonstrating that the averaging criteria are met. Section II describes the survey method. The technical basis for the averaging concentrations and survey method is presented in Section III.

II. SURVEY METHOD FOR SUBSURFACE THORIUM CONTAMINATION

The final survey method for subsurface contamination should ensure that the number and location of samples are sufficient to; 1) demonstrate, with reasonable confidence, that a significant volume of subsurface contamination is identified by one of the samples, and 2) demonstrate that the average contamination level in the identified volume would not result in a significant dose after excavation.

The survey method described below can be used to satisfy the above two objectives. The technical basis for this survey method is presented in Section III. The concentration values are based on the current unrestricted use limit of 10 pCi/g total thorium for widespread surface contamination. If the guideline value changes, the averaging criteria will change accordingly. Other survey methods may be acceptable if they are justified on a dose basis and provide sufficient confidence that significant volumes of soil are identified.

Survey Assumptions:

1. Samples are collected on a 5 meter square grid.

2. Samples are composited over each 1 meter layer of soil.

3. Each sample is assumed to represent 25 m^3.

4. 100 m^3 averages are represented by the average of four samples collected from each 1 meter layer of soil.

5. Volumetric averages greater than 100 m^3 are calculated assuming each sample represents 25 m^3.

Averaging Criteria for Total Thorium (Th-232 + Th-228):

0-1 meter depth	Maximum Individual Sample < 50 pCi/g 10 m^3 average < 20 pCi/g 100 m^3 average < 13 pCi/g
1-2 meter depth	Maximum < 50 pCi/g 200 m^3 (0-2 m depth) < 10 pCi/g
2-3 meter depth	Maximum < 50 pCi/g 300 m^3 (0-3 m depth) < 10 pCi/g
3-4 meter depth	Maximum < 50 pCi/g 100 m^3 < 13 pCi/g 400 m^3 (0-4 m depth) < 10 pCi/g
> 4 meter depth	maximum < 50 pCi/g volume from surface to depth "x" < 10 pCi/g
survey unit	The volumetric average over the entire survey unit < the unrestricted use limit (10 pCi/g for total thorium)

The averaging criteria apply to any contiguous volume defined by the given number of 5 m grid samples, where each sample represents 25 m^3. For averaging over a 100 m^3 volume, each combination of four samples in a given 1 m layer should be evaluated. This would only be necessary if an individual sample exceeds 10 pCi/g. To calculate the average for volumes greater than 100 m^3, consider the samples in a given 10 m X 10 m area projected to the depth of interest. For example, the 300 m^3 volume average is calculated by averaging 12 samples represented by the four samples in the 0-1 m layer of a given 10 X 10 m area (assuming 5 m grid), and the 4 samples each in the 1-2 m and 2-3 m layers directly below the given 10 X 10 area. The samples at the respective depths would likely be from the same borehole.

In addition to the above, a vertical averaging criteria is also defined. This averaging criteria is intended to identify significant volumes of contiguous contamination in the vertical, as opposed to the horizontal, direction. The sampling and averaging described below also assumes a 5 m grid size.

- The average of the two samples from 0-2 meters in same borehole (50 m^3) < 14 pCi/g total thorium

- The average of the three samples from 0-3 meters in same borehole (75 m^3) < 13 pCi/g total thorium

III. TECHNICAL BASIS FOR SUBSURFACE SURVEYING AND AVERAGING METHOD

Discussion

After the contaminated soil is excavated and brought to the surface, the surface exposure pathways, and the surface averaging methods apply. The surface averaging method used for excavated subsurface soil is consistent with that used in NUREG/CR-5849. However, the NUREG/CR-5849 procedure was modified to reduce the conservatism. A discussion of how the NUREG/CR-5849 averaging method for surface contamination was modified is presented in the following section. How the modified averaging method was applied to excavated subsurface soil is presented in subsequent sections.

The averaging method in NUREG/CR-5849 was based on a combination of past practice and dose assessments. The averaging method has three steps:

1) elevated areas should be less than 3 times the release criteria,

2) the concentration in the elevated area should not be greater than $(100/A)^{1/2}$ times the release criteria, where "A" is the size of the elevated area in m^2, and

3) the average over any 100 m^2 area should be less than the release criteria.

The maximum criterion of 3 times the average limit in NUREG/CR-5849 (step #1 above) was based on a qualitative ALARA judgement and a comparison with the maximum criteria in "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material," which also uses 3 times the average value as the maximum. Since radionuclide specific evaluations will be performed (as described below), the 3 times maximum criterion was not used in the volumetric averaging method for subsurface contamination. The maximum criterion was determined by estimating the minimum volume of soil that could be excavated without mixing with surrounding soil and assessing the relative dose from this volume of soil compared to uniform, widespread contamination.

The area averaging criterion in NUREG/CR-5849 (step #2 above) was based on a dose assessment made in 1985 for the Department of Energy using the DOE "Manual for Implementing Residual Radioactivity Guidelines." This manual was eventually updated and codified in 1989 as DOE's RESRAD pathway analysis/dose assessment code. The dose from elevated areas of various sizes was estimated using default input parameters for the code. The conclusion from these dose estimations was that the dose is reduced as the area of contamination is reduced, assuming the same concentration. The extent of the reduction in dose as a function of area depends on whether the predominant dose pathway is from direct exposure, or from one or more of the other pathways such as inhalation and ingestion. In general, there is a greater dose reduction for elevated

areas containing radionuclides that deliver a significant fraction of the dose through the inhalation and ingestion pathway than for radionuclides that deliver a higher fraction of dose via the direct exposure pathway. The formula in NUREG/CR-5849 (restated below) was derived from the 1985 DOE study of the dose consequences of elevated areas of various sizes.

$$\text{Allowable Concentration in Elevated Area} < C(100/A)^{1/2}$$

where: C = unrestricted use criteria
A = area of elevated area, m^2

The above formula represents the lower bound of acceptable concentrations in an elevated area of size "A" for all of the radionuclides evaluated. A similar dose assessment for a specific radionuclide will very likely result in an allowable concentration exceeding that calculated using the above formula. This is evidenced by Enclosure 1, which shows the nuclide specific dose consequences of elevated areas (represented by the multiple of the authorized limit on the Y axis) ranging in size from 1 m^2 to 100 m^2. Enclosure 1 also includes a line defined by the $(100/A)^{1/2}$ formula. Note that the $(100/A)^{1/2}$ line is below all of the nuclide specific curves, and represents the most conservative result.

Enclosure 1 was generated in 1985 and summarizes the results of the dose assessments used to select the $(100/A)^{1/2}$ formula for determining acceptable concentrations of contamination in elevated areas. To ensure that the current version of RESRAD is consistent with the 1985 dose assessments, a similar series of dose assessments were conducted using a recent version of RESRAD. As shown in Enclosure 2, the results are very similar. This demonstrates that RESRAD is appropriate, and will provide averaging criteria that is consistent with, albeit less conservative than, the $(100/A)^{1/2}$ criteria. Therefore, in order to provide more realistic criteria, the volumetric averaging method described below relies on radionuclide specific dose assessments, using the DOE RESRAD code, to determine the acceptable concentration in subsurface soil containing elevated contamination levels.

The third part of the averaging method in NUREG/CR-5849 (step #3 above) is that the average over [illegible]0 m^2 should be less than the release criteria. The 100 m^2 average [illegible]n was intended to address the potential for a 10 m x 10 m house being b[illegible] the 100 m^2 parcel of land. The 10 m x 10 m averaging criteria is essentially maintained in the subsurface volumetric averaging method.

The following sections describe the assumptions and calculations used to develop the volumetric averaging criteria for subsurface soil.

Excavation Assumptions

- Excavation scenarios for both a house w/basement and a house w/out basement
- House Size: 10 m x 10 m

- Dimensions of footers for house w/no basement:
  1 m deep x 1 m wide x 10 m long

- Basement Depth: 3 m

- Excavation Equipment Bucket Size: 1 m^3

- Five excavation scenarios evaluated:

  1) each of four 1 m deep x 1 m wide x 10 m long footer excavation for a house w/out basement is placed in separate pile

  2) the 1 m deep x 10 m wide x 10 m long portion of soil from the surface to a depth of 1 m is excavated for a house with no basement and placed in separate pile

  3) each 3 m deep x 2.5 m wide x 10 m long portion of soil for basement excavation placed in separate pile

  4) entire 3 m deep x 10 m wide x 10 m long excavation for house w/basement placed in one pile

  5) one bucket (1 m x 1 m x 1 m) of excavated soil placed in separate pile

- Each excavated pile uniformly blended

- Each pile spread over a 1 foot depth

Method for Calculating Acceptable Averaging Volumes and Concentrations for Subsurface Contamination

To determine the averaging volume for subsurface contamination, and the acceptable concentration as a function of volume, the first step was to calculate the volume of soil excavated in each of the above five scenarios. The dose from the excavated soil was then estimated and compared to the dose from widespread, uniform contamination.

To estimate the dose, the soil volumes defined by the five excavation scenarios were assumed to be brought to the surface and spread over a 1 foot depth. Using the resulting calculated surface area as input to the RESRAD code, the dose from the excavated soil was estimated using the resident farmer scenario and the input parameters from Policy and Guidance Directive PG-8-08 "Scenarios for Assessing Potential Doses Associated with Residual Radioactivity," May 1994. A second RESRAD run was then made, using the same concentration, and assuming the default area of 10,000 m^2. The ratio of the dose from the 10,000 m^2 area to the dose from the calculated area was then multiplied by the unrestricted use criteria to determine the acceptable concentration in the elevated area, and hence the corresponding subsurface volume. This concentration is considered acceptable since the dose from the elevated area containing this concentration will deliver the same dose as a large area contaminated at the unrestricted use level. To determine

compliance with the volumetric averaging criteria, the average concentration over the in-situ volume of soil defined in the scenario must be less than the above ratio times the guideline.

For example, the following calculation provides the averaging volume and concentration for excavation Scenario #1, assuming that the contamination is total thorium (Th-232 + Th-228):

1. Volume of 1 m deep x 1 m wide x 10 m long footer is 10 m^3.

2. Assuming the 10 m^3 volume is excavated and spread over a 1 foot depth, the area of contamination on the surface would be 30 m^2.

3. Run RESRAD to estimate dose assuming 10 pCi/g total thorium and assuming that the contaminated area is 30 m^2 (Enclosure 3).

4. Run RESRAD to estimate dose, also assuming 10 pCi/g total thorium, but using the RESRAD default area of 10,000 m^2 (Enclosure 4).

5. Calculate the ratio of the dose from Step 4 to the dose from Step 3. For total thorium, the ratio is 2.0.

6. Multiply the ratio, i.e., 2.0, by the unrestricted use limit for total thorium, i.e., 10 pCi/g. The resulting concentration is 20 pCi/g, which represents the acceptable average concentration in a 10 m^3 volume of soil.

Note that Scenario #1 applies only to volumes of soil starting on the surface and ending at the first meter since the excavation is assumed to be for a footer, and would not go below 1 m.

The same calculations were performed for the other four excavation scenarios. The resulting five volumetric averaging guidelines for subsurface thorium contamination are listed below. The criteria for other radionuclides should be developed on a case-by-case basis. The excavation scenarios described above for housing construction are assumed to result in conservative averaging criteria since excavations for larger structures should result in larger excavated volumes, and a greater degree of mixing with surrounding soil.

<u>Volumetric Averaging Guidelines For Subsurface Thorium Contamination</u>

The five excavation scenarios were evaluated to determine acceptable averaging volumes and concentrations for subsurface thorium contamination. Enclosure 5 contains the RESRAD output for each of the five evaluations.

1) The average concentration of total thorium in a 10 m^3 volume should be less than 20 pCi/g.

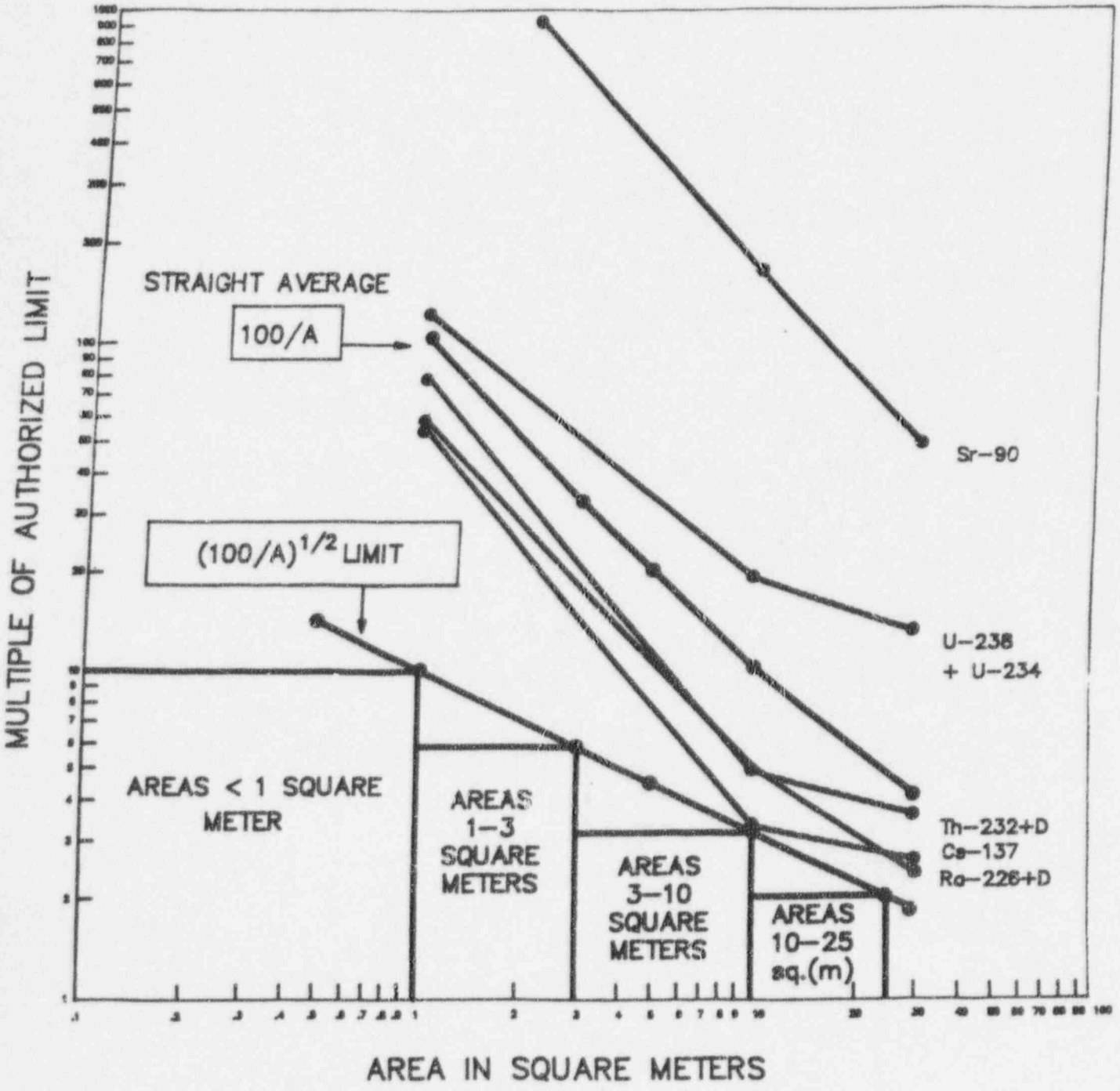
2) The average concentration of total thorium in a 100 m^3 volume of soil should be less than 13 pCi/g.

3) The average concentration of thorium in a 75 m^3 volume of soil should be less than 13 pCi/g.

4) The average concentration of thorium in a 300 m^3 volume of soil should be less than 10 pCi/g.

5) The average concentration of thorium in a 1 m^3 volume of soil should be less than 50 pCi/g. This concentration is considered the maximum value for an individual sample composited over a 1 meter depth.

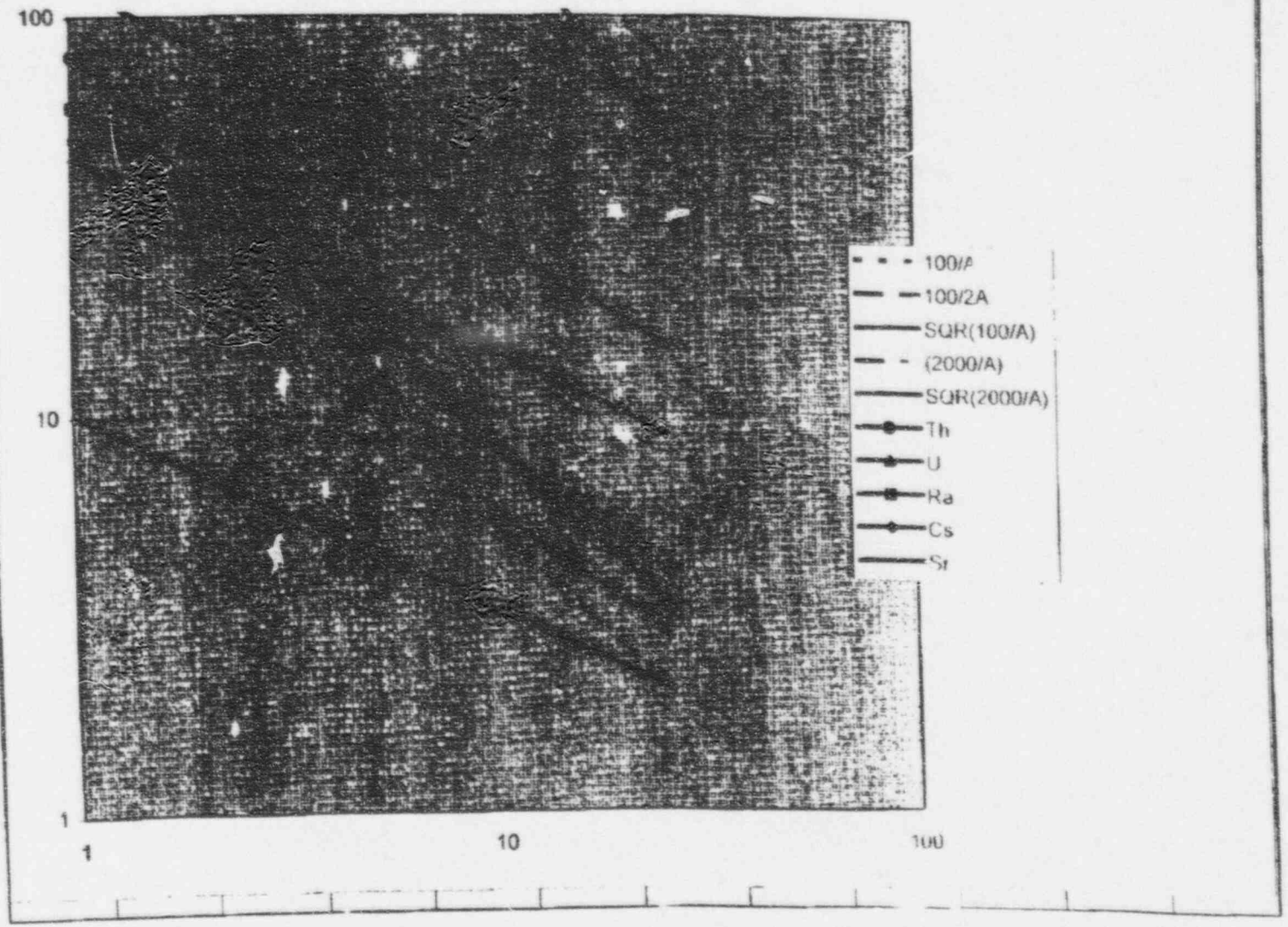
The above averaging guidelines were developed assuming that the soil is excavated and placed on the ground surface. The final step is to ensure that the volumetric averaging does not result in a layer of exposed soil with excessive concentrations. The soil layers of concern are the layer from 0-1 m and 3-4 m, which are the layers upon which the foundations for the slab-on-grade house and a house with a basement, respectively, are assumed to be built. To control these scenarios, the average over the 100 m^3 defined for these layers will be limited to the 100 m^3 averaging criteria.



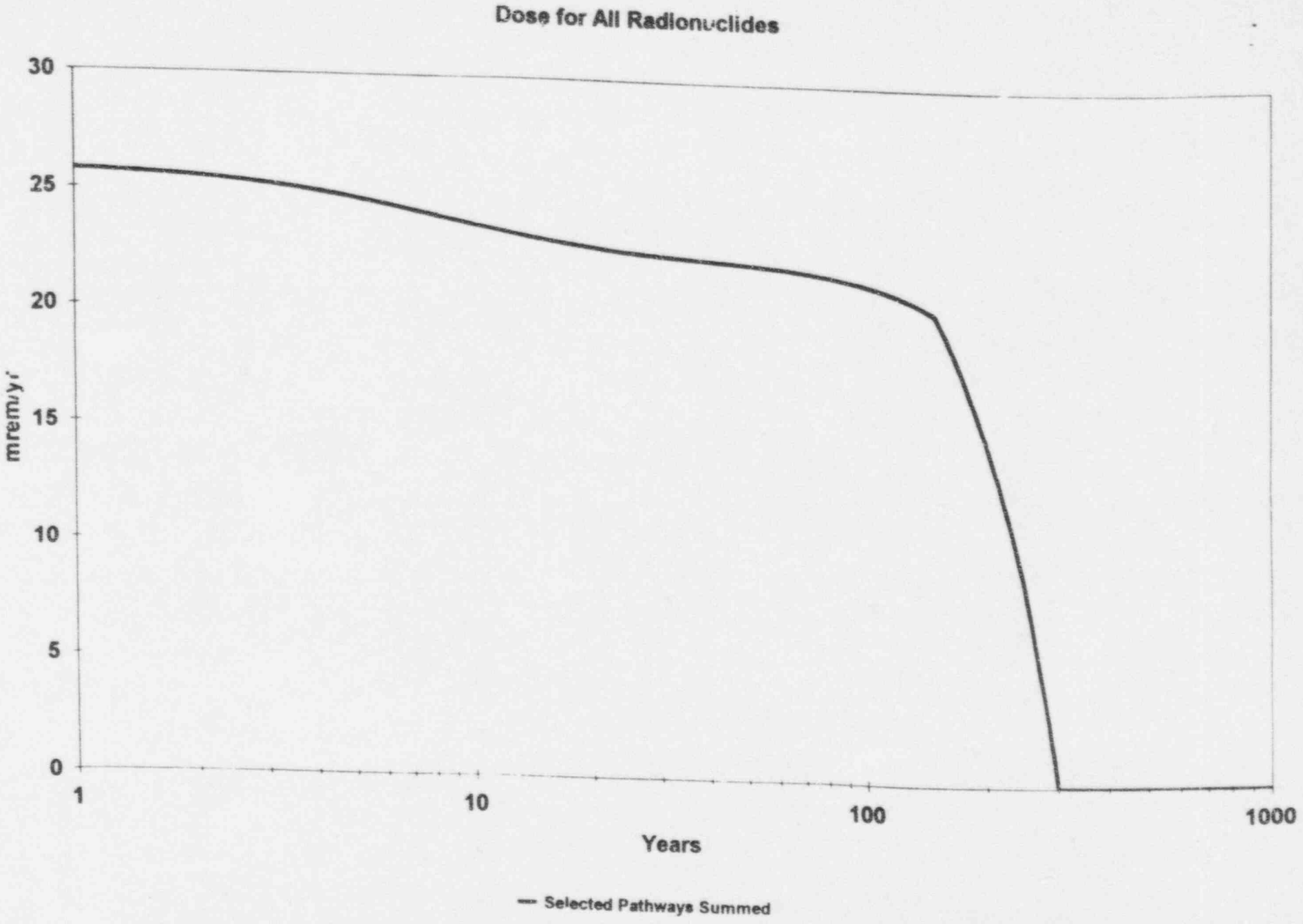
COMPARISION OF HOT SPOT LIMITS BASED ON $(100/A)^{1/2}$ AND mrem DOSE LIMIT

Enclosure 1

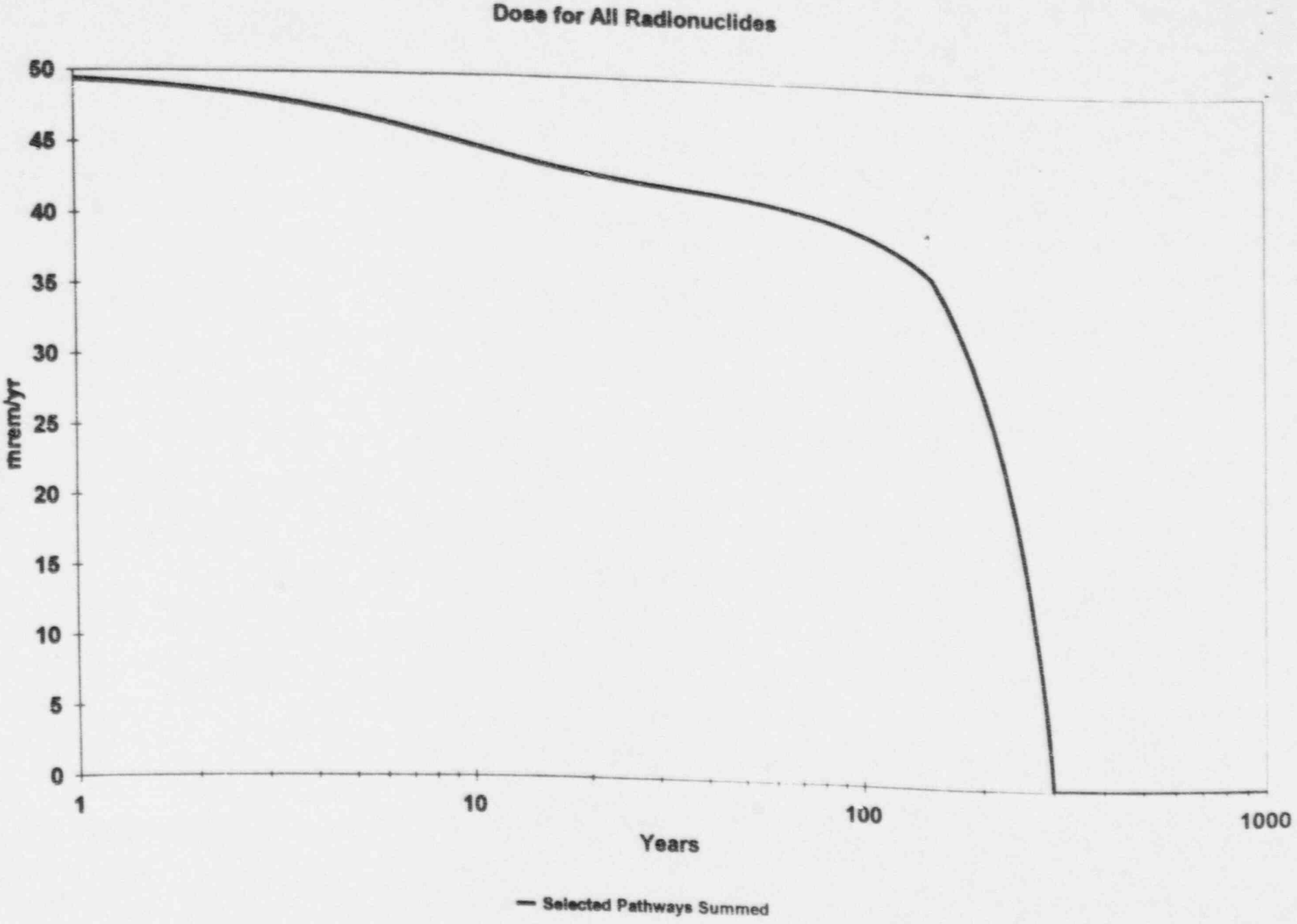
Area	100/A	100/2A	SQR(100/	(2000/A)	SQR(2000	Th	U	Ra	Cs	Sr	
1	100	50	10	2000	44.72136	80	120	60	60		
3	33.33333	16.66667	5.773503	666.6667	25.81989	34	68	28	24		
10	10	5	3.162278	200	14.14214	8	27	8	5.5	180	
25	4	2	2	80	8.944272	4	15	3.3	2.8	50	



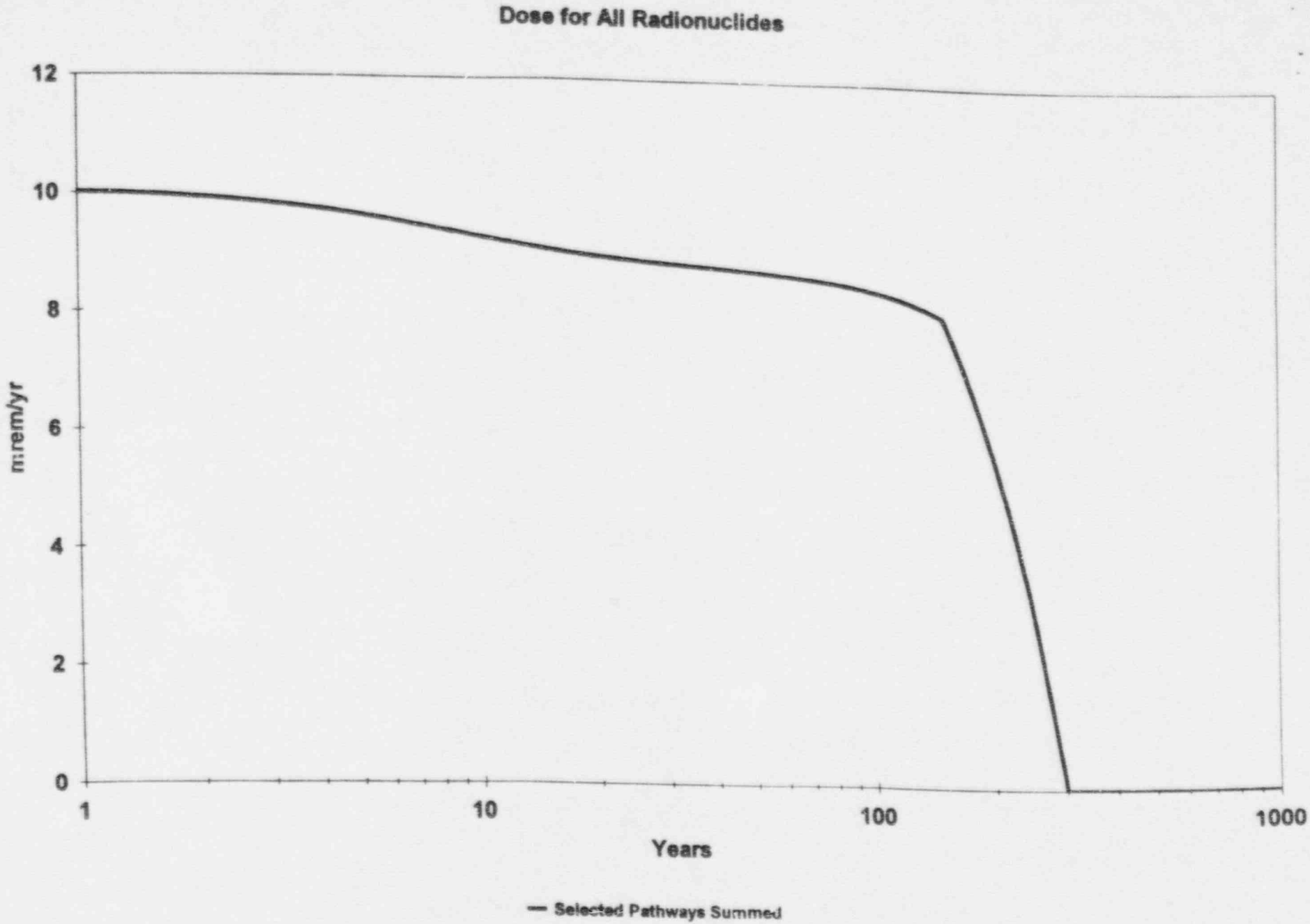
Enclosure 2


Dose for All Radionuclides
30
25
20
15
10
5
0
mrem/yr
1
10
100
1000
Years
Selected Pathways Summed

Enclosure 3


Dose for All Radionuclides
50
45
40
35
30
25
20
15
10
5
0
mrem/yr
1
10
100
1000
Years
Selected Pathways Summed
FAUVER RAD 10/22/96 Includes All Pathways

Enclosure 4


Dose for All Radionuclides
12
10
8
6
4
2
0
mrem/yr
1
10
100
1000
Years
— Selected Pathways Summed
FAUVER.RAD 10/23/96 Includes All Pathways

Enclosure 5

Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	3.00 square meters	Ra-228	5.000E+00
Thickness:	0.30 meters	Th-228	5.000E+00
Cover Depth:	0.00 meters	Th-232	5.000E+00

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 30 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
TDOSE(t):	1.008E+01	1.001E+01	9.828E+00	9.295E+00	8.872E+00	8.479E+00	3.692E-09	2.756E-10
M(t):	3.360E-01	3.336E-01	3.276E-01	3.098E-01	2.957E-01	2.826E-01	1.231E-10	9.187E-12

Maximum TDOSE(t): 1.008E+01 mrem/yr at t = 0.000E+00 years

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years
Water Independent Pathways (inhalation excludes radon)

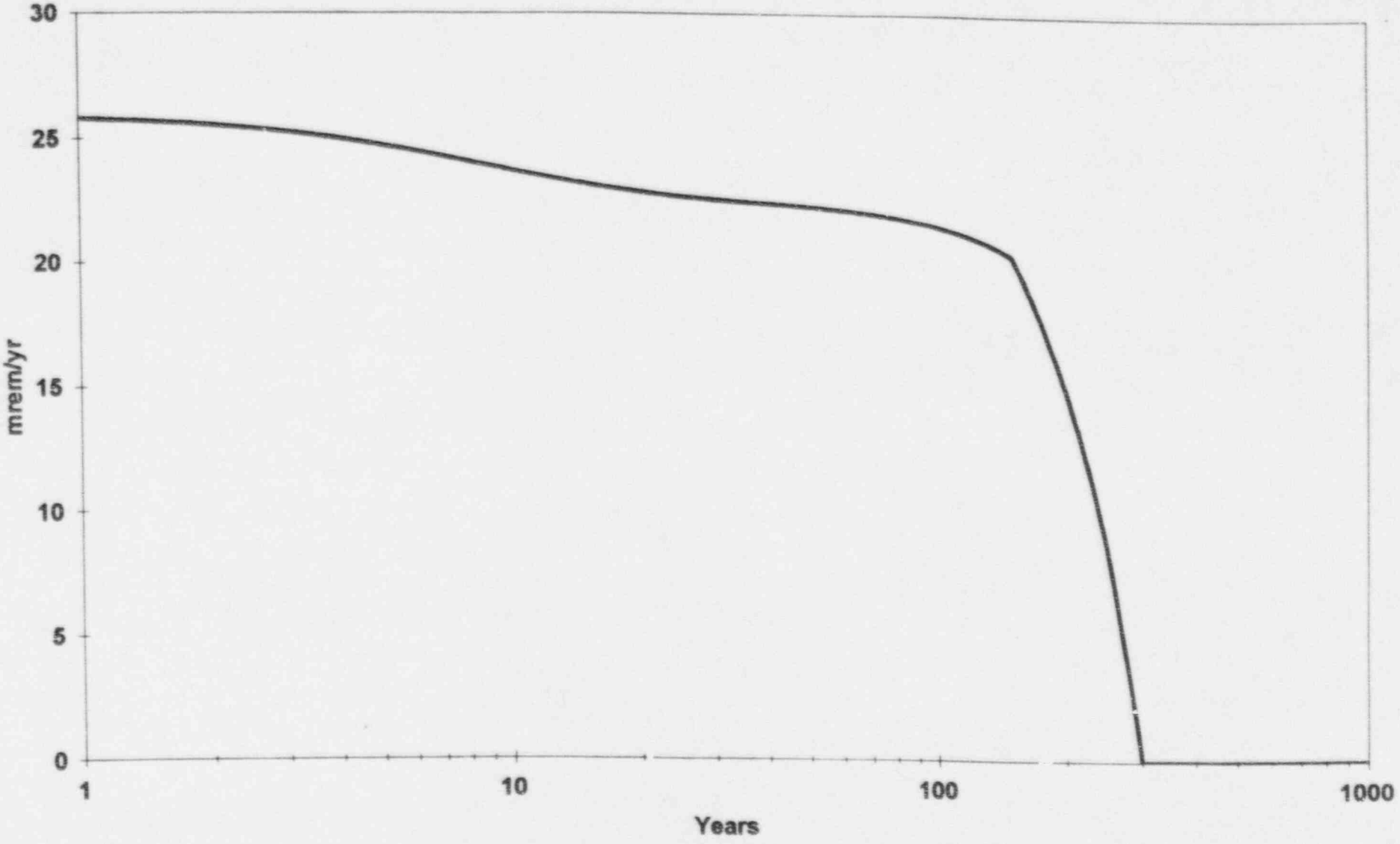
Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-228	2.405E+00	0.2386	9.480E-03	0.0009	0.000E+00	0.0000	2.538E-02	0.0025	9.422E-05	0.0000	1.321E-04	0.0000	2.996E-04	0.0000
Th-228	3.933E+00	0.3902	6.438E-01	0.0639	0.000E+00	0.0000	3.555E-04	0.0000	1.955E-06	0.0000	1.568E-07	0.0000	1.681E-04	0.0000
Th-232	2.657E-04	0.0000	3.060E+00	0.3036	0.000E+00	0.0000	1.217E-03	0.0001	6.751E-06	0.0000	5.312E-07	0.0000	5.680E-04	0.0001
Total	6.339E+00	0.6288	3.714E+00	0.3684	0.000E+00	0.0000	2.695E-02	0.0027	1.029E-04	0.0000	1.327E-04	0.0000	1.036E-03	0.0001

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years
Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.441E+00	0.2421
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.578E+00	0.4541
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.062E+00	0.3038
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.008E+01	1.0000

*Sum of all water independent and dependent pathways.

Dose for All Radionuclides



FAUVER.RAD 10/23/96 Includes All Pathways

Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	30.00 square meters	Ra-228	5.000E+00
Thickness:	0.30 meters	Th-228	5.000E+00
Cover Depth:	0.00 meters	Th-232	5.000E+00

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 30 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
TDOSE(t):	2.599E+01	2.578E+01	2.525E+01	2.371E+01	2.253E+01	2.154E+01	3.713E-08	2.771E-09
M(t):	8.663E-01	8.593E-01	8.417E-01	7.903E-01	7.510E-01	7.179E-01	1.238E-09	9.237E-11

Maximum TDOSE(t): 2.599E+01 mrem/yr at t = 0.000E+00 years

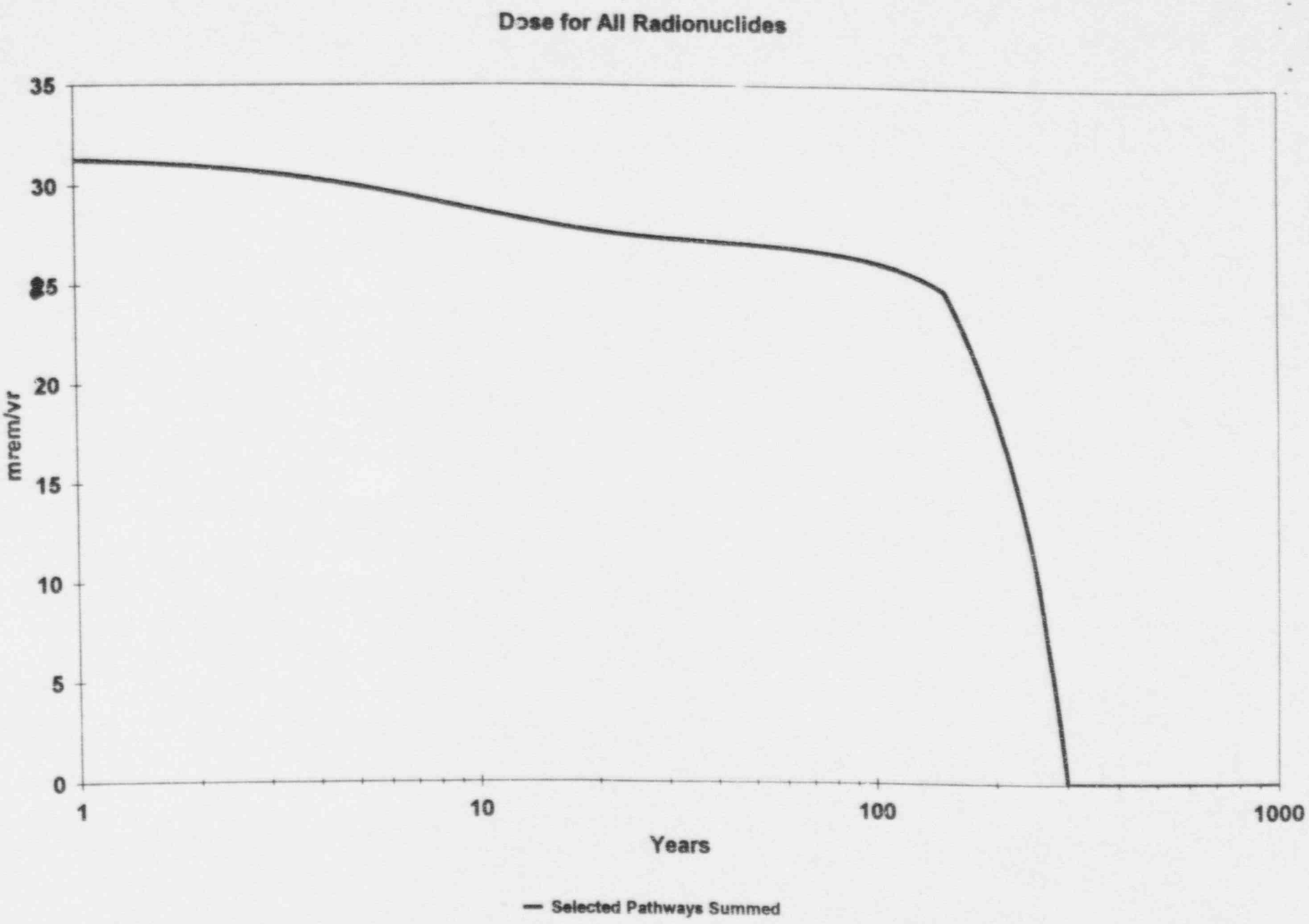
Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years
Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-228	7.218E+00	0.2777	1.673E-02	0.0006	0.000E+00	0.0000	2.539E-01	0.0098	9.426E-04	0.0000	1.321E-03	0.0001	2.996E-03	0.0001
Th-228	1.193E+01	0.4592	1.136E+00	0.0437	0.000E+00	0.0000	3.575E-03	0.0001	1.957E-05	0.0000	1.570E-06	0.0000	1.681E-03	0.0001
Th-232	7.110E-04	0.0000	5.402E+00	0.2079	0.000E+00	0.0000	1.224E-02	0.0005	6.758E-05	0.0000	5.317E-06	0.0000	5.680E-03	0.0002
Total	1.915E+01	0.7369	6.555E+00	0.2522	0.000E+00	0.0000	2.697E-01	0.0104	1.030E-03	0.0000	1.328E-03	0.0001	1.036E-02	0.0004

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years
Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.494E+00	0.2883
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.308E+01	0.5031
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.421E+00	0.2086
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.599E+01	1.0000

*Sum of all water independent and dependent pathways.

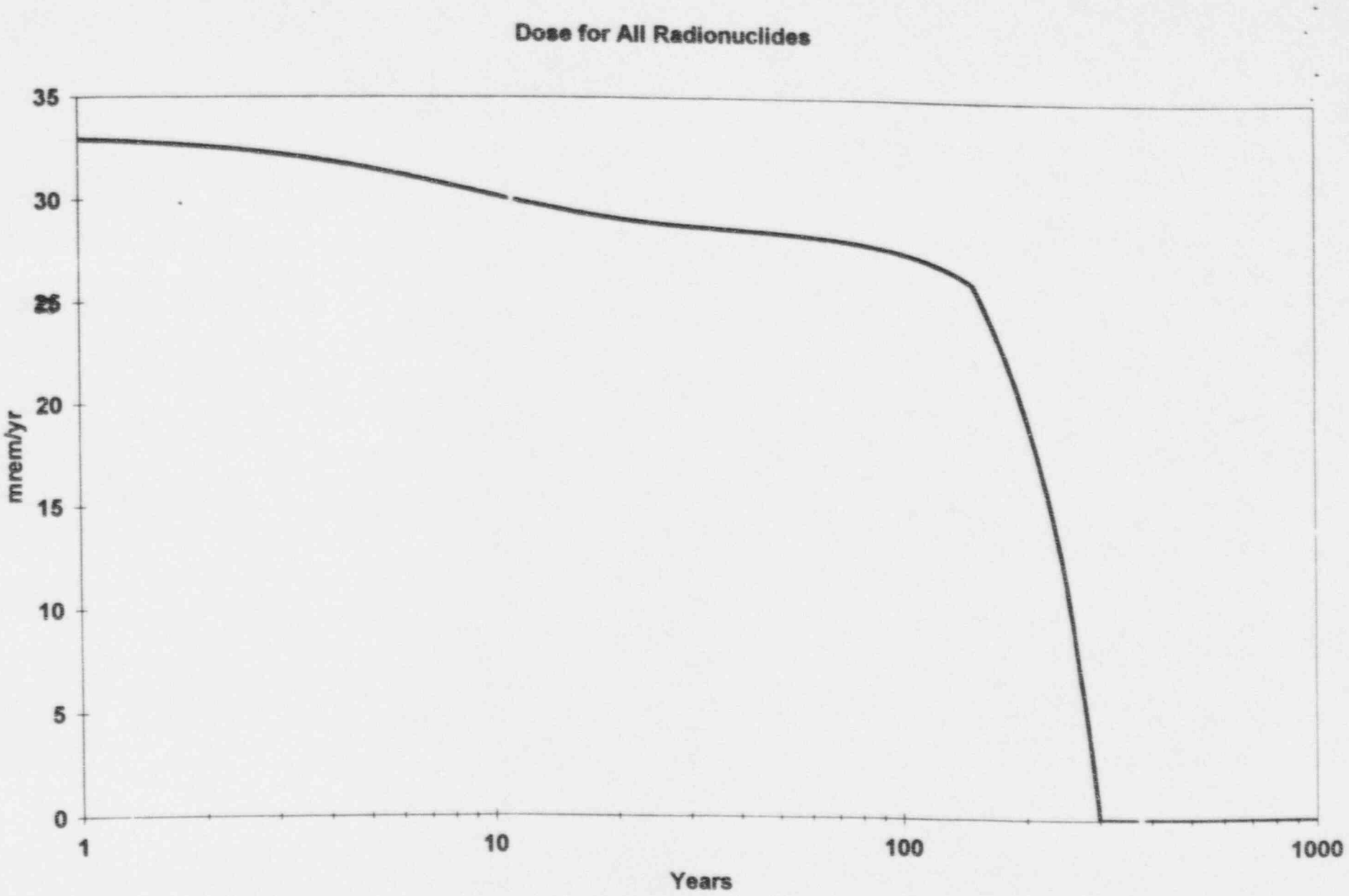

Dose for All Radionuclides
35
30
25
20
15
10
5
0
mrem/yr
1
10
100
1000
Years
Selected Pathways Summed
FAUVER.RAD 01/14/97 Includes All Pathways

Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	75.00 square meters	Ra-228	5.000E+00
Thickness:	0.30 meters	Th-228	5.000E+00
Cover Depth:	0.00 meters	Th-232	5.000E+00

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 30 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
TDOSE(t):	3.154E+01	3.128E+01	3.063E+01	2.875E+01	2.733E+01	2.619E+01	1.076E-06	8.034E-08
M(t):	1.051E+00	1.043E+00	1.021E+00	9.583E-01	9.109E-01	8.731E-01	3.588E-08	2.678E-09

Maximum TDOSE(t): 3.154E+01 mrem/yr at t = 0.000E+00 years


Dose for All Radionuclides
35
30
25
20
15
10
5
0
mrem/yr
1
10
100
1000
Years
Selected Pathways Summed
FAI VER.RAD 01/14/97 Includes All Pathways

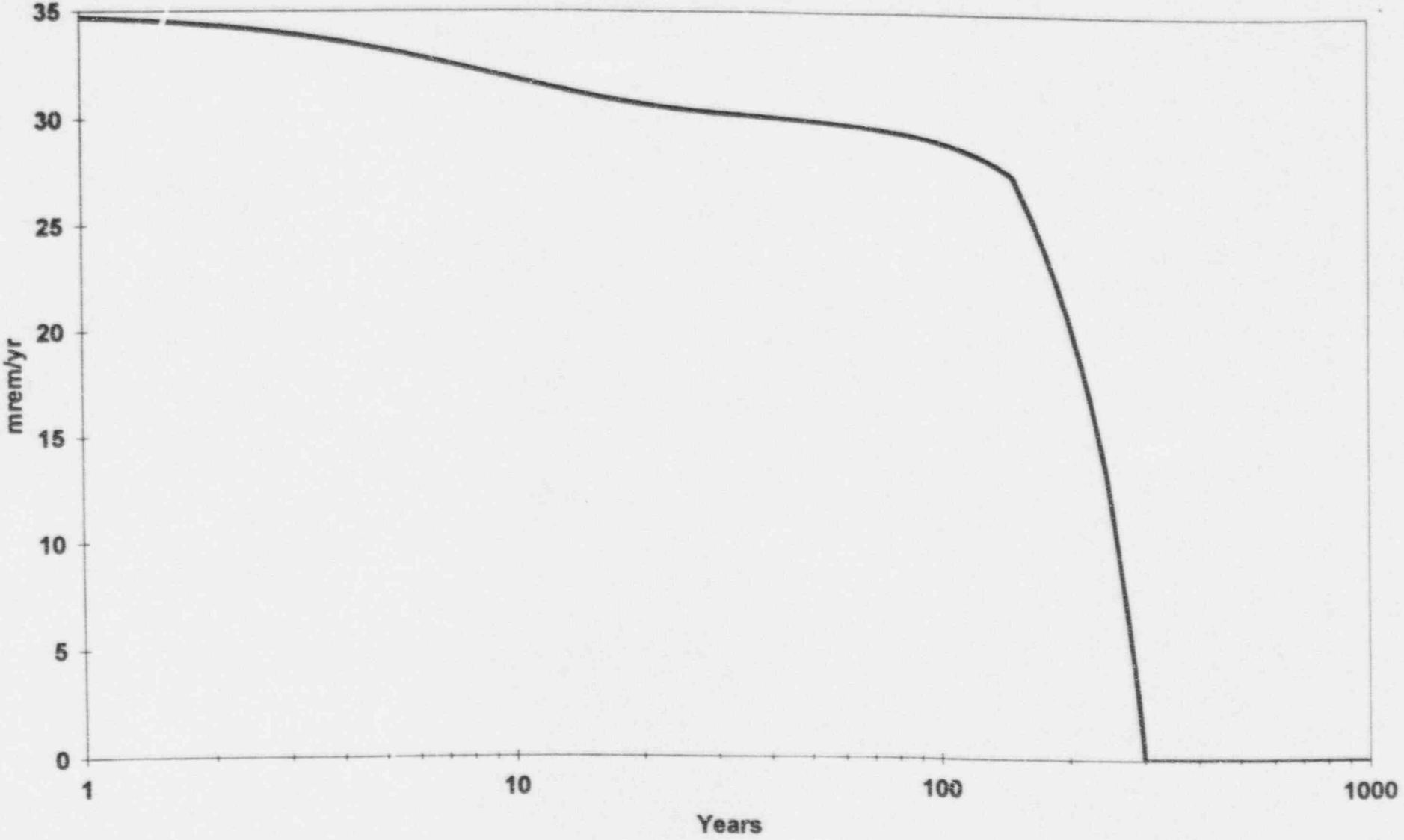
Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	100.00 square meters	Ra-228	5.000E+00
Thickness:	0.30 meters	Th-228	5.000E+00
Cover Depth:	0.00 meters	Th-232	5.000E+00

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 30 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
TDOSE(t):	3.319E+01	3.292E+01	3.223E+01	3.025E+01	2.875E+01	2.756E+01	1.255E-06	9.366E-08
M(t):	1.106E+00	1.097E+00	1.074E+00	1.008E+00	9.583E-01	9.188E-01	4.183E-08	3.122E-09

Maximum TDOSE(t): 3.319E+01 mrem/yr at t = 0.000E+00 years

Dose for All Radionuclides



FAULTER.RAD 01/14/97 Includes All Pathways

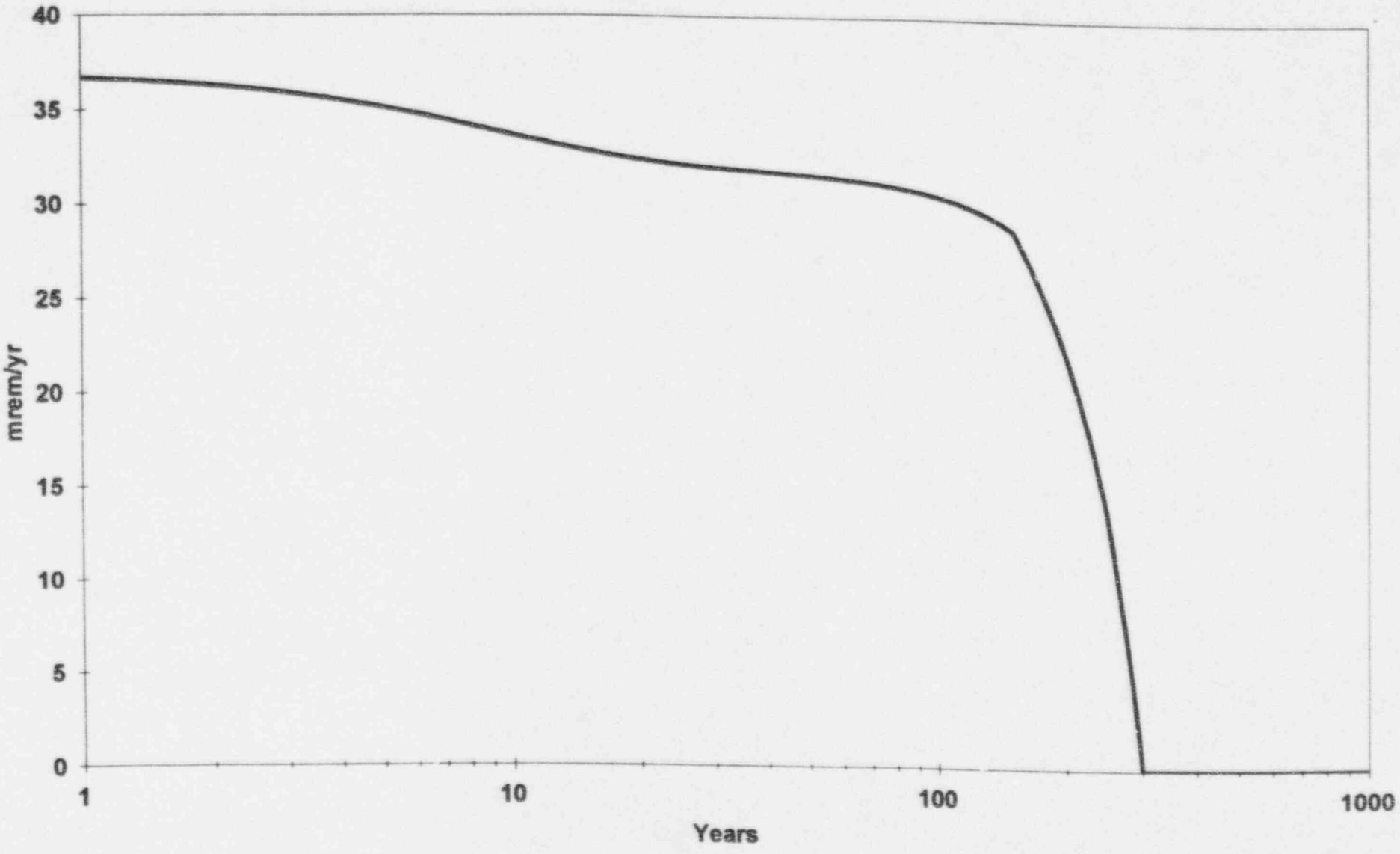
Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	150.00 square meters	Ra-228	5.000E+00
Thickness:	0.30 meters	Th-228	5.000E+00
Cover Depth:	0.00 meters	Th-232	5.000E+00

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 30 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
TDOSE(t):	3.499E+01	3.470E+01	3.397E+01	3.187E+01	3.029E+01	2.902E+01	1.558E-06	1.163E-07
M(t):	1.166E+00	1.157E+00	1.132E+00	1.062E+00	1.010E+00	9.672E-01	5.194E-08	3.877E-09

Maximum TDOSE(t): 3.499E+01 mrem/yr at t = 0.000E+00 years

Dose for All Radionuclides



FAUVER.RAD 10/22/96 Includes All Pathways

Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	225.00 square meters	Ra-228	5.000E+00
Thickness:	0.30 meters	Th-228	5.000E+00
Cover Depth:	0.00 meters	Th-232	5.000E+00

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 30 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
TDOSE(t):	3.699E+01	3.668E+01	3.590E+01	3.368E+01	3.199E+01	3.058E+01	2.895E-07	2.160E-08
M(t):	1.233E+00	1.223E+00	1.197E+00	1.123E+00	1.066E+00	1.019E+00	9.650E-09	7.201E-10

Maximum TDOSE(t): 3.699E+01 mrem/yr at t = 0.000E+00 years

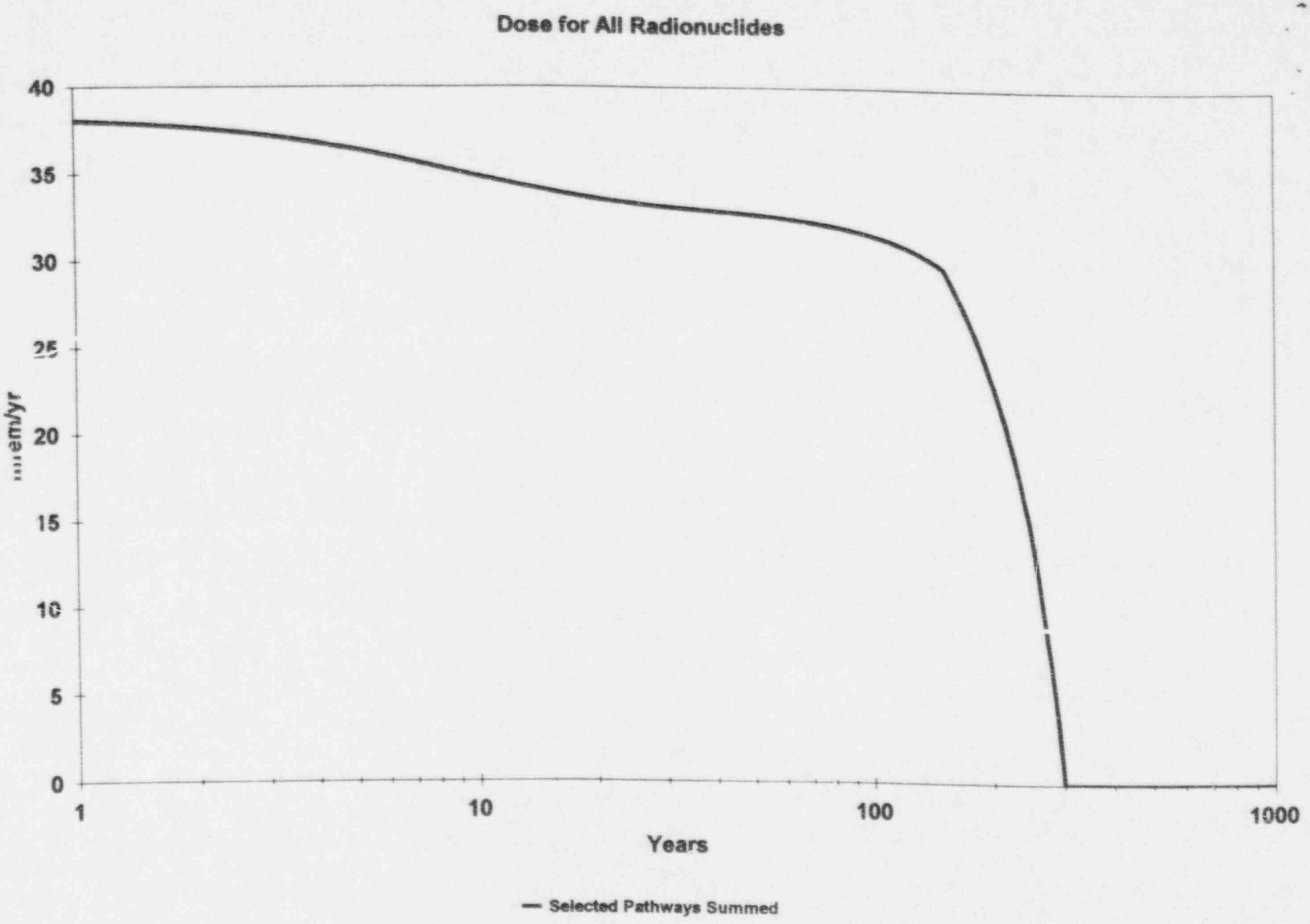
Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years
Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-228	9.869E+00	0.2668	2.158E-02	0.0006	0.000E+00	0.0000	1.904E+00	0.0515	7.071E-03	0.0002	9.910E-03	0.0003	2.247E-02	0.0006
Th-228	1.655E+01	0.4474	1.466E+00	0.0396	0.000E+00	0.0000	2.691E-02	0.0007	1.469E-04	0.0000	1.178E-05	0.0000	1.261E-02	0.0003
Th-232	9.030E-04	0.0000	6.968E+00	0.1883	0.000E+00	0.0000	9.213E-02	0.0025	5.072E-04	0.0000	3.990E-05	0.0000	4.260E-02	0.0012
Total	2.642E+01	0.7142	8.455E+00	0.2285	0.000E+00	0.0000	2.023E+00	0.0547	7.725E-03	0.0002	9.961E-03	0.0003	7.768E-02	0.0021

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years
Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.183E+01	0.3199
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.806E+01	0.4881
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.104E+00	0.1920
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.699E+01	1.0000

*Sum of all water independent and dependent pathways.


Dose for All Radionuclides
40
35
30
25
20
15
10
5
0
mrem/yr
1
10
100
1000
Years
Selected Pathways Summed
FAUVER.RAD 10/22/96 Includes All Pathways

Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	300.00 square meters	Ra-228	5.000E+00
Thickness:	0.30 meters	Th-228	5.000E+00
Cover Depth:	0.00 meters	Th-232	5.000E+00

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 30 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
TDOSE(t):	3.833E+01	3.801E+01	3.719E+01	3.487E+01	3.310E+01	3.155E+01	3.917E-07	2.923E-08
M(t):	1.278E+00	1.267E+00	1.240E+00	1.162E+00	1.103E+00	1.052E+00	1.306E-08	9.742E-10

Maximum TDOSE(t): 3.833E+01 mrem/yr at t = 0.000E+00 years

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years
Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-228	1.002E+01	0.2615	2.208E-02	0.0006	0.000E+00	0.0000	2.539E+00	0.0662	9.429E-03	0.0002	1.321E-02	0.0003	2.996E-02	0.0008
Th-228	1.684E+01	0.4392	1.499E+00	0.0391	0.000E+00	0.0000	3.590E-02	0.0009	1.958E-04	0.0000	1.570E-05	0.0000	1.681E-02	0.0004
Th-232	9.119E-04	0.0000	7.127E+00	0.1859	0.000E+00	0.0000	1.229E-01	0.0032	6.763E-04	0.0000	5.320E-05	0.0000	5.680E-02	0.0015
Total	2.686E+01	0.7007	8.648E+00	0.2256	0.000E+00	0.0000	2.698E+00	0.0704	1.030E-02	0.0003	1.328E-02	0.0003	1.036E-01	0.0027

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years
Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.264E+01	0.3297
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.839E+01	0.4797
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.308E+00	0.1906
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.833E+01	1.0000

*Sum of all water independent and dependent pathways.

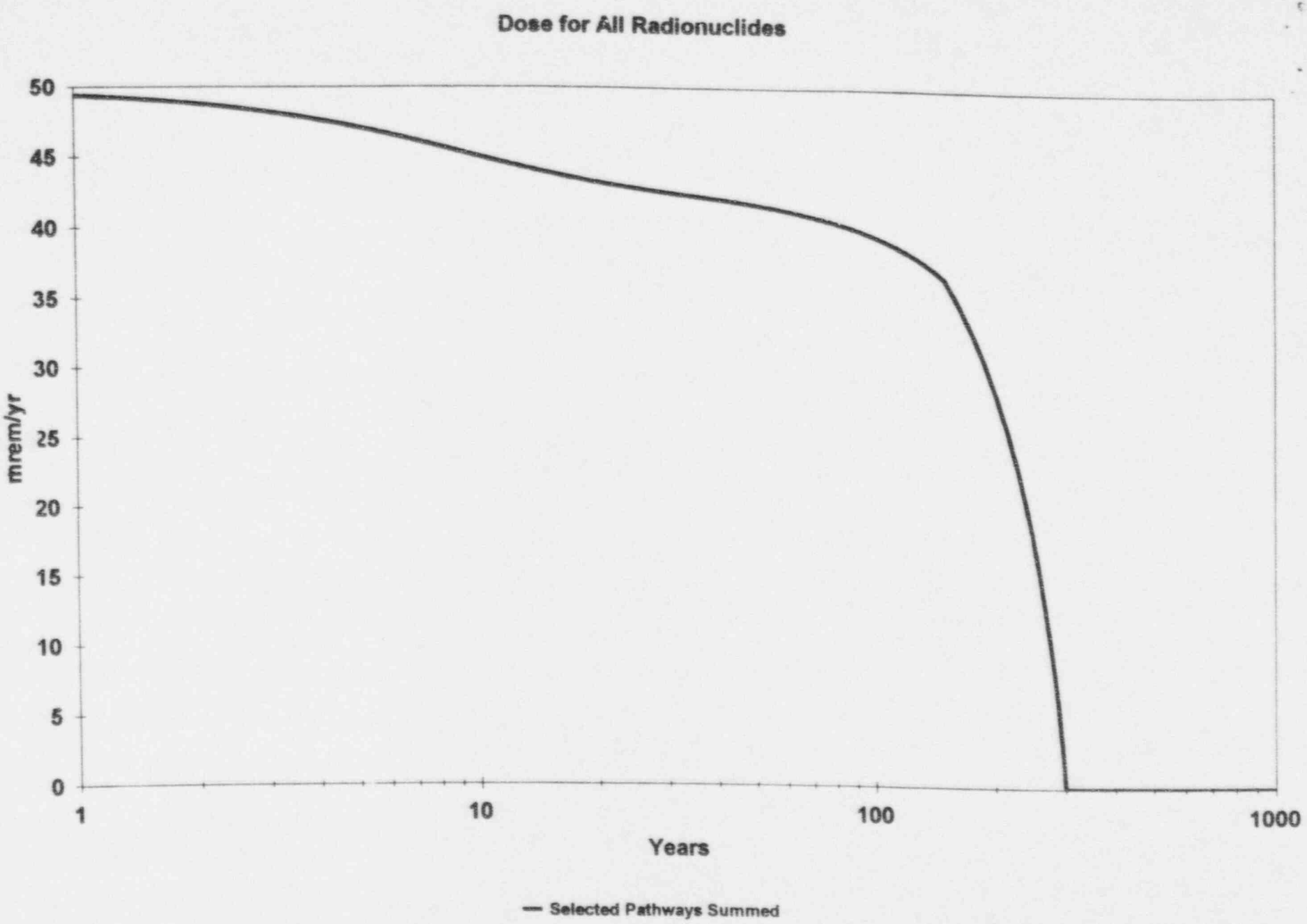

Dose for All Radionuclides
50
45
40
35
30
25
20
15
10
5
0
mrem/yr
1
10
100
1000
Years
— Selected Pathways Summed
FAUVER.RAD 10/22/96 Includes All Pathways

Table of Contents

Part I: Mixture Sums and Single Radionuclide Guidelines

Dose Conversion Factor (and Related) Parameter Summary
File: DOSFAC.BIN

Menu	Parameter	Current Value	Default	Parameter Name
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Ra-228+D	5.080E-03	5.060E-03	DCF2(1)
B-1	Th-228+D	3.450E-01	3.450E-01	DCF2(2)
B-1	Th-232	1.640E+00	1.640E+00	DCF2(3)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Ra-228+D	1.440E-03	1.440E-03	DCF3(1)
D-1	Th-228+D	8.080E-04	8.080E-04	DCF3(2)
D-1	Th-232	2.730E-03	2.730E-03	DCF3(3)
D-34	Food transfer factors:			
D-34	Ra-228+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(1,1)
D-34	Ra-228+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(1,2)
D-34	Ra-228+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(1,3)
D-34				
D-34	Th-228+D , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(2,1)
D-34	Th-228+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(2,2)
D-34	Th-228+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(2,3)
D-34				
D-34	Th-232 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(3,1)
D-34	Th-232 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(3,2)
D-34	Th-232 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(3,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Ra-228+D , fish	5.000E+01	5.000E+01	BIOFAC(1,1)
D-5	Ra-228+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(1,2)
D-5				
D-5	Th-228+D , fish	1.000E+02	1.000E+02	BIOFAC(2,1)
D-5	Th-228+D , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(2,2)
D-5				
D-5	Th-232 , fish	1.000E+02	1.000E+02	BIOFAC(3,1)
D-5	Th-232 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(3,2)

Site-Specific Parameter Summary

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	1.000E+04	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	3.000E-01	2.000E+00	---	THICK0
R011	Length parallel to aquifer flow (m)	1.000E+02	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	3.000E+01	3.000E+01	---	BRDL
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E+00	1.000E+00	---	T(2)
R011	Times for calculations (yr)	3.000E+00	3.000E+00	---	T(3)
R011	Times for calculations (yr)	1.000E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	3.000E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	1.000E+02	1.000E+02	---	T(6)
R011	Times for calculations (yr)	3.000E+02	3.000E+02	---	T(7)
R011	Times for calculations (yr)	1.000E+03	1.000E+03	---	T(8)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(9)
		not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): Ra-228	5.000E+00	0.000E+00	---	S1(1)
R012	Initial principal radionuclide (pCi/g): Th-228	5.000E+00	0.000E+00	---	S1(2)
R012	Initial principal radionuclide (pCi/g): Th-232	5.000E+00	0.000E+00	---	S1(3)
R012	Concentration in groundwater (pCi/L): Ra-228	not used	0.000E+00	---	W1(1)
R012	Concentration in groundwater (pCi/L): Th-228	not used	0.000E+00	---	W1(2)
R012	Concentration in groundwater (pCi/L): Th-232	not used	0.000E+00	---	W1(3)
R013	Cover depth (m)	0.000E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	not used	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	not used	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.630E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	1.000E-03	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	3.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone effective porosity	2.000E-01	2.000E-01	---	EPCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	1.000E+01	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	5.300E+00	5.300E+00	---	BCZ
R013	Humidity in air (g/cm**3)	not used	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	5.000E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	1.000E+00	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	7.600E-01	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	2.000E-01	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	1.000E+06	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	1.000E-03	1.000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	1.630E+00	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	3.000E-01	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	2.000E-01	2.000E-01	---	EPSZ
R014	Saturated zone hydraulic conductivity (m/yr)	1.000E+02	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	2.000E-02	2.000E-02	---	HGWT
R014	Saturated zone b parameter	5.300E+00	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	0.000E+00	1.000E-03	---	VWT
R014	Well pump intake depth (m below water table)	1.000E+01	1.000E+01	---	DWIBWT
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	ND	ND	---	MODEL
R014	Well pumping rate (m**3/yr)	2.500E+02	2.500E+02	---	UW

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R015	Number of unsaturated zone strata	1	1	---	NS
R015	Unsat. zone 1, thickness (m)	1.000E+00	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	1.630E+00	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	3.000E-01	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	2.000E-01	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	5.300E+00	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	1.000E+01	1.000E+01	---	HCUZ(1)
R016	Distribution coefficients for Ra-228				
R016	Contaminated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCU(1,1)
R016	Saturated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.274E-02	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R016	Distribution coefficients for Th-228				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(2)
R016	Unsaturated zone 1 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCU(2,1)
R016	Saturated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.658E-05	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R016	Distribution coefficients for Th-232				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(3)
R016	Unsaturated zone 1 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCU(3,1)
R016	Saturated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.658E-05	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)
R017	Inhalation rate (m**3/yr)	1.051E+04	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	2.000E-04	2.000E-04	---	MLINH
R017	Dilution length for airborne dust, inhalation (m)	3.000E+00	3.000E+00	---	LH
R017	Exposure duration	3.000E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	5.000E-01	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	3.300E-01	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	5.500E-01	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	2.100E-01	2.500E-01	---	FOTD
R017	Shape factor flag, external gamma	1.000E+00	1.000E+00	1 shows circular AREA.	FS

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R017	Radii of shape factor array (used if FS = -1):				
R017	Outer annular radius (m), ring 1:	not used	5.000E+01	---	RAD_SHAPE(1)
R017	Outer annular radius (m), ring 2:	not used	7.071E+01	---	RAD_SHAPE(2)
R017	Outer annular radius (m), ring 3:	not used	0.000E+00	---	RAD_SHAPE(3)
R017	Outer annular radius (m), ring 4:	not used	0.000E+00	---	RAD_SHAPE(4)
R017	Outer annular radius (m), ring 5:	not used	0.000E+00	---	RAD_SHAPE(5)
R017	Outer annular radius (m), ring 6:	not used	0.000E+00	---	RAD_SHAPE(6)
R017	Outer annular radius (m), ring 7:	not used	0.000E+00	---	RAD_SHAPE(7)
R017	Outer annular radius (m), ring 8:	not used	0.000E+00	---	RAD_SHAPE(8)
R017	Outer annular radius (m), ring 9:	not used	0.000E+00	---	RAD_SHAPE(9)
R017	Outer annular radius (m), ring 10:	not used	0.000E+00	---	RAD_SHAPE(10)
R017	Outer annular radius (m), ring 11:	not used	0.000E+00	---	RAD_SHAPE(11)
R017	Outer annular radius (m), ring 12:	not used	0.000E+00	---	RAD_SHAPE(12)
R017	Fractions of annular areas within AREA:				
R017	Ring 1	not used	1.000E+00	---	
R017	Ring 2	not used	2.732E-01	---	FRACA(1)
R017	Ring 3	not used	0.000E+00	---	FRACA(2)
R017	Ring 4	not used	0.000E+00	---	FRACA(3)
R017	Ring 5	not used	0.000E+00	---	FRACA(4)
R017	Ring 6	not used	0.000E+00	---	FRACA(5)
R017	Ring 7	not used	0.000E+00	---	FRACA(6)
R017	Ring 8	not used	0.000E+00	---	FRACA(7)
R017	Ring 9	not used	0.000E+00	---	FRACA(8)
R017	Ring 10	not used	0.000E+00	---	FRACA(9)
R017	Ring 11	not used	0.000E+00	---	FRACA(10)
R017	Ring 12	not used	0.000E+00	---	FRACA(11)
					FRACA(12)
R018	Fruits, vegetables and grain consumption (kg/yr)	1.660E+02	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	1.10E+01	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	1.000E+02	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	6.300E+01	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	5.400E+00	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	9.000E-01	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	1.825E+01	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	7.300E+02	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	1.000E+00	1.000E+00	---	FDW
R018	Contamination fraction of household water	not used	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	1.000E+00	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	1.000E+00	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	5.000E-01	5.000E-01	---	FR9
R018	Contamination fraction of plant food	-1	-1	0.500E+00	FPLANT
R018	Contamination fraction of meat	-1	-1	0.500E+00	FMEAT
R018	Contamination fraction of milk	-1	-1	0.500E+00	FMILK
R019	Livestock fodder intake for meat (kg/day)	6.800E+01	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	5.500E+01	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	5.000E+01	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	1.600E+02	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	5.000E-01	5.000E-01	---	LSI
R019	Mass loading for foliar deposition (g/m**3)	1.000E-04	1.000E-04	---	MLFD

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
RC19	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
RC19	Depth of roots (m)	9.000E-01	9.000E-01	---	DROOT
RC19	Drinking water fraction from ground water	1.000E+00	1.000E+00	---	FGWDW
RC19	Household water fraction from ground water	1.000E+00	1.000E+00	---	FGWHH
RC19	Livestock water fraction from ground water	not used	1.000E+00	---	FGWLW
RC19	Irrigation fraction from ground water	1.000E+00	1.000E+00	---	FGWIR
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
STOR	Storage times of contaminated foodstuffs (days):				
STOR	Fruits, non-leafy vegetables, and grain	1.400E+01	1.400E+01	---	STOR_T(1)
STOR	Leafy vegetables	1.000E+00	1.000E+00	---	STOR_T(2)
STOR	Milk	1.000E+00	1.000E+00	---	STOR_T(3)
STOR	Meat and poultry	2.000E+01	2.000E+01	---	STOR_T(4)
STOR	Fish	7.000E+00	7.000E+00	---	STOR_T(5)
STOR	Crustacea and mollusks	7.000E+00	7.000E+00	---	STOR_T(6)
STOR	Well water	1.000E+00	1.000E+00	---	STOR_T(7)
STOR	Surface water	1.000E+00	1.000E+00	---	STOR_T(8)
STOR	Livestock fodder	4.500E+01	4.500E+01	---	STOR_T(9)
R021	Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	---	TPCV
R021	Total porosity of the building foundation	not used	1.000E-01	---	TPFL
R021	Volumetric water content of the cover material	not used	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	not used	3.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	not used	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
R021	in contaminated zone soil	not used	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	not used	2.000E+00	---	HMIX
R021	Average annual wind speed (m/sec)	not used	2.000E+00	---	WIND
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	---	REXG
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
R021	Building interior area factor	not used	0.000E+00	---	FAI
R021	Building depth below ground surface (m)	not used	-1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	not used	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)

Summary of Pathway Selections

Pathway	User Selection
1 -- external gamma	active
2 -- inhalation (w/o radon)	active
3 -- plant ingestion	active
4 -- meat ingestion	active
5 -- milk ingestion	active
6 -- aquatic foods	active
7 -- drinking water	active
8 -- soil ingestion	active
9 -- radon	suppressed

Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	10000.00 square meters	Ra-228	5.000E+00
Thickness:	0.30 meters	Th-228	5.000E+00
Cover Depth:	0.00 meters	Th-232	5.000E+00

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 30 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
TDOSE(t):	4.986E+01	4.938E+01	4.821E+01	4.507E+01	4.251E+01	3.955E+01	1.938E-06	1.445E-07
M(t):	1.662E+00	1.646E+00	1.607E+00	1.502E+00	1.417E+00	1.318E+00	6.459E-08	4.817E-09

Maximum TDOSE(t): 4.986E+01 mrem/yr at t = 0.000E+00 years

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years
Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-228	1.112E+01	0.2230	2.515E-02	0.0005	0.000E+00	0.0000	8.463E+00	0.1698	3.143E-01	0.0063	4.405E-01	0.0088	9.986E-02	0.0020
Th-228	1.876E+01	0.3763	1.708E+00	0.0343	0.000E+00	0.0000	1.199E-01	0.0024	6.531E-03	0.0001	5.237E-04	0.0000	5.603E-02	0.0011
Th-232	9.864E-04	0.0000	8.118E+00	0.1628	0.000E+00	0.0000	4.106E-01	0.0082	2.255E-02	0.0005	1.774E-03	0.0000	1.893E-01	0.0038
Total	2.988E+01	0.5993	9.851E+00	0.1976	0.000E+00	0.0000	8.994E+00	0.1804	3.434E-01	0.0069	4.428E-01	0.0089	3.452E-01	0.0069

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years
Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.046E+01	0.4104
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.065E+01	0.4142
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.743E+00	0.1754
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.986E+01	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years
Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-228	1.492E+01	0.3022	5.033E-01	0.0102	0.000E+00	0.0000	7.396E+00	0.1498	2.771E-01	0.0056	3.813E-01	0.0077	1.023E-01	0.0021
Th-228	1.306E+01	0.2644	1.189E+00	0.0241	0.000E+00	0.0000	8.321E-02	0.0017	4.545E-03	0.0001	3.645E-04	0.0000	3.900E-02	0.0008
Th-232	1.597E+00	0.0323	8.152E+00	0.1651	0.000E+00	0.0000	1.367E+00	0.0277	5.845E-02	0.0012	5.129E-02	0.0010	2.016E-01	0.0041
Total	2.957E+01	0.5989	9.844E+00	0.1994	0.000E+00	0.0000	8.846E+00	0.1791	3.401E-01	0.0069	4.330E-01	0.0088	3.429E-01	0.0069

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years
Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.358E+01	0.4776
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.437E+01	0.2910
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.143E+01	0.2314
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.938E+01	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years
Water Independent Pathways (Inhalation exclude: radon)

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-228	1.695E+01	0.3516	9.015E-01	0.0187	0.000E+00	0.0000	5.553E+00	0.1152	2.091E-01	0.0043	2.854E-01	0.0059	9.402E-02	0.0020
Th-228	6.323E+00	0.1312	5.759E-01	0.0119	0.000E+00	0.0000	4.005E-02	0.0008	2.201E-03	0.0000	1.765E-04	0.0000	1.890E-02	0.0004
Th-232	5.546E+00	0.1150	8.332E+00	0.1728	0.000E+00	0.0000	2.903E+00	0.0602	1.165E-01	0.0024	1.307E-01	0.0027	2.255E-01	0.0047
Total	2.882E+01	0.5978	9.809E+00	0.2035	0.000E+00	0.0000	8.495E+00	0.1762	3.278E-01	0.0068	4.163E-01	0.0086	3.384E-01	0.0070

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years
Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.399E+01	0.4977
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.960E+00	0.1444
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.725E+01	0.3579
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.821E+01	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years
Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-228	9.213E+00	0.2044	6.046E-01	0.0134	0.000E+00	0.0000	2.007E+00	0.0445	7.662E-02	0.0017	1.033E-01	0.0023	4.347E-02	0.0010
Th-228	4.997E-01	0.0111	4.558E-02	0.0010	0.000E+00	0.0000	3.097E-03	0.0001	1.741E-04	0.0000	1.396E-05	0.0000	1.496E-03	0.0000
Th-232	1.692E+01	0.3754	9.026E+00	0.2003	0.000E+00	0.0000	5.737E+00	0.1273	2.256E-01	0.0050	2.789E-01	0.0062	2.826E-01	0.0063
Total	2.663E+01	0.5909	9.676E+00	0.2147	0.000E+00	0.0000	7.747E+00	0.1719	3.024E-01	0.0067	3.822E-01	0.0085	3.276E-01	0.0073

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years
Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.205E+01	0.2673
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.500E-01	0.0122
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.247E+01	0.7205
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.507E+01	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years
Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-228	5.683E-01	0.0134	3.867E-02	0.0009	0.000E+00	0.0000	1.067E-01	0.0025	4.194E-03	0.0001	5.648E-03	0.0001	2.615E-03	0.0001
Th-228	3.540E-06	0.0000	3.247E-05	0.0000	0.000E+00	0.0000	2.057E-06	0.0000	1.237E-07	0.0000	9.924E-09	0.0000	1.065E-06	0.0000
Th-232	2.449E+01	0.5760	9.536E+00	0.2243	0.000E+00	0.0000	6.823E+00	0.1605	2.750E-01	0.0065	3.463E-01	0.0081	3.181E-01	0.0075
Total	2.506E+01	0.5894	9.574E+00	0.2252	0.000E+00	0.0000	6.930E+00	0.1630	2.792E-01	0.0066	3.519E-01	0.0083	3.207E-01	0.0075

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years
Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.261E-01	0.0171
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.897E-04	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.179E+01	0.9829
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.251E+01	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years
Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-228	2.413E-05	0.0000	1.706E-06	0.0000	0.000E+00	0.0000	3.485E-06	0.0000	1.565E-07	0.0000	2.125E-07	0.0000	1.153E-07	0.0000
Th-228	3.276E-15	0.0000	3.134E-16	0.0000	0.000E+00	0.0000	1.482E-17	0.0000	1.182E-18	0.0000	9.501E-20	0.0000	1.028E-17	0.0000
Th-232	2.403E+01	0.6075	9.550E+00	0.2415	0.000E+00	0.0000	5.115E+00	0.1293	2.378E-01	0.0060	2.994E-01	0.0076	3.197E-01	0.0081
Total	2.403E+01	0.6075	9.550E+00	0.2415	0.000E+00	0.0000	5.115E+00	0.1293	2.378E-01	0.0060	2.994E-01	0.0076	3.197E-01	0.0081

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years
Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-228	9.812E-07	0.0000	3.332E-09	0.0000	0.000E+00	0.0000	1.942E-07	0.0000	2.154E-08	0.0000	3.585E-08	0.0000	3.104E-05	0.0000
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.615E-15	0.0000
Th-232	1.484E-07	0.0000	5.020E-10	0.0000	0.000E+00	0.0000	2.937E-08	0.0000	3.260E-09	0.0000	5.424E-09	0.0000	3.955E+01	1.0000
Total	1.130E-06	0.0000	3.834E-09	0.0000	0.000E+00	0.0000	2.235E-07	0.0000	2.480E-08	0.0000	4.127E-08	0.0000	3.955E+01	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years
Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years
Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-228	5.656E-16	0.0000	1.922E-18	0.0000	0.000E+00	0.0000	1.119E-16	0.0000	1.240E-17	0.0000	2.064E-17	0.0000	7.124E-16	0.0000
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	1.537E-06	0.7931	5.220E-09	0.0027	0.000E+00	0.0000	3.059E-07	0.1579	3.372E-08	0.0174	5.612E-08	0.0290	1.938E-06	1.0000
Total	1.537E-06	0.7931	5.220E-09	0.0027	0.000E+00	0.0000	3.059E-07	0.1579	3.372E-08	0.0174	5.612E-08	0.0290	1.938E-06	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years
Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years
Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	1.147E-07	0.7938	3.882E-10	0.0027	0.000E+00	0.0000	2.270E-08	0.1571	2.519E-09	0.0174	4.194E-09	0.0290	1.445E-07	1.0000
Total	1.147E-07	0.7938	3.882E-10	0.0027	0.000E+00	0.0000	2.270E-08	0.1571	2.519E-09	0.0174	4.194E-09	0.0290	1.445E-07	1.0000

*Sum of all water independent and dependent pathways.

Dose/Source Ratios Summed Over All Pathways
Parent and Progeny Principal Radionuclide Contributions Indicated

Parent (i)	Product (j)	Branch Fraction	t=	DSR(j,t) (mrem/yr)/(pCi/g) 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Ra-228	Ra-228	1.000E+00		4.092E+00	3.541E+00	2.650E+00	9.618E-01	5.307E-02	2.300E-06	1.423E-16	0.000E+00
Ra-228	Th-228	1.000E+00		0.000E+00	1.176E+00	2.148E+00	1.448E+00	9.216E-02	3.908E-06	2.105E-19	0.000E+00
Ra-228	ΣDSR(j)			4.092E+00	4.716E+00	4.798E+00	2.410E+00	1.452E-01	6.208E-06	1.425E-16	0.000E+00
Th-228	Th-228	1.000E+00		4.130E+00	2.874E+00	1.392E+00	1.100E-01	7.794E-05	7.231E-16	0.000E+00	0.000E+00
Th-232	Th-232	1.000E+00		1.749E+00	1.748E+00	1.748E+00	1.745E+00	1.739E+00	1.717E+00	0.000E+00	0.000E+00
Th-232	Ra-228	1.000E+00		0.000E+00	4.591E-01	1.198E+00	2.582E+00	3.239E+00	2.878E+00	3.867E-07	2.890E-08
Th-232	Th-228	1.000E+00		0.000E+00	7.787E-02	5.053E-01	2.167E+00	3.379E+00	3.314E+00	8.028E-10	0.000E+00
Th-232	ΣDSR(j)			1.749E+00	2.285E+00	3.451E+00	6.494E+00	8.357E+00	7.910E+00	3.875E-07	2.890E-08

Branch Fraction is the cumulative factor for the j'th principal radionuclide daughter: CUMBRF(j) = BRF(1)*BRF(2)* ... BRF(j).
The DSR includes contributions from associated (half-life ≤ 0.5 yr) daughters.

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 30 mrem/yr

Nuclide (i)	t=	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Ra-228		7.331E+00	6.361E+00	6.252E+00	1.245E+01	2.066E+02	4.832E+06	*2.726E+14	*2.726E+14
Th-228		7.264E+00	1.044E+01	2.155E+01	2.727E+02	3.849E+05	*8.192E+14	*8.192E+14	*8.192E+14
Th-232		1.716E+01	1.313E+01	8.694E+00	4.620E+00	3.590E+00	3.793E+00	*1.096E+05	*1.096E+05

*At specific activity limit

Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
at tmin = time of minimum single radionuclide soil guideline
and at tmax = time of maximum total dose = 0.000E+00 years

Nuclide (i)	Initial pCi/g	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
Ra-228	5.000E+00	2.070 ± 0.002	4.893E+00	6.132E+00	4.092E+00	7.331E+00
Th-228	5.000E+00	0.000E+00	4.130E+00	7.264E+00	4.130E+00	7.264E+00
Th-232	5.000E+00	36.29 ± 0.04	8.386E+00	3.577E+00	1.749E+00	1.716E+01

Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated
DOSE(j,t), mrem/yr

Nuclide (j)	Parent (i)	BRF(i)	t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Ra-228	Ra-228	1.000E+00	2.046E+01	1.770E+01	1.325E+01	4.809E+00	2.654E-01	1.150E-05	7.114E-16	0.000E+00
Ra-228	Th-232	1.000E+00	0.000E+00	2.296E+00	5.988E+00	1.291E+01	1.620E+01	1.439E+01	1.934E-06	1.445E-07
Ra-228	ΣDOSE(j):		2.046E+01	2.000E+01	1.924E+01	1.772E+01	1.646E+01	1.439E+01	1.934E-06	1.445E-07
Th-228	Ra-228	1.000E+00	0.000E+00	5.878E+00	1.074E+01	7.239E+00	4.608E-01	1.954E-05	1.052E-18	0.000E+00
Th-228	Th-228	1.000E+00	2.065E+01	1.437E+01	6.960E+00	5.500E-01	3.897E-04	3.615E-15	0.000E+00	0.000E+00
Th-228	Th-232	1.000E+00	0.000E+00	3.894E-01	2.526E+00	1.084E+01	1.689E+01	1.657E+01	4.014E-09	0.000E+00
Th-228	ΣDOSE(j):		2.065E+01	2.064E+01	2.023E+01	1.862E+01	1.736E+01	1.657E+01	4.014E-09	0.000E+00
Th-232	Th-232	1.000E+00	8.743E+00	8.741E+00	8.738E+00	8.727E+00	8.696E+00	8.586E+00	0.000E+00	0.000E+00

BRF(i) is the branch fraction of the parent nuclide.

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated
S(j,t), pCi/g

Nuclide (j)	Parent (i)	BRF(i)	t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Ra-228	Ra-228	1.000E+00	5.000E+00	4.333E+00	3.253E+00	1.193E+00	6.794E-02	2.994E-06	1.073E-18	0.000E+00
Ra-228	Th-232	1.000E+00	0.000E+00	5.615E-01	1.470E+00	3.202E+00	4.147E+00	4.196E+00	4.174E+00	4.097E+00
Ra-228	ΣS(j):		5.000E+00	4.894E+00	4.723E+00	4.395E+00	4.215E+00	4.196E+00	4.174E+00	4.097E+00
Th-228	Ra-228	1.000E+00	0.000E+00	1.410E+00	2.592E+00	1.753E+00	1.122E-01	4.951E-06	1.775E-18	0.000E+00
Th-228	Th-228	1.000E+00	5.000E+00	3.480E+00	1.686E+00	1.335E-01	9.507E-05	9.175E-16	0.000E+00	0.000E+00
Th-228	Th-232	1.000E+00	0.000E+00	9.251E-02	6.074E-01	2.619E+00	4.109E+00	4.196E+00	4.174E+00	4.097E+00
Th-228	ΣS(j):		5.000E+00	4.982E+00	4.885E+00	4.505E+00	4.222E+00	4.196E+00	4.174E+00	4.097E+00
Th-232	Th-232	1.000E+00	5.000E+00	5.000E+00	5.000E+00	4.999E+00	4.996E+00	4.987E+00	4.960E+00	4.869E+00

BRF(i) is the branch fraction of the parent nuclide.